Forest Carbon Sinks: European Union, Japanese, and Canadian Approaches

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Abstract

This report compares the approaches of the governments of Japan, Canada, and the European Union member countries toward using carbon sinks to meet their respective Kyoto Protocol carbon reduction targets. Various policies have been proposed by which governments can sequester carbon by promoting afforestation and reforestation, slowing deforestation, and undertaking forest management activities under Articles 3.3 and 3.4. At this time, carbon emissions reduction programs are still under development, both within individual countries and within the context of the protocol. Although some of the details have been worked out, concrete definitions are often still lacking, especially as regards impermanence of forests, additionality, leakage, and socioeconomic and environmental impacts.

Japan appears most likely to rely most heavily on forest and biological sinks to meet its Kyoto targets. For Canada, sinks are likely to play a rather modest role. For the EU, the role of sinks is likely to be even smaller, with sinks playing no role for some EU countries (including Sweden, our case study country). However, the final decisions have not yet been made for any of these countries, and the actual role of sinks remains to be determined.

Key Words: Climate, Sinks, Kyoto Protocol, Forestry. Canada, Japan, European Union,

JEL Classification Numbers: F01, Q23, Q28, Q48

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1. Introduction

This report compares the approaches of the governments of Japan, Canada, and the countries of the European Union (EU) to meeting their respective Kyoto Protocol carbon reduction targets through the creation of carbon sinks. The study examines existing as well as proposed government policies to achieve carbon sequestration by promoting afforestation and reforestation and slowing deforestation and by conducting forest management under Articles 3.3 and 3.4 of the protocol, as well as to establish a reporting system for the Intergovernmental Panel on Climate Change (UNFCCC) inventory report under Article 5.

Though it is commonly believed that biological sinks may constitute only a small portion of the carbon mitigation necessary to meet the various country targets, recent work by the Dutch National Institute for Public Health and the Environment (van Vuuren, D. 2003) suggests that the role of sinks could be much larger.

The RIVM study finds that up to 40% of the mitigation achieved worldwide could come from biological sinks.[1] For each country or region, we examine the extent to which the government is planning to use forest sequestration to meet its carbon reduction targets. Three case studies—Sweden (as an example of an EU country), Japan, and Canada—focus on how

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[1] Part of this high proportion is due to the anticipate that a substantial portion of the carbon mitigation credit will be due to credit for "hot air," which does not represent actual mitigation, although it does provide credits in meeting the Kyoto targets.

afforestation, reforestation, and forest management are being interpreted, promoted, and implemented under Articles 3.3 and 3.4 of the Kyoto Protocol.

The emissions reduction programs involving forestry and land use activities are still under development, however. Many details were worked out at Bonn (Spring 2002) and later in the Marrakesh Accords (Fall 2002), which determined what reforestation and afforestation projects would be eligible to be clean development mechanism (CDM) activities. CDMs are carbon-reducing projects in non-Annex 1 countries (generally, the developing countries) that generate emissions reduction units for the Annex 1 country (generally, the industrialized nations). An afforestation or reforestation activity for carbon sequestration may be a CDM, but protection of an existing forest, which would also sequester carbon, may not be eligible. Furthermore, small forestry projects are not eligible as CDMs because the monitoring costs would be disproportionately high. Finally, carbon gas removals from such projects are limited and may be used to meet emissions targets only up to 1% of a party's baseline for each year of the commitment period.

Concrete definitions are still lacking, especially as regards impermanence of forests, additionality, leakage, and socioeconomic and environmental impacts. Among the options considered in New Delhi to deal with the impermanence of forests was an insurance scheme, proposed by Canada, whereby liability would be assigned to the project developers. Also, the EU has expanded on a concept developed by Colombia (2000) that envisioned expiring emissions credits. The EU proposal (Denmark 2002) uses the concept of a temporary certified emissions reduction (T-CER) created under Article 12 of the Kyoto Protocol that could be issued during one commitment period and would expire during the subsequent commitment period unless specifically renewed (Ott 2003; Sedjo and Marland in press). At this time the accounting of temporary sinks has not been fully determined. Although discussions were undertaken at the eighth conferences of the parties (COP 8), the final conclusions await COP 9 in December 2003 (Ott 2003). Finally, at this writing, not enough countries have ratified the protocol to allow it to take effect.[2]

[2] At this writing Russia has yet to ratify the Kyoto Protocol. Russian ratification is necessary to achieve the requisite number of countries required for the protocol to take effect.

2. Background

The governments of Japan, Canada, and the EU nations are currently developing their approaches to using carbon sinks for meeting their carbon reduction targets under the Kyoto Protocol. Thus, this report can at best capture activities and policies at a point in time. Many policies will certainly be modified and revised before the compliance period begins, in 2008. However, the basis for these activities and their modifications is found in the Kyoto Protocol, which these countries have ratified.

