GOVERNING CLIMATE

The Struggle for a Global Framework Beyond Kyoto

Edited by Taishi Sugiyama

The Fridtjof Nansen Institute

Hamburgisches WeltWirtschafts Institut
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Taishi Sugiyama is the Leader of Climate Policy Project at the Central Research Institute of Electric Power Industry (CRIEPI), Japan. He serves as a member of the IPCC Fourth Assessment Report. He also serves as a member of the Future Framework Committee that made recommendations on a post-2012 framework to the Japanese government, as well as a member of the Market Mechanisms Committee of the Japanese government. He also served on the Small Scale CDM Panel of the CDM Executive Board and the Scientific Steering Committee of the International Human Dimension Program (IHDP)/Institutional Dimensions of Global Environmental Change (IDGEC).

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Introduction

Where to? Future steps for the global climate regime

Taishi Sugiyama

Leader of Climate Policy Project at the Central Research Institute of Electric Power Industry (CRIEPI), Japan

1. Background

How can we further develop international regimes to prevent climate change? We, an international group of researchers, investigated this question in a two-year research project called "Developing Post-2012 Climate Regime Scenarios." This book is the final product.

The Kyoto Protocol under the United Nations Framework Convention on Climate Change (UNFCCC) is an important first step in the development of a truly global climate regime.

Through the Kyoto Protocol, the regime covers a range of gases, as well as emissions from all economic sectors, leading to linkages of multilateral discussions on energy, transportation, forestry, agriculture and broader issues related to trade and investment.

Further, after coming into force in 2005, the importance of Kyoto over the long term is not the specific targets or number of Annex B Parties in the agreement, but that it has set the stage for ongoing international discussions on the issue. One important aspect of the current agreement is that it has now assigned an international market value to carbon. Carbon emissions now carry a price, and will continue to carry one after Kyoto expires in 2012.

That said, it must also be recognized that the regime looks markedly different than what was originally intended, mainly due to the decision of the U.S. to opt out. Moreover, there is no indication that the U.S. is willing to return to the Kyoto fold anytime soon. For future negotiations, views are sharply divided between, and among, developed and developing countries on how best to share the burden of targets. While the Kyoto Protocol calls for another negotiation round, beginning in 2005, to set further targets beyond 2012, countries may consider developing alternatives to the current framework, particularly if the world's largest emitters refuse to re-engage in the Kyoto process.

In the first phase of this two-year project, we developed a range of scenarios that countries may wish to consider for a post-2012 framework, illustrating the many possible futures under which the global climate regime may evolve (Sugiyama 2005). The scenarios include: *Graduation and Deepening*, the strengthening of a binding-cap approach under UNFCCC (Michaelowa, Butzengeiger and Jung 2005); *Converging Markets*, the bottom-up evolution of emission markets on a global scale (Tangen and Hasselknippe 2005); *Orchestra of Treaties*, a regime consisting of multiple treaties among like-minded countries (Sugiyama and Sinton 2005); and *Human Development*, a binding-cap regime with emphasis on equity (Pan 2005).

Building upon the lessons learned in the scenario work, the papers in this book further explore three key building blocks of the future climate regime. First, a number of ideas on how to broaden the current cap-and-trade regime are discussed. Second, the role of technology is explored. Lessons from past successes are reviewed with a view to developing options for their most effective use over the near future. Last, the issue of financial flows to developing countries is addressed, including the issue of mainstreaming assistance for climate-change response.

2. Future of the cap-and-trade regime

Many negotiators seem to think that a new protocol under the UNFCCC, with binding targets and the same flexible instruments as in the Kyoto Protocol, would be the best framework to control and reduce global greenhouse gas emissions. However, to be successful, negotiations will have to overcome significant and entangled challenges, including re-engaging the United States, establishing commitments for developing countries that are stronger than those under the Kyoto Protocol, establishing new emissions targets, and breaking the current atmosphere of suspicion and recrimination that currently exists between developed and developing countries.

Potential modifications to the Kyoto Protocol's approach are discussed by *Tangen, Hasselknippe and Michaelowa*. The ideas include: a procedure for permitting allowances from non-Party trading schemes to be used for compliance; sector targets for developing countries; expanding the scope of Clean Development Mechanism (CDM) investments to cover sectoral, sub-national and/or policy-based activities; target-setting for sectors or whole economies for reductions from estimated baselines, approved by an international review team; and additional eligibility criteria for CDM host countries. In order to break the current stalemate, it will be important that some Parties show leadership. A coalition of like-minded countries, notably those that have already introduced market-based mechanisms, might show leadership by presenting a mandate or plan for future negotiations, and proposing an allocation for these countries for the period after 2012. To be effective, this coalition, like any leading group, should lead by uniting the world, not dividing it.

In terms of targets, the Kyoto Protocol has two major problems: the target-setting was arbitrary and unpredictable; and the targets turned out to be immensely skewed. Some countries, such as Russia, had very "lax" targets while others, such as the U.S., Canada and Japan, took on targets that were beyond their ability to achieve through domestic actions alone. Greater predictability would facilitate more effective goal-achievement, and a model for guiding target-setting could be helpful, although, of course, politics will always play a role in such negotiations. It is worth considering whether a simple and transparent model could be used for developing fair targets in the post-2012 period.

While seriously exploring possible options, *Tangen, Hasselknippe and Michaelowa* admit that it is not likely that the world can implement a perfect cap-and-trade system with global coverage and prices high enough to reverse rising global emissions in the near future. Instead, the cap-and-trade system will likely remain partial in coverage and low in price. Still, even with limited participation and weak targets, it is important that the climate regime maintain the cap-and-trade system so that the institution will develop and demonstrate the environmental effectiveness of the approach, thus convincing other countries to follow suit.

3. Promoting climate technology development

A cap-and-trade regime alone will not be enough to induce the technological innovation that is instrumental to prevent climate change in the long term. The price signal created by the carbon markets is currently between five and 30 € per tonne of CO_2 and it is politically difficult to raise this much higher. At this level, the price signal may foster short-term emission reductions using existing technologies, but it by no means represents a high enough price to justify significant research, development and demonstration (RD&D) investments in nascent technologies. Hence, it is necessary to develop other policy instruments.

A distinctive opportunity lies in international cooperation on technology. If we can successfully reframe the climate issue as the promotion of technologies, there may be more chances for countries to mobilize a large amount of resources towards preventing climate change. The current U.S. administration, for example, has made it clear that it will emphasize technology in fighting greenhouse gas emissions, and has initiated a number of voluntary, technology-centred bilateral and multilateral partnerships.

Taishi Sugiyama, Takahiro Ueno and Jonathan Sinton develop a scenario in which regional or like-minded partners cooperate on climate technologies in their mutual national interests. Their technological choices may differ depending on their respective resource endowments and political concerns, such as security. Examples include cooperation on energy conservation among China, Japan and other Asian countries; geological carbon storage among major fossil-fuel producers such as the U.S., Canada, Norway, Australia, Russia and Saudi Arabia; and wind power among EU and other countries. Once technologies are developed in niche markets and the costs are brought down, they will diffuse to the rest of world through the international interplay of technologies and institutions. A complementary global framework may play a role in legitimizing these activities, to let the countries recognize what their counterparts are doing, to maintain high political salience.

A distinctive feature of the paper is that they put emphasis on niche market creations and market transformations—deployment activities—rather than the basic RD&D projects that have been popular and which have been most closely associated with the term "technology cooperation." There are certain areas where basic RD&D works, but they do not represent the full range of possible technology cooperation. Creation of international niche markets for nascent technologies for renewable energy, carbon sequestration and cutting-edge energy conservation technologies (e.g., hybrid cars and geothermal heat pumps) could lead to rapid technological change. For energy conservation in transport and the residential sector, transforming markets by implementation of energy efficiency standards and labels is a proven and powerful policy, and harmonization of standards among countries could harness powerful synergies.

The latest episode in the development of China's automobile sector is very impressive. Efficiency standards are approaching those of some developed countries, and standards for sport utility vehicles (SUVs) are very ambitious. China's deep concern about its increasing oil imports has made this possible. The development of its regulatory program was assisted by foreign aid, and there are many similar ongoing activities. Further enhancing these activities could have significant impact.

Axel Michaelowa provides case studies on how "green-and-greedy" coalitions are at work in wind power and carbon sequestration technologies in Europe. *Ingvild Andreassen Sæverud and Arild Moe* provide a case study of the Norwegian initiative to develop carbon sequestration technology and international coordination on the legal status of the technologies. While players and national circumstances differ, there are many green-and-greedy coalitions that could bring to market technologies that are essential to cope with global climate change. Understanding their dynamics is a prerequisite for designing an environmentally effective climate regime.

The authors also discuss concerns about the "technology track," including its potential use as a disguise for doing nothing. In such a case, the technology track would be worse than doing nothing because it could create the impression that the countries are serious about climate change and that no further actions are needed.

4. The role of development assistance and investment flows

4.1 Development

Jiahua Pan, Xianli Zhu, and Ying Chen provide a Chinese perspective. In their innovative paper, they define terminology and develop a conceptual framework markedly different from those produced by the climate policy circles of developed countries. They argue that basic human needs are multi-dimensional and that an essential part of human rights is fulfillment of these needs. Economic development builds the material basis for the satisfaction of basic needs, but pursuit of a low-emissions path poses substantial challenges for a developing country like China. Large amounts of energy-intensive investment is needed to accumulate fixed stocks of physical infrastructure and capital as well as durable goods. High levels of energy flows are also required to support daily activities such as cooking, lighting, heating and air-conditioning, in addition to maintenance, operation and renewal of the fixed stocks. In comparison with developed countries, where fixed stocks are already built, a rapidly industrializing China is at the stage of increasing both stocks and flows of carbon.

However, the authors argue, there are approaches to low-carbon development that can substantially reduce emissions without compromising development goals. First, there exist many opportunities for China to contribute positively to building a post-2012 climate regime through no-regrets commitments to greenhouse gas emission reductions, taking energy conservation in the industrial sector as an example. Second, they anticipate that there will be three major vehicles for post-2012 climate negotiations: continuation of the Kyoto Protocol by amendment; negotiation of a new protocol under the UNFCCC; and initiatives outside of the UNFCCC process. In their view, a post-2012 climate regime is likely to consist of a basket of treaties. The Kyoto Protocol aims at emission reductions, and either its amendments or variations will be included in the basket. Developing countries are likely to push for an agreement on adaptation, which would also be included. Elements of a technological treaty are also in their primary stages, covering research, development and deployment of technologies on renewable energy, energy efficiency, and carbon capture and storage. Developing countries have to address climate change issues in the context of sustainable development, so a comprehensive agreement concerning sustainable development, climate change mitigation and adaptation may also be included in the basket of treaties.

4.2 Assistance

John Drexhage argues for "mainstreaming" climate change in international assistance. Developing countries have, for the most part, not identified climate change as an issue of concern to development agencies. A number of analyses have indicated that, while there have been some successful initiatives—particularly those related to supporting G77 and China in preparing their National Communications and, to a lesser extent, helping them develop National Adaptation Strategies—these successes have not spread into "normal" technical assistance. In other words, the strong linkages that do exist between the threat of climate change and poverty eradication and development are still not appreciated on the ground.

He further argues that mainstreaming climate issues with development priorities means paying more attention to the "co-benefits" of climate mitigation and local environments, integration of mitigation and adaptation at project and policy levels, realizing that in many respects, they can be complementary drivers. It also means broadening the scope of current market mechanisms, such as Joint Implementation (JI) and the CDM, to cover sectoral policy and sub-national initiatives. It could also mean finding ways to include developing countries in emissions, or allowance-based, trading.

They also note that it is necessary to be cautious when addressing the challenge of mainstreaming. On both sides, there are concerns that climate-change response is in competition with other development objectives for funding. Recipient nations are worried that existing aid budgets will be cut in order to fund the solution to a "developed country" problem, as the argument came to the fore during the negotiation of use of ODA for CDM. Since current ODA projects are targeted at areas that directly or indirectly support climate change response, there could be ways to resolve these concerns in a constructive manner.

Another caveat is that developed countries' willingness to pay would be insufficient to induce developing countries to choose less carbon-intensive development paths immediately. However, development assistance, with modifications, could catalyze other financial resources and enable developing countries to take further actions themselves.

Felicia Müller-Pelzer and Axel Michaelowa assess 145 renewable energy, energy efficiency and forestry projects financed by German ODA in the last 25 years. They find that about a third of these projects have failed, illustrating the high risks facing project implementation under the CDM. They argue that pre- and post-project evaluation could weed out unsatisfactory approaches.

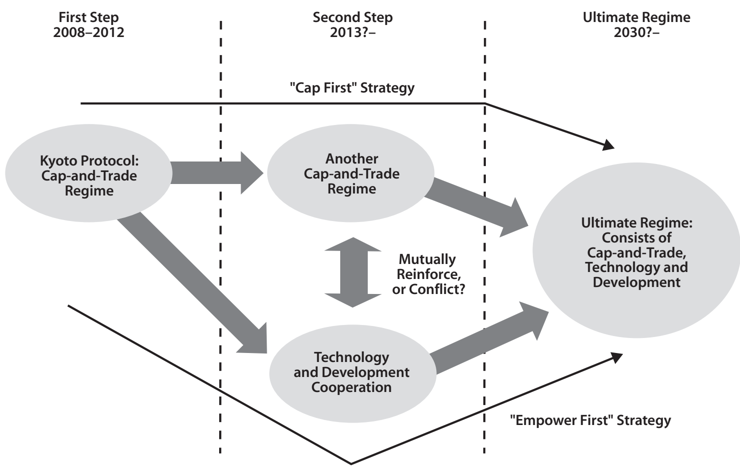
5. Closing remarks

What are the international regimes that can prevent climate change? Ultimately, all members of this scenarios group share the view that, in the long run, a lasting global solution will include three elements: (1) cap-and-trade schemes; (2) agreements for technology development; and (3) assistance packages for developing countries. However, there can be many different ways to reach the goal, and our views on their feasibility and effectiveness are still divided.

One way is to continue the efforts started at Kyoto and to broaden and deepen the current absolute, binding caps. Several ideas to envisage this are debated. This approach assumes that countries have the necessary political will and that international agreements have the teeth necessary to make real change.

Another way to get there is to focus on creating an "enabling environment" for a cap-and-trade regime through technology and development cooperation. Even if effectively implemented, emissions trading will probably not be sufficient and may prove politically unacceptable in some countries, particularly over the short term. Be it *ex ante* or *ex post* to a cap-and-trade regime, it will be critical to effectively deploy technologies. This assumes that countries are not yet ready to commit to binding targets and that reframing climate issues so that they are more carefully embedded in countries' other national priorities will be a more effective way to ensure that the climate regime will be economically and environmentally effective in the long run.

Figure 1. "Cap First" and "Empower First" strategy of the future climate regime



These two strategies, named, respectively, "Cap First" and "Empower First" are summarized in Figure 1. They may either be mutually reinforcing or conflicting. Caution is necessary to ensure that technology and development cooperation do not dilute political attention to climate change, and that the cap-and-trade regime does not cripple technology and development cooperation by creating an adversarial negotiation atmosphere.

European countries will be the key players in setting the tone of the upcoming negotiations on the post-2012 regime. If they remain within the framework that is comfortable for them so far—competing to cut emissions from 1990 levels—and insist that the rest of the world follow suit, then there will be no chance to make any effective deal. The current framework itself favours Europe while making it difficult for the U.S., Japan and Canada to even cosmetically make ambitious commitments. The choice of framework and the target indicators for commitments are critical for countries to impress their domestic constituencies, and what serves one country well may not suit another. For example, if measuring energy efficiency, Japan would be the best. If measuring R&D and scientific contributions, then the U.S. stands out. It is of utmost importance that negotiators do not try to be the sole winners of a negotiation, but to work toward arrangements where each negotiating party can say it obtained a good deal, thereby inspiring the best efforts from each country.

One danger lies in the adversarial nature of international environmental politics itself. To paint itself as green, a negotiating party may desperately need an enemy of a different colour. By creating a framework that looks fair to itself but which is a non-starter to its counterparts, and by further announcing "ambitious targets" for itself, such a party may keep its popularity with its domestic constituency while actually hindering international coordination of action. We hope that voters in all countries are wise enough to understand that this kind of populism can damage the climate, and ultimately those domestic interests that negotiators serve. Negotiation arenas must be chosen with care so that the negotiators can cooperate to solve the common problems without being pitted against each other.

The authors hope that our efforts may contribute to setting the scene for policymakers and stakeholders to engage in constructive debate and make decisions in the common interest. The story is told that when two disciples asked Confucius if they should immediately do what they thought to be good, he answered, "Yes, do it," to the timid one and, "No, consult your father first," to the arrogant one. He always gave different answers to different disciples based upon his analysis of their characters. In our view, the Kyoto Protocol is a significant first, bold step. The wiser second step should now be undertaken with careful analysis of the characteristics of the myriad alternative paths for international climate policies.

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Part 1: Cap-and-Trade

Modifying Kyoto

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Abstract

The scene is set for negotiations of commitments under the UNFCCC for the period after 2012. This paper discusses how to move these negotiations forward. It argues that a new protocol under the United Nations Framework Convention on Climate Change (UNFCCC), with binding targets and the same flexible instruments as in the Kyoto Protocol, represents the most promising structure for establishing a framework that will control and reduce global greenhouse gas emissions. However, in order to move towards such a framework, negotiations will have to overcome significant and entangled barriers, including: re-engaging the United States; establishing commitments for developing countries that are stronger than those in the Kyoto Protocol; establishing new emission reduction targets; and avoiding stalemates in the negotiations. With the UNFCCC, the Kyoto Protocol and other international agreements as a backdrop, the paper attempts to identify modifications to the Kyoto structure and develop concrete strategies that could move the negotiations forward. The suggested modifications to the Kyoto Protocol include: a procedure for permitting allowances from non-Party trading schemes to be used for compliance; sector targets for developing countries; target setting as reductions from baseline; and additional eligibility criteria for CDM host countries. In order to avoid stalemates, it will be important that some Parties show leadership, and the EU is a natural candidate for this role. The paper concludes by discussing some ways in which the EU might play such a role.

1. Introduction

The international negotiations on climate change are about to enter a new phase. Over the last decade, climate diplomats from all over the world have been pre-occupied with negotiations of the Kyoto Protocol under the UNFCCC and the rules and procedures that will guide its implementation (the Marrakech Accords). The scene is now set for negotiations of commitments after the Kyoto period, i.e., after 2012.

These new negotiations got off to an early start in 2004 during the Tenth Conference of the Parties (COP-10) in Buenos Aires. The conference did not do much in terms of moving the negotiations forward but post-2012 commitments clearly emerged as an (informal) agenda item, and were taken forward in the so-called SOGE meetings (Seminar of Environmental Experts) in May 2005.

While the international negotiations can sometimes appear painfully slow, it is worth bearing in mind that they have covered a lot of ground over the last 10 years.

They have introduced an impressive framework that has the ambition—and, in our view, the potential—to be an effective control of global greenhouse gas emissions. It has also established innovative new mechanisms that have, so far, gone untested in international environmental agreements; mechanisms that currently fundamentally change the landscape of national and international climate politics. This is no small achievement in light of the 189 Parties involved and the central role emissions-generating activities play in industrial economies.

In light of inertia of the negotiation process, the fact that post-2012 commitments actually became a part of the agenda in Buenos Aires—one year ahead of what was scheduled in the Kyoto Protocol[1]—can be seen as a promising sign. However, this does not mean that future negotiations will be easy. On the contrary, in order to establish a truly effective framework for reducing global emissions, the negotiations will have to overcome significant barriers.

The purpose of this paper is to discuss what will be fruitful strategies to overcome the barriers and move toward an effective global framework. We argue that the core of the Kyoto Protocol (binding targets and timetables, and the flexibility mechanisms) represents a sensible and, so far, the only credible framework for moving in that direction. Hence, the question boils down to: how do we modify the Kyoto framework in order to make it broader and more effective?

This question is addressed by looking at four major obstacles:

- The world's largest emitter, the U.S., refuses to discuss future targets and timelines for emission reductions, and it is evident that the current administration is actively trying to convince other countries not to take on future commitments. How might the Kyoto framework be modified in order to increase the chances for constructive engagement with the U.S.?
- The developing countries have, so far, rightly insisted that the industralized countries bear the responsibility for the climate change problem and should lead the way in terms of reducing emissions before developing countries take on emission targets. However, developing countries are not a monolithic block and in terms of per capita income, as well as per capita emissions, a significant number of developing countries have already risen above the level of the less prosperous industrialized countries. As for the period after 2012, one key question is: how can the Kyoto framework be modified to strengthen the commitments for the developing countries?
- At the core of the negotiations of a "Kyoto-style" agreement is the allocation of emission allowances (Assigned Amount Units, or AAUs). The allocation of AAUs was a fairly arbitrary process under Kyoto. How should the allocation be done under future agreements and how can it be better structured?
- Concluding an agreement means getting consensus among the more than 190 Parties that participate in the negotiations, and for whom priorities, knowledge and preferences vary considerably. Hence, the risk of stalemate is imminent. In light of this, how should the negotiations be organized in order to press forward?

1 The Kyoto Protocol, Article 3.9.

We try to shed light on how to overcome these barriers from four strands of insights. First, to the extent it is relevant, we draw lessons from other comparable international negotiation processes. However, it can be argued that the climate change problem is so complex, and that the Kyoto Protocol represents such a new and innovative approach, that the climate negotiations are unprecedented by other international agreements. Hence, the second strand of insights must be a thorough understanding of the dynamics of the climate negotiations, past and present.

Third, as noted above, the mechanisms created by the Kyoto Protocol, i.e., emissions trading, the Clean Development Mechanism and Joint Implementation are likely to have transformative powers that change the political landscape. Hence, insight into the development of the carbon market, emerging from the implementation of the Kyoto Protocol, represents an important input to our discussion of negotiation strategies.

Fourth, and finally, the policy scenarios developed earlier under the project that led to this book, represent a wealth of innovative ideas (Sugiyama 2005). We draw on the insights from developing these policy scenarios, to the extent we believe they are relevant for the main issue in this chapter: how to modify the Kyoto framework in order to move towards a broader framework.

This paper is structured in six sections. First, we discuss the Kyoto Protocol and the Marrakech Accords and argue that they represent a sensible long-term approach for establishing a framework for controlling and reducing global greenhouse gas emissions. Second, we review the current development of the carbon market and speculate what it might mean for future policy-making. Third, the paper assesses how the Kyoto framework might be modified in order to foster constructive engagement with the U.S. Fourth, we discuss how the commitments for developing countries might be expanded. Fifth, we discuss how the allocation under future agreements might be made more predictable and fair. Sixth, we discuss how future negotiations should be organized in order to move forward. To conclude, we draw main policy implications from the analysis.

2. The Kyoto Protocol and the Marrakech Accords

The UNFCCC was established in 1992, with the overriding goal of preventing dangerous anthropogenic interference with the climate system. There was wide agreement on the convention, but it did not set specific targets and timelines for when countries should reduce their greenhouse gas (GHG) emissions. At the Third Meeting of Parties to the UNFCCC in 1997, the Kyoto Protocol (KP) was agreed to in the Japanese city that bears its name. The KP set clear targets and timelines for industrialized countries, requiring them to reduce their emissions by 5.2 per cent by the 2008–2012 period, compared to 1990 levels. The most important part of the KP was the introduction of the flexibility mechanisms; International Emissions Trading (IET) for trade of Assigned Amount Units (AAUs) between countries; the Joint Implementation (JI) procedure for creating tradable credits from emission reductions projects in industrialized countries; and the Clean Development Mechanism (CDM) for credits from reduction projects in developing countries. However, the procedures for making the KP and the flexibility mechanisms operational were still missing, and these came first in 2001, when the so-called Marrakech Accords were agreed. These were the final pieces that were needed in order to start the ratification process, and countries started approving the KP. With Russia's ratification in 2004, the KP entered into force in February 2005.

A number of developments have left the KP very different than what was intended at the outset. First of all, the withdrawal of the United States means that the world's largest national emitter remains on the outside of the agreement. Australia has also decided not to adhere to the agreement, but that is not as important as the American abandonment of the process. The inclusion of significant forestry-related reductions for a number of countries, together with the option for some countries to change their base-year, means that the reductions that will take place under the KP are significantly less than the 5.2 per cent first agreed.

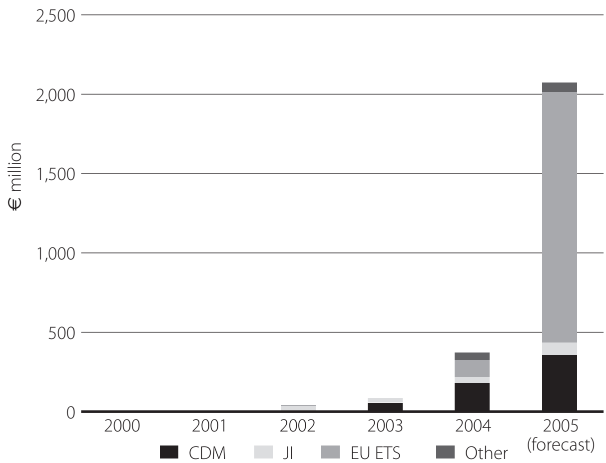
Nevertheless, in our view, the Kyoto Protocol and the Marrakech Accords represent the most sensible approach to dealing with an issue as complex and multifaceted as international climate change. There are several reasons for this. First, the use of targets and timelines is the best way of imposing limits on emissions. Experiences with carbon taxes in European countries suggest that, although they have been reasonably successful in reducing the rate of emissions growth, they have not been able to halt the growth. In fact, in some European countries the carbon taxes play a more important role as revenue raiser for the government than an environmental policy instrument. Second, the use of the flexibility mechanisms ensures that emission reductions will, at least in theory, take place where the costs are least, thus ensuring that the overall costs for the system as a whole will be optimized. Finally, the fact that the combined efforts of a multitude of countries have gone into the negotiation process, and the high number of countries that have actually ratified the agreement (150 states as of April 29, 2005), means that the majority of the countries in the world will find at least some aspects of the agreement that they would also like to maintain in the future.

3. The birth of a global carbon market

The international market for sale and purchase of GHG emission allowances and credits from GHG emission reduction projects has been in operation since the late 1990s. While the carbon market in the early days was dominated by transactions in the North American market, the focus quickly changed to Europe as domestic emissions trading markets were developed in Denmark and the U.K. The EU Emissions Trading Scheme (ETS) came into operation on January 1, 2005, but forward trading in the market had taken place since May 2003. Figure 1 shows the financial size of the different segments of the carbon market, and Point Carbon forecasts for the development of the market in 2005. Figure 2 shows the historical and forecasted development of the physical size of the market.

As shown by the figures, there has been substantial growth in the carbon market in recent years. While 2003 saw 27.8 Mt traded in all market segments, corresponding to a financial value of €83 million, volumes in 2004 had more than tripled, with 94 Mt, or €377 million trading throughout the year. Point Carbon's forecast for 2005 suggests that volumes in all market segments could reach as high as 380 Mt, with the financial size increasing to about €2.1 billion.

Figure 1. Financial size of the international carbon markets, million €

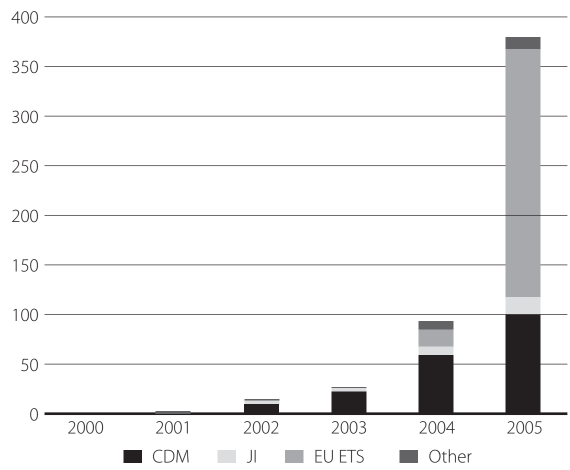


Point Carbon 2:2005

In brief, the data show that a substantial new market is developing. Ensuring the effective operation of these mechanisms will be instrumental in achieving the goals of the Kyoto Protocol. Although the European Union Greenhouse Gas Emission Trading Scheme (EU ETS) is by far the largest and most active of the different market segments, the market is very much an international effort. The CDM ensures that developing countries can participate in the marketplace, bringing a potential 148 host countries into the cooperative effort. Other industrialized countries are also increasingly involved in the market. Canada plans to have a domestic emissions trading system in place by 2008, and Japanese companies are actively pursuing CDM and JI opportunities.

However, we are still a long way from the seamless, global market that was envisaged when the Kyoto Protocol was agreed. The market is still fragmented, and the prices for the different commodities are very different. The lack of one international price for CO_2 is primarily due to the early stage the carbon market is in, and this is expected to change once more market participants trade actively and, equally important, once current delays at the international decision-making level are removed. While the price in the EU ETS has skyrocketed since February 2005, the market breached €20/t in June 2005, there has not been a similar development in the prices for JI and CDM projects. This can be explained by CDM and JI prices reflecting the various risk aspects surrounding such projects. EU Allowances (EUAs) have, in most cases, been issued to the European companies' registry accounts, and the commodity can be bought or sold directly in the market. Certified Emission Reductions (CERs) from CDM projects and Emission Reduction Units (ERUs) from JI projects can only be sold directly once they've been issued, expected in late 2005 for CERs and 2008 for ERUs. Until this has taken place, the investments in CDM and JI will reflect the risks that the project might not result in the required emission reductions after all. At the time of writing, early summer 2005, companies in the EU were paying €6–7 per CER if the seller took most of the performance/delivery risk, while governments and Japanese firms paid €4–6/CER. Sellers that could guarantee delivery of the CERs were reportedly struggling to get €8/CER and tended to hold out for higher bids. Figure 3 shows the daily bid-offer closing price development and the volumes traded for EUAs with delivery in December 2005.

