Paper for discussion

Linking National Cap-and-Trade Systems in North America

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By Matthew Bramley, P.J. Partington and Dave Sawyer

Clean Energy and Climate Action:

A North American Collaboration

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Draft Paper for Discussion

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Clean Energy and Climate Action: A North American Collaboration

The International Institute for Sustainable Development and the Pembina Institute have partnered in a multi-year project entitled **Clean Energy and Climate Action: A North American Collaboration**. This project is committed to the creation of an ambitious and coherent policy approach to climate change and energy issues in North America.

Three policy papers are being prepared under the project. The goal of this paper, *Linking National Cap-and-Trade Systems in North America,* is to examine the pros and cons of linking cap-and-trade systems and to examine the prospects for linking in North America.

This version of the paper is a draft for review. Comments and input are welcome, and can be provided to Matthew Bramley, matthewb@pembina.org.

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Linking National Cap-and-Trade Systems in North America

Clean Energy and Climate Action: A North American Collaboration

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Summary

National cap-and-trade systems for greenhouse gas (GHG) emissions are expected to be at the heart of the policy response to climate change in North America. The purpose of this paper is to shed light on the prospects for linking those systems, where "linking" means allowing allowances to be traded between systems (and not simply aligning systems' cap levels or carbon prices).

There are significant reasons both in favour of and against linking cap-and-trade systems (see Section 2). For example, linking should minimize overall costs, but it can also lead to an unwanted change in domestic policy stringency or the importation of lower environmental integrity. A detailed analysis (Section 3) shows that the cap-and-trade design elements that most need to be harmonized to allow linking are cap type, limits on use of offsets, borrowing, mechanisms to constrain the carbon price, and quality of enforcement. Stringency (measured by the carbon prices in the un-linked systems), and offset types and standards, also likely need to be harmonized to allow linking.

Many North American governments actively developing cap-and-trade systems have expressed a significant interest in linking, but there are wide variations (Section 4). At the national level, U.S. policymakers have shown very little interest in linking, while the Government of Canada has repeatedly expressed enthusiasm about full linkage with the U.S., to allay competitiveness concerns. More specifically, Canada's rapidly growing exports to the U.S. from Alberta's oil sands create two possible motivations for Canada to seek to link its cap-and-trade system to a U.S. system: as a means to reduce Canada's carbon price, or to justify weakening (or failing to meet) Canada's national GHG target for 2020 (Section 5).

The importance of linking as a means of addressing competitiveness concerns is explored in this paper through an economic modelling analysis (Section 6). It shows that production accounting for only about 5% of industrial emissions seem to be at risk if Canadian carbon prices are significantly higher than those in the U.S., although there is evidence of greater levels of exposure at the sub-sector level. There is therefore likely not a strong competitiveness rationale for linking cap-and-trade systems: while linking likely reduces the risk of production leakage, it likely does not do so significantly. Instead, the primary effect of linking is to lower overall carbon costs, which in turn lowers the transitional costs of decarbonizing the economy.

We consider four possible outcomes for linking national cap-and-trade systems in North America, ranging from a single integrated North American system to separate national systems with minimal linkage (Section 7). It appears that the most likely outcome is one with minimal U.S.-Canada linking but a significant U.S.-Mexico link. Canada is very unlikely to meet its current national GHG target for 2020 under this outcome, because its carbon price would be lowered to the U.S. level, without any compensating import of allowances.

Overall, linking cap-and-trade systems in North America may not produce the best environmental outcome in the near term. And despite the strength of the fundamental economic argument for linking cap-and-trade systems — minimizing total costs — the divergent interests, circumstances and ambitions of Canada, the U.S. and Mexico pose significant obstacles to linking.

1. Introduction

Cap-and-trade systems place a cap on emissions by requiring emitters to surrender a government-issued tradeable allowance for every tonne emitted. Offsets, representing emission reductions achieved by non-capped sources, may also be accepted for compliance in lieu of allowances. The level of the cap is determined by the number of allowances issued, and is lowered over time to achieve emission reductions.

National cap-and-trade systems for greenhouse gas (GHG) emissions are expected to be at the heart of the policy response to climate change in North America. The U.S. Congress is currently debating detailed cap-and-trade legislation; the Government of Canada has indicated it will unveil its own cap-and-trade proposal in the near future; and the Mexican government has announced that it too is developing a national[1] cap-and-trade program. There are also three major regional GHG cap-and-trade initiatives in North America, one of which (the Regional Greenhouse Gas Initiative in the Northeast U.S.) has its cap already in effect.