In Articles 3.3,3.4,6, and 12, the protocol allows Annex I countries to take into account land use change and forestry activities (sinks) to meet their CO_2 emissions reduction targets during the commitment period 2008–2012. Article 3.3, which covers afforestation, reforestation, and deforestation (ARD) is compulsory, but 3.4, which refers to additional human activities involving forest and agricultural management, is optional.

When some of the rules for eligible activities were defined in Bonn and Marrakesh, they included categories beyond those in Articles 3.4 and 3.4. Articles 6 and 12 refer to CDM and joint implementation (JI) activities in foreign countries. Such activities may have sink components but are somewhat limited. Under Article 6, JI projects could be undertaken by Annex 1 parties in other Annex 1 countries. Activities under both 3.3 and 3.4 are eligible under JI, but countries must include JI projects involving foreign management in the cap of forest management under 3.4.

At issue was the extent to which carbon sequestered by forest management activities could be counted toward the target carbon reductions. The agreed cap was 15% of current carbon sequestration totals attributable to forest management. However, for Japan, Canada, and Russia, the cap has been adjusted upward. Table 1 lists participating countries, their baseline emissions (in millions of tons of carbon dioxide emitted per year, $MtC0_2$/yr.), and their Kyoto targets as a percentage of baseline emissions. Table 2 presents their maximum allowable forest sink credits under Article 3.4 of the Kyoto Protocol as agreed to in the Bonn (COP 6) and Marrakesh discussions. Note that the credits allowed to the Russian Federation represent a subsequent upward revision.

One question that remains is whether and the extent to which the European countries, and particularly the EU, are likely to use the sink option.—something to be resolved by the individual countries as the compliance period approaches. A final option available to countries to meet their targets is the purchase of credits of "hot air," i.e., excess credits available from

Russian and other countries of the former Soviet Union, due to their lower levels of economic activity and/or the rapid renovation of their carbon polluting sectors.

Table 1. Base-year emissions (1990)

	Emissions ($MtCO_2$/yr.)	*Percentage of total*	*Reduction as percentage of base year*
Austria	59,200	0.4	92
Belgium	113,405	0.6	92
Bulgaria	82,990	0.6	92
Canada	457,441	3.3	94
Czech Republic	169,514	1.2	92
Denmark	52,100	0.4	92
Estonia	37,797	0.3	92
Finland	53,900	0.4	92
France	366,536	2.7	92
Germany	1,012,443	7.4	92
Greece	82,100	0.6	92
Hungary	71,673	0.5	94
Iceland	2,172	0.0	110
Ireland	30,719	0.2	92
Italy	428,941	3.1	92
Japan	1,173,360	8.5	94
Latvia	22,976	0.2	92
Liechtenstein	208	0.0	92
Luxembourg	11,343	0.1	92
Monaco	71	0.0	92
Netherlands	167,600	1.2	92
New Zealand	25,530	0.2	100
Norway	35,533	0.3	101
Poland	414,930	3.0	94
Portugal	42,148	0.3	92
Romania	171,103	1.2	92
Russian Federation	2,388,720	17.4	100
Slovakia	58,278	0.4	92
Spain	260,654	1.9	92

Sweden	61,256	0.4	92
Switzerland	43,600	0.3	92
United Kingdom	584,078	4.3	92
United States of America	4,957,022	36.1	93

Source: UNFCCC Kyoto Protocol, http://www.unep.ch/iuc**/.**

Table 2. Forest carbon caps under Kyoto[1]

	MtC/yr.
Australia	0.00
Austria	0.63
Belarus	
Belgium	0.03
Bulgaria	0.37
Canada	12.00
Croatia	
Czech Republic	0.32
Denmark	0.05
Estonia	0.10
Finland	0.16
France	0.88
Germany	1.24
Greece	0.09
Hungary	0.29
Iceland	0.00
Ireland	0.05
Italy	0.18
Japan	13.00
Latvia	0.34
Liechtenstein	0.01
Lithuania	0.28
Luxembourg	0.01
Monaco	0.00
Netherlands	0.02
New Zealand	0.20

Norway	0.40
Poland	0.82
Portugal	0.22
Romania	1.10
Russian Federation	33.00[2]
Slovakia	0.50
Slovenia	0.36
Spain	0.67
Sweden	0.58
Switzerland	0.50
Ukraine	1.11
United Kingdom	0.37

[1] The list of countries in this table differs from that found in decision 5/COP 6 as a result of consultations undertaken during the session.

