NIES/ IGES Research Project Final Report

The Future Climate Regime:

Using the Scenario Planning Approach to Develop Options

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Preface

Climate change is a global problem that calls for global actions. The Kyoto Protocol under the UN Framework Convention on Climate Change (UNFCCC) is currently the only international climate regime that sets legally-binding commitments for countries to mitigate climate change. Commitments under the protocol cover only the years between 2008 and 2012, however, leaving any targets for the ensuing years to be negotiated in the future.

The Kyoto Protocol entered into force on February 16, 2005 (followed by the first meeting of the Parties [COP/MOP 1] in Montreal, Nov.-Dec. 2005). The Kyoto Protocol's entry into force is a significant step forward for global action against climate change. As it covers the period up to 2012, countries are now aware that discussions must begin on commitments beyond 2012.

This paper is the final report of a three-year research project on climate regime beyond 2012. It was mainly conducted by the National Institute for Environmental Studies and the Institute for Global Environmental Strategies (IGES). Names of the project participants are listed at the end of the report in Appendix 1. The entire funding of the project – 66,848,000 yen (about US$607,000) in total for fiscal years 2003 to 2005 – came from the Global Environmental Research Fund of Japan's Ministry of the Environment.

The aim of this project was to come up with several different options for a future climate change regime beyond 2012. These options include not only the final overall structure of international institutions involved, but also scenarios for negotiations that could lead to an international agreement on those institutions, and evaluation of the regimes from various perspectives – including effects on the environment, equity, and the economy – as well as other pros and cons.

To achieve its challenging aim, the project applied the scenario planning approach, the details of which are elaborated in the main text as well as in Appendix 2. In the end, the project team felt that this was a useful and creative approach to help formulate a comprehensive picture of how the climate debate is likely to develop in the coming years.

The project team would like to thank many officials at Ministry of the Environment of Japan for the funding, for the opportunities to discuss policy making related to climate change, and for sharing their views. The team would also like to thank the experts who accepted our interviews and enlightened us with their perspectives. The names of those experts are listed in Appendix 3.

Note: This project was funded by Global Environmental Research Fund of the Ministry of the Environment, but it does not mean the contents of this paper reflect any positions of the Ministry. This report should be treated as a compilation of academic activities of the project members.

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Summary

Much literature has been published offering proposals on what should be done with a climate regime beyond 2012. Such proposals are based on different world views and assumptions, which makes it difficult for policy makers to compare and assess those options. Such world views could be considered as “scenarios”.

The NIES/IGES team introduced the scenario planning approach to develop scenarios that may become reality over the next 5–10 years. Two driving forces, *development of international emissions trading*, and, *people’s expectation towards innovative technology*, were considered as most influential and uncertain driving forces that are likely to determine the future world related to climate change. With the two selected driving forces, the team developed the following three scenarios.

- **Carbon Market Initiative**: Emissions trading at the international level becomes the most widely-used means to tackle climate change. Many countries and private firms discover the benefits of participating in the trading. Countries recognize that to ensure that emissions trading systems continue, it is necessary to set a cap on each country’s emissions beyond 2012, for both developed and developing countries.

- **Government-led Policies and Measures**: Little incentive exists to set emission targets for each country, but they recognize the necessity of agreeing on concrete commitments to mitigate climate change. Instead of negotiating national emission caps, countries prefer to coordinate their policies and measures (PaMs), as this is considered to be a good way to maintain the international competitiveness of industries.

- **Technology Optimist**: Countries recognize the limitations of merely spreading existing technologies and changing consumer behavior. They believe that climate change can only be solved by innovative technologies that may emerge over the next several decades. Governments seek ways to stimulate quick development and diffusion of such innovative technologies.

The team then categorized various existing proposals into three groups based on the three scenarios that may reflect underlying world view in each proposal. With this approach, any evaluation can be detached from concerns as to whether or not a certain proposal is agreeable to one party or another. We found that proposals that we classified under any given scenario shared common features, strengths and weaknesses. After making these assessments, the NIES/IGES team offered additional ideas to minimize weaknesses of existing proposals, and developed a climate regime for each scenario, as outlined below.

- The **“Carbon Credit Banking”** is developed for the Carbon Market Initiative scenario. This regime requires a legally-binding emission reduction (or limitation) target to be set for each country, including non-Annex I countries (under the current UN Framework Convention on Climate Change). In addition, a Carbon Credit Bank is to be established, and it introduces an international “safety-valve”. Countries or private firms can invest in the bank to start projects similar to those under the Clean Development Mechanism. The bank could also offer money for adaptation to climate change.

- The **“Dual Track Approach”** is developed for the Government-led Policies and Measures scenario. This regime also requires an emission target to be set for each country, but the targets are not necessarily legally-binding. After allocation of emissions, each country shall select one of two “commitment tracks.” Countries that chose Commitment Track A are requested to submit a list of PaMs that they pledge to

implement. Countries that chose Commitment Track B are not required to submit PaM lists, but their emission targets are legally-binding, and they are expected to utilize emissions trading to help achieve their respective targets.

- The **“Technology +Compensation Funds”** is developed for the Technology Optimist scenario. Under this scenario, it is likely that numerous bilateral or regional agreements on climate-related technology cooperation appear around the world. Participants in such agreements are requested to establish Compensation Funds. When it is estimated that the global emission is likely to shoot above a climatic limit, all the technology-related agreements around the world are asked to pay a certain amount of money from their Compensation Funds to diffuse certain technologies to quickly reduce emissions. The Funds are also asked to contribute to adaptation activities.

There is no simple way to address the costs of abatement to allow a comparison of the three climate regimes, but distribution patterns of the costs are more predictable. Negotiating processes for regimes are expected to balance such benefits to other less profiting countries to be able to achieve an agreeable solution.

This exercise assumes that all scenarios have same possibility of becoming reality. It may be possible, however, to lead the world into one specific scenario if the intention exists. It is the governments’ role to promote dialogue about what type of world is ideal, in the context of climate change. In order to reach environmentally-effective agreements in any of the three scenarios, it is critically important that the public have adequate awareness of the seriousness of climate change.

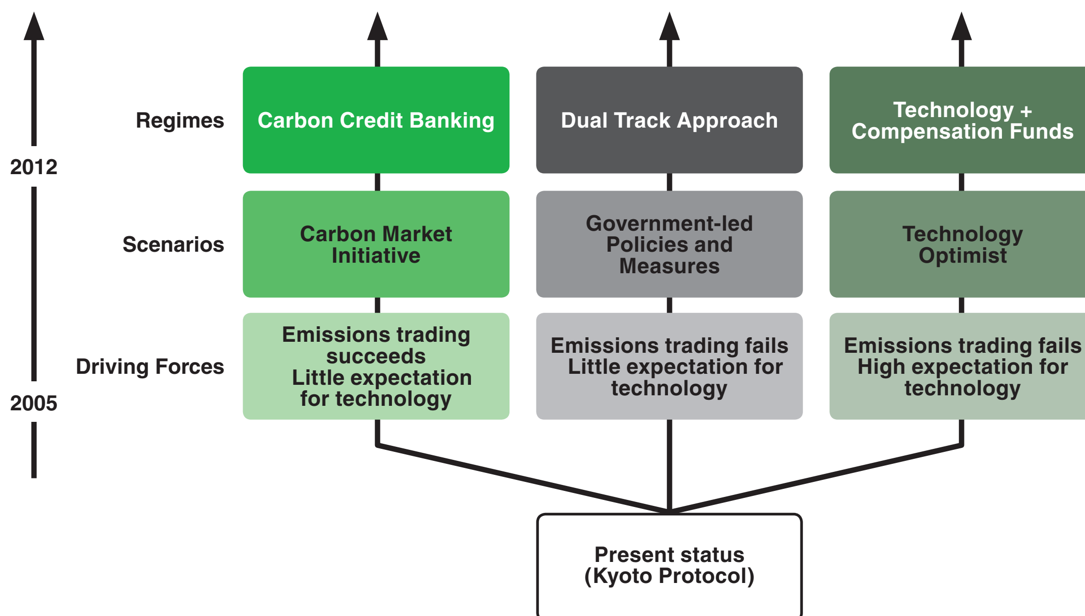

Figure S.1 Structure of summary of the NIES/IGES report

1. Outline of the study

1.1 Purpose of the study

Climate change is a global problem that calls for global actions. The Kyoto Protocol under the UN Framework Convention on Climate Change (UNFCCC) is currently the only international climate regime that sets legally-binding commitments for countries to mitigate climate change. Commitments under the protocol cover only the years between 2008 and 2012, however, leaving any targets for the ensuing years to be negotiated in the future.

The Kyoto Protocol entered into force on February 16, 2005 (followed by the first meeting of the Parties [COP/MOP 1] in Montreal, Nov.-Dec. 2005). The Kyoto Protocol's entry into force is a significant step forward for global action against climate change. As it covers the period up to 2012, countries are now aware that discussions must begin on commitments beyond 2012.

The aim of this project was to come up with several different options for a future climate change regime beyond 2012. These options include not only the final overall structure of international institutions involved, but also scenarios for negotiations that could lead to an international agreement on those institutions, and evaluation of the regimes from various perspectives – including effects on the environment, equity, and the economy – as well as other pros and cons.

It is worth noting that when the Kyoto Protocol was adopted in 1997 at the third Conference of the Parties to the UNFCCC (COP3), the emission reduction targets listed in Annex B of the protocol were not agreed to independently of other factors. The figures listed were the result of tradeoffs with other parts of the protocol, such as articles on the Kyoto Mechanisms (Article 6, 12 and 17), carbon sequestration (Article 3.3 and 3.4), types of gases and sectors (Annex A) and joint fulfillment of commitments (Article 4). This outcome offers a hint for future negotiations – namely, that future commitments are also likely to be agreed upon in a comprehensive manner that considers other relevant agendas.

This study paid attention to these tradeoffs and negotiating processes. The project team was interested not only in the final outcome of the negotiations – a future climate regime – but also in the negotiating processes that might lead to the final agreement. Countries are more likely to agree to make certain commitments if they believe that other articles in the same agreement will benefit them. We were interested in how such tradeoffs will unfold in the coming round of negotiations and how they might help to create the most effective climate regime. Thus, an examination of dynamics of tradeoffs has become a significant part of the aim of this research project.

1.2 Background of the study

A plethora of articles have discussed the design of a climate regime after the year 2012, the year that marks the end of the first commitment period under the Kyoto Protocol (Bodansky et al. 2004). Some writers hold the opinion that the world should not wait until 2012, arguing that the Kyoto Protocol was a failure and should be completely replaced by an alternative architecture. In addition, many articles review,

classify, compare, or assess various types of proposals.

At the starting point of this project, a review was conducted of existing literature on a future climate regime or architecture (Kameyama 2004a). The review concluded that preferences regarding proposals on a future climate regime differ tremendously according to the type of world that is presumed to exist "behind the screen". For instance, those who prefer a "Kyoto"-type of architecture – one that involves "legally-binding" emission limitation objective for each nation – assume a world where all countries basically participate in the regime and where some kind of punishment is applied when actions fail to honor those "legally-binding" commitments. On the other hand, many of those who criticize the Kyoto Protocol assume an anarchic world in which each country takes action to maximize its own national interest (Kagan 2002). From such observations, we can state that in order to adequately evaluate proposals for a future climate regime, we first need to articulate the types of future worlds that we will use in our scenarios. As we do not know yet with certainty what kind of world we are actually going to encounter, at this moment we cannot state which proposal would be the "best". At best, we can only state our assumptions.

In order to elaborate different scenarios, the project team developed three separate scenarios for the international climate debate over the next decade. Each scenario shows a plausible future world in the context of international debate relating to future commitments on climate change after the year 2012. As each scenario incorporates different types of economic benefits, social structures and perceptions, the world in each scenario is likely to accept different types of future climate regime. Those climate regimes that are *most likely* to be negotiated in each scenario are not necessarily the *most preferable* regimes. Thus, we compared the regimes in the three scenarios – from perspectives related to the environment, economy, equity, and institutional efficiency. Finally, we offer some new ideas for the regimes in order to get closer to our initial aim of developing several different options for a future climate regime beyond 2012.

1.3 Structure of the study

This report's structure basically follows the three steps used for this study (Figure 1.1). The first step is elaboration of three plausible scenarios that describe the world in the next decade, in ways that are likely to affect debates on the climate regime (Section 2). This step is explained in considerable detail for two reasons. First, the details of the scenarios are important if one is to obtain a clear picture of climate regimes that are likely to be accepted in each scenario. Second, details are important in order to grasp not only the nature of the regime itself but also the negotiating process to achieve such a regime. We are interested to know not only what type of climate regime is likely to be agreed upon, but also how the final agreement is likely to be reached, how each major country and region may decide on its position, and what kinds of tradeoffs might be made between various elements in order to reach agreement.

The second step is categorization, evaluation and comparison of regimes identified in each scenario (Section 3). It should be noted that those regimes identified as most likely to be agreed upon are not necessarily the most environmentally effective, equitable, economically efficient, or institutionally efficient. Thus, it would be helpful to evaluate existing proposed regimes according to those criteria. The result of that evaluation is the final comprehensive proposal arising from this project.

The third step is development of our own ideas for future climate regimes (Section 4). Such regimes are developed based on evaluation of existing proposals in the previous section. One regime is developed for each scenario. The result of this exercise leads us to the final comprehensive proposal arising from this project.

The conclusion (Section 5) emphasizes that there may be two paths to success in the future round of climate negotiation. First, discussions could lead to general agreement on one scenario, in which

one particular climate regime will be perceived as being more agreeable to countries than other scenarios. Second, after the world has moved into a certain scenario, we could still be able to choose the right type of architecture so that some kind of effective climate regime will be constructed.

