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Tax Policy and Global Warming

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PRÉCIS

Le 17 décembre 2002, le gouvernement du Canada a annoncé sa ratification du Protocole de Kyoto à la Convention-cadre des Nations Unies sur les changements climatiques. En vertu du protocole, le Canada a accepté de ramener ses émissions annuelles de gaz à effet de serre (GES) à 6 % en deçà des niveaux de 1990 pour la période 2008-2012 — un engagement qui exige une réduction de 30 % par rapport aux émissions de GES projetées pour 2010, si rien ne change. Pour atteindre cet objectif, le gouvernement canadien a établi des cibles de réduction précises et proposé divers moyens dans le cadre de son *Plan d'action sur le changement climatique* (PACC), rendu public en novembre 2002. Bien que les principaux moyens d'action prévus dans le plan requièrent l'engagement de dépenses publiques, la conclusion d'ententes volontaires et la mise en place d'un programme d'information publique, il y est également fait mention de l'adoption de mesures fiscales — bien qu'elles ne soient pas clairement précisées.

Le présent article se veut une contribution au PACC puisqu'on y examine le rôle que la politique fiscale peut jouer pour aider le Canada à respecter ses engagements en vertu de l'accord de Kyoto. La partie II contient une justification générale des taxes écologiques et des encouragements fiscaux pour répondre aux défis environnementaux et examine les différents motifs qui justifient ces mesures fiscales ainsi que leur incidence sur la conception de ces taxes et encouragements fiscaux. La partie III passe en revue les mesures fiscales actuelles et potentielles au Canada et dans d'autres pays développés qui sont axées sur le problème du réchauffement de la planète, à la lumière de leur efficacité probable dans la réduction des émissions de GES ou l'augmentation des puits de carbone qui éliminent les émissions de GES de l'atmosphère terrestre. La partie IV revient sur le CAPP et montre comment l'apport des mesures fiscales peut se concrétiser dans chacun des domaines où des moyens d'action sont proposés dans le cadre du *Plan d'action sur le changement climatique* du gouvernement canadien : (1) transport; (2) habitations et bâtiments commerciaux/institutionnels; (3) grands émetteurs industriels (incluant énergie renouvelable et combustibles fossiles plus

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propres); (4) PME et émissions fugitives; (5) agriculture, foresterie et enfouissement; et (6) réductions des émissions internationales. La partie V contient des conclusions générales sur le rôle que peut jouer la politique fiscale dans la lutte contre le réchauffement de la planète.

ABSTRACT

The Canadian government announced its ratification of the Kyoto Protocol to the United Nations Framework Convention on Climate Change on December 17, 2002. Under this protocol, Canada has agreed to reduce annual emissions of greenhouse gases (GHGs) to 6 percent below 1990 levels during the period 2008-2012—a commitment that requires a 30 percent reduction relative to projected GHG emissions for 2010 assuming business as usual. In order to achieve this objective, the Canadian government has established specific reduction targets and proposed various policy instruments in its climate change action plan (CCAP) released in November 2002. Although the main policy instruments contemplated in the plan involve public spending, voluntary agreements, and public information programs, it also mentions tax measures—though these are not clearly spelled out.

This article seeks to contribute to the CCAP by considering the role that tax policy can play in helping to meet Canada's commitments under the Kyoto accord. The author first provides a general justification for environmental taxes and tax incentives to address environmental challenges, examining different rationales for these tax measures and their implications for the design of environmental taxes and tax incentives. He then reviews existing and potential tax measures in Canada and other developed countries that are directed at the problem of global warming, considering their likely effectiveness to reduce GHG emissions or enhance carbon sinks that remove GHGs from the earth's atmosphere. Returning to the CCAP, the author suggests ways in which tax measures can contribute to each of the areas for which action is proposed under the plan: (1) transportation; (2) housing and commercial/institutional buildings; (3) large industrial emitters (including renewable energy and cleaner fossil fuels); (4) small and medium-sized enterprises and fugitive emissions; (5) agriculture, forestry, and landfills; and (6) international emission reductions. Finally, he offers general conclusions on the role of tax policy in reducing global warming.

KEYWORDS: ENVIRONMENT ■ GASOLINE TAXES ■ FUELS ■ MOTOR VEHICLES ■ TAX INCENTIVES ■ TAX EXPENDITURES

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INTRODUCTION

The government of Canada announced its ratification of the Kyoto Protocol to the United Nations Framework Convention on Climate Change on December 17, 2002.[1] Designed to stabilize and reduce emissions of greenhouse gases (GHGs)[2] that are predicted to increase the earth's surface temperature, affecting natural ecosystems and human health, the Kyoto protocol establishes specific limitations on each party's annual carbon dioxide (CO_2) equivalent emissions during the period 2008 to 2012 relative to its emissions in 1990. According to article 3 of the protocol, these limitations may be satisfied by both reductions in GHG emissions and the enhancement of "sinks" that remove GHGs from the atmosphere.[3] Article 6 allows parties to meet their commitments by acquiring "emission reduction units" from other parties, while article 17 establishes an international trading system for GHG emissions. Commitments may also be satisfied through joint implementation involving investments in emission reductions or sinks in other industrialized countries,[4] and

1 See Kyoto Protocol to the United Nations Framework Convention on Climate Change (1997) (herein referred to as "the Kyoto protocol" or "the Kyoto accord") and United Nations Framework Convention on Climate Change (1992), available at http://unfccc.int/index.html. For a useful review of the process and structure of the Kyoto protocol, see Jutta Brunnée, "The Kyoto Protocol: Testing Ground for Compliance Theories?" (2003) vol. 63, no. 2 *Zeitschrift für ausländisches öffentliches Recht und Völerrecht (Heidelberg Journal of International Law)* 255-80.

2 Article 1 of the United Nations Framework Convention on Climate Change defines "greenhouse gases" as "those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and re-emit infrared radiation." GHGs occur both naturally and as a result of human activities, and include water vapour, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). Although different gases have different effects on global warming, it is customary to standardize these emissions to CO_2 equivalents when measuring their effects on global warming.

3 Article 1 of the United Nations Framework Convention on Climate Change defines a "sink" as "any process, activity or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere." Trees, plants, and soils act as carbon sinks since trees and plants absorb carbon dioxide from the atmosphere through the process of photosynthesis, and soils contain decomposed plant life that is transformed into soil organic matter.

4 Kyoto protocol, article 6.

through the clean development mechanism involving investments in emission reductions or sinks in developing countries that have ratified the protocol.[5]

Under the protocol, Canada has agreed to lower annual GHG emissions during the 2008 to 2012 "commitment period" to 6 percent below 1990 levels.[6] Assuming "business-as-usual" emissions of approximately 800 million tonnes or megatonnes (MT) of CO_2 equivalent emissions in 2010, this commitment requires a reduction of 240 MT annually by the end of this decade.[7] Although the achievement of this objective represents a significant challenge for Canadian individuals, businesses, and governments, it also promises a more efficient and environmentally sustainable economy through which Canada will contribute to a concerted international effort to limit global warming.

In order to achieve this objective, the Canadian government has established specific reduction targets and proposed various policy instruments in its climate change action plan released in November 2002.[8] According to this document, Canadian individuals, businesses, and governments should achieve annual reductions of 80 MT from actions initiated in the government's 2000 action plan[9] and the 2001 federal budget,[10] another 100 MT from new actions announced in the 2002 action plan, and a further 60 MT from other measures both underway and anticipated.[11] Proposed instruments for the reduction of GHGs include (1) "innovation and technology investments" to increase energy efficiency (production, distribution, and conservation) and develop cleaner sources of energy; (2) "infrastructure investments" involving urban public transit, intermodal transportation of goods, and the capture and storage of GHGs; (3) the creation of a "Partnership Fund" to "co-invest and collaborate on emissions reductions projects"; (4) voluntary agreements and the establishment of a domestic emissions trading system linked to the international carbon market to be established under the Kyoto protocol; and (5) "targeted measures" involving information (such as labelling), incentives, regulations, and tax measures.[12]

Although the climate change action plan identifies tax measures as one of the policy instruments through which it plans to meet its reduction targets, these measures appear to be few and solely in the form of tax incentives for environmentally

5 Ibid., article 12.

6 Ibid., article 3 and annex B.

7 Canada, *Climate Change Plan for Canada* (Ottawa: Public Works and Government Services, 2002), 13.

8 Ibid.

9 Canada, *Action Plan 2000 on Climate Change* (Ottawa: Public Works and Government Services, 2000).

10 Canada, Department of Finance, 2001 Budget, Budget Plan, December 10, 2001.

11 *Climate Change Plan for Canada*, supra note 7, at 11-15.

12 Ibid., at 15-17.

preferred consumption or investment.[13] Indeed, aside from the proposed emissions trading system, the main instruments on which the Canadian government intends to rely in order to meet its commitment under the Kyoto protocol involve public spending,[14] voluntary agreements,[15] and public information programs.[16] Absent from the plan are various environmentally related taxes that have been introduced or proposed in Canada or other developed countries.[17]

This article seeks to contribute to the Canadian government's climate change action plan by considering the role that tax policy can play in helping to meet Canada's commitments under the Kyoto accord. The second part of the article provides a general justification for environmental taxes and tax incentives to address environmental challenges, concluding that these can serve a useful role alongside other environmental policy measures such as direct regulation, voluntary agreements, information campaigns, and emissions trading regimes. The third part reviews existing and potential tax measures in Canada and other developed countries that are directed at the problem of global warming, considering their likely

13 The only specific example provided in the document involves an existing exemption in the federal excise tax for ethanol in gasoline. Ibid., at 17. While the plan also discusses the possibility of various financial incentives, it does not indicate whether these would be delivered in the form of tax incentives or through direct grants. See, for example, ibid., at 26 (discussing incentives for retrofits of residential housing); and at 35 (mentioning a "financial incentive program to sequester . . . CO_2 into long-term storage"). More recently, the federal government announced a financial incentive for energy-efficient retrofits of residential buildings in the form of direct grants. See the Office of Energy Efficiency Web site at http://oee.nrcan.gc.ca/.

14 See *Climate Change Plan for Canada*, supra note 7, at 23 (infrastructure funding for public transit); and at 36 (explaining that the "Government of Canada is prepared to consider participation in suitable clean coal demonstration projects, whether through the retrofit of an existing plant and/or the construction of a new generating station").

15 See ibid., at 21 (stating that "the Government of Canada will negotiate targets for the introduction of more fuel-efficient vehicles into the Canadian market with automobile manufacturers"); at 23 (discussing "voluntary performance agreements" to promote more efficient transportation of goods); at 29 (discussing voluntary targets for energy-efficiency improvements by large industrial emitters); at 30 (proposing that targets for emission reductions by large industrial emitters be "established through covenants with a regulatory or financial backstop"); and at 8 (discussing "voluntary energy efficiency targets" for small and medium-sized enterprises and "voluntary targets to reduce fugitive emissions" of waste gases during oil and gas production and exploration, as well as from small leaks in natural gas equipment, lines and storage tanks).

16 See, for example, ibid., at 21 (suggesting that the Canadian government will work with other levels of government and the private sector "to provide better information" on the fuel economy of passenger vehicles).

17 According to one definition, "[a] tax falls into the category environmental if the tax base is a physical unit (or a proxy for it) of something that has a proven specific negative impact on the environment, when used or released." ATW-Research, "Manual: Statistics on Environmental Taxes" (commissioned by the European Commission, 1996), cited in Organisation for Economic Co-operation and Development, *Environmental Taxes and Green Tax Reform* (Paris: OECD, 1997), 18. More generally, the OECD defines "environmentally related taxes" as

effectiveness to reduce GHG emissions or enhance carbon sinks. The fourth part returns to the Canadian government's climate change action plan, suggesting ways in which tax measures can contribute to each of the areas for which action is proposed under the plan: (1) transportation; (2) housing and commercial/institutional buildings; (3) large industrial emitters (including incentives for renewable energy and cleaner fossil fuels); (4) small and medium-sized enterprises and fugitive emissions; (5) agriculture, forestry, and landfills; and (6) international emission reductions. The fifth part offers general conclusions on the role of tax policy in reducing global warming.

ENVIRONMENTAL TAXES AND TAX INCENTIVES

In public discourse and scholarly literature, taxes are widely regarded as unwelcome but necessary burdens that must be imposed in order to obtain revenues to finance essential public expenditures. From this perspective, it is often suggested, taxes should affect market outcomes as little as possible, applying to broad-based

compulsory payments to governments "on tax-bases deemed to be of particular environmental relevance." Organisation for Economic Co-operation and Development, *Environmentally Related Taxes in OECD Countries: Issues and Strategies* (Paris: OECD, 2001), 15. For useful discussions of environmental taxes in the Canadian context, see Canada, *Economic Instruments for Environmental Protection: Discussion Paper* (Ottawa: Supply and Services, 1992); D.N. Dewees, "Taxation and the Environment," in Richard M. Bird and Jack M. Mintz, eds., *Taxation to 2000 and Beyond*, Canadian Tax Paper no. 93 (Toronto: Canadian Tax Foundation, 1992), 29-60; Ontario Fair Tax Commission, Environment and Taxation Working Group, *Final Report—Environment and Taxation* (Toronto: Ontario Fair Tax Commission, December 1992); Ontario, *Fair Taxation in a Changing World: Report of the Ontario Fair Tax Commission* (Toronto: University of Toronto Press in cooperation with the Ontario Fair Tax Commission, 1993), chapter 25; Arthur Donner and Fred Lazar, "The Economic Effects of an Environment Tax," in Allan M. Maslove, ed., *Taxes as Instruments of Public Policy* (Toronto: University of Toronto Press in cooperation with the Ontario Fair Tax Commission, 1994), 93-166; Canada, *Report of the Technical Committee on Business Taxation* (Ottawa: Department of Finance, April 1998), chapter 9; National Round Table on the Environment and the Economy, *Toward a Canadian Agenda for Ecological Fiscal Reform: First Steps* (Ottawa: National Round Table on the Environment and the Economy, 2002); and Amy Taylor (with Robert Hornung and Stephanie Cairns), *Environmental Tax Shifting in Canada: Theory and Application* (Calgary: Pembina Institute for Appropriate Development, 2003). For reviews of environmentally related taxes in other developed countries, see Jean-Philippe Barde and Nils Axel Braathen, "Environmentally Related Levies," paper prepared for the conference on Excise Tax Policy and Administration, sponsored by the Research Centre for Economic and Financial Policy of Erasmus University Rotterdam and the International Tax and Investment Center, held at the Ministry of Finance, The Hague, April 11-12, 2002; *Environmentally Related Taxes in OECD Countries*, supra; J. Andrew Hoerner and Benoît Bosquet, *Environmental Tax Reform: The European Experience* (Washington, DC: Center for a Sustainable Economy, 2001); European Environment Agency, *Environmental Taxes: Recent Developments in Tools for Integration* (Copenhagen: EEA, November 2000); *Environmental Taxes and Green Tax Reform*, supra; and European Environment Agency, *Environmental Taxes: Implementation and Environmental Effectiveness* (Copenhagen: EEA, 1996). See also the database of environmentally related taxes on the OECD Web site at http://www.oecd.org/.

measures of economic well-being such as income, consumption, or wealth.[18] Moreover, to the extent that market outcomes are regarded as presumptively efficient, tax incentives are often dismissed as questionable departures from tax neutrality, distorting market signals and reducing aggregate welfare.[19]

Notwithstanding these perspectives on taxation and tax incentives, a number of arguments can be advanced in favour of environmental taxes and tax incentives to address environmental challenges. The following discussion reviews these arguments, as well as their implications for the design of environmental taxes and tax incentives and the interaction of these measures with other environmental policy instruments.

Environmental Taxation

Among economists, environmental taxation is typically justified as a way to internalize negative externalities, requiring economic actors to take the full costs of their behaviour into account when determining their actions.[20] To the extent that activities such as production, transportation, or consumption impose environmental costs that are not taken into account by those engaging in the activity, economic analysis suggests that economic actors will engage in too much of the activity, equating marginal benefits with marginal private costs while ignoring environmental costs. In these circumstances, environmental taxes may improve economic efficiency by requiring economic actors to confront the full costs of their actions.

In addition to this economic rationale, environmental taxes are also justified on grounds of justice and morality.[21] According to the "polluter-pays principle," for example, those who cause harm to the environment should bear the cost of measures both to remedy this harm and to minimize future harm.[22] Formally adopted

18 See, for example, Robin W. Boadway and Harry M. Kitchen, *Canadian Tax Policy*, 3d ed., Canadian Tax Paper no. 103 (Toronto: Canadian Tax Foundation, 1999), chapter 2.

19 See, for example, the discussion of the "universal market efficiency" approach in Edward A. Zelinsky, "Efficiency and Income Taxes: The Rehabilitation of Tax Incentives" (1986) vol. 64, no. 5 *Texas Law Review* 973-1037, at 980-86.

20 For a useful summary of this argument for environmental taxation, see *Environmentally Related Taxes in OECD Countries*, supra note 17, at 21-31. For a critical evaluation of this justification for environmental taxation, see J. Andrew Hoerner, *Harnessing the Tax Code for Environmental Protection: A Survey of State Initiatives* (Washington, DC: Center for a Sustainable Economy, 1998), 4-8.

21 See, for example, Hoerner, supra note 20, at 8-11.

22 See, for example, Organisation for Economic Co-operation and Development, *Economic Instruments for Environmental Protection* (Paris: OECD, 1989), 27 ("the polluter should bear the cost of measures to reduce pollution decided upon by public authorities to ensure that the environment is in an acceptable state"); *Environmental Taxes: Recent Developments*, supra note 17, at 19 ("In accordance with the 'polluter pays principle,' it was considered appropriate that the cost of regulation and treatment should be paid by those being regulated"); Hoerner, supra note 20, at 9 ("polluters . . . and not the innocent public, should be required to pay the costs of

by the Organisation for Economic Co-operation and Development (OECD) in 1974,[23] this principle regards the environment as a common resource for the use of which polluters must compensate the public. From this perspective, as J. Andrew Hoerner explains, environmental taxes are "a way of asserting our common ownership of the environmental commons"[24] and fairly allocating the costs of environmental damage among those responsible for this damage.[25]

A third rationale for environmental taxation emphasizes the educational and transformative role of environmental taxes, conveying information about environmentally harmful activities, fostering different attitudes regarding the costs and benefits of these activities, and encouraging alternative activities with less deleterious environmental consequences.[26] Unlike the narrower economic rationale for environmental taxation, which regards environmental harms as a cost to be taken into account by those engaging in economic activities, and the polluter-pays principle, which views environmental harms as injuries that must be compensated, this transformative rationale for environmental taxation views these harms as regrettable consequences of economic development that can be minimized by different attitudes and concerted efforts at environmentally sensitive practices. On this account, it follows, the main purpose of environmental taxes is not to internalize costs or assign blame for environmental harms, but to encourage environmental awareness and shared responsibility for creating a better environmental future.[27]

Not surprisingly, these justifications for environmental taxation have different implications for the design of these taxes. According to the economic rationale, for example, environmental taxes should in theory be levied at a rate equal to the

environmental cleanup and the associated monitoring and compliance costs"); and *Environmentally Related Taxes in OECD Countries*, supra note 17, at 16 ("This principle means that the polluter should bear the expenses of carrying out [pollution prevention and control] measures decided by public authorities to ensure that the environment is in an acceptable state"). See also Sanford E. Gaines, "The Polluter-Pays Principle: From Economic Equity to Environmental Ethos" (1991) vol. 26 *Texas International Law Journal* 463-96. While there is also an economic rationale to the polluter-pays principle to the extent that it allocates the costs of compliance and treatment to those responsible for environmental harm, the very use of the word "polluter" reflects an underlying ethical dimension.