[2] This figure was initially 17.63 but was increased to 33.00 MtC/yr by decision 12/COP 7 (forest management activities under Article 3, paragraph 4, of the Kyoto Protocol: Russian Federation).

Source: UN FCCC/CP/2001/13/Add.1, English, p. 63

3. European Union

The EU has ratified the Kyoto Protocol, which requires an overall 8% reduction in total EU emissions. This figure will probably apply to the EU's original 15 countries, although some adjustments could still be made as eastern European countries join the EU over the first compliance period of the protocol.

Many EU countries have already imposed various types of carbon and energy taxes, although at different levels and with varying applications and exemptions (Appendix A), and the expectation is that much of the real emissions reductions will be generated through the energy sector.

Under Kyoto, the use of credits obtained via biological sequestration is constrained. Offsets to net emissions are subject to an 85% discount and an individual cap (listed in an appendix in the Marrakesh Accords, UNFCCC 2002) for each party. Also, reporting on Article 3.4 activities is optional. Countries must decide whether to undertake any or all of the activities under 3.4 and declare their intentions at least two years prior to the beginning of the commitment period. This is also the deadline for changing the cap values for forest management under Article 3.4. If they desire a reevaluation of these values, they must submit new data up to 2006. The EU

is working as a unit at meeting its emissions targets, and the entire union could be in violation if some individual countries don't meet their targets.

In addition, the use of land use, land use change, and forestry (LULUCF) activities remains controversial, and countries have the right to choose not to use them. Sweden, for example, has decided not to use forest carbon sink credits. Should a country chose not to use LULUCF to obtain carbon credits, then it will not be liable for emissions that might occur on those lands. Some believe that Article 3.3 is likely to be significant in only a few countries—perhaps Ireland and some of southern Europe only (Schlamadinger 2002)

The EU forest sink activities to mid-2002 are examined in a RIVM report (Petroula 2003), and this part of the study draws heavily upon that report. RIVM collects data both through National Communication, a system of regulated communication among the countries, and from country-specific sources. According to Petroula (2002), preliminary evidence suggests that within the existing 15 EU countries, sinks are expected to contribute to an average 2% of individual countries' reductions, with the range being 1% to 4%. However, sinks are not a high priority, and the anticipated delay in making final decisions could result in contributions that vary substantially from that level.

Additionally, Petroula argues that the various accounting systems and indicators make an accurate quantification of potential carbon sequestration difficult at this time, since new guidelines on LULUCF activities are to be produced in 2003. These will interpret and take into consideration the earlier rules written in Bonn and Marrakesh.

3.1 Member country situations

The members of the EU are in various stages of providing updated estimates on sinks in their Third National Communication. For some countries—Finland, Sweden, the Netherlands, and the United Kingdom—the latest estimates were developed from a combination of their National Communication data and their country-specific data. Others—Austria, Denmark, and Germany—have based their projections on country-specific data only. Still other countries use additional sources of mostly national data. Many countries are still developing their projections.

Most EU countries are expected to report carbon debits under Article 3.3 (afforestation, reforestation, and deforestation) and thus will not receive any credits. Furthermore, the data suggest that the majority of countries may reach or exceed their forest management cap as given in Table 2.

Table 3 provides estimates of biological sinks, using current data, for the 15 EU members. The final column provides an estimate of the percentage of base-year emissions that could potentially be covered by sinks, given the 15% rule under Kyoto accounting. It ranges from 0.3% in Italy to 4.0% in Austria and Sweden.

To what extent the provisions of Article 3.4 (forest and agricultural management) will actually be used has yet to be determined in many countries. Table 3 indicates the current intentions of the EU countries based on a survey by Petroula (2002).

Table 3. Estimates of carbon removal allowed or anticipated via sinks during first commitment period (based on all available data)

	Base-year emissions	*Maximum under Articles 3.3 and 3.4*	*Actual if Articles 3.3 and 3.4 are used*	*Maximum allowance for CDM sinks*	*Actual if CDM is used*	*Total maximum or actual, if Article 3.4 and CDM are used*	*Percentage base-year emissions*
	MtC/yr.	*MtC/yr.*	*MtC/yr.*	*MtC/yr.*	*MtC/yr.*	*MtC/yr.*	*MtC/yr.*
Austria	21.04	0.63	≤0.63	0.21	≤0.21	≤0.84	4.0
Belgium	37.24	0.03	<0.03	0.37	≤0.37	≤0.40	1.1
Denmark	19.08	0.14	!	0.19	≤0.19	0.33	1.7
Finland	20.51	0.16	≤0.16	0.21	≤0.21	≤0.37	1.8
France	148.96	0.88	0.88	1.49	0.45	1.33	0.9
Germany	330.28	1.24	≤1.24	3.30	≤3.30	≤4.54	1.4
Greece	29.28	0.09	!	0.29	≤0.29	0.38	1.3
Ireland	14.59	0.41	0.28	0.15	≤0.15	≤0.43	2.9
Italy	141.64	0.65	!	1.42	1.15	~1.8	0.3
Luxembourg	3.67	0.01	≤0.01	0.04	≤0.04	≤0.05	1.4
Netherlands	59.77	0.06	0.055	0.60	≤0.60	≤0.65	1.1
Portugal	17.12	0.22	!	0.17	≤0.17	0.39	2.3
Spain	84.13	2.53	2.08	0.84	≤0.84	≤2.92	3.5
Sweden	19.25	0.58	≤0.58	0.19	≤0.19	≤0.77	4.0
U.K.	208.84	1.22	≤1.22	2.09	≤2.09	~3.31	1.6