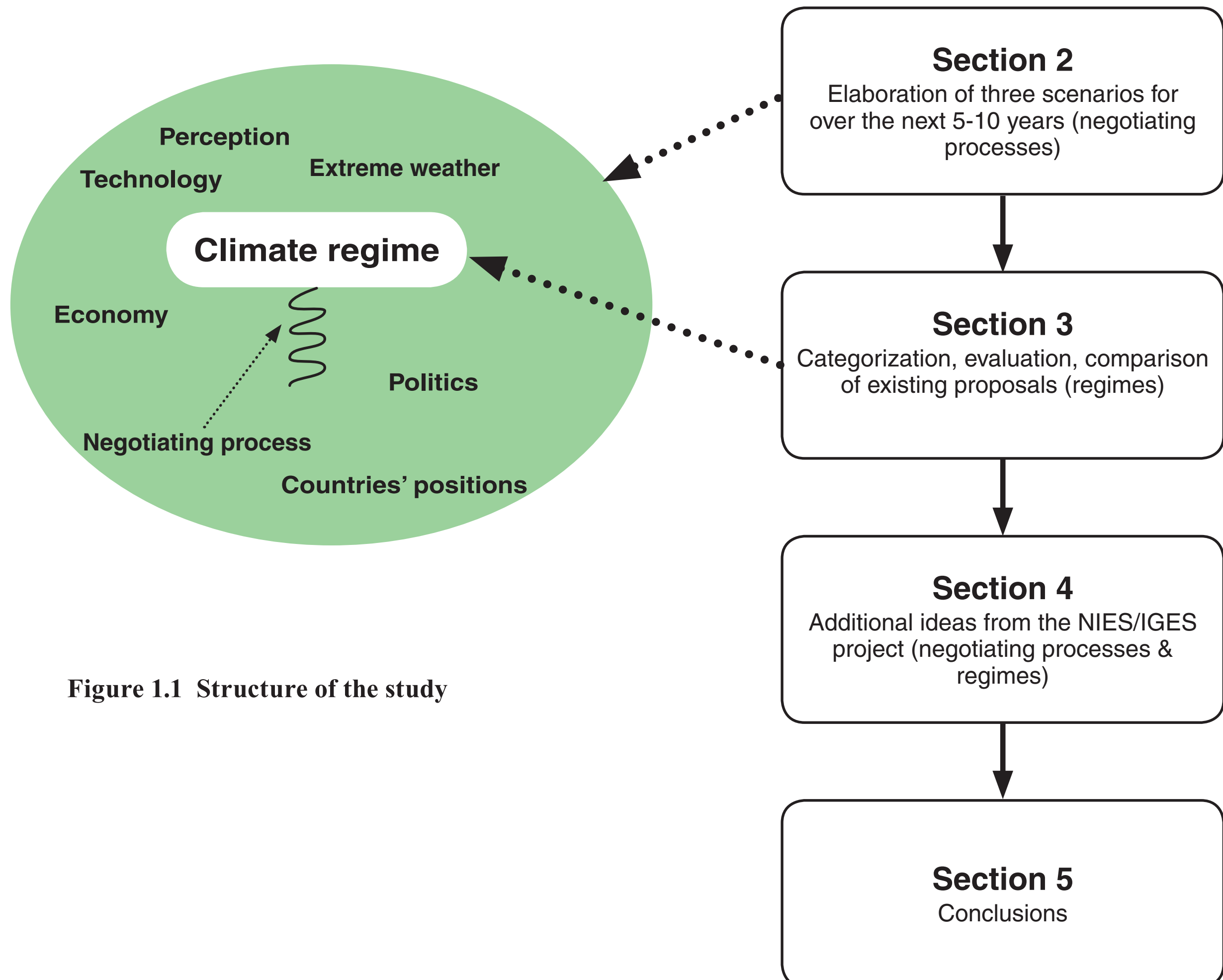

Figure 1.1 Structure of the study

2. Elaboration of Scenarios

2.1 Development of three scenarios

A scenario is not merely a means to develop the most realistic image of the future. It is also a tool to understand the views of others, and to clarify underlying assumptions that may have been unnoticed even by the person holding the view. A scenario approach is also a way to simulate the dynamic processes by which international negotiations reach a certain outcome. By investigating a scenario closely, we may be able to identify key elements that could affect the process to reach a different outcome.

For these reasons, the project team introduced the scenario planning approach to develop scenarios into which the world may evolve. A detailed explanation of the process of scenario development is elaborated

Table 2.1 Summaries of features of each scenario

	"Carbon Market Initiative" Scenario	"Government-led Policies and Measures" Scenario	"Technology Optimist" Scenario
Development of international emissions trading	Dramatic progress	Fails	Fails
Expectation of rapid climate change mitigation by innovative technology	Pessimistic	Pessimistic	Optimistic
Primary objective of actions or agreements	Maximization of benefits by emissions trading	Climate mitigation	Technology development and diffusion
Equity between developed and developing countries	Considered	Considered	Not considered
Equity among developed countries, or among developing countries	Considered	Considered	Not considered
Economic incentives	Economic benefits from international emissions trading	Taxes and subsidies ("sticks and carrots") at domestic policy level	Funding for technology R & D at international and domestic levels
Contribution to sustainable development (SD)	Reflected in CDM, or by committing to intensity targets	Dealt with by differentiation of policies and measures	Priority given to economic development by developing countries
Types of agreement	A single multilateral agreement	A single multilateral agreement	A number of regional/ bilateral agreements
Legally binding commitments?	Yes (on emission target)	Yes (on implementation of PaMs)	No
Adaptation[1] issue on agenda?	Interest declines after emissions trading begins	Strong demand from developing countries to put on the agenda	Little concern

[1] Adaptation is a collection of actions that is aimed at minimizing adverse effects of climate change that have occurred as a result of insufficient effort to reduce greenhouse gas emissions. Adaptation became one of focus area for negotiation especially after COP10.

in Appendix 2. All members of the project team participated in the initial development of the scenarios. Interviews with various stakeholders that will be affected by the outcomes of climate change negotiations were made to further elaborate the scenarios(Appendix 3). An attempt was also made to consider the different perceptions and assumptions held by authors who have written articles related to a climate regime beyond 2012 and have come up with different proposals. Table 2.1 summarizes the key features of the three scenarios, which include (1) the "Carbon Market Initiative" scenario, (2) the "Government-led Policies and Measures" scenario, and the "Technology Optimist" scenario (Table 2.1).

2.2 "Carbon Market Initiative" scenario

In this scenario, emissions trading at the international level becomes the most widely-used means to tackle climate change. Many countries or private firms discover the benefits of participating in the trading. Countries recognize that to ensure that emissions trading systems continue, it is necessity to set a cap on each country's emissions for years beyond 2012, for both developed and developing countries.

The **EU** is the first region to fully develop an emissions trading system. The EU positions itself to support other schemes like its own EU Emissions Trading Scheme (EUETS) and the Clean Development Mechanism (CDM), and through them intends to substantially reduce greenhouse gas (GHG) emissions in the medium and long term. Just after the EUETS started in January 2005, the price of an EU allowance (EUA) rises to 28 euros (Figure 2.2). EUETS is linked with the Norwegian market, which was also launched in January 2005. EU member states and stakeholders see emissions trading as an efficient climate policy. Responding to the active market, the number of supporters of ETSs increases. This includes the financial sector, trading companies (Martinez and Neuhoff 2005), legal and financial consultants, and power companies who have recognized the benefits of ETSs (Lafeld 2003). Around 2008 and 2009, preparation begins for the second phase of EUETS. In order to achieve the EU's Kyoto target, the emissions allocations become stricter than that for the first phase. The EUETS expands to gases other than CO_2, bunker fuels (Wit et al 2005), installations not included in the first phase (including chemicals and aluminum), and the transportation sectors. It also geographically expands due to the entrance of Romania and Bulgaria into the EU.

Figure 2.2 Price of an EU allowance (EUA, in euros) in 2005 (PointCarbon 2005).

Linkages to the EUETS market also develop. Switzerland aims to establishing a system and link it with the EUETS. Observing the success of the EU carbon market, other countries are motivated to revise or introduce their own schemes similar to the EUETS, including countries with schemes that were originally difficult to link with EUETS[2] for technical reasons (Canada) and countries that had not yet decided to introduce an ETS (Japan). As a result of Article 25 of the EU Emissions Trading Directive – which requires other countries to ratify the Kyoto Protocol before they can link with the EUETS – parties that have not yet ratified the protocol (the United States and Australia) work to resolve this issue in order to participate in a wider market and enhance market liquidity.

The drafting process of National Action Plans (NAP) for the EUETS third phase starts around 2011. Solutions for technical issues regarding linkages[3] with other ETSs are identified based on experiences of linkages with Norway, Canada, and other countries. In this way, all major remaining issues relating to linkages are addressed. The EU strongly promotes EUETS-like emissions trading schemes, with the aim of substantially reducing emissions based on such schemes in the international regime beyond Kyoto.

In the **United States**, the Regional Greenhouse Gas Initiative (RGGI), an effort by nine northeastern states to establish a regional emissions trading program, starts trading in 2008/2009 as scheduled,[4] and successfully expands its membership by convincing neighboring states (importantly, Pennsylvania) to take part.[5] This expansion helps mitigate the issue of trans-state "leakage".

In parallel, the west-coast states, led by California, launch a different type of emissions trading system with a cap on power demand rather than generation.[6] Such emerging regional trading markets builds significant momentum for a federal program. In addition to the development of regional-level emissions trading markets, the political muscle of the financial community adds further momentum. The U.S. financial community finds substantial profits in emissions trading businesses, and creates a strong lobby group calling for a nation-wide trading market (Schmidheiny and Zorraquin 1996). Reflecting these changes in political arena, Congress passes the McCain-Lieberman bill for a mandatory, nation-wide cap-and-trade scheme, which requests major GHG emitters to return their emissions to 2000 levels by 2010–2015.

While the United States continues to stay outside the Kyoto Protocol process, it stays heavily involved in the negotiation process regarding a future climate regime. Between the United States and Europe are differences in ideas on the level of carbon prices (i.e., the EU is interested in high prices to stimulate technology innovation, while the United States prefers lower prices in conjunction with more direct governmental involvement in technology policy) (Pizer and Tamura 2005). Indeed, while the price of EU allowances stays in the 20–30/t-CO_2 range; in the United States, the carbon price ranges from \$9/t-CO_2 to \$16/t-CO_2 in 2010.[7] Given the political difficulty in bridging such differences, the United States chooses its own course for building an international framework for emissions trading markets, where the carbon price is set more moderately than provided under the Kyoto Protocol.

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[2] Interview with Dr. Arthur Runge-Metzger, Director, Climate Policy Division, European Commission, 2005. Similar discussion can also be found in Hasselknippe (2003).

[3] Technical issues for the linkages are identified in Watanabe et al. (2005). See also Watanabe (2003) for development of regional climate regime in the EU.

[4] IGES/CCAP workshop on Local Climate Initiatives in the U.S. and Japan, held on 29 March 2005, in New York.

[5] Personal conversation with Eric Haites of Margaree Consultants in June 2005. According to him, the member states of RGGI are now trying to convince Pennsylvania, which is currently an observer, to fully join the regional trading programme. Many coal-fired power plants are located in Pennsylvania, and provide the northeastern region electricity.

[6] Stacey Davis of Center for Clean Air Policy, a consultant to the California Energy Commission, pointed out advantages of a cap on emissions associated with power demand in California. See http://www.energy.ca.gov/global_climate_change/04-CCAC-1_advisory_committee/documents/2005-04-06_meeting/2005-04-06_DAVIS.PDF

[7] The low price estimates are from Paltsev et al. (2003). The high prices are from Energy Information Administration (2003).

Joint implementation (JI) and the CDM still fails to attain much importance by 2005–2008, as most countries are interested mainly in emissions trading, while JI and the CDM are seen to be competing with emissions trading schemes.[8] However, as the final year of the first commitment period of the Kyoto Protocol draws near, the two flexibility mechanisms start to attract attention as the price of emissions trading allowances become high. The EU's Linking Directive allows member states to count ERUs and CERs[9] derived from JI and CDM projects and exchange them from EUAs under the EUETSs, in order to achieve their Kyoto targets. This feature expands the size and volatility of the carbon market (Kimura and Lee 2005). In particular, countries may opt to depend heavily on unilateral CDM projects (which were officially approved by the UNFCCC in 2005), and CDM projects related to industrial processes involving HFC23 and methane (both having high global warming potential, or GWP), in order to ensure compliance with Kyoto commitments, and these could therefore occupy a large share of the CER market (Lecocq and Capoor 2005). Those CDM projects promote technology transfers from Annex I to non-Annex I countries. CDM afforestation and reforestation projects are not implemented as much as has been originally hoped, because of the long time-frame of such projects (Haites 2003) and the exclusion of carbon sinks from the-CDM and land use, land-use change and forestry (LULUCF) from the EUETS (2003/87/EC) (Commission of the European Communities 2003).

Through restructuring of the CDM framework, the post-2012 climate regime allows CDM projects that are policy- and sector-based, and those that involve transportation (Browne et al. 2005), products, and so on. Those changes attract the attention of **non-Annex I** countries as well. The greater attention contributes to further expansion of carbon markets and the number of CDM projects. CDM projects are promoted by technology transfers involving energy reduction, biomass, and renewable energy, etc., which contribute to sustainable development in developing countries (IGES 2005). Although CDM-related activities are high in Asia and South America, countries in Africa and the Middle East are left behind – this is consistent with the overall distribution of flows of foreign direct investment (FDI) (Lecocq and Capoor 2005). To solve this problem, some international measures are taken.