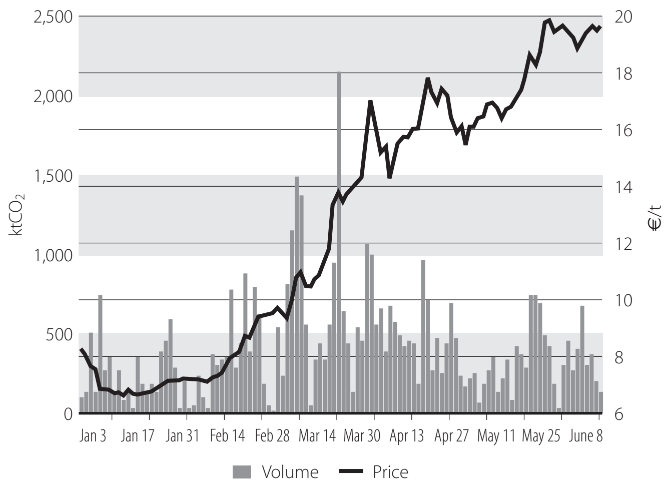
Figure 2. Physical size of the international carbon market, million tonnes CO_2 equivalents



Point Carbon 2:2005

While the carbon market has come about as a result of the international climate change policy development, it is likely that the market will play an important role when it comes to setting the policy agenda in the years to come. As more and more companies and governments throughout the world gain experience from the use of the market, and share their lessons with others that have so far stayed out, it will be easier to develop a market and a policy framework that can aid countries' towards reaching their targets. However, we are not there yet. In order for the market to set the political agenda, it is essential that it operates smoothly and effectively. The project market, in particular, is likely to be prone to politicking also in the years ahead, and thus expected to remain a much smaller segment of the market than the obligatory domestic and regional trading systems. Although the number of emission reduction projects has increased rapidly over the past years, the delays at the international approval levels, where the CDM Executive Board (EB) is the primary entity, means that only a handful of projects have been approved and no CERs have been issued. Figure 4 shows the growth in CDM projects in the most active host countries in 2004. The graph shows that the number of projects grew significantly throughout 2004 in several countries. The growth has continued also in 2005. Point Carbon has a total of 1,293 CDM projects in its database of projects, 297 of these at Project Design Document (PDD) level. However, only seven projects have been registered at the CDM EB to date. For JI projects, the total number of projects is 261, with 108 at PDD level, but the JI Supervisory Committee that will oversee the process has yet to be established.

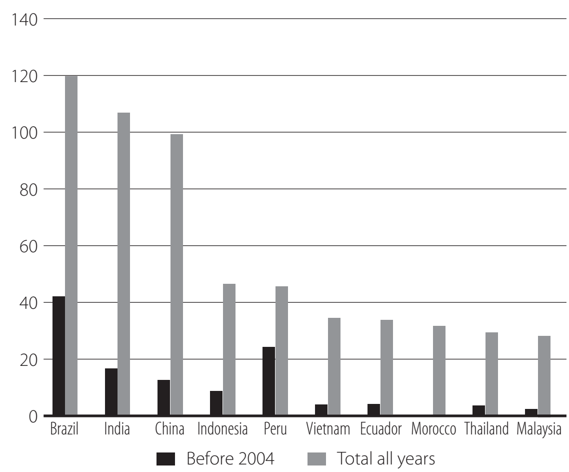
Figure 3. EU prices 2005, €/t



For EU Allowances with delivery in December 2005. Daily bid-offer closing. Volumes reported for the brokered market only.

Source: Point Carbon's Carbon Market Trader

Figure 4. Growth in CDM projects



Number of projects in Point Carbon's database prior to 2004, and total number of projects at end of 2004. (Point Carbon, 1:2005)

Source: Point Carbon's Project Database

While many observers have interpreted the delay of registering projects and issuing credits as a sign that the EB does not function, we feel that this is primarily due to lack of sufficient funding from UNFCCC Member States. In fact, despite the difficulties, we feel that the EB has done an impressive job in creating an intricate market regulator authority. Nevertheless, discussions surrounding the role of CDM in a future climate agreement, and the function of its decision-making body, have the potential to keep potential investors away from the market, thus limiting the use of the project-based flexibility mechanisms in the 2008 to 2012 period.

4. Re-engaging the USA

The opposition from the current U.S. administration to binding emission targets and timetables represents a major obstacle to a broadening of the Kyoto framework. The U.S. is by far the largest emitter in the world and will probably remain on the top at least to 2020.[2] Of course, including the U.S. in a constructive manner is crucial for getting a truly global and efficient mitigation framework in place.

The opposition to the Kyoto Protocol by the Bush administration is partly ideological, but also has to be seen in the light of the tight connections between the administration and the U.S. oil and coal lobby. It is, for example, quite telling that the Global Climate Coalition (GCC)—one of the most vocal groups in the 1990s, lobbying against the Kyoto Protocol on behalf of the U.S. oil and coal industry—disbanded itself in early 2002, after endorsing President Bush's climate policy and praising its focus on technology development and voluntary action.[3]

Also when it comes to the strategy towards the developing world, there is a strong resemblance between the positions of the Bush administration and the U.S. oil and coal industry. President Bush has repeatedly stated that he opposes the Kyoto Protocol because "it exempts 80 per cent of the world."[4] This strange argument, i.e., measuring the climate problem as size of population and not emissions, is a carbon copy of statements previously made by the GCC. Moreover, the strategy of the current U.S. administration is the same as the one employed by the GCC: arguing domestically that the U.S. cannot take on commitments as long as developing countries do not and, at the same time, telling developing countries that they should not take on commitments as this would be crippling to their economic development. Thus, any meaningful action would be prevented. Moreover, in the recent negotiations, the U.S. delegation has consistently opposed suggestions of a negotiation schedule beyond six months ahead, and supported the most watered-down version of official declarations such as the Delhi Declaration, etc.[5]

These findings, in combination with reports of U.S. researchers being harassed by White House representatives for participating in projects looking at long-term climate policy regimes[6]—as well as the lack of a credible U.S. plan for bringing down

2 According to the World Energy Production System (WEPS), available at the website of U.S. DOE/EIA.

3 Press releases from the Global Climate Coalition, quoted by PRwatch.org.

4 See, for example, President Bush's letter to Senator Hagel March 13, 2001, available at the Web site of the White House, http://www.whitehouse.gov.

5 This negotiation strategy was, for example, employed by the current administration at COP-8, COP-9 and COP-10, according to private communications with negotiators.

6 Private communication with U.S. researchers.

domestic emissions—leads to one conclusion: the current U.S. administration is not serious about tackling climate change. Rather, the balance of evidence indicates that the administration has sided with the U.S. industry lobby and is actively trying to fend off future emission targets, not only for the USA, but also for other countries. In light of this, how should countries that are serious about tackling climate change proceed?

It is reasonable to assume that ,at one point in the future, the U.S. government will change and there will be a U.S. administration that is serious about climate change. When this happens, the U.S. is likely to seek international cooperation. After all, global warming is a truly global problem that has to be tackled through international cooperation. Moreover, it is likely that a U.S. administration that is serious about climate change will embrace the core of the Kyoto Protocol; binding targets and emissions trading. These instruments are deeply rooted in the U.S. regulative culture, and key U.S. constituencies (including industry) prefer market-based instruments over other types of environmental instruments, such as direct regulations and taxes. Indeed, in the negotiations leading up to the Kyoto Protocol, the U.S. was pushing some of its most innovative elements such as the Kyoto Mechanisms and a strong compliance regime; the Protocol thus reflects U.S. interests to a large extent. Hence, there are good chances that a U.S. administration that wants to take action on climate change will favour an agreement that is quite similar to the Kyoto Protocol.

Of course, until the U.S. joins a target-based agreement it is unlikely that other countries will agree to very strong future commitments and thus the emission reductions that are achievable will be limited as long as the U.S. does not have commitments. Nevertheless, in order to gain experience, initiate reduction efforts and prepare the scene for a U.S. re-entry, active use and refinement of the Kyoto instruments will be key. If the world can show that the market limits reduction costs, then the U.S. will be more likely to come on board, especially as it can then say that the successful approach was chosen only due to their insistence.

The Kyoto Protocol is by no means the first international treaty that has been rejected by the U.S. Famous victims of the past include the treaty on the League of Nations after the First World War and the International Trade Organization after the Second World War. However, history shows us that these rejections never persisted if there was a clear benefit to the U.S. from an international agreement. The development of the international trade negotiations deserves to be looked at in more detail as it provides an excellent roadmap for the post-2012 climate negotiations.

When the Second World War had ended, there was a consensus that the high trade barriers of the pre-war period had exacerbated the economic depression and led to tensions between nations. Thus, negotiations began quickly with the target to set up an international body to oversee international trade. At Havana in 1947, the charter of the International Trade Organization (ITO) was signed; the proposal to set up the ITO had emanated from the U.S. government. The ITO would have had far-reaching power to oversee violations of the principle of the most-favoured nation clause, coordinate negotiations about tariff reductions and declare when competition would be unfair. Given the U.S.'s economic weight compared to the rest of the world, the isolationist mood in the U.S. after the successful war and the feeling that there was no threat to U.S. supremacy, the ITO treaty failed in the Senate.

The historical analogue fits nicely into the climate negotiations: we have an international problem which is seen as a serious issue and an international treaty is negotiated to address this issue. The U.S. is enjoying unchallenged supremacy and domestic interests manage to convince policy-makers that U.S. freedom to act is impaired by the treaty. Now we can look at the further development of international trade policy.

After ITO had been rejected, the ascendance of Soviet power and the beginning of the Cold War convinced the U.S. that a multilateral strategy was necessary to contain the Soviet Union. Thus, the rapid economic development of the war-ravaged European countries became a priority and ushered in the Marshall Plan. In 1950, the Korean War started and the U.S. was in need of raw material imports. So international trade liberalization became important for the U.S. Quietly, the General Agreement on Tariffs and Trade (GATT), [7] which had survived the ITO disaster, set up a secretariat in Geneva and the first round to negotiate tariff reductions was finalized in the small French resort Annecy in 1949, followed by the second round in the English holiday resort Torquay in 1951. The locations clearly show the low-key nature of the activity. The resounding success of this endeavour led to the emergence of a regime with recurrent multi-year negotiation rounds with an increasingly universal participation. However, only in 1995, was the historical circle closed with the agreement to set up the World Trade Organization (WTO).

What lessons can be drawn from the ITO/GATT story for the international climate regime? First, a U.S. rejection does not mean that the issue is closed forever. If the U.S. perceives its interests are served by international action, it will reconsider its stance fairly quickly. Second, relabelling of an issue is helpful even if contents do not change. Third, a bottom-up approach with trust-building can restore the original top-down approach but this can take decades. Fourth, the principle of multi-year negotiation and commitment rounds is a robust means to address a long-term issue.

The above analysis has implications for how to proceed in the negotiations in the short term, and also some bearings for the design of a post-2012 agreement. However, it is also important to take into account the U.S. behaviour in the previous Kyoto negotiations. Following the withdrawal from the agreement by President Bush, many observers have noted what they have described as the U.S. "sabotaging" the negotiation process. Although much of this has taken place behind closed doors, there are a number of reports substantiating this. In light of this, we'd recommend negotiators to consider the following in the future climate talk rounds:

1. Be skeptical of any official U.S. proposals;
2. To avoid U.S. sabotage, negotiations should take place at COP/MOP, where the U.S. does not have access, and not under the UNFCCC;
3. There should be a new protocol, i.e., not an amendment to the Kyoto Protocol, in order to avoid the negative connotations of the Kyoto Protocol in the U.S. It would be ideal to give the impression that there is a fresh start to international action.

7 Note the absence of any terms denoting a global or international agreement.

4. Cooperate with U.S. researchers who can provide input to what kind of protocol might be palatable to the U.S. in the future to open informal ways of gauging the mood in the U.S.

5. The protocol should be open to using non-party allowances for compliance through a COP/MOP decision. This would strengthen interests within the U.S. that profit from emission reductions and show U.S. constituencies that market mechanisms really work and reduce emissions at low costs.

Regarding the last point, even if the U.S. administration is positive towards an international agreement, it is still questionable whether the U.S. Senate will ratify. This was the case during the Clinton period, where the Kyoto Protocol was first signed by the White House, only to later be turned down by the Senate, as it did not adhere to the principles set out in the Byrd-Hagel resolution, requiring the participation of key developing countries in an agreement. In order to allow for active participation in the event that the U.S. Senate does not ratify, there might be a for the U.S. to participate:

- the COP/MOP can permit allowances from non-parties' trading schemes to be used for compliance; and
- the COP/MOP can allow non-parties to participate in the governing institutions of the protocol, e.g., the CDM EB.

This will make it possible for a future U.S. president to link a domestic U.S. trading scheme to the international one, despite the protocol not being ratified by the U.S. Senate. Hence, the USA would be able to comply with its obligations under a protocol with the full use of the flexibility mechanisms, even if it has not ratified. This is fairly similar to some other international agreements, e.g., Law of the Sea where the U.S. followed much of the content of the law without ever ratifying it.

5. Commitments for developing countries

In the international climate negotiations, the developing countries usually act as one block, the G77/China group. The G77/China will normally take a common position and so far they have strongly resisted commitments for developing countries. Although they have been able to speak with one unified voice in the negotiations, a closer look reveals striking differences among the members of the group.

Some "developing countries" are actually far more developed than many industrialized countries both in terms of per capita income and greenhouse gas emissions. Table 1 shows these countries that are starting to be called "advanced developing countries" in the context of negotiations.

One sees that countries above the average of Annex II (i.e., all OECD countries giving development assistance) combined annual emissions of 0.5 billion t CO_2, a considerable amount but still accounting for only 3.4 per cent of Annex B emissions. If one includes all countries with a per capita income above the level of the poorest Annex B country, expansion would cover 28 per cent of Annex B emissions. Please note that the large emitters, China and India, that have the same emissions level (29 per cent) as all the countries listed in Table 1 have per capita incomes and emissions (2.4 and 0.9 t, respectively) that are much below the lowest Annex B country levels.

Table 1. Income and emissions of advanced developing countries compared to Annex B levels

	GDP/capita	t CO_2/ capita	Emissions (million t CO_2)	Emissions change (%) 1990–2000
Qatar	26,051	60.0	35.1	+150.4
Singapore	22,716	10.5	42.0	+46.0
Average Annex B	**20,218**	**11.2**	**77.1**	**+80.2**
Cyprus	19,197	8.4	6.3	+63.1
Taiwan	18,547	9.7	215.3	+88.9
Israel	18,454	10.0	62.4	+85.8
United Arab Emirates	18,182	23.7	68.7	+68.0
Oman	17,667	9.8	23.5	+120.1
Brunei	16,264	15.0	5.1	+57.8
Malta	15,333	5.8	2.3	-0.9
Lowest Annex II	**15,019**	**3.4**	**460.7**	**+83.3**
Bahamas[1]	15,000	7.5	1.9	NA
Kuwait	14,833	31.5	62.6	+213.1[2]
Barbados[1]	14,500	8.2	2.2	NA
Bahrain	14,203	20.4	14.1	+20.7
Korea	13,790	9.2	433.6	+91.7
Argentina	11,506	3.5	130.2	+33.1
Saudi Arabia	10,452	12.6	260.6	+54.1
Mauritius[3]	9,940	NA	1.8	NA
Chile	8,898	3.2	48.1	+58.9
South Africa	8,754	6.9	295.8	+16.2
Uruguay	8,452	<2.8	5.3	+25.4
Trinidad and Tobago	8,446	11.6	15.1	+38.7
Mexico	8,358	2.6	359.6	+23.1
Malaysia	8,195	4.6	106.1	+123.9
Costa Rica	7,630	<2.8	4.6	+74.3
Botswana[3]	7,170	<2.8	3.1	NA
Brazil	6,949	<2.8	303.3	+57.0
Turkey	6,299	3.1	204.1	+58.4
Thailand	6,020	<2.8	147.2	+89.0
Tunisia	5,986	<2.8	17.8	+45.4
Gabon	5,878	<2.8	1.4	+32.0
Colombia	5,843	<2.8	57.2	+27.8
Namibia	5,744	<2.8	1.9	+55.8[4]
Dominican Republic	5,728	<2.8	17.8	+132.6
Equatorial Guinea[3]	5,600	<2.8	NA	NA
Panama	5,580	<2.8	4.9	+98.8
Iran	5,567	4.6	292.1	+83.7
Venezuela	5,518	5.3	128.6	+25.4
Bosnia and Herzegovina	5,452	3.9	15.4	-21.6[5]

	GDP/capita	t CO_2/ capita	Emissions (million t CO_2)	Emissions change (%) 1990–2000
Kazakhstan	5,194	8.3	122.8	-50.7[5]
Peru	4,518	<2.8	26.4	+37.7
Macedonia	4,729	4.1	8.4	-8.1
El Salvador	4,177	<2.8	5.2	+141.7
Paraguay	4,115	<2.8	3.3	+70.6
Philippines	3,845	<2.8	68.9	+91.4
Guatemala	3,577	<2.8	8.8	+166.5
Turkmenistan	3,548	6.6	34.3	+17.6[5]
Lowest Annex B	**3,528**	**2.8**	**3,766.2**	**+49.6**

1 Data from national communication and World Bank
2 Very low 1990 level due to Iraqi occupation; compared to 1989 level, the increase is only 22.7 per cent
3 Philibert and Pershing (2002) and respective national communications
4 Compared to 1991
5 Compared to 1992

Source: IEA (2002)

As these differences reveal, there is unlikely to be "one-size-fits-all" when it comes to commitments for developing countries. As a consequence, several methodologies have been proposed to differentiate their commitments. One example of such a methodology is the one proposed in the Graduation and Deepening scenario (Michaelowa *et al.* 2005) that builds on a considerable strengthening of Annex B emission targets. Targets for Non-Annex B countries are defined on the base of a concentric ring structure where a graduation index consisting of per capita emissions and per capita GDP is calculated for all Non-Annex B countries. The countries in the inner rings take on more stringent targets than those in the outer rings: countries whose index level is above the Annex B average get Annex B average targets, albeit with a base year of 2012. Countries with an index above the lowest Annex II level get a target which corresponds to the lowest Annex B level, and those above the lowest Annex B level have to stabilize their emissions. Large emitters below this threshold are exempt.

However, as long as the G77/China negotiates as one bloc, they tend to end up with the minimal common denominator: rejection of future commitments. Hence, from a negotiation perspective a main question is how to set up a negotiating process that will end with such differentiation along the lines suggested above. And, what kind of leverage will the Annex I countries have; what are their bargaining chips?

Earlier, the main bargaining chip of the Annex I countries has been the various funds established under the Kyoto Protocol (e.g., the Special Climate Change Fund). These were established in order to persuade the developing countries to accept the protocol. However, the introduction of the Clean Development Mechanism (CDM) may shift the balance of power. As illustrated in Figure 4, there is now a substantial number of CDM projects taking place in key developing countries. Moreover, particularly in India and Brazil, a large CDM business community has developed related to development of CDM projects, consulting, etc. These business groups will have an interest in continuation of the CDM, and they are normally well represented in the national delegations to the climate negotiations. Hence, threats of stopping CDM investments are likely to have some leverage. It appears that the EU has been thinking along these lines and is considering terminating the CDM after 2012, depending on what kind of commitments developing countries are willing to take on. Threatening the discontinuation of the CDM would jeopardize CDM investments in a critical period of the market. However, the EU Directive on Emissions Trading does not have a defined end date, and signals from the European Commission suggest that the Linking Directive, governing the use of CDM and JI, will remain operational also in a subsequent commitment period.

The negotiations on the continuation of the CDM (and the various funds established under the Kyoto Protocol) could, for example, be traded against an opening for developing countries to take on commitments on an individual basis, and some common minimum requirements when it comes to reporting. Introducing a more comprehensive and complex graduation scheme, or even better, emission targets for all developing countries, would of course be desirable, but it is probably overly ambitious for the first commitment period after 2012.

There have been several suggestions for what kind of targets developing countries could take on. Several authors have suggested dynamic, or intensity-based targets, where emissions are measured in relation to another variable, e.g., GDP. Other and more innovative means have also been suggested. For example, Kim and Baumert (2002) suggest a dual-intensity target, where two different targets are set for a country. Reductions below the lower intensity target will allow the country to sell allowances, while emissions will have to be above the upper intensity for the country to be in non-compliance. Emissions between the two targets would have no implications, positive or negative, for the country.

Tangen and Hasselknippe (2005) suggest sector targets for developing countries, i.e., that developing countries will not have to take on targets for the whole economy, but could choose to include a limited number of sectors, or even single installations. This suggestion is partly practically motivated: for many developing countries emissions data are of poor quality, and meeting the eligibility requirements for participating in emissions trading might require substantial investments. Hence, limiting the number of sectors that are covered by emissions trading might lower the entry costs. The suggestion of sector targets is also partly politically motivated. By limiting the number coverage of the scheme to a few sectors, the country will avoid massive expenses if the emissions increase faster than first anticipated but, at the same time, allow for substantial learning-by-doing for the sectors that are covered, and for the country as a whole.

Investor countries also have the opportunity to put pressure on developing countries in order for them to take on reduction targets, as well as providing financial incentives for doing so. In total, industrialized countries have plans to purchase credits from CDM and JI projects for €4.2 billion to 2012 (Point Carbon 3:2005). However, this will not meet more than about 10 per cent of these countries' Kyoto requirements, and additional investments are expected to increase. Using this money as leverage to get developing countries to take on targets, for instance by stating that future investments will only be made in countries that enter into some sort of agreement on reporting and capping of emissions in different sectors, could be an option to broaden the climate agreement. By providing guaranteed investments to sectors that will take on targets it will be easier for the developing countries to agree to enhance their participation. Such pressure could be applied either through statements by buyer countries on their future purchase plans, or through bilateral agreements guaranteeing future investments.

6. Acceptable and predictable targets

In terms of targets, the KP has two major problems: the target-setting was arbitrary and unpredictable, and the targets turned out to be immensely skewed, e.g., Russia versus USA. Targets were the outcome of a bazaar-like negotiation procedure without any underlying rationale. This compares unfavourably with the burden-sharing negotiations in the EU that were done on the basis of the Triptych approach that had been developed by the University of Utrecht. The negotiations about the LRTAP Convention were even more based on a rational approach—the RAINS model developed by the international think tank IIASA. In the post-2012 negotiations, enhanced predictability along such lines is preferable to the Kyoto bazaar in order to make for more effective goal-achievement. A methodology or model to guide target-setting would allow a much more targeted negotiation although the targets are still likely to be set by political negotiations in the end. Table 2 shows the path from Triptych to actual EU burden-sharing targets.

Table 2. Path from Triptych to actual EU burden sharing targets (reductions from 1990 in %)

Country	National CO_2 targets for 2000	Original triptych 1997**	Dutch proposal 1997	1997 agreement*	U.K. proposal 1998	1998 agreement*
Austria	20 (2005)	1 to 25	25	25	20.5	13
Belgium	5	12 to15	15	10	9	7.5
Denmark	5	12 to 25	25	25	22.5	21
Finland	0	4 to 7	10	0	0	0
France	+13	4 to 12	5	0	0	0
Germany	25 (2005)	17 to 30	30	25	22.5	21
Greece	+25	2 to +2	+5	+30	+23	+25
Ireland	+20	2 to 5	+15	+15	+11	+13
Italy	0	5 to 9	10	7	7	6.5
Luxembourg	0	17 to 20	40	30	30	28
Netherlands	3 to 5	6 to 9	10	10	8	6
Portugal	+40	+16 to +21	+25	+40	+24	+27
Spain	+25	+6 to +11	+14	+17	+15	+15
Sweden	0	+5 to +26	+5	+5	+5	+4
U.K.	0	17 to 20	20	10	12	12.5
EU	0	9 to 17	15	9.2	8.5	8

* Three gas basket in 1997 burden sharing, six gas (Kyoto) basket in 1998 burden sharing
** Range of results among the four scenarios analyzed by the triptych approach

Sources: EU Council (1997), European Commission (1994), Anonymous (1997, 1998), Ringius (1999)

One could call on University of Utrecht again and use their numbers on global Triptych developed during the last years (Groenenberg *et al*. 2000) as a starting point for the international negotiations. If the Triptych route is found to be too complex, a model that has clear assumptions and whose output is understood by policy-makers and negotiating officials could help to make target-setting more acceptable to use reductions from baseline for guiding the establishment of Assigned Amounts. Like in the RAINS case, such a model could again be developed by IIASA building on the results of many modelling exercises worldwide, particularly those collaborating in the Stanford Energy Modelling Forum.

Still it seems likely that baselines will be inflated, such as was the case in the development of National Allocation Plans (NAPs) under the EU ETS by EU Member States, and this will have to be factored in. However, the process within the EU showed that the EU Commission was able to develop considerable clout in rejecting overly generous NAPs. Even in those cases where NAPs were not formally rejected, negotiations behind the scenes were able to reduce allocation levels compared to the earlier drafts. While a body with the formal powers of the EU Commission does not exist on an international level, the CDM Executive Board and its methodology panel have shown a surprisingly high willingness to safeguard the environmental integrity of the CDM without being reined in by the COP. This lesson would suggest that in the post-2012 system, an international body could be charged with the evaluation of baseline projections. Such an "emission projection board" would issue emissions projections for all countries. It could be supported by a panel of modelling experts.

Establishing baselines for countries will be much easier than in Kyoto as the transformation of Eastern Europe has largely been accomplished and the KP will provide for much better emissions data. Moreover, the choice of 2012 as a base year for graduating countries would allow enough time to collect data while also allowing independent checks before the end of the commitment period.

7. Pressing forward

During the Kyoto negotiations, the U.S. was instrumental in terms of providing innovative solutions and pressing the negotiations forward, while the EU, to a large extent, was locked into internal discussions. Also, at some of the conferences after the Kyoto Conference, particularly at COP-6 in The Hague, the EU appears to have spent as much time on negotiating with itself as it did with other Parties. As the U.S. is likely to be out of the substantial negotiations over the post-2012 framework, there is need for another Party that can press the process forward much in the same way as the U.S. did in Kyoto. The EU is currently the only party that has the necessary weight, and the ambition, for playing such a leadership role—but will it be up to the task?

In has been feared that the expansion of the EU by another 10 members would increase its coordination problems. There are, however, few signs of this actually happening. Rather, at COP-9 and COP-10, EU appeared less constrained by its internal coordination than what was the case on the previous conferences. Rather, according to non-EU negotiators, the EU was surprisingly effective in formulating positions due to more centralized decision-making.[8] Hence, it looks that, in face of the immeasurable challenges of coordinating the positions of 25 members, the

8 Personal communication.

EU reformulated its (informal) negotiation structure and accepted the fact that in order to be effective, more decision-making power had to be given to the EU Presidency. This has been supported by more effective “Troika” procedures involving previous and future presidencies.

The EU is also the only party with real experience of using the Kyoto mechanisms. While the so-called Umbrella members (e.g., Japan and Canada) have been caught up in domestic policy battles, the EU has managed to establish the world’s largest trading scheme, by far. And, as elaborated above, this scheme is, at the time of writing, the “motor” of the global carbon market (see Figures 1 and 2). Unlike what many feared—and anticipated—the EU got the scheme in place according to its original schedule. Nor has the price collapsed because of a lax allocation. Rather, currently the EU scheme is quite a success; it will probably deliver reductions of the scale of 100–200 Mt and the liquidity increases by the day. Obviously, this gives the EU some authority when it comes to discussing and negotiating targets and market mechanisms under a future climate regime. Moreover, the painstaking allocation process has probably given the EU a more realistic picture of what can be achieved in the short term. This was already visible in the ministerial discussions on the target level to be aimed at by the EU in the negotiations. After lengthy exchanges, the EU announced a target range of -15 to -30 per cent for 2020 compared to 1990.[9]

The 30 per cent was a formal reference to the German government’s coalition agreement of 2002. Experience from the pre-Kyoto negotiations show that setting a range has been useful in signalling environmental ambition to voters while showing realism to seasoned negotiators. The -15 per cent would mean a reduction of seven per cent from the first commitment period—not an overly difficult task given the remaining low-cost potential in the new Member States.

Hence, it could be argued that the EU is currently in a much better position to exercise leadership in the international climate negotiations than what was the case a few years ago. The decision-making has been improved; it has more experience and authority but also a sufficient dose of realism. In order for the EU to fully realize this potential, we find that before the next round of climate talks it is important that the EU:

- does its homework and prepares well before going to the negotiations;
- shows developing countries that it takes the CDM seriously by implementing liberal interpretations of the linking directive on a Member State level. This would mean that no burdensome additional requirements for CDM projects are set up such as envisaged by some Member States. This also reduces costs for the emitters covered by the EU trading scheme and reduces pressure to set a weak target;
- uses bilateral channels. This could lead to the development of a “Beyond 2012 group” consisting of EU and other progressive industrialized countries such as Norway, Switzerland and New Zealand. This group could link with

9 The German government was reported to be in favour of not setting a target level at the Council meeting.

progressive forces in Canada and Japan, and develop a joint target proposal. Moreover, trust-building with progressive advanced developing countries should be started. The European Capacity Building Initiative supported by a number of EU governments and launched at the climate negotiations in May 2005 would be a useful platform for such an endeavour (Mueller 2005); and

- suggests a targeted CDM program for OPEC and advanced developing countries. This could help to dispel the notion that climate policy blocks growth and would also show long-term alternatives to fossil fuels. Moreover, constituencies in those countries favouring emission reductions would be built.

At COP-11, the EU should:

- state that it is willing to take on a unilateral target in any case (e.g., three per cent from baseline), but that it is prepared to take on stronger targets if other Annex I countries take on targets, or developing countries take on sector targets. This would be similar to the successful approach on tariff reduction in the trade negotiations that reduced tariffs substantially during three decades; and
- present a draft mandate for the process that will lead to a new protocol under the UNFCCC for the period after 2012.

The EU's unilateral target would be enough to keep the Kyoto institutions (barely) alive without hurting national competitiveness if they have to go alone, but will make it difficult for other countries not to put a target on the table. When other countries propose targets, EU should increase its own target, and hence create a "race to the top."

8. Conclusions

The analysis in this chapter does not leave much hope for a constructive climate dialogue with the U.S. under its current administration. This poses a huge barrier to getting an ambitious international climate agreement in place. Although the EU seems better fit for playing a leadership role in the negotiations than was the case only a few years ago, expectations for the post-2012 regime have to be modest. The best the EU can hope for is probably to further develop the Kyoto framework, establish modest targets and involve some advanced developing countries. The resulting emission reductions will probably be a far cry from what is needed in order to seriously slow down climate change. We are heading for a warmer world.

Then what is the use of spending time and energy on negotiating a post-2012 agreement which will probably have limited effect anyway on the rate of global warming? The main reason is that it will be important to continue to learn how to reduce emissions effectively. A new U.S. administration that is serious about climate change will probably return to the international negotiation in a constructive manner and prefer an agreement that has many of the same characteristics as the Kyoto Protocol (i.e., binding targets and market-based mechanisms). With a constructive U.S., there is likely to be a wide scope of solutions, besides the few discussed in this chapter.

Although the analysis is pessimistic about including the U.S. in a target and timetable agreement under the current administration, it does not suggest that the rest of the world should not move. On the contrary, experience over the last decade has shown how painfully slow the negotiation process can be. Moreover, the practical implementation of market-based mechanisms is a time-consuming learning process. It is now, eight years after the Kyoto Protocol was signed, that we are able to start learning from practical experience. Consequently, even with limited participation and unilateral targets, it will be important that the EU and other countries that are serious about tackling climate change maintain the flexibility mechanisms, so that the world will not have to start from scratch when the U.S. is ready to join.