Source: Petroula (2002).

Table 4 provides survey estimates of the countries' intentions to implement CDM and JI projects. The Netherlands appears most likely to use both CDM and JI at this time. Denmark is positively inclined toward JI but negatively inclined toward CDM. Italy is positively inclined

toward CDM. The intentions of the other EU countries remain uncertain, but conversations with various researchers and policymakers suggest that the EU is unlikely to take full advantage of forest sinks. For example, Frank Messussen (2002), Belgium Cabinet Minister of Federal Defense and Environment, mentioned a series of new carbon taxes on fossil fuels, incentives for insulation, higher petroleum prices, lower public transport prices, and new wind-powered electrical generation facilities. Forest carbon was hardly mentioned.

Similarly, Norway, not now part of the EU, has no plans for either biological sequestration or a major biomass approach. Most of Norway's electricity is generated by hydropower, but a cap is expected for the carbon dioxide emitted by North Sea gas-powered generators. Norway is, however, looking for some form of hydrogen separation from oil that would allow for geological sequestration of the CO_2 by-product (Greaker 2002).

Table 4. EU member countries' intent to use CDM and JI projects

	CDM	*JI*
Australia	**?**	**?**
Belgium	**?**	**?**
Denmark	**✗?**	**✓?**
Finland	**?**	**?**
France	**?**	**?**
Germany	**?**	**?**
Greece	**?**	**?**
Ireland	**?**	**?**
Italy	**✓?**	**?**
Luxembourg	**?**	**?**
Netherlands	**✓?**	**✓?**
Portugal	**?**	**?**
Spain	**?**	**?**
Sweden	**?**	**?**
United Kingdom	**?**	**?**

Key:

? = undecided ✓? = undecided, but possibly yes ✗? = undecided, but possibly no

Source: Petroula (2002).

Table 5 provides survey estimates of the EU countries' intentions toward the use of forest and agriculture management projects under Article 3.4 of the protocol. France, Ireland, and Spain appear most likely at this time to use forest management activities to help meet their carbon targets. However, those same three countries are not inclined to undertake agricultural management for carbon objectives. The United Kingdom is the only county with a positive inclination toward agricultural management for carbon. Most of the countries were undecided at the time of this survey.

Table 5. EU member countries' intent to use Article 3.4

	Forest management	*Agricultural activities*
Australia	**?**	**?**
Belgium	**✓?**	**✕?**
Denmark	**?**	**?**
Finland	**?**	**?**
France	**✓**	**✕**
Germany	**?**	**?**
Greece	**?**	**?**
Ireland	**✓**	**✕**
Italy	**?**	**?**
Luxembourg	**?**	**?**
Netherlands	**?**	**?**
Portugal	**?**	**?**
Spain	**✓**	**✕**
Sweden	**?**	**?**
United Kingdom	**✓?**	**✓?**

Key:

✓ = Yes

✕ = No

? = undecided

✓? = undecided, but possibly yes

✕?- = undecided, but possibly no

Source: Petroula (2002)

3.2 Sweden: A Case Study Within the EU

Sweden has developed a long-term approach that includes taxes and charges on carbon dioxide emissions, subsidies for direct heating and bioenergy, regulations, and research and development. A major strategy will be to replace fossil fuels with bioenergy, at a cost increase of roughly 50% to 100%. A substantial fossil fuel energy tax is already in effect (see Appendix B). Bioenergy, derived from forest waste and logging residuals, is expected to play a major role. In the context of a carbon tax on fossil fuel emissions, nontaxed biofuels become a economically viable supplement to fossil fuel energy production (Sedjo 1997, p. 565). The challenge is great because during the first two decades of the 21st century, Sweden intends to phase out nuclear power. However, the initial target date of 2000 has been substantially extended, and the schedule for this phaseout remains flexible.