With a well-functioning emissions trading market, a **forest** offset market also starts functioning, as the problems on measurement, monitoring and certification can readily be accomplished (Sedjo and Toman 2001). On the other hand, the use of forestry CDMs had been constrained by a limit in the current Kyoto Agreement, whereby a maximum of 1% of a country's targeted reductions can be met by CDM forest sequestration projects. This constraint is reconsidered and either raise or eliminate a cap on the maximum allowable sequestration limit. Other types of forest-related arrangements are discussed. For example, a rental arrangement has been suggested that would continue for the length of the period during which the forestry project continues to sequester carbon, be it long or short (Sedjo and Marland 2003).

There are two groups of developing countries: those that have the institutions to accept CDM projects (NEDO 2004), and those that do not. The former group, especially large countries such as China, India and Brazil, starts enjoying the benefits of the CDM, but in the early years, the CDM market has little activity, as developed countries are more interested in emissions trading. Fewer CDM projects are realized than developing countries had originally expected (State Ministry for the Environment 2001; Pelangi 2001). As the price of allowances under emissions trading becomes higher, however, the CDM becomes more popular. Opportunities for finding low-cost CDM projects, especially involving technology transfers

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[8] The McCain-Lieberman bill would have permitted regulated entities to satisfy 15 percent of their obligation through international offsets and sequestration projects.

[9] Emissions reduction units (under Joint Implementation) and certified emission reductions (under the Clean Development Mechanism).

for energy saving, are likely to run out by 2012. One reason of the CDM's inactivity is the limitation on sectors and types of projects that can be covered. Only a limited number of developing countries can expect to benefit by energy saving or renewable energy. Discussions begin about baselines of **agricultural CDM** projects, and more studies prove their strong benefits for developing countries.

The inclusion of emissions from agriculture is considered as effective in many relatively small developing countries, as the agricultural sector's share of CO_2 and methane within total greenhouse gas emissions is higher in many developing countries. Improvements in feed quality, increase in productivity, and decrease in the number of cattle are considered to be effective countermeasures to decrease GHGs emissions derived from animal production (IPCC 1996). Since developing countries consider as against sustainable development to decrease the number of cattle, the first two options are seen as most attractive. Grassland improvement is one of the most effective countermeasures in developing countries where cattle are raised by large-scale grazing.[10]

Since countries have come to recognize the promise of economic benefits from tacking climate change, all seek ways to maximize the amount of "excess" reductions of GHGs. In this regard, in both Annex I and non-Annex I countries, **technological R&D** is attributed more importance within the policy making circle. Governments increase their spending on technology R&D as well as innovative technologies. There is a significant increase in demand for transfers of climate-friendly technologies from industrialized Annex I to non-Annex I countries. Besides activities under the CDM, new markets emerge in the global arena for such technologies. As a way to maximize the amount of CERs obtained, some Annex I countries propose methods to generate credits through technology transfers.[11]

Each trading scheme has a **compliance mechanism** at its own level, either national (like in the UK) or regional (like in the EU). Emissions trading schemes, by nature, require effective enforcement of compliance to deter non-compliance, in order to keep the carbon market operating soundly – a point that has been broadly recognized by scholars (e.g., Haites 2005) as well as by lessons from precedents such as a trading scheme for SOx emissions in the United States (Ellerman et al. 2003; Commission of the European Communities 2001). Significant efforts are made to try to link one emissions trading scheme with the other. The reason for linking emissions trading schemes is to offer the potential for larger cost savings, which is essentially one of the objectives of such schemes (Haites 2004; Commission of the European Communities 2001). Generally speaking, the larger the number of participants, the greater the diversity in the compliance costs and the larger the potential cost savings (Haites 2005). For linking, some of these schemes' components have to be harmonized in order to maintain the sound functioning of the carbon market as well as to avoid creating distortions in competitiveness. Key factors include not only reliable monitoring and verification systems, but also the size of penalties for non-compliance, and the level of a "safety-valve" price (price cap on allowances), if one exists.

The coordinated compliance mechanism is expected to play two main roles. The first is to monitor and review the inventory of emissions from sources and removals by sinks, for which the Kyoto Protocol has provided a good basis for a future monitoring and review system. The second is to ensure that allowances

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[10] For example, the daily methane emissions from cattle in Japan are closely related to dry matter intake (CH4=-17.766+42.793DMI-0.8486DMI2, r=0.966, Shibata et al. 1993). This suggests that decreasing dry matter intake by using high nutrient (high quality) feed would be an effective way to decrease methane emissions. Many developing countries are located in climatic regions that have a dry and a rainy season. In these regions the daily weight gain of beef cattle in dry season is low because of a decrease in feed supply (Sere and Steinfeld 1996). Nevertheless, improving grassland to increase productivity does not always decrease GHG emissions. They may actually increase as farmers increase the number of cattle in order to further increase production. It has also been pointed out that reducing livestock numbers is not financially viable for farmers (Clark et al. 2001). The point to remember is that it is important to maintain a balance between economic and environmental objectives when seeking to decrease GHGs emissions and increase production.

[11] Japan's Ministry of Economy, Trade and Industry (METI) may propose such an idea at COP/MOP1 (PointCarbon 2005).

are properly allocated under national trading schemes, and to monitor whether or not national compliance mechanisms work in whatever way countries agree to harmonize them.

Annex I countries' interest in **adaptation** declines as emissions trading becomes the priority objective of the regime. As the Adaptation Fund – supplied by contributions from the "Adaptation Levy" on all transactions under the Kyoto Protocol (Huq and Reid 2004) – is well-funded, Annex I countries wish to focus on measures concerning scientific and technological aspects of adaptation, which are addressed in the SBSTA's 5 Year Work Programme on Adaptation,[12] and they have little interest in introducing new measures for adaptation in a post-2012 framework. Non-Annex I countries pay more attention to the operation of financial mechanisms under the UNFCCC and the Kyoto Protocol (Takahashi and Kubota 2005), particularly the Adaptation Fund, which is supposed to support "concrete adaptation" actions. Non-Annex I countries propose establishment of a mechanism for payments by emitting countries to countries that are adversely affected by climate change, in order to cover costs of adaptation and damage (Jaeger 2003). The Alliance of Small Island States (AOSIS) requests that the special funding track for Small Island Developing States (SIDS) as a first step identify the immediate and urgent vulnerability and adaptation needs of SIDS (Tuvalu on behalf of AOSIS 2005). African and Middle Eastern countries desire special assistance for adaptation from Annex I countries, because they are often left behind in economic development – this is consistent with the overall distribution of FDI flows.

2.3 "Government-led Policies and Measures" scenario

Under this scenario, countries have little incentive to set emission targets for each country, but do recognize the necessity of agreeing on concrete commitments to mitigate climate change. Instead of negotiating emission caps for each country, countries prefer to coordinate policies and measures (PaMs), as this is considered to be a good way to maintain the international competitiveness of industries.

Many Annex I countries do not wish to negotiate new emission targets after the year 2012 as they consider this process to be too political. On the other hand, they share the view that something needs to be done to mitigate climate change. Early in the first commitment period of the Kyoto Protocol, **Japan and Canada** realize that it would be difficult to achieve their respective Kyoto targets. There is not much activity to be seen in international emissions trading. Some countries feel their burden is unfair compared to countries that are not participating in the Kyoto Protocol (the United States and Australia), countries with relatively less stringent targets (EU, Russia), and countries with large emissions but no emission targets (China, India, etc.). Thus, those two countries take the initiative in insisting on a regime that is different from the Kyoto Protocol, and they hold the view that coordination on PaMs is the way to go.

In the **EU**, the **ETS** does not function as expected. Since the allocation is not strict and banking is not allowed for the first phase, purchasing enthusiasm decreases and transactions decline. EU member states and stakeholders are disappointed about ETS. For mitigation measures from industry and energy sectors, the EU is expected to position itself to promote the coordination of PaMs. However, the EU is not ready to stop emissions trading after investing huge administrative costs for its introduction. The EU continues to utilize emissions trading in combination with technology transfers to level the playing field within the region. Through the coordination of PaMs and the transfer of technologies relevant to the PaMs, the EU urges developing countries to participate in the international scheme. As the CDM remains inactive, the

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[12] For example, establishing databases on essential information (such as the current and future climate data and climate scenarios), establishing methodologies for impact and vulnerability assessment, sharing information about adaptation measures and technology.

EU supports the introduction of another scheme to transfer technology in the household and transportation sectors.

It is difficult to reduce GHGs emissions by more than allocated in the sectors covered by EUETS, so substantial reductions in the household and transportation sectors become necessary. In order to enhance measures in member states that have not yet developed and implemented PaMs in these sectors, PaMs are strengthened at the EU level. This includes energy efficiency directive in building and house sectors, fuel efficiency of cars, a car tax based on CO_2 emissions,[13] and a tax on energy products. The EU becomes increasingly aware of the necessity of coordinating such policies and measures with countries outside of the EU in order to maintain international competitiveness of industry sectors. In the years beyond 2012, the EU puts its emphasis on coordination of PaMs at the international level. EUETS is used only for energy-intensive sectors as an instrument for leveling the playing field within the EU. The combination of Best Available Technology (BAT), energy efficiency standards, and subsidies for technology development becomes a plausible option.

The linkage of emissions trading schemes outside of EU member states is limited to Norway. Observing the rupture of EUETS, other countries such as Japan and Canada delay their own introduction of emissions trading.

In the **United States**, the Regional Greenhouse Gas Initiative (RGGI) faces serious difficulties at the program design stage. It takes much longer than originally expected to reach an agreement about such key issues as the determination of model reference cases (base cases), cap levels, and offsets outside the region (reductions from external sources). Furthermore, the decision by Pennsylvania not to join the RGGI fuels further fears that it will only end up raising electricity prices in the region and driving power generation outside the region (Pizer and Tamura 2005). In the end, RGGI makes no substantial progress by 2010. At the federal level, no bill for a national emissions trading scheme attracts enough support in Congress.

The failure to place a value on carbon hinders progress with carbon capture and sequestration. Though government-led carbon capture and storage (CCS) projects continue through 2010, there is little incentives for the private sector to invest in and apply CCS technologies, in the absence of policies that impose a sufficiently high implicit or explicit price on carbon emissions (Anderson and Newell 2004). Furthermore, the issue of long-term financial liability relating to carbon leakage is not resolved in the United States.[14] The international community also fails to agree upon common guidelines for national GHG inventories that account for CCS as well as for related risk management, due to diverse interests and different political agendas among countries.[15] The underdevelopment of any regulatory framework becomes another disincentive for the private sector to invest in CCS technologies and projects. As a result, there is a pessimistic mood toward such technology in the United States.

With no pragmatic prospects for CCS (and in fact, for a domestic emissions trading scheme), the idea of command-and-control style regulation prevails in the United States – like motor vehicle standards did in California. The state of California successfully introduces its own motor vehicle GHG emissions standards, and many other states decide to follow suit.[16] Under the regulation, new vehicles are required to reduce tailpipe GHG emissions by 22 percent by the 2012 model year and by 30 percent by the 2016

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[13] Related issues are observed in COM/2005/261/FINAL

[14] On a long-term liability issue regarding geological carbon sequestration, see de Figueiredo et al. (2003).

[15] On the importance of regulatory frameworks for CCS, see Wilson and Keith 2003.

[16] Currently, 10 states (Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Oregon, Rhode Island, Vermont, and Washington) have indicated their interests in following the California standards. See http://www.pewclimate.org/what_s_being_done/in_the_states/vehicle_ghg_standard.cfm

model year. This regulatory patchwork in the U.S. domestic car market creates great pressure on the federal government to take action (Rabe 2002). Movement at the federal level raises concerns about international competitiveness of the domestic car industry. Industries that are subject to unilateral and strict regulations in their home country find themselves at a competitive disadvantage to international rivals. Such industries argue for sector-based regulatory co-ordination among nations, which could ensure some sort of a competitive "level playing field" for internationally competing firms.

The slump in the international ETS market and low expectations for diffusion of innovative technology limits the number of **JI and CDM** projects approved and lower the price of CERs. This outcome increases the frustration of **all developing countries** regarding the CDM, which leads to demands to the reform of conventional CDM (Parikh and Parikh 2004; Shrestha 2004; Kimura 2005). Governments of Annex I countries cannot offer appropriate incentives for the private sector to invest in CDM projects – although that was something for which was originally designed. Instead, they establish publicly-funded purchasing funds to acquire the necessary CERs (Michaelowa 2004). In the post-2012 regime, energy efficiency standards of cars, energy standards of electrical appliances, and the proportion of renewable energy in the energy mix become the major issues in terms of "participation" of developing countries (Sugiyama et al. 2005). As the price of gas rises, many developing countries become interested in energy efficiency and renewable energy. Those countries hold the view that participating in a climate regime will bring them the benefits of access to the relevant technologies.

Many developing countries are faced with the severe **deforestation** caused by rapid population growth and poverty. Developing countries insist that their efforts to protect deforestation should be evaluated as carbon emission reduction. This requires net-net accounting system as an appropriate method to assess their efforts to fight with deforestation and degradation of forest resources. Under the poor functioning of emissions trading mechanism, however, investors do not foresee the future demand of temporary CER. Governments start discussing PaMs concerning forestry sector, which do not require detailed calculations on the amounts of carbon sequestered by the forests.