The motivation for the "trade" part of cap-and-trade is the reduction of overall costs: when allowances can be freely traded, emissions can be reduced where it is least expensive to do so. It is therefore natural that when cap-and-trade systems are proposed in neighboring jurisdictions, there should be wide interest in further reducing costs by allowing allowances to be traded *between*, not just *within* the systems — in other words, linking them.[2] According to Nicholas Stern, "Expanding and linking the growing number of emissions trading schemes around the world is a powerful way to promote cost-effective reductions in emissions and to bring forward action in developing countries."[3]

The purpose of this paper is to shed light on the prospects for linking national cap-and-trade systems in North America, where "linking" means allowing allowances to be traded between systems (and not simply aligning systems' cap levels or carbon prices). The paper begins by considering general pros and cons of linking (Section 2) and then identifies which cap-and-trade design elements need to be harmonized to allow linking (Section 3). It then looks governments' and legislators' current stance on linking, as revealed in the actual cap-and-trade systems that are emerging, and in public statements (Section 4), before examining more closely two frequently cited motivators for U.S.-Canada linking: the cross-border trade in oil (Section 5), and competitiveness concerns (Section 6). Section 7 presents conclusions, including an assessment of possible outcomes for linking cap-and-trade systems among the three countries.

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[1] Although the Mexican system is only expected to cover a few industry sectors, it is national, as opposed to regional, in scope.

[2] In this paper, linking means one system accepting another system's allowances for compliance purposes. An indirect, limited form of linking also occurs when two systems do not accept one another's allowances, but both accept a limited volume of international offsets from the same sources. However, this paper is focused on direct linking.

[3] Nicholas Stern, *Stern Review: the Economics of Climate Change* (London, UK: HM Treasury, 2006), short Executive Summary. Available online at http://www.hm-treasury.gov.uk/sternreview_summary.htm.

2. Pros and cons of linking

There are three major reasons for linking cap-and-trade systems. First, linking should equalize the marginal cost of emissions — the price of allowances, or carbon price — across the different systems. As noted above, this means that emissions can be reduced where it is least expensive to do so, minimizing the overall cost of achieving the level of aggregate emissions represented by combining the caps of the linked systems. Second, linked systems should result in a more liquid, more competitive carbon market in which prices more accurately reflect the cost of reducing emissions; this should help ensure that overall costs are close to the theoretical minimum.[4] Third, the equalization of the carbon price, as well as any harmonization of other system design elements that may be needed to allow linking (see Section 3), should reduce concerns about the effect of cap-and-trade on the relative competitiveness of industries in the different jurisdictions.

On the other hand, each linked jurisdiction has to cede some sovereignty, losing a degree of control over policy and its administration,[5] which may lead to unwanted outcomes. In opposition to the three reasons for linking identified above, there are three clear reasons why, in certain circumstances, it might *not* be desirable to link cap-and-trade systems.

First, if two systems have significantly different stringencies (as measured by the carbon prices in the un-linked systems), linking them will result in shifts in carbon prices and net inter-jurisdictional financial flows. A jurisdiction that sees a net export of allowances when linking will experience an inflow of money to pay for them but a higher carbon price than in the un-linked system. A jurisdiction that sees a net import of allowances when linking will experience an outflow of money but a lower carbon price than in the un-linked system.

The reader may observe that equalization of the carbon price was cited above as the first reason *in favour of* linking. But the consequences may be seen as unwelcome in both allowance-exporting and -importing jurisdictions.[6] If the cap-and-trade system of an allowance-exporting jurisdiction is already viewed as stringent, one can expect opposition from many stakeholders[7] to the prospect of any further increase in the carbon price. Even though it will be accompanied by a net inflow of money that will more than pay for the corresponding extra domestic emission reductions, the higher price could be widely viewed as an unacceptable toughening of domestic policy. In effect, a higher level of domestic policy stringency will have been imported from the linked jurisdiction(s).

In an allowance-importing jurisdiction, the net outflow of money may not be politically acceptable, even though it will be less costly than having to reduce emissions domestically

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[4] However, with a larger market, there may be more more price volatity unrelated to actual emission reduction costs (as a result of speculation, derivatives trade, etc.).

[5] Carbon Trust, *Linking Emissions Trading Systems: Prospects and Issues for Business* (London, UK: Carbon Trust, 2009), 18. Available online at http://www.carbontrust.co.uk/publications/publicationdetail?productid=CTC759.

[6] Carbon Trust, 16–18.