Sweden has made a preliminary policy decision not to include forest carbon in meeting its carbon emissions reduction targets (Lonnstedt 2003).[3] Additionally, Sweden has decided that it will not use flexible mechanisms, such as tradable emissions reduction credits or Russian "hot air." However, Sweden's policy allows it to reconsider flexible mechanisms (but not forest sinks) if the chosen approaches do not yield expected results.[4]

3.3 Summary

Although the rules for the Kyoto Protocol were set in Marrakesh, most EU countries have not yet determined their policies regarding forest sinks. Accounting and data systems differ, and the details remain to be worked out. Difficulties in quantification complicate the use of sinks, and the question of how to account for impermanence has yet to be resolved. Many countries appear to be delaying action. By 2006, however, countries must report definitely whether they intend to implement activities under Article 3.4.

Most of the countries that provided data to Petroula (2002) will report debits for Article 3.3 activities and thus will not receive credits under 3.3. However, the data suggest that many of these countries could reach their forest management cap and thus acquire the maximum credits allowed. The likely use of Article 3.4 is even more uncertain. Negotiation on the details of CDM

[3] The substitution of biofuels for fossil fuels will assist Sweden in meeting its targets. Under this approach, little if any additional carbon is likely to be sequestered in Swedish forests,and net losses are possible.

[4] A decision not to use forest management as a source of carbon credits relieves countries from the requirement of reporting on the 3.4 option.

and JI projects continues, and thus countries may be waiting for clarification before making policy decisions. As evident in Table 3, the maximum contribution of forest sinks is likely to range from 1% to 4% of most countries' targets and about 2% of the target of the EU as a whole. Some countries may decide to argue for a higher cap, based upon new data. Although discussions were undertaken at COP 8, the final conclusions await COP 9 in December 2003.

4. Japan

The Kyoto Protocol requires Japan to reduce emissions 6% from the 1990 base year, when total CO_2 emissions were 1,229 million tons of CO_2. By 1999, however, CO2 emissions had risen about 7% above the base, to 1,314 million tons. Furthermore, under current conditions, the total CO_2 emissions are predicted to reach 1,320 million tons in 2010. To meet the protocol's target, therefore, emissions must be reduced 165 million tons, or 13% from the predicted 2010 level.

4.1 A new climate program

The basic approach of the Japanese Government is to hold energy use and emissions constant or have them decline from current levels by virtue of a program which calls for a reduction of 22 million tons of emissions through public efforts, largely voluntary, and various emission reducing technological improvements. The program includes more than 100 domestic measures and policies. The introduction of wind, bioenergy, and other new energy sources, plus fuel conversion from coal to natural gas and a 30% increase in nuclear energy, would all provide increasing energy outputs without generating additional CO_2 emissions. Also, carbon dioxide emissions from nonenergy uses are expected to decline slightly. The program seeks to expand the total share of new, noncarbon-emitting energy from 1% to 3% during the first commitment period (van Kooten, 2004).

The government recognizes biomass energy as a new energy source that can be promoted to reduce greenhouse gas emissions. However, the future market share of bioenergy is expected to be small because the biomass raw material from forests in Japan is expensive. Possibilities for the development of innovative biomass material supply systems, supported by the government, are being explored.

Finally, the Japanese government's New Climate Change Policy Programme adopted in March 2002, seeks to develop policies and measures necessary to achieve a 6% emissions reduction from the 1990 base (Table 5). The New Climate Change Program should be viewed as a step-

by-step program that will be revised periodically to meet the reduced greenhouse gas emissions targets of the Kyoto Protocol.

4.2 The role of forests

Whereas forest sequestration is likely to account for a maximum of no more than 4% of the carbon reduction targets in the European Union, the role of forest sinks in Japan is expected to be large and may account for more than half of the carbon reductions from the base, and up to one-quarter of the reductions from business-as-usual 2010 levels. Under the Kyoto targets, Japan is allowed credits of up to 13 million tons of carbon per year from forest sequestration, which can be used against its emissions.

Emissions from noncarbon greenhouse gases are expected to rise by 2% of the 6% targeted reduction of carbon dioxide, while technology and lifestyle changes will reduce emissions by 2%. This leaves a very significant role for sinks, which are expected to account for 3.9% of the 6% emissions reduction target (Table 5).

Meeting that objective would require that Japanese forests sequester about 13 million tons of carbon annually—an amount equal to the maximum forest sink credit allowed Japan under the protocol, or more than half of the national annual target of 25 million tons of carbon in 2010.

Japan has relatively young forests. Well over half the area covered by trees has regenerated since the end of World War II. As these forests continue to mature, they will substantially increase the amount of sequestered carbon. However, to meet the target of sequestering 13 million tons of carbon, additional amounts must be captured.