In **agriculture**, many developing countries have high expectations for the Adaptation Fund because agriculture is vulnerable to the impacts of climate change (Bratasida 2004). In an effort to find convergence between the CDM and the Adaptation Fund the agriculture sector debates whether agricultural land should be treated under the CDM or as GHG sinks. In that context, governments of developing countries, especially in Asia and Latin America, become interested in subsidies to promote grassland improvement, and in the restriction of the number of cattle, in an effort to mitigate GHG emissions from those sectors. As the consumption of livestock products continues to increase in developing countries (FAO 2002), it is important to maintain a balance between economic and environmental factors when considering decreases in GHG emissions versus increases in production. To raise productivity of milk and meat, a decrease in the number of livestock is considered as one effective countermeasure (Ministry of Science, Technology and Environment Thailand 2000).

While non-Annex I countries continue to demand that Annex I countries **transfer both finance and technologies** and criticize Annex I countries for not having done enough, Annex I countries continue to claim that they have done much to transfer technologies and financial resources to developing countries. Negotiations on technology transfer continue to stick to important but peripheral issues, and Annex I countries try their best to avoid any kind of additional responsibility. No concrete and meaningful solutions on these matters are evident under the auspices of the UNFCCC.

Meanwhile, amid concerns about the international competitiveness of industry, Annex I governments try to minimize the transfer of technologies to non-Annex I countries. They claim that

frameworks for protecting intellectual property rights in non-Annex I countries are still inadequate, with the result companies in Annex I countries tend to refrain from transferring their technologies, in which they have invested huge amounts of money and effort.[17] In this regard, the level of the technological cooperation between Annex I and non-Annex I countries under the UNFCCC umbrella remains at a minimum level.

As countries lose interest in emissions trading schemes, there is no pressure for stronger enforcement at the international level. This is because, first of all, countries see no necessity to keep the carbon market operating soundly. Second, because mitigation costs are likely to be more predictable, the overall likelihood of **non-compliance** is lower compared to the Kyoto regime (Hovi 2005). As countries become more interested in making commitments to harmonize PaMs at the national level, the role of the compliance mechanism is to keep an eye on whether these PaMs are actually implemented and to what extent mitigation has actually occurred. It is unlikely that countries will agree on a compliance mechanism forcing a non-compliant country to implement PaMs.[18] Rather, new compliance mechanisms are allowed to request non-compliant countries to submit reports or "compliance plans," and the mechanisms then keep them under their review.[19]

As countries start discussing uniform or harmonized standards – especially product-related ones such as energy efficiency standards on electric appliances – non-compliance with such standards by one country raises the likelihood that other countries might agree to ban imports of products that do not meet those standards (Barrett 2003). Countries subject to such import bans could threaten to dispute them either under the compliance mechanism or under the World Trade Organization (WTO) dispute settlement body. Countries consider a harmonized carbon tax, as well as the idea of countervailing duties against countries that fail to coordinate such measures. Such countervailing duties raise the specter of disputes among countries under the compliance mechanism or the WTO. In addition, discussions about applying a carbon tax raise complex problems of calculating the effective carbon tax, forcing proponents to consider many technical economic issues. Some voices call for a compliance mechanism similar to that used in the WTO (Nordhaus 2001).

Both Annex I and non-Annex I countries recognize the importance of mainstreaming **adaptation** into development policy (Takahashi and Kubota 2005), especially the importance of integrating it into sustainable development (Verheyen 2003). Non-Annex I countries request that an extra funding mechanism for adaptation be established, and that it be financed by funds raised in proportion to responsibility for causing climate change (Kameyama 2003; Ott et al. 2004). Non-Annex I countries also request that Global Environment Facility (GEF) rules be modified to allow it to fund adaptation projects that have local benefits (Ott et al. 2004).

2.4 "Technology Optimist" scenario

Under this scenario, countries recognize the limitation of merely spreading existing technologies and changing consumer behavior in the short term. They believe that climate change can only be solved by innovative technologies that may emerge over the next several decades. Examples include hydrogen production, storage and use; more substantial use of renewables such as solar and biomass energy; and

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[17] Expert Group on Technology Transfer (EGTT), Overview of IPR Practices and other Issues Associated with Publicly-Funded Activities, Discussion Paper prepared for EGTT 7 and SBSTA 22, May 2005.; Internal discussions within the Technology Development and Transfer negotiations. Several papers under the Technology Transfer agenda item also mention such issues.

[18] Except in the case of clearly deliberate inactions by a country, countries are unlikely to agree that an international body can order that policies and measures be implemented domestically, as there is no motive to do so in the absence of market concern.

[19] The current system for national communications and their reviews, under the UNFCCC and the Kyoto Protocol, could be considered a good basis for a compliance mechanism under this scenario.

carbon sequestration, capture and separation (GCEP 2005). Governments seek ways to stimulate quick development and diffusion of such innovative technologies.

Because this scenario is more suitable with a regime that is rather contradictory to the current Kyoto regime, creation of a new regime is mainly driven by countries that are not participating in Kyoto and have high potential to develop innovative technology – mainly the **United States**.

U.S. domestic politics pay little attention to climate change in general. Expectations to take action come mostly from outside the country, as it continues to be the largest emitter of greenhouse gases. RGGI starts trading among the original nine states by 2008/2009, but results in two separate grid systems within the northeastern electricity market (i.e., the capped RGGI system and the uncapped system by the remainder), thereby raising electricity prices in the RGGI system and driving power generation elsewhere. California fails to solve regulatory problems caused by the fact that California imports a significant part of power from other states, and finally give up its initiative to create an emissions trading scheme. In addition, political concerns about wealth transfers, as well as huge national differences in ideas on the appropriate level of carbon prices, prevents the United States from joining an international linkage of domestic emissions trading markets. The low volume of transactions in emissions trading markets keeps carbon prices too low to stimulate technological R&D. Instead, the U.S. government seeks a more direct approach to technology policy.

In parallel, the successful demonstration of the FutureGEN program shows the technological feasibility of integrated gasification combined cycle (IGCC) with carbon capture and storage (CCS), and the prospect of low-carbon sources of hydrogen becomes highly realistic.[20] One estimate of capacity of carbon storage in currently-abandoned U.S. oil and gas fields is 1 GtC, and estimated eventual capacity is about 25-30 GtC in the United States. (Stevens et al. 2000). Simultaneously, technological breakthroughs in fuel cells lead to the expectation that the cost of the technology will drop dramatically in the next decade. Equally important, the U.S. government provides a domestic regulatory framework for managing the geological sequestration of carbon. Political opposition to the siting of carbon storage facilities is also overcome through transparency, compensation, monitoring, and enforcement (Reiner and Herzog 2004). Alongside these domestic regulations, the U.S. government prepares its national GHG emissions inventory. The United States takes international leadership in developing guidelines as to how to account for geological carbon sequestration under the UNFCCC, and hints at the creation of a new international scheme.[21]

In the Technology Optimist scenario, Australia supports the United States as it too is not a Party to the Kyoto Protocol. Canada also follows the United States as it is the country's largest trading partner, and is also politically influenced by its neighbor. Japan follows the United States as it is also a country with high technology potential, and its traditional foreign policy considers the United States as the most significant partner both politically and economically (Kameyama 2004b).

In the **EU**, EU**ETS** starts in 2005, but it is revealed that the allocation for the short term harms technology development for addressing climate change (Cames 2004; Ernst and Young 2004). Industries worry that they will lose international competitiveness (Reinaud 2004). EU member states and actors are disappointed about the ETS. Casting a side glance at the EU, the United States and Japan promote technology innovation. The EU also starts promoting technology innovation, especially in the area of renewable energy.

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[20] The FutureGen Initiative, a proposed $1 billion, zero-emissions coal-fired power plant, is one of the Bush administration's premier efforts against climate change, as it would employ carbon capture and sequestration, and would provide hydrogen fuel for use in fuel cells. The Initiative plans to build a "showcase" plant by 2013. For further detail, see http://fossil.energy.gov/programs/powersystems/futuregen/

[21] On U.S. tendency to internationalize its domestic environmental rules, see DeSombre 2000.

The EU sees technology as the most reliable keyword to capture the attention of the United States. The EU starts to raise its expectation that technologies will be able to realize substantial emissions reductions in the short term.[22]

Because of the failure of carbon markets and increasing prospects for innovative technology to be available in the next decade, there is less demand from Annex I countries for CERs to be created by **CDM**s projects. **Non-Annex I countries** are disappointed by the failure of the CDM. As a result, international discussion on a future climate regime depends on technology and the technological aspects of the CDM (Shrestha 2004), including the creation of a technology agreement, which could also cover R&D and funding for technology diffusion to developing countries (Barrett 2003). The lowered expectations for technology transfers through the CDM reduce the priority of restructuring the CDM (Sugiyama et al. 2005). The inadequacy of financial mechanisms becomes a major barrier to implementation of CDM projects (Mizuno 2004).

Only a few influential developing countries, such as China and India, are able to negotiate bilaterally with Annex I countries to cooperate on innovative technology. Some other developing countries, because of their high population growth, urgently need to increase their agricultural production (ADB et al. 1998a; 1998b; Munawar 2004). They expect that the CDM could be used also for agricultural projects to increase productivity, but developed countries do not have high expectations for agricultural projects under the CDM, and no progress is made here, and instead agricultural technology transfers continue through official development assistance (ODA). Production-enhancing agents such as bovine somatotropin, anabolic agents and ionophores are effective to decrease methane emissions and to increase production efficiency in cattle (EPA 1999). Though the governments of the developing countries consider introducing these technologies, they ultimately give up for the following reasons (Clark et al. 2001): (1) Few dairy farmers and feed-lot systems can accommodate this technology, (2) there are no practical methods to add these agents to feed for grazing livestock, and (3) they add to the cost of meat production.

With high expectation for an innovative technology to drastically reduces GHG emissions and absorbs carbon in the atmosphere, some of Annex I countries that enjoyed high **sequestration** potential under the Kyoto rules on Article 3.3 and 4 do not rely on the biological carbon sequestration measures (Amano and Sedjo 2003). The deforestation in tropical area continues to be one of major concerns of many developing countries, but this concern is taken up not by a climate regime, but by a new international agreement on tropical forests.

As interest in innovative technology increases, discussions for **transferring** conventional eco-friendly **technologies** from Annex I to non-Annex I become irrelevant in international negotiations. Rather than discussing ways to transfer existing technologies that are perceived to have finite effects in mitigating climate change, countries (particularly Annex I) shifts their focus to R&D for innovative technologies that, they hope, will have the potential of dramatically reduce GHG emissions and atmospheric concentrations. They stop negotiating internationally under the concept of "global commitments" to mitigate GHG emissions. They see no use in discussing individual short-term or medium-term targets, compliance issues, or equity among nations and generations. Instead, countries that believe they have high potential and capacity to innovate with such "super-technologies" focus on joint R&D among like-minded countries that

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[22] For example of the EU's interest in technology, the British Prime Minister Blair emphasized the importance of role of technology for climate change mitigation during the G8 Summit at Gleneagles (G8 Gleneagles 2005).

[23] Some critics say that these are exactly the basic positions of the Six Party Partnership on clean technology development (Australia, China, India, Japan, Republic of Korea, and the United States), signed on July 28, 2005. Documents related to this partnership can be found through the White House website, greenwire (www.greenwire.com), and other sources.

have similar socio-economic and technological conditions.[23] Annex I countries start to dissociate themselves from topics relating to sustainable development in developing countries. Rather, their attention shifts to technology innovation and the commercialization of such technologies. Wider gaps appear between those who possess such technologies and those who do not. Technologically advanced nations gain greater control of international climate change politics.

The climate regime focuses on encouraging the development and diffusion of innovative technologies. It does not necessarily require a universal regime and could have been formed mainly by major countries capable of developing such technologies. As the regime does not require countries to achieve pre-determined results, such as development of a certain technology, a **compliance mechanism** with a strong enforcement component is not considered necessary. This rational is reinforced by the facts that (a) there is no special market concern in this regime, and (b) the overall likelihood of non-compliance is lower compared to the Kyoto regime, as mitigation costs are likely to be more predictable (Barrett 2003; Hovi 2005).

Under this scenario, the most practical measure against non compliance is seen as the suspension of the rights and privileges that have been established under a climate regime, such as suspension of eligibility for applications to, or receive the money from the funds. Disputes arise concerning technologies developed under a climate regime, such as issues concerning intellectual property rights. Although it is desirable for countries to agree in advance on precise terms regarding such technologies, countries also desire a compliance mechanism or other forum capable to settle such disputes.

Annex I countries pay much attention to mitigation technology (both existing and innovative) and have little interest on **adaptation** measures. On the other hand, developing countries, which have the potentials to disseminate new technologies in their own markets, seek financial and technological assistance from Annex I countries for adaptation in order to obtain advantageous positions against competitors (UNFCCC 2005). Developing countries do not fail to notice the huge investment by developed countries into innovative technologies, and try to access some of these funds as extra funds for adaptation – such through the proposed UNFCCC Disaster Relief Fund, which is intended to cover the cost of international relief efforts for climate-related disasters, and is financed by contributions from industrialized countries based on their historical responsibility and ability to pay (Müller 2002), and through weather-related insurance (Hamilton 2004). Developing countries also notice the usefulness of technologies for adaptation (Klein 2005), and request greater efforts for transferring them.

Note: Paragraphs on forests in this section involves contribution of Roger Sedjo of Resources for the Future.

3. Future Climate Regime in Three Scenarios

3.1 Categorization of existing proposals from literature

As explained in Section 1, there is an abundance of literature that offers proposals on what should be done after the first commitment period of the Kyoto Protocol. After reviewing the literature, the project team concluded that the proposals differ basically because they make different assumptions, namely relating to different types of world views.