23 Organisation for Economic Co-operation and Development, "Recommendation of the Council on Implementation of the Polluter-Pays Principle," recommendation C(74)223, adopted November 14, 1974.

24 Hoerner, supra note 20, at 12.

25 Ibid., at 9 ("When the polluter-pays principle is treated as a moral doctrine, environmental taxes can play a key role in ensuring that the burdens of past and current pollution are fairly distributed").

26 See, for example, ibid., at 14-16.

27 See, for example, *Environmental Taxes: Recent Developments*, supra note 17, at 9 (explaining that environmental taxes "provide 'soft signals' that increase attention, awareness and concern about the environmental issues to which they relate").

external environmental cost associated with each activity at the margin.[28] In practice, however, these "Pigouvian" taxes are exceedingly difficult to implement, given incomplete information on environmental impacts and differing value judgments regarding the measurement of known impacts. Whether the measurement of these costs should include impacts on future generations and other living beings, for example, cannot be resolved by economic analysis. Nor can economic analysis determine whether environmental costs should be measured by an affected population's willingness to pay to be free from environmental harm (which assumes a polluter's right to pollute) or its willingness to accept a payment in order to suffer the harm (which assumes a basic right to be free from pollution). As a result, therefore, more policy-oriented economists generally suggest that environmental taxes should be set at a level that is sufficient to induce whatever reduction in environmental harm is desired by the relevant policy maker.[29] As a general rule, this approach favours a close connection between the tax and the decisions having an impact on the environmental objective,[30] and careful attention to the own-price elasticities of products and activities subject to taxation and the cross-price elasticities of substitutes for these products and activities.[31]

In contrast to the economic rationale for environmental taxation, the polluter-pays principle is concerned less about incentives than about compensation. From this perspective, environmental taxes constitute a form of user fee to finance the costs of regulation, monitoring, cleanup, and compensation to injured parties.[32] While the imposition of these taxes is likely to increase efficiency by internalizing negative externalities, these advantages are, as Hoerner observes, "ancillary to their main purpose, which is to fairly allocate environmental control and remediation costs."[33]

As compared with the economic rationale for environmental taxation and the polluter-pays principle, the transformative rationale for environmental taxation is less categorical in its implications for the design of environmental taxes. While sharing with the economic rationale an emphasis on incentives and behavioural

28 See A.C. Pigou, *The Economics of Welfare* (London: Macmillan, 1920).

29 See, for example, William J. Baumol and Wallace E. Oates, *The Theory of Environmental Policy*, 2d ed. (New York: Cambridge University Press, 1988).

30 *Economic Instruments for Environmental Protection*, supra note 17, at 52. See also *Environmentally Related Taxes in OECD Countries*, supra note 17, at 25 (suggesting that it is preferable "to tax the behaviour to be influenced as directly as possible, in order to enhance the chance of actually influencing behaviour").

31 Own-price elasticities measure the decrease in an activity or product acquired in response to an increase in its price. Cross-price elasticities measure the increase in another activity or product acquired in response to an increase in the price of the activity or product. As a general rule, elasticities increase over time as economic actors respond to different price signals.

32 Hoerner, supra note 20, at 10.

33 Ibid.

responses, the transformative rationale is less concerned with price elasticities per se than with the combined effect of environmental taxes and other policy measures on environmental attitudes and practices. Instead of requiring those engaged in environmentally harmful activities to account for the full environmental costs of their actions, therefore, this approach might recommend more modest taxes combined with informational campaigns and other measures such as tax incentives to encourage those affected by the taxes to adopt more environmentally sensitive alternatives.[34] Nor is the transformative rationale for environmental taxation satisfied with the static efficiency produced by the internalization of negative externalities, aiming instead at more fundamental changes involving environmentally sensitive attitudes and practices and technological advances that reduce the costs of environmental protection over time. For this reason, a transformative approach to environmental taxation is likely to combine taxes on environmentally harmful activities and products with other policies designed to encourage environmental awareness and practices and to foster environmentally beneficial technological improvements.

As the previous paragraph suggests, different rationales for environmental taxation also have different implications for the relationship between environmental taxes and other policies to prevent environmental damage. The economic rationale, for example, tends to regard environmental taxation as an efficient alternative to both traditional "command and control" regulation and voluntary agreements to reduce environmental damage. While regulatory measures tend to impose a single set of standards on different economic actors and create little or no incentive to achieve further improvements beyond stipulated requirements, environmental taxes promote static efficiency by minimizing the aggregate costs of environmental protection[35] and dynamic efficiencies by creating ongoing incentives to reduce environmental damage whenever the costs of so doing are less than the taxes otherwise payable.[36]

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34 Ibid., at 15 (noting that the educational effect of the tax and related programs "is often sufficient to induce significant environmental improvement" notwithstanding that the economic impact of the tax itself may be "quite small").

35 According to economic analysis, the aggregate costs of environmental protection are minimized where the costs incurred by each party are equal at the margin (since larger marginal costs to achieve a given level of protection by one party could otherwise be spent more efficiently by another party for whom the marginal cost to achieve the same level of environmental protection is less). Since a rational economic actor faced with an environmental tax can be expected to invest in environmental protection where its cost is less than the tax and pay the tax where the amount of the tax is less than the cost of environmental protection, an environmental tax can be expected to induce economic actors to spend up to the same marginal cost on environmental protection equal to the amount of the tax, thereby minimizing the aggregate costs of a given level of environmental protection.

36 See, for example, *Economic Instruments for Environmental Protection*, supra note 17, at 14-16; Dewees, supra note 17, at 30-42; and *Environmentally Related Taxes in OECD Countries*, supra note 17, at 22-24. Environmental taxes also encourage substitution away from environmentally harmful activities and products through their effect on relative prices. To the extent that environmental regulations increase the costs of activities that are subject to these regulations, this efficiency may also result from regulatory measures.

Similarly, although voluntary approaches provide economic actors with greater flexibility to achieve stipulated environmental goals, negotiated agreements do little to minimize the aggregate costs of environmental protection and provide no incentive to reduce environmental damage beyond negotiated requirements.[37] For these reasons, economic analyses generally regard regulatory and voluntary approaches to environmental protection as "inferior to environmental taxes in addressing environmental objectives."[38]

The economic rationale for environmental taxation also does not favour the earmarking of environmental tax revenues to environmental purposes, since this practice may lessen cost-effective avoidance by those affected by pollution[39] and distort appropriate expenditures to redress and reduce environmental harms—which have no necessary relationship to the amount of revenue collected by taxes designed to internalize environmental costs.[40] Moreover, the economic rationale is not readily amenable to direct grants or tax incentives for environmental purposes, since these subsidies distort price signals and allow economic actors to avoid the full environmental costs of their actions.[41] In contrast, this rationale is generally sympathetic to the idea of tradable permits, which promise the same static and dynamic efficiencies as environmental taxes.[42] Although a system of tradable permits

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37 *Environmentally Related Taxes in OECD Countries*, supra note 17, at 41-42. For a detailed evaluation of the experience of OECD countries with voluntary approaches to environmental protection, see Organisation for Economic Co-operation and Development, *Voluntary Approaches for Environmental Policy: An Assessment* (Paris: OECD, 1999) (reporting that negotiated agreements tend to be poorly enforced and involve substantial administrative and transaction costs to set up). For a recent critique of voluntary agreements in the Canadian context, see Andrew Green, "Incentives, Public Goals and Environmental Contracts," research paper prepared for the Ontario Panel on the Role of Government (November 2002).

38 *Environmentally Related Taxes in OECD Countries*, supra note 17, at 41 (referring to voluntary approaches). See also ibid., at 22 (discussing the "theoretical advantage of economic instruments compared to command and control regulation").

39 Hoerner, supra note 20, at 5-6.

40 See, for example, *Environmentally Related Taxes in OECD Countries*, supra note 17, at 26 (explaining that "earmarking fixes the use of tax revenue in advance, which creates obstacles for a re-evaluation based on economic and environmental rationale of a targeted expenditure programme financed by earmarked revenues, and the frequent result is inefficient spending of government revenue").

41 See, for example, Dewees, supra note 17, at 39 ("Whenever the government provides a tax abatement scheme for pollution control equipment or provides direct cash subsidies for pollution abatement, it encourages output in an industry that is environmentally harmful. The effect of such subsidies is likely to be excessive production"). See also Chris Edwards, Ada Rousso, Peter Merrill, and Elizabeth Wagner, "Cool Code: Federal Tax Incentives To Mitigate Global Warming" (1998) vol. 51, no. 3 *National Tax Journal* 465-83, at 475 ("subsidies for pollution abatement are inherently less efficient than taxes on the pollutants themselves, because the subsidy causes overproduction of pollution-causing goods").

42 See the explanation in *Environmentally Related Taxes in OECD Countries*, supra note 17, at 22-24. In order to ensure that relative prices reflect the environmental costs of different activities and

might be regarded as a substitute for environmental taxation,[43] experience and reflection suggest that tradable permits and environmental taxes can be combined in several ways: introducing tradable permits for specific activities or sectors and environmental taxes for others;[44] imposing taxes on environmentally harmful activities even where these are allowed by tradable permits;[45] or taxing environmentally harmful activities that are not sanctioned by tradable permits.[46] Moreover, according to one study, the combination of environmental taxation and tradable permits can be expected to reduce the cost of environmental protection compared to the cost from environmental taxation alone.[47]

Like the economic rationale for environmental taxation, the polluter-pays principle is generally antagonistic to voluntary approaches to environmental protection as well as direct grants or tax incentives that assist polluters in reducing environmental harms. To the extent that negotiated agreements allow contracting parties to engage in environmentally harmful activities without paying any compensation for resulting environmental damage, voluntary approaches contradict the very premise of the polluter-pays principle. Likewise, the idea of subsidizing those who engage in environmentally harmful activities contradicts the normative judgment that those

products and to prevent windfall gains to existing firms and industries, it is often suggested that these permits should be purchased by auction. In practice, however, most tradable permits are generally distributed free of charge.

43 For a useful analysis of the relationship between tradable permits and other environmental policies including environmental taxes, see Stephen Smith, "The Compatibility of Tradable Permits with Other Environmental Policy Instruments," in Organisation for Economic Co-operation and Development, *Implementing Domestic Tradable Permits for Environmental Protection* (Paris: OECD, 1999), chapter 10.

44 In the United Kingdom, for example, emission trading has been proposed for energy-intensive sectors covered by negotiated agreements that confer substantial exemption from the new climate change levy. *Environmentally Related Taxes in OECD Countries*, supra note 17, at 43. For a critical assessment of this method of combining tradable permits and environmental taxes, see P. Schreiner, "Obstacles to the Implementation of Tradable Permits: The Case of Norway," in *Implementing Domestic Tradable Permits for Environmental Protection*, supra note 43, at chapter 6.

45 In the United States, for example, the federal government levies a tax on ozone-depleting substances that applies to manufacturers of these substances notwithstanding that they hold tradable permits authorizing the manufacture of the substances up to a particular amount. Since the permits were distributed free of charge, the tax was introduced in order to reduce the windfall gains of manufacturers who received these allowances. For a brief description of this tax, see *Environmentally Related Taxes in OECD Countries*, supra note 17, at 43 (box 7).

46 Under this approach, the environmental tax functions as a ceiling on the market price of tradable permits, since those engaging in economically harmful activities would be expected to purchase permits as long as the tax exceeds the permit price and pay the tax whenever the permit price exceeds the tax.

47 Japan, Ministry of the Environment, *The Carbon Tax To Reduce GHG Emission: Report of the Study Group on Economic Instruments in Environmental Policies* (Tokyo: Ministry of the Environment, 2000), cited in *Environmentally Related Taxes in OECD Countries*, supra note 17, at 42.

who are responsible for environmental damage should bear the costs of its remediation and prevention. In contrast to the economic rationale, however, the polluter-pays principle favours the earmarking of environmental taxes to the remediation and prevention of environmental harms, since these expenditures are consistent with the character of these taxes as fees for the use of a common resource.[48] The polluter-pays principle is also compatible with regulatory alternatives to environmental taxation that limit or prevent the very damages that justify the imposition of environmental taxes as user fees, and with tradable permits, provided that the permits are not distributed free of charge.

Unlike the economic rationale for environmental taxation and the polluter-pays principle, the transformative rationale for environmental taxation is compatible with all other policies to reduce environmental harm. According to this approach, for example, environmental regulation may be preferable to taxation where the number of persons engaged in an environmentally harmful activity is few or the policy objective is to prevent the harm altogether.[49] In contrast, where the number of persons engaged in the activity is large and the policy goal is to reduce the extent of the harm without preventing it altogether, environmental taxation is generally preferable to regulation.[50] Where environmental taxes are imposed at relatively low rates, however, environmental regulations can support the educational and transformative aims of these taxes by establishing minimum standards reflecting currently available technology and practices.[51] At the same time, environmental taxation can enhance regulatory measures, increasing the likelihood of effective enforcement and creating a dynamic incentive to reduce environmentally harmful activities beyond regulated levels.[52]

Moreover, to the extent that environmental taxation is intended to convey information about environmentally harmful activities, foster different attitudes regarding their costs and benefits, and encourage alternative activities with less deleterious environmental consequences, environmental taxes are also compatible with voluntary agreements, tradable permits, informational campaigns, direct grants and tax incentives, and the earmarking of revenues for environmental purposes. Where voluntary agreements foster environmental awareness and a sense of shared responsibility for environmental protection, for example, this approach to environmental protection

48 See, for example, Hoerner, supra note 20, at 10 ("earmarking can ensure that taxation is proportional to, or sufficient to remedy, harm caused to the public").

49 See, for example, *Fair Taxation in a Changing World*, supra note 17, at 554.

50 Ibid.

51 See, for example, Hoerner, supra note 20, at 16 ("Technology-based regulations embody our resolve to do the best we can today"). In practice, environmental taxes are often imposed at relatively low rates on account of political opposition and competitiveness concerns. See, for example, *Environmentally Related Taxes in OECD Countries*, supra note 17, at 40-41; and *Environmental Taxes: Recent Developments*, supra note 17, at 9.

52 See, for example, Hoerner, supra note 20, at 16-17.

complements the educational and transformative role of environmental taxes.[53] Correspondingly, environmental taxation can support voluntary approaches to environmental protection by creating a financial incentive to negotiate and adhere to meaningful commitments to reduce environmental harms.[54] Tradable permits also complement the transformative role of environmental taxation by creating ongoing incentives to reduce the cost of environmental protection,[55] as do informational campaigns and subsidies that encourage environmental awareness and practices and foster environmentally beneficial technological improvements.[56] The transformative rationale for environmental taxation is also consistent with the earmarking of revenues for environmental purposes, particularly where these revenues are used to encourage environmentally sensitive practices and technological improvements that reduce the cost of environmental protection over time.[57] Besides improving the environmental effectiveness of environmental taxes,[58] earmarking may also improve the political acceptability of environmental taxation, which might otherwise be perceived as little more than another source of government revenue.[59]

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53 Notwithstanding its concerns about voluntary agreements, for example, the OECD acknowledges that voluntary approaches to environmental protection "are likely to generate significant 'soft effects' in terms of the dissemination of information, innovation diffusion and awareness raising." *Environmentally Related Taxes in OECD Countries*, supra note 17, at 48, note 10.

54 In Denmark and the United Kingdom, for example, exemptions from taxes on energy and carbon are granted to industries that enter into negotiated agreements to increase energy efficiency. Ibid., at 41. Similarly, the *Climate Change Plan for Canada*, supra note 7, at 30, contemplates a "financial backstop" to reinforce negotiated agreements with large industrial emitters of GHGs.

55 See supra note 42 and accompanying text.

56 See, for example, Hoerner, supra note 20, at 15 (observing that modest taxes on environmentally injurious activities are often combined with "campaign[s] to educate the relevant population about available alternatives, often funded by the tax"). According to one study, the recycling of revenues from a carbon tax into investments in energy-efficient technologies is likely to significantly reduce the costs of reducing CO_2 emissions compared to a carbon tax alone. *The Carbon Tax To Reduce GHG Emission*, supra note 47, cited in *Environmentally Related Taxes in OECD Countries*, supra note 17, at 44.

57 See, for example, Hoerner, supra note 20, at 16 (explaining that "taxes on emissions that remain after mandatory controls and tax incentives for investments in new clean technologies . . . can, when properly integrated with more conventional regulatory approaches, play an important role in policy packages that meet our pressing immediate environmental concerns while placing us on the path to meeting our long-term environmental aspirations").

58 See, for example, ibid., at 10 (reporting that "empirical work has suggested that earmarked taxes appear [to] provide a more effective incentive for emission reductions than a strict economic analysis would suggest"). See also M.S. Anderson, "Governance by Green Taxes: Implementing Clean Water Policies in Europe 1970-1990" (1999) vol. 2, no. 1 *Environmental Economics and Policy Studies* 39-63 (concluding that earmarking of revenues was a significant factor in the relative success of the Dutch system of water-related charges compared to the Danish and Belgian systems, improving cooperation between polluters and regulators and easing the transition to lower levels of pollution).

59 *Environmentally Related Taxes in OECD Countries*, supra note 17, at 26.