[7] Notably, all those who expect to be net buyers of allowances.

instead. In Canada, for example, objections to "sending money out of the country" to meet GHG targets have been a prominent feature of public debate on climate policy since the Kyoto conference in 1997. In addition, the lower carbon price and reduced volume of domestic emission reductions (and of local co-benefits such as cleaner air, or job creation in low-emission industries) will be opposed by those seeking stronger domestic environmental action and innovation. In effect, a lower level of domestic policy stringency will have been imported from the linked jurisdiction(s).

Varying levels of environmental integrity — i.e., the degree to which the cap reflects the physical reality of emissions — are a second possible reason not to link cap-and-trade systems. In a system that has low integrity — e.g., because emissions are not accurately quantified, or because low-quality offsets can be used for compliance — emissions may be reduced less in reality than on paper. The carbon price will typically (but not necessarily) be higher in a higher-integrity system, and lower in a lower-integrity system. If the two systems are linked, there will then be a net export of allowances towards the higher-integrity system, and a net export of lower integrity along with the allowances. In some cases the linkage may not just export but also amplify the loss of integrity, causing real aggregate emissions to be higher when the systems are linked than when they are not.[8] For example, if a first system allows unlimited use of low-quality offsets, and a second system allows only limited use of high-quality offsets, the supply of low-quality offsets will tend to increase when the systems are linked. Even when the linkage does not amplify the loss of integrity, the substitution of real domestic reductions by cheaper foreign reductions of questionable reality might not be acceptable in the jurisdiction with higher integrity.

Varying treatment of a given sector or sectors constitutes a third possible reason not to link systems if significant net inter-jurisdictional financial flows are expected as a result of linking. This is because those flows could be seen as firms funding their competitors in a linked jurisdiction, or as one jurisdiction providing another with subsidies for actions that it does not subsidize at home. For example, steel producers in one jurisdiction might have to buy allowances to cover their emissions, while their counterparts in a linked jurisdiction receive allowances free of charge at historical emission levels, and are able to sell some of them after reducing their emissions in response to the carbon price. If the first jurisdiction makes a net purchase of allowances from the second, the producers in the first may be seen as subsidizing their competitors in the second — even if money does not flow directly. In another example, a first jurisdiction might mandate landfill gas capture, while a second jurisdiction instead allows landfill gas capture projects to generate offsets. If the first jurisdiction makes a net purchase of allowances (or offsets) from the second, then the first jurisdiction will effectively be subsidizing a foreign activity that it does not subsidize domestically.

[8] Erik Haites and Xueman Wang, *Ensuring the Environmental Effectiveness of Linked Emissions Trading Schemes* (Toronto, ON: Margaree Consultants Inc., 2006). Available online at http://www.margaree.ca/papers/Linking%20Trading%20Schemes-2006-05.pdf.

3. Which cap-and-trade design elements need to be harmonized to allow linking?

Section 2 we identified three reasons why, in certain circumstances, it might *not* be desirable to link cap-and-trade systems: varying levels of stringency; varying levels of environmental integrity; and varying treatment of sectors. A divergence between systems on a particular design element can be an obstacle to linking if it gives rise to one or more of these reasons.

Looked at from the other direction, a desire to link will create pressure to harmonize a particular cap-and-trade design element if a divergence on that element gives rise to one of those three reasons. A detailed analysis of which design elements need to be harmonized to allow linking is provided in Appendix A. Harmonization will rarely be a *technical* requirement: technical solutions are available to allow cap-and-trade systems to be linked even when they have divergent designs.[9] However, divergences may nonetheless effectively create a political requirement to harmonize, which is what we have assessed.

Table 1 summarizes the results of the analysis. The design elements that most need to be harmonized to allow linking are cap type, limits on use of offsets, borrowing, mechanisms to constrain the carbon price, and quality of enforcement. The projected carbon price (in the absence of linking), and offset types and standards, also likely need to be harmonized. Several other design elements may possibly require harmonization depending on cirumstances.

What is clear is that the need to harmonize is dominated by concerns about environmental integrity. For example, the Waxman-Markey bill (H.R. 2454) passed by the House of Representative in June 2009 (see Appendix B, Table B1) includes a "classic" cap-and-trade system with a relatively high level of environmental integrity. To link to such a system, Canada would need to respect a similar level of integrity by having an overall absolute cap and avoiding the compliance option of technology fund payments (a mechanism to constrain the carbon price). Canada would also likely need to have a similar projected carbon price (in the absence of linking) to that of the U.S., to limit the net outflow of money from Canada and avoid increasing the U.S. carbon price.