In the Section 2, three versions of "the world" were elaborated as three scenarios. Most of the proposals made to date assume a world described by one of the three scenarios. Seen this way, it is evident that criticism of any existing proposal is mostly by those who assume another type of scenario. At the same time, we can more easily evaluate each proposal by clearly defining the type of the world we are envisioning. By doing so we can detach our evaluation from any concern as to whether or not the proposal is agreeable. Thus, this section categorizes existing proposals to find commonalities among proposals categorized in the same scenario.

3.1.1 Existing proposals that assume the "Carbon Market Initiative" scenario

The "Carbon Market Initiative" scenario assumes that a procedure is used to establish emission targets, and that the resulting emissions allowances or credits will be fully tradable. Such a world view is the most suitable for proposals that introduce specific ways to allocate emission targets to countries, or those that introduce specific ways to improve the current rather simple emissions trading scheme. Examples include the following regimes.

- "Contraction & Convergence" (Meyer 2000): This proposal aims for equal emissions per capita in the long term (such as by 2050), and links each country's present emissions and long term target in order to set emission targets for the years between now and 2050.
- "Triptych Approach" (Phylipsen et al. 1998; Groenenberg et al. 2001): This approach sets sectoral emission targets according to various indicators, such as population or gross domestic product (GDP), and determines national targets by adding up those sectoral targets. This approach was actually introduced during the European Union's internal debate on burden sharing to consolidate the EU position on commitments under the Kyoto Protocol (Ringius 1999).
- "Multi-Sector Convergence" (Jansen et al. 2001; Sijm et al. 2001): This approach is similar to the Triptych Approach, with some differences in rules. The basic model prescribes that the amounts of per capita emissions assigned ultimately converge at the same level for all countries. Additional allowances may be conceded to countries facing specific circumstances that warrant higher emissions than countries that have more favourable circumstances relating to emissions mitigations, other factors being the same.
- "Brazilian Proposal" (Brazil 1997): This approach focuses on the level of contribution of countries to current and future global warming. Brazil made this proposal before the Kyoto Protocol was adopted, but has not raised it again as a proposal for the years beyond 2012. Nevertheless, this approach remains

valid as one way of dealing with burden sharing.

Some proposals attempt to classify countries into groups according to certain indicators, and set emission targets for a few of those groups. This is considered as a way to ensure that equity concerns are addressed, in order to facilitate reaching an agreement. The emission targets of the wealthiest group are to be determined by one of the rules mentioned above. Countries in groups that do not commit to emission targets (e.g., the least developed countries) either make other types of commitments, such as qualitative commitments, or no commitments at all. Examples include the following regimes.

- "Multi-stage Approach"(den Elzen and Lucas 2003): Under this approach, countries are put into several groups according to GDP per capita, and emission targets are set for countries in the developed country group. Actual burden sharing is calculated using the proponents' economic model (Framework to Assess International Regimes for differentiation of commitments, or FAIR), and the results are compared with results of the "Contraction & Convergence" and "Brazilian" proposals.
- "South-North Dialogue Proposal" (Ott et al. 2004): The basic approach here is similar to the "Multi-stage" approach. Countries are classified into six groups according to a mixture of three indicators (potential to mitigate, responsibility to mitigate, and capacity to mitigate). Commitments are categorized into emission limitation commitments, qualitative action, and financial transfers to support mitigation activities.

Other proposals take the position that countries, including developing countries, should commit to some kind of emissions target. Such proposals elaborate new ways of setting targets and still maintain emissions trading schemes.

- "Intensity targets" (targets on emissions per unit of GDP) or "Dynamic targets" (other indices) (Philibert and Pershing 2001): This approach sets quantitative targets, not based on absolute levels of emissions but on emissions per unit of GDP. Absolute emissions can grow as long as the GDP grows at a much faster rate than emissions. This approach is considered to be a way to accommodate those who are concerned about economic losses due to climate mitigation actions.
- "Dual targets" (Kim and Baumert 2002): This approach sets two emission targets, one legally binding and one not legally binding (but more ambitious). Countries aim to achieve the latter, but they may only consider participation in emissions trading until they achieve the former target.
- "Sectoral CDM" (Samaniego and Figueres 2002): This approach focuses on developing countries. Instead of committing to national emissions targets, developing countries may commit themselves to develop and host sectoral projects under the CDM. By dealing with emission from a whole sector, developing countries may be able to control their emissions while being able to obtain technological and financial assistance from developed countries.
- "International Auctioning of Emission Permits" (Bradford 2002): This approach also starts from the argument that the world will not reach an agreement on an absolute cap on emissions. As an alternative, this approach gives authority to an international organization, the UNFCCC Secretariat for instance, to auction emissions allowances. Countries are free to buy any amount of emission allowances as long as they pay for them. The resulting income could be used for climate-related purposes, such as financial support for developing countries.
- International version of the "Safety-Valve" Approach (Pizer 2002): Some critics of the current emissions trading system under the Kyoto Protocol and Marrakech Accords are concerned about unlimited price risk, as the price of emissions allowances could become unreasonably high if a dominant seller controlled prices. This approach sets a price cap on emission permits, and countries can emit as much as they want as long as they pay the price. This is also described as a "hybrid" approach, referring to the combination of emissions trading and emissions tax.
- "Domestic Hybrid Trading System" (McKibbin 2000): This approach involves establishing emissions trading systems at the domestic level in each country. The system offers two types of allowances, one annual and the other in perpetuity.

3.1.2 Existing proposals that assume the "Government-led Policies and Measures" scenario

In the "Government-led Policies and Measures" scenario, countries have little interest in emissions targets set country by country, as they assume that emissions trading will be a failure. In stead, countries become more interested in coordinating their climate policies and measures without using emissions trading. This option is supported by their industry sectors that call for maintaining a fair arena of international competitiveness. In such a world, proposals to mitigate climate change specify *qualitative* (as opposed to *quantitative*) actions for countries. Examples include the following regimes.

- "Agreements on Standards on Energy Efficiency, Carbon Efficiency or Technology" (Ninomiya 2003): This approach seeks coordination of various standards among industries around the world. It is considered to be the best way to maintain international competitiveness of industries, and at the same time give them incentives to aim for higher standards.
- "Agreements on Carbon Tax" (Cooper 1998; Nordhaus 2001): This approach is based on the view that the coordinated introduction of carbon taxes would be more effective than cap and trade systems. This approach could accommodate the circumstances of developing countries by lowering their carbon tax rates.
- "SD-PAM" (Winkler et al. 2002): An abbreviation of "Sustainable Development Policies and Measures," this approach was proposed mainly for developing countries, many of which find quantitative emission targets to be unacceptable – not only for political but also of technical reasons. In order to commit to and deal with emission targets, countries require good national inventory systems to know the amount of greenhouse gases they are emitting, but many developing countries lack adequate capability to collect such data. This approach urges countries to fully incorporate climate policy into their economic planning. From the perspective of energy conservation, many climate policies would be beneficial not only for the climate but also for the economy, especially from the point of energy saving.
- "Financial Transfer" (Schelling 2002; METI 2004): This approach is based on the view that the most efficient and effective way to solve climate change globally is to start what has been deemed a "Climate Marshall Fund" (after the Marshall Plan that helped restore a war damaged Europe), in which developed countries contribute funds and developing countries commit themselves to emissions mitigation strategies using the funds.
- "Climate Tariffs for Non-Participation (Charnovitz 2003): Although this idea has not been formally introduced by any individual, its possibilities have been analysed in many articles. Under the current state of international affairs, countries are free to withdraw from international agreements at any time. In order to avert such a situation, countries need adequate incentives to participate, or disincentives to prevent them from withdrawing. Applying extra tariffs to goods imported from non-participating countries has been proposed as one way of increasing the disincentives for withdrawing.

3.1.3 Existing proposals that assume the "Technology Optimist" scenario

In the "Technology Optimist" scenario, countries are less willing to commit either to quantitative emission limitation targets or qualitative coordinated climate mitigation measures, as they expect certain innovative technologies will solve climate problems. They also think that the countries that develop the technology will be able to dominate the technology market, to set international standards for the relevant technologies, and at the same time to take the lead in climate negotiations. It is thus the potential economic incentives that drive the development and diffusion of technologies to tackle climate change. In such a world countries aim to specify the technology for development and diffusion. Examples include the following regimes:

- "Agreements on Technological R&D (Edmonds and Wise 1999; METI 2004): This approach aims at giving countries incentives to stimulate technological research and development (R&D) at the domestic level. International agreements may be used to promote collaboration on technological R&D.
- "Technology Fund" (Barrett 2001): This approach involved creation of an international technology fund to invest efficiently in the most innovative, effective technologies to mitigate climate change.

Some other proposals do not necessarily focus on technology per se, but strongly rely on countries' own desire to obtain economic benefit out of the regime.

- "Bilateral Agreements on Technology Transfer" (Stewart and Wiener 2003): This approach anticipates the U.S. leadership in efforts to mitigate climate change. It assumes that the Untied States will not agree to any international commitment on climate mitigation unless major developing countries, such as China and India, participate at the same time. It suggests that the United States and China, and some other developing countries if necessary, establish an agreement based on a cap-and-trade system, and other countries stick to the current Kyoto Protocol. It is assumed that the two regimes will merge after a while.
- "Orchestra of Treaties" (Sugiyama 2003; Bodansky 2002): This approach leaves it up to countries' own willingness to agree to a number of agreements, which would be established to address single issues, such as emissions trading, technology cooperation, and others. Only basic elements of commitments involved, such as submission of national communications, would be left to be addressed under the UNFCCC.

3.2 Evaluation of climate regimes in each scenario

3.2.1 Environmental effectiveness

As long as the objective of any climate regime is to mitigate climate change, any regime that is agreed to should be expected to fulfill this objective. Most regimes under the "Carbon Market Initiative" scenario share the common ground that they are structured in a way to control global greenhouse gas emissions in a quantitative manner. They are all basically approaches that set a certain emissions target and let countries make their own decisions as to how to reach the target, making full use of international emissions trading.

There are, however, three possible ways in which the regimes may fail to achieve the desired environmental effectiveness. First, countries might agree to accept only loose targets, in an effort to ensure that developing countries stay involved. The Kyoto Protocol allowed some countries to set loose targets during the first commitment period, and this created what is called "hot air". This experience in the past is likely to be emphasized by developing countries in negotiations for a new regime and demand loose targets for themselves. Second, some proposals are structured in a way to allow global emissions to exceed the initially-agreed global absolute emission target under the UNFCCC. Global total emissions may increase if unexpected economic growth occurs under a climate regime that uses intensity targets. The number of countries exceeding initially-allocated emission targets will depend on the price of allowance under the "international safety-valve" option. Third, even if all countries were able to agree to emissions limitation targets, there remains the possibility of countries withdrawing from the regime, just as the United States withdrew from the Kyoto Protocol. There is also a possibility of countries not being able to achieve the target.

Most of the regimes proposed in the "Government-lead Policies and Measures" scenario do not aim directly at controlling global emissions in a quantitative manner. Rather, their intention is to *control actions* that affect emissions. Thus, at the time an agreement is reached, there will be no certainty as to the size of emissions reductions that could be achieved by the agreement. There is no way to judge with certainty whether or not the agreement will be adequate to achieve the desired environmental effectiveness. On the

other hand, this type of regime does not raise the risk of creating "hot air" in order to entice developing countries participate in the regime. In addition, even if some countries do not participate in the regime, their emissions could still be reduced if the agreed coordinated PaMs were to become international standards.

Most of the regimes proposed in the "Technology Optimist" scenario are the least environmentally effective among the three. Countries are simply counting on some kind of technology to appear in the future and solve the problem, so there will be little environmental effectiveness, at least in the short term. In the longer term, the regime could certainly be environmentally effective if the necessary innovative technologies are developed and spread around the globe. On the other hand, there is always the risk of not succeeding in the development of such technologies. In the worst case, climate change could be far worse than now by the time the failure of technology development is perceived, and the world may then realize that it has crossed a point of no return.

3.2.2 Equity

In the climate debate, equity has been considered as a significant indicator to evaluate any agreement (Banuri et al. 2001). One problem is that many criteria have been proposed to measure "equity" and there is no consensus as to which one should be used to evaluate a climate regime. Thus, this report evaluates regimes using various aspects of equity.

Most of the regimes based on the "Carbon Market Initiative" scenario assume that equity concerns could be reflected by, and incorporated into, emission allocation rules. Countries that are considered to have more responsibility, more capacity, or more potential to mitigate emissions are urged to commit to more ambitious emission targets than others. On the other hand, there is less concern over equity in terms of actual amount of emissions after emissions trading begins. It is possible that wealthier countries would purchase as much credits as necessary, and less wealthy countries would be required to limit their domestic emission up to the level of the target, or even required to sell their initially allocated emission allowances. In such cases, equity between South and North may be satisfied in terms of GDP per capita, but equity in terms of emission per capita may end up being disregarded.

Most of the regimes based on the "Government-led Policies and Measures" scenario can reflect equity concerns by the type and level of coordinated PaMs. Equity between North and South could be achieved by differentiating the commitments. Equity concerns between industrialized countries – an issue often raised by industry – could be reflected in the processes through which policies are coordinated. It may be more difficult for governments to reach an agreement when each country has already implemented different kinds or levels of relevant policies.

Most of the regimes based on the "Technology Optimist" scenario do not initially address the need to consider equity. In this "winner-gets-all" world view, countries or firms that develop innovative technologies will dominate with its power to maximize the resulting economic benefits for itself. This is partially unavoidable as research and development requires large investments of time and money, and no country or firm is likely to accept the risk if it cannot expect to enjoy commensurate rewards. After the implementation of the regime, the economic gap between countries would widen, based on technological gaps. Only if the innovative technology is fully developed and shared will emissions per capita in each country converge in the long term.