Although these rationales for environmental taxation have different implications for the design of environmental taxes and the interaction of these taxes with other environmental policy instruments, each has a role to play in a general justification for these taxes as instruments of environmental policy. Where marginal environmental costs are easily determined, for example, efficiency considerations provide a persuasive rationale for environmental taxes to internalize negative externalities. Even where marginal environmental costs are not easily determined, at least some level of environmental taxation may be more likely to promote economic efficiency than no tax at all. Attention to the price elasticities of different products and activities is also advisable where the goal of environmental taxation is to effect behavioural change. To the extent that human behaviour is also shaped by factors other than marginal costs and benefits, however, justifications for environmental taxes would do well to take into account their educational and transformative role as well as estimates of price elasticities.[60] For this reason, as well, one might question the weight of economic objections to environmental policies other than environmental taxes and tradable permits.[61] Although efficiency considerations may favour environmental taxation in many circumstances, other approaches to environmental protection may also be useful complements to environmental taxes that serve educational and transformative purposes.[62]

In addition to economic and transformative rationales for environmental taxation, the polluter-pays principle provides a powerful justification for environmental taxes where environmental damage is clearly established and moral responsibility is readily assigned, although regulatory fines and criminal penalties are often preferable in this context. Where environmental harms represent regrettable consequences of economic development, however, the polluter-pays principle seems inappropriately individualistic, while the transformative rationale provides a convincing justification for environmental taxes to encourage environmental awareness and shared responsibility for environmental protection.[63] For the same reason, the aversion of the polluter-pays principle to voluntary agreements and subsidies to encourage environmental protection might also be challenged.

In practice, environmental taxes are typically justified on various grounds—economic and moral, as well as transformative.[64] Moreover, notwithstanding economic or moral objections, these taxes are usually applied in combination with other environmental policy instruments, including environmental regulations, voluntary agreements, tradable permits, information campaigns, direct grants and tax incentives,

60 See supra note 34 and accompanying text.

61 See the discussion supra at notes 35 to 47 and accompanying text.

62 See the discussion supra at notes 48 to 59 and accompanying text.

63 See supra note 27 and accompanying text.

64 Hoerner, supra note 20, at 4-25.

and the earmarking of revenues to environmental purposes.[65] While this variety of rationales and policy instruments might be regarded as arbitrary and inefficient,[66] it also reflects a multiplicity of circumstances in which environmental protection is warranted and a concomitant diversity in the methods through which this protection is best pursued. In the analysis that follows, therefore, this article adopts a pluralistic approach to the justification for environmental taxation and a complementary perspective on the relationship between environmental taxes and other environmental policy instruments.

Environmental Tax Incentives

Unlike other tax provisions, which define the amount or transaction subject to tax and the rate or rates at which the tax applies, tax incentives represent deliberate departures from otherwise applicable taxes in order to encourage the activity at which the incentive is directed. For this reason, these subsidies are accurately described as "tax expenditures" and properly evaluated like any other public spending program, by weighing the public goals pursued by the program against its cost and overall effectiveness in promoting these goals.[67] In order to justify a tax incentive for environmental purposes, therefore, it is necessary to defend both a public subsidy for the product or activity that the incentive is designed to encourage and the delivery of this subsidy in the form of a tax incentive rather than direct government spending.

Beginning with the first of these issues, at least three reasons can be advanced to support public subsidies for environmentally sensitive behaviour.

First, to the extent that certain kinds of activities generate public benefits in addition to those enjoyed by the persons engaging in the activity, economic analysis suggests that a subsidy may be appropriate to encourage a socially efficient quantity of the activity by internalizing these positive externalities.[68] For this reason, for example, governments often subsidize the research and development of new products and processes, the benefits from which are typically enjoyed by third parties as well as those incurring the cost of the research and development. For this reason as well, it may be economically efficient to subsidize both research and development

65 *Environmental Taxes: Recent Developments*, supra note 17, at 9. See also *Environmentally Related Taxes in OECD Countries*, supra note 17, at 40-45.

66 See, for example, *Environmentally Related Taxes in OECD Countries*, supra note 17, at 30 and 45 (questioning the efficiency of policy mixes that produce "wasteful policy overlap").

67 See, for example, Stanley S. Surrey, "Tax Incentives as a Device for Implementing Government Policy: A Comparison with Direct Government Expenditures" (1970) vol. 83, no. 4 *Harvard Law Review* 705-38; Stanley S. Surrey, *Pathways to Tax Reform: The Concept of Tax Expenditures* (Cambridge, MA: Harvard University Press, 1985); and Stanley S. Surrey and Paul R. McDaniel, *Tax Expenditures* (Cambridge, MA: Harvard University Press, 1985).

68 See, for example, the discussion of positive externalities in Zelinsky, supra note 19, at 1005-8.

regarding environmentally sensitive processes and technologies,[69] and environmentally sensitive forms of consumption and production that yield public benefits in the form of reduced environmental harm.[70]

A second reason to subsidize environmentally sensitive products and activities is to encourage dynamic efficiencies resulting from reductions in the cost of these products and activities over time. To the extent that subsidies increase the demand for new products and activities, output is likely to increase and costs can be expected to fall with increasing economies of scale. For this reason, subsidies for environmentally sensitive products and activities may be supported on the grounds that they accelerate market penetration of new technologies, creating a more mature market for these technologies and reducing the costs of environmental protection.[71] Moreover, where an expanding market causes the cost of an emerging clean technology to be lowered to a level that is comparable with that of environmentally harmful technologies currently in use, subsidies and other environmental policies can "'flip' the clean technology from the low-production, high-cost state to a stable high-production, low-cost state, with corresponding benefit to the environment and the economy."[72] As the cost effectiveness of subsidies for this purpose depends on the extent to which demand for the clean technology increases as a result of the subsidy, attention to price elasticities is crucial in this context.[73]

A third rationale for environmental subsidies emphasizes their educational and transformative function, conveying information about environmentally preferred products and activities, fostering different attitudes toward environmentally sensitive and harmful products and activities, and encouraging environmentally sensitive

69 See, for example, Hoerner, supra note 20, at 18 (explaining that "production of new environmental technologies yields a positive technological externality that provides a benefit to the public").

70 Ibid. Although environmental taxes represent a more efficient response to the negative externalities associated with environmental harms, the use of subsidies to reduce these harms may be efficiency enhancing where environmental taxes are levied at low rates or not at all.

71 See, for example, United States, Department of Energy, Energy Information Administration, *Analysis of the Climate Change Technology Initiative: Fiscal Year 2001* (Washington, DC: Energy Information Administration, 2000), x (characterizing "the intended purpose" of the Clinton administration's climate change technology initiative [CCTI] as "encouraging the penetration of [new and environmentally sensitive] technologies, reducing costs, and creating a more mature market"). See also Hoerner, supra note 20, at 18-19 (explaining that the goal of these incentives "is not to find the optimal balance between the cost of emissions reductions and the benefits of environmental improvements at a given level of technology, but rather to achieve a market transformation that makes clean production cheaper and relaxes the environment/economy tradeoff").

72 Hoerner, supra note 20, at 18.

73 Where demand for the clean technology is price inelastic, the effect of a subsidy is to provide a windfall to those who would have acquired the technology in any event. In contrast, where demand is highly elastic, the subsidy can induce sufficient market penetration and cost reductions to justify its cost.

behavioural changes. Where established practices cause environmental harms, for example, subsidies and other environmental policies can encourage environmentally sensitive alternatives by increasing awareness and encouraging institutional changes that make these alternatives less costly and more feasible.[74]

Although one or more of these rationales might justify a subsidy for environmental purposes, it is not obvious why such a subsidy should be delivered in the form of a tax incentive rather than a direct grant. Indeed, tax incentives are often criticized on the grounds that they increase the complexity of tax legislation, establish open-ended budgetary commitments, lack effective accountability, bypass traditional legislative controls on budgetary expenditures, and portray as tax reductions what are in effect spending programs.[75] Moreover, where tax incentives take the form of exemptions, deductions, or deferrals from progressive income taxes, these measures are justifiably regarded as regressive "upside-down" subsidies that confer a greater benefit on taxpayers with high incomes than on those with low incomes.[76]

While these concerns suggest that direct grants are preferable to tax incentives in many contexts, they do not rule out all tax incentives. Where an incentive is introduced and monitored in a manner similar to a spending program, for example, with its cost estimated in advance and reviewed regularly thereafter through annual tax expenditure budgets, concerns about accountability and transparency are greatly reduced.[77] Moreover, where the amount of the incentive does not depend on the taxpayer's level of income, concerns about the equitable distribution of the associated tax benefits are similarly allayed.[78] In these circumstances, in fact, tax incentives may be preferred to direct grants on the grounds that they facilitate more decentralized forms of decision making and are less costly for governments to promote and administer.[79] Whether these advantages are actually satisfied in the context of a particular tax incentive, however, depends on the design of the incentive and the

74 See, for example, Hoerner, supra note 20, at 19-20.

75 See, for example, Surrey, *Pathways to Tax Reform*, supra note 67, at 126-54.

76 See, for example, Surrey, "Tax Incentives as a Device for Implementing Government Policy," supra note 67, at 720-25.

77 Both Canada and the United States publish annual estimates of tax expenditures, measuring their cost in terms of forgone revenues. For a useful history of the origins of these tax expenditure budgets, see Jonathan Barry Forman, "Origins of the Tax Expenditure Budget" (1986) vol. 30, no. 6 *Tax Notes* 537-45. For a recent proposal to extend the concept to include the costs of regulatory measures, see Julie Roin, "Truth in Government: Beyond the Tax Expenditure Budget," *Hastings Law Journal* (forthcoming) (available online at http://ssrn.com/abstract_id=350981).

78 This is the case, for example, where an incentive takes the form of a refundable tax credit in computing the taxpayer's income rather than an exemption, deduction, or deferral in computing income for tax purposes. Exemptions or deductions in computing flat-rate sales or consumption taxes also appear to satisfy this concern, although such measures would presumably have distributional implications.

79 See, for example, Zelinsky, supra note 19, at 1010-12.

manner of its administration. As a result, these policy choices cannot be made in the abstract but only by considering the particular incentive in question. The next part of this article therefore turns to specific taxes and tax incentives to reduce global warming.

TAX MEASURES TO REDUCE GLOBAL WARMING

Among OECD countries, the main category of anthropogenic GHG emissions is carbon dioxide (CO_2), the vast majority of which results from the combustion of fossil fuels for energy.[80] In addition to CO_2, other anthropogenic GHGs include

- methane (CH_4), most of which results from the anaerobic decomposition of solid wastes in landfills, the production and distribution of oil and natural gas, enteric fermentation in ruminants, coal mining, and manure management;[81]
- nitrous oxide (N_2O), most of which is attributable to agricultural soil management (including the application of synthetic and organic fertilizers), the combustion of fossil fuels, the production of nitric acid for synthetic fertilizers, and manure management;[82] and
- hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6), one or more of which is either used as a substitute for ozone-depleting substances (ODS), attributable to the production of ODS substitutes, used in electrical transmission and distribution, or attributable to the production of aluminum, the manufacture of semiconductors, or the production of magnesium.[83]

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80 According to the OECD, CO_2 is responsible for over 60 percent of anthropogenic GHG emissions. *Environmentally Related Taxes in OECD Countries*, supra note 17, at 117. In the United States, approximately 82 percent of estimated GHG emissions in 1999 were attributable to CO_2, of which 98 percent resulted from the combustion of fossil fuels. United States, Department of State, *U.S. Climate Action Report—2002* (Washington, DC: Department of State, May 2002), 37-42. Other sources of CO_2 emissions include the production of cement and lime, the combustion of solid wastes, and natural gas flaring.

81 According to the OECD, CH_4 is responsible for approximately 15 to 20 percent of the greenhouse effect. *Environmentally Related Taxes in OECD Countries*, supra note 17, at 117. In the United States, CH_4 accounted for approximately 9 percent of CO_2 equivalent GHG emissions in 1999. Of these emissions, approximately 35 percent were attributable to landfills, 23 percent to the production of oil and natural gas, 20 percent to enteric fermentation in ruminants, 10 percent to coal mining, and 6 percent to manure management. *U.S. Climate Action Report—2002*, supra note 80, at 42-45. Other sources of CH_4 emissions include wastewater treatment, rice cultivation, and the combustion of automotive fuels.

82 In the United States, N_2O accounted for approximately 6 percent of total GHG emissions in 1999. Of these emissions, almost 70 percent were attributable to agricultural soil management, 18 percent to the combustion of fossil fuels, 5 percent to the production of nitric acid, and 4 percent to manure management. *U.S. Climate Action Report—2002*, supra note 80, at 45-46.

83 In the United States, these gases accounted for approximately 2 percent of total GHG emissions in 1999. Of these emissions, over 40 percent were attributable to ODS substitutes, approximately

While GHG emissions contribute to global warming, the enhancement of carbon sinks can offset this effect by removing carbon dioxide from the atmosphere. Although forests are the most important carbon sink, agricultural soils serve this function as well.[84]

The following sections review existing and potential tax measures designed to address global warming by reducing GHG emissions and enhancing carbon sinks, considering both taxes and tax incentives. Rather than examining each tax and incentive in detail, the purpose of this survey is to provide a general description of the most promising tax measures and their expected effectiveness in reducing global warming.

Taxes

As the combustion of fossil fuels for energy constitutes the leading source of anthropogenic GHG emissions in OECD countries, it is not surprising that fossil fuels and energy consumption are the main targets of environmental taxes to reduce global warming. This section considers taxes on fossil fuels and energy consumption as well as taxes on other sources of GHG emissions.

Taxes on Fossil Fuels and Energy Consumption

Among OECD countries, the most significant taxes on fossil fuels and energy consumption apply to automotive fuels and motor vehicles.[85] In addition to these taxes, several countries have contemplated or introduced broader taxes on energy and other fossil fuels.[86]

Automotive Fuel Taxes

Beginning with taxes on automotive fuels, rates vary widely from one country to another and also among different fuels. In Europe, for example, tax rates for unleaded gasoline as of January 1, 2000 ranged from a low of approximately Cdn 56 cents per litre in Greece to almost Cdn $1.25 per litre in the United Kingdom.[87] In Canada

22 percent to the production of HFC-22 (an ODS substitute), 19 percent to electrical transmission and distribution, 7.5 percent to the production of aluminum, 5 percent to the manufacture of semiconductors, and 4.5 percent to the production of magnesium. Ibid., at 46-47.

84 In the United States, improved forest management practices and management of agricultural soils are estimated to have resulted in net sequestration of approximately 15 percent of gross GHG emissions in 1999, over 90 percent of which was attributable to forests. Ibid., at 42.

85 See, for example, *Environmentally Related Taxes in OECD Countries*, supra note 17, at 55 (reporting that taxes on automotive fuels and motor vehicles accounted for 90 percent of environmentally related tax revenues in OECD countries in 1995).

86 See, for example, ibid., at 55-56 and 58-60.

87 See the database of environmentally related taxes on the OECD Web site at http://www.oecd.org/. Tax rates are converted to Canadian currency based on an exchange rate in April 2003 of €1 = Cdn$1.58701.

and the United States, rates are considerably lower at Cdn 10 cents per litre of unleaded gasoline at the federal level in Canada[88] and approximately Cdn 7 cents per litre at the federal level in the United States.[89] Although provincial and territorial governments in Canada and state governments in the United States also levy excise taxes on automotive fuels, rates for unleaded gasoline vary between Cdn 6.2 cents and Cdn 16.5 cents per litre in Canada,[90] and approximately Cdn 3 cents and Cdn 12 cents per litre in the United States,[91] meaning that combined automotive fuel taxes by both levels of government are significantly lower than applicable rates throughout Europe.

With respect to taxes on different fuels, leaded gasoline is uniformly subject to higher rates than unleaded gasoline,[92] while diesel fuel is generally taxed at lower rates than other fuels.[93] Moreover, in recent years, governments have introduced

88 Excise Tax Act (Canada), RSC 1985, c. E-15, as amended (herein referred to as "ETA"), subsection 23(1) and schedule II, paragraph 9(a).

89 US motor fuel excise tax rates available online at http://www.taxadmin.org/fta/rate/motor_fl.html (US 18.4 cents per gallon). Tax rates are converted to litres and Canadian currency based on an exchange rate in April 2003 of US $1 = Cdn $1.447.

90 The lowest rate for unleaded gasoline is in Yukon Territory and the highest is in Newfoundland and Labrador. In Ontario, unleaded gasoline is taxed at a rate of 14.7 percent. Although automobile fuels are not subject to separate retail sales taxes imposed in most Canadian provinces, they are subject to the federal goods and services tax (GST), a 7 percent value-added tax that applies to the total consideration paid for the supply of fuel in Canada, including federal and provincial fuel taxes. In Quebec, which levies its own value-added tax, as well as New Brunswick, Newfoundland and Labrador, and Nova Scotia, which have harmonized their sales taxes with the federal GST, these taxes also apply to automobile fuel as well as federal and provincial fuel taxes.

91 See the US motor fuel excise tax rates available online at http://www.taxadmin.org/fta/rate/motor_fl.html. The lowest rate for unleaded gasoline (US 7.5 cents per gallon) is found in the state of Georgia and the highest (US 31 cents per gallon) in the state of Rhode Island. In key border states like Michigan, New York, and Ohio, state tax rates on unleaded fuel range from Cdn 7.2 cents per litre (US 19 cents per gallon in Michigan) to Cdn 8.7 cents per litre (US 22.6 cents per gallon in New York State). Tax rates are converted to litres and Canadian currency based on an exchange rate in April 2003 of US $1 = Cdn $1.447.

92 In the United Kingdom, for example, the tax rate for leaded gasoline as of January 1, 2000 was almost Cdn $1.40 per litre, compared to Cdn $1.24 per litre for unleaded gasoline. See the database of environmentally related taxes on the OECD Web site at http://www.oecd.org/. Tax rates are converted to Canadian currency based on an exchange rate in April 2003 of € 1 = Cdn $1.58701. Likewise in Canada, leaded gasoline is subject to a federal tax of Cdn 11 cents per litre compared to Cdn 10 cents per litre for unleaded gasoline. See ETA subsection 23(1) and schedule II, paragraphs 9(a) and (b). In Ontario, leaded gasoline is taxed at a rate of Cdn 17.7 cents per litre, compared to Cdn 14.7 cents per litre for unleaded gasoline. Gasoline Tax Act (Ontario), RSO 1990, c. G.5, as amended, section 2(1).