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Part 2: Technology

The "Coalition for Climate Technology" Scenario

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Abstract

This paper describes the "Coalition for Climate Technology" scenario for the future of the international climate regime in which like-minded countries cooperate on technology development and diffusion, while the Kyoto-style binding cap regime receives less attention. In this scenario, technology is not only instrumental to prevent climate change, but also provides an opportunity to change the game structure of climate negotiation from conflict over cap allocation to cooperation on national interests, thereby enabling countries to mobilize resources necessary to mitigate climate change. Key events in the scenario include: weakening of the binding cap regime after the first commitment period (2008–2012) of the Kyoto Protocol, development of cooperation among like-minded countries, technology areas in particular, e.g., renewable energy (EU and others), energy conservation (Japan and others) and geological carbon sequestration (U.S. and others). The countries shift away from the binding cap regime and pursue technology cooperation for some years, and then come back to the binding cap regime in the future, when technology options for mitigation are more affordable and strong constituencies have developed to support the technologies. Technological dynamics and alternative futures are discussed in detail.

1. Introduction

This scenario is presented as one plausible future for the post-Kyoto regime. There are several intentions behind developing this scenario. The first is to present the key ideas in a reader-friendly manner. For this purpose, we have tried to make the narration simple and bold, and have illustrated it with hypothetical events and agreements.

The second intention is to challenge the conventional wisdom. In this case, the conventional wisdom is that the future climate regime must be a continuation of a binding cap regime and emissions trading systems. This is often viewed as a "natural" development, since they are regarded as the major characteristics of the existing Kyoto regime. However, upon closer examination, a very different path could naturally develop from the current set of circumstances. Both the binding cap regime and the emissions trading system are still subject to testing in practice and they may not turn out to be environmentally effective in the end. On the other hand, there are signs suggesting that activities among like-minded parties on technological development and diffusion may become key pillars of the post-Kyoto regime.[1]

In Sections 2 through 5 below, we narrate the emergence of this scenario, from the stagnation of current negotiations to emergence, regionalization and institutionalization of technology-centred agreements, to eventual reunifications of the technology-centred and the cap-centred approaches. Section 6 summarizes this progression in diagrammatic form. Possible bifurcations of the scenario are assessed in Section 7, followed by a concluding discussion in Section 8.

2. Stagnation of UNFCCC negotiations in the post-Kyoto period and emergence of activities among like-minded parties (up to 2005)

Our scenario begins with the description of two past trends that serve as precursors to future changes. The first is the continued difficulty in achieving global consensus on the best approach to mitigation, embodied in the stalemate at COP-10 over the UNFCCC negotiations for the post-Kyoto Period. The second trend is the emergence of activities among like-minded countries for development and diffusion of renewable energy, carbon capture and storage (CCS), and energy conservation technologies.

2.1 Stagnation of negotiations for the post-Kyoto period in the UNFCCC

COP-10, held in Buenos Aires in 2005, exemplified how difficult the post-Kyoto negotiation process under the UNFCCC has become. While the EU and Japan tried to create an arena for the post-Kyoto negotiations with full participation, the U.S. refused to join. The consequent decision on the post-Kyoto framework was very weak and meant little. The decision, titled Seminar of Governmental Experts (SOGE), reads: "Without prejudices to any future negotiations, commitments, process, framework or mandate under the UNFCCC and the Kyoto Protocol, the Conference of the Parties requests the secretariat to convene a seminar of Governmental Experts (SOGE) in order to promote an informal exchange of information on a) Actions relating to mitigation and adaptation to assist Parties to continue to develop effective and appropriate responses to climate change; and b) Policies and measures adopted by their respective governments that support implementation of their existing commitments under the United Nations Framework Convention on Climate Change and the Kyoto Protocol."[2] The negotiation intended to begin the process of the U.S. participation under UNFCCC revealed that it was hampered from the very first step.

1 This paper is the elaboration of the Orchestra of Treaties Scenario (Sugiyama and Sinton 2005) with a focus on the technology cooperation.

2 The decision is available at http://www.unfccc.int.

Major developing countries, as usual, did not show any sign of willingness to take on binding caps in the near future. They argued that developed countries bear responsibility for their past emissions, and their current per capita emissions are much higher than those of developing countries. Developed countries argued that emissions from developing countries will make up half of global emissions in the near future, hence developing countries have to take on caps. Developing countries have been increasingly careful and uncooperative in negotiating any issues, such as submission of national communications and implementing CDM at a sector level, that developed countries might take advantage of to bring developing countries into the binding cap regime.

2.2 European activities for renewable energy

On the other hand, there have been activities among like-minded countries for key climate technologies without official legal linkages to the UNFCCC.

As a first example, European countries have been promoting renewable energy technologies, particularly wind power, since the 1990s. There have been institutional arrangements to create niche markets collectively, including EU directives with targets and timetables[3] and the Johannesburg Renewable Energy Coalition (JREC) for cooperation with developing countries.[4]

The key drivers of this political development include rich wind resources, land availability, popular political support, and support by domestic manufacturers of wind turbines. Coalitions among socialist and green governments were supportive of wind energy in 1990s. They have successfully fostered the growth of wind turbine manufacturers and operators. Once domestic manufacturers were established, it was possible for governments to argue that the costs for the new technologies were not necessarily burdensome to their economies because the manufacturers contributed to job creation (Michaelowa 2005b).

While the consequences of European wind power development remain to be seen, we argue that this is at least a good trial. If successful, the costs of wind power will be brought down and the technology will be readily marketable to any country. The rest of the world will benefit enormously by installing low-cost, clean and proven technology. Even if not successful, it provides important lessons to the rest of the world. What have the barriers been? Are the costs of the technology intrinsically high, after all these efforts? Are there formidable "Not-In-My-Back-Yard" problems with wind turbines, as it was heatedly debated in the journal *Der Spiegel* in 2004 in Germany? Are the windmills not socially acceptable since they disturb the landscape, create noise, and kill birds? Is intermittence the problem? Is the lack of wind resources a problem? If some countries are confident that they can overcome

3 It seems that the target and timetable approach is more popular in European environmental policy-making than in the rest of the world. Targets for renewables are examples, and there have been binding caps for SO_X, NO_X, and other air pollutants in the acid rain regime, not to mention the binding cap for greenhouse gas emissions.

4 EU countries are not the only ones promoting wind power. For example, the U.S. is the third biggest country in terms of megawatts installed. In the U.S., support for wind power began earlier (in the 1970s), but has been unstable at both the federal and state levels leading to stagnation in deployment. The narration here is simplified for readability.

the key barriers, they can launch their own new programs. If, unfortunately, it turns out that one of the barriers is too high and not possible to overcome, the rest of the world, particularly developing countries, will not have to repeat the test by themselves, and can change their focus to other technologies.

At the 2002 World Summit on Sustainable Development (WSSD) in Johannesburg, European countries tried to extend their target-and-timetable approach to the rest of the world, but the proposal was not accepted by other countries. The European contingent changed their "one-size-fits-all" approach at the subsequent Renewables 2004 conference hosted by the German government at Bonn. The Bonn conference has been successful in facilitating dialogue among developed and developing countries on renewable energy, but there has been no sign that the target-and-timetable approach will be accepted by the rest of the world in the foreseeable future.

However, from the technological development perspective, global coherence in policy is perhaps neither necessary nor productive. European countries can provide a sufficiently large niche market for technology by themselves. Expanding the size to the global scale is neither politically infeasible nor significantly beneficial to the technological development of nascent technologies. The lessons of case studies on environmental technology policies indicate that one big country is usually enough to provide a niche market in which technologies can be nurtured from laboratory curiosity to marketable product. See the appendix for further details of this line of reasoning.

2.3 Initiatives for carbon capture and storage (CCS) technologies

In the U.S. and other countries, research, development and demonstration of carbon capture and storage technologies (CCS) have been promoted first by the IEA-GHG program, and then by the Carbon Sequestration Leadership Forum (CSLF). Also, the IPCC has been working on a special report concerning CCS to be published by the end of 2005.

CCS provides another interesting opportunity to create niche markets for one of the key nascent climate technologies. Big fossil fuel producers, companies and countries alike, are becoming aware that they face the risk of not being able to continue fossil fuel production without CCS technologies that recover CO_2 from emissions and store them underground in geological reservoirs.

Having common ground, the actions taken by countries are various. In Norway, carbon taxes motivated Statoil to capture CO_2 at Sleipner gas field (Sæverud and Moe 2005). In the U.S., enhanced oil recovery (EOR) technology contributed to the development of CCS technologies, and the Bush administration has launched the FutureGen program to cut the costs down to a level acceptable to markets. The international extension of this activity is named the Carbon Sequestration Leadership Forum (CSLF), and more than 20 parties have signed on to this non-binding information exchange body. Australia, with rich coal resources, has also been interested in this technology and has hosted a series of international workshops, including the IEA Zero Emission Technologies (ZETS) conference in 2004. Saudi Arabia, on behalf of OPEC countries, has repeatedly supported collective efforts to develop this technology in plenary speeches at UNFCCC conferences.

The key political characteristic of this technology is that it enables the world to prevent climate change without changing the current fossil-fuel-dependent industrial structure and lifestyle. While this feature is recognized as a merit by CCS proponents, it is also a source of irritation for those who believe that changing current industrial structure and lifestyle should be the key part of climate change prevention (Sugiyama 2000; Anderson 2004).

Potential barriers to CCS technology include high costs and a large energy penalty, as well as possible leakage of stored CO_2, and acidification of the local environment. Typical estimates show that current costs are typically US$20–70 per tonne of CO_2 with 20 per cent to 30 per cent of total energy output required to capture the CO_2 from flue gases (IEA GHG 2003; IEG GHG 2004). It remains to be seen if the barriers can be successfully overcome by significantly changing the design of facilities. Candidates include Integrated Gasified Combined Cycle (IGCC) technology, which separates CO_2 at the pre-combustion stage.

It makes sense for the U.S., Australia, Germany, China, India and other fossil-fuel-rich countries—particularly those with high dependence on coal—to develop CCS technologies because their fossil fuel producing industries are facing the risk of losing their lucrative businesses if climate change is strongly addressed in the future. Fossil fuel resources are estimated to be abundant to the extent that the atmospheric concentration of CO_2 could be raised far beyond 1,000 ppm.[5] Similar to the wind power case in Europe, framing the issue as the matter of CCS technological development would make it possible to mobilize resources in these countries because the policy would be perceived as making their national economy robust—not as a mere burden to their economy, as emission caps are often perceived.

2.4 International cooperation for energy conservation

In Asia, there have been many technology cooperation activities aimed at energy conservation. For example, Japan has programs to exchange personnel and information and to demonstrate technologies with China and other Asian countries through government-affiliated organizations such as the Japan International Cooperation Agency (JICA), the New Energy and Industrial Technology Development Organization (NEDO), the Energy Conservation Center of Japan, and others. Also, there have been other international activities intended to promote energy conservation in Asia and other countries, as well as funding from multilateral agencies for efficiency policies, programs and investments. While not all of them have been successful, important lessons have been accumulated.

Most countries have developed energy efficiency policies since the 1970s, and many have constantly strengthened them. They did this because the policies were perceived to contribute to their energy security. Later, climate change was added as another reason to further strengthen such activities. However, the major drivers for energy efficiency policy remained energy security and domestic economic concerns, not climate change.

5 See (Metz *et al*. 2001) for example for the estimates of the fossil fuel resources.

The range of successful policies and programs is broad. Energy efficiency standards and labelling for electric appliances and automobiles have proven to be effective in eliminating poor performance equipment out of the markets. Standards for buildings, while more difficult to implement, have also proven worthwhile. Governmental procurement programs have helped to create markets for high-performance equipment. Demand-side management programs and fiscal and tax measures have been used, often with significant results.

Having recognized the effectiveness of such policies, there have been many international activities that aim at facilitating their design and implementation in developing countries. Examples include the Collaborative Labeling and Appliance Standards Program (CLASP) network that provides information, expertise and technical assistance to governments that are interested in establishing efficiency standards and labelling systems. Their success has been remarkable, and indicates one way in which international society can effectively address energy efficiency. For example, CLASP contributed to the implementation of efficiency standards for 11 appliances and efficiency labels for eight appliances in China. The energy savings accrued from these activities are estimated to be equivalent to nine per cent of projected residential consumption in China in 2010.[6] The cost effectiveness, in terms of energy saving per unit of external funding for the activity, is estimated to be roughly as low as several per cent of the CDM credit price.

Recent development in Chinese automobile fuel-economy (efficiency) regulation is another impressive example. In China, fuel-economy standards have been set for the target years 2005 and 2008. The 2008 standards are slightly more stringent than those of the U.S. Furthermore, the 2008 standard for sport utility vehicles (SUVs) is more stringent than that of Japan, and probably anywhere else in the world (China Automotive Technology & Research Center 2003; Sauer and Wellington 2004). The key driver is the concern over increasing oil imports, or energy security in short. The U.S.-based Energy Foundation (EF) provided part of the funding for the technical work necessary for developing the regulation. This case illustrates clearly that (1) there are strong incentives for energy conservation in key developing countries; (2) international cooperation is important for developing countries to implement policy and measures; and (3) there is no need to mention climate change in order to cut emissions arising from energy use.

In principle, most governments understand that energy efficiency improvement contributes to multiple benefits, ranging from energy security to economic efficiency, pollution reduction and climate change prevention. However, political attention and resource allocation have rarely been enough to consistently implement energy efficiency policies on the ground. Many countries lack dedicated institutions with the scientific expertise and industrial participation that are necessary to regularly update standards and labels and monitor compliance. Often, there is only a handful of staff in charge of the whole of energy efficiency policy for a developing country. It will be important to draw attention to the need to strengthen the institutions of energy efficiency policy and to enhance their activities through international cooperation.

6 See the CLASP Web site (http://www.clasponline.org) for further information.

Other modes of technology cooperation will be important, but their roles will be complementary to the policy assistance above. There have been many cases of technology demonstration projects that have not resulted in the diffusion of the targeted technologies, due to lack of appropriate market analysis or appropriate environmental regulation (Ohshita 2002). Personnel training and exchange programs have generally met their own internal goals, but their effectiveness is generally difficult to measure in quantitative terms such as energy or CO_2 reductions. For an international framework to be widely supported, it seems important that both actions (e.g., persons trained, standards set) and outcomes (energy reductions, CO_2 reductions) are measurable. Assisting the implementation of policies and measures, particularly energy efficiency standards, has a good record in this regard.

3. Regionalization of the Kyoto Protocol and institutionalization of like-minded activities (2005–2008)

Our scenario now enters the future, which we illustrate with hypothetical, but plausible events. This stage is characterized by two key events:

1. Post-Kyoto negotiations under the UNFCCC become radicalized under the *Montreal Mandate* and the *Bonn Protocol*, which are concluded with strong binding targets that apply to developed countries alone.
2. Non-EU countries, after opting out of the *Montreal Mandate* process, begin institutionalizing their own international activities. Japan and Asian developing countries conclude an "Energy Conservation Agreement," and the U.S. and several fossil-fuel-rich countries conclude a "Carbon Capture and Storage Agreement." These agreements are mutually recognized under the overarching "General Agreement on Climate Technology (GACT)."

3.1 Montreal Mandate: Radical greening of post-Kyoto negotiation

In November 2005, negotiation on the post-Kyoto regime begins among the signatories to the Kyoto Protocol at COP/MOP-1 held in Montreal, Canada. The negotiation is mostly led by the EU in the absence of the U.S. With increasing pressure from Environmental NGOs (ENGOs), the negotiation becomes radically in favour of strong unilateral actions by developed countries to cut emissions quickly. Finally, two decisions are adopted:

a) *The Montreal Mandate*: Developed countries will take binding caps in the commitment period from 2013 to 2017. The caps will be negotiated and adopted at COP/MOP-3 in 2007. Developing countries will not be required to take on binding caps.

b) The binding caps in item (a) will be negotiated in accordance with the target of stabilizing global atmospheric concentrations of CO_2 at 450 ppm in order to limit global average temperature increase to less than 2°C.

Items (a) and (b) have the potential to be adopted since they reflect the positions of some key actors at recent negotiations. Item (a) is a replica of what was adopted at Berlin in 1995. It was named the Berlin Mandate, which set the key structures, i.e., targets and timetable for developed countries alone, of the Kyoto Protocol adopted in 1997. Many developing countries made it clear at COP-10 that such a clear safeguard at the beginning of the negotiation is the prerequisite to begin the negotiation on any future binding caps. Item (b), the ambitious global concentration target, was the position expressed by several European institutions, including the European Council (1996) and the WBGU (2003). ENGOs widely celebrated the decisions because items (a) and (b) are basically copies of proposals put forward to date by many ENGOs.

3.2 Bonn Protocol: Regionalization of the Kyoto Protocol

The negotiation under the *Montreal Mandate* begins, but it immediately turns out to be very difficult. With the 450 ppm ceiling, the binding caps required for developed countries are very ambitious. For developing countries, it is obvious that the caps will be tightened up in the near future once they join the group with binding caps. Against this backdrop, developing countries become much more careful in negotiating any issues that might be taken advantage of by the developed countries to bring developing countries to the binding cap regime.

Canada and Australia hope to secure extremely loose accounting rules for terrestrial sinks. However, the prospects turn hopeless in the face of strong pressures from the EU, supported by ENGOs. Eventually, the two countries opt out of the negotiation, citing many reasons such as the non-participation of the U.S. and developing countries. Japan also feels uncomfortable negotiating what seems infeasible in her eyes, and she opts out. The new protocol is concluded at Bonn in COP/MOP-3, but the membership for the binding cap regime is limited to European countries, Russia and Ukraine. Russia and Ukraine exert strong leverage in the negotiations as the last non-EU developed country members and succeed in securing another round of hot air under the new protocol. Critics declare that the shortcomings of the Kyoto Protocol are aggravated in the new protocol.

3.3 Energy Conservation Agreement

In parallel with the negotiations under the *Montreal Mandate*, there are two negotiations on like-minded activities emerging. Japan, with skepticism of the environmental effectiveness of the process under the *Montreal Mandate*, announces that she will begin negotiation on an "*Energy Conservation Agreement*" that aims at strengthening the policies and measures of participating East Asian countries. They conclude an agreement in 2007:

a) [Commitment of Actions] Countries commit to stipulate, monitor and periodically revise energy conservation policies and measures such as laws and standards.

b) [Commitment of Outcomes] Countries set quantitative targets as a measure of the actions in the item (a) above. The targets can be sector- or technology-specific. The nature of targets are voluntary and complementary to item (a) above.

c) [Pledge and Review] The policies and measures, as well as the complementary targets of (a) and (b) above are subject to a voluntary pledge and review system.

d) [Fund] The "Energy Conservation Fund" is established to assist the implementation of policies and measures in item (a) above.

e) [Contributions] Payments into the fund are voluntary, but Japan announces it will pay US$50 million annually for the coming several years.

The agreement is based upon the increasing understanding of the national interests detailed below.

For Japan, there are six national interests in promoting energy efficiency policies and measures in East Asia: 1) *Energy security*. Less energy consumption in developing countries eases competition for sources of supply; 2) *Regional security*. Territorial disputes are often related to mineral resources. Energy conservation would moderate the potential for such disputes. To cooperate on the common agenda would contribute to mutual trust; 3) *Market development for highly efficient equipment*. Japanese manufacturers will benefit; 4) *Incentives for more ambitious efficiency policies in Japan*. With the expectation that Asian countries will follow suit in future, ambitious efficiency policies would be welcomed by policy-makers and manufacturers; 5) *Climate change mitigation*; and 6) *Trans-boundary air pollution mitigation*.

For developing countries, there are at least six national interests. 1) *Economic efficiency*. Energy efficiency improvement is a key element of productivity and contributes to the economic efficiency of the economy as a whole; 2) *Development of the market for globally-competitive equipment*. China and Southeast Asian countries have used the international system as a vehicle to train and modernize their industries. A notable example is their willingness to participate in the WTO, despite the challenges to some domestic economic sectors; 3) *Energy security*. China, Korea and some Southeast Asian countries are dependent upon imported oil; 4) *Regional security*; 5) *Pollution prevention*; and 6) *Climate change mitigation*.

Some of these national interests have been present for decades, but some are new, and the importance of energy efficiency policy is constantly increasing, given burgeoning economic development, energy consumption growth, mounting environmental concerns and territorial tensions in the region. The time seems ripe for further enhancing regional cooperation on policies and measures for energy efficiency that fit well with the national interests of all sides.

3.4 Carbon Capture and Storage Agreement

Another activity is spurred with the approval of the IPCC's special report on CCS. Developed countries with rich fossil fuel resources, such as the U.S., Australia, Germany, Norway and Canada, recognize the approval as a "green light" for the technology, which was sometimes seen as heretical.

Increasing numbers of countries begin supporting CCS technology by treating it on par with renewable energy resources. By 2008, some governments introduce feed-in-tariff or subsidies for CCS at the same levels as those afforded to renewable energy supplies, while other governments credit CCS under *zero-emission portfolio standard (ZPS)* regulations, which is an expansion of renewable energy portfolio standard (RPS) regulations.

Several groups promote this institutionalization. The first group is power producers and consumers who think the supporting measures for renewable energy are very costly and who are looking for cheaper alternatives. The second group is composed of fossil fuel energy producers that want to sell more fuel. The third one includes equipment manufacturers that want to sell CCS facilities. The fourth group is made up of those environmental NGOs that view CCS technology positively.[7]

Such a coalition of actors promotes institutionalization of CCS activities at both domestic and international levels in cooperation with existing international networks such as the CSLF and the IEA-GHG programs. The activities culminate in the conclusion of the "*Carbon Capture and Storage Agreement*" at Queensland in Australia in 2008.[8]

3.5 General agreements for climate technologies (GACT)

Japan, after opting out of the *Montreal Mandate* process, immediately wants international legitimacy for her like-minded activities for energy conservation. Canada and Australia aspire to the same, and they have become active promoters of CCS technologies. In 2006, they will jointly announce to intensively negotiate and conclude an alternative global framework which, they think, is more environmentally effective than the *Montreal Mandate* process.

They first seek recognition under the UNFCCC, but it turns out not to be feasible. Their activities are critically perceived as being out of malintention to avoid binding caps. Then, they choose to create another global umbrella treaty under which they mutually recognize their activities. The pact, the "General Agreement for Climate Technology (GACT)," is concluded in 2008 among the non-EU developed countries. China and India join it, attracted by the assistance to the energy efficiency policy.

The key elements of the *GACT* include:

- [Ministerial meetings] Keep political salience of climate technology. For this purpose, periodical gatherings of ministers are to be held.
- [Get the signals rights to the players] Instead of articulating the goal in terms of temperature and concentrations, concerning which high scientific uncertainty remains, countries articulate the need for technological innovation and diffusion to prevent climate change. Signatories share the common goal to shift to "near-zero CO_2" energy systems that consist of renewable, CCS and nuclear technologies on the supply side and high energy efficiency equipment and systems on the demand side.
- [Pledge and review of the commitments] Countries, or groups of like-minded countries, pledge the commitments. They can be legally binding, or negotiated among a group of countries if its members agree. Periodic reviews of the commitments help keep countries on the track whether they are on the track.

7 The current views of environmental NGOs regarding CCS technology are mixed. For example, Anderson (2004) provides a cautious view without rejecting it *a priori*.

8 The author chose Queensland because the Australian government has shown strong interest in the carbon sequestration technology and invited an IEA conference to Queensland in 2004.

- [Legitimize like-minded activities] There are many ways to legitimize activities. Easiest is to register the activity or to prepare a joint international declaration. Further strengthened versions of this would make some key targets legally-binding.

GACT is not intended to have teeth in its early stages, but rather to increase the political salience of international climate technology cooperation and legitimize like-minded activities. Providing legitimacy will help these regional activities to secure more stable and larger amounts of resources within the region. Any national or regional technological programs have volatility, since all programs are subject to constantly changing constellations of domestic political forces. The role of international agreements is to smooth out this uncertainty by making activities subject to open and unanimous agreement among signatories. Creating stable political support is important for any serious technological development investments from the private sector.

Another key idea of the GACT is that currently commercial technologies alone are not enough to prevent climate change in the long run. Therefore, parties agree to develop new technologies and to cut the costs to meet the environmental challenge. There have been like-minded cooperative activities on technology already but they are less attended in the UNFCCC and Kyoto Protocol, whose major focus has been the cap-and-trade systems.

In order to demonstrate the effectiveness of the pledge-and-review systems, key actions and outcomes would have to be measurable. Examples of measurable actions include enacting laws, adopting standards and labelling programs, and establishing fiscal incentives to improve energy efficiency. Estimates of reductions in energy use and CO_2 emissions would serve as the quantitative measures of outcomes. For CCS and renewable energy policies, stipulating laws (such as RPS and feed-in-tariffs) or amounts of subsidies can be considered a measure of actions, and installed capacities and unit cost reductions can be a measure of outcomes. Measuring both actions and outcomes are important for at least two reasons. On one hand, measuring actions alone makes it difficult to assess whether activities are effective. On the other hand, putting too much emphasis on outcomes, particularly emission reductions, is inappropriate since it may limit the scope of eligible activities, as has been experienced in the development of CDM (Sugiyama, Yamaguchi and Yamagata 2005). Furthermore, measures of outcomes do not necessarily have to be emission reductions. Technological targets may be more workable, depending on the nature of policies.

4. Reunification under the GACT (2008–2012)

The two events characterize this stage:

1. The GACT regime makes steady progress in energy conservation and CCS activities.
2. The *Bonn Protocol* fades away. The key EU activities, including the EU Emissions Trading System and renewable directives, are integrated in the GACT.

4.1 Steady progress in like-minded technology activities

In the annual meetings of the GACT, a mounting number of "actions," which are new laws, standards and other policies, for energy efficiency are reported. The estimated emission reductions outpace those from the CDM. While total emissions are increasing in most countries, the development of this institution is welcomed as a good signal for change. Manufacturers increase their expectations of more-stringent global energy efficiency regulation in the future. The progress of energy conservation policy attracts interest from non-member developing countries, which wish to improve their economic efficiency and global competitiveness, and membership increases. Attracted by the record of success, increasing numbers of developed countries with environmental concerns join the funding mechanism.

CCS technologies begin diffusing rapidly once niche markets for renewable energy are extended to CCS technologies.[9] By 2012, the long-term forecast of emission reductions accrued from planned CCS projects exceeds that for wind and solar power. Major fossil fuel producers exert their political clout to secure constant governmental support for the technology, just like the wind-power manufacturers did in Germany in the 1990s.

In Europe, renewable energy steadily grows despite some disruptions due to high costs, noise and landscape problems. By 2012, wind power accounts for more than 10 per cent of power production in several countries. Biodiesel also accounts for more than 10 per cent of fuel in the automobile sector in several countries. While they still fall short of being the main supply source, their contributions are becoming significant.

4.2 Bonn Protocol fades away – Kyoto Protocol becomes another UNCTAD

Despite the ambition demonstrated at the conclusion of *Montreal Mandate*, the carbon price in the Kyoto regime and the EU Emissions Trading System (ETS) remains low for three reasons. First is the additional hot air allocated to Russia under the Bonn Protocol. Second are the competitiveness concerns of companies whose emissions are capped in the EU ETS. The price continues to stay under US$30 per tonne of CO_2, a price level too low to induce significant technological change. The final reason is that the binding cap regime itself is unlikely to cover the rest of the world after the Bonn Protocol. As a consequence, emissions do not significantly decrease in the facilities covered by the EU ETS. The residential and transport sectors, whose emissions have been increasing much faster than industrial sectors, are not covered by the EU ETS, and they continue rising.

On the other hand, demand from developing countries is mounting. Annual financial flows from the EU to developing countries under the Kyoto Protocol

9 Typical cost estimates for CCS technologies range from US$20–70 per tonne of CO_2 for power plants (IEA GHG 2004). This translates to US¢1.70 to 5.94 per kWh for a typical coal power plant, assuming a net efficiency of 40 per cent and an emissions factor of 1.08 Mt-C/Mtoe (EDMC 2005). The cost range is below that of renewable energies in many situations and emission reductions accrued from a single project are typically much more than renewable energy projects.

increases up to US$1 billion annually by 2010, and is expected to be US$5 billion annually in the commitment period of the *Bonn Protocol*.[10]

The Kyoto and Bonn Protocols become unpopular given the two developments above. They are recognized as largely ineffective in cutting emissions, and mounting financial flows to developing countries are denounced by EU taxpayers. As a consequence, negotiations for a further commitment period of the Bonn Protocol, initiated in 2010, fail to set targets for EU countries, and they become inactive in the UNFCCC.

There is a precedent for a UN process that faded away through the reluctance of developed countries after articulating many nice declarations. The United Nations Conference on Trade and Development (UNCTAD) was established to make the trade regime more equitable. The activity culminated at the adoption of a "New International Economic Order" in 1974, where developing countries demanded that developed countries remove the barriers for commodity imports from developing countries, and that they increase the share of industrial output by developing countries to 25 per cent of the global total, and so forth. However, developed countries have quietly retreated from the activities since then and they successfully strengthened another trade framework—the GATT and then the WTO, where developed countries were more comfortable (Nester 2001). Developing countries had no choice but to join the WTO regime later.

4.3 Reunification under the GACT

Now that the European countries realize that the binding cap is not the only way forward, they reconsider their policies. The *Bonn Protocol* is so unpopular that the global cap-and-trade system seems likely never to continue. Emissions trading systems seem to have achieved modest, though not remarkable, success. Renewable policy turns out to be successful in developing technologies. Ironically, it turns out that the successful elements—policies to promote renewables and emissions trading—are like-minded-type activities and fit well with the concept of the GACT.

European countries realize that they need to legitimize the regional activities if they discontinue the *Bonn Protocol*, just like non-EU countries did after opting out of the Kyoto Protocol. They choose to join the GACT, so they can explain that their counterparts around the globe—particularly the U.S.—are making efforts comparable to the EU, hence they can secure support for their domestic policies. EU emissions trading and renewable policies are welcomed as the part of the GACT, as policies that address diffusion and demonstration of the technology-deployment process, respectively.

10 There are two channels of financial flows from developed to developing countries in the Kyoto and Bonn Protocols, i.e., either direct, or indirect via CDM. Through direct channels, developing countries requested several billion dollars of funding at COP-7. As a consequence, several developed countries pledged to finance US$470 million to the three funds established by the Marrakesh Accord. In this scenario, it increases up to US$1 billion annually under the Bonn Protocol. The indirect channel can be as much as US$4 billion if countries continue CDM with ambitious binding targets for developed countries. For example, China emits about four billion tonnes of greenhouse gases annually. If 10 per cent of emissions are cut through CDM and the average CO_2 price is US$10, it means US$4 billion dollars annually would be transferred to China alone.

5. Further development under the GACT (2012 and after)

The main events that characterize this stage are:

1. Some technologies make significant progress, and technology policies are understood to be not in conflict with economic growth. Successful technologies and policies diffuse across the world.
2. Commitments by countries under the GACT become more ambitious and binding. After building confidence in the effectiveness of individual policies and measures to cut emissions, countries begin agreeing upon ambitious binding caps at the national level.

5.1 Technology policies are demonstrated and diffused

Development of CCS policies and emissions trading systems in the U.S.

The costs of CCS technology continue to fall, given support comparable to that for renewable energies. By 2012, half of the planned new power facilities in the U.S. incorporate CCS technologies.