This highlights an additional environmental reason *in favour of* linking, to add to those identified in Section 2: the desire to link can create pressure on a jurisdiction like Canada that has a starting point of relatively low environmental integrity to strengthen its cap-and-trade policy and perhaps accelerate its implementation.

[9] Haites and Wang, 4.

Table 1. Summary of which cap-and-trade design elements needs to be harmonized to allow linking

Design element	Does linking require harmonization of this element?
Sectors covered and thresholds	Likely not
Gases covered	Possibly
Cap type[10]	Yes
Timing of compliance periods	Possibly
Projected carbon price (in the absence of linking)	Likely yes
Extent of allowance auctioning	Possibly
Use of allowance value	Possibly
Additional compliance options:	
Domestic offsets (limits on use)	Yes
International offsets (limits on use)	Yes
Banking	Likely not
Borrowing	Yes
Offset types and standards	Likely yes
Mechanisms to constrain the carbon price	Yes
Emissions quantification standards	Possibly
Penalties for non-compliance	Possibly
Complementary policies applying to covered sources	Likely not
Quality of enforcement	Yes

[10] When we refer here to a cap on emissions intensity, we mean that the level of the overall system cap, in terms of emissions, varies with the level of industrial production. It is possible to distribute allowances to certain sectors or facilities in proportion to production, i.e., output-based allocations, while maintaining an overall cap on absolute emissions. For example, Canada's *Turning the Corner* plan has an intensity cap, while U.S. bill H.R. 2454 (Waxman-Markey) has an absolute cap with some output-based allocation underneath it. (See Table B1.)

4. Policymakers' current stance on linking

Several cap-and-trade systems are already emerging in North America. Each of the three countries has a proposal for a national system; there are three major emerging regional systems, two straddling the U.S.-Canadian border, and one entirely within the U.S; and two Canadian provinces have implemented their own significant carbon pricing policies. British Columbia's carbon tax and Alberta's GHG regulations are not cap-and-trade systems, but they will interact strongly with, and will need to be reconciled with, future provincial or national cap-and-trade systems. The key design elements of all these emerging policies, including their provisions for linking to other cap-and-trade systems, are summarized in Appendix B.

As shown in Appendix B, most of the emerging cap-and-trade systems in North America contain provisions for linking to other systems, or at least demonstrate openness to doing so. Government officials are generally sympathetic to the economic case for linking. At the political level, many North American governments actively developing cap-and-trade systems have expressed a significant interest in linking, but there are wide variations. The states and provinces that have been attempting to make faster progress than their national governments have an understandably keen interest in linking as they seek to expand their coalition for action. Another reason for their enthusiasm may be that carbon leakage could be greater, when measured relative to total jurisidictional emissions, between neighboring states or provinces than between neighboring countries.

Alberta, on the other hand, has shown minimal interest in linking, to the point of prohibiting offsets from outside the province. This lends support to the view that Alberta's system of emissions intensity targets is primarily a defence against more stringent national or continental policy and against the financial outflows that might (but not necessarily) accompany it.

At the national level, U.S. policymakers have shown very little interest in linking, although they have laid out the most detailed criteria for it. This apparent paradox can be explained by the fact that the details of national cap-and-trade policy have been developed much further in the U.S. than in Canada or Mexico. The Government of Canada, on the other hand, has repeatedly expressed enthusiasm about full linkage with the U.S., to allay competitiveness concerns. However, having made less progress in elaborating its cap-and-trade policy, the government has published no details to date on how linking would work. Little information is currently available as to Mexico's intentions.

Illustrations of North American policymakers' stance on linking are provided below.

4.1 Canada

Section 5 identified two reasons why Canada's rapidly growing exports to the U.S. from Alberta's oil may motivate Canada to seek to link its cap-and-trade system to a U.S. system.

The present Government of Canada expressed an interest in linking North American trading systems in its 2007 proposal for a regulatory framework for industrial GHG emissions, stating: "Canada will actively work with U.S. partners to explore opportunities for linking Canada's emissions trading system with regulatory-based emissions trading systems at the regional and state level, and with any that may be established at the federal level. Canada will also actively explore cooperation on emissions trading with Mexico."[11] More recently, Canada has been publicly pursuing a system very closely linked with that of the U.S. Following the election of President Obama, Canada's Environment Minister Jim Prentice stated that "it is our view that a key objective should be a common cap and trade system [between Canada and the U.S.] that would allay competitiveness concerns in both countries."[12] Minister Prentice reiterated in late October 2009 that "this government will press forward with a continental approach, a suggested North American cap-and-trade approach."[13]