93 See, for example, *Environmentally Related Taxes in OECD Countries*, supra note 17, at 57, figure 7. In Germany, for example, automotive fuel taxes in 2000 were approximately Cdn 60 cents per litre for diesel fuel and Cdn 89 cents per litre for unleaded gasoline. See the database of environmentally related taxes on the OECD Web site at http://www.oecd.org/. Tax rates are converted to Canadian currency based on an exchange rate in April 2003 of € 1 = Cdn $1.58701. In Canada,

reduced rates or exemptions for clean-burning and renewable fuels such as ethanol and methanol and biodiesel fuels of non-fossil fuel origin. In Norway, Sweden, and the United Kingdom, for example, diesel fuel rates vary according to the sulphur content of the fuel.[94] In the United States, automotive fuels that meet stipulated alcohol content requirements are subject to a reduced federal fuel tax rate of approximately Cdn 5 cents per litre.[95] In Canada, the portion of blended gasoline that is ethanol or methanol produced from biomass has been exempt from the federal fuel tax since 1992.[96] Consistent with this exemption, the 2003 federal budget proposed to remove the federal excise tax on diesel fuel from the biomass-produced ethanol or methanol portion of blended diesel fuel and to exempt biodiesel fuel and the biodiesel portion of blended diesel fuel, provided that the biodiesel is of a biological non-fossil fuel origin (such as vegetable oils and animal fats, including recycled cooking greases).[97] Similar exemptions or tax rebates for these clean-burning and renewable fuels are also available in several provinces and territories.[98]

Until recently, these taxes have generally been regarded as administratively convenient sources of general revenue or as benefit taxes, the payment of which helps finance the construction and maintenance of roads and highways.[99] Notwithstanding these origins, however, automotive fuel taxes have assumed an increasingly important environmental character as rates have distinguished between leaded and unleaded fuels, and reduced rates or exemptions have been introduced for clean-burning and renewable fuels. From an environmental perspective, however, lower rates for diesel fuel than for gasoline are generally regarded as inappropriate, since diesel produces larger CO_2 emissions per terajoule of energy than gasoline[100] and

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diesel fuel is subject to a federal tax of Cdn 4 cents per litre compared to Cdn 10 cents per litre for unleaded gasoline. See ETA subsection 23(1) and schedule II, paragraph 9(a) and section 9.1. In the United States, on the other hand, diesel fuel is taxed slightly more heavily than unleaded gasoline both at the federal level and in many states. See the US motor fuel excise tax rates online at http://www.taxadmin.org/fta/rate/motor_fl.html.

94 *Environmentally Related Taxes in OECD Countries*, supra note 17, at 58.

95 Ibid. (reporting a rate of US 13.1 cents per gallon). For a brief explanation of the required alcohol content of these fuels, see United States, Department of the Treasury, *Excise Taxes for 2003*, Internal Revenue Service Publication 510 (revised February 2003), 11-12.

96 ETA section 23.4.

97 Canada, Department of Finance, 2003 Budget, Budget Plan, February 18, 2003, at 343.

98 In Ontario, for example, biodiesel fuel is fully exempt from the province's fuel tax, whether or not it is mixed with ordinary diesel fuel. Fuel Tax Act (Ontario), RSO 1990, c. F.35, as amended, section 2(3.1). In the Northwest Territories and Nunavut, all non-petroleum-based automobile fuels are completely exempt from tax. See Petroleum Products Tax Act (Northwest Territories), RSNWT 1988, c. P-5, as amended and as duplicated for Nunavut by section 29 of the Nunavut Act, SC 1993, c. 28.

99 See, for example, the discussion in *Report of the Technical Committee on Business Taxation*, supra note 17, at 9.1-2.

100 Donner and Lazar, supra note 17, at 97.

much higher emissions of particulates and other pollutants such as ozone (NO_x) and sulphur dioxide (SO_2).[101]

Regarding the effectiveness of automotive fuel taxes in reducing GHG emissions, available evidence is inconclusive but suggestive. On the one hand, US studies indicating a low price elasticity of demand for gasoline suggest that fuel taxes are less an effective way to change behaviour than an efficient way to raise revenues.[102] European studies, on the other hand, indicate that while the number of kilometres driven is generally unresponsive to fuel price increases, the demand for gasoline is relatively price elastic, suggesting that higher fuel taxes encourage more efficient fuel consumption rather than discouraging driving.[103] In the United Kingdom, for example, one study concluded that increases in fuel taxes in the 1990s contributed to a 13 percent increase in the average fuel efficiency of heavy trucks between 1993 and 1998.[104] As a result, the UK Treasury department projected that scheduled increases in automotive fuel taxes during the period 1996-2002 would reduce annual CO_2 emissions from the transport sector by 4.6 to 11.5 percent by 2010.[105] In the United States also, a strong correlation exists between inflation-adjusted gasoline prices and trends in the fuel efficiency of new vehicles, with significant improvements in fuel efficiency as gasoline prices increased in the 1970s, followed by a sustained stagnation in fuel efficiency as real fuel prices fell in the 1980s and 1990s.[106]

In addition to these effects, it is important to recognize the role that other policies can play in enhancing the environmental effectiveness of increased taxes on automotive fuels. Where these taxes are accompanied by increased spending on public

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101 *Environmentally Related Taxes in OECD Countries*, supra note 17, at 57 (adding that although diesel-powered vehicles cause lower CO_2 emissions per kilometre driven than vehicles powered by gasoline, this is not an argument for preferential tax treatment for these fuels, since drivers benefit directly from this fuel consumption advantage).

102 See, for example, Kristin N. Snipes and Robert Mendelsohn, "The Effectiveness of Gasoline Taxation To Manage Air Pollution" (2001) vol. 36, no. 2 *Ecological Economics* 299-309, cited in Barde and Braathen, supra note 17, at paragraph 65 (reporting short-term elasticities of –0.4 to –0.6 and long-term elasticities of –0.5 to –0.7).

103 See the studies cited in *Environmental Taxes: Recent Developments*, supra note 17, at 45 (reporting elasticities in the range of -0.65 to -1.0). Other studies indicating that the number of kilometres driven is unresponsive to increases in the price of automotive fuel suggest that drivers are apt to respond to increased fuel taxes by obtaining more energy-efficient vehicles rather than by driving less.

104 United Kingdom, Department of the Environment, Transport and the Regions, *Climate Change—The UK Programme* (London: Department of the Environment, Transport and the Regions, 2000).

105 United Kingdom, Her Majesty's Treasury, *Economic and Fiscal Strategy Report* (London: Her Majesty's Treasury, 1999); and United Kingdom, Her Majesty's Treasury, *Financial Statement and Budget Report* (London: Her Majesty's Treasury, 1999). After sustained protest by the domestic trucking industry in the United Kingdom, the scheduled increases were abandoned in 2000.

106 *Environmentally Related Taxes in OECD Countries*, supra note 17, at 103-4, figure 13.

transportation, for example, improvements in service quality can further the environmental objectives of automotive fuel taxes by encouraging commuters to shift from private automobiles to public transit. Moreover, where spending programs or tax incentives support the production and consumption of fuel-efficient and clean-energy vehicles, these efficiency improvements can make it easier for drivers to respond to automotive fuel taxes by reducing their consumption of GHG-producing automotive fuels. For these reasons, it is important to consider the environmental effectiveness of automotive fuel taxes not in isolation but as one of several possible measures to address global warming.

Motor Vehicle Taxes

Among other environmental policies directed at reducing GHG emissions from the combustion of automotive fuels, an increasingly common measure involves taxes and registration fees on the sale or use of motor vehicles. In the United States, for example, the federal government levies a gas guzzler tax (GGT) on the sale by the manufacturer of automobiles with a fuel economy standard as measured by the Environmental Protection Agency (EPA) of less than 22.5 miles per gallon (greater than approximately 10.5 litres per 100 kilometres).[107] Starting at $1,000 for automobiles with a fuel economy of 21.5 to 22.5 miles per gallon (MPG), the tax increases as fuel economy falls, reaching a maximum of $7,700 for automobiles with a fuel economy of less than 12.5 MPG (greater than approximately 19 litres per 100 kilometres).[108] Similarly, in Canada, Ontario levies a tax for fuel conservation (TFFC) on the sale or lease of new passenger vehicles and sports-utility vehicles (SUVs) with highway fuel-use ratings exceeding 6 litres per 100 kilometres for passenger vehicles (less than approximately 39 MPG) and 8 litres per 100 kilometres for SUVs (less than approximately 29 MPG).[109] For passenger vehicles, the tax is $75 for vehicles with a fuel-use rating of 6 to 9 litres per 100 kilometres (approximately 26 to 39 MPG), rising to $7,000 for vehicles with ratings over 18 litres per 100 kilometres (less than approximately 13 MPG). For SUVs, the tax increases from $75 on vehicles with a fuel-use rating of 8 to 9 litres per 100 kilometres (approximately 26 to 29 MPG) to $3,200 for vehicles with ratings over 18 litres per 100 kilometres (less than approximately 13 MPG). Moreover, for passenger vehicles with a fuel-use rating less than 6 litres per 100 kilometres (greater than approximately 39 MPG), Ontario provides a tax credit for fuel conservation (TCFFC) of $100.[110] Other tax incentives for fuel-efficient and clean-fuel vehicles are discussed later in this article.[111]

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107 For a brief description of the tax, see *Excise Taxes for 2003*, supra note 95, at 22-23.

108 Internal Revenue Service Form 6197, "Gas Guzzler Tax" (revised July 1998).

109 Retail Sales Tax Act, RSO 1990, c. R.31, as amended (herein referred to as "RSTA"), sections 4(5) and (6). For a brief description of the tax, see Ontario, Ministry of Revenue, *Retail Sales Tax Guide* no. 513, June 2001.

110 RSTA section 4.1.

111 Infra notes 170 to 178 and accompanying text.

As an alternative to taxes on fuel-inefficient automobiles, a number of European countries levy vehicle registration fees that vary with the fuel efficiency of the vehicle. In Austria, for example, the rate at which a vehicle registration tax is applied increases as fuel economy decreases.[112] Similarly, in Denmark, Germany, Switzerland, and Sweden, annual registration fees vary according to the vehicle's fuel consumption and environmental characteristics.[113] Beginning in March 2001, the United Kingdom introduced graduated rates for the annual vehicle excise duty (VED) on private vehicles based on CO_2 emissions per kilometre driven.[114]

Like automobile fuel taxes, motor vehicle taxes and registration fees have traditionally been viewed as benefit taxes or user fees for the public provision of roads and highways. For this reason, most European countries base motor vehicle registration fees on the weight of the vehicle, its engine size, or the number of axles.[115] For the same reason, revenues from the US GGT are dedicated to the Highway Trust Fund notwithstanding that the tax itself is designed to discourage purchases of fuel-inefficient vehicles.[116] Where rates vary according to fuel efficiency and other environmental characteristics, however, these taxes and registration fees assume a clear environmental character.

With respect to the effect of these taxes and registration fees on GHG emissions, evidence is limited. In Sweden, which introduced differentiated registration fees for motor vehicles in 1993, reducing fees for cleaner class 1 vehicles and increasing them for less fuel-efficient class 3 vehicles, the percentage of class 1 and 2 vehicles increased from 16 to 73 percent between 1993 and 1996—a result that the Swedish Environmental Protection Agency attributes more to so-called soft effects from advertising and consumer awareness than from the registration fees themselves.[117] Likewise in Germany, where differentiated registration fees were introduced in the mid-1990s, the number of high-emission vehicles fell from 6.9 million to 3 million between July 1997 and January 2000, while the number of vehicles meeting high-efficiency standards increased from 6.2 million to nearly 16 million during the same

112 This tax is based on the net price of the vehicle, with rates calculated as follows: fuel consumption in litres per 100 kilometres less 3 (2 for diesel-powered vehicles) times 2 percent. See the database of environmentally related taxes on the OECD Web site at http://www.oecd.org/.

113 Ibid.

114 The rates for this graduated vehicle excise duty (GVED) are available on the Web site of the UK Driver and Vehicle Licensing Agency at http://www.dvla.gov.uk/vehicles/taxation.htm.

115 *Environmentally Related Taxes in OECD Countries*, supra note 17, at 61.

116 National Center for Environmental Economics, *The United States Experience with Economic Incentives for Protecting the Environment* (Washington, DC: National Center for Environmental Economics, 2001), 49.

117 Sweden, Environmental Protection Agency, *Environmental Taxes in Sweden* (Stockholm: Environmental Protection Agency, 1997), cited in *Environmentally Related Taxes in OECD Countries*, supra note 17, at 104-5.

period.[118] In the United States and Ontario, however, the GGT and the TFFC do not appear to have had a significant impact on the fuel efficiency of new vehicles.[119] To the extent that these taxes fall mostly on a small percentage of fuel-inefficient vehicles, however, this outcome is not particularly surprising.[120] Indeed, Ontario's TFFC has been criticized not only on the basis that the rate is essentially flat for most vehicles, but also for levying lower rates on fuel-inefficient SUVs than on passenger vehicles and failing to include light trucks and vans, which represent approximately 25 percent of vehicles sold in the province.[121]

Another reason that motor vehicle taxes and registration fees appear to have been more effective in Europe than in North America relates to the combined effect of these measures and higher automotive fuel taxes, which together discourage purchases of fuel-inefficient vehicles. Here too, therefore, it is important to consider the environmental effectiveness of motor vehicle taxes not in isolation but together with other measures to address global warming. Among these other measures, one of the most promising could be the use of revenues from environmentally differentiated motor vehicle taxes or registration fees to finance tax incentives or other subsidies to encourage drivers to retire older fuel-inefficient vehicles and to purchase fuel-efficient and clean-energy vehicles.[122]

Taxes on Energy and Other Fossil Fuels

Although the combustion of automotive fuels constitutes a major source of CO_2 emissions in developed countries, a much larger share of these emissions results from the combustion of other fossil fuels for industrial, commercial, and residential purposes. In the United States, for example, the transportation sector is estimated to have accounted for 31 percent of CO_2 emissions in 1999, while combustion of fossil fuels for industrial uses and electricity generation accounted for 35 percent of CO_2 emissions, and commercial and residential sectors accounted for 16 and 19 percent

118 H. Jatzke, "The Ecological Reform in Germany," paper presented at the conference on Green Tax Reforms in Europe, Paris, October 10, 2000, cited in *Environmentally Related Taxes in OECD Countries*, supra note 17, at 104.

119 In the United States, for example, the fuel efficiency of new vehicles has remained largely unchanged since the early 1980s, shortly after the GGT was introduced. *Environmentally Related Taxes in OECD Countries*, supra note 17, at 104, figure 13.

120 In Ontario, for example, approximately 90 percent of passenger vehicles fall in the fuel-efficiency range that attracts the minimum TFFC of $75. *Fair Taxation in a Changing World*, supra note 17, at 567.

121 Ibid., at 566.

122 For Canadian proposals to this effect, see *Final Report—Environment and Taxation*, supra note 17, at 10; and Canadian Centre for Policy Alternatives, *Alternative Federal Budget 2003*, Technical Paper no. 2, *An Action Plan for Kyoto* (Ottawa: Canadian Centre for Policy Alternatives, January 27, 2003), 6.

of CO_2 emissions respectively.[123] Similarly, in Canada, transportation is estimated to account for approximately 25 percent of the country's total GHG emissions.[124]

For this reason, in order to encourage energy efficiency and reduce GHG emissions from the combustion of other fossil fuels, several countries have introduced broader taxes on energy consumption and other fossil fuels. In Denmark, for example, taxes on electricity (most of which is generated by burning coal) and non-automotive fuel oils were first introduced in 1978.[125] In 1988, the Netherlands introduced a general fuel charge, the revenues from which were earmarked for environmental expenditures administered by the Ministry of the Environment.[126] In the early 1990s, Finland, Norway, and Sweden introduced broad-based fuel taxes specifically targeting CO_2 emissions,[127] and Denmark and the Netherlands restructured their fuel taxes to correspond more closely to the carbon content of different fuels.[128] More recently, Austria, Belgium, Germany, Italy, and the United Kingdom have also introduced broad-based taxes on energy consumption and fossil fuels.[129] Although neither Canada nor the United States has introduced similar taxes, proposals for broad-based taxes on energy consumption and fossil fuels have been made in both countries.[130]

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123 *U.S. Climate Action Report—2002*, supra note 80, at 39-41.

124 *Climate Change Plan for Canada*, supra note 7, at 20.

125 Hans Larsen, *Energy Taxes: The Danish Model* (Copenhagen: Danish Ministry of Taxation, September 1998).

126 Willem Vermeend and Jacob van der Vaart, *Greening Taxes: The Dutch Model* (Deventer, the Netherlands: Kluwer Academic, 1998), 17. See also Hoerner and Bosquet, supra note 17, at 19.

127 For general discussions of these tax reforms, see *Environmentally Related Taxes in OECD Countries*, supra note 17, at 51 and 55-56; and Hoerner and Bosquet, supra note 17, at 15-17 (Finland), 22-23 (Norway), and 23-26 (Sweden).

128 For an overview of these reforms in Denmark, see Jens Holger Helbo Hansen, "Green Tax Reform in Denmark," in Kai Schlegelmilch, ed., *Green Budget Reform in Europe: Countries at the Forefront* (Berlin: Springer, 1999), 51-66. For a detailed explanation of environmental tax reform in the Netherlands, see Vermeend and van der Vaart, supra note 126. See also Hoerner and Bosquet, supra note 17, at 11-15 (Denmark) and 19-21 (the Netherlands).

129 See, for example, Barde and Braathen, supra note 17, at paragraphs 41, 42, and 44. See also Hoerner and Bosquet, supra note 17, at 28-29 (Austria), 17-18 (Germany), 18-19 (Italy), and 26-27 (the United Kingdom).

130 In the United States, for example, the Clinton administration proposed a broad-based energy tax in February 1993. Although a modified version of the tax was approved by the House of Representatives in June 1993, the proposal was narrowly defeated in the Senate, which opted to increase the federal gasoline tax instead. See J. Andrew Hoerner and Frank Muller, *Carbon Taxes for Climate Protection in a Competitive World*, paper prepared for the Swiss Federal Office for Foreign Economic Affairs (College Park, MD: University of Maryland, Center for Global Change, Environmental Tax Program, June 1996), 9-11. In Canada, both the Ontario Fair Tax Commission and the federal Technical Committee on Business Taxation recommended that existing automotive fuel taxes be extended to other fossil fuels, with rates based on the carbon content of these fuels. See *Fair Taxation in a Changing World*, supra note 17, at 562; and *Report of the Technical Committee on Business Taxation*, supra note 17, at 9.14.

In theory, taxes on energy should help to reduce GHG emissions by decreasing energy consumption and encouraging greater energy efficiency. From an environmental perspective, however, taxes on fossil fuels are clearly preferable to energy taxes since they encourage not only increased energy efficiency but also a substitution away from fossil fuels toward clean and renewable sources of energy. Better still are taxes based on the carbon content of different fuels, since carbon content is an excellent proxy for CO_2 emissions,[131] and such taxes can be expected to encourage both energy efficiency and the substitution of low-carbon fuels for high-carbon fuels.[132] Not surprisingly, therefore, the introduction of taxes based on the carbon content of different fuels is generally regarded as one of the most cost-effective ways to stabilize and reduce GHG emissions.[133]

In general, taxes in Austria, Belgium, Germany, and the United Kingdom are based mainly on energy consumption, while Denmark, Finland, Italy, the Netherlands, Norway, and Sweden have introduced carbon or CO_2 taxes.[134] In practice, however, the distinctions between these taxes are blurred by the fact that many countries tax both energy and carbon,[135] by the availability of energy tax exemptions and rebates for energy from clean and renewable sources,[136] and by the existence of substantial carbon tax rate reductions or rebates for energy-intensive industries such as manufacturing.[137] As a result, most energy taxes contain some differentiation according to CO_2 emissions from input fuels, while the effective rates of carbon or CO_2 taxes vary only "*to some extent* . . . according to the carbon

131 See, for example, Donner and Lazar, supra note 17, at 97-98, tables 2 and 3. Coal, for example, contains the highest amount of carbon and produces the largest CO_2 emissions per unit of energy produced. Petroleum has approximately 25 percent less carbon than coal, while natural gas has about 45 percent less carbon than coal. *U.S. Climate Action Report—2002*, supra note 80, at 38. Although taxes based on the carbon content of different fuels create no incentive to develop "end-of-pipe" abatement technologies, technological limits on abatement opportunities make this deficiency more theoretical than real. *Economic Instruments for Environmental Protection*, supra note 17, at 57. As technologies for the capture and storage of CO_2 become available, incentives to introduce these technologies could be created by allowing a deduction or credit against tax otherwise payable.