The diffusion of CCS technologies creates a political atmosphere that enables reconsideration of domestic energy and environmental policy in the U.S. Eventually, the emissions trading system is adopted at the federal level for large power plants and factories in 2012. The story here replicates what happened to SO_X regulatory policy in the U.S. The availability of an affordable SO_X scrubber and centralized monitoring of real-time emissions data from power plant stacks were the prerequisites for seriously negotiating alternative regulatory frameworks and eventually led to the SOx emissions trading systems.[11]

Like the EU, the price level remains as low as US$20 per tonne of CO_2 due to competitiveness concerns. With this price level, emissions grow more slowly than in the past, but they do not decline. More emissions are cut by the "Zero-Emissions Portfolio Standard (ZEPS)," that mandates power producers to hold certain shares of zero emissions sources, either renewables or CCS, in their power plant portfolio.[12]

Internationalization of the U.S. climate policies

The development of domestic regulations described above simultaneously creates pressure on the U.S. government to push the rest of the world to take on similar

11 We assume that the development of CCS technologies will lead to cap-and-trade systems, since the politics would resemble that of SO_X regulations once affordable CCS technologies become available. In the U.S., the discussion of the mandatory installation of SO_X scrubbers brought about a division in the utility industry. Power producers with high-sulfur coal pushed for mandatory installation so that the costs of SO_X regulation would be the same for their competitors. Power producers with low-sulfur coal opposed the idea. The unified coalition against any regulation was thus broken, and the cap-and-trade systems were introduced as a consequence (Sugiyama 2000).

12 One should not harbour unrealistic expectations of the environmental effectiveness of the cap-and-trade system. The record of the SO_X emissions trading systems of the U.S. is that the price level was too low for power producers to equip plants with high-performance (90 per cent or more emissions reduction) SO_X scrubbers. Ironically, they are widely installed in Japan under the negotiated agreement scheme. A novel policy instrument is not necessarily environmentally effective.

regulations. Cap-and-trade systems are promoted and a "Group of Emission Markets (GEMs)" system appears (Sugiyama and Sinton 2005). In GEMs, countries implement emission market systems in each country or region while retaining control over their respective total amounts of emissions as their sovereign right. Instead of having a unified market across the world with a single emissions "currency," which is politically infeasible, they keep their own markets and negotiate target price levels, and then begin gradual harmonization of the market structures, such as accounting rules for sinks and project-based activities. Some emissions-trading companies try to forcefully expand the U.S. system abroad. They succeed at the NAFTA level, but they fail to expand it to the rest of the world (Vogel 1995).[13]

Another track of the internationalization of U.S. climate policy is the promotion of CCS technologies. The manufacturers are interested in selling their CCS facilities and push the government strongly. The mandatory installation of CCS technologies expands to NAFTA countries first, then many other countries are mandated to install CCS equipment. Developing countries are granted a grace period and some aid is provided by developed countries.

This scenario is a replica of what happened under the Ozone Depleting Substances (ODS) regime. Under the ODS regime, manufacturers that developed the key substitutes for ODSs, chlorofluorocarbons (CFCs), pushed for a global treaty that would eliminate CFCs in developed countries. Developing countries were granted a grace period and some aid was provided by developed countries through a dedicated fund. This precedent demonstrates that once a couple of strong companies find special interest in promoting environmental equipment, they can mobilize governments in coalition with environmental groups.

With the development of CCS technologies, hydrogen becomes available at an affordable cost, and it becomes a policy fashion to introduce Zero Emissions Vehicle (ZEV) standards.[14] While the costs of fuel cells remain very high, hydrogen gas engine vehicles begin to diffuse in California and many other U.S. states, then at the federal level, and in EU countries (U.S. DOE 2004).[15]

Renewables steadily increase their share and costs are brought down. While their growth rate is very high, the share of wind, solar and biomass altogether in the energy supply systems remain less than 10 per cent in most countries. With the climate benefits recognized, nuclear power revives again and begins increasing its share in the 2010s in countries where public communication succeeds.[16]

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13 Environmental policies adopted in strong countries tend to be "exported" to the rest of the economic community. This tendency, called "trading-up," is stronger in more integrated communities (e.g., NAFTA) than in loose ones (e.g., the WTO).

14 Conceptually, ZEV regulation mandates auto makers to produce a certain share of zero emissions vehicles (electricity or hydrogen) out of their total sales. There have been many variations of ZEV regulations debated so far.

15 Hydrogen gas engine vehicles are not difficult to develop and are expected be the first generation of hydrogen vehicles, once hydrogen supply systems become available.

16 An emission scenario in the U.K. white paper illustrated the revival of nuclear power as a major contributor to a projected 60 per cent GHG emissions reduction by 2050 (UK DTI 2003). Massive emissions cuts are possible if nuclear revives.

5.2 Deeper Institutionalization under the GACT

While the GACT began as voluntary in nature, emerging industrial interest groups change it to become more ambitious and stringent. Most of those who have the best technologies are giant firms, hence influential when they mobilize their financial and political clout in domestic policy and international negotiations. They have direct interests in higher energy efficiency standards, more niche markets for CCS technologies, and more niche markets for renewable energy. They all have benefited from policies enhanced under the GACT regime.

By 2018, the GACT mandates installation of CCS in all participating countries. This affects other technology areas. Renewable and energy efficiency policies are also becoming binding. Price levels and accounting systems of the GEM are constantly being negotiated too. Many climate technologies become more affordable under the GACT regime and cutting CO_2 emissions becomes an ordinary part of life. The shadow price implied by technology policies within the GACT and carbon prices in the GEMs, which were far apart in 2008, move closer. Eventually, in 2030, key countries—the largest 20 emitters plus like-minded countries—agree upon binding targets and timetables with strong enforcement systems, which had been dreamed of when the countries negotiated at COP-3 in Kyoto.

6. Graphical representation of technology policy dynamics in the scenario

This section provides a summary of the technology policy dynamics in the scenario narrated in the previous sections.

In the scenario, the framing of issues and the policy framework are totally different from the Kyoto Protocol (Table 1). Once the issue is framed as technology, countries perceived agreements serving their own national interests.

Table 1. Reframing the issue and policy from the Kyoto Protocol to the GACT

	Kyoto Protocol	Future Framework
Framing of the issue	Capping total amount of emissions	Drastic change of energy system
Policy framework	Allocating allowances	R&D and diffusion of technology
Consequence	Battle over allowances. Distrust, inefficiency	International cooperation for mutual interests

In our scenario, the turning point of the reframing is the radical decisions known as the *Montreal Mandate*. Non-EU countries develop like-minded activities, and seek an alternative global framework.

The activities would be politically stable since they are identified by the convening countries to be compatible with their respective national interests and resource endowments (Figure 1).

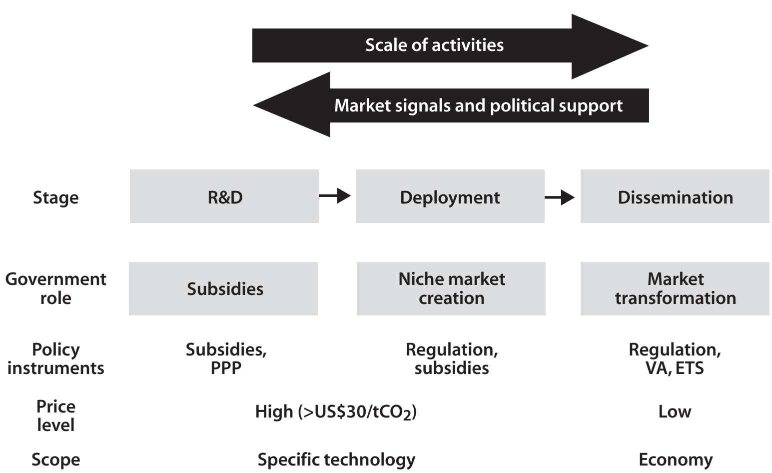
For technologies at all stages of development, there are appropriate roles for government (IEA 2000). For prospective technologies, direct funding of R&D and demonstration projects with public-private partnership for specific technologies are appropriate. As the technologies mature, niche market creation serves to bring costs down and to foster markets. When markets do form, creating fair competition with internalization of the social costs in the market is appropriate. Political support and feedback from market stakeholders are important for efficient technology policy-making. (Figure 2).

Figure 1. Schematic diagram of like-minded technology activities under the GACT

Wind	Carbon Capture	Energy Efficiency
Wind rich countries	Fossil fuel rich countries	Countries with fragile access to energy
EU directives, JREC, etc.	CSLF, etc.	APEC, CLASP, etc.
European Union	United States, Australia	Japan, China

JREC: Johannesburg Renewable Energy Coalition, CSLF: Carbon Sequestration Leadership Forum, APEC: Asian-Pacific Economic Cooperation

Figure 2. Dynamics of technology policies



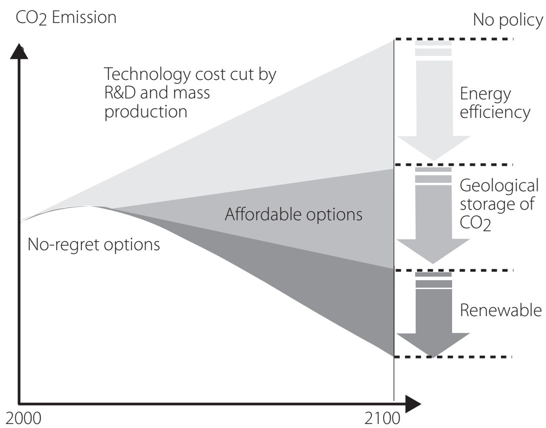
PPP: public-private partnership VA: voluntary agreement ETS: emissions trading systems

The stages addressed by each agreement under the GACT differ depending on the nature and stage of the technology. Agreements on nascent technologies like renewables and CCS technologies would focus more on R&D and demonstration.

The Energy Conservation Agreement for appliances and boilers would focus more on diffusion, given the maturity of those technologies and the short lifecycles of such equipment. Cap-and-trade systems are dedicated to the diffusion stage only. One aim of the GACT is to create a set of policy incentives at the international level so that all stages are appropriately addressed.

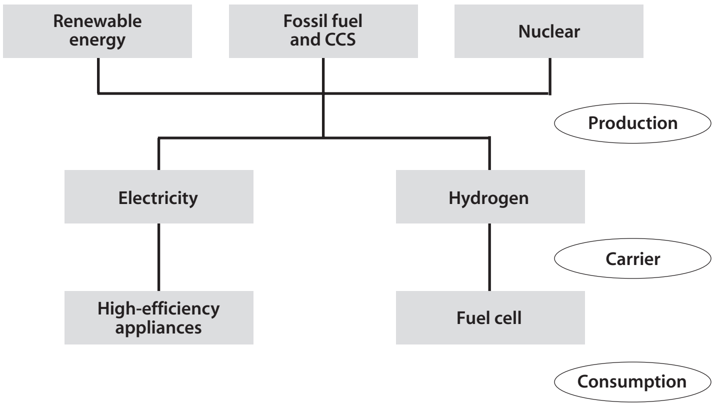
The technological development envisaged in the GACT enables developing countries to follow suit. For the time being, developing countries concentrate on no-regrets policy such as energy conservation. In the future, however, when technologies have matured and costs are brought down, developing countries will also use those options (Figure 3).

Figure 3. Schematic diagram for CO_2 emissions of a hypothetical developing country



Such efforts, if successful, can lead to energy systems that are free of carbon emissions. It is possible to create such energy systems with known technologies alone. It should be remembered that such a change is not possible by shrinking the size of current energy systems, but is only possible through drastic changes in the energy systems. A rough illustration of the goal is useful in communicating this view (Figure 4). On the supply side, renewables, nuclear and fossil fuels with the CCS technologies would be used. Electricity and hydrogen would be the energy carriers. End uses would be highly efficient electric equipment and hydrogen gas engines, as well as fuel cells.

Figure 4. Schematic diagram of a hypothetical zero carbon emission energy system



7. Bifurcations of the scenario

There can be several bifurcations to our scenario. In this section, we discuss their plausibility, political feasibility and environmental effectiveness.

7.1 Graduation and deepening

This scenario describes the future in which the binding cap regime will be steadily strengthened after 2012. The binding caps get stronger ("deepening") for developed countries and developing countries join the binding cap regime as they economically develop ("graduation") (Michaelowa *et al.* 2005). It might emerge if, and only if, countries perceive climate change as having utmost importance and put it high on the policy agenda—that is very far from the current political reality. An unprecedented big event, such as catastrophe in the climate system in the U.S., would be necessary for such a scenario to emerge in the near future. As such, we argue that the chances are low for the scenario.

7.2 Successful emissions trading systems

The European Union's emissions trading system (EU ETS) created a political fever and attracted wide attention in the past couple of years. If the EU ETS is successful in making massive emission cuts at a low cost as promised, the policy will be copied by the rest of the developed world in the near future. An optimistic view in this direction is provided by the *Converging Market Scenario* (Tangen and Hasselknippe 2005).

However, there are caveats. First, the emissions trading systems need to be tested in the real world to see whether they can actually deliver on the theoretical benefits. Second, the lessons from precedence are mixed at best. There is no convincing evidence that the SO_X emissions trading system in the U.S. performed better than Japanese regulatory systems that relied upon direct regulations and voluntary agreement. Third, it seems difficult to keep the price high due to competitiveness concerns. If the price is not high, the impacts are limited. The emissions trading systems may contribute to marginal emission cuts—some energy saving or fuel switching in the industrial sector—but not further. The low price signal does not have any impact in the residential and transport sectors in which emissions are rising much faster than in the industrial sector.

Nor does the low price lead to technological innovation. In order to develop the nascent technologies, a high shadow price has to be attached by a dedicated policy. There is a trade-off between the coverage of the policy instrument and the level of shadow price created by it when the policy is put in practice. A high price signal can be created if the target technology area is specified (e.g., the CCS, wind power), but it is not possible if a wide range of economic activities are targeted (e.g., ETS).

In summary, emissions trading systems could play some role, but overall effectiveness is unknown and needs to be tested in the real world. Furthermore, while emissions trading systems might be effective for large power plants and factories, they cannot cut emissions from residential and transport sectors whose emissions are rapidly rising.

7.3 Flexible UNFCCC negotiation

In our scenario, the radical turn of the negotiation by the *Montreal Mandate* was the point of departure from the Kyoto Style regime. On this basis, we purposely made the drastic assumption so that the storyline impresses readers. Alternatively, the real world may be more subtle—and boring.

One can imagine a more "flexible" negotiation in the UNFCCC. In fact, there has been some "flexibility" suggested by the EU already, including a sector-based cap, non-binding cap, intensity-based cap, lax sink accounting rules and so on. However, it seems that the EU is not yet ready to reconsider the key structure—emphasis on binding caps—of the Kyoto regime. This attitude is seen in the latest publication by the EU on the period after Kyoto (Commission of the European Communities 2005).

Such a negotiation stance might secure some more participation, like Korea and Turkey with loose targets, for example, but not major emitters such as the U.S., China and India. As such, what the critics describe as the shortcomings of the Kyoto Protocol—limited coverage of global emissions and low carbon price—will not disappear. There is a certain possibility that the post-Kyoto world may evolve in this way. However, it will be far from promising since it will not fix any essential problems that the current Kyoto regime is facing. An irony of this bifurcation is that without a clear departure point such as the *Montreal Mandate* in our scenario, non-EU countries, such as Canada and Japan, may lose the reason to innovate a new global framework. In this sub-scenario, a weak cap-and-trade regime survives, but with little success in cutting emissions and technological development, and with no hope for the future.

Alternatively, the continuation of the binding cap regime, despite all these shortcomings, could increase the awareness of climate change, promote policy and measures, and nurture the industrial interest groups. The question here is whether the regime can survive until the moment when these activities mature and the countries commit to ambitious targets with full participation. Binding caps could, theoretically, foster all the changes. However, we do not think the chances are high since weak targets mean low prices, hence it is doubtful that it will be a strong driver for ambitious policy and measures. It would be better for a weak binding cap regime to be flanked by strong like-minded technology activities. Then, the entire regime looks similar to the GACT.

Such "flanking" activities could take place either within or outside of the UNFCCC. The authors are pessimistic with the first approach since no progress has been made in the past. Article 2 of the Kyoto Protocol was supposed to serve the purpose of implementation of policy and measures (often referred to as PAMs) including technology policies. However, there was simply a stalemate in the negotiations. We understand that there was a problem with the institutional arrangement. In the negotiation under the UNFCCC, cap-and-trade was the major focus and then the negotiating style was hostile. This atmosphere contaminated all the negotiation items through "package deal" practices at each conference. If a country had made a commitment out of good will on PAM, it would have been taken as hostage at a later stage of negotiation. It was impossible to negotiate any ambitious policy and measure in this atmosphere.

The negotiations outside the UNFCCC, such as the GACT negotiation in the scenario, will have more chances to foster truly constructive international cooperation. It can be negotiated among a limited number of like-minded countries at first. Two levels of efforts seem necessary. The lower level is the development of a like-minded (or regional) base, cooperation to develop the climate technologies compatible with their national interests. The upper level is the development of the global treaty to legitimize these activities. It is important to keep the upper level cooperative—not adversarial. For this reason, it will be necessary to keep the structure non-binding at first, and make it gradually binding once countries can comfortably commit themselves.

There may be another sub-scenario. Once the GACT systems begin to grow outside the UNFCCC, the atmosphere of UNFCCC negotiations will also be affected. The process may restructure itself to accommodate the technology activities. There may be a chance then that the UNFCCC will be more flexible. A change from inside would be more difficult given the institutional memory—but the change may come from outside.

7.4 Lost political momentum or new green and greedy coalition

Environmental groups may be concerned that the political momentum will be lost once the global binding cap regime is lost. However, it does not necessarily have to be. The environmental movements will not disappear, but they will change their style in the GACT.

Historically, environmental groups had a coalition with chemical manufacturers in the ozone regime and it was successful in forging regulation. They formed a coalition with windmill manufacturers and succeeded in setting targets and timetables for the renewable share, and implementing a feed-in-tariff policy in Europe.

In the GACT regime, there are three key coalitions formed by environmental constituency—with renewable, energy conservation and the CCS industries. Such a coalition is nothing new—actually, there have been a lot of precedent in environmental policies. Furthermore, if certain environmental groups could work positively with nuclear industries, that would contribute much to mitigation.

In a nutshell, changing the regime structure certainly means a re-alignment of the stakeholders for the environment, but it does not necessarily mean that the political momentum to mitigate climate change will be lost. Continuation of the Kyoto Protocol may be much easier to envisage, but choosing the right structure would be more important in the long run. The scenario suggests possible re-alignment of environmental groups for the technologies that were not their fancy so far.

8. Concluding remarks

Technology has a critical role to play in preventing climate change. The most important technological developments have taken place, and will continue to do so, at the national level for security and many reasons other than climate change. The role of an international climate framework would be to encourage such activities as much as possible. Because resource endowment, history and national interests differ across countries, it is unlikely that countries will cooperate seriously on the minutiae of technology policy on the global scale. Like-minded activities with shared national interests will present greater opportunities for serious cooperation. The global framework will have to play a role in legitimizing these activities.

If successful, stakeholders, particularly industries, would be nurtured in each country under the GACT regime. Their political support would be translated into government actions to seek legitimacy at the global level for industrial technology policies. This would provide an opportunity for players in different sectors and different regions to work together for mutual benefit. For example, it may be possible for promoters of renewable policy in Europe to secure more budgetary support for their domestic feed-in-tariff policies by negotiating with proponents of U.S. carbon capture technology and with Japanese energy conservation policy supporters to mutually recognize their respective commitments in an international forum. The possibility for this kind of cooperation has been rarely noted—and is worth the attention of policy-makers.

Appendix

Niche market and institutional interplay: Lessons from successful "global" environmental policies

This appendix summarizes our case studies on the environmental technology policy. Case studies include regulation of automobile pollutant emission in the 1970s; zero-emission vehicles (ZEV) in 1990; SO_X at stationary sources, 1970s–2000s; wind power deployment in the 1990s; and ozone layer protection in the 1980s.[17]

We have learned four lessons. First, technology matters. Technological developments were closely associated with the successful environmental policies in all cases. Second, country-level activities matter for technological development. Important technological innovations take place at the national level in most cases, not through formal global coordination. It reflects the diversity of resource endowment and different political priorities and situations across countries. Third, creation of niche markets for nascent technology has been the key for innovation, and one big country is usually enough to create critical mass. The niche market was created by various modes—direct regulation and negotiated agreements in stationary SO_X regulation in Japan, feed-in-tariff subsidies in German wind power, and a state-level direct regulation in California for ZEV.

Fourth, countries learn from each other and develop their own regulatory institutions. The development of environmental technology in one country is the key for others to follow suit. In all cases, once the technology had been marketable in a country, it was diffused to the rest of the world. SO_X scrubbers diffused in Japan at first, and then diffused to Europe, the U.S. and China a couple of decades later. Hybrid cars were first invented in Japan to comply with expected Californian regulation, then deployment policies were implemented in Japan followed by the U.S.[18]

Fifth, a formal treaty was not necessary for the global implementation of such environmental policies. A formal treaty was useful in the ozone regime, but it was exceptional, and closely linked with the domestic politics and national interests of the U.S. In many cases, the key environmental technologies diffused without formal treaties. Studies of political science suggest that international interplay of institutions is driven by international exchange of ideas among policy-makers (called elite-networking) and by the interests of manufacturers to improve their competitive advantage and expand their business opportunities. With the two drivers combined, the environmental regulation tends to "race to the top" instead of "race to the bottom" in many cases (Vogel 1995; Drezner 2001; DeSombre 2000).

The findings led us to the idea of the GACT, which puts emphasis on encouraging domestic technology policies. Creation of niche markets helps the technology mature and reduce costs. The private firms are empowered and acquire vested interests in the technologies. Once the technology is affordable for the national economy, the firms, in coalition with environmentalists, push for diffusion policies. Such policies are copied in the rest of the world in the "race to the top." The entire development creates a strong constituency for a more ambitious and binding international regime.

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17 Details of the case studies are available in Japanese (Sugiyama 2003; Ueno 2001).

18 (Shiroyama 2002) provides an analysis of the drivers for R&D of hybrid cars.

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The German wind energy lobby

How to successfully promote costly technological change

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Abstract

German wind power development is a technological success story but has involved very high subsidies. Germany was a latecomer to wind power but specific political conditions in the late 1980s and early 1990s allowed the implementation of the feed-in-tariff regime which has characterized Germany ever since. The wind lobby managed to constitute itself at an early stage and to develop stable alliances with farmers and regional policy-makers. The concentration of the wind industry in structurally-weak regions reinforced these links. With an increased visibility of the subsidies and saturation of onshore sites in the early 2000s, the lobby has been less successful in retaining support. The current attempt to develop offshore projects may suffer from less favourable interest constellations.

1. Introduction

A very effective, but not cost-efficient, policy has boosted renewable energies in Germany throughout the last decade. It started with investment subsidies such as the program "250 MW Wind" and continued with guaranteed feed-in tariffs set out in the "Energy Feed-In Law" of 1991 to be paid by regional utilities. Wind energy in particular grew with double-digit rates that surprised even its hardiest proponents. In February 2002, the northern German state of Schleswig-Holstein generated more than 50 per cent of its electricity from wind (for Germany's installed capacity and electricity generation see Table 1). The sector quickly became a powerful lobby and managed to retain the law despite forceful opposition from energy companies operating in areas with a high potential for renewable energies. Their pressure led to a hardship clause according to which the feed-in-tariff was not applicable if the sale of regenerative electricity to the grid was more than five per cent of total sales of the respective energy company. In the revamped Renewable Energy Law (EEG), all types of renewable energy receive differentiated feed-in-tariffs that make them economically attractive for investors. Here, a compensation model was introduced that evenly distributes the burden among the energy companies. These pass on the extra costs to the consumers, since electricity prices are no longer regulated by the Länder authorities.

Moreover, after the change of government in 1998 new highly-symbolic investment subsidies were set up such as the 100,000 roof program for PV. The overall amount of subsidies is shown in Table 2.

1 This paper has been written in the framework of the project "Developing a post-2012 climate policy architecture" financed by the Government of Japan and the Government of Norway. Taishi Sugiyama from the Central Research Institute of Electric Power Industry (Tokyo) and Kristian Tangen and Henrik Hasselknippe from Fridtjof Nansen Institute (Oslo) have provided valuable comments.

Table 1. Renewable energy in Germany 2003

Type of renewable energy	Feed-in-tariff (ct/kWh)	Installed capacity end 2003 (MW)	Electricity production 2003 (TWh, % of total)
Wind	6.2–9.1	14,700	18.5 (3.1)
Biomass	8.7–10.2	1,000	5.1 (1.2)
PV	50.6	400	0.3 (0.06)
Small hydro (<5 MW)	6.7–7.6	NA	NA
Geothermal	7.1–8.9	0.25	0

Source: BMU (2004a)

Table 2. Subsidies for renewable energy in Germany (million €)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Feed-in-law/EEG	301	403	551	639	1,136	1,540	2,212	2,618	3,363	3,760
Investment subsidy	9	9	9	102	153	102	200	190	200	215
100,000 roofs PV	-	-	-	92	113	113	113	69	70	70
Biofuels	-	-	-	-	3	5	10	10	512	512
Sum	310	412	560	833	1,405	1,800	2,535	2,887	4,145	4,567

Source: Ministry of Environment (2002, 2004b), VDN (2003), for biofuels from 2004 own calculations from UFOP (2004 a,b). All figures for 2003 onwards are estimates

2. Starting with a failure

Germans, in general, have a strong environmental attitude and are willing to invest (at least moderately) in a clean environment. Just one example: Germany is today by far the most important donor of funds to Greenpeace. On the other hand, there is quite some ambivalence in their relationship to technology. They seem to be both technophile and technophobe at the same time. The more transparent, open and understandable technology is, the more it will be appreciated. Hard-to-understand technologies with unknown consequences are less accepted or even violently refused. Renewable energies, because they are open and transparent, will benefit from that attitude (Welle 1997). Compared to the United States and Denmark, Germany was a latecomer in wind technology. This was due to the utter failure of the technology top-down approach pursued in the late 1970s that culminated in the multi-million Euro 3 MW "GROWIAN" (badly chosen acronym signifying "large wind energy plant" but rhymes with the German word for rowdy) built in 1983. This 100 m giant faced severe technological problems and was operational just about 500 hours. It failed due to an unmanageable leap-frog approach (everything in one step), half-hearted political support, resistance of utilities and the absence of interest by Germany's high tech industry. GROWIAN was unceremoniously dismantled. Nobody spoke of wind power for many years afterwards but without much publicity, small turbines coming from Denmark were adopted by some farmers.

In the late 1980s, Germany was one of the first countries to seriously discuss climate policy and thus all forms of renewable energy were revived. In 1988, the Ministry of Research and Technology started a large-scale research program that included an investment subsidies program to install 100 MW of wind power capacity. By 1989, it was already scaled up to 250 MW. Under the 250 MW program, two options existed: either investment subsidies, which were calculated as "hub height [m] x rotor radius [m] x 400" (maximum amount 46.016 Euro[2] and 60 per cent of total building cost), or operation subsidies of 3.1 ct/kWh. This program was complemented by additional programs in many of the German federal states. The decisive element of this program was that it gave enough long-term security to enable banks to lend money to small operators. Moreover, without government support and unnoticed by the public, environmentally-oriented individuals had started to develop small wind turbines.

3. The roaring nineties

The decisive step for the rapid expansion of wind power to levels that had not even been considered feasible by the wildest wind enthusiasts was the Electricity Feed-In Law (EFL) of 1991 which gave, for the first time, every private operator a reliable financial base. Under this law, utilities are obliged to accept power from independent producers of renewable energy. The feed-in tariff was set at 90 per cent of the average retail electricity rate (about nine ct/kWh). The law was supported by all parties. Müller (2000) explains the support of the conservative Christian Democrats that were in power and traditionally not very environmentally-minded by the pressure of small hydro producers from Bavaria.

Thus, despite the Danish technological advance, German manufacturers were able to exploit the incentives and dominated the market, followed by Danish manufacturers, which partly produce in Germany. Between 1982 and 1996, German manufacturers had installed 76 per cent of total capacity. Market leaders were Enercon (29.1 per cent) and Tacke (17.3 per cent); the companies Nordex, Nordtank, Lagerwey and Husumer Schiffswerft all had less than eight per cent. The average capacity per turbine grew from 175 kW in 1991 to 380 kW in 1994 and 510 kW in 1996 (Welle 1997). Initially, most of the German manufacturers were small engineering outfits that profited from the availability of highly skilled engineers that were no longer needed in the economically depressed shipbuilding industry. All companies were set up near the coast, Husumer Schiffswerft originally was a shipyard. Later, production plants in East Germany were added where qualified labour was available and infrastructure was cheap. Political support in these locations was extremely strong, as wind energy enabled diversification in the economy.

A decisive element of the wind expansion drive in Germany was the alliance that formed between several interest groups at a very early stage. Wind plants were planned and financed by small associations, predominantly farmers initially. Farming has long been heavily subsidized in Germany but nevertheless declines consistently. Seeing the possibility of additional revenue from using a tiny portion of their grazing land, dairy farmers near the coast embraced wind eagerly. The farmers dominated local policy-making and thus were able to get wind projects approved quickly. Ninety-five per cent of wind plants in Germany have utility-independent private ownership (Scheer 2004b). The lack of involvement of large banks or companies from the cities prevented a not-in-my-back-yard-(NIMBY)-type backlash that was prevailing in the U.K. at the same time. This group was strengthened by parliamentarians that saw renewables as salvation to a

2 All values of the DM era are converted into Euros to facilitate comparison.

world crisis. As a social democrat Scheer is known for his strong views that equate fossil power with suppression of labour interests (Scheer 2004a). Quickly, wind energy got the same planning rights as large fossil power stations.

In the mid 1990s, the explosive growth of wind capacity made some politicians uneasy about the swelling volume of subsidies. Utilities stepped up their pressure and business reporters criticized the system (e.g., Lampe 1998). The EFL was retained in 1997 only after a great effort by the German Wind Energy Association (Bundesverband Windenergie, BWE) which argued that the abolition of the subsidy would lead to job losses of several thousand located in structurally-weak regions. Welle (1997) estimated that, at that time, the German wind industry employed about 5,000 people directly and that some 5,000 additional indirect jobs had been created. With growth rates of about 80 per cent per year it was one of the fastest growing segments in mechanical engineering. BWE joined forces with trade unions (metal workers have traditionally been well organized) and the agricultural lobby and managed to get 4,000 people to Bonn for a protest march. The success made BWE a strong lobby with 40 regional groups. In 2003, it had 16,000 members (BWE 2003a).

In the second half of the 1990s, the financing structure of wind projects changed. Now the tax-saving funds came to the fore. They collected money from many people that formerly became shareholders in the wind projects. For example, the company Energiekontor collected 120 million Euro and built 57 wind projects within 10 years (Asendorpf and Rauner 2004). As the expenses could be fully deducted from income tax and the EFL allowed to project double-digit rates of return, this vehicle was very powerful. However, the ever larger projects started to mobilize the first NIMBY protests.