Under a business-as-usual approach, domestic production of timber from Japanese forests is expected to be about 25 million cubic meters in 2010. However, to meet its Kyoto target, Japan may need to reduce its domestic commercial harvest to 17 million to 18 million cubic meters so that its forests can sequester the requisite additional carbon. Accomplishing this objective while meeting the economy's needs for industrial wood may mean importing wood to fill the gap. Note that although this would allow Japan to meet its Kyoto targets, it would simply push timber harvesting offshore.

Table 5. Quantitative targets for greenhouse gases and sectors

CO_2 emissions from energy use	± 0%
CO_2 emissions from nonenergy use, methane emissions, and nitrous oxide emissions	–0.5%
Emissions of HFCs, PFCs, and SF6	+2.0%
Reductions by innovative technologies and change of lifestyle	–2.0%
Use of sinks	–3.9%
CDM, JI, other flexible tools	-1.8%
Total	-6.0%

Source: New Climate Change Policy Programme, March 19, 2002 (tentative translation).

4.3 Summary

More than either the European Union or Canada (see below), Japan appears poised to use carbon sinks to meet its Kyoto targets. The goal appears to be to increase energy availability to the economy without increasing emissions—something that can be achieved through cleaner and more efficient technologies, as well as the greater use of nontraditional energy, including nuclear. Nevertheless, the Kyoto target will not be easy for Japan to meet without using the country's rather large sink sequestration allowance to the greatest extent feasible.

5. Canada

5.1 The climate change plan

Under the Kyoto Protocol, Canada has committed to a carbon dioxide emissions reduction of 6%, or 240 million tons below the base year, 1990. The "Climate Change Plan for Canada," released in November 2002, outlines how it plans to achieve its Kyoto target, including creation of an emissions trading system. At this time Canada is still examining the options for forest sinks, and a definitive plan of action has not yet been selected. However, it is expected that forest sinks will be included in an offset trading system in which credits for sinks could be sold to companies in the emissions trading system.

The Climate Change Plan sets out a three-step approach for achieving Canada's objective of reducing annual greenhouse gas emissions by about 240 million tons of carbon dioxide (65.2

million tons of carbon) and carbon dioxide equivalents. First, there are investments to date that will address one-third of the total reduction, or 80 million tons of carbon dioxide (21.8 million tons of carbon). Second, the plan articulates a strategy for a further 100 million tons of carbon dioxide annually (27.2 million tons of carbon) reduction. Finally, the approach outlines actions that should enable Canada to address the remaining 60 million tons of carbon dioxide (16.4 million tons of carbon).

5.2 Domestic emissions trading

Canada is creating a domestic emissions trading system (DETS) in which emissions reduction credits would be traded. Offset credits, generated by the sequestration of carbon in forests, agricultural systems, or reduced gas releases from landfills, could be part of this market system.

DETS would have the effect of limiting carbon emissions from much of the economy's energy and industrial sectors. The details of the system have not been determined but would likely be as follows. Emissions permit allocations would be tied to recent or current output levels for the sector and firm. The reduction in emissions would be negotiated on a subsector-by-subsector basis but would average about 15%. The emission reductions, however, would be not an absolute figure but rather related to output. For example, if output increased by 15%, the absolute level of allowable emissions could remain unchanged as long as the targeted 15% reduction in emissions to output was met. Thus, the targets involve emissions *intensity*. Because it creates credits that are different from, for example, EU credits, this approach has raised questions about the international tradability of Canadian emissions credits. The choice of a reduction in emissions intensity also implies that in a period of rapid industrial expansion, Canada may meet its national goal of a 15% reduction in carbon emissions intensity but not meet the Kyoto targets for its industrial sector emissions reductions.

The challenge for industry is obtaining needed permits. A firm could improve efficiency and thereby reduce emissions and hence its required permits. Or it could purchase them from firms with surplus credits. A firm that reduced its emissions below its requirement would have surplus permits that it could trade domestically or internationally (they could become Kyoto currency). A firm could also purchase emissions permits from abroad, including perhaps Russian hot air. The plan also suggests that the government of Canada purchase a minimum of 10 million tons of international credits. It should be noted, however, that the federal government has indicated that it would buy hot air only if the permits were "greened"(Climate Change Plan for Canada 2002, p. 43). Such a proviso could also apply to industry purchases.

Canada is considering creating additional domestic credits by allowing carbon offset credits for certain types of "certified" domestic forestry and agricultural activities, as well as providing credits for capping greenhouse gas emissions from landfills.