132 See, for example, Hoerner and Muller, supra note 130, at 3.

133 *Economic Instruments for Environmental Protection*, supra note 17, at 58. See also Roger C. Dower and Mary Beth Zimmerman, *The Right Climate for Carbon Taxes: Creating Economic Incentives To Protect the Atmosphere* (Washington, DC: World Resources Institute, 1992).

134 See the brief descriptions of these taxes in *Environmentally Related Taxes in OECD Countries*, supra note 17, at 51-52.

135 In Finland, for example, the original carbon tax was amended in the mid-1990s to apply partly to the energy content and partly to the carbon content of specific fuels. Similarly, Denmark, the Netherlands, and Sweden levy taxes on both energy use and the carbon content of fuels. See the database of environmentally related taxes on the OECD Web site at http://www.oecd.org/.

136 See the brief summary of these environmentally motivated exemptions and rebates in *Environmentally Related Taxes in OECD Countries*, supra note 17, at 64.

137 See the brief summary of these special provisions ibid., at 56.

content of those fuels that are taxed."[138] As well, both energy and carbon taxes include various rate reductions, exemptions, ceilings, and rebates designed to address competitiveness concerns and distributional effects (both regional and among different income groups).[139]

With respect to the effectiveness of these taxes in reducing GHG emissions, estimates vary but are generally positive. According to a study conducted by the International Energy Agency in 1989, a tax of US $50 per tonne of carbon content on all fossil fuels was projected to cause coal consumption in OECD countries to decrease by 25 percent, thermal electricity generation to decrease by 19 percent, oil consumption to fall by 5 percent, and natural gas consumption to decrease by 4 percent, resulting in reductions of CO_2 emissions of 11.7 percent in the OECD as a whole and 14.3 percent in North America.[140] A subsequent study in Ontario concluded that a carbon tax of approximately Cdn $25 per tonne of carbon would reduce CO_2 emissions in the province by 4 percent over a 15-year period, with much larger reductions realized by the industrial sector (8.5 percent) and lower reductions realized by the commercial, transportation, and residential sectors.[141] Studies of proposed energy and carbon taxes in Denmark, Germany, and the Netherlands projected reductions in CO_2 emissions of 1.5 to 2 percent.[142]

Although some studies suggest that appreciable reductions in CO_2 emissions are likely only where energy or carbon taxes are levied at very high rates,[143] European experience is more encouraging. In Finland and Sweden, for example, studies conducted after relatively modest carbon taxes were introduced in the early 1990s concluded that these taxes resulted in reduced GHG emissions of 7 and 9 percent respectively.[144] Other studies estimating the effects of energy and carbon taxes in Norway and the Netherlands have also reported meaningful reductions in CO_2 emissions.[145]

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138 Ibid. (emphasis in original).

139 See, for example, ibid., at 56, 62-63 (box 10), 78, and 89. For a useful overview of competitiveness considerations in the design of environmentally related taxes, see ibid., at 71-85. For a brief discussion of the distributional impact of energy and carbon taxes, see ibid., at 87-89.

140 International Energy Agency, *Policy Measures and Their Impact on CO_2 Emissions and Accumulations* (Paris: International Energy Agency, 1989).

141 Donner and Lazar, supra note 17, at 128, table 21.

142 See the discussion of the Danish and German studies in *Environmentally Related Taxes in OECD Countries*, supra note 17, at 105-6; and the discussion of the Dutch study in Vermeend and van der Vaart, supra note 126, at 45.

143 See, for example, Donner and Lazar, supra note 17.

144 See the discussion of the Finnish study in *Environmentally Related Taxes in OECD Countries*, supra note 17, at 105; and the discussion of the Swedish study in *Environmental Taxes: Recent Developments*, supra note 17, at 46.

145 See the discussion of the Norwegian study in *Environmentally Related Taxes in OECD Countries*, supra note 17, at 105; and the summary of the Dutch results in Vermeend and van der Vaart, supra note 126, at 35.

As with automotive fuel and motor vehicle taxes, it is important to consider the effectiveness of energy or carbon taxes not in isolation, but together with other policies aimed at reducing GHG emissions. Where these taxes are combined with tax incentives or other subsidies for renewable energy sources and energy conservation, for example, the environmental effectiveness of the tax is likely to be greater and the cost of reducing GHG emissions correspondingly lower.[146] Moreover, where the revenues from these taxes are "recycled" in the form of reductions in other taxes, competitiveness concerns can be significantly reduced and economic advantages realized by substituting efficiency-enhancing environmental taxes for distortionary taxes on labour or capital.[147] For these reasons, European countries that have introduced energy or carbon taxes have generally used these revenues to reduce other taxes and to encourage clean-energy sources and energy efficiency through tax incentives and other subsidies.[148] For the same reasons, Canadian studies advocating taxes on the carbon content of fuels have generally proposed that revenues be used to reduce other taxes and provide tax incentives or other subsidies for investments in energy-efficient equipment and clean and renewable energy.[149] To the extent that a broad-based carbon tax could be expected to impose a heavier burden on low-income households, which devote a greater percentage of income than high-income households to the consumption of energy, and to regions of the country such as Alberta that depend more heavily than other regions on fossil fuels, another

146 See, for example, *The Carbon Tax To Reduce GHG Emission*, supra note 47, cited in *Environmentally Related Taxes in OECD Countries*, supra note 17, at 44. See also Hoerner, supra note 20, at 15-16.

147 For useful discussions of this so-called double dividend hypothesis, see Ernest U. Von Weizsäcker and Jochen Jesinghaus, *Ecological Tax Reform* (London: Zed Books, 1992); Lawrence H. Goulder, "Environmental Taxation and the Double Dividend: A Reader's Guide" (1995) vol. 2, no. 2 *International Tax and Public Finance* 157-83; *Environmental Taxes and Green Tax Reform*, supra note 17, at 33-36; *Environmental Taxes: Recent Developments*, supra note 17, at 16-17; and *Environmentally Related Taxes in OECD Countries*, supra note 17, at 35-40. Although the magnitude of any "double dividend" depends on the amount of revenue raised from environmental taxes, the kinds of taxes subject to rate reductions, the incidence of environmental taxes, and general equilibrium effects, empirical evidence suggests that the introduction of a carbon-energy tax with cuts to labour taxes is likely to result in at least some double dividend in the form of environmental improvements and employment gains. See, for example, A. Majocchi, "Green Fiscal Reform and Employment: A Survey" (1996) vol. 8, no. 4 *Environmental and Resource Economics* 375-97; and Benoît Bosquet, "Environmental Tax Reform: Does It Work? A Survey of the Empirical Evidence" (2000) vol. 34, no. 1 *Ecological Economics* 19-32. For this reason, as Hoerner and Bosquet conclude, comprehensive environmental tax reform, in which revenues from environmental taxes are used in part to finance reductions in distortionary taxes, "is better than environmental taxes alone." Hoerner and Bosquet, supra note 17, at 61.

148 *Environmentally Related Taxes in OECD Countries*, supra note 17, at 27, 39, 61, and 78.

149 See, for example, *Fair Taxation in a Changing World*, supra note 17, at 562; and *Final Report—Environment and Taxation*, supra note 17, at 35.

important recommendation involves the use of tax revenues to offset undesirable distributional effects by income class or region.[150] The former could be accomplished by reductions in other regressive taxes or increases in transfer payments to low-income households, while the latter could be accomplished by intergovernmental transfers or reductions in other taxes.

Taxes on Other Sources of GHG Emissions

Although CO_2 from the combustion of fossil fuels is the leading source of GHG emissions in OECD countries, other GHGs are significant contributors to global warming and considerably more potent per unit of emissions.[151] Nevertheless, OECD countries have very little experience with the taxation of non-CO_2 GHGs.[152]

One reason for this record is undoubtedly the variety of non-CO_2 GHGs and sources of these emissions, many of which are either unsuitable for taxation or effectively addressed through regulatory means or voluntary agreements.[153] Although it is technically feasible to substantially reduce methane emissions from the distribution of natural gas, for example, it would be difficult and expensive to measure emissions over long stretches of pipeline, making taxation impracticable.[154] Nor is it administratively practicable to monitor for tax purposes methane emissions from old landfills, surface coal mines, and rice cultivation, emissions of methane and nitrous oxide from manure management, or emissions of hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride in the manufacture of semiconductors.[155] Conversely, while taxation may be administratively feasible for methane emissions from oil and gas production, modern landfills with gas collection facilities, and underground coal mines, PFC emissions from the production of aluminum, and SF_6 emissions from the production of magnesium,[156] the limited number of stationary sites for these emissions may make regulatory measures and voluntary agreements

150 See, for example, *Economic Instruments for Environmental Protection*, supra note 17, at 59; and *Final Report—Environment and Taxation*, supra note 17, at 36.

151 In terms of global warming potential (GWP), CH_4 is 21 times more potent than CO_2, N_2O is 310 times more potent, HFCs range from 140 times more potent (HFC-152a) to 11,700 times more potent (HFC-23), PFCs range from 6,500 times more potent (CF_4) to 9,200 times more potent (C_2F_6), and SF_6 is 23,900 times more potent than CO_2. *U.S. Climate Action Report—2002*, supra note 80, at 37.

152 *Environmentally Related Taxes in OECD Countries*, supra note 17, at 121.

153 For a detailed analysis of the potential for environmental taxation to reduce non-CO_2 GHG emissions, see Organisation for Economic Co-operation and Development, *The Potential for Using Tax Instruments To Address Non CO_2 Greenhouse Gases: CH_4, N_2O, HFCs, PFCs and SF_6* (Paris: OECD, 2000).

154 *Environmentally Related Taxes in OECD Countries*, supra note 17, at 135.

155 Ibid., at 120 and 135.

156 Ibid., at 119 and 134.

effective alternatives to environmental taxation.[157] To the extent that environmental taxes create a dynamic incentive to go beyond regulatory requirements or voluntary agreements, however, taxes on these emissions or close proxies may be useful complements to other measures.[158]

In practice, OECD countries appear to levy only two kinds of taxes related to non-CO_2 GHG emissions: taxes on synthetic fertilizers, the production and application of which release nitrous oxides; and taxes on packaging and solid wastes deposited at landfills, which are the most significant anthropogenic sources of methane. Although the former are generally regarded as user fees to finance fertilizer inspection and storage and other agricultural policy measures,[159] taxes on fertilizers also have the potential to reduce N_2O emissions by decreasing fertilizer consumption and production.[160] In Austria, for example, a levy on synthetic fertilizers is estimated to have reduced the demand for nitrogen fertilizer by 2.5 percent.[161] In Sweden, fertilizer taxes are estimated to have reduced aggregate nitrogen dosages by approximately 10 percent.[162] Together with environmental regulations, therefore, taxes on synthetic fertilizers may help to reduce GHG emissions and global warming.

In contrast to taxes on synthetic fertilizers, taxes on packaging and solid wastes deposited in landfills have an explicit environmental purpose—although this purpose is not primarily to reduce emissions of CH_4, but to reduce unnecessary packaging and to encourage individuals and enterprises to recycle and produce less waste.[163] To the extent that these taxes reduce the volume of solid waste deposited in landfills, however, corresponding reductions in CH_4 emissions are an inevitable consequence.[164] This secondary benefit is likely to be greater where, as in the United Kingdom, the tax applies at higher rates to CH_4-producing active wastes than to

157 In many OECD countries, in fact, GHG emissions from these sources are subject to regulatory oversight and/or voluntary agreements. See *The Potential for Using Tax Instruments To Address Non CO_2 Greenhouse Gases*, supra note 153.

158 See the discussion supra at notes 49 to 54 and accompanying text.

159 *Environmental Taxes: Recent Developments*, supra note 17, at 48. See also National Center for Environmental Economics, *The United States Experience with Economic Incentives for Protecting the Environment* (Washington, DC: National Center for Environmental Economics, 2001), 46.

160 See the discussion in *The Potential for Using Tax Instruments To Address Non CO_2 Greenhouse Gases*, supra note 153, at 22 (cautioning that taxes on synthetic fertilizers could cause farmers to increase the use of manure or sewage sludge from wastewater treatment plants, which would increase emissions of N_2O).

161 M.F. Hofreither and F. Sinabell, "The Austrian Levy on Mineral Fertilizers: Selected Observations," in L. Gazzola and K. de Roest, eds., *Economic Instruments for Nitrogen Control in European Agriculture* (Reggio Emila, Italy: Research Centre on Animal Production, 1999), 67-78, cited in *Environmental Taxes: Recent Developments*, supra note 17, at 48.

162 *Environmental Taxes in Sweden*, supra note 117, cited in *Environmental Taxes: Recent Developments*, supra note 17, at 49.

163 For a brief summary of these taxes in OECD countries, see *Environmentally Related Taxes in OECD Countries*, supra note 17, at 63-66.

164 *The Potential for Using Tax Instruments To Address Non CO_2 Greenhouse Gases*, supra note 153, at 12.

inactive wastes that do not result in GHG emissions.[165] In Austria, Denmark, and Norway, waste taxes encourage reductions in CH_4 emissions through lower rates for landfills with energy recovery systems.[166] In Norway, the combination of this waste tax and licensing requirements is projected to reduce CH_4 emissions from landfills by more than 10 percent per year.[167] Here too, therefore, environmental taxation may complement and enhance other environmental policies such as regulation and voluntary agreements.

Tax Incentives

In addition to environmental taxes, environmental tax incentives may also reduce global warming by encouraging practices that decrease GHG emissions and enhance the scope and quality of carbon sinks. The following sections consider tax incentives aimed at reducing CO_2 emissions, tax incentives designed to reduce other GHG emissions, and tax incentives aimed at the preservation and enhancement of carbon sinks.

Tax Incentives To Reduce CO_2 Emissions

The vast majority of CO_2 emissions result from the combustion of fossil fuels for energy.[168] Since opportunities for "end-of-pipe" abatement of these emissions are limited,[169] the most effective ways to decrease these emissions involve the efficient use of energy and the substitution of clean and renewable energy sources for carbon-based fuels. Not surprisingly, therefore, tax incentives aimed at reducing CO_2 emissions tend to encourage energy efficiency in various activities and the generation of energy from clean and renewable sources.

Tax Incentives for Fuel-Efficient and Clean-Fuel Vehicles

Among these incentives, some of the most obvious encourage purchases of fuel-efficient and clean-fuel vehicles. In the United States, for example, the federal government introduced a tax credit for "qualified electric vehicles" in 1992, computed at 10 percent of the cost of the vehicle up to a maximum amount of $4,000 and deductible against income tax otherwise payable.[170] Another incentive allows a

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165 For a description of the UK landfill tax, see, for example, Robert E. Whittall, "Landfill Tax in the United Kingdom," available on the Environmental Taxation Worldwide Web site at http://www.greentaxes.org/country/uk/land.asp.

166 *Environmentally Related Taxes in OECD Countries*, supra note 17, at 65. See also Norway, Ministry of the Environment, *Norway's Third National Communication Under the Framework Convention on Climate Change* (Oslo: Ministry of the Environment, June 2002), 38.

167 Calculated from figures presented in *Norway's Third National Communication Under the Framework Convention on Climate Change*, supra note 166, at 41 and 43.

168 See supra note 80.

169 *Economic Instruments for Environmental Protection*, supra note 17, at 57.

170 Internal Revenue Code of 1986, as amended, section 30 (herein referred to as "IRC"). For this purpose, a qualified electric vehicle is defined as a motor vehicle that is powered primarily by

limited deduction for part of the cost of "clean-fuel vehicles" powered by natural gas, liquefied natural gas, liquefied petroleum gas, hydrogen, electricity, and any other fuel at least 85 percent of which is methanol, ethanol, or any other alcohol or ether.[171] In addition to these incentives, which are scheduled to decrease and disappear by 2006, recent proposals would introduce further tax credits for fuel-efficient hybrid vehicles, vehicles powered by fuel cells, and alternative and mixed-fuel vehicles.[172] As well, several US states provide tax incentives for alternative-fuelled vehicles in the form of credits against income taxes or exemptions from sales taxes.[173] In Ontario, rebates against provincial sales taxes are available for vehicles powered by electricity, propane, natural gas, or other clean-burning fuels.[174] In British Columbia, a partial refund of provincial sales tax is available for the purchase of an alternative-fuel vehicle, computed at 30 percent of the tax paid up to $1,000 for a passenger vehicle and $10,000 for a passenger bus.[175]

In theory, these incentives should increase sales of fuel-efficient and clean-fuel vehicles by reducing their after-tax prices relative to those of conventional vehicles.

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an electric motor drawing current from rechargeable batteries, fuel cells, or other portable sources of electrical current.

171 IRC section 179A. The deduction is limited to the portion of the vehicle's cost that is attributable to the engine, the fuel tank, the system for delivering fuel to the engine, and the exhaust system, and is capped at $50,000 for a truck or van with a gross vehicle weight over 26,000 pounds or a bus with a seating capacity of at least 20 adults, $5,000 in the case of a truck or van with a gross vehicle weight between 10,000 and 26,000 pounds, and $2,000 in the case of any other vehicle. Where the vehicle is used in a trade or business, the cost of the vehicle for purposes of depreciation is reduced by the amount of the deduction.

172 For example, as part of the CCTI (supra note 71), the Clinton administration proposed a credit against federal income tax for hybrid vehicles purchased between 2003 and 2006, equal to $1,000 for a vehicle that is one-third more fuel efficient than a comparable vehicle in its class, $2,000 for a vehicle that is two-thirds more fuel efficient than a comparable vehicle in its class, $3,000 for a vehicle that is twice as fuel efficient as a comparable vehicle in its class, and $4,000 for a vehicle that is three times more fuel efficient than a comparable vehicle in its class. For a detailed discussion of this incentive, see J. Andrew Hoerner and Avery P. Gilbert, *Assessing Tax Incentives for Clean Energy Technologies: A Survey of Experts Approach* (Washington, DC: Center for a Sustainable Economy, 2000), 19-31. For more recent proposals, see United States, Staff of the Joint Committee on Taxation, *Description of S. ___ "Energy Tax Incentives Act of 2002,"* JCX-2-02 (Washington, DC: Joint Committee on Taxation, February 11, 2002).