3.2.3 Economic efficiency

This criterion relates to the economic cost necessary to achieve a certain level of emissions limitation. As cost implications are considered by many stakeholders to be a primary excuse for not taking

action, it is important that a climate regime should be as cost effective as possible.

Most of the regimes under the "Carbon Market Initiative" scenario consider that climate mitigation actions will be made in such a way as to minimize total cost at the global level, because an emissions trading system would be fully incorporated. However, it should be noted that this economic efficiency achieved by emissions trading is only under a short time frame. In a longer time frame, efficiency might be improved if trading is restricted and the money is invested to reduce emissions by social structural changes, such as development of public transportation system, or by technology developments that require long-term planning. In addition, domestic climate policies also need to be economically efficient in order to minimize the total global cost. For instance, income gained by selling extra emission allowances should be invested to achieve further emissions reductions, rather than in something else.

Regimes under the "Government-led Policies and Measures" scenario do not directly aim at maximizing economic efficiency at global level. Among those proposals, a coordinated tax is the only system that equalizes the marginal cost of abatement in each country, and can thus be evaluated as being economically efficient. Meanwhile, the coordination of technical standards would be economically efficient in the long term, as industry in every country would be able to foresee which type of technology will be needed.

Regimes under the "Technology Optimist" scenario will achieve the most cost effective solution at the global level *only if* the hoped-for innovative technology is fully developed and diffused. As stated above, however, the risk exists of failure to develop the technology and in that case, huge economic costs may be necessary several decades later to make large emission reductions in a short time. In addition, this scenario is likely to stimulate different agreements around the world, and to the extent that they remain independent of each other, there is no assurance of achieving the goal of climate mitigation goal at the lowest cost.

3.2.4 Institutional efficiency

A climate regime should more or less fulfill all the criteria mentioned above. However, any international regime should not be unnecessarily complicated. It is important to keep a regime as simple as possible (Keep It Simple and Stupid, KISS (Gupta 2003)) for many reasons. First, simplicity will make it easier for participants to understand the mechanisms involved. Second, simplicity will help stakeholders achieve agreement without requiring many years of negotiations on detailed rules. Third, simplicity can be expected to minimize transaction costs, as maintenance of complex systems would require additional paper works, human resources, and financial resources.

In this sense, regimes under the "Carbon Market Initiative" scenario may end up requiring rather burdensome institutional arrangements. For a fully-developed emissions trading system to function, data on actual emissions and on amounts of credits sold from and purchased by each participating country must be submitted frequently. Many developing countries may not be capable of handling such a scheme at present. Their capability shortfalls may be even more severe if emissions trading is expanded to cover non-CO_2 greenhouse gases such as methane, or to cover sequestration by sinks.

Such technical problems are not a serious concern in the regimes under the "Government-led Policies and Measures" scenario. As the commitments are on actions rather than the consequence of actions (emissions), it is easier to monitor or to judge whether the commitment was implemented or not. On the other hand, the coordination of PaMs risks becoming a tiresome process. Even within a single industry, there may be many ways to categorize technologies, and such categorization may be different from one country to the next. In addition, the best-available technologies (BATs) would probably change continuously as advances are made each year, so any agreement guiding a climate regime would need to account for such

improvements. It would also be difficult to compare two different policies aimed at similar purposes but with different environmental consequences. For example, policies related to nuclear power are still being debated, and there is no simple answer as to whether all countries should be urged to implement such policies.

In the "Technology Optimist" scenario, the institutions are likely to be the simplest of the three scenarios. No negotiation among more than 180 countries is necessary to achieve the agreement. There is no need to monitor amounts of GHG emissions from each country each year. As well, no tracking of emission allowances is necessary. This simplicity is the tradeoff for risking that the world will reach a dangerous level of climate change. Institutional arrangements are likely to be more complex if countries need to know precisely the level of development and diffusion of technology. As technology development is in many cases run by the private sector, firms usually consider it important to conceal their R&D activities until the technology is ready to be publicized.

Table 3.1 Summary of categorization of proposals

	"Carbon Market Initiative" scenario	"Government-led Policies and Measures" scenario	"Technology Optimist" scenario
Proposals from literature	- Multistage approach - Triptych -Contraction & convergence - Intensity target (targets on emission/GDP) - International version of safety-valve - Auctioning of allowances at international level - Sectoral CDM - Dual target	Agreements on coordinated policies and measures, such as, - Agreements on standards on energy efficiency, carbon efficiency, best-available technology, etc. - Agreements on taxes and tariffs - SD-PAM	-Agreements on technological R&D -Technology fund - Agreements on innovative technology program - Bilateral agreements on technology transfer - Orchestra of treaties
Scope and number of agreements	A single multilateral agreement	A single multilateral agreement	Several regional and/or bilateral agreements
Strengths	- Easy to see how much emission mitigation is to be achieved - Likely to be the most cost-effective solution at global level. - Able to maintain flexibility of national actions - Equity considered	- Relatively easy to judge countries' achievement - Regime's effect could influence non -Parties' emissions - Able to achieve equity among certain industries in different countries	- The most cost-effective regime if the expected technology is developed and diffused. - Could be simple institutionally
Weaknesses	- May cause "hot air" - Unable to influence non-participating countries - Likely to be complex institutionally	- Uncertainty as to whether the agreed policies are sufficient to achieve the desired level of environmental effectiveness - Countries could implement other policies that might offset effects of agreed climate policies - May not be the most economically efficient solution - Could become complex institutionally	- Bears the risk of not achieving the necessary emission reduction to avoid a dangerous level of climate change - Prevents immediate action - Always bears the risk of failure to develop and diffuse the expected technology - Equity not considered

4. Overcoming the Weaknesses:
Additional ideas from the NIES/IGES project

4.1 Additional ideas

The previous section categorized existing proposals into three scenarios, and evaluated their strengths and weaknesses. The aim of this next section is to provide additional ideas to complement the existing proposals in each scenario in order to offset or minimize their weaknesses, and to explore our original proposals for the future climate regime.

4.1.1 "Carbon Credit Banking" for the "Carbon Market Initiative" scenario

In the "Carbon Market Initiative" scenario elaborated in Section 2.2, future international negotiations are likely to aim for a regime in which international emissions trading becomes a major part of the institutional arrangements. The EU leads the negotiations, as continuation of the EU Emissions Trading System (EUETS) is a major incentive for it to seek a leadership role. Most other Annex I countries also support this direction, as an emissions trading regime is believed to be the least-cost solution for GHG abatement, although it is difficult to convince some Annex I countries that face strong opposition to such schemes in their domestic politics. It may be difficult to convince many non-Annex I countries to participate without the prospect of a lot of "hot air" (or extra amounts of emission allowances).

Meanwhile, Section 3.2 showed weaknesses common to most existing proposals under this scenario: the creation of "hot air"; the inability to influence non-participating countries; and the complexity of institutional arrangements. In order to avoid the creation of "hot air," it is necessary to set emission targets that are not too generous. On the other hand, it is important to offer incentives, especially for developing countries, to convince them to participate in a regime that involves commitments. The project team felt that "hot air" should not be used as an incentive for non-Annex I countries to participate. Some ideas for other means to gain participation, especially from developing countries, include the following: streamlining the Kyoto Mechanisms, setting targets for climate-friendly development assistance, providing incentives for technology development and transfer for renewable energy, creating a new incentive structure based on alternatives to binding commitments, providing resources for mobilization of social and political capital, and creating additional institutional agreements for supporting adaptation (Srinivasan 2003).

After the EU and most other Annex I countries succeed in convincing major non-Annex I countries to participate in the regime by those new elements, an arrangement could be made whereby those non-Annex I countries could voluntarily open their climate-related business markets only to countries that are parties to the regime. This will bring in more participants. Establishment of tariffs against importation of less carbon-efficient goods from non-party countries could be another way to create disincentives for non-participation in the regime.

With those additional ideas, the NIES/IGES project team arrived at one climate regime that could be well-suited for the "Carbon Market Initiative" scenario and pose fewer weaknesses. This is named "Carbon

Credit Banking". In this proposed regime, emissions trading and other flexible mechanisms play a central role in meeting global emissions targets at the lowest cost possible. First, each country (both Annex I and non-Annex I) is to commit to an emissions limitation target, just like in Annex B of the Kyoto Protocol. Annex I countries are expected to commit to an emissions reduction target that is ambitious enough to meet the ultimate objective of Article 2 of the UNFCCC in the long run. Non-Annex I countries are allowed to set emissions limitation targets that allow some emissions growth for the time being, but the targets should not be intended to create a lot of "hot air."

In addition, a "Carbon Credit Bank" is to be established under the UNFCCC Secretariat. The bank will set an upper limit price for carbon allowances (to act as an international "safety-valve"), and any country or private sector firm in a country that is party to the regime may purchase extra carbon allowances at that price if its emissions are likely to surpass its emissions target. A lower price may be set for non-Annex I countries. On the other hand, countries could sell their extra carbon allowances to the bank at a price a little lower than that of the market. The difference between the selling and buying prices is the bank's transaction cost. Countries also could bank or borrow their emissions allowances for the next commitment period. Countries or private sector firms could invest funds in the bank to start CDM-type projects in non-Annex I countries. Sector-wide CDM projects could also be permitted. For example, non-Annex I countries could offer project designs to the bank, and the bank could support the projects by combining small-sized project investments into one large investment. Understandably, only those developing countries that are parties to the regime would be eligible for hosting these projects.

This regime also requires involvement, or even leadership, from the private sector. For example, private firms may prefer to participate in emissions trading rather than being taxed by the government. They could make deals with their governments by which they pledge to cap emissions and participate in international emissions trading, in return for a reduction in taxes.

The bank could also offer funds for adaptation. For example, any party, especially non-Annex I countries could be eligible for some kind of offer from the bank if they have suffered severely adverse impacts of climate change. Such benefits could be important to maximize the incentive for countries to participate in the regime. Since the idea is for this bank to be run by the UNFCCC Secretariat, it should be noted that the role of this bank is merely as a place for transactions. The bank should not be empowered to make its own decision as to how the money is to be spent. Meeting of the Parties (MOP) could be a place for any substantial decisions.

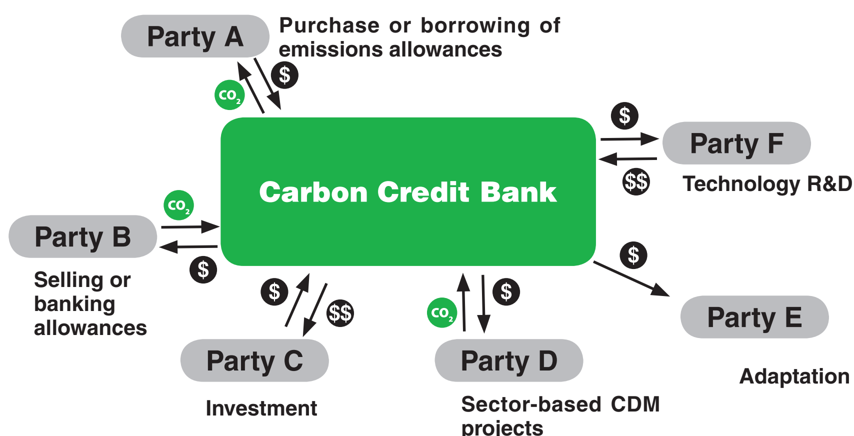

Figure 4.1 Structure of "Carbon Credit Bank"
Note: A "party" here could either be a country or a private firm in a country that is party to the climate regime.

4.1.2 "Dual Track Approach" for the "Government-led Policies and Measures" scenario

In the "Government-led Policies and Measures" scenario elaborated in Section 2.3, future international negotiations are likely to aim for a regime in which the coordination of policies and measures (PaMs) to address climate change becomes the major part of the institutional arrangements. Under this scenario, it is countries like Japan and Canada that hold a view that something needs to be done against climate change, but that the "cap and trade" approach is not preferable. The EU also starts to hold the view that the coordination of PaMs is a better tool than emissions trading. Those countries support each other to work on the harmonization of PaMs. They also strongly urge the United States to work together, as any harmonization of PaMs that occurs without the United States would harm the competitiveness of industry in participating countries. Japan, Canada and EU also start discussions with some relatively industrialized non-Annex I countries on some aspects of PaMs, such as energy efficiency standards. Non-Annex I countries demand a mechanism for technology transfers to help them implement such PaMs, as the CDM is seen as a failure (in this scenario) and no other tool exists to support technology transfer.

Meanwhile, Section 3.2 showed weaknesses common to most of the existing proposals under this scenario: uncertainty as to whether the agreed policies are sufficient to reach the expected level of environmental effectiveness; economic inefficiency in terms of global total cost; and complexity of institutional arrangements. The first weakness should be given the top priority, as environmental effectiveness is the primary objective of the climate regime. In order to offset this deficiency, it may be worthwhile to set quantitative (but perhaps not legally-binding) emissions targets that would work as an indicator to assess implementation of the agreed policies and measures. Inefficiency in terms of global total costs could be remedied by giving countries an opportunity to choose between the full use of emissions trading and coordination of PaMs.

With those additional ideas, the project team arrived at a climate regime that could fit the "Government-led Policies and Measures" scenario while minimizing weaknesses, and called it the "Dual Track Approach." This approach sets two types of commitments (tracks) under a single agreement (Kameyama 2003). A global emissions cap is set based on scientific knowledge accumulated by bodies such as the Intergovernmental Panel on Climate Change (IPCC), and emissions reduction quotas will be distributed to all Parties to the UNFCCC. The allocation of caps will be based on business-as-usual (BaU) scenarios. Developed countries shall be required to reduce emissions at a higher rate and developing countries are required to reduce at a lower rate from BaU. Through the experience of negotiations from 1995 through 1997 leading up to the Kyoto Protocol, countries are aware of the difficulties of setting emissions targets for each country. During those years, it was not scientific modeling or indicators that determined emissions targets, but rather a laborious and repetitive process of negotiation among negotiators. Some criticize that such a way of deciding a target is too political. On the other hand, it is important to have adequate discussion among participants to allow them to understand each other's circumstances and difficulties in implementing a certain policy (Kameyama 2003).