Another important fight was waged by the German wind lobby on the EU level. It opposed a directive by the EU of doubling the renewable energy production of member countries by 2010 and was based on a quota system. Christophe Bourillion, executive director of the EWEA, criticized the BWE, citing liberalization of the European energy market as inevitable. The directive would give wind a level playing field while we develop to full maturity and become more competitive. He noted that Germany would have had until 2010 to reform its current fixed-price wind power program (Asmus 1999). In the end, the German position prevailed and the directive allowed all types of national incentives. A European Court case against the EFL was also dismissed in 2001.

The EFL did not provide an incentive to reduce costs of wind power as the guaranteed price level made it more profitable to churn out a maximum of turbines than to focus on cost-saving innovation. Therefore, the producers concentrated on offering ever bigger turbines without lowering the costs. Actually, in the second half of the 1990s, costs rose when the MW barrier was breached (see Morthorst and Chandler 2004, p. 130[3]).

3 The data relate to Denmark, but in Germany the average size of plants has even been bigger (Langniß and Neij, 2004, p. 179).

4. The Renewable Energy Law

Due to the liberalization of the electricity markets, retail prices started to plummet in 1998. Therefore, the wind lobby called for a legal basis that would abolish the link to retail prices. They argued that banks were stopping lending to wind power projects (Müller 2000). Parliament started to debate a successor, the Renewable Energy Law (REL) that entered into force in 2000. A new element was that utilities could also get the feed-in-tariffs.

In 2001, economics minister Müller launched an outright attack against the REL. BWE hurriedly commissioned a study to prove that the average cost of the REL amounted to just 0.1 ct/kWh and would only rise to 0.2 ct in 2010 (Krzikalla 2001) Müller's successor Clement stepped up that fight and called for a quota system. The Ministry of Environment wanted to decrease the feed-in-rates by 1.5 per cent per year. Clement called for a 15 per cent decrease outright and then an annual rate of five per cent.

Utilities joined the fight arguing that they would have to use up to seven per cent of energy produced as "buffer energy" to cover short-term variability of wind (Asendorpf 2002). The wind lobby fought back by stressing that it had created 35,000 jobs and was adding 3,000 more each year, particularly in economically-weak regions (BWE 2002). All major turbine manufacturers were indeed using the subsidies provided for industries in East Germany to build up production plants there. Moreover, it was stressed that wind power manufacturers had become the second most important customer in the German steel industry, after automobiles. The renewables lobby organized a large demonstration in Berlin (Bundesverband Erneuerbare Energien *et al*. 2003). Interestingly, the powerful metal workers' trade union joined. Utilities counteracted by raising electricity prices using the additional costs from the REL as main argument. BWE (2003b) tried to refute their argument but had to concede that the cost of the REL now amounted to 0.4 ct/kWh, double the level that Krzikalla (2001) had forecast for 2010 on its behalf. BWE tried to circumvent this issue by arguing that "10 years from now, renewable energy will be cheaper than fossil fuels," without corroborating this. Nitschke (2003), still with very favourable assumptions for renewables, says that it will be 16 years before wind power becomes competitive. BEE (2003) now says that the maximum of 0.5 ct/kWh would be reached in 2006. This reminds of the classical position in climate policy: "nowadays we have problems in achieving our targets but 10 years from now, everything will be easy."

Clement continued to fight against renewables and got a supporting study by the social democrat-leaning Bremen Energy Institute (Bremer Energie-Institut 2004) that argues that, macro-economically, wind energy had a negative employment impact. Immediately, BWE launched a counter-offensive now claiming that 50,000 jobs had been created through wind energy and that the externalities of fossil fuels had been underestimated by the Bremen Energy Institute study (BWE 2004).

5. The NIMBY backlash

In the early 2000s, the NIMBY wave has increased even if the general population largely remained in favour of wind power (for a nice overview of their arguments from a wind power advocate, see Scheer 2004b). It consists of many local groups with a loose coordination by the Bundesverband Landschaftsschutz; its roots had been set in the late 1990s (Wolfrum 1997). Moreover, the media which had earlier overwhelmingly supported wind power, have turned against it. The popular magazine *Spiegel* in early 2004 titled its cover story “The windmill craze” (Spiegel 2004). The story was well-timed with the parliamentary discussions about the extension of the REL. Nevertheless, wind power supporters rallied, denounced the editor-in-chief for waging a personal crusade against windmills in his backyard. Even within the *Spiegel* editorial office emotions ran high. A senior editor quit (Seel 2004); already in October a draft article on the role of the utilities in fighting against renewables had been turned down by the editor-in-chief.

The NIMBY wave led to a change in the REL that reduced support of less attractive locations that so far had received higher subsidies. The REL revision reduces the feed-in-tariff to 5.5 ct/kWh for plants that do not achieve a certain yield. Plants that achieve less than 44 per cent of that yield do not get any subsidy at all (v. Hammerstein 2004).

In 2002 and 2003, changes in the tax law made wind power funds less attractive for investors and, therefore, the inflow of money was considerably reduced.

6. Emissions trading against feed-in tariffs

In early 2004, the economics and environment ministers engaged in a bitter and publicly visible fight about the allocation of CO_2 emission allowances under the trading system to be introduced in 2005. In the end, the economics minister prevailed and the allocation was set in a very lenient way. Only a few days later, the revised REL was adopted; it contained more generous tariffs than the earlier draft and fixed the annual decrease at two per cent. Media reported that the renewables lobby managed to trade the allocation issue against the tariffs. Anyway, the renewables industry sees emissions trading as a threat to the REL.

7. Salvation by offshore?

Due to the NIMBY movement and the objective exhaustion of attractive onshore sites, for the last three years the wind lobby has tried to promote offshore projects (for a detailed analysis of the discussion see Bartolomäus 2002). It argues mainly that the capacity factor is 50 per cent higher than onshore. The government was convinced very quickly and visions took gigantic proportions. The Ministry of Environment aims at 25 GW offshore capacity by 2030 and the REL provides sizeable subsidies. The hope was to induce the large utilities to invest in such projects but so far they have not been eager to do so (Netzeitung 2004). Initially, the feed-in tariffs of 9.1 ct/kWh were only limited to plants operating by 2006; they are granted for 12 years and then reduced to 6.2 ct. However, only few projects, if any, are likely to be operational by that time. Project opposition has been stiff from coastal communities that fear impacts on their tourism industry. Therefore, the distance to shore has to be very big which increases costs considerably. Likewise, environmental NGOs fear impacts on maritime biodiversity which leads to costly environmental impact assessments. Asendorpf and Rauner (2004) estimate total costs at least as double of those onshore, not least due to the need to get approvals from more than 20 different institutions, which takes about five years. Any project has to be very big to exploit scale effects—several hundred million Euro per project are expected. Nevertheless, 14 requests have been lodged with the authorities. Many port cities are trying to become the base for offshore operations. The race for the first offshore projects has provided an incentive for the turbine manufacturers to offer five MW plants. Enercon has already reached 4.5 MW, Repower and Multibrid wanted to unveil their five MW prototypes in 2004. But whether offshore will offer the salvation that the wind lobby hopes for remains to be seen. The first licence for an offshore site, Butendiek near the island of Sylt, gives them some hope. But the Butendiek consortium uses Danish three MW turbines that have been tested in the first large-scale offshore plant there. Allnoch (2004) sees the first project coming online in 2006. The government reacted and, in the REL overhaul, shifted the cut-off date to 2010. However, an annual decrease of two per cent will apply for projects coming on stream after 2007. As the legal framework is now more conducive to investments, the utility E.ON has invested in two offshore projects, one of which has recently been approved. The utility Vattenfall Europe is discussing similar investments (Gassmann and Gammelin 2004; Anonymous 2004).

8. Conclusions

The German wind lobby has shown that clever utilization of a window of opportunity can lead to a positive feedback loop to implement a costly renewable energy technology. The window of opportunity was provided by the early German enthusiasm about climate policy coupled with euphoria about reunification. Moreover, renewable energy was seen as a chance to reinvigorate regions that had suffered from industrial decline. Once the wind turbine manufacturers got hold there, they were able to mobilize a coalition of local politicians, farmers and trade unions that became stronger, the higher the share of wind in the job market and farmer revenue became. The construction of the subsidy regime was very successful because it distributed the costs to the entire population where they were diluted so strongly that no opposition could be organized. The only threat to wind power is the increasing NIMBY movement that has led to the strategy to develop offshore projects. However, the success factors that were prevalent concerning onshore projects are absent offshore. These projects need large-scale financing and thus do not generate local benefits. It is no surprise that they have already generated substantial opposition.

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Carbon capture and geological storage research – a capture by fossil fuel interests?

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1. Introduction

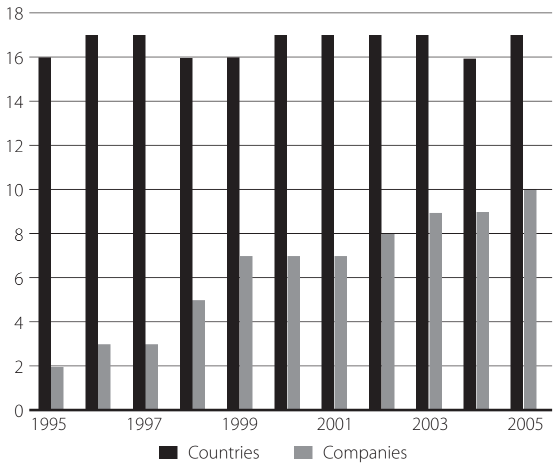
For a long time, carbon capture and geological storage (CCS) has been seen as an expensive, unproven technology that would not play a major role in mitigation of climate change in the near term (Kallbekken and Torvanger 2004). However, in the last three years, this perception has changed considerably. Now CCS is seen by many as a cheap backstop technology of choice that will become relevant in less than a decade (Gibbins 2005; but also in a relatively balanced discussion in U.K. Parliamentary Office for Science and Technology (2005)). What are the reasons for this shift and what role did interest groups play?

2. Forerunners of the CCS movement

In the early 1990s, CCS was seen as a purely academic exercise. But in 1991, the IEA Greenhouse Gas R&D Program (GHG R&D) was established. Despite its generic title, it concentrated on bundling research to promote CCS. Initially, only 16 IEA countries supported this initiative as most national climate policy programs assumed it would be fairly easy to mobilize energy efficiency improvement potential. Moreover, two companies (electric utilities) financed the program. Nevertheless, the GHG R&D Program slowly managed to create a group of CCS adepts and facilitated networking, particularly through biannual conferences from 1993. They alternated with the academic "International Conference on Carbon Dioxide Removal," a series that started in 1992. Countries like Norway, Australia and Japan that felt that mitigation would be costly, co-organized workshops with the GHG R&D Program. In 1996, the two conference series were combined under the new title "International Conference on Greenhouse Gas Control Technologies." Initially, the focus was on ocean sequestration which was immediately attacked by environmental NGOs. Interestingly, the term "disposal" was initially used and only later substituted by the much more positively connoted "storage." Despite these activities, neither the UNFCCC nor the Kyoto Protocol explicitly mentions CCS. Despite that, a few pioneering projects in CCS were started in the second half of the 1990s—all of them with concrete incentives. The Norwegian Sleipner project sequestering one million t CO_2 per year was driven by a carbon tax of 45 €/t CO_2 which led to a payback period of the project of just 18 months (Herzog *et al.* 2000). The Weyburn project in Canada that became operational in 2000 uses CO_2 for enhanced oil recovery (EOR), essentially increasing greenhouse gas emissions as more oil is made available.

From 1995 onwards, company participation in the GHG R&D initiative slowly increased (see Figure 1). Several oil companies and a coal-mining technology provider joined. Country participation fluctuated with countries joining (Belgium, Korea); leaving (Italy, Spain); and even leaving and coming back (Finland).

Figure 1. Participation in the IEA GHG R&D Program

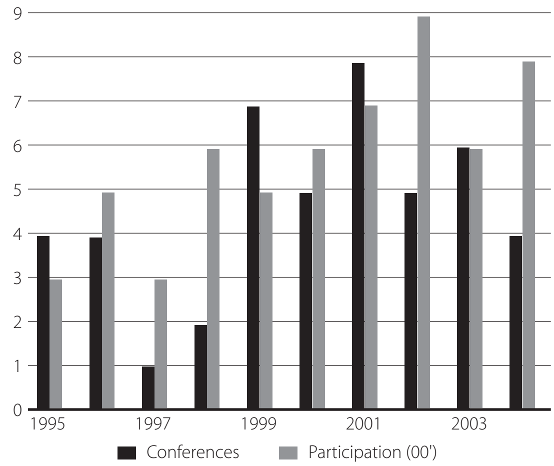


3. CCS interests coming of age

The first big upswing for CCS came with U.S. President Bush's rejection of the Kyoto Protocol in 2001 and the development of a technology-oriented obfuscation initiative of the U.S. government's inaction. This was the continuation of a vigorous, multi-disciplinary CCS research program already started in 1998 by the Clinton administration. By then the target of CCS costs of <3$/t CO_2 by 2015 had been set. The first "National Conference on Carbon Sequestration" was held in May 2001 with 370 participants. In 2003, the Department of Energy launched the plan to develop a zero-emission 275 MW coal power plant called "FutureGen." The U.S. did an active outreach through bilateral agreements and set up the Carbon Sequestration Leadership Forum in 2003 with 14 countries as members. The number of CCS conferences and their attendance had a strong increase between 1997 and 2002 (see Figure 2).

The second boost for CCS came with the growing realization that EU countries will face problems in reaching their Kyoto targets due to the generous allocation of emission allowances to the large emitters. To soothe them to the prospect of long-term carbon control, in many EU countries national CCS programs were launched—the largest initiatives being undertaken in the Netherlands, the U.K. and Germany. In 2000–2001, four large EU research projects on mapping of reservoirs in the EU; reservoir stability; enhanced coal bed methane recovery; and monitoring of EOR carbon sequestration—as well as a network for CCS technology development—started. The Netherlands began a project aimed at a demonstration storage facility and in 2004 started a 25 million € national CCS research program, including nine research institutes; eight companies and—a rare feature—three environmental NGOs. Denmark launched research on EOR in the North Sea. However, opposition of environmental NGOs led to the stop of an ocean sequestration project in Norway in 2002. Further EU research on storage sites in Denmark, Germany, Norway and the U.K. started in 2003. Four concrete storage facilities in Austria, the Netherlands, Norway and Spain and a capture facility in a Danish power plant are developed by a consortium of 12 research institutes, six electric utilities, five oil and gas companies and five technology providers with a budget of 15.8 million €. A storage site in Germany brings together eight research institutions and five companies. Most EU projects involving industry have a cost-sharing between the EU and industry partners of 1:1 (EC 2000).

Figure 2. CCS conferences and participation



Source: Conference announcements and reports in "Greenhouse Issues"

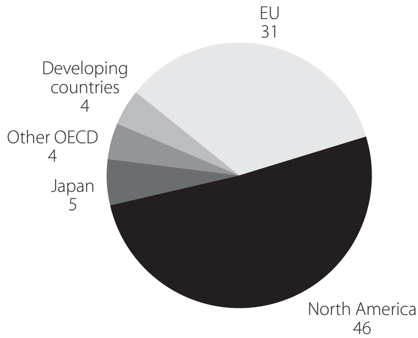
In 2002, Japan drew hitherto dispersed initiatives together in the "CO_2 Fixation and Utilization Programme." Australia set up a "Cooperative Research Centre for GHG Technologies" while Canada opened its "International Test Centre for CO_2 Capture." Even renewable energy pioneer Germany has set up a "COORETEC" program with strong input from coal companies and electric utilities (COORETEC 2004).

BP and six other oil companies ran a three-year "CO_2 capture project" with a cost of US$20 million from 2001 (IEA Working Party 2003). The absence of ExxonMobil was notable.

In 2002, the IPCC was charged with writing a special report on CCS which saw a strong involvement of authors from industry. The draft report was released for expert review in early 2005; it stresses the low costs of CCS.

Country participation of the GHG R&D continued to fluctuate with countries joining (France, Italy) and leaving (Belgium, Poland). Other oil and power companies entered while the coal technology company left.

Figure 3. CCS research projects worldwide 2005



Source: http://www.co2captureandstorage.info, accessed March 28, 2005

4 Development of interest group positions

Emitters are currently dominating the discussion on CCS since they have concluded that it could become a quick fix once government subsidies for its introduction are harnessed. Doucet (2003), Secretary General of the energy utility lobby organization World Energy Council (WEC), stresses that before 2002 "WEC has not treated it [CCS] as a best practice or cleaner system technology because [...] it was not seen as commercially viable in a short enough timeframe to gain political support. [...] Basic research in this area is the joint responsibility of government and industry. The objective of this research should be to bring down the total system costs per tonne of carbon to about \$40/tc [\$11/t CO_2] by 2010." The emitters' long-term vision is nicely summarized in IPIECA (2003, p. 4): "In scenarios where CO_2 concentration is stabilized over the next century, CCS can play a primary role in controlling global CO_2 emissions. Such scenarios entail added CCS infrastructure rivalling that of the current global energy system, with its construction extending over decades due to its massive capital requirements." Or, more bluntly phrased by Doucet (2003): "If you can capture the carbon and sequester it, you can continue to use fossil fuels in the sustainable global energy mix for much longer in the 21st century than heretofore assumed." The World Coal Institute (2002) states, relatively cautiously: "Technologies exist and are being developed that can prevent emissions from the production and use of coal reaching the atmosphere. In the long-term, the capture and storage of CO_2 offers one of the most promising routes to zero emissions."

Industry representatives argue that CCS is an emission reduction under the Kyoto Protocol. They are influencing the definition of IPCC good inventory practice due in 2006 in that direction. The argument of researchers (Bode and Jung 2004) that CCS should be treated analogously to terrestrial sequestration through LULUCF and thus only generate temporary credits drew a lot of criticism from industry. Industry positions also pervade politicians' views. Norwegian politicians try to water down the rules of the OSPAR treaty prohibiting dumping of wastes under the seabed arguing that "a successful development of sequestration technologies could prove to be of vital importance for further use of fossil fuels as an energy source. […] CO_2 is likely to be stored in geological structures that have contained oil and gas securely for millions of years" (Håbrekke 2004).

Consultancies have only recently started to see the revenue potential of this field. The Dutch company Ecofys sees CCS as a "new and potentially very powerful solution to strongly reduce carbon dioxide emissions," uncritically taking the emitters' perspective.

Duckat *et al.* (2004) sum up the environmental NGO perspective on CCS: it should only be used as "bridging technology." The energy penalty due to capture increases the exploitation need for fossil fuels and the cost intensity of the technology makes it only feasible in large, centralized power plants. CCS could crowd out renewable energy and energy efficiency technologies. Non-permanence and ecological risks of ocean storage would be unacceptably high; a clear liability for reversal of storage should be defined. Voicing the same concerns, CAN Europe (2004) sees benefit in CCS if it leads to reduced air pollution from vehicles and more modern fossil power plants or is linked to the use of biomass fuel. Astonishingly, most other NGOs have remained silent on CCS so far. Norwegian Bellona even strongly supports CCS "as a key measure for creating a bridge to a society powered by hydrogen from renewables" (Bellona 2003).

5 Conclusion

The CCS community acted very cautiously in the beginning of the 1990s, using terms that could be seen as encompassing all types of mitigation and trying to avoid sparking of public interest. The IEA played a catalytic role in this endeavour. From the mid-1990s, CCS programs have become increasingly bold and interest-group driven. Greenhouse gas-emitting companies have played a growing role in defining directions of CCS programs as well as working in concrete research projects. This is the case both within and outside of the EU. Countries that were earlier focused on renewable energy programs only (Germany and Denmark) are now embarking on large CCS research. Policy-makers are generally uncritically repeating the arguments of the emitters concerning continuation of fossil fuel use and the accounting of CCS as an emission reduction. NGOs are not able to effectively oppose this trend but have been able to stop experiments in ocean sequestration. However, as general public acceptance and support is of great importance for CCS and the public is largely unaware of CCS (IPIECA 2003; Shackley *et al.* 2004), the outcome of the debate is by no means assured. A backlash compared to the debate about nuclear waste storage is possible as feared by WWF representative Singer (quoted in Bellona 2003). However, Shackley's *et al.* (2004) finding that initial scepticism is substituted by slight support "once information is provided on the role of carbon storage in reducing CO_2 emissions to the atmosphere" (*sic*, again the industry wording[1]) indicates that this is not guaranteed.

1 This may be due to the fact that the study was commissioned as part of the U.K. Department of Trade and Industry's Cleaner Coal Technology Transfer Programme which means that the industry perspective played a role.

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Carbon storage and climate change – the case of Norway

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1. Introduction

The possibility of extracting and storing CO_2 in a safe place to avoid emissions has for many years been considered a future remedy to the climate problem. Earlier referred to as one of several forms of CO_2 sequestration, it is now more commonly referred to as CO_2 capture and storage, leaving sequestration to only refer to terrestrial (biological) storage of CO_2. The attractiveness of CO_2 storage, and also its weakness in the eyes of its opponents, is that it offers a method to reduce emissions that does not require major changes in the energy supply system, at least for some time.

Storage of CO_2 in structures under the ocean floor has for several years been considered a promising option for handling CO_2. Norway has taken a particular interest in this theme, due to its position as a CO_2 emitter connected to offshore oil and gas production, as well as to the existence of geological formations suitable for storage. The purpose of this paper is to give an overview of the challenges related to carbon storage as a climate policy measure, exemplified by the case of Norway. Based on the experience of Norway, we wind up the paper by discussing implications for the climate regime of bringing the issue into the formal channels of the UNFCCC and the Kyoto Protocol.

2. Carbon storage as a climate policy measure – an overview

CO_2 capture and storage embraces three steps. The first step is capture or separation of the CO_2. *Capture* of CO_2 generally refers to a process of capturing the CO_2 released from large emission sources like power generation. *Separation* of CO_2 refers to the process of separating CO_2 from a gas stream. While technologies for both capture and separation of CO_2 are available, there are significant cost differences. As will be discussed in the following sections, the cost of capturing CO_2 from power generation is a major challenge facing carbon capture and storage as a climate policy measure. There is also a cost issue with separation, but of a much smaller magnitude. Because of the different economic challenges concerning handling CO_2 from power generation and gas streams respectively, we find it useful to distinguish between capture and separation, but will include separation as part of the more general concept "carbon capture and storage."

The second step of carbon capture and storage is transportation of the CO_2 to the storage location. Pipelines and ship transport are the alternatives. The final step of carbon capture and storage is long-term disposal of the CO_2. Several options are available. Pure storage solutions include disposing of the CO_2 underground or in the ocean. Other options of long-term disposal are using the CO_2 as input in industrial processes or injecting the CO_2 in producing petroleum reservoirs to improve the recovery of oil. Pure storage and injection to improve oil recovery are the two disposal options today that can handle substantial volumes of CO_2, and we will hence limit the discussion to those alternatives (Norwegian Ministry of Petroleum and Energy 2003).

Pure storage of CO_2 can take place in the ocean or in geological formations.[1] Due to uncertainty about the permanency of ocean storage, this method has so far not been tried out, and following the present policy debate and technical R&D efforts we will focus on geological storage in this paper. Geological formations with potential for storage of CO_2 are aquifers (water reservoirs in the subsoil), producing and non-producing petroleum reservoirs, and non-mineable coal formations (NOU 2002, 7). Large-scale storage in aquifers is currently only taking place on the Norwegian Continental Shelf, but several small- as well as large-scale projects are in the pipeline in other countries, notably the In Salah gas project in Algeria which started in 2004, and the proposed development of the Gorgon offshore gas field in Australia (U.K. Department of Trade and Industry 2004). Note that these three projects all regard storage of CO_2 separated from the gas stream. Technology for storage of CO_2 in non-mineable coal formations is demonstrated at installations in the U.S.

Injection of CO_2 in producing oil reservoirs to improve oil recovery has been used onshore in the U.S. and Canada for more than 30 years. A Canadian oil and gas company, Encana, has been operating a major CO_2 injection facility in their Weyburn, Saskatchewan, oil field for a number of years. The CO_2 is pipelined to the oil field from a syngas facility in the northern U.S. While this is a commercial, enhanced oil recovery operation, it has also been the subject of a monitoring research study conducted with the support of the International Energy Agency Greenhouse Gas Research and Development Programme (IEA GHG). The IEA Weyburn Monitoring and Storage Project is an international research project intended to establish the degree of security with which greenhouse gases, particularly carbon dioxide, can be sequestered in geological formations during large-scale, commercial, enhanced oil recovery operations. This will be accomplished through the scientific mapping of the movement of CO_2 in the reservoir, and technical prediction of the future long-term storage and migration characteristics of the CO_2. This monitoring project is managed by the Petroleum Technology Research Centre.[2]

According to the IEA greenhouse gas R&D program, the global storage potential in exploited oil and gas formations is about half of global emissions to 2050 (920 Gt CO_2) and 150 per cent of emissions to 2050 in deep saline aquifers (3,000 Gt CO_2).[3] Due to uncertainty about emission projections and varying safety of storage locations, these figures should be treated with care and understood as a rough indication of the huge potential of carbon storage sites actually existing. The technology applied for injection is well developed as numerous sites have been used for the temporary storage of natural gas for decades.

1 It is also a possibility to store mineralized CO_2 as a solid substance, but this option is presently not high on the agenda of carbon capture and storage as a climate policy measure, and we will hence not include it in the further analysis.

2 http://www.nrcan.gc.ca/es/etb/cetc/combustion/co2trm/pdfs/co2trm1_cpreston.pdf

3 "Technical options for placement of CO_2 in the maritime area." Presentation by Paul Freund, the IEA Greenhouse Gas R&D Programme, at Ospar workshop, October 27, 2004.

3. Environmental challenges

There are two main environmental challenges facing carbon capture and storage: the first is, of course, whether it is possible to store the CO_2 safely in the geological formation in the long term—i.e., the technical risk. The second question is political: will investments in carbon storage replace investments in renewable energy and conservation, and accordingly be a barrier to de-carbonization of the energy systems? This last question seems to be the main reason why some environmental NGOs have taken a negative stand on carbon storage.[4] With respect to the technical risk, a conclusion from a workshop of the International Panel on Climate Change (IPCC) on carbon capture and storage in 2002 was that the environmental impacts of geological storage are likely to be small, but are not well characterized.[5] If huge amounts of CO_2 are stored, the release rates must be very low in order to prevent them from becoming a large source of future emissions (Bode and Jung 2004).

An underground deposit must display certain characteristics to be suitable for CO_2 storage. It has to be deep under the ocean surface to have high enough pressure, and the species of rock must be sufficiently porous to permit the gas to be pumped in. And of course, it is essential that the geological formation is stable and not earthquake prone. With reference to natural CO_2 fields[6] and studies of natural analogues, geologists conclude that, under favourable circumstances, geological formations with certain characteristics can hold CO_2 for millions of years.[7]

Establishment of procedures for risk assessment when selecting storage sites and monitoring systems are necessary both in order to ensure environmental performance and to build stakeholder confidence. The methods for risk assessment and monitoring are available: reservoir behaviour can be predicted with simulation tools based on reservoir information, and seismic and sediment samples are some of the available methods for monitoring.[8] There is extensive national and international research going on covering both risk assessments of leakage from geological formations and monitoring issues.[9]

In addition to the environmental challenges in the storage phase, there is also an environmental issue related to the capturing of CO_2, often referred to as the energy penalty. Capturing CO_2 requires energy, and according to the IEA Greenhouse Gas R&D Program, capturing CO_2 reduces the energy efficiency in a power plant by as much as 10–15 per cent.

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4 http://www.cslforum.org/documents/von_Goerne_Gabriella_mon_Pal_AB_1330.pdf

5 Presentation by Heleen de Coninck with the IPCC on an OSPAR workshop, October 26, 2004.

6 Workshop report: Ospar workshop on the environmental impact of placement of carbon dioxide in geological structures in the maritime area, October 26–27, 2004.

7 Workshop report: Ospar workshop on the environmental impact of placement of carbon dioxide in geological structures in the maritime area, October 26–27, 2004.

8 "Safe storage of CO_2." Presentation by Erik Lindeberg, Sintef, at Ospar workshop October 27, 2004. "How can injected CO_2 be monitored?" Presentation by Barthold Schroot, TNO's Institute of Applied Geoscience, at Ospar workshop October 27, 2004.

9 An updated overview of projects can be accessed via the IEA Greenhouse Gas R&D Programme's Web site: http://www.co2captureandstorage.info/

4. Economic challenges

The IPCC estimates the costs of carbon capture and storage to be approximately US$40–60 per tonne of CO_2 (IPCC 2001), while the International Energy Association estimates that capturing and storing CO_2 would cost from $50 to $100 per tonne (Carbon Market News, December 15, 2004). Several other studies estimate the total costs to range from about $20 per tonne of CO_2 up to about $100, depending on the capture source, modes of transportation and types of reservoirs (Torvanger, Kalbekken and Rypdal 2004). Compared to current prices in the European emissions trading market of about 8.5 Euro, or about US$11, it is fair to conclude that the cost obstacle is at present significant, but there is probably scope for reduction of costs in the future through technical developments and wider application (IPCC 2001).

Of the total costs, the capture costs are expected to constitute a much larger share than transport and storage, about 70–80 per cent according to some sources. Reducing capture costs is hence identified as the major economic challenge. But as noted above, this is only relevant with regard to CO_2 from large emission sources like power generation and not CO_2 separated from the gas stream.

5. Political and legal challenges

There are also legal barriers and potential political barriers on the international level with regard to disposal of CO_2. There is a need for clarification of the legal status of carbon storage in international conventions; simply because carbon capture and storage was not foreseen as a climate policy measure at the time the conventions were developed. Because of scepticism among several environmental NGOs and some states towards the measure as a climate policy measure, ongoing international processes aimed at solving the legal challenges might meet political barriers.

The first set of legal, and potential political, challenges stems from conventions developed to protect the marine environment. It has been maintained that injection of CO_2 is in conflict with the OSPAR convention, which was established to protect the marine environment in the northeast Atlantic area. This convention is far more concrete and operative than the UN Convention on the Law of the Sea, which also has provisions to protect the environment. The issue is whether injection of CO_2 can be considered dumping of a toxic. And since this process was not foreseen when both conventions were developed, there is scope for discussion and interpretation (Brubaker and Christiansen 2001). Dumping, which is defined as the discharge of waste or other substances into the ocean or the underground from ships, airplanes or offshore installations, is prohibited. But there are clauses that permit discharges from sources onshore as well as offshore if the precautionary principle and best available technology were employed.

A process, which might lead to the necessary revision of OSPAR, was started only recently within committees of the convention. There is also a need for clarification with regard to the London Convention on dumping (Gran 2004). To some extent these legal problems must be regarded as technicalities and, whereas they form obstacles to CO_2 injection today, the conventions can be adapted if consensus on the environmental safety issue can be established.