To explore trading as a tool to reduce emissions and increase removals, the federal government, some provincial governments, industry associations, and environmental groups operated a Greenhouse Gas Emission Reduction Trading Pilot in 1998–2002. One forest sequestration project reviewed as part of the pilot was a reforestation and forest protection program of Saskatchewan Power. This project would sequester some 52,135 tons of carbon dioxide via reforestation and another 1,541,273 tons via protection (GERT, p. 88).

5.3 The forest sector

The forest industry in Canada could have a potentially important role in helping the country meet its reduction targets. The forest industry includes the following phases:

- forest establishment;
- forest management, including harvesting and forest regeneration;
- transport;
- mill operations;
- further transport; and
- consumption.

Emissions reductions could occur in several ways. Establishment, forest management practices, transport, and mill operations allow various opportunities for reducing carbon emissions. An increase in mill efficiency, for example, would permit more output from less energy, thereby reducing emissions per unit of output. Replacement is another option: biofuels could substitute for fossil fuels as well as be a carbon sink before their harvest. Nonsink approaches include hydrogen, solar, and wind energy. Removing carbon—that is, biological sequestration—offers a third option. Forest growth, forest soils, longer rotations, full forest stocking, and immediate regeneration all promote greater sequestration. The focus of the following section is on removal options under consideration in Canada.

5.4 Forest sequestration

It is estimated that the Canadian forest sector will sequester roughly 35 million tons of carbon dioxide annually in the first commitment period on its managed forests, through the net effect of forest growth, harvesting, and natural disturbances, as well as about 1 million tons of carbon dioxide from business-as-usual afforestation and reforestation, while releasing about 16 million tons of carbon dioxide from deforestation. Under the Kyoto Protocol, Canada is allowed 44 million tons of carbon dioxide sequestration from forest management (under Article 3.4) as well as an unlimited amount from agricultural activities. However, it must decide whether to use the biological sequestration option by 2006. If afforestation, reforestation, and deforestation result in net carbon emissions, Canada can use removals from forest management to offset this debit up to a limit of 9 million tons (fccc/cp/2001/13/add.1, available at http://unfccc.int).

Canada is anticipating giving carbon offset credits for "certified" projects that sequester carbon over and above the anticipated baseline level. Thus, private investors could create offset credits for trade in carbon permits markets. One possible sequestration approach might proceed as follows. First, the private sector undertakes approved projects to sequester carbon through, for example, tree planting. The certified offset credits are then sold in markets to firms that have not met their targets. The time covered by the permits remains to be determined. If only for the first compliance period, 2008–2012, the potential for sequestering significant amounts of carbon is limited, given the modest growth associated with planted forests in their early years, especially in Canada's cool climate. If credits will be generated beyond the first compliance period, however, the long-term returns to the sink investment are likely to be better, even though the carbon sequestered for Canada's current emission target in 2008–2012 would remain modest.

Issues that arise with forest carbon sinks include measurement and monitoring, but these appear to be manageable (e.g., Sedjo and Toman 2001). Much of the current focus is on the issue of permanence. If the forest carbon is released prematurely—for example, by wildfire—who bears the liability, the permit buyer or the permit seller? The liability issue is critical to the workability of this system for forests and other carbon sinks that may not be permanent.

Numerous types of arrangements are possible (see Marland et al. 2001; Sedjo and Marland in press). A rental arrangement has been suggested for Canada whereby the carbon emitter bears the final liability but can meet the liability temporarily through forest or other biological sequestration. Should carbon release occur, the liability reverts to the emitter. Another approach would be to require sellers of biological carbon sequestration credits to purchase insurance covering the associated liability. A variant of this approach would be for the government to purchase the certified carbon offset and assume permanent, full liability

(essentially providing the insurance). The government could then treat the carbon offsets like tradable permits—using them to meet emissions reduction targets or reselling them in the market. Government backing and the permanence guarantee would make the offsets perfect substitutes for emissions permits purchased at home or abroad. Still another alternative would be for the government to guarantee the offsets for a limited period, perhaps the compliance period, or as long as 50 years.

Whether the forest carbon offsets could be traded internationally remains a question. Certainly, if the liability issues were unclear or difficult to enforce, then marketability in international markets might be limited. However, with some sort of permanence guarantee, this system would allow firms to meet domestic requirements from offsets, thereby freeing them to trade emissions permits internationally. Thus, fungibility would allow carbon offsets to be *de facto* tradable internationally, even if such trades were formally prohibited. In essence, under any of these systems, the value of the offset and its tradability would depend on the extent to which the credit was viewed as permanent and the liability was covered.