173 Hoerner, supra note 20, at 38-39. In Oregon, for example, individuals who purchase an alternative-fuel vehicle can obtain a credit against state income tax of up to $1,500, while businesses can claim a credit against state business tax of 35 percent of the difference between the cost of a hybrid-electric or other dual-fuel vehicle and the cost of a conventional vehicle of the same class and size. See Oregon Office of Energy, "Hybrid Electric and Dual-Fuel Vehicles," available on the Web at http://www.energy.state.or.us/trans/hybridcr.htm.

174 RSTA sections 48(3)(g) and (h). The amount of the rebate is up to $750 for vehicles powered by propane and up to $2,000 for vehicles powered by electricity, natural gas, or other clean-burning fuels.

175 British Columbia, Ministry of Provincial Revenue, *Consumer Taxation Branch Bulletin* no. 085, "Alternative Fuel Vehicles and Tax Concessions," August 2000, revised March 2002.

Moreover, where increased sales facilitate reductions in production costs, the market for these vehicles might be expected to expand, resulting in a gradual replacement of conventional vehicles and corresponding reductions in CO_2 emissions—provided that the incentives encourage mainly the substitution of fuel-efficient and clean-fuel vehicles for conventional vehicles, rather than an increase in total vehicle purchases, and that drivers do not significantly increase the number of kilometres driven in response to increases in the fuel efficiency of the vehicles they drive.

In practice, the effectiveness of tax incentives for fuel-efficient and clean-fuel vehicles is likely to depend on the commercial viability of the qualifying vehicles and the price differential between these vehicles and conventional vehicles, as well as the amount and form of the incentive. In the case of qualified electric vehicles, for example, the amount of the US credit appears to have been insufficient to significantly increase sales of a commercially uncertain and expensive technology.[176] More promising are tax incentives for hybrid vehicles such as the Toyota Prius and Honda Insight, which are commercially available but 20 to 25 percent more expensive than conventional vehicles. Although this price differential suggests that tax incentives would have to be substantial to be effective,[177] the combination of a lesser incentive with increased automotive fuel taxes and taxes on fuel-inefficient vehicles might also prove effective.[178]

Finally, with respect to the form of the incentive, an exemption from otherwise applicable sales or value-added taxes is likely more effective and more equitable than a deduction or non-refundable credit against income tax, since a deduction or credit is realized some time after the vehicle is purchased, requires the consumer to maintain and file receipts, and depends on the consumer's taxable income. In the United States, however, the absence of a federal sales or value-added tax makes such an approach impossible at the federal level.

Tax Incentives for Ride Sharing and Public Transportation

In addition to tax incentives for clean-fuel vehicles and fuel-efficient vehicles, several jurisdictions provide tax relief for ride sharing or public transportation. In the United States, for example, the federal income tax exempts employer-provided vanpooling and transit passes from tax as employment benefits.[179] Similar incentives for ride sharing and mass transit exist in several US states, in the form of either exemptions from income tax as employment benefits or special credits against state

176 Notwithstanding the credit, sales of these vehicles in the United States were only 1,238 in 1998. Hoerner and Gilbert, supra note 172, at 21.

177 *Analysis of the Climate Change Technology Initiative*, supra note 71, at 32 (concluding on this basis that the CCTI incentive would do little to encourage sales of vehicles that would not otherwise have occurred, producing windfalls for consumers who would have purchased the qualifying vehicles without the incentive).

178 Hoerner and Gilbert, supra note 172, at 29.

179 IRC section 132(f).

income tax for costs incurred by employers.[180] In Canada, Quebec recently announced that it would also exempt employer-provided transit passes from tax and permit employees who do not receive these passes as employment benefits to deduct the cost of public transit in computing their incomes for provincial tax purposes.[181] Other jurisdictions exempt high-occupancy vehicles and public transportation from automotive fuel taxes.[182]

To the extent that current tax rules favour commuting by private vehicle—by failing to include employer-provided parking as an employment benefit,[183] for example—these measures may be considered necessary to prevent an existing tax bias in favour of single-occupancy vehicles. More generally, these incentives can be expected to increase ride sharing and public transit use by reducing the after-tax cost of these methods of transportation relative to alternatives. Moreover, since urban commuting is likely to be relatively price inelastic, at least in the short run, one would expect the use of private vehicles to decrease as commuters shift to ride sharing and public transit. In Washington State, for example, tax credits for ride sharing and public transit have increased the use of these methods of transportation and decreased the number of single-occupancy vehicles on the road, leading the State Energy Office to conclude that the tax incentives are much more cost-effective than is the building of more roads.[184] More important, perhaps, these incentives have the potential to change attitudes and habits, resulting in behavioural responses exceeding those predicted by economic analysis alone.[185] Together with other policies such as increased funding for public transit, these measures can help to reduce GHG emissions from urban commuting as well as road congestion more generally.

With respect to the design of these incentives, it is unclear whether they are best directed at employers, who determine compensation packages and are well placed to establish institutional arrangements for ride-sharing programs, or at employees, who make the ultimate decisions about methods of transportation to and from work.

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180 In Wisconsin, employer-provided vanpooling and transit passes are exempt from tax as employment benefits. Hoerner, supra note 20, at 39. Washington State, on the other hand, provides a 50 percent income tax credit for costs incurred by employers to establish employee ride-sharing programs and a 30 percent credit for employer-provided bus passes. Ibid., at 20. Similarly, in Minnesota, employers may claim a 30 percent credit against state income tax for the cost of providing vanpools and transit passes to their employees. See the Web site of Minnesotans for an Energy-Efficient Economy at http://www.me3.org/projects/greentax/.

181 Government of Quebec, 2003-2004 Budget, Additional Information on the Budgetary Measures, March 11, 2003, 12-14.

182 *Environmentally Related Taxes in OECD Countries*, supra note 17, at 64; and Hoerner, supra note 20, at 39.

183 The failure to include these benefits in computing an employee's income appears to be common to OECD countries. *Environmental Taxes and Green Tax Reform*, supra note 17, at 19.

184 Hoerner, supra note 20, at 20.

185 Ibid.

In either event, a tax incentive in the form of an exempt benefit or deduction, as the government of Quebec proposed in its 2003-4 budget, is open to the criticism that it is a regressive "upside-down subsidy" worth more to high-income employees than to those with lower incomes. Where commuting expenses are viewed as a cost of earning income, however, an exempt benefit or deduction may be defended as a necessary adjustment to the computation of taxable income. In practice, however, these expenses are typically characterized as discretionary personal expenses rather than costs of earning income.[186]

Tax Incentives for Energy-Efficient Buildings and Equipment

Although transportation accounts for a significant percentage of CO_2 emissions in OECD countries, a substantial share of these emissions is attributable to the heating and cooling of air and water and the operation of appliances and other equipment in commercial and residential buildings.[187] For this reason, incentives for energy-efficient buildings and equipment represent another important category of tax incentives to reduce global warming.

Like tax incentives for clean-fuel and fuel-efficient vehicles, these incentives tend to take one of two forms: credits in computing income tax payable, and sales tax exemptions or rebates. In the Netherlands, for example, a 40 percent tax credit for investments in energy-saving measures was introduced in 1997.[188] In Oregon, a business energy tax credit provides a 35 percent credit against state business taxes for investments in approved energy-efficiency investments.[189] Montana and Hawaii offer income tax credits for investments in residential energy conservation, while Connecticut provides an income tax credit up to 60 percent for investments in residential energy conservation in units with a high percentage of low-income households.[190] The Clinton administration's climate change technology initiative

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186 See, for example, the decision of the UK Court of Appeal in *Newsom v. Robertson (HM Inspector of Taxes)* (1952), 33 TC 452 (CA).

187 In the United States, for example, the commercial and residential sectors are estimated to have accounted for 35 percent of CO_2 emissions (28 percent of GHG emissions) in 1999, slightly more than the 31 percent attributable to transportation. *U.S. Climate Action Report—2002*, supra note 80, at 41. In Canada, commercial and residential buildings are estimated to account for a smaller percentage of GHG emissions—closer to 10 percent. *Climate Change Plan for Canada*, supra note 7, at 13.

188 See Vermeend and van der Vaart, supra note 126, at 63-68.

189 See Hoerner, supra note 20, at 22. Eligible investments must produce "substantial" energy savings, defined as 50 percent of the energy used to heat water, 10 percent of the energy used to heat a building, 10 percent of commercial or industrial process load, or 30 percent of a waste heat stream for heat recovery projects. Applicants must certify that projects satisfy these criteria, which are subject to audit by the Oregon Department of Energy.

190 Ibid., at 36.

(CCTI) would have introduced tax credits for purchases of energy-efficient building equipment and energy-efficient new homes,[191] but these have not been approved by Congress.[192] In British Columbia, materials used to improve the energy efficiency of residential and commercial buildings are exempt from provincial sales tax.[193] Similarly, the Ontario government provides a rebate for provincial sales taxes on purchases of energy-efficient clothes washers, refrigerators, and dishwashers purchased after November 25, 2002 and before November 26, 2003.[194] In addition, the United States allows taxpayers to exclude from income the value of any subsidy provided by a public utility for the purchase or installation of an energy conservation measure designed to reduce the consumption of electricity or natural gas or to improve the management of energy demand with respect to a dwelling unit.[195]

In principle, these tax incentives should increase investments in energy-efficient buildings and equipment, thereby reducing energy consumption and CO_2 emissions. Moreover, to the extent that owners of buildings either undervalue or fail to fully capture the economic gains from energy-efficient investments, these incentives may address a market failure that prevents an efficient level of investment. Such is often the case, for example, with rental buildings where neither the landlord nor the tenant obtains the full benefit from energy-efficient investments that one or the other might make.

In practice, however, the effectiveness of many of these incentives is highly uncertain.[196] Incentives for energy-efficient appliances, for example, may not only induce consumers to substitute energy-efficient appliances for less efficient appliances, but may also increase total appliance purchases and encourage owners to use these appliances more intensively (for example, washing clothes more frequently or running air conditioners longer and at lower temperatures), leading to increased

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191 For detailed descriptions and analyses of these proposed tax incentives, see Hoerner and Gilbert, supra note 172, at 32-56; and *Analysis of the Climate Change Technology Initiative*, supra note 71, at 14-22.

192 Some of these proposals appear to have been revived in more recent legislative proposals. See, for example, *Description of S. ___ "Energy Tax Incentives Act of 2002,"* supra note 172, at 13-17 (business tax credit for construction of new energy-efficient homes, and tax credit for energy-efficient appliances).

193 See Social Service Tax Act (BC), RSBC 1996, c. 431, as amended, section 74(a) and Social Service Tax Act Regulations, BC Reg. 84/58, as amended, section 3.20, which exempt thermal insulation material, polystyrene forming blocks used as insulation, storm windows and doors, multiglazed windows, weather stripping and caulking materials, chemicals used to make spray polyurethane foam insulation, and specified window-insulating systems.

194 RSTA section 9.1.

195 IRC section 136(c)(1).

196 In the Netherlands, for example, the Bureau for Economic Policy Analysis concluded that the tax credit for investments in energy-saving measures would generate little in the way of energy savings relative to its cost in terms of forgone revenues. Vermeend and van der Vaart, supra note 126, at 68.

energy consumption and GHG emissions.[197] However, where the elasticity of demand for the particular type of appliance is low and more intensive use of an energy-efficient appliance is unlikely (as might be the case with a refrigerator), these incentives are likely to be more effective.

Incentives for energy-efficient new homes have a limited impact on global warming, owing to the slow turnover of the housing stock, and are probably better directed at those who build new homes than at purchasers who have little involvement in the key decisions affecting the energy efficiency of new homes.[198] As the number of builders is much smaller than the number of purchasers, however, improved energy efficiencies might be achieved more effectively through a combination of regulatory requirements, voluntary agreements, and direct subsidies.[199]

More promising, perhaps, are tax incentives for energy-efficient retrofits, which could affect a much larger percentage of the building stock[200] and encourage innovative solutions by subsidizing certified efficiency improvements (subject to audit) without specifying particular methods or technologies.[201] Such is the case, for example, with Oregon's business energy tax credit, which is reported to have had a significant effect on energy conservation investments in the state.[202] Special incentives might also be directed at improving energy efficiency in rental units and low-income households, where market failures and resource limitations make energy-efficient investments less likely.

Whether these incentives should take the form of tax expenditures, however, is much less certain. While tax incentives may be less costly to administer than direct spending programs, they increase the complexity of the tax system and may be less effective than a direct grant program, the benefit from which does not depend on the time of year when tax returns are filed.[203] In Canada, energy-efficient retrofits are currently supported by two federal spending programs: one for commercial

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197 Bruce Yandle and Stuart Buck, "Bootleggers, Baptists, and the Global Warming Battle" (2002) vol. 26, no. 1 *Harvard Environmental Law Review* 117-229, at 209.

198 Hoerner and Gilbert, supra note 172, at 40.

199 In Canada, for example, a commercial building incentive program provides a direct subsidy of up to $60,000 for buildings that are at least 25 percent more efficient than buildings satisfying the requirements of the Model National Energy Code for Buildings. For a brief description of this program, see the FiscallyGreen Web site at http://www.fiscallygreen.ca/experience.html.

200 Hoerner and Gilbert, supra note 172, at 40.

201 For a brief description of an efficiency tax credit along these lines, see Hoerner and Muller, supra note 130, at 23.

202 See Hoerner, supra note 20, at 22-23 (reporting on an Oregon Department of Energy study that concluded that half of the investment projects supported by the credit either would not have occurred without the credit or would have involved more extensive conservation measures than would have been taken without the credit).

203 I am indebted to Lisa Philipps for this observation.

and industrial buildings,[204] and a recently introduced program for residential buildings.[205] On balance, these direct spending programs are probably preferable to a tax-delivered incentive.

Tax Incentives for Clean and Renewable Energy

A final category of tax incentives aimed at reducing CO_2 emissions involves incentives to encourage the generation of energy from clean and renewable sources. In countries with taxes on energy or electricity, for example, exemptions or rebates are generally available for energy from clean and renewable sources.[206] Likewise, the use of clean-burning and renewable automotive fuels is encouraged by reductions or exemptions from otherwise applicable taxes.[207] In the United States, the use of alternative energy sources for motor vehicles is also encouraged by a tax credit for the sale or use of alcohol as a fuel[208] and a current deduction for otherwise depreciable property used to refuel clean-fuel vehicles and recharge electric vehicles.[209]

In addition to these incentives, several countries also provide tax incentives for direct investments in equipment used to generate heat or power from clean and renewable sources. In the Netherlands, for example, investments in renewable energy are encouraged through tax-exempt green investment funds and accelerated depreciation for various kinds of environmental investments, including investments in renewable energy equipment.[210] In the United States, a federal income tax credit for purchases of solar and geothermal energy equipment was introduced in 1978.[211] Although the credit for residential uses expired in 1985, a credit for commercial uses

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204 Under the energy innovators initiative, the federal government contributes up to 25 percent of the eligible costs of pilot projects to a maximum of $250,000, provided that the recipient replicates the energy-efficient measures in at least 25 percent of its remaining facilities. For a brief description of this program, see the FiscallyGreen Web site at http://www.fiscallygreen.ca/experience.html.

205 Under the energuide for houses program, which came into effect in October 2003, homeowners may obtain up to $3,348 for retrofits to a principal residence that achieve stipulated improvements in energy efficiency. For details, see the Office of Energy Efficiency Web site at http://oee.nrcan.gc.ca/.

206 *Environmentally Related Taxes in OECD Countries*, supra note 17, at 64.

207 See the discussion supra at notes 94 to 98 and accompanying text.

208 IRC section 40.

209 IRC section 179A.

210 See Vermeend and van der Vaart, supra note 126, at 60-63 (green investment funds) and 52-59 (accelerated depreciation). To qualify as a green investment fund, the fund must devote at least 70 percent of its assets to investments in qualifying green projects defined by legislation. Until 1998, these projects had to be in the Netherlands. Since then, however, qualifying projects may also be situated in Eastern Europe or developing countries.

211 See the description of this credit in Hoerner and Gilbert, supra note 172, at 72. As originally enacted, the tax incentive provided a credit of 30 percent of the first $2,000 investment in qualifying property and a credit of 20 percent on the next $8,000 spent. In 1980, the credit was increased to 40 percent on the first $10,000 spent.

remains,[212] and several legislative proposals would both restore a credit for residential purposes and make the credit available for investments in wind energy equipment as well as solar and geothermal energy equipment.[213] Another US tax incentive encourages the generation of electricity by wind or closed-loop biomass through a credit of 1.5 cents per kilowatt hour of electricity generated from these sources.[214] Other US legislative proposals include a tax credit for investments in combined heat and power (CHP) systems,[215] and tax credits both for investments in clean coal technology facilities and for the generation of electricity from these facilities.[216] As well, several US states provide tax incentives for solar power and electricity produced by wind or biomass, typically in the form of investment tax credits against state personal or corporate income taxes, but also in the form of sales tax exemptions and reduced property taxes.[217]

In Canada, tax incentives for clean and renewable energy take the form of accelerated depreciation for qualifying investments, sales tax exemptions or rebates, and income and property tax holidays.[218] Since the 1970s, for example, the federal

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212 IRC section 48. Although 15 percent in 1986 and 12 percent from 1987 to 1991, this credit was reduced to 10 percent in 1992, where it has remained. See Hoerner and Gilbert, supra note 172, at 72-73.

213 The Clinton administration's CCTI, for example, would have introduced a credit for purchases of rooftop photovoltaic systems and solar water-heating systems located on or adjacent to a building for uses other than heating swimming pools, equal to 15 percent of qualifying investments up to $1,000 for solar water-heating systems and $2,000 for rooftop photovoltaic systems. For detailed descriptions and evaluations of this proposal, see Hoerner and Gilbert, supra note 172, at 72-86; and *Analysis of the Climate Change Technology Initiative*, supra note 71, at 22-24. A more recent legislative proposal would provide a 15 percent credit for purchases of rooftop photovoltaic systems and solar water-heating systems and a 30 percent credit for purchases of wind energy equipment and qualified fuel cell power plants. See *Description of S. ___ "Energy Tax Incentives Act of 2002,"* supra note 172, at 17-19.