The other set of legal and political challenges at the international level comes from the treatment of the issue in the climate convention and the Kyoto Protocol, or the lack thereof. Carbon storage is not discussed directly and can only be inferred from general provisions about sequestration.[10] In the IPCC Third Assessment Report from 2001, CO_2 capture and storage is mentioned as a serious mitigation option alongside the more established options, but safety and verification are noted as problems. The IPCC is presently working on a report on carbon capture and storage to be finished during 2005. The report will include environmental, geological, technical as well as economic issues. The adoption of the report can become an important step towards clarification of the status of carbon storage as a climate policy instrument, but as will be discussed in the last section of the paper, it could also be another complicating factor in the international climate negotiations.

How the issue is handled with respect to the EU emissions trading scheme (EU ETS) will also be important for the acceptance of the measure within the future climate regime, since the EU ETS has become somewhat of a benchmark for potential future GHG emissions trading schemes. According to the EU regulations on reporting and monitoring, the member states are allowed to report storage projects upon approval by the EU Commission, until permanent regulations have been developed.[11]

The major environmental, economic and legal/political challenges are summarized in Table 1.

Table 1. Carbon capture and storage as a climate policy measure – major challenges

	CHALLENGE			
STEP	**Environmental**	**Economic**	**Legal**	**Political**
Capture	Investments in capture technology replacing investments in renewables?	Capture technology is not commercial at present.		
Transportation		Establishment of new infrastructure		
Storage	Investments in storage technology replacing investments in renewables? Developing procedures for risk assessment and monitoring of storage sites to ensure safe storage.		Clarifications of the legal status of carbon storage as a climate policy measure in OSPAR, the London Convention, under the UNFCCC and in the EU ETS.	Building confidence in storage as a safe and sound environmental measure.

10 The issues related to the Convention, as well as key technological challenges are discussed in (Torvanger, Kallbekken and Rypdal 2004).

11 Commission decision of January 29, 2004, establishing guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council.

6. The case of Norway

Norway has no suitable structures for CO_2 storage on land, but storage in geological formations like aquifers and producing and non-producing petroleum reservoirs offshore is applicable in Norway.[12] Utsira alone, the aquifer where CO_2 from the gas field Sleipner is presently stored, has been estimated to have a capacity of 600 billion cubic meters of CO_2. The second storage option applicable in Norway is to inject CO_2 into non-producing and producing petroleum reservoirs. CO_2 can be stored in either oil or gas fields after production has ceased. About 20 fields on the Norwegian Continental Shelf with an estimated storage potential of just over 1,000 million tonnes of carbon dioxide have either ceased production or are due to cease within the next 10 years (Norwegian Ministry of Petroleum and Energy 2003).

Since 1996, the partly state-owned Norwegian oil company Statoil has injected more than five million tonnes of CO_2 into a sandstone formation at the huge offshore gas field Sleipner—the so-called Utsira formation. This is considered to be the first full-scale project of its kind. The CO_2 has been separated out from natural gas produced at the Sleipner fields. To market the Sleipner gas, the high CO_2 content (nine per cent) must be drastically reduced. Thus, the *separation* of CO_2 is part of the industrial/commercial solution for Sleipner. The separated CO_2 could have been emitted, but this would have incurred costs in the form of the Norwegian CO_2 tax. Consequently, *injection* of the gas becomes economically more attractive. The second major storage project on the Norwegian Continental Shelf is planned at the Snøhvit gas field in the Barents Sea. Production start at the field is scheduled for early 2006. Like at Sleipner, CO_2 from the gas stream will be separated and injected into a sandstone formation at the field. The annual storage volume will be 700,000 tonnes of CO_2.

It is also possible to inject CO_2 into producing petroleum fields to enhance oil or gas recovery by increasing the pressure in the reservoir. Injection of CO_2 will then normally replace injection of water or natural gas. Since CO_2 injection offers the added advantage of storing CO_2, the method should also be discussed in a climate policy context. CO_2 for enhanced oil recovery has so far not been applied offshore, and based on 30 years of experience from the U.S. and Canada, onshore cannot be transferred directly to the petroleum fields offshore Norway. Nevertheless, Norwegian authorities as well as oil companies have been assessing the potential for injecting CO_2 for enhanced oil recovery in various fields on the continental shelf. According to those assessments, both technological and economic challenges remain to be solved before the option can be realized in Norway.[13]

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12 Storage of CO_2 in the ocean is also a theoretical possibility, but due to scientific uncertainty about the permanency of such storage, the method is controversial and has so far not been tried out. The Norwegian Ministry of Environment stopped an experiment of releasing about five tonnes of CO_2 in deep water in the Norwegian Sea in 2002. The Norwegian Institute for Water Research had first been admitted a permit to carry through the experiment from the Norwegian Pollution Control Authority, but Greenpeace and WWF submitted a complaint of the decision to the Ministry of the Environment, which consequently altered the decision.

13 Report No 38 to the Storting (2003–2004).

6.1 Norway in the international setting

The Norwegian government seems to increasingly arrange for CO_2 storage to become an accepted climate measure internationally. Norway's positive position on carbon storage has most strongly been expressed in the form of participation in international technological cooperation. The Norwegian companies Statoil and Hydro are participating in the technological cooperation that was established by the CO_2 Capture project (CCP) in 2000. The CCP is directed towards technology developments for all aspects of capture and geological storage of greenhouse gases, and comprises eight international energy companies.[14] Norwegian authorities provide some funding through the Research Council of Norway, and there has also been financial support for research from the European Union and the U.S. Department of Energy.

Another international cooperative effort, with stronger political overtones, was launched in 2003 with the establishment of the Carbon Sequestration Leadership Forum (CSLF). This was an American initiative and has 16 countries as members, as well as the EU. The Forum is "an international climate change initiative that is focused on development of improved cost-effective technologies for the separation and capture of carbon dioxide for its transport and long-term safe storage. The purpose of the CSLF is to make these technologies broadly available internationally; and to identify and address wider issues relating to carbon capture and storage. This could include promoting the appropriate technical, political, and regulatory environments for the development of such technology."[15] The Forum holds meetings on a minister or deputy minister level and can be regarded as a framework for international cooperation in research and an effort to focus public support to technology development.

Norway's support for the initiative can be understood both on the background of the country's natural conditions for CO_2 storage, but also as a way to find some common ground with the U.S. in climate politics and a forum for climate dialogue. Norwegian authorities are anxious to stress though, that "it is a precondition that the cooperation is not presented as an alternative to the Kyoto protocol or other international climate agreements with binding emission commitments." (Norwegian Ministry of Petroleum and Energy 2004). The other pro-Kyoto members of the forum probably share this concern.

Norway has also developed a more pro-active policy within the climate negotiations, seeking to reduce or lift the barriers discussed above. The Norwegian Minister of Environment at COP-9 in Milan in 2003 highlighted the success of the Sleipner experience in order to promote the idea of carbon storage as a climate policy measure in a bridging period from fossil fuel-based economies to economies based on renewable energy (ENB 2003; Norwegian News Agency, December 11, 2003). At COP-10 in 2004, the minister also stressed technologies to capture and store CO_2 and pointed to the possibility of storing CO_2 from other European countries on the Norwegian Continental Shelf.[16]

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14 BP, Chevron, Eni, Hydro, Suncor, ConocoPhillips, Shell, Petrobras. http://www.CO2captureproject.com/index.htm

15 http://www.cslforum.org/intro.htm

16 Statement by Mr. Knut Arild Hareide, Minister of the Environment, Norway, Panel Discussion, COP-10, Buenos Aires, December 16, 2004.

Even though official pronouncements have been more supportive lately, Norway has been careful not to tout carbon storage as an established climate policy measure. Nevertheless, the main carbon capture or, more precisely, separation and storage project in Norway is clearly connected to the climate regime. As described above, the economic stimulus for the injection of Sleipner gas into the Utsira formation is caused by the Norwegian CO_2 tax. By injecting the gas, companies avoid the tax. But if this procedure is to make sense in Norway's overall emissions accounting, the injected volumes must be subtracted from the country's CO_2 emissions when they are reported to the UNFCCC Secretariat. Thus, Norway presupposes that carbon storage will be recognized under the UNFCCC.

The idea of Norway offering a solution to CO_2 emissions from other European countries by injecting the gas for enhanced oil recovery in Norwegian oil fields has also recently been communicated to the European Union by the Norwegian government. An expert group consisting of representatives of various European countries has been set up.[17]

7. Carbon storage and the international climate negotiations

So far, international processes on carbon storage have been developing separately from the negotiations on the climate regime, and the processes have mainly taken place in technical, not political arenas. Even so, some countries, i.e., Norway, and also Canada, have brought the issue to attention in the climate negotiations from time to time unilaterally. Carbon storage has, however, not been on the official agenda. Thus, the status of the measure in relation to the UNFCCC and the Kyoto Protocol has not been clarified. With the launching of the IPCC report on the issue in autumn 2005, carbon storage will formally be brought into the international climate regime. This does not necessarily mean that the issue will be high on the political agenda in the international negotiations. The report as an input to policymakers will probably first be discussed at a SBSTA meeting, which attracts much less political attention than the Conferences of the Parties do. Whether the IPCC report will contribute to clarification of the status of carbon storage within the climate regime, will hence depend on how the process develops from the initial SBSTA discussions, and also on whether actors within the climate regime see it in their interest to obtain guidelines.

If, as a consequence of the IPCC report and increasing international attention, the issue is put high on the agenda in the international climate negotiations in the near future, it is possible to outline at least two opposite scenarios. One possibility is that this will advance the international negotiations one step further; the other is the opposite, namely that international climate diplomacy will be further complicated.

It seems possible that carbon storage might constitute some common ground between the parties on the Kyoto track and the U.S. It is an option compatible with the U.S. emphasis on technology development and a measure that does not threaten the fundamental interests of important domestic actors within the U.S., i.e., the coal and oil industries. It is also important that the U.S. was the initiator of the

17 Press release from the Norwegian Ministry of Petroleum and Energy, May 23, 2004.

Carbon Sequestration Leadership Forum. The EU, also a member of the CSLF, is like the U.S. in emphasizing research and development on carbon capture and storage, and several R&D programs are ongoing or in the pipeline.

Unfortunately, the scenario of carbon storage complicating the climate negotiations seems more realistic. As has been stated above, there are still many unresolved questions regarding the overall feasibility of carbon storage as a measure to combat climate change on a large scale. There is also a list of more specific issues, which will have to be solved if carbon storage should be accepted as a climate measure. One such issue is whether it should be treated as a sink, with all that implies in the climate regime, or whether it should be counted as emission reductions (Bode and Jung 2004). Another set of problems will be connected to certification and verification procedures for storage sites.[18] And third, as would be highly relevant for Norway, it is necessary to determine how to share credits for CO_2 reductions in situations where capture and storage are taking place in different countries.

What will be the consequences of bringing these issues into the climate negotiations in the near future? Carbon storage is still very uncertain, and a lot of new controversies are likely to erupt. Furthermore, if carbon storage is brought into the negotiations, the discussions will have a conditional character since there are still fundamental technical uncertainties. To clarify and develop the option, considerable economic resources are needed. It is easy to imagine that these efforts will be at the expense of other options that are already at hand, i.e., energy conservation and renewable energy. This will create tension in the negotiations.

We will argue that bringing the issue of carbon capture and storage into the climate negotiations at this time will probably do more bad than good. The questions of monitoring, verification, selection of storage sites and public confidence should be allowed to mature outside the climate negotiations before the issue is fully discussed within the framework of the UNFCCC. Also, the potential to constitute common ground between the U.S. and the Kyoto Parties would probably be higher if these issues are allowed to develop further outside the climate negotiations.

This argument does not disregard carbon storage as a possible future option. According to the most optimistic analyses, carbon storage offers a possibility to deal with a substantial share of the world's CO_2 emissions over many years. This "service" can, in principle, be made available to many emitters and many countries. But there are a limited number of countries where the required geological structures can be found. These countries, which include Norway, will have an additional interest in developing carbon capture and storage as a feasible technology. They will be able to charge customers for the use of storage capacity. Thus, it can be argued that they will have a strong economic self-interest in developing solutions for carbon capture and storage, and that it should not be necessary to use mechanisms negotiated at the global level to support research and development for this purpose. In other words, the collective action problem associated with several forms of development and transfer of technology will be much less pronounced in the case of carbon capture and storage, since the number of users

18 Some of those issues are discussed in Torvanger, Kalbekken and Rypdal 2004.

will be limited by the natural distribution of storage sites. Nevertheless, the need for international cooperation—among storage "owners" to reduce costs is there, and also to develop environmentally-solid methods for selection of storage sites and monitoring.

To a large extent, such a "regionalization" of carbon capture and storage development outside the global climate negotiations is actually what has happened, with the establishment of various fora, as mentioned above. The argument here is that the development should continue along these lines until sufficient certainty about environmental as well as economic aspects of carbon storage has been reached. The prospects for realization of carbon storage as a climate policy measure might, in fact, be better if the issue is not brought into the framework of COPs/MOPs for the time being. In other words, carbon capture and storage belongs in the debate and research efforts about future climate policy measures, but not yet in the negotiations about a post-Kyoto climate regime.

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Part 3: Development and Assistance

Fulfilling basic development needs with low emissions[1]

China's challenges and opportunities for building a post-2012 climate regime

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Abstract

Fulfilling multi-dimensional basic needs is an essential element of human rights. Economic development builds up the material basis for satisfying basic needs, but pursuit of a low-emissions path is a substantial challenge for a developing country like China. Large amounts of energy-intensive investment has to be made to accumulate fixed stocks of physical infrastructure, capital and durable goods. High levels of energy flows are also required to meet daily needs such as cooking, lighting, heating and cooling, in addition to the maintenance, operation and renewal of the fixed stocks. Compared to developed countries, where fixed stocks have already been built up, a rapidly industrializing China is at the stage of increasing both stocks and flows of carbon. However, there exist many opportunities for China to contribute positively to building a post-2012 climate regime through no-regrets commitments to greenhouse gas emission reductions.

1. Introduction

The Kyoto Protocol entered into force in February 2005, and the post-2012 international negotiations are set to begin at the end of 2005. With the major parties having significant disputes about some key issues, the process of building an international climate regime has reached an important crossroads. Ever since the Kyoto Protocol was negotiated in 1997, increasing attention has been paid to the architecture of post-2012 commitment frameworks.

One fundamental issue for emission reductions is baseline setting. In the Kyoto Protocol, the baselines for industrialized countries are their respective 1990 emissions levels. This choice of base year is reasonable, as these countries had already built up fixed stocks of carbon and emissions-intensive infrastructure and reached a relatively high level of carbon and emission flows in both the residential and public sectors. Both fixed stocks and flows of carbon and emissions were sufficient to meet basic needs for food, clothing, shelter, mobility and the like in these countries. Although a few Annex I Parties did require a change of the base year, such

1 The authors acknowledge the kind assistance from other staff members at the Research Centre for Sustainable Development, Chinese Academy of Social Sciences, in the process of preparing this paper. Comments and suggestions were also received from the participants at the Workshop on a Post-Kyoto Policy Regime in Beijing, January 19–20, 2005. The members of the South-North Dialogue team provided valuable input for further work on the idea of emissions for human development at a Workshop in Capetown, South Africa, January 22–25, 2004. However, the views are those of the authors and the authors bear responsibility for any errors.

changes are in general close to the baseline. The United States withdrew from the Protocol, but it has never protested against the setting of the base year.

Developing country Parties are not required to make any commitment to emission reductions under the Convention and its Kyoto Protocol. Instead, development is acknowledged as a priority over emission reductions in these countries. Evidently, not a single developing country would accept as a baseline the levels of emissions in a past year, since both stocks and flows of carbon have been associated with economic activity too low to meet basic needs. An alternative would be to set a dynamic baseline some distant time in the future, but the development process in many developing countries is so uncertain that no one can say for sure when and how basic needs will be met. Moreover, there is a methodological issue of how to understand and evaluate basic needs and how demand for emissions is linked to or embedded in basic needs.

In this paper, an attempt is made to understand and define basic needs and their relationship to GHG emissions. Fulfillment of basic needs has to be through a development process that builds up energy-intensive stocks and energy flows to levels sufficient to satisfy basic needs. As China is in the process of rapid industrialization and urbanization, energy consumption and emissions have been increasing quickly to build energy-intensive, man-made capital stocks and to raise energy flows. We assume that for a given level of stocks and flows of energy, an alternative low-emissions path is possible. The challenges China faces in its development can be overwhelming, but there exist opportunities for its participation in building an international climate regime. In the final section, we discuss methodological issues and draw conclusions about China's potential to mitigate global climate change.

2. Basic needs and their implications for welfare and emissions

Fulfillment of basic needs is ethically well-grounded and politically undisputed, as this is an essential part of human rights. Basic needs are finite from a biological perspective, but are also subject to environmental and physical constraints. Elements of basic needs such as food, clothing and shelter are not measured in terms of carbon, but they are linked to carbon and energy consumption, and consequently to emissions as well.

2.1 Basic needs as an issue of rights and limits

Human welfare is multi-dimensional and the satisfaction of basic needs is an immediate and imperative goal for human development (Sen 1985). However, human development is not a process associated with unlimited resource demand. In terms of material consumption, there is a biological limit. Furthermore, there are physical and environmental limits as well due to the finite nature of the Earth. In fact, basic needs satisfaction is the foundation for conceptualizing sustainable development (WCED 1987, p. 43), which requires meeting the basic needs of both current and future generations. Therefore, human welfare is a function of basic needs but subject to biological and physical constraints (Pan 2003).

Individuals and communities of a society are entitled to development rights, including social, economic and political liberties (Dasgupta 1993, p. 40). Communities are highlighted here because individual human beings are organized into social entities with demands for consumption of public goods and services. Some basic needs are required to make survival possible, while others are identified with "positive freedom," i.e., with the ability "to be somebody, not nobody; a doer-deciding, not being decided for" (Berlin 1969, p. 131).

From a biological perspective, elements such as nutrition, shelter, sanitation, health care and primary education are essential for the continuation and functioning of individuals and communities. Positive freedom often refers to civil and political rights that are non-material and non-physiological, such as the right to vote and to be elected, freedom of speech, protection of individual dignity, and security of legitimately-acquired private properties (Sen 1985; Dasgupta 1993).

Given the discussion above, the satisfaction of basic needs is an essential part of human rights that individual human beings are entitled to have, but there are differences in the level of basic needs satisfaction among individuals, groups and regions.

Unlike basic needs, which are subject to certain biological limits, luxury and wasteful demands tend to be unlimited. For instance, nutritional needs for growth and daily activities are in the range of 2,500 to 3,200 calories per day per person. Excessive nutritional intake actually causes harm to health, such as obesity, high blood pressure and hyperglycemia. These harms would require consumption of more resources (including time, financial and material resources) in order to reduce damages. Since land resources are fixed, "the bigger the better" is not an appropriate standard to apply to house construction. Only one bed is needed for sleep no matter how big a house one has. Few people can live a life longer than 100 years despite continuous efforts to increase life expectancy.

Due to biological and physical limits, basic needs satisfaction should take priority over luxury and wasteful consumption. Efficient allocation of resources can lead to profit maximization, but development rights should be respected to guarantee the satisfaction of basic needs and the political and economic interests of individuals, especially the most disadvantaged.

2.2 Matrix of basic needs

Basic needs are multi-dimensional, but they fall into two broad categories: physical and spiritual needs. Physical needs have to be satisfied through material resource consumption. Spiritual needs, to a large extent, also have to be met with the support of material conditions. For instance, a concert is basically for spiritual enjoyment, but a concert hall is needed to make it possible. A tour to see beautiful landscapes does not "consume" the landscape, but to realize it, transport, food, accommodation and other material support is necessary. Spiritual satisfaction itself is not necessarily measured by material consumption, but material needs are required to support non-material consumption. Therefore, in Table 1, only material needs with direct physical measurements are given for understanding the nature of different types of basic needs.

Stocks are capital goods and durable consumption products that last a relatively long time. Physical infrastructure is a typical example of capital goods that once built is not replaced every year. Both private housing and public buildings are constructed for useful lives of decades. Many durable goods are also in this category, such as cars and electric appliances. By contrast, flows are normally for instant consumption, such as food, clothing, energy for cooking and heating. Nothing is left after consumption, except perhaps waste. Nevertheless, it is not easy to draw a clear line between stocks and flows. Some temporary buildings and some clothing are designed for short-term use but can last years.

Table 1. Matrix of basic needs

		Fixed stocks	Variable flows
Private needs	Clothes	NA	Decent seasonal clothes
	Food	NA	Variety of food products, cooking
	Shelter	Housing	Maintenance, lighting
	Mobility	Cars/bicycles	Fuel and maintenance
	Utilities	Electric appliances	Heating, air-conditioning, use of appliances
Public needs	Clothes	NA	NA
	Food	NA	NA
	Shelter	Government offices, educational, cultural and sports facilities, hospitals, etc.	Maintenance, lighting
	Mobility	Infrastructure (railways, roads, airports) and vehicles	Maintenance and daily operation
	Utilities/ infrastructure	Public utilities (water supply, electricity, gas pipelines, etc.) and urban infrastructure (roads, subways, wastewater treatment, etc.)	Maintenance and daily operation

Note: NA: not applicable

From a biological and socio-cultural perspective, elements of basic needs must include clothing, food, shelter, mobility, utility and institutional services such as public security, law and order, education, health care and cultural events. Some of the needs are for individual or private purposes only, such as food and clothing, while others are of a public nature, such as government buildings and infrastructure. Some elements can serve both public and private purposes, e.g., shelter. Residential housing is for individual consumption, while public buildings are constructed for collective or public needs. As for mobility, there are private vehicles and public transport facilities and services. With respect to utilities, lighting, cooking and household appliance use are in the category of individual needs; but equipment and construction of infrastructure facilities are in general for collective or public needs.

For collective needs, fixed stock goods include public buildings, public vehicles, physical infrastructure, utilities and durable goods consumed for public services. By contrast, many material needs have to be met on a regular basis. Examples include food and clothing for individuals, energy consumption for heating and cooling buildings, fuel consumption by vehicles, and energy consumption by public buildings and infrastructure.

In summary, basic needs can be fulfilled by both goods intended for private consumption and by goods and services intended for public and collective consumption. In addition to a flow of consumables, a certain amount of stock of capital and durable goods is required to meet basic needs.

2.3 Carbon requirement for basic needs

In Table 1, basic needs do not include carbon, but all the elements of basic needs imply the consumption of carbon-containing resources. Although the carbon content of agricultural products comes from the atmosphere through photosynthesis and is, therefore, carbon neutral, agricultural production consumes carbon-intensive industrial products such as inorganic fertilizers and energy for machinery and irrigation. Furthermore, food processing and cooking in much of the world also consumes commercial energy. Similar logic holds true for all the other elements of basic needs. In a way, capital stocks and durables are a kind of carbon stock for basic needs. Construction materials for buildings are highly energy-intensive, so a building represents a certain fixed carbon stock. Even after the lifetime of the building expires, much of the stored carbon can be reused or disposed of with limited emissions of carbon. For instance, steel recovered from dismantled buildings can be recycled without going through the energy-intensive process of mining iron ore and making iron in a blast furnace.

Nevertheless, carbon itself is not a necessity for human welfare. For instance, steelmaking requires electricity. If electricity is generated from fossil fuel combustion, carbon emissions are unavoidable, but little carbon would be emitted if the electricity were from hydropower or wind turbines. This would suggest that development for fulfillment of basic needs could be de-carbonized.

In practice, it may not be easy to set a universal quantitative definition of basic needs. However, the level of consumption across countries can give some indication on the fulfillment of basic needs. In the next section, we examine cross-sectional data and make some empirical estimates for China as a possible baseline for participation in building a post-2012 climate regime.

3. Assessment of basic needs satisfaction in context

Basic needs have to be understood in context. Fulfillment of basic needs can be a long process, like economic development. It may not be easy to arrive at a criterion with consensus, but the numbers should fall within a certain range. Therefore, it is useful to look at current levels of consumption in different countries and observe the gaps. After examination of individual indicators, overall levels of development among countries are compared to show that development represents the means to meet basic needs.

3.1 Clothing and food

Clothing and food are essential biological needs, although the former can vary greatly depending on quality of life. However, the primary function of clothing is simply to keep warm and look decent. Fashion does not represent an essential component of basic needs. In 2000, world fibre consumption was 53.1 million tonnes and per capita consumption was 8.7 kg. Per capita consumption in North American was 36.1 kg, while in China it was only 6.6 kg per person. China is below the world average in terms of per capita consumption, but the gap is relatively small.

Nutrition is essential for survival and normal life. UN Food and Agriculture Organization (FAO) statistics indicate that food consumption by the average Chinese person is slightly higher than the world average and about 10 per cent higher than the average for developing countries, suggesting that nutritional intake in China is close to and has probably reached the level of basic needs.

3.2 Buildings

Buildings are stocks that have to be accumulated to fulfill both private and public needs. They provide shelters for family life and public services and have to reach a certain level of quality for long-time use and be equipped with necessary facilities to provide a particular level of comfort.

Building stocks for urban residents in China in 2003 are close to the median world level according to a 1990 survey, but in rural areas only a small proportion of housing is made of steel and concrete. Furthermore, many rural houses suffer from poor heat insulation and lack necessary sanitation facilities.

In addition to private housing, collective or public buildings are also an essential part of basic needs. Under this category are buildings for commercial interests, services, offices, education, research, culture and entertainment. In developing countries, the commercial and service sectors are underdeveloped, and education, research, medical, culture and entertainment facilities are far from satisfying social development needs.

3.3 Transport

Car ownership among the Chinese urban population was 1.36 cars per 100 families in 2003. This is much lower than the 40 to 90 cars per 100 families in developed countries.

Transport infrastructure constitutes one of the largest capital stocks in an economy. As industrialization and urbanization proceed, accumulation of transport infrastructure accelerates and reaches a level sufficient to support basic needs. The stocks include urban infrastructure, roads, railways, airports and harbours. Developed countries have passed this period of physical expansion and their transport systems have generally reached saturation. Developing countries' transport network densities are far lower than those of developed countries.

3.4 Utilities

Public utility infrastructure facilities include heat supply, gas supply, water supply, electricity supply, telecommunications, solid waste disposal, wastewater treatment, etc. In the past few years, with economic development, public utility infrastructure facilities have attracted investors. In the course of rapid urbanization, much more needs to be built. For instance, most Chinese cities do not now have adequate facilities for treating municipal solid waste and wastewater.

3.5 Levels of overall development

The underlying causes behind the gaps are the large differences in levels of economic development between developed countries and developing countries, represented by per capita income, urbanization level, economic structure and employment structure (see Table 2).

Table 2. A comparison of major development indicators among selected countries

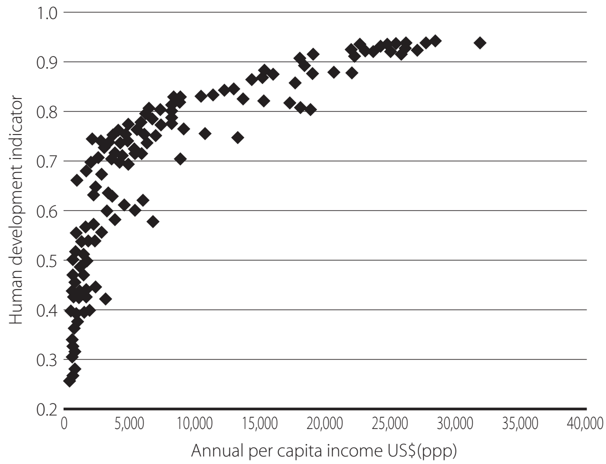
	Per capita GDP (US$) 2001	Per capita GDP (PPP) 2001	Urbanization level (%) 2001	Share of agriculture in GDP (%) 2002	Proportion of labor employed in agriculture (%)
USA	35,277	34,320	77%	2%	2%
U.K.	24,219	24,160	89%	1%	1%
South Korea	8,917	15,090	82%	4%	10%
Japan	32,601	25,130	79%	1%	5%
Russia	2,140	7,100	73%	6%	-
China	911	4,020	38%	15%	46%
India	462	2,840	28%	23%	60%

Source: UNDP, Human Development Report, 2003, Tables 5 and 12; World Development Indicators 2004, Table 4.2

The UNDP (2004) Human Development Indicator (HDI) is often used to measure human development levels for cross-country comparisons (Figure 1). If the criterion is set at HDI>0.8, per capita GDP should be no less than US$8,000. In this case, China is half-way to basic needs fulfillment using PPP measurement, but only one-eighth of the way using exchange rate measurement of GDP.

The above assessment reveals that basic needs for survival, i.e., food and clothing are close to the level of fulfillment, while stocks like buildings and physical infrastructure and flows like energy and electricity are well below the world averages. In the next section, the development stage in China is examined and estimates of energy and emissions demands for fulfillment of basic needs are made.

Figure 1. Human Development Indicator (HDI) and per capita income



4. Challenges for China to realize basic development targets

In the development process, survival needs in China do not pose a challenge, as they do in the least developed nations. The major challenge for China is to consolidate the necessities and increase both the quantity and quality of basic needs for stocks and utility flows. As clothing and food are close to the levels of basic needs satisfaction, the analysis here focuses on the stocks of utility flows.

4.1 Transitional stage from labour-intensive to capital-intensive industrialization

The experience of developed countries shows that basic needs are met to differing degrees in accordance with stages of development (Chenery 1986). At early stages, the economy is normally labour-intensive due to a lack of capital and a large supply of unskilled labour. Later, a transition from labour- to capital-intensive industrialization takes place, characterized by massive investment in infrastructure, utilities, buildings for residential and public uses, and heavy machinery and equipment.

The primary driving force for increase in energy consumption is the growth of the economy and consumption. During the last two decades of the 20th century, the Chinese economy more than quadrupled. However, the increase in energy consumption grew at a much slower rate, only doubling during the same period. At the turn of the century, the Chinese government set the target to quadruple its GDP again by 2020. Given the experience of a doubling energy consumption to support quadrupling GDP from 1980 to 2000, the projection made by the Energy Research Institute in China was very optimistic (Zhou *et al.* 2003); considering technological progress and development of renewable energy, the projected demand for 2010 was 1.9 billion tce[2] and for 2020 around 2.8 billion tce. But in the last few years, this "authoritative" projection has proved to be too low. The actual figure increased from 1.30 billion in 2000 to 1.97 billion tce in 2004, exceeding the projection for 2010 six years earlier than expected.

Industrialization and urbanization are energy-intensive processes and require large amounts of energy. Energy consumption for industrial production increases for two reasons: share and size of the industrial sector in the economy. Half a century ago, China was primarily an agrarian society. Until the early 1970s, industrial output accounted only for one third of the national total, but this share exceeded 50 per cent 30 years later. Traditional agriculture requires a very limited amount of commercial energy. In 2004, the agricultural sector accounted for only 15.2 per cent of China's GDP, with that of industry as high as 53 per cent and the service sector 31.8 per cent. Urban physical infrastructure is currently inadequate and requires large-scale construction and improvement. Within about 20 years, another 300 million rural people, out of the current 900 million in rural China, will become urban residents. They will shift from traditional non-commercial, carbon-neutral biomass to commercial fossil energy, and for these people, energy-intensive urban infrastructure has to be constructed and kept running.