Specifically for forestry, Canada is allowed to claim up to 44 million tons of carbon dioxide (12 million tons of carbon) from forestry against its Kyoto emissions reduction targets of 240 million tons; thus 18.3% of the reduction would come from forestry. Existing forest management practices will sequester another 20 million tons of carbon dioxide (5.4 million tons of carbon), after accounting for the estimated net debit from business-as-usual afforestation, reforestation, and deforestation. Additional actions under way are estimated to sequester another 8 million tons of carbon dioxide (2.2 million tons of carbon). However, only a portion of this involves forest sink removals—rather, most of it is agriculture and landfills—and the forest portion comes from potential new afforestation efforts, for a total of 28 million tons (Climate Change Plan for Canada 2002), or about 11.7 % of the total targeted reduction.

The estimated net business-as-usual forest sink of 20 million tons from forest management will count toward Canada's overall Kyoto targets but will not generate any offset credits. Under the Kyoto rules, an additional 24 million tons of carbon dioxide could be removed through forest management as a result of policy changes and investments to reduce deforestation and increase forest growth. This sequestered carbon would also count toward Canada's target. Increased afforestation and reforestation activity could also contribute toward the goal.

The Canadian national target is an emissions reduction of 240 million tons of carbon dioxide, and thus the 24 million tons of carbon dioxide offset credits from forestry could account for up to 10% of the total emissions reductions. However, the technical and economic feasibility of achieving this level of forest sequestration by 2008–2012 is highly questionable, unless

Canada were to reduce harvests and so increase carbon stocks. This approach is under consideration in Japan. Although it could be very costly, under some circumstances the timber values need not be lost but could rather be deferred. Ultimately, the economic viability of such an approach would depend upon both the price of timber and the price of carbon offsets (van Kooten et al. 1996) and the extent to which harvests would need to be reduced. The economic costs and benefits would need careful scrutiny.

5.5 Summary

Like other countries, Canada is still working out its plan to meet its emission reductions under the Kyoto Protocol. Changes in some of the preliminary or hypothetical numbers given above are certain. Nevertheless, the outlines of a forest sink program in Canada are becoming clear. Canada faces a basic carbon "gap" of about 240 million tons. Of this, the protocol allows 44 million tons (about 18.3%) to be met by forestry. Of this, roughly 20 million tons (11.7%) is already or about to be utilized, leaving 24 million tons (10%) of the target eligible to be met by forestry.

To expand its use of forestry to meet the allowable forest sequestration target, Canada would almost certainly need to develop several large carbon forestry projects. Some question remains about how much of the 24 million tons could be generated in time for the compliance period, 2008–2012. Offsets credits would be given to investors to the extent that the amount of sequestered carbon exceeded that expected in the business-as-usual or baseline case. These would probably be tradable, and the degree to which they were discounted, vis-à-vis emission permits, would depend upon the specifics including the period they cover and the nature of the liability for impermanence.

6. Overall Summary and Conclusions

This report has compared the approaches of the governments of Japan, Canada, and the European Union member countries toward using carbon sinks to meet their respective Kyoto Protocol carbon reduction targets. Various policies have been proposed by which governments can sequester carbon by promoting afforestation and reforestation, slowing deforestation, and undertaking forest management activities under Articles 3.3 and 3.4. At this time, carbon emissions reduction programs are still under development, both within individual countries and within the context of the protocol.

Table 3: Summary Forest Sink Use: Potential and Anticipated

Country	% of Kyoto target reduction **allowed** by forest sinks	% of Kyoto target reduction **anticipated** from sinks
EU	7%	2%
Japan *	65%	50% +
Canada	18%	10%

* Calculations based on targeted reductions from 1990 base.

Although some of the details have been worked out, and concrete definitions are often still lacking, nevertheless it is clear from table 3 that Japanese will need to rely heavily on forest sinks, the EU will use them minimally and Canada will be in an intermediate situation. Additionally, Canada's targets are stringent and it may be forced to try to more fully use the sinks reductions it is allowed. However, the final decisions have not yet been made for any of these countries, and the actual role of sinks remains to be determined.

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Appendix A: Carbon / energy taxes in Europe

Ten European countries have energy or carbon taxes:

CO_2 tax : Denmark, Finland, France, Italy, Norway, Netherlands, Switzerland.

Energy tax : Czech Republic, Germany, Netherlands, UK

Tax levels differ:

Finland: \$19 / ton CO_2,

France : \$25 - \$35 / ton CO_2,

Switzerland : \$125 /ton CO_2

Applications vary:

Germany : diesel, heating oil, electricity;

Norway: shipping fuels, landfill waste;

UK : excise taxes on cars

Exemptions / derogations are numerous :

Germany & UK : energy intensive industry;

France: gas and cogeneration,

Norway: major industry, oil and gas.

Source: Grubb, Michael. 2002. The UK Climate Change Programme: Structuring national investment for the global future. Presentation to Resources for the Future, 19 November 2002.