214 IRC section 45. This credit is indexed for inflation and was 1.7 cents per kilowatt hour in 2001. For the purpose of this credit, "closed-loop" biomass is defined as "any organic material from a plant which is planted exclusively for purposes of being used at a qualifying facility to produce electricity." For detailed discussions and evaluations of this credit, and of legislative proposals to extend it to electricity produced by non-closed-loop biomass and the use of biomass in coal-fired plants, see Hoerner and Gilbert, supra note 172, at 86-102; and *Analysis of the Climate Change Technology Initiative*, supra note 71, at 36-37, 38-46, and 54-55.

215 The Clinton administration's CCTI, for example, proposed an investment tax credit of 8 percent for purchases of qualifying combined heat and power (CHP) systems between 2000 and 2002. For a detailed description and evaluation of this proposal, see Hoerner and Gilbert, supra note 172, at 57-71. A more recent legislative proposal would provide a 10 percent credit for investments in CHP systems. See *Description of S. ___ "Energy Tax Incentives Act of 2002,"* supra note 172, at 23-24.

216 *Description of S. ___ "Energy Tax Incentives Act of 2002,"* supra note 172, at 25-29.

217 Hoerner, supra note 20, at 35.

218 In addition to these tax incentives, the Canadian government provides direct subsidies for clean and renewable energy through a production incentive of 1.2 cents per kilowatt hour (declining to 0.8 cents per kilowatt hour) for wind energy, and through the Canadian renewable energy

government has allowed investments in qualifying solar heating equipment, small-scale hydroelectric generating equipment, and equipment to generate electricity from wind or biomass to be depreciated at accelerated rates for the purpose of computing business income.[219] More recent amendments also allow accelerated depreciation for investments in geothermal energy equipment, fuel cell generating equipment, and equipment used to convert biomass into bio-oil,[220] and permit the current deduction of expenses (such as the clearing of land) that are incurred in the development of clean and renewable energy projects.[221] In addition to these income tax incentives, British Columbia provides a sales tax exemption for purchases of wind, solar, and small-scale hydroelectric generating equipment,[222] while Ontario offers sales tax rebates for purchases of solar energy systems and building materials that are incorporated into clean, alternative, or renewable electricity generation facilities.[223] Moreover, in December 2002, the Ontario government introduced a 10-year corporate income tax holiday for income from the generation of electricity from clean, alternative, or renewable sources,[224] and a 10-year property tax holiday for assets used to generate electricity from these sources.[225]

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deployment initiative (REDI), which offers businesses and institutions a financial incentive of 25 percent of the purchase and installation costs of qualified renewable energy systems for space and water heating and cooling, up to a maximum of $80,000. For brief descriptions of these programs, see the FiscallyGreen Web site at http://www.fiscallygreen.ca/experience.html.

219 See the descriptions of class 34 and class 43.1 properties in schedule II of the Income Tax Regulations, CRC 1978, c. 945, as amended, which provide for rates of 50 percent and 30 percent, respectively, as opposed to the otherwise applicable class 1, 2, or 8 rates of 4 percent, 6 percent, or 20 percent.

220 See the description of class 43.1 property in schedule II of the Income Tax Regulations.

221 See the definition of "Canadian renewable and conservation expense" (CRCE) in regulation 1219 of the Income Tax Regulations, which is included in calculating the taxpayer's "Canadian exploration expense" (CEE) in paragraph 66.1(6)(g.1) of the federal Income Tax Act, RSC 1985, c. 1 (5th Supp.), as amended (herein referred to as "ITA"). CEE is fully deductible in computing income under ITA subsection 66(1) or (3). Unclaimed CRCE can be carried forward indefinitely for deduction in future taxation years. Alternatively, where a corporation incurring these expenses enters into a flowthrough share agreement with shareholders, CRCE may be renounced in favour of the shareholders who may claim the deductions.

222 Social Service Tax Act (BC), supra note 193, section 74(a) and Social Service Tax Act Regulations, ibid., section 3.20 (exempting wind-powered generating equipment specifically designed to produce mechanical or electrical energy, solar photovoltaic collector panels, solar thermal collector panels, and micro-hydroelectric turbines).

223 RSTA sections 48(3)(r) and (q). In the March 27, 2003 Ontario budget, the government announced its intention to expand this sales tax rebate to include wind energy systems, micro-hydroelectric systems, and geothermal heating and cooling systems for residential purposes.

224 Corporations Tax Act (Ontario), RSO 1990, c. C.40, as amended, section 13.6.

225 Assessment Act (Ontario), RSO 1990, c. A.31, as amended, section 3.1. As property taxes fall within the jurisdiction of municipal governments, the government indicated that it would compensate municipalities for lost property tax revenues.

While reductions or exemptions from energy or automotive fuel taxes aim to create indirect incentives for investments in clean and renewable sources of energy by increasing the demand for alternatives to fossil fuels, tax credits, accelerated depreciation, and sales and property tax exemptions or rebates for clean and renewable energy equipment are intended to create direct incentives for these investments by lowering the after-tax cost of the property used to generate this energy. Production tax credits, tax-exempt investment funds, and income tax holidays are meant to encourage investments in clean and renewable energy by lowering the pre-tax rate of return necessary to invest in these projects, thereby increasing the supply of investment capital.

Evidence on the effectiveness of these incentives is limited and mixed. In the United States, tax credits for solar energy equipment helped to create a significant increase in the market for these systems in the late 1970s and early 1980s, though many turned out to be "poorly designed, poorly built and poorly installed," resulting in high failure rates and a negative reputation.[226] With the expiration of credits for residential use in 1985 and decreases in fuel prices in the latter half of the 1980s, the US market for these systems collapsed and has yet to recover.[227] Although the cost of solar photovoltaic systems has come down in the 1990s,[228] they remain significantly more costly than other forms of energy, making it unlikely that existing and proposed tax credits will have much impact on overall demand.[229] In contrast, solar water-heating systems can be economically competitive with conventional alternatives over the life of the system, making tax incentives a useful way to offset the high initial cost of these systems and encourage lower costs through economies of scale.[230] Likewise, incentives for wind generation appear to have been relatively successful, encouraging substantial investments in wind turbines,[231] which have caused prices to fall as output has expanded.[232] Incentives for biomass energy and CHP

226 Hoerner and Gilbert, supra note 172, at 73.

227 *Analysis of the Climate Change Technology Initiative*, supra note 71, at 23.

228 Hoerner and Gilbert, supra note 172, at 76.

229 Ibid., at 85. See also *Analysis of the Climate Change Technology Initiative*, supra note 71, at 24 (concluding that the proposed CCTI incentive would make solar technologies economically attractive only in "[n]iche markets with local incentives in place and electricity rates much higher than the national average").

230 Hoerner and Gilbert, supra note 172, at 74.

231 In the Netherlands, for example, over 350 wind turbines were supported by green investment funds between 1995 and 1998. Vermeend and van der Vaart, supra note 126, at 62-63. In the United States, the production tax credit for wind energy is credited with the establishment of new wind-generating facilities in Texas, Minnesota, Wyoming, and Colorado. Hoerner and Gilbert, supra note 172, at 89.

232 See, for example, Frank Muller, "Tax Credits and the Development of Renewable Energy in California," in Robert Gale and Stephen Barg, eds., *Green Budget Reform: An International Casebook of Leading Practices* (London: Earthscan Publications, 1995), chapter 2. See also Hoerner and Gilbert, supra note 172, at 88-90 (concluding that the combination of these price

systems, on the other hand, seem less promising, as the former is significantly more costly than conventional sources,[233] while the primary impediment to the latter appears to involve regulatory barriers to third-party generation and sale of power.[234] At the same time, it is important to recognize that incentives for clean and renewable energy are likely to be most effective when combined with environmental taxes and other environmental measures that also encourage these alternatives.[235]

With respect to the form of these tax incentives, the optimal approach presumably depends on the kinds of activities intended to be encouraged. For residential purchasers of solar energy and heating equipment, sales and value-added tax exemptions are likely to be more effective and more equitable than income tax credits or deductions that do not reduce the immediate out-of-pocket cost of the equipment and (except for refundable tax credits) depend on the purchaser's level of income. For business investments in clean and renewable energy generation, tax credits and accelerated depreciation are likely to be more effective, although equity and administrative simplicity suggest that these incentives be delivered in the form of refundable tax credits. Refundable credits do not vary with the investor's level of income and do not encourage elaborate ownership structures and transactions in order to ensure that non-refundable credits and deductions can be claimed in the taxation years in which they are available.[236] Similarly, financing incentives may be a useful way to encourage capital investments in clean and renewable energy, but are inequitable when delivered in the form of tax-exempt investments and income tax holidays, which are worth more to high-income taxpayers than to taxpayers with little or no income.[237] Somewhat more equitable is a recent Canadian proposal for tax-assisted environmental organization capital investment funds, which would be required to invest in qualifying environmental investments, although this proposal contemplates a non-refundable credit rather than a refundable credit.[238]

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decreases and the US production tax credit could make wind energy competitive with energy from fossil fuels by 2005).

233 Hoerner and Gilbert, supra note 172, at 91 (adding that investments in biomass plants involve a greater commitment of capital, and therefore greater risk, than investments in solar or wind facilities, and that the expansion of biomass energy requires a reliable and economically viable source of biomass, which is unlikely to develop without established markets for this biomass). Where biomass is used in coal-fired plants, on the other hand, cost considerations suggest that tax incentives may be more effective. See ibid., at 93; and *Analysis of the Climate Change Technology Initiative*, supra note 71, at 44.

234 Hoerner and Gilbert, supra note 172, at 68-70.

235 See, for example, *Analysis of the Climate Change Technology Initiative*, supra note 71, at 45 (noting that new wind plants appear to have been encouraged by the combination of federal tax incentives, state mandates, and other incentive programs).

236 See *Economic Instruments for Environmental Protection*, supra note 17, at 60-63.

237 Ibid., at 64-65.

238 See "Proposal for the Creation of Environmental Organization Capital Investment Funds—Introduction," on the AlkalizeForHealth Web site at http://www.alkalizeforhealth.net/eocif/introduction.htm.

Tax Incentives To Reduce Non-CO_2 GHG Emissions

In addition to incentives to reduce CO_2 emissions, tax incentives can also be used to encourage reductions in non-CO_2 GHG emissions. In the United States, for example, the use of landfill CH_4 to generate electricity is encouraged by a production tax credit of 1.0 cent per kilowatt hour.[239] In Canada, equipment used to collect landfill gas became eligible for accelerated depreciation in 1994.[240] The Clinton administration's CCTI proposed to introduce a 10 percent tax credit for the installation of new power circuit-breaker equipment to replace power circuit breakers that are prone to leak SF_6, and a 10 percent tax credit for the installation of HFC and PFC recovery/recycling equipment in semiconductor manufacturing plants, though neither was enacted.[241] Other tax incentives might be imagined to encourage the capture of CH_4 for storage or energy generation from oil and natural gas production and coal mining, reduced CH_4 emissions from natural gas pipelines, reduced CH_4 and N_2O emissions from manure management, reduced PFC emissions from the production of aluminum, and reduced SF_6 emissions from the production of magnesium.

Although some of these tax incentives might encourage reductions in non-CO_2 GHG emissions, many of these emissions are either difficult to monitor or effectively addressed through regulatory approaches or voluntary agreements.[242] In the United States, for example, increases in electricity generation from landfill gas are attributable primarily to state regulatory mandates, such that the majority of the tax benefits from the federal production tax incentives are expected to flow to landfills that would have installed energy-generating systems even without the credit.[243] For this reason, the rationale for tax incentives in this context may be less to encourage environmentally sensitive behaviour than to share the cost of new emission reduction measures established by regulation or voluntary agreement. Given the limited number of stationary sites for these emissions, however, direct subsidies may be a more transparent and effective method of cost sharing in these settings than tax incentives.

Tax Incentives To Preserve and Enhance Carbon Sinks

A final strategy to reduce global warming involves the preservation and enhancement of carbon sinks, the most important of which are forests and agricultural

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239 For detailed descriptions and analysis of this incentive, and the CCTI proposal to extend it to landfill gas-to-energy projects placed in service between January 1, 2001 and December 31, 2005, see *Analysis of the Climate Change Technology Initiative*, supra note 71, at 37-38 and 46-47.

240 See the description of class 43.1 property in schedule II of the Income Tax Regulations.

241 For brief descriptions of these proposed credits, see Edwards et al., supra note 41, at 474-75. In order to qualify for the first credit, the proposal stipulated that the replaced circuit-breaker equipment would have to be destroyed to prevent further use. In order to qualify for the second credit, the proposal required the equipment to recover 99 percent of HFCs and PFCs.

242 See the discussion supra at notes 153 to 158 and accompanying text.

243 *Analysis of the Climate Change Technology Initiative*, supra note 71, at 46-47.

soils.[244] Together with tax incentives to reduce GHG emissions, many jurisdictions provide tax incentives to maintain or expand forests and agricultural soils. In the United States, for example, several states encourage the preservation of forest and agricultural property through property tax assessments based on current use rather than market value.[245] In Maine and the Canadian provinces of British Columbia, Ontario, and Quebec, property tax reductions are available only for woodlots that are managed in accordance with environmental criteria.[246] The Canadian government also encourages the preservation of forests and agricultural land through special rules permitting tax-deferred transfers of farm property and commercial woodlots operated in accordance with a prescribed forest management plan.[247] In addition to these rules, the preservation of ecologically sensitive land is encouraged by a special tax incentive for charitable donations of this property.[248] Reforestation is also encouraged in the United States through tax credits[249] and in Ontario through the exemption of tree seedlings from provincial sales tax.[250] Other proposals include income tax incentives for environmentally sensitive forest-harvesting equipment and practices,[251] reduced sales taxes on forest products certified to have come from a forest subject to a certified environmentally sensitive forest management

244 See supra notes 3 and 84 and accompanying text.

245 Hoerner, supra note 20, at 39.

246 See, for example, ibid., at 23 (Maine); and Nathalie Chalifour, "Ecological Fiscal Reform and the WTO—An Analysis of the Limitations of the Canadian Government To Implement EFR Relating to Forests," paper presented at the Third Annual Global Conference on Environmental Taxation: Issues, Experience and Potential, Woodstock, Vermont, April 12-13, 2002, 17-18 (British Columbia, Ontario, and Quebec).

247 ITA subsections 70(9) (testamentary transfer) and 73(3) (inter vivos transfer). As a general rule, capital property transferred at death or by inter vivos gift is subject to a deemed disposition at fair market value. ITA subsections 69(1) (inter vivos gift) and 70(5) (transfer at death).

248 See ITA paragraph 38(a.2), which reduces the taxable capital gain on gifts of ecologically sensitive land from the generally applicable inclusion rate of one-half to one-quarter. Although accrued capital gains on gifts of this property are partly taxable, the charitable contributions deduction (for corporations) or credit (for individuals) that may be claimed on the gift is based on the fair market value of the property.

249 IRC sections 194 and 48(b). For a brief discussion of this tax incentive, see Roberta Mann, "Waiting To Exhale? Global Warming and Tax Policy" (2002) vol. 51, no. 6 *American University Law Review* 1135-1222, at 1193-94. In addition to this federal credit, the state of North Carolina also provides an income tax credit for reforestation. See Hoerner, supra note 20, at 40.

250 See RSTA section 7(1)13 and Revised Regulations of Ontario 1990, regulations 1012 and 1013, as amended.

251 See, for example, Chalifour, supra note 246, at 13-16 (proposing accelerated depreciation for environmentally sensitive forest-harvesting equipment, a tax credit for research and development carried out in order to modify forest management practices in order to satisfy environmental certification standards, and a tax credit for the cost of hiring new staff to use environmentally sensitive forestry equipment).

plan,[252] and a carbon sequestration tax credit based on the annual quantity of carbon sequestered by new projects.[253]

Evidence on the effectiveness of these tax incentives in reducing global warming is extremely limited. According to one study, however, incentives to encourage the preservation of forest and agricultural properties are unlikely to have much impact absent other measures such as zoning regulations.[254] Nor are these incentives likely to enhance the capacity of these carbon sinks unless they are contingent on owners' employing environmentally sound forest and soil management practices.[255] Provided that the satisfaction of environmental standards is a condition of the incentive, however, some of these measures may be useful ways to encourage and share the cost of carbon sequestration. Particularly promising are proposals for a carbon sequestration tax credit, which could encourage innovative strategies for the preservation and enhancement of carbon sinks. As with incentives for energy-efficient retrofits to commercial and residential buildings, however, direct grants are likely to be less complex, more effective, and better monitored than tax incentives.

TAX POLICY AND CANADA'S CLIMATE CHANGE ACTION PLAN

As explained in the introduction to this article, Canada's climate change action plan (CCAP) proposes actions in several areas in order to achieve targeted reductions of 240 MT of CO_2 equivalent emissions by the end of this decade. Building on the survey of tax measures to reduce global warming presented in the third part of this article, the following sections review each of the areas for which action is proposed under the CCAP, summarizing the actions that are proposed and discussing the potential role that environmental taxes and tax incentives can play in each area.

Transportation

Beginning with the transportation sector, which accounts for approximately 25 percent of Canada's GHG emissions,[256] the CCAP proposes to reduce emissions by 21 MT through (1) increased use of ethanol-blended gasoline and biodiesel fuel; (2) negotiated improvements in new vehicle fuel efficiency and public information programs to promote fuel-efficient vehicles; (3) research and development of fuel cell vehicles and other fuel cell and hydrogen technologies; (4) public information programs and voluntary agreements with manufacturers to reduce emissions from and improve the fuel efficiency of off-road diesel-fuelled commercial equipment such as construction and logging equipment, and gasoline-powered consumer products such

252 Ibid., at 18-19.

253 See, for example, Mann, supra note 249, at 1214-15.

254 Hoerner, supra note 20, at 40.

255 Ibid., at 23.

256 *Climate Change Action Plan*, supra note 7, at 20.

as outboard motors and snowmobiles; (5) investments in public transportation; and (6) public-private collaboration to improve efficiencies in goods transportation.[257]

With respect to automotive fuels, the CCAP itself mentions the role that tax exemptions can play to encourage the use of clean and renewable fuels.[258] In addition, US experience suggests that increased use of clean-burning fuels can also be encouraged by tax incentives directed at the production and distribution of these fuels.[259] As well, higher automotive fuel taxes are apt to encourage increased use of clean and renewable fuels as the price differential between taxed and untaxed fuels increases. In practice, however, Canada's ability to increase automotive fuel taxes is significantly constrained by combined federal and state taxes in key border states in the United States, which are currently about 40 percent less than Canadian rates.[260] As a practical policy to help achieve Canada's commitments under the Kyoto protocol, therefore, increases in Canadian automotive fuel taxes depend on corresponding action in the United States.