4.2 Estimated amount of building stocks to meet basic needs

At the end of the transitional stage from labour- to capital-intensive industrialization, basic needs for capital stocks and utilities will be fulfilled. To illustrate the scale of energy demand and a possible baseline for emissions commitments, two sectors are estimated here: the buildings sector accumulation of capital stocks; and the utilities sector flows needed to supply buildings. For details of methodological issues and estimates of other sectors, information is available in Pan *et al.* (2005).

For calculation of capital stocks for buildings, assumptions of population and per capita building space have to be made. At the beginning of 2005, China's population reached 1.3 billion. To simplify analysis, this figure is used as the population in the basic needs projection. The other key factor is the rate of urbanization. Currently, 40 per cent of the Chinese population is in urban areas and the rest are rural residents. We assume that at the end of capital-intensive industrialization, 80 per cent of the population will live in cities and 20 per cent in rural areas. This implies that 585 million rural people will move from rural to urban areas.

Current building space for urban residents is 23.7 m^2 per capita and for rural residents it is 27.2 m^2 per capita. In rural regions, however, only a quarter of the building space is constructed with steel and concrete, i.e., 8.53 m^2 per capita. Therefore, the current level of rural housing counts only this latter part towards meeting basic human needs, since wood and earth houses are not equipped with running water and flush toilets.

Taking into account the huge population and low per capita land area in China, we assume that residential area of 25 m^2 is needed for each person to satisfy basic needs. For collective or public needs, we adopt a figure of 15 m^2, following urban

2 One metric ton of standard coal equivalent (tce) equals 29.31 GJ.

statistics and planning guidelines in China. Adding private housing and public building areas together, a total of 40 m^2 will meet basic needs for urban people. For rural people, an additional 10 m^2 per capita is included in the calculation, as farmers require space for farm animals and agricultural tools.

The results of the estimates are as follows. In total, residential building space and public service buildings would amount to 35.1 billion m^2 and 19.5 billion m^2 to meet basic needs for shelter. Existing stocks of residential housing and public buildings total 24.7 billion m^2, and the additional amount needed to meet basic needs for residential and public uses is estimated to be 29.9 billion m^2.

Current Chinese statistics and design parameters suggest that to build each square metre of floor space requires 67.5 kg of steel and 142.1 kg of cement. Assuming steel and cement use in construction remains unchanged in the next few decades, new building stocks of 29.9 billion m^2 would require 2.02 billion tonnes of steel and 4.25 billion tonnes of cement to be produced.

In 2003, China built 550 million m^2 of housing and public buildings, so even without considering depreciation and replacement of existing buildings, it would take around 30 years to satisfy the basic need for housing and public buildings. In 2004, China's total cement output was 0.97 billion tonnes, up 12.5 per cent from the previous year and its total steel output was 0.297 billion tonnes, up 23.3 per cent—both record highs. As steel is also used in infrastructure construction and the manufacturing sector, a large proportion of cement is used in road, dam and other infrastructure construction, their current production levels, if sustained in the years to come, would also imply that it will take about 30 years before China satisfies the basic housing and public building needs of its population.

4.3 Estimated energy flows in the buildings sector for basic needs satisfaction

Energy used in the buildings sector accounts for 30 per cent of the world total energy consumption. Space cooling and heating in the buildings represents around 60 per cent of energy consumption in the buildings sector, including both residential housing and public service buildings. Among the energy needs of different countries, basic energy needs for space heating and cooling are closely related to climate conditions. Due to the influence of the East Asia Continental monsoon, China is colder in winter and hotter in summer than the average temperatures of other regions of the same latitudes. This unfavourable climate makes cooling and heating needs a major source of energy consumption.

According to the engineering designing codes for heating in residential and public buildings, five climate regions are delineated with different heating and cooling requirements.

In calculating energy demand, government standards for heating and cooling are adopted as the basic needs level. This represents a conservative estimate, since most buildings in China, including new buildings, are considerably less efficient than building energy standards call for. In winter, indoor room temperatures are assumed to be equal to or higher than 16°C while in summer indoor temperatures are assumed to be kept at 26°C. Total building space follows the analysis above, at 54.6 billion m^2.

Technologies used for heating and cooling in the buildings sector follow building codes. District heating is assumed in the cold and severe cold regions, while air conditioners are assumed to be used for cooling in areas of hot summers and cold winters. Sources of energy for heating include coal, gas and electricity while for cooling, only electricity is used. In the calculation, heating and cooling are provided when people are at work or at home, with no cooling or heating during the rest of the day. National survey data are used to set the hours for daily operation of heating and cooling.

Energy needs for heating and cooling are closely related to the insulation quality of houses and buildings. To reduce energy use and GHG emissions, one key measure is improvement of building insulation. Another measure is changing heat supply approaches. In areas without built-in central heating systems, people tend to use electric heaters and air conditioners, which consume more energy than central heating. In all the calculations, the assumption is to follow national standards, though many buildings do not comply with standards in order to lower the cost of building construction.

Table 3. Energy demand for basic needs satisfaction in the buildings sector

Residential buildings	Mtce	%	Commercial, government and service buildings	Mtce	%
Heating and cooling	610	54	Urban heating and cooling	290	51
Lighting	60	5.3	Urban lighting, appliances and equipment	220	38
Electric appliances	300	27	Rural heating and cooling	50	8
Cooking and water heating	140	12	Rural lighting, appliances and equipment	10	1.8
Water supply	20	1.7			
Subtotal	**1,130**	**100**	**Subtotal**	**570**	**100**
Grand total	**1,700**				

Energy demand is also estimated in the buildings sector for cooking (households and restaurants) and electric appliances (household appliances, lighting, ventilation, office equipment). Survey data from national statistics are used to calculate energy consumption to meet basic needs in the buildings sector.

In the buildings sector, the current stock only meets about 45 per cent of basic needs. At the current rate of construction, 30 to 50 years would be required to fulfill all basic needs. Assuming a lifetime of 50 years for buildings, each year about one billion m^2 of new building space would be required to meet the basic needs level of 25 m^2 per capita residential and 15 m^2 public building space. As indicated in Table 3, total energy flows in the buildings sector would amount to 1,700 Mtce. In most parts of China, heating is required in winter and cooling is a necessity in summer. As a result, heating and cooling of buildings account for half of total energy flows. In fully industrialized economies, energy demand in the buildings sector is about one-third of total energy use. If this ratio applies, total energy consumption to meet basic needs at a reasonable level of quality of life in China would reach 5,100 Mtce. This figure is about 2.5 times the current actual consumption and nearly twice the level of U.S. total energy consumption in 2001. Nevertheless, per capita energy consumption for fulfillment of basic needs in China would be only 45 per cent of the U.S. level.

5. Post-2012 climate regime building

Negotiating the international climate regime is a highly complicated process influenced by multiple factors. The vehicles for post-Kyoto negotiations will not be confined to the UNFCCC process; bilateral, multilateral and even unilateral commitments outside the UNFCCC are also likely to take place. Furthermore, the content of agreements may expand to cover not only mitigation, but also adaptation, technologies and low carbon development. In the end, it is likely that a basket of agreements will be concluded under the overall framework of sustainable development. In the next 20 years or so, China will engage in large-scale and rapid industrialization and urbanization. When choosing among different climate agreements, China has to consider the reduction of possible risks, avoid inflexible restrictions, and actively participate in the negotiation and formulation of international regimes to safeguard and promote its sustainable development.

5.1 Likely climate regime

Major factors influencing the negotiation progress

Future international climate negotiations are influenced by different factors, of which the most important ones include political will, economic interests and scientific knowledge. Political will depends in part on international relations, in addition to domestic factors. The United States' withdrawal from the Kyoto Protocol is partially due to economic considerations, but more importantly, due to a lack of political will and consideration of its global strategies. Russia finally ratified the Kyoto Protocol because of a combination of many factors, among which political will is also a key driver. Economic interests are a determinant shaping the various positions taken by different countries, including the possible domestic economic losses from negative global climate change impacts and the possible economic costs of GHG emission reductions. Climate change impacts can be a long-term issue, while the costs of emission reductions are often immediate. Decision-makers must rely on comprehensive comparison and analysis. Uncertainties related to scientific knowledge also represent a major factor influencing the process of international negotiation. Under scientific uncertainty, international climate policy-making is subject to adjustment from time to time and among different regions to reflect advances in scientific understandings.

Multiple approaches to building up the post-2012 climate regime

There will be three major vehicles for post-2012 climate negotiations: continuation of the Kyoto Protocol by amendment; renegotiation of a new protocol under the UNFCCC; and initiatives outside of the UNFCCC process. The Kyoto Protocol has entered into force and its architecture can be a sound basis for the second commitment period negotiation. The EU is determined to follow this approach, but the United States is unlikely to go back to the Kyoto design, and large developing countries like China and India find it difficult to accept emissions caps or limits. A few Parties explicitly refused to ratify the Kyoto Protocol, but not a single Party has withdrawn from the UNFCCC. Going back to the Convention for post-2012 policy negotiation would meet hardly any objection by the Parties. Due to conflicts of interest and complications of relations among the players, the negotiations will be time-consuming and complex. Therefore, some "like-minded" countries may jump out of the UNFCCC process to negotiate treaties for technological cooperation in the areas of renewable energy development and carbon capture and storage. Similar to the mechanism of the G20 (Group of 20) Meeting of Financial Ministers, leaders of the top 20 emitters may agree upon climate change mitigating actions. Nevertheless, these actions may be linked and fed back to the UNFCCC process.

A basket of treaties for post-2012

Any post-2012 climate regime is likely to consist of a basket of treaties. The Kyoto Protocol aims at emission reductions. Either its amendments or variations will be included in the basket. Adaptation has been an issue on the agenda and developing countries are likely to push for an agreement on adaptation. Elements of a technology treaty are also in their primary shape, covering research, development and deployment of technologies on renewable energy, energy efficiency, and carbon capture and storage. Developing countries have to address climate change issues in the context of sustainable development and, therefore, a comprehensive agreement of sustainable development and climate change mitigation and adaptation may also be included in the basket of treaties.

5.2 Opportunities for development with low emissions

Post-2012 climate regime building will be a development-oriented, action-taking process. Contributing to the process means benefiting from the process. Given the severe challenges China has to face to fulfil basic needs, active participation in the climate regime-building process means taking opportunities for development with low emissions.

Narrowing the technological gaps in energy-intensive industries

Climate change mitigation is not necessarily in conflict with development. As a developing country Party to the Kyoto Protocol, China is entitled to undertake CDM (Clean Development Mechanism) projects, which would promote sustainable development. As China is at the stage of capital-intensive industrialization, energy and consequently carbon-intensive stocks such as buildings and infrastructure have to be built up to meet the private and collective basic needs. Table 4 indicates that the gap in energy intensities of important industrial processes between China and advanced OECD levels falls in the range of 10–30 per cent. These estimates are conservative as small-scale plants are even less energy efficient.

These gaps represent highly-attractive opportunities for China to cooperate with the developed nations on technology. As total production and consumption are so large, energy savings for the four products in 2004 would have been 194 Mtce, if China had been able to employ the currently available more-efficient technologies. The energy saving from these four energy intensive products alone would account for 10 per cent of total energy consumption in China. Reductions of emissions from these sectors by closing the technological gaps would be as high as 488 million tonnes of CO_2e.

Potentials in the buildings sector could be even larger if insulation were increased up to the European level. In rural areas, few have considered insulation. In urban areas, concrete buildings rarely have insulation either. The heat conducting coefficients for roofs and walls in China are normally in the range of 0.6 to 1.5, compared to around 0.3 in Western Europe. As heating and air conditioning are the most energy-intensive needs, improvement in building insulation would result in even more energy savings than energy-intensive industrial products.

Table 4. Gaps of energy intensity for selected products between China and the developed nations

Product	Unit	China 1990	China 2002 (x)	OECD levels (y)	Gap (y-x)	China output (2004, Mt) (z)	Energy saving potential (Mtce) z*(y-x)
Electricity generation, coal-fired	gce/kWh	427	383	316	67	1787.7b[a]	119.8
Steel (large and medium plants)	kgce/t	997	715	646	69	297.23	20.5
Cement (large and medium plants)	kgce/t	201.1	172.0	127.7	44.3	970	43.0
Synthetic ammonia (large enterprises using natural gas)	kgce/t	1343	1215	970	245	45.0	11.0

Note: gce = grams of coal equivalent

a billion kWh. Total output was 2,187 billion kWh; coal-fired electricity accounted for 81.7 per cent

Sources: China Energy Association, Energy Policy Study, 2003. For Output in 2004, China Statistical Bureau, Statistical Bulletin, 2005

Technological development

Participating in technological cooperation would contribute to emission reductions and sustainable development in China, and there is potential for technology transfer to proceed in both directions. For example, there is a lack of certain technologies for renewable energy development in China, in particular commercial technologies for large wind turbines and for solar photovoltaic systems. There are, however, many other renewable technologies in which China is highly competitive, such as solar thermal panels, bio-methane utilization, and small and micro-hydro power. By 2002, some 40 million m^2 of solar water heaters had been installed, saving the equivalent of 4.86 Mtce in fuel use. Small hydropower produced some 37.8 Mtce in 2002. Such technologies are fully commercialized and currently receive no subsidies in China. They can be transferred to other developing countries as well as developed ones.

Since China is highly dependent on coal, carbon capture and storage would represent an opportunity to reduce emissions at a later stage when China is able to commit to emission reductions. China can also be a leader in clean coal technologies and biodiesel, as the market potential is larger than in any other country in the world.

Taking co-benefit into consideration

From a long-term perspective, there are synergies between mitigation and adaptation to climate change. A consortium of experts made a comprehensive assessment of environmental and climate change in China (Qin *et al.* 2005). They concluded that climate change in China follows a pattern and degree similar to the global trend. Over the past century, the average temperature increased 0.6 to 0.8°C in China. During the past 50 years, sea levels rose at a rate between 0.10 and 0.25 cm per year. Global warming will make China more vulnerable to climate-related damages, including sea-level rise, drought, flooding, tropical cyclones, sand storms, heat waves and the like. Many large engineering projects such as irrigation systems, dams and water diversion are essential for adaptation to climate change, and they are also subject to possible adverse impacts of climate change. In 2004, 1,282 people died from flooding and coastal storms. Over 37 million hectares of arable crops suffered flooding and drought, with 4.4 million hectares remaining unharvested.

There are also many short-term co-benefits from climate change mitigation. Acid rain is a directly associated with SO_2 emissions that come from the burning of coal. Coal mining is not only dirty but also highly risky to miners. It destroys underground water systems and leads to ecological damages. On average in China, each million tonnes of raw coal costs over five lives. In year 2004, some two billion tonnes of raw coal were produced and more than 10,000 lives were lost. Energy savings brings about economic gains from an economic viewpoint—in addition to saved lives. From a strategic perspective, energy efficiency contributes to energy security.

5.3 Contribution to post-2012 climate regime building

Opportunities do exist for China to contribute to post-2012 climate regime-building without compromising the goal of satisfying basic needs. In the energy-intensive stage of industrialization, China has to be careful in committing to emission reductions, but positive no-regrets commitments are consistent with development goals.

Basic considerations for commitment

As an important player in the global climate regime building, there is no escape for China. Fulfillment of basic needs is part of human rights that should be protected. In this regard, some basic considerations have to be taken into account in making commitments to safeguard development rights and interests, create a climate-friendly international image and promote sustainable development.

Risks have to be comprehensively assessed. In addition to climate change impacts and vulnerability, international relations and politics are also worth consideration. Furthermore, economic implications should be included, too. For instance, outside the Kyoto process, a developing country cannot make use of the CDM for technological and financial sources. If basic needs satisfaction is a fixed target for China, emissions commitments have to be flexible. Therefore, any definitive and quantitative targets should be avoided in commitment making.

The post-2012 climate regime will be multi-dimensional. Mitigation is only one component of the architecture. Adaptation is an issue in China. Technological cooperation not only contributes to mitigation and adaptation, but also generates short-term and long-term benefits for China. Short-term benefits include energy efficiency and commercialization of renewable energy, while long-term ones will help China tackle the challenges of making quantitative commitments after fulfillment of basic needs in China.

Mitigation and adaptation should not be separated from sustainable development. Together with many developing country parties, China should take the initiative to create a comprehensive framework promoting sustainable development and climate change mitigation and adaptation. Active involvement in the post-2012 negotiation process will generate opportunities for early fulfillment of basic needs with low emissions.

Voluntary actions

There are many areas in which China has been making contributions to global climate change mitigation, such as population and social policies, energy efficiency improvement, renewable energy promotion and greater efforts for environmental protection. Many climate-friendly energy policies have been under implementation. With respect to legislation, there have been laws for energy saving and promotion of renewable energy. In the automobile sector, European emissions standards have been introduced and enforced, requiring new cars meeting Euro II standards in 2004, while there was virtually no requirement before 2000. Improvement in energy efficiency has been a primary target in all the "five-year plans." In the eleventh Five-Year Plan (2006–2010), aggressive targets are under discussion for energy saving and efficiency, in line with the "Medium- and Long-Term Goals for Energy Efficiency" promulgated in 2004. In rural areas, the government allocates 10 billion RMB (US$1.25 billion) each year to subsidize the use of biogas, thereby reducing the consumption of coal and unsustainably-harvested biofuels.

Conditional initiatives

Taking the opportunity to achieve low-carbon development is also a huge challenge to China. The potential for energy savings in energy-intensive sectors is substantial, but an external push may help China to realize reductions without compromising development goals. Therefore, emission reductions initiatives have to be conditional on (1) transfer of technologies or financial assistance by developed country parties; and (2) fulfillment of basic needs through development. These conditions also imply that costs of emission reductions in developing countries are lower than those in investing countries, otherwise there would be no incentives for such transfers of resources from one party to another.

Behavioural adjustment

In reality, there exist luxurious and wasteful uses of energy and emissions in both the developed and developing countries. Since luxurious and wasteful consumption can be unlimited, for environmental sustainability and equity considerations it is necessary to restrict them. Environmental and climate awareness can stimulate people to take action, but financial incentives will be essential to discourage luxury and wasteful emissions. For basic needs satisfaction, a lower rate of tax or even a subsidy may apply on energy consumption and emissions. However, for luxury emissions, the tax rate should be high enough to curb wasteful behaviour.

It should be noted that this scheme does not entail eliminating luxury or wasteful emissions. This is for several reasons: (1) it is against human nature to forbid luxury consumption; (2) as earning power varies widely among individuals, a small handful of consumer groups or even ordinary consumers may be able or willing to enjoy some degree of luxury; and (3) the pursuance of luxury is an incentive to creativity and innovation and also contributes to fiscal revenues for income redistribution.

6. Discussion and conclusions

The analysis in this paper builds upon the conceptual understanding of basic needs to demonstrate that they can be fulfilled through development with low emissions. A methodological framework was established to differentiate types of basic needs. Basic needs include individual private needs and collective public needs. Food and clothing are examples of exclusively private basic needs, while physical infrastructure and public buildings fulfil public needs. Both private and collective needs at a basic level are essential for survival and decent living. Some of the basic needs have to be satisfied with capital stocks that are accumulated for long-term consumption while others are fulfilled with a constant flow of consumable goods and services. Physical infrastructure and buildings (both public and private residential) are typical capital stocks. During construction, large amounts of energy and carbon intensive materials are required, but their maintenance and operation require much less annual energy consumption. For elements of basic needs in the flow category, goods and services are "consumed" to meet human needs, e.g., electricity consumption in the public and household sectors.

An assessment of the key elements of basic needs reveals that the level of fulfillment between developing and developed countries varies widely. The gaps are generally smaller for private individual needs, while they can be large for collective needs. With respect to food and clothing, China is close to fulfillment of basic needs. In the urban sector, residential housing has also reached a moderate level. However, urbanization will require additional building space of 29.9 billion m^2 to meet basic needs defined as 25 m^2 per capita for private housing and 15 m^2 per capita for public and commercial buildings. At the current rate of construction of about one billion m^2 a year, this would mean that the capital stock of buildings would need another 30 years to accumulate. These stocks, once built, do not need to be replaced every year, but depreciation, maintenance and operation will demand a flow of energy consumption. In the buildings sector, a considerable amount of energy is required daily for operation. Due to China's unfavourable climate conditions, heating and cooling are needed for buildings in most parts of the country. Estimates suggest that some 1.7 billion tce would be required to provide heating, air conditioning, operation of electric appliances, lighting, cooking and water heating. Considering social (population) and climatic conditions, total energy demand for fulfillment of basic needs in China would exceed five billion tce, two and a half times the 2004 level and nearly twice the U.S. level in 2001. Nevertheless, in per capita terms, an average Chinese, for fulfillment of basic needs, would demand 45 per cent of the American consumption in 2001.

For post-2012 climate regime building, there exist opportunities for China to meet basic needs with low emissions. Eliminating the technological gaps in four sectors (steel, electricity, cement and ammonia) alone would save 194 million tce each year at 2004 production levels, accounting for 10 per cent of total energy consumption in 2004. Associated emission reductions would be as high as 488 million tCO_2. Since a post-2012 climate regime is likely to consist of different treaties, China can contribute to the building process for all the elements, including mitigation, adaptation, technological development, and mitigation and adaptation for sustainable development. As an important player in climate regime-building, China can lead in taking voluntary actions and joint mitigation initiatives. One last point to make is that luxurious and wasteful emissions should be restricted.

Although the results in this paper can be illustrative, the analysis is incomplete and a great deal of work is needed to take advantage of the opportunities China has. Furthermore, extension of this type of analysis to other countries would generate a comparative picture that would be useful in guiding concerted global actions.

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The role of development assistance and investment flows

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1. Introduction

Over the last 10–15 years of negotiations covering both the UNFCCC and the Kyoto Protocol, two things have become increasingly evident. First, development assistance and overall investment flows to developing countries will play a critical part in laying the foundation for any active global regime on climate change. Second, however, there has been very little progress in reaching any satisfactory agreements on these very same issues, particularly as they relate to technology transfer and addressing the impacts of and actions on climate change.

The roots of the problem lay in the contradiction between overall levels of Official Development Assistance (ODA) funds, which have been declining for 20 years, and rising obligations to provide ODA. The commitments laid out in the Convention and the Protocol appear to many, particularly in the NGO and developing country communities, to formally oblige Organisation for Economic Co-operation and Development (OECD) countries to "bankroll" climate-change-related activities in addition to the financing they are already providing through ODA. Moreover, it is unlikely that we will see any strong reversal in the decline in total ODA funding, even accounting for climate-change-related activities. The result has been an acrimonious negotiating dynamic with not much hope for reaching a satisfactory resolution on either side.

This may change over the year, with the strong push by the U.K., as host of this year's G-8 summit, for OECD countries to commit to using .7 per cent of their GDP towards financing ODA activities. But we must be realistic about the prospects for major donors, particularly the U.S. and Japan, to agree to such an objective. Up until now, they are adamant in their opposition to formally committing towards such an objective, and while the jury is still out with respect to Canada, it is currently far away from reaching such an objective.

Nor has the issue of climate change been effectively integrated in the mainstream activities of development agencies. Developing countries have, for the most part, not identified climate change as an issue of concern to development agencies. A number of analyses have indicated that, while there have been some successful initiatives, particularly those related to supporting G77 and China in their National Communications and, to a lesser extent, helping them develop National Adaptation Strategies, these successes have not spread into "normal" technical assistance. In other words, the strong linkages that do exist between the threat of climate change and poverty eradication and development are still not appreciated at the field level.

A challenge on the donor side is to engage finance and development planners effectively in the climate policy discussion, whereas recipients have to acknowledge that new funds can only be effectively harnessed if their use is likely to be more effective than in the past. While developing countries have, for the most part, not identified climate change as an issue of concern to development agencies, in negotiating forums they have been badgering OECD countries for significant new and additional funds as a quid pro quo for cooperation on climate change. There are ways to fix these issues in ODA, and they are finally beginning to try and fix them. For example, there is an increasing number of initiatives looking at the issues of climate and development together (as the Brundtland report and many others since have advocated), and looking to engage finance and development planners in those discussions.

The mainstreaming of climate issues with development priorities means paying more attention to the "co-benefits" of climate mitigation and local environments, integration of mitigation and adaptation at project and policy levels, realizing that in many respects, they can be complementary drivers. It also means broadening the scope of current market mechanisms, such as Joint Implementation (JI) and the Clean Development Mechanism (CDM), to cover sectoral, policy and sub-national initiatives. It could also mean finding ways to include developing countries in emissions-, or allowance-based, trading.

From the development perspective, this means the climate change issue working to effectively reflect mainstream priorities in the development of sustainable energy systems (re: mitigation) and sustainable natural resource management practices (re: adaptation).

On the energy question, the recently sponsored Energy for Development World Conference, held in the Netherlands in December 2004, represents an excellent initiative from which to build. The five action areas it identified in the Chair's conclusions—widening access to energy services; mainstreaming energy in the development process; improving/protecting the environment and health impacts to climate change; enhancing financing options for energy development, covering public and private sector investments; and a focus on developing a market-based approach, with special attention paid to removing energy subsidies that distort the market or inhibit sustainable development—are an excellent "launching pad" for developing a realistic and integrated future mitigation regime on climate change that seeks to address both development and global environmental priorities.

It is also clear that any post-2012 climate change regime, in the context of development, must also effectively address the issue of impacts and adaptation. There is a core equity issue here that must be recognized—namely that those sectors of the world's population most vulnerable to the impacts of climate change (the poor, particularly in Africa, small island states, Latin America and Asia, along with indigenous peoples of the Arctic) are the least responsible, in the matter of GHG emissions, for the impending reality of climate change. And it is in this area, where the role of the private sector is far from being clearly understood or defined, that ODA will, at least over the short and medium term, need to play a prominent role. While understanding this, a realistic approach would recognize the limitations of addressing adaptation only through the formal UNFCCC negotiating process. A necessary complement will be bilateral and multilateral aid agencies effectively integrating climate variability/change considerations in their mainstream natural resource management programs and projects in areas such as agriculture and forestry.

That said, one must be cautious when addressing the challenge of mainstreaming. On both sides there are concerns that climate-change response is competing with other development objectives for funding. Recipient nations are worried that existing aid budgets will be cut in order to fund the solution to a "developed country" problem, as the argument came to the fore during the negotiation of use of ODA for CDM. Since current ODA projects are targeted at areas that directly or indirectly support climate-change response, there could be ways to resolve these concerns in a constructive manner.

Still, even if these issues are resolved, ODA alone brings a limited benefit in the end. The opportunities for large-scale activities that will be significant in terms of mitigating climate change lie with private investment, including the CDM in a manner that is more effective than its current overly bureaucratic state. Where progress really has to be made, and where it will make a difference, is in the maturation of these market opportunities and broadening participation through incentive-based mechanisms. This will not be easy. An immediate barrier is the limited willingness to pay by the developed countries. Our case studies for the existing international environmental financial assistance showed that financial flows of more than a billion dollars have been extremely difficult to agree upon and to implement. It is not certain that developed countries will agree to and implement any scheme that finances the "additional" reductions that could easily add up to several billion dollars annually. Things can move forward, but only if countries are open to being innovative.

2. The role of leveraging investments

For the Kyoto Protocol to take hold and effectively establish a future regime that endures is to recognize that, above all, with this agreement in force, we are actually establishing a global investment regime. The implications of this for climate change and international investment rules, therefore, need to be more explicitly analyzed. Some work on this has already begun, for example, in understanding the impacts of the Clean Development Mechanism for foreign direct investment (FDI) flows (Niederberger *et al*. 2005), the relationship between FDI, ODA and a climate change regime, and international investment rules (Werksman *et al*. 2003), and we will now look at these a bit more closely.

First of all, with respect to FDI and ODA, there has been an increasing focus on the need for appropriate host country reforms in the developing world, particularly among least developed countries (LDCs), to ensure effective financial flows that will be of lasting benefit to recipients. It is becoming increasingly apparent that it is critical to be able to more effectively make use of FDI flows towards environmentally sustainable development (French 1998). To not take greater advantage of these opportunities would result in a situation whereby explicit ODA funds used for environmental purposes would be completely dwarfed by the international flow of private capital and investments. To give but one illustration, between 1990 and 1997, funding from the Global Environment Facility to developing countries, explicitly established to help developing countries address global environmental issues, amounted to around US$5.25 billion, while FDI investments between the North and South, during the same period, amounted to US$250 billion (Forsyth 1998). As another illustration, it has been estimated that Asia (Japan excepted) would require approximately US$1 trillion in infrastructure, with about 70 per cent of that needed to meet power and transportation needs (Schmidheiny 1996)—clearly FDI would be the major player in such investments.

This is not to say that all of these FDI investments run counter to the objectives of GEF, but only to point out the need to seek innovative ways for these funding flows to more effectively complement each other. And in the context of the climate change negotiations, while technology transfer and capacity building for developing countries are all too often approached as a public sector issue, the fact is that North-South investment is increasingly determined by private-sector financial flows.

ODA and FDI can, and must, work more effectively together. For example, there is a mutual interest in both the public and private sector that host countries in the developing world provide an appropriate enabling environment for such financial investments to be sustainably used. While much attention, such as in the G-8, has been focused on issues related to governance and corruption, it is also interesting to note that analysis has seen a real correlation between **expected** rates of growth and FDI flows, so that "the extent to which LDCs can raise their overall growth rates through a variety of efforts not directly associated with FDI, indirectly these policies would also affect FDI" (Gastanga 1998). One of these "variety of efforts" could include ODA flows to needy countries—in other words, properly designed and implemented, ODA directed towards global environmental goods, can serve as an effective foundation for much higher private investment flows, for example, through the use of the CDM. (We will return to the issue of FDI, investment rules and the CDM below.)

A critical component in this area is the behaviour of financial markets—how can we work to ensure that financial markets begin to more effectively support sustainable development, including helping to address climate change? The Kyoto Protocol has provided a very important signal in that regard—through emission limitation, reduction commitments and its recognition of international market mechanisms, a global price signal is now being established for greenhouse gas emissions. By providing a price, pension and capital venture funds are now beginning to take into account the "carbon liability" of relevant industrial activities. This is no small achievement—while the OECD agreed as far back as 1972 to the "polluter pays" principle, it hardly caused a ripple in the environmental behaviour of FDI flows. Allocating a real price, even at the relatively moderate stage it is now at, helps to send that message home.

The use of market mechanisms is also generally recognized as a much more cost effective means of meeting environmental goals. This is particularly important for developing countries that may not be able to afford the extra costs of a more regulatory environment (WB 1992). That said, it is the policies of the public sector, particularly national governments, which play a crucial role in providing substantive direction for FDI flows. For example, if governments become more willing to use fiscal policies as a way of incenting eco-friendly investments, and also revise their national accounting systems to reflect local and global environmental impacts, financial markets are likely to pursue more appropriate investment directions.