Under the proposed regime, after allocation of emissions reduction quotas to all Parties to the UNFCCC, each country shall select one of two Commitment Tracks outlined in Table 4.1.

For countries that chose Commitment Track A, their emissions targets are not legally-binding. They are requested to submit a list of PaMs that they pledge to implement. Those PaMs are to be chosen from a menu of PaMs agreed under the regime. Implementation of those PaMs is to be legally-binding, and in case of non-compliance, some kind of penalty is instituted. For countries that chose Commitment Track

B, on the other hand, emissions targets are legally-binding. They are not requested to submit their PaM list, and it is up to each country as to how the target is reached. The regime for countries in Commitment Track B will be similar to the current Kyoto Protocol.

By allowing each party to make a choice between the two tracks, countries that prefer continuing emissions trading as well as countries that are hesitant to agree on a legally-binding emissions target are able to agree to one regime. Establishment of one single regime is preferable to acquire a common understanding as to whether the world as a whole has been able to stay within the environmental limits set by nature (e.g., Article 2 of UNFCCC). Having one single institution is better in terms of institutional efficiency.

Creation of this regime requires strong initiative by governments. For most members of the private sector, there is no incentive to participate in a regime that brings additional burdens. In the absence of governmental involvement, it is normally only when a certain industry initiate voluntary actions that some kind of standards can be set. With the proposed "Dual Track Approach", however, governments in Annex I countries will be able to convince their own industries that industries in other countries face similar standards or regulations. Governments in non-Annex I countries may be able to make deals with Annex I countries to obtain technology transfers by agreeing on a certain level of PaMs.

One serious shortcoming of this regime is its institutional complexity. Even when taken separately, emissions trading or the coordination of PaMs themselves present institutional challenges, so the "Dual Track Approach" would not be institutionally simple. Thus, efforts to simplify emissions trading mechanisms and the coordination of PaMs would be necessary to make this proposed regime more feasible.

Table 4.1 Outline of two Commitment Tracks (Kameyama 2003)

	Commitment Track A	Commitment Track B
Emission limitation targets (allocated to all countries in advance)	Emission limitation targets are not legally-binding; they are goals that should be aimed at in good faith.	Emission limitation targets are legally-binding commitments.
Policies and measures (submission of country list of PaMs and implementation)	Countries shall submit a list of policies and measures (country PaM list) which they pledge to implement. The best available methodology shall be used to prove that PaMs in the list are sufficient to achieve emission targets. A given country's PaM list should be consistent with a menu of PaMs listed in the climate agreement, so that there is some degree of coordination across all countries.	Countries do not need to submit lists of PaMs in addition to the national communications. It is up to a country to decide how the emissions target will be achieved.
Compliance procedure	No penalty for non-achievement of emissions targets. A report that describes causes of non-compliance shall be submitted. Penalty is applied if a large gap is observed between a country's PaM list and what was actually implemented.	There will be a penalty if the emissions target is not met.
Emissions trading and CDM	A country can buy permits, but it can only sell when its actual emissions are below the targets. Also, a country can participate in CDM projects.	A country can fully participate in international emissions trading and CDM projects.

4.1.3 "Technology + Compensation Funds" for the "Technology Optimist" scenario

In the "Technology Optimist" scenario elaborated in Section 2.4, future international negotiations are likely to aim for a regime in which bilateral or regional cooperation on innovative technology development and transfer become a major part of institutional arrangements. It is likely that the United States, which is not a Party to the Kyoto Protocol and has large potential for such innovative technology, could play a leadership role in the creation of such a scenario. Under this scenario, other Annex I countries start to follow the U.S. example of giving strong incentives for R&D in innovative technologies. Non-Annex I countries, especially large emitters of GHGs such as China, India and Brazil, are enticed by the potential transfers of such technology, and request technological cooperation with Annex I countries. Other relatively smaller non-Annex I countries are likely to be left out of the institutional arrangements. Thus, gaps may become larger between relatively large and small developing countries.

Meanwhile, Section 3.2 showed major weaknesses common to most of the existing proposals under this scenario: discouragement of immediate action; risk of not being able to develop and spread the hoped-for technology; and failure to consider on equity. All three points are characteristics of the scenario itself where countries are not interested in creation of a multilateral climate regime that involves commitments on emissions targets. Countries consider themselves to be independent nation-states that aim to maximize self-interest. No single country seeks a leadership role in climate change politics (Kanie 2003). People are optimistic about future innovative technologies that will significantly reduce GHG emissions at low cost.

In such a scenario, the world faces a great risk of not being able to keep climate change within an acceptable range. Thus, a parallel process or regime aimed directly at complementing the climate regime would be necessary to offset its weak points. Linking a Kyoto Protocol type of architecture to technology agreements may be worth considering as an option (Tamura 2003), but it is not likely that something like the Kyoto Protocol would be agreed to in this scenario. Inclusion of rules that benefit early actions within the technology development regime may be another option.

With those ideas, the project team arrived at a climate regime that could fit the "Technology Optimist" scenario while minimizing its weaknesses, and called it the "Technology + Compensation Funds" regime (Figure 4.2). In this scenario, it is assumed that countries have no intention to agree on a single multilateral agreement on climate change. Rather, it is likely that numerous bilateral or regional agreements (Takahashi 2003) on climate-related technology cooperation appear all around the world.[24]

In this regime, each of those technological agreements is requested to establish a Compensation Fund in addition to the initial technology cooperation. Meanwhile, a group of scientists, such as the IPCC, will be given the task of closely monitoring global emission trends as well as any adverse effects of climate change. If this group finds that global GHG emissions are likely to shoot above a climatic limit (e.g., as stated in Article 2 of UNFCCC), all the technology-related agreements around the world are asked to pay a certain amount of money from their respective Compensation Fund to spread certain technologies and quickly reduce emissions. When the scientific group determines that a certain disaster was caused by climate change, compensation will be made by money from those Funds.

A certain penalty will be set for those countries that do not pay from the Fund. The size of the penalty needs to be large enough so that countries have an incentive to honor their agreements rather than

[24] Carbon Sequestration Leadership Forum (CSLF) is a good example of cooperation assumed in this regime. Its activities are on its website http://www.cslforum.org/.

choosing non-compliance. On the other hand, countries will not commit to any agreement in the first place if penalty is too severe. Thus, the penalty should be set in a way to prevent withdrawal of countries from the regime, rather than at a level that would punish them. The use of trade barriers may also be considered as a tool. Restricting permission to use the technology only to countries in the regime may be another.

The issue of equity between those involved in the regime and those not involved (e.g., relatively small non-Annex I countries) needs to be addressed. Compensation funds could be partially used to assist countries most affected by the adverse effects of climate change. The fund could also be used to diffuse existing technologies to those non-Annex I countries to be able to reduce GHG emissions promptly.

Under this regime, as long as this Compensation Funds are established, countries have total freedom to establishing technology agreements among themselves. They do not have to worry about the amounts of their own emissions each year. On the other hand, the size of Compensation Funds needs to be rather large, so that all the adaptation and mitigation around the world could be fulfilled by the Funds.

In this scenario, technology cooperation is driven mainly by the private sector, not by governments. Technology-based R&D here is in the realm of private sector, and technologies developed belong not to governments but to the firms that own the rights to the technologies. Even in such a case, however, a regime involving Compensation Funds needs to be established by the government, as it is the governments' role to ensure that scientists monitor whether anthropogenic activities are within the scope of an "acceptable" level of climate change. It is also governments' role to promote technology diffusion to those small and middle-sized developing countries that have little opportunity to obtain the technologies they need in a "laissez-faire" free-economy world.

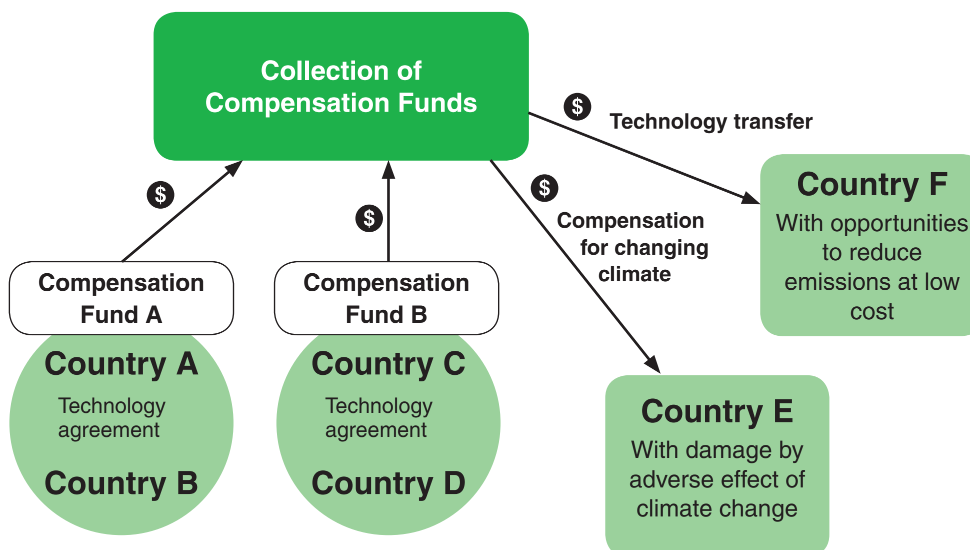

Figure 4.2 Structure of" Technology + Compensation Funds" regime

Table 4.2 Summary of weaknesses of proposals, and additional ideas (taken partly from Table 3.1)

	"Carbon Market Initiative" scenario	"Government-led Policies and Measures" scenario	"Technology Optimist" scenario
Names of climate regimes with additional ideas from NIES/IGES	Carbon Credit Banking	Dual Track Approach	Technology + Compensation Funds
Proposals from existing literature (taken from Table 3.1)	- Multistage approach - Triptych -Contraction & convergence - Intensity target (targets on emission/GDP) - International version of safety-valve - Auctioning of emission permits at international level - Sectoral CDM - Dual target	Agreements on coordinated policies and measures, such as, - Agreements on standards on energy efficiency, carbon efficiency, best-available technology, etc. - Agreements on taxes and tariffs. - SD-PAM	-Agreements on technological R&D -Technology fund - Agreements on technology standards - Bilateral agreements on technology transfer -Bilateral agreements on technology transfer - Orchestra of treaties
Weakness (taken from Table 3.1)	- May cause "hot air" - Unable to influence non-participating countries - Likely to be complex institutionally	- Uncertainty as to whether the agreed policies are sufficient to achieve the desired level of environmental effectiveness - Countries could implement other policies that might offset effects of agreed climate policies. - May not be the most economically efficient solution. - Could become complex institutionally	- Bears the risk of not achieving the necessary emission reduction to avoid a dangerous level of climate change - Prevents immediate action - Always bears the risk of failure to develop and diffuse the expected technology. - Equity not considered
Additional ideas to minimize the weaknesses	- Use means other than "hot air" to create incentives for developing countries to participate, such as streamlining the Kyoto Mechanisms, creating a new incentive structure based on alternatives to binding commitments, creating additional institutional agreements for supporting adaptation, etc. - Introduce tariffs on importation of less carbon-efficient goods from non-Party countries	- Introduce quantitative, indicative emission targets to assess level of implementation of PaMs. - Let countries choose between full use of emissions trading and coordination of PaMs.	- Link technology agreements with others such as Kyoto-type agreements or other means to stimulate early actions. - Offer financial and/or technological support for developing countries, to compensate for inequity between North and South

4.2 Assessment of the three climate regimes of NIES/IGES project

Some kind of quantitative analysis would be useful in order to compare various consequences of the three climate regimes addressed in the NIES/IGES project. Many assumptions are required to produce even one figure for evaluation, however, and very different results might be produced even when using similar assumptions. The NIES/IGES project team therefore felt that it would be inappropriate to offer quantified results that might be hard to justify and might give wrong signals to readers. Thus, it was decided that this exercise would include no calculation by modeling, for example, the economic costs of GHG abatement, price of emission allowances, or size of emissions reduction in each country, etc. Instead, we introduce other literature related to this exercise, in order to give the readers a general overview of the three climate regimes discussed in this paper.

4.2.1 Quantitative analyses related to the "Carbon Credit Banking" regime

The "Carbon Credit Banking" regime fully utilizes emissions trading schemes. It is based on similar assumptions to those used by many models that examine economic costs of GHG emissions abatement (IPCC 2001). Those works share a common view that global costs for reducing or limiting CO_2 emissions are reduced dramatically by introducing international emissions trading, but the amount of cost differs tremendously depending on underlying assumptions. Some show differences in cost according to which atmospheric concentration of GHG gases (e.g., 450 ppm, 500 ppm, etc.) is aimed at, as well as which emissions trajectory (e.g., WG1, WRE, etc.) is followed. For example, one calculation indicated that a global total of nearly U.S.$8 trillion will be necessary to stabilize atmospheric concentrations of CO_2 at 550 ppmv (discounted to 1990 at 5%) by the WG1 path without emissions trading, around $4 trillion with full emissions trading, about $2 trillion by the WRE path without trading, and about $1 trillion with trading (Manne and Richels 1999). Other models focus on countries that participate in the trading, and find that emissions abatement costs in all countries differ depending on *which* countries are involved in the trading scheme. One report on the change in Japan's GDP in 2010 for the country to meet its Kyoto target (a -6% emissions reduction from 1990 levels for the period 2008–2012) predicted a 0.42% drop in GDP without emissions trading, a 0.14% drop with emission trading among Annex I countries with U.S. participation, a 0.06% drop without U.S. participation, and a 0% drop with full use of trading as well as CDM projects in non-Annex I countries (Kainuma et al. 2003). The price of carbon allowances is likely to be lowered by the participation of developing countries. This means that developing countries could make deals with developed countries by participating in a climate regime on condition that they are assisted financially or technically.