Regarding vehicle efficiency and alternative-fuel vehicles, the CCAP proposes negotiated agreements with manufacturers, public information programs, and federal funding for research and development.[261] In addition to these measures, excise taxes and/or annual registration fees on fuel-inefficient vehicles, tax incentives for fuel-efficient and clean-fuel vehicles, and financial incentives to retire older fuel-inefficient vehicles represent potentially effective market-based instruments to improve the fuel efficiency of the motor vehicle stock in Canada.[262] Tax incentives can also help to improve efficiencies in goods transportation, at least where this requires investments in new equipment such as anti-idling systems for rail and truck services, on-board tire inflation technologies, and aerodynamic drag reducers.[263]

In practice, annual registration fees that are differentiated according to the fuel efficiency of different vehicles appear to have had a greater impact on the fuel efficiency of newly acquired vehicles than up-front excise taxes, although this result likely depends on the design of existing taxes in Ontario and the United States, and on the combined effect of differentiated registration fees in European countries and considerably higher taxes on automotive fuels.[264] With respect to incentives to

257 Ibid., at 20-24.

258 Ibid., at 23 (mentioning the Ontario fuel tax exemption for biodiesel).

259 See the discussion of the US tax credit for the sale of use of alcohol as a fuel and the current deduction for otherwise depreciable property used to refuel clean-fuel vehicles, supra at notes 208 to 209 and accompanying text.

260 See supra notes 88 to 91 and accompanying text.

261 *Climate Change Action Plan*, supra note 7, at 21-22.

262 See the discussion of taxes, registration fees, and tax incentives supra at notes 107 to 122 and 170 to 178 and accompanying text.

263 See *Climate Change Action Plan*, supra note 7, at 24.

264 See the discussion of registration fees and excise taxes supra at notes 117 to 122 and accompanying text.

purchase fuel-efficient and clean-fuel vehicles, sales and value-added tax exemptions are likely more effective than income tax incentives and are probably best targeted at commercially viable vehicles with a cost that is currently somewhat higher than that of less fuel-efficient vehicles.[265] Financial incentives to retire older fuel-inefficient vehicles, on the other hand, are probably best delivered in the form of direct grants rather than tax expenditures, the benefit from which depends on the filing of a tax return.

In addition to these measures, environmental taxes and tax incentives may also contribute to the CCAP's other proposals for the transportation sector. Where purchases of gasoline and diesel fuel for off-road uses are not subject to sales and excise taxes,[266] taxation of these fuels would contribute to increased fuel efficiency and reduced emissions. As well, tax incentives to use public transportation can complement federal funding for basic infrastructure.[267] Moreover, to the extent that employer-provided parking is not effectively taxed as an employment benefit, tax incentives such as those for employer-provided vanpooling and transit passes can help to correct an existing tax distortion in favour of commuting by private vehicle.

Housing and Commercial/Institutional Buildings

For residential and commercial/institutional buildings, which generated direct emissions of approximately 77 MT in 2000 and a further 57 MT from the consumption of electricity generated from coal, oil, or natural gas,[268] the CCAP proposes to reduce GHG emissions by 8 MT through (1) energy-efficient retrofits for 20 percent of Canada's residential and commercial/institutional building stock by 2010; (2) increased energy efficiency for all new housing and commercial/institutional buildings built by 2010; and (3) improved standards for equipment and appliances.[269] Although consultation with the building industry and building owners is mentioned as one way to achieve this target,[270] other measures include existing financial incentives for commercial and institutional buildings,[271] unspecified "actions to promote wider penetration of energy efficient construction practices and products in the building community and their adoption on the market,"[272] and the possibility of financial incentives for residential retrofits.[273]

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265 See the discussion supra at notes 176 to 178 and accompanying text.

266 In Ontario, for example, gasoline that is used by persons engaged in the business of farming or fishing may be exempt from gasoline tax and retail sales tax. See, for example, RSTA section 7(1)4.

267 See the discussion of these incentives supra at notes 179 to 186 and accompanying text.

268 *Climate Change Action Plan*, supra note 7, at 25.

269 Ibid., at 25-27.

270 Ibid., at 26-27.

271 Ibid. See the brief discussions of the commercial building incentive program and the energy innovators initiative supra at notes 199 and 204.

272 *Climate Change Action Plan*, supra note 7, at 26.

273 Ibid.

On balance, direct spending programs for energy-efficient retrofits are likely to be more effective and less complicated than tax incentives for this purpose. Tax incentives are not an optimal way to encourage energy efficiency in new buildings, since measures for this purpose are probably best directed at builders rather than purchasers; for purchasers, regulatory requirements, voluntary agreements, and direct subsidies are likely to be more effective and less complicated than tax expenditures.[274] Nor are tax incentives for energy-efficient appliances likely to have a significant impact on reductions in GHG emissions, since these are apt to increase the demand for these appliances, as well as the intensity of their use.[275] On the other hand, commercially viable technologies for clean-energy generation such as solar and geothermal heating and cooling might be encouraged by tax incentives in the form of exemptions from federal and provincial sales and value-added taxes.

In addition to these measures, further encouragement for energy-efficient buildings could be created by the adoption of a broad-based energy or carbon tax such as those introduced in many European countries, which would create a continuing incentive to improve energy efficiency beyond standards embodied in regulations or grant programs.[276] Although the prospect of these taxes can generate concerns about effects on competitiveness and the distributional impact on low-income households,[277] the impact on aggregate living expenses and total business costs is likely to be small and can be offset by the recycling of revenues to industries and income groups that are adversely affected through tax reductions, subsidies for energy-efficient retrofits, and support to low-income households in the form of social assistance and/or refundable tax credits.[278]

Large Industrial Emitters (Including Renewable Energy and Cleaner Fossil Fuels)

Large industrial emitters, comprising the electricity sector, the oil and gas industry, mining, and manufacturing, are expected to account for approximately half of Canada's GHG emissions by 2010.[279] In order to reduce these emissions by 96 MT, the CCAP contemplates (1) "targets for emissions reductions established through covenants with a regulatory or financial backstop"; (2) an emissions trading regime, with access to domestic offsets and international permits to provide flexibility; and

274 See the discussion supra at notes 198 to 199 and accompanying text.

275 See the discussion supra at notes 196 to 197 and accompanying text.

276 See the discussion supra at notes 125 to 150 and accompanying text.

277 See the discussion of these issues in *Environmentally Related Taxes in OECD Countries*, supra note 17, at 71 to 85 (competitiveness) and 87 to 89 (distributional impact).

278 At the federal level, for example, the GST credit could be decreased to offset the increased burden of a tax on energy consumption or fossil fuels.

279 *Climate Change Action Plan*, supra note 7, at 28.

(3) "complementary measures," including financial incentives and cost-shared investments in clean and renewable energy.[280] According to the CCAP, a "large proportion" of emissions permits "would be provided free to companies, based on their level of production and an emissions intensity factor."[281] The "complementary measures" identified by the plan include an existing incentive for wind power production,[282] consumer information to encourage the consumption of "green power,"[283] cooperation with provincial governments to reduce barriers to interprovincial trade and transmission of electricity,[284] and cost-shared investments in clean coal technology and other technologies to capture and store CO_2 emissions before they are released into the atmosphere.[285]

Although the CCAP does not identify the kind of "financial backstop" that might support voluntary agreements by large industrial emitters to reduce GHG emissions, a broad-based energy or carbon tax could serve this function well.[286] Indeed, the United Kingdom and Denmark combine voluntary agreements with energy and carbon taxes by reducing taxes on energy-intensive firms that have entered into negotiated agreements to reduce energy consumption or GHG emissions.[287] Moreover, to the extent that emissions permits are distributed free of charge, a broad-based energy or carbon tax could, like the US tax on ozone-depleting substances, reduce the windfall gains of those receiving these permits.[288] Alternatively, a carbon tax applied only to emissions that exceed levels that are authorized by permit could function as an effective ceiling on the domestic price of tradable permits, since firms could be expected to pay the tax where the cost of permits exceeds the tax and purchase permits whenever the cost of permits is less than the tax.[289] While competitiveness concerns could be significant for some large emitters, these concerns could be addressed in part by border tax adjustments,[290] and also by

280 Ibid., at 30.

281 Ibid. Although the document does not specify the manner in which an emissions intensity factor would be defined, it presents as possible options "actual performance in a defined period or a technical and economic assessment of emissions reductions possibilities for the sector." Ibid.

282 Ibid., at 34. For a brief discussion of this incentive, see supra note 218.

283 *Climate Change Action Plan*, supra note 7, at 34.

284 Ibid., at 35.

285 Ibid., at 35-36.

286 See the discussion supra at note 54 and accompanying text.

287 *Environmentally Related Taxes in OECD Countries*, supra note 17, at 41.

288 See the discussion supra at note 45 and accompanying text.

289 See the discussion supra at note 46 and accompanying text.

290 For an excellent discussion of the use of border tax adjustments in environmental taxation, see Hoerner and Muller, supra note 130. See also J. Andrew Hoerner, "The Role of Border Tax Adjustments in Environmental Taxation: Theory and U.S. Experience," paper presented at the International Workshop on Market Based Instruments and International Trade of the Institute for Environmental Studies, Amsterdam, March 19, 1998.

revenue recycling in the form of reductions to other taxes and tax incentives or other subsidies for efficiency improvements and clean and renewable energy.[291] Concerns about the regional distribution of such a tax could also be addressed by revenue recycling.

In addition to a broad-based tax on energy consumption or the carbon content of fossil fuels, tax incentives for energy efficiency and clean and renewable energy could also contribute to the CCAP's targeted emission reductions for large industrial emitters. In the oil and gas, mining, and manufacturing sectors, for example, refundable tax credits for demonstrated improvements in energy efficiency could help to encourage and offset the cost of targeted emission reductions. In the electricity sector, generation from clean and renewable sources is currently encouraged by accelerated depreciation, sales tax exemptions and rebates, and income and property tax holidays;[292] however, a more equitable and efficient approach may be the use of refundable tax credits to reduce the cost of investments in qualifying equipment and production tax credits to reduce the cost of the resulting "green power" relative to electricity generated by fossil fuels.

Small and Medium-Sized Enterprises and Fugitive Emissions

Small and medium-sized enterprises (SMEs) engaged in general manufacturing (such as textiles, wood products, food and beverage, and electronics) account for 2 to 3 percent of Canada's GHG emissions,[293] while fugitive emissions from the exploration for and production of oil and natural gas, coal mining, and the distribution of natural gas are responsible for 7 percent of these emissions.[294] Although these emissions will not be subject to the emissions trading system contemplated for large industrial emitters,[295] the CCAP anticipates approximately 3 MT of reductions by SMEs and 4 MT of reductions in fugitive emissions.[296] Emission reductions by SMEs are to be achieved by voluntary energy-efficiency targets, cost-shared audits, and sectoral bench-marking and best practices under the Canadian industry program for energy conservation, as well as technical and financial assistance under the industrial research assistance program,[297] the aims of which are to encourage "thousands of discrete investments in new capital, . . . switching fuel, and programs of continuous

291 See, for example, *Final Report—Environment and Taxation*, supra note 17, at 35-36.

292 See supra notes 218 to 225 and accompanying text.

293 *Climate Change Action Plan*, supra note 7, at 37 (reporting that SMEs account for about 5 percent of industrial emissions, which are approximately 50 percent of all GHG emissions).

294 Ibid., at 38.

295 According to the CCAP, emissions trading is inappropriate for SMEs "given the diverse nature and small size of firms" and impracticable for fugitive emissions "because of difficulties with precise measurement." Ibid., at 37.

296 Ibid., at 37-38.

297 Ibid., at 38.

improvement in their operations."[298] Reductions in fugitive emissions are to be achieved through "information, demonstrations, regulations and guidelines."[299]

In addition to these measures, environmental taxes and tax incentives could help to reduce GHG emissions. A broad-based energy or carbon tax, for example, would create an additional financial incentive for SMEs to conserve energy, the revenues from which could be recycled in the form of lower income or payroll taxes and tax incentives or other subsidies for energy-efficiency improvements. A carbon tax would create incentives both to conserve energy and to switch from fossil fuels to clean and renewable sources of energy. Fugitive emissions, on the other hand, are probably more amenable to regulatory and voluntary approaches than are environmental taxation and tax incentives,[300] although tax incentives or direct subsidies might be used to share the cost of emission reductions and/or to encourage the use of these emissions to generate power.

Agriculture, Forestry, and Landfills

The final sources of GHG emissions in Canada are agriculture, which is responsible for roughly 60 MT of emissions (CH_4 and N_2O), and landfills, which emit approximately 24 MT of emissions (primarily CH_4).[301] Forests and agricultural soils, on the other hand, are projected to provide a carbon sink of 30 MT under current management practices.[302] From actions already underway, the CCAP anticipates additional carbon sequestration of 5.8 MT, and GHG reductions of 2.2 MT from the capture and flaring or use of CH_4 from landfills.[303] Further actions are expected to increase the volume of forest and agricultural sinks and reduce CH_4 emissions from landfills by an additional 8 MT.[304] Existing and proposed measures to achieve these results include (1) information programs to "encourage more planting of trees around farms to absorb carbon dioxide and reduce wind erosion of soil," to "promote climate-friendly practices that improve soil nutrients, soil and livestock management," and to "promote sustainable land use and expand the area covered by perennial forage and trees"; (2) public investments in science and technology to develop lower-emission technologies and strategies for enhancing carbon sinks; (3) a framework whereby carbon sinks can be sold as offsets within a domestic emissions trading system; and (4) public funding for municipal projects to capture and flare or use CH_4 emissions from landfills.[305]

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298 Ibid., at 37.

299 Ibid., at 38.

300 See the discussion supra at notes 153 to 158 and 242 to 243 and accompanying text.

301 *Climate Change Action Plan*, supra note 7, at 39.

302 Ibid.

303 Ibid.

304 Ibid., at 40-41.

305 Ibid., at 39-41.

While informational programs, voluntary agreements, and regulatory measures are probably the most effective way to reduce GHG emissions from agriculture and landfills, environmental taxes and tax incentives may also help to reduce these emissions. Taxes on synthetic fertilizers, for example, may help to reduce emissions of N_2O from the production and use of these fertilizers.[306] Taxes on packaging and solid wastes are likely to reduce CH_4-generating solid wastes, particularly where they distinguish between active and inactive wastes that do not produce CH_4.[307] At the same time, the capture and use of CH_4 might be encouraged by reduced waste tax rates for landfills with energy recovery systems[308] and tax incentives like the US production tax credit for electricity generated by landfill CH_4.[309] In practice, however, the latter incentive is probably less effective than regulatory measures.

The preservation and enhancement of carbon sinks might also be encouraged by the use of environmental tax incentives, such as property tax reductions for forest and agricultural properties that are managed in accordance with environmental criteria, although these incentives are also likely to be less effective than regulatory requirements. In addition to these and other tax incentives to preserve forest and agricultural properties, such as those for transfers and gifts of these properties under the federal ITA,[310] tax incentives can also be used to encourage reforestation.[311] Perhaps most interesting are US proposals for a carbon sequestration tax credit, which, together with a system of tradable offsets in a domestic emissions trading system, could create a valuable set of financial incentives to preserve and enhance carbon sinks.[312]

International Emission Reductions

Under the Kyoto protocol, parties may satisfy their commitments not only by reducing domestic emissions and enhancing domestic carbon sinks, but also through investments in emission reductions or sinks in developing countries that have ratified the protocol (the clean development mechanism), investments in emission reductions or sinks in other industrialized countries (joint implementation), and the acquisition of "emission reduction units" from other parties through international emissions trading (IET). Although the CCAP expects to achieve most of Canada's emission reduction target through domestic measures, it also anticipates credits of at least 2 MT through participation in international investments

306 See the discussion supra at notes 159 to 162 and accompanying text.

307 See the discussion supra at notes 164 to 165 and accompanying text.

308 See the discussion supra at notes 166 to 167 and accompanying text.

309 See the discussion supra at note 239 and accompanying text.

310 See supra notes 247 to 248 and accompanying text.

311 See the description of income and sales tax incentives supra at notes 249 to 250 and accompanying text.

312 See supra note 253 and accompanying text.

and the acquisition of at least 10 MT through IET.[313] For these purposes, the CCAP proposes to consult with the private sector on "the best approach to work together in support of their investments and purchases on the international market."[314]

The purchase and sale of emissions permits through IET has important tax implications that should be addressed as part of this consultation.[315] More important in the context of this article, the availability of emissions credits through international investments suggests that tax incentives to reduce GHG emissions or enhance carbon sinks should be available not only for investments in Canada, but also for qualifying investments under the clean development mechanism or joint implementation.

CONCLUSION

Environmental taxes and tax incentives are not a panacea to address the problem of global warming. As this article has attempted to demonstrate, however, they are important policy instruments that should be considered along with other environmental measures in any strategy to reduce global warming. In addition to promoting economic efficiency and justice, environmental taxes can also play an educational and transformative role, encouraging environmental awareness and a shared sense of environmental responsibility. These objectives can also justify environmental tax incentives, although these should properly be regarded as tax expenditures and subject to the same scrutiny as other public spending programs. Moreover, as a general rule, environmental taxes and tax incentives should be regarded as complements to other environmental policies, interacting with environmental regulations, voluntary agreements, tradable permits, informational campaigns, direct subsidies, and the earmarking of revenues for environmental purposes.

Among environmental taxes to reduce global warming, the most promising involves the extension of automotive fuel taxes to other fossil fuels, with different rates based on the carbon content of these fuels. Together with other environmental policies, a broad-based carbon tax along these lines would create a continuing incentive to improve energy efficiency and to substitute clean and renewable sources of energy for those most responsible for global warming. Other environmental taxes meriting serious consideration include differential motor vehicle excise taxes and/or annual registration fees based on fuel-efficiency ratings, environmental taxes on synthetic fertilizers, and taxes on the disposal of organic solid waste.

With respect to environmental tax incentives to reduce global warming, the most promising are sales and value-added tax exemptions for commercially viable fuel-efficient and clean-fuel vehicles, credits or exemptions for employer-provided

313 *Climate Change Action Plan*, supra note 7, at 42.

314 Ibid.

315 Key questions involve the characterization of these permits for the purpose of determining allowable deductions and gains or losses on their disposition.

ride sharing and public transportation, and targeted tax incentives for commercially viable clean-energy sources such as solar water heating and wind generation. Other tax incentives worth considering include investment and production tax credits for generating electricity from clean and renewable sources such as biomass and CH_4 from landfills, and tax credits for preserving and enhancing carbon sinks. However, in these and other areas—for example, the energy efficiency of residential and commercial/industrial buildings—regulatory requirements and direct subsidies are likely to be more effective and less complicated than tax expenditures.

Although this article proposes several taxes and tax incentives, it does not address the detailed design of these tax measures, or the level of government by which they should be implemented. However, by encouraging greater attention to the role that tax policy can play in reducing global warming and by identifying the most promising tax measures for this purpose, it should serve a useful purpose.