Another important element in this equation is the role of multilateral financial institutions and other risk-taking financial institutions, such as Export Credit Agencies (ECAs), in leveraging substantial private sector investments. ECAs are uniquely qualified to play a "bridging role" between the private and public sector, more specifically in working with host country governments, multilateral lending institutions, private-sector financial and insurance institutions, and project developers and equity investors. In effect, ECAs invest or indirectly support development activities that are regarded as too risky (e.g., investment returns may take longer than more traditional investors are willing to accept) for the private and/or public sector. We would argue that climate-change-friendly investments would be an effective candidate for such investments.

ECAs are, in other words, experts in risk investments, traditionally covering technology, commercial, political, legal and financial risks. As environmental issues will increasingly play a role in defining these risks, one would assume that ECAs should play a much higher profile than they have up until now. Barriers include a low level of awareness and understanding of alternative investments in traditional energy and related sectors, a lack of clear policy and legislative signals from governments and little quality information available at the project level. What needs to be appreciated is that ECAs are reactive institutions and respond best to demonstrated needs of their exporters and instructions from their shareholders, including national governments.

The International Finance Corporation (IFC), the private-sector investment arm of the World Bank Group, is another institution that can play a critical role in leveraging private-sector investments in addressing climate change. Its overall mandate is to complement the WB's support for public-sector projects by providing financing and technical expertise to the private sector in developing countries to spur further economic growth on a commercial basis. Recognizing the international economic value, through the global carbon market, of activities that work to reduce GHG emissions, the IFC is increasingly occupied in supporting regional environmental business facilities, particularly small- and medium-sized businesses, that are active in supporting energy efficiency and cleaner production methods in industry, local commercial lending opportunities for sustainable energy investments, renewable energy and other carbon finance opportunities. In doing so, the IFC is able to send a broader message to the private sector that sustainable investments, which take into account the value of GHG reductions for the burgeoning international carbon market, are well worth pursuing.

3. The market mechanisms and FDI

The CDM represents a critical precedent in using market mechanisms to deliver on international environmental goals (Werksman *et al.* 2003). As such, its success or failure will play a large role in determining whether a future regime on climate change, post-2012, will continue to rely on market mechanisms as a way of implementing international environmental policies. And the extent to which the CDM is a success will, to a large degree, be determined by the extent to which the public and private sector can effectively work together in launching environmentally credible and cost-effective greenhouse gas reduction projects. While FDI initiatives, through brokers, ECAs or other private sector mechanisms, are being seen as a "natural" entry point for the private sector in climate change-friendly investments, it is by no means limited to that sector. In fact, we are seeing an increasing number of OECD countries and Multilateral Financial Institutions (MFIs) funded by these countries (including the Netherlands, Spain, Denmark, and the World Bank's Carbon Fund), develop and implement public procurement programs for CDM and JI investments.

That said, one would assume that CDM flows would reflect overall FDI trends. However, so far, that does not appear to be the case. In fact, it appears that regions that have not been fully successful in drawing in FDI—India and many Latin American countries—have shown relatively strong success in attracting CDM interest because they have a fairly well established reputation for developing sound projects with clear carbon reduction potential (Niederberger 2005). On the other hand, other countries with strong FDI flows, primarily China, have not been as successful in drawing CDM investments due to concerns that such investments may work to impinge on their domestic development priorities. The one exception to this rule, unfortunately, is Africa. As with FDI, CDM investments in Africa are few and far between; according to the WB, only four per cent of all CDM investments have taken place in Africa up to the year 2003.

Another challenge in implementing CDM projects is the extent to which they conflict or complement international investment rules. And where potential for conflict exists, where and how should they be addressed—by the institutions governing international investment and trade, or through the UNFCCC, the body responsible for implementing international climate change policy? The vast majority of the literature recommends that nations should clearly designate the UNFCCC as the ultimate arbiter on all things related to the CDM (Werksman *et al.* 2003), but it still begs the question, can and should the international investment regime change so as to expedite eco-friendly projects? And if it should, what would be the substance of such changes to international rules? It must be noted that an agreement on "eco-friendly" initiatives would be very difficult to pass through the relevant GATT and related processes, since most mainstream trade and investment negotiators would regard such practices as conflicting with the core principle of non-discrimination.

One of the most marked differences between the climate change and international investment regimes is the fact that the former explicitly recognizes the principle of differentiation, where countries' obligations are determined by their relative level of development and consequent differing capacities to deliver on commitments. Hence Annex B Parties under the Kyoto Protocol, have agreed to targets and timetables for reducing net emissions; Annex II Parties under the UNFCCC are obliged to finance international initiatives related to climate change; and non-Annex I Parties do not have specific GHG reduction responsibilities. On the other hand, as strong a tenet for international investment regime is the principle of non-discrimination. For the CDM, this could have interesting implications for the eligibility criteria some countries, such as China, are considering imposing on potential Annex I CDM investors. Will their efforts to clearly define national standards for participating in the CDM run in the face of the intent of the international investment regime? And now with the Executive Board of the CDM explicitly recognizing the right of developing countries to invest in CDM projects domestically (commonly referred to as "unilateral" projects) what is the potential for conflict with international investment rules should governments explicitly promote unilateral projects to the disadvantage of Annex I investors?

4. ODA, FDI and sustainable development: How to work together for a future global climate regime

Surely ODA and private financial resources can play effective complementary roles. What appears to make the most sense is that ODA should focus on capacity building, policy cooperation and activities related to climate change adaptation. The extent to which the CDM begins to successfully fund mitigation activities in developing countries will ensure that limited ODA funds can be most effectively used where the private sector is not likely to be nearly as active, for example, in the field of adaptation. But we should be careful not to be too simplistic or formulaic in our prescriptions—there is a clear need for ODA to support capacity-building activities related to the CDM, for example in helping developing countries set up National Designated Authorities or in helping them to develop national sustainable development criteria. And the WB's Carbon Fund and the initiatives of governments such as the Netherlands (although not directly tied to ODA) have been extremely useful in helping to ensure that the CDM is a major player in the international carbon market. That said, as the market matures, particularly after 2012, one hopes that the WB and these national governments will play a less prominent role in developing a certified emission reductions (CER) market, leaving it to the private sector to be the major player in that market.

Nor should we immediately dismiss prospects for private-sector participation in adaptation-related activities. CDM sink investments, for example, if properly designed, can provide sustainable mitigation and adaptation benefits. Traditional climate policy tends to isolate adaptation and mitigation and assumes that one chooses from a portfolio of independent adaptation and mitigation options. It is argued that adaptation benefits are felt locally in time and space, whereas mitigation benefits (as opposed to the direct benefits of energy provision) are felt distant in time and on a global scale. Even if large methodological hurdles can be overcome allowing costs and benefits to be reliably estimated on vastly different temporal and spatial scales, mitigation and adaptation measures are only substitutable at the global level and relevant only to some non-existent global decision-maker. However, such analysis provides no practical insight at the project or national/regional scale where adaptation and mitigation decisions will actually be taken. The potential for project-level integration of adaptation and mitigation is also downplayed, and likely reflects the residual northern domination of the climate policy discourse.

Instead, it might be more beneficial and effective if we examine the potential for adaptation and mitigation synergies, particularly to the extent that such activities support ecosystem-oriented poverty alleviation priorities counselled by the World

Summit on Sustainable Development in its Plan of Implementation (WSSD 2002). Poverty is both a driver and an outcome of critical sustainable development-climate linkages such as energy deprivation, desertification and deforestation. The ecosystem focus to poverty alleviation moves us beyond the rather platitudinous observation that the poor are endowed with the least adaptive capacity and hence are most vulnerable to climate change, to practical intervention policy.

The WB's initiatives on the Community Development Carbon Fund and the Biocarbon Fund represent innovative investments that provide a twinning of adaptation and mitigation opportunities. Recognizing the challenge of delivering GHG reductions in a competitive CDM market environment, these funds are explicitly established to help small-scale projects from the local community become competitive in the global market. In focusing on adaptation opportunities, while also emphasizing GHG credit reduction opportunities, the Bank is helping to highlight the potential role of the private sector in natural resource management activities.

The key implication is that coherent climate policy as it relates to developing countries becomes much more closely aligned and, indeed, one aspect of a sustainable development pathway committed to poverty alleviation. Climate change mitigation is a large co-benefit of this approach. The reader is cautioned that the intersection of adaptation-mitigation benefits is not proposed as panacea for climate policy; it is however, proposed as a logical and equitable prerequisite to engaging the South in an eventual comprehensive post-Kyoto mitigation regime.

In relation to ODA, it must be emphasized that the extent to which the market can help bear the costs of climate change, including adaptation, is the extent to which we are dependent on ODA to deliver on an issue that is but one of many, and vastly less important than most developing countries' immediate priorities for development and poverty eradication.

5. Conclusion

It is critical that attention be paid to domestic implementation mechanisms and priorities. In particular, institutionalization of climate-change issues in domestic government agencies would effectively create "champions" for mitigation and adaptation within governments of developing countries. This is a crucial step that would build a constituency for action, and help give domestic and foreign businesses and NGOs reliable points of contact to engage government on climate change.

It also means much more effective co-ordination between aid agencies and international financial institutions (IFIs) and enhanced coherence, in turn, with the FDI flows to developing countries. And finally, above all, for OECD countries, it means showing leadership at home. OECD countries must demonstrate that they are taking significant actions at home to mitigate climate change and without compromising their economic objectives. Until developing countries can see that this is in fact the case, the prospects for bringing them aboard will always be challenging.

But what, at the end of the day, is the proper role of development aid and financial flow considerations in the post–2012 negotiations? First of all, we would strongly advise that Parties have a much more realistic understanding of how appropriate development takes root in developing countries. For example, in the area of technology transfer, it needs to be recognized that most of these technologies are not in fact a public good, but the result of private-sector investments. Even if OECD countries strongly increase their ODA contributions, what will be made available for climate change is likely to be limited. Second, the role of market mechanisms should be expanded in the post-2012 regime, hopefully with emissions trading representing a sufficient incentive for broader participation. In addition, the scope of the CDM needs to be broadened beyond project-based initiatives if it is to play the prominent role it needs to play in the international carbon market. Approval and administrative procedures for the CDM also need to be significantly simplified. Finally, the primary concerns of most LDCs on adaptation activities need to be respected, notwithstanding the fact that there are potentially much stronger synergies between mitigation and adaptation than originally supposed. To the extent that mitigation opportunities are addressed through ODA, it should only be with a view to helping developing countries develop more sustainable and accessible forms of energy systems.

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Experiences from German ODA-financed greenhouse gas reduction and sequestration projects and lessons for the CDM

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1. Introduction

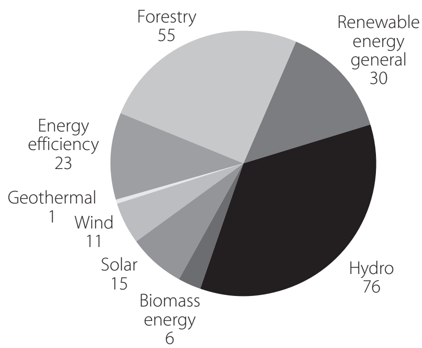
Many observers assume naively that Clean Development Mechanism (CDM) projects in developing countries will be implemented as specified in their Project Design Documents (PDDs). This is very unlikely given the number of challenges to successful project implementation. As there are substantial experiences with renewable energy, energy efficiency and afforestation projects in over two decades of development cooperation, we have a proxy to evaluate problems that CDM projects will encounter. We analyzed 145 projects of German development cooperation implemented in the last 25 years and draw conclusions for CDM project development.

The information has been collected from project records and comments which are publicly available in the reports of the implementing agencies and on the Internet. As the qualitative information used for evaluation is collected from different sources that base their judgments on diverse evaluation approaches, a direct comparison between the projects is not possible. However, these case studies illustrate the problems development projects frequently faced during implementation. Thus, the findings from this analysis indicate which difficulties CDM project activities in these sectors are also likely to encounter.

2. Overview of the projects

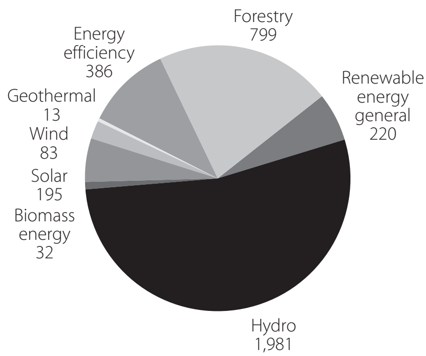
The quantitative project information has been taken from the reports of the Bank for Reconstruction and Development (KfW) and the German Agency for Technical Cooperation (GTZ). It is summarized in Figures 1 to 4.

Figure 1. Share of project types (numbers)



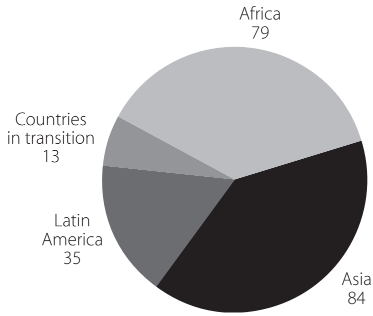
The distribution of the different projects is not very different from the one in the CDM, except for the high share of sinks.

Figure 2. Share of project types (volume of ODA, million €)



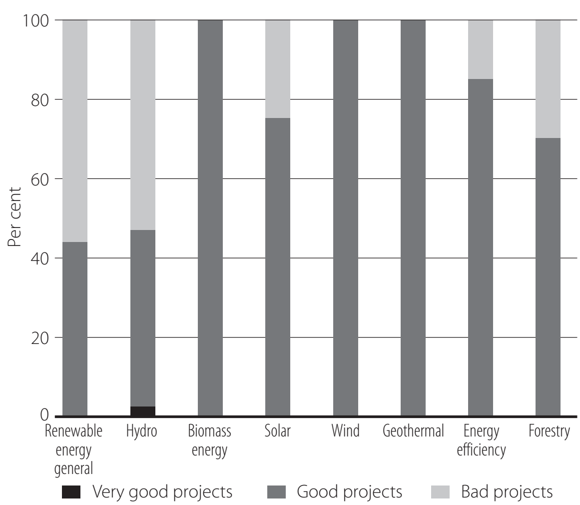
There is much more large hydro represented than in the current CDM portfolio. The biggest difference relates to the regional distribution, where Africa has the lion's share.

Figure 3. Host countries by regions



A rough evaluation of the qualitative information on a five-point scale shows that more than one-third of the projects are a failure (levels four and five). Failure rates are very high in the general renewable energy programs and hydropower, followed by forestry and solar.

Figure 4. Evaluation of projects



In the following sections, detailed descriptive results from the analysis are presented for each project category. Difficulties encountered throughout the categories are subsequently summarized.

3. Findings by project category

3.1 Hydroelectricity

When observing the implementation of various hydro-electric projects, it becomes evident that they can lead to disastrous consequences, especially when large-scale dams are constructed. Changes in water level—either increasing or decreasing—are often provoked by the installation itself and cause far-reaching socio-economic interferences (e.g., affecting fish production, irrigation and ecological diversity). Sinking water replenishment rates (Agrhymet 2004) and siltation reduce the economic viability of hydro-electric power stations. Settlers are those who suffer most under the construction of the dam, because they often become the victims of poor resettlement and inadequate compensation by local authorities. Immigration to newly irrigated areas, displacing former inhabitants, may lead to increased ethnic violence.

Small scale hydro-electric projects have better chances to contribute to sustainable development. They do not provoke as many negative side effects as associated with large-scale projects. Nevertheless, they face a major obstacle: due to their limited scale, transaction costs matter a great deal and financial viability is difficult to achieve. Thus, the success of these sustainable solutions depends very much on appropriate market conditions.

Finally, it has to be questioned whether heavily relying on hydro-electricity can be considered a sustainable strategy against the background of increasing water shortage in many developing countries.

3.2 Biogas and biomass

Today, the use of biogas and biomass no longer causes major technical problems. Thus, economic viability of **biogas plants** is above all dependent on the structure of the local tariffs. In Ankara, the tariffs allow one to cover the cost of a biogas plant constructed with funding from the KfW, while the biogas plants in Nepal will remain dependent on subsidies. When biogas plants are to be installed by farmers, the high investment costs can create an obstacle to widespread adoption. Digested sludge, a side product of the process, is an excellent fertilizer; yet training has to be organized to enable the target group to make use of it (KfW Schlussprüfung 2001a).

Biomass used in household appliances (e.g., more efficient stoves) faces, first of all, an investment barrier. Low incomes of the households and lack of access to credit restrict the financial margin. Further, long distances and bad communication networks complicate the dissemination.

3.3 Solar energy

The biggest problem of solar energy remains the gap between the target populations' income levels and the price of equipment.

Solar PV power plants: The present sectoral conditions in most developing countries do not allow for a sustainable introduction of this so-far expensive energy source which, therefore, remains dependent on subsidies. Grid-connected solar power plants would need a legal framework guaranteeing an appropriate remuneration. Plants operating off-grid are more costly as they require the use of a battery, which has to be displaced regularly. Thus, if either knowledge or financial resources are lacking, an actually intact plant runs the risk of being left to decay after some short time of operation.

Solar Home Systems (SHS): Already today, SHS are an attractive option for off-grid villages, when the overall investment required for the SHS is lower than that for conventional equipment, taking into account connection costs and interior installation. However, in case financial services are not available (such as in Morocco), the typical SHS sold on a cash basis are of the smallest type which often creates problems due to under-sizing, poor technical design and lack of after sale services (GTZ 2000, p. 32f.). In countries with bad infrastructure, the use of SHS is further complicated by expensive delivery systems. In Namibia, for instance, transport is organized by taxis which increases the initial costs substantially and creates a barrier to investment. Due to the deficient infrastructure, all communication with the users is difficult or even virtually impossible. Finally, maintenance is impeded by the fact that local technicians do not dispose of spare parts. Nevertheless, **solar cookers** have recently been successfully introduced in South Africa. Manifold positive impacts could be observed (such as the strengthening social networks, higher school attendance, monetary savings and shift in fuel mixing). The key factor for the successful introduction was to abandon any technology-driven approach and to focus on raising the user's acceptance of the appliance. The solar cookers need to fit the existing habits in the best possible way. When the user recognizes the multiple benefits of the new appliance, he may be disposed to adjust its habits to insuperable technical restrictions, e.g., by cooking hot meals at noon instead of in the evening after sunset.

PV used for irrigation purposes: In spite of the high investment costs, photovoltaic pumps may be more cost-efficient than diesel- or petrol-powered pumps under certain conditions. But the high initial investment costs are often not compensated by the lower operational costs. High degrees of system utilization are necessary to make photovoltaic appliances economically viable, at least if interest rates on loans are high (IEA PVPS 2003). Therefore, barriers to the competitiveness of photovoltaic pumps are found, above all, in the lack of low-cost loans, in import duties on photovoltaic systems and in subsidies for diesel fuels. In addition, demands in terms of management are much higher with PV-powered irrigation and intensive training is required. Appropriately used, the technology is reliable and needs little maintenance (Key Factor Energy 2004). For irrigation purposes, mainly surface water pumps are required, which still have to be developed or optimized for PV, even though the technical aspects of solar irrigation are generally regarded as adequately developed (IEA PVPS 2003).

3.4 Wind energy

The experience from wind farms shows that most installations are technically satisfying, yet struggling financially. In the case of Colombia, the wind farm installed in the context of the TERNA program can barely be operated economically even with an estimated electricity production of 82 million kWh p.a., which is 2.3 times more than a comparable German wind farm. This is not due to technical shortcomings but to the low electricity market prices in Colombia. However, under optimal wind conditions, wind farms may even turn out to be the most competitive solution. This is the case of the Zafarana wind farm in Egypt. Nordex reports that electricity production costs four cents per kWh, which is well below the costs of the conventional power plants. In such cases, it has to be carefully analyzed, how much ODA is actually required to realize the project, as it may just be a very innovative, but entirely competitive, business-as-usual solution.

Regarding their sustainability, wind farms have often been subject to criticism. They are suspected of being detrimental to bird migration and, in case of off-shore wind farms, to submarine fauna. Thus, project developers are especially requested to examine possible impacts on surrounding species in their EIA.

3.5 Geothermal energy

In this project category, the analysis focused on the Geothermal plant Olkaria II, co-financed by KfW. This project is an example of a completely competitive application of renewable energy technologies. In Kenya, geothermal energy represents the country's lowest-cost option for power generation. Therefore, the Government of Kenya is strongly fostering the development of geothermal sources in order to raise its ratio in the energy mix (KenGen 2003).

One could reason that this project has been an example of successful use of German ODA. However, one major problem has to be recognized: the project would probably have been feasible without such a large amount of ODA (or even with none), as it would have been an attractive investment option for the private sector. This is why the construction and operation of later units, Okaria III and Olkaria IV, are now financed by private investors. KfW just provides the funding for the initial planning stage.

3.6 Afforestation and reforestation

Sustainable forest cultivation offers a variety of benefits: the control of soil and water erosion; improvements in local ecology; and the creation of new income sources for the local rural economy. Positive benefits for the inhabitants may consist of an improved water supply and increased productive capacity of agro-sylvo-pastoral resources. Forest products, such as dead wood, branches, palm leaves and fodder, can obtain market value (e.g., in Gambia). However, many obstacles may hamper successful implementation.

Political conflicts are one of the big problems faced by afforestation and reforestation measures. In most developing countries, the position of the ministry of environment is very weak. Local power constellations often impede improvements in the livelihood of disadvantaged population groups as political lobby groups are powerful and not ready to enter into negotiations. NGOs vehemently act against the timber companies that disregard certification. Against this background, little mutual acknowledgement renders any consensus utopian (such as in the case of Cameroon). When farming land is turned to grassland or forests, farmers are affected and need to be compensated appropriately. However, in many countries (e.g., China), it is very unlikely that full compensation is given, due to financial constraints of the state, arbitrariness of local authorities and corruption.

Successful afforestation and reforestation projects have to be backed by an appropriate legal system, otherwise poverty alleviation and equitable sharing of the benefits will be prevented. Any sound forest cultivation will be undermined, when a high ratio of timber resources are illegally logged, possibly even with the consent of state forest officers (such as in the case of Benin). The same is true when the national fire legislation is not implemented.

Successful implementation is further impeded by the low awareness of the citizens. Forests are widely considered as future land for agricultural use by citizens. In most cases, people are not able to recognize the development potential forests can create for them. A positive long-term impact can only be achieved when the stakeholders are willing and enabled to operate and maintain the structures and plantations. However, benefits resulting from sustainable forest cultivation take decades to become visible. Many risks are associated with forest cultivation. Immature forests cannot yet provide the full variety of benefits of mature forests (e.g., they lack full hydrological functionality) and depending on local circumstances, new trees often only have a low rate of survival. Although China has conducted extensive forest management reforms over the past 20 years, and both forest area and volume of forest stands increased, the forestation rate has improved little, because China is a vast country and the results become visible only after a certain period.

This long-term perspective is irreconcilable with the population's short-term time horizon. Development is desperately required, which makes it very difficult to convince the stakeholders. Incentive-driven remuneration may be a way out of the dilemma. Opportunities for additional income raise the acceptance for sustainable forest management. The key factor for guaranteeing satisfying maintenance by the locals is the use of an appropriate financial tool. For instance, in Vietnam, a savings account approach was applied instead of the usual direct disbursement of the remuneration by the forest authority. On the one hand, this led to a reduction of governmental intervention, and on the other hand, the private economic character of the intervention was enhanced (KfW Projektkurzdarstellung 2001a).

Projects imposed upon the stakeholders are condemned to failure. In order to guarantee the sustainability of the intervention, the project has to be accompanied by a public education program. Long-term impacts can only be achieved when the citizens internalize the underlying values and consider the protected area as an integral part of their national identity.

Apart from shortcomings in general conditions and stakeholders' awareness, afforestation and reforestation activities may fail due to inappropriate program design. For instance, when forests are not ecologically restored, but artificially "constructed," they do not generate the multitude of ecological advantages associated with natural forests. In Lesotho, the wrong market approach was chosen. The evaluation of the project came to the final result that private tree nurseries operated more efficiently than the public tree nurseries installed by the project (KfW Schlussprüfung 2002).

3.7 Energy efficiency

The biggest barrier to energy efficiency improvements on the **supply side** is the limited access to foreign capital and expertise. Therefore, technology transfer and capital from industrialized countries is urgently needed. Unfavourable conditions of the electricity sector such as electricity losses, blackouts and inefficient private self-supply are detrimental to successful implementation.

When improvements are to be undertaken by the **demand side**, very similar problems can be encountered as already described for biomass used in household appliances and solar home systems. For instance, the Stove Dissemination Program in Pakistan (stoves with a double function: heating and cooking) faced strong problems with dissemination due to its poor user-friendliness: the stove was complex and could only be manufactured by skilled workers, the cleaning was difficult and the use was limited to particular utensils only. In addition to the shortcoming that the product did not correspond to the consumers' needs, dissemination was further impeded because the population in mountain areas is sparse and scattered over a wide area, i.e., difficult to inform and to physically reach. When energy consumption is charged at a flat-rate (e.g., the heating costs in Macedonia) (Key Factor Energy 2004), the population's awareness of the need of rational energy use is low and energy efficiency measures are difficult to implement. Therefore, ODA projects have to choose a broader approach in establishing household energy issues as a priority in national energy policies. This is especially important as the topic has little prestige value for policy-makers and financiers.

Generally, the signal effect of a lower electricity price is a valuable incentive, but it may be ruined by the depreciation of the local currency, which is a frequent event in developing countries. Therefore, in an unstable economic context, it is risky to base the success of an energy efficiency activity exclusively on the price effect. When a power plant is to be rehabilitated, due consideration has to be paid to the remaining lifetime of the facility. Taking into account the unpredictable reliability of old plants after repairs, the rehabilitation of a power plant towards the end of its useful economic life (such as in the case of the "Kosovo A" project) is contentious regarding sustainability.

3.8 Sector programs to promote renewable energies

Sector programs hold a high potential when they aim at adjusting general conditions. They can support the restructuring of the sector, foster the elaboration of a legal framework and improve infrastructure. But frequently, the result is a mix of selective and incoherent interventions, as too little attention is paid to actively shaping project environment and integrating projects into their specific sectoral context. Thus, in many cases, little success is earned when translating the project's achievements into significant development impulses (Meyer-Stamer 1994).

The results of sector programs depend very much on the capabilities of the local actors and on the involvement of the partner country. First, decision-makers have to be made sensitive to the benefits renewable energies can create. In many developing countries, they are still mainly interested in a large-scale energy supply that encourages industrialization. But even if technical maturity is granted (which is not yet the case for all uses of renewable energies), the appliance needs above all to meet consumers' needs in order to finally sell on the market. A technology-push is not a promising approach. Renewable energy sources shall not be taken as an end in themselves, because the main objective is to contribute to sustainable development.

4. Lessons across project categories

Throughout the project categories some prominent errors stand out. **Bad planning and management** by the developers is a frequently-found deficiency. Many reasons for failure can be traced back to errors at the planning stage. For instance, if the problem analysis is crude and the goal system is unclear, all efforts made by the participants will be misguided. This may even cause counter-productive effects. There are also errors that occur during implementation. Quality assurance, which is often neglected, is a pre-condition to immediately detect shortcomings and to take counter-measures. Therefore, quality assurance measures have to be specified in the CDM monitoring methodology at least for the components related to emission reductions.

Even if the project itself is working, it is possible that **no significant impact on development** is achieved. Two main reasons for this can be identified: first, a project fails to contribute to the development goal when it is not appropriately embedded into its context. Locals have to be enabled to maintain the project's achievements in the future. Many projects fail in the long term due to a lack of technical understanding and capital from the local population. A pre-condition, which is often neglected, is to sufficiently involve the stakeholders in the project planning. Above all, when a project is supposed to benefit the poor, their needs have to be taken into account when designing the project. Otherwise, the desired distributional effects cannot be reached. When support from the host country is lacking, it is virtually impossible to appropriately embed the project.

The second reason, why a project may have no positive impact on development, is a lack in allocation efficiency. If the long-term marginal costs of a plant are not covered, if technology is not commercially viable or if the product is simply not convincing the consumers, the project will remain dependent on subventions and therefore, cannot be considered sustainable.

The general conditions of the host country may create **barriers** which inhibit implementation. A deficient infrastructure complicates transactions. The political and legal framework may not be supportive for the use of renewable energy sources, e.g., regarding the electricity pricing policies. In many developing countries, stealing electricity and poor payment morality are jointly responsible for project failure. Due to the poor state of electricity systems in developing countries, technical losses contribute to weakening the viability of grid-connected projects. In addition to these technical difficulties, credits may not be obtainable. Financial shortage, high capital costs, high interest rates and even possible devaluations of local currency are prohibitive. Political conflicts and disturbances (such as weak local administrative structures, bribery, corruption and violent attacks) create further risks for project developers. When barriers are so apparent that they cannot be overcome, it is not advisable to undertake the project. The fifth step of the additionality tool for CDM project activities addresses this question.

5. Conclusion

The evaluation of 145 German ODA projects in renewable energy, energy efficiency and afforestation shows that more than one-third of the projects are failures.

Throughout the project categories some prominent errors stand out. **Bad planning and management** by the developers is a frequent deficiency. In the CDM context, quality assurance could be achieved and specified in the CDM monitoring methodology.

Development impacts of projects have been mixed at best. Integration of the project in the local context and direct involvement of economically important stakeholders are necessary conditions for positive impacts. Otherwise, the desired distributional effects cannot be reached. When support from the host country is lacking, it is virtually impossible to appropriately embed the project.

The second reason why a project may have no positive impact on development is a lack in allocation efficiency. If the long-term marginal costs of a plant are not covered, if technology is not commercially viable or if the product is simply not convincing the consumers, the project will remain dependent on subventions and therefore, cannot be considered sustainable.

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While the detailed causes of the failures differ, they make clear that without a sound evaluation framework for CDM project activities or future transfer-based mitigation and adaptation projects, it is very probable that shortcomings such as those highlighted by the evaluation will occur. If evaluations are only carried out after completion of the project, problems occurring during implementation can be detected too late. Therefore, ODA activities as well as CDM project activities should be required to carry out on the one hand, formative evaluations to be able to troubleshoot during implementation and, on the other hand, summary evaluations to assess the project's impact and to draw conclusions for future projects. In this context, the *ex-ante* determination of a baseline is a crucial element in order to reduce implementation risks and to make the projects appraisable. Many aid projects have been undertaken without clearly specifying the reference case *ex-ante*, which renders an *ex-post* evaluation difficult.

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Governing Climate

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The papers in this book, written by international climate experts, explore three key building blocks of the future climate regime. First, a number of ideas on how to broaden the current cap-and-trade regime are discussed. Second, the role of technology is explored. Lessons from past successes are reviewed with a view to developing options for their most effective use over the near future. Finally, the issue of financial flows to developing countries is addressed, including the issue of mainstreaming assistance for climate-change response.

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