In addition to the simple trading scheme that is part of its function, the "Carbon Credit Bank" could also collect investments for technology-related R&D as well as for speculative trading on emissions allowances. The money could also be used for adaptation projects. Such additional roles may further influence to balance the price of emissions allowances with other related costs such as costs of technology-related R&D or costs of adaptation.

4.2.2 Quantitative analyses related to the "Dual Track Approach" regime

The "Dual Track Approach" is a combination of an international trading scheme and coordinated PaMs. This scheme, however, allows countries in both Commitment Tracks to participate in international

emissions trading, and thus it could be assumed that global cost of emissions abatement under the "Dual Track Approach" is the same as under the "Carbon Credit Banking" scheme, or even lower, as PaMs are to be coordinated among countries under Commitment Track A.

There has been increasing number of academic works in recent years are aimed at quantifying the economic cost and effectiveness of harmonized PaMs. One modeling exercise compares several types of emissions trading schemes with various coordinated PaMs, such as improvement of electricity intensity, change of fuel mix, and introduction of automobile standards, and shows that similar environmental effects could be expected from different types of commitments (Edmonds 2005). The work shows that various PaMs, such as the introduction of electricity technology or automobile standards can be effective at similar costs compared with emissions trading.

The Triptych approach could be seen as a similar regime to the "Dual Track Approach," as the former approach sets emissions targets for each country based on the countries' level of efficiency of emissions. Relatively stringent emissions targets will be set for countries with less stringent emissions efficiency, and the consequence is similar to commitment to a common standard across nations. A work using this Triptych approach (Höhne et al. 2005) shows that for selected global emission levels leading to stabilization and for the parameters of the approach chosen here, Annex I countries would need to reduce emissions to about 20% below 1990 levels in 2020 to aim at 450 ppmv CO_2, versus roughly a 15% reduction for 550 ppmv CO_2, and roughly a 35% reduction for 400 ppmv CO_2. The report concludes that "negotiations within the UNFCCC have to be supplemented by agreements on renewable energy, technology in general and development cooperation."

In another modeling work, coordination of PaMs, such as technology and performance standards, is represented by the Triptych approach, and is compared with top-down type of approach such as multi-stage and C&C. It showed that abatement costs in Annex I countries will not change much according to the types of regimes to be chosen, but abatement costs in non-Annex I countries differ widely according to region as well as type of regime. For example, under the 550 ppmv profile, Latin America will face the least abatement cost under the Triptych approach (abatement cost in terms of percent of GDP are 0.51 for the Multi-Stage, 0.39 for C&C, 0.26 for Triptych), while Southeast and East Asia will bear the least cost under the Multi-Stage approach (abatement cost in terms of percent of GDP are 0.14 for the Multi-Stage, 0.29 for C&C, 0.32 for Triptych) (den Elzen and Berk 2004).

What kind of PaMs are actually foreseen in this regime? One option is to deal with the electricity sector by committing to achieve a certain share of renewables by a certain year. According to a report from International Energy Agency (IEA), the world's demand for electricity is expected to double between 2000 and 2020. Of global electrical production, the share of renewables in 2000 was about 19%, of which most was hydro (92% of all renewables). In order to minimize CO_2 emissions growth from the power sector, it is necessary to meet the rapidly growing demand for electricity by renewables. Actually, electricity supply by non-hydro renewables are expected to grow at a rate of 10.4% each year between 2000 and 2010, and if this trend continues, renewables will be able to meet about 11.3% of all electricity demand in 2020 without any additional policies to promote renewables (IEA 2003). This, however, is not enough to cover all the additional demand for electricity since 2000, and therefore, additional PaMs will be both necessary and effective in reducing CO_2 emissions from electricity generation.

In the transportation sector, emissions from automobiles are estimated to increase from 5 $GtCO_2$ in 2000 to 7 $GtCO_2$ in 2020 (WBCSD 2004). According to figures in the same report, the emissions from automobiles in 2020 could be reduced 8.5% by introducing a number of globally-harmonized PaMs: increase share of diesel engine trucks to 45% of all freight trucks by 2030, increase share of hybrid cars to

50% of all passenger cars by 2030, increase share of bio-fuel automobiles to one-third of all automobiles by 2050, increase energy efficiency of all automobiles by 0.4%/year, and improve transportation systems by introducing information technologies.

4.2.3 Quantitative analyses related to the "Technology + Compensation Funds" regime

The "Technology + Compensation Funds" regime is based on voluntary technology cooperation among several countries. It would be difficult to predict emissions abatement costs related to innovative technology developed through such cooperation. Some literature suggest that costs for CO_2 storage will remain relatively high, and that adequate recognition and support for the necessity of CO_2 storage would be needed for such technology to be spread on a market basis (Ohsumi 2004). Others expect that costs related to some technologies such as CO_2 sequestration will become low enough to be developed on a market basis. One study estimates that for CO_2 enhanced oil recovery (EOR) cases, net CO_2 sequestration costs were -U.S.$12 to 14/t CO_2. In contrast, CO_2 enhanced coal bed methane production (ECBM) led to positive net CO_2 sequestration costs of between +U.S.$8 and +13 /t$CO_2$ for Chinese and Canadian cases respectively (IEA 2003).

According to an interview-based survey of Japanese experts on innovative technology (Appendix 3), it is generally very difficult to forecast the costs of emission abatement by innovative technology. That said, carbon sequestration seems to be the most promising option in terms of cost and size of potential emissions sequestration. On the other hand, other technologies, such as hydrogen-related technologies may require more years for development and diffusion.

As for international cooperation on carbon sequestration, the Carbon Sequestration Leadership Forum (CSLF) may be a good example. Its purpose is to make carbon sequestration-related 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 (CSLF 2005). Currently 27 countries are members of CSLF.

While the CSLF is a forum for governments, the Global Climate & Energy Project (GCEP) is promoted by the private sector (GCEP 2005). Stanford University plays a central role in organizing the project, but all the funding, anticipated to reach U.S.$225 million over ten years, comes from private companies. The GCEP's specific goals are to identify promising research opportunities for low-emissions, high-efficiency energy technologies; identify barriers to the large-scale application of these new technologies; conduct fundamental research into technologies that will help to overcome these barriers and provide the basis for large-scale applications; and share research results with a wide audience, including the science and engineering community, media, business, governments, and potential end-users.

The costs required to establish such projects should not be considered merely as a cost of carbon mitigation. If a firm has succeeded in technology development, it enjoys the possibility of making a profit by selling the technology. Firms naturally expect that at least a portion of their investment will be returned by selling the developed technology in the future.

The discussion of quantitative analyses shown in Sections 4.2.1 to 4.2.3 shows that costs of emissions abatement cannot be compared simply between the three climate regimes. Distribution patterns of the costs are, however, more predictable. In the proposed "Carbon Credit Banking" regime, countries that have obtained relatively loose emission targets are likely to benefit the most. In the "Dual Track Approach"

regime, countries that have already implemented relatively stringent PaMs are likely to benefit the most. In the "Technology + Compensation Funds" regime, countries that are home to companies that have a relatively high potential for technology-related R&D are likely to benefit the most. It is hoped that negotiating processes for a future regime would try to consider ways to balance such benefits for countries that are less likely to profit, and that this effort would increase the chance of arriving at an agreeable solution for all.

5. Conclusion

In this report, the NIES/IGES team investigated three plausible scenarios for the next decade, and the three plausible climate regimes that may be agreed internationally. In the end, which scenario will the world follow?

The scenario planning approach assumes, from a methodological point of view, that all scenarios have same possibility of becoming reality. We have assumed that no one knows whether or not emissions trading will succeed, and no one can control the outcome. We have assumed that no one possesses full information regarding the speed of development and diffusion of innovative technology. In reality, however, it may be possible to lead the world into one specific scenario if the intention exists. We believe that governments could lead the world intentionally into the "Carbon Market Initiative" scenario if they fully support emissions trading schemes. Alternatively, governments could actively encourage research and development of innovative technologies to lead the world into the "Technology Optimist" scenario. *Now* is the time for governments to play a role in clarifying an image of the ideal world in the context of climate change.

In each scenario, the opportunity exists for agreement on a climate regime that is environmentally effective and minimizes its own shortcomings (no regime is completely free of weaknesses). In order to reach such agreement, one more aspect must be reconsidered: the public's awareness about the seriousness of climate change. Without adequate public awareness, effective agreements are not attainable in any of the three scenarios. The public's awareness is raised by various factors – for instance, an increase in frequency of extreme weather events and the extent of damage caused by them. It would not be wise, however, to simply wait for a dramatic increase in damage caused by climate change to boost awareness. It is thus important that proactive efforts be made to inform people properly about the mechanisms and consequences of climate change. Ultimately, in all of the three scenarios examined, it is the level of humanity's collective willingness that determines the possibility of arriving at any environmentally-effective agreement.

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Appendix 1: Members of the NIES/IGES "Beyond-2012" project

(Alphabetical order)

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Appendix 2: Methodology for scenario development

The project team introduced the scenario planning approach in order to develop scenarios for this study. This methodology is useful when developing strategies for an uncertain future in the long term (e.g., 30 to 50 years), but we also found this methodology to be suitable in developing scenarios even for the short term (i.e., the next decade).

As is well acknowledged, the scenario planning approach was first developed by Shell, a worldly-known oil company. The initial objective of scenario planning was to generate projects and decisions that are robust under a variety of alternative futures (van der Heijden 2002). By participating in the development of scenarios, better thinking about the future became the second objective of scenario planning. The approach has recently been applied not only in business management but also in the field of environmental policies. The most well-known exercise using this approach in climate-related activities may be the Special Report on Emission Scenarios (SRES) of the Intergovernmental Panel on Climate Change (IPCC) (IPCC 2000), in which four emission scenarios were developed in terms of key driving forces such as future population and economic growth.

In the current NIES/IGES project, we followed a process similar to one shown in Schwartz (Schwartz 1991). The methodology consists of eight steps: (1) identify focal issue or decision, (2) key factors in the local environment, (3) identify driving forces, (4) rank by importance and uncertainty, (5) select scenario logic, (6) flesh out the scenarios, (7) consider implications, (8) select leading indicators and signposts.

The elaboration of scenarios was the joint work of project team members. Each member took responsibility for his or her own field of expertise. After elaboration of scenarios by the project members, the scenarios were further reviewed by 18 experts and stakeholders involved in climate policy processes. The scenarios were revised accordingly. The project team followed the eight steps systematically, as shown below.

(1) Identify focal issue or decision

The focal issue of the project was to identify the type of climate regimes most likely to be agreed upon for the period after 2012.

(2) Identify key factors in the local environment

The project team identified the key factors influencing the focal issue, with the following questions:

- Should the future climate regime directly aim for climate mitigation?
- Does the regime assure equity among developed and developing countries?
- Does the regime assure equity among Annex I or among non-Annex I countries?
- Does the regime incorporate economic incentives?
- Does the regime incorporate institutions to aim for sustainable development?

- Should the regime limited to one, or can there be more than one?
- Does the regime incorporate legally-binding commitments?
- Does the regime include adaptation policies?

(3) Identify driving forces

The project team identified many driving forces that may affect the future of the key factors. Basic driving forces depending on projections for the next decade (e.g., such as growth of population, economy, and emissions of greenhouse gases) were thought to involve relatively low degrees of uncertainty, because this project deals mainly with a rather short timeframe. More uncertain driving forces are as follows:

- Changes in public perception of climate change impacts, such as the frequency of extreme weather events and the resulting damage
- Level of Annex I countries' achievement of Kyoto Protocol targets
- Politics and climate policies of the United States
- Politics and climate policies of the European Union
- Politics and climate policies of other Annex I countries
- Possibility of some key developing countries accepting mitigation commitments
- Development of international emissions trading
- World Trade Organization (WTO) rules affecting trade and climate
- Relevance of a climate regime relative to other international affairs
- People's expectation towards innovative technology
- Possibility of developing countries' facing economic crisis
- Possibility of sudden increase in energy prices

(4) Rank by importance and uncertainty

In order to clearly identify differences between scenarios, it is important to choose a few driving forces that could be considered as most influential on key factors. The project team selected the following two driving forces as the most influential and uncertain:

- Development of international emissions trading
- People's expectation towards innovative technology

It was pointed out that these forces might not necessarily be exogenous, considering the fact that they could be influenced by certain policies. The project team, however, concluded that they could still be treated as uncontrollable forces, as no single government could control the relevant actions of other governments or of numerous actions in the private sector.

(5) Select scenario logic

With the two selected driving forces, the project team developed three different scenarios.

	Scenario A	Scenario B	Scenario C
Development of international emissions trading	Develop	Fail	Fail
People's expectation towards innovative technology	Low	Low	High

Initially, we also created a fourth scenario based on full implementation of international emissions trading and high expectation towards innovative technology (Scenario D). As we elaborated the four scenarios, however, we discovered that Scenario D resembled Scenario A and C and decided that it could be deleted.

(6) Flesh out the scenarios
See Section 2 of the report.

(7) Consider implications
See Section 3.1 of the report.

(8) Select leading indicators and signposts
See Section 3.2 of the report.

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Appendix 3: Acknowledgments

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