However, the government's most recent statements have emphasized "harmonization" with U.S. climate policy more than full, near-term linking of cap-and-trade systems. For example, in a November 2009 speech, Minister Prentice called for "an effective North American climate change regime with national policies that are harmonized, consistent and free from conflict... I can assure you [that Canada's cap-and-trade system] will be a made-in-Canada system - a 'separate but equal' system that will take into account our unique Canadian conditions and circumstances, while still being capable and worthy of integration into an eventual North American carbon market."[14]

The present Canadian government has been skeptical about international emissions trading more generally. Notably, in its 2008 *Turning the Corner* plan (an updated version of the 2007 regulatory framework proposal), only up to 10% of each firm's "regulatory obligation" (which appears to have meant the gap between a firm's actual or business-as-usual emissions and its intensity target) could be met through international offsets (see Table B1). As noted in Section 2, objections to "sending money out of the country" to meet GHG targets have been a prominent feature of public debate on climate policy in Canada since the Kyoto conference in 1997.

4.2 United States

The Waxman-Markey bill (H.R. 2454) passed by the House of Representatives in June 2009 allows allowances from a foreign national or supra-national cap-and-trade system to be used for compliance (subject to approval by EPA) if it "imposes a mandatory absolute tonnage limit" and

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[11] Environment Canada, *Regulatory Framework for Air Emissions* (Ottawa, ON: Government of Canada, 2007), 15. Available online at http://www.ecoaction.gc.ca/news-nouvelles/pdf/20070426-1-eng.pdf.

[12] Speech to the Canadian Council of Chief Executives, January 20, 2009. Available online at http://www.ec.gc.ca/default.asp?lang=En&n=6F2DE1CA-1&news=E110AAE9-B810-4F07-ADEC-2A4C245D67D9.

[13] Remarks in the House of Commons, October 27, 2009. Available online at http://www2.parl.gc.ca/HousePublications/Publication.aspx?Language=E&Mode=1&Parl=40&Ses=2&DocId=4177807.

[14] Speech to the Edmonton Chamber Of Commerce, November 13, 2009. Available online at http://www.ec.gc.ca/default.asp?lang=En&n=6F2DE1CA-1&news=757C0154-3353-4BB4-B2F3-9E095A0DA33E.

"is at least as stringent" as the U.S. system "including provisions to ensure at least comparable monitoring, compliance, enforcement, quality of offsets, and restrictions on the use of offsets." EPA may limit the amount of foreign allowances that an entity can use for compliance. (See Table B1.)

However, observers in Washington report that Canada is absolutely not on Congress' radar as it debates climate legislation.[15] Likewise, the White House has been silent on the prospect of linking U.S. and Canadian cap-and-trade systems, despite the opportunities provided by a number of joint statements by President Obama and Prime Minister Harper. The North American Leaders' Declaration cited below provides one exception, but the statement is very vague.

4.3 Mexico

Mexico has been a significant participant in the Kyoto Protocol's Clean Development Mechanism (CDM). As of mid-November 2009, Mexico accounted for nearly 3% of the expected annual average credits from registered CDM projects — a share exceeded only by China, India, Brazil and South Korea.[16] This indicates considerable interest in, and experience with, international emissions trading.

In August 2009 the Heads of Government of the U.S., Canada and Mexico jointly pledged to "develop comparable approaches to measuring, reporting, and verifying emissions reductions, including cooperating in implementing facility-level greenhouse gas reporting throughout the region," and to "build capacity and infrastructure with a view to facilitate future cooperation in emissions trading systems, building on our current respective work in this area."[17]

4.4 States and provinces pursuing regional systems

British Columbia's Premier Gordon Campbell exemplifies the interest in linking cap-and-trade systems that typifies the states and provinces pursuing regional systems: "Tackling global warming requires international cooperation and collaboration unlike anything we have seen before. It is vitally important that as we design our own market systems we coordinate with other provinces, states, nations and continents."[18]

Many of the states and provinces in the Western Climate Initiative (WCI) and Regional Greenhouse Gas Initiative (RGGI) are members of the International Carbon Action Partnership

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[15] Personal communications.

[16] UNFCCC, *Registration*, http://cdm.unfccc.int/Statistics/Registration/AmountOfReductRegisteredProjPieChart.html (accessed November 18, 2009).

[17] *North American Leaders' Declaration on Climate Change and Clean Energy*, August 10, 2009. Available online at http://www.whitehouse.gov/the_press_office/North-American-Leaders-Declaration-on-Climate-Change-and-Clean-Energy/.

[18] International Carbon Action Partnership, "Nations, States, Provinces Announce Carbon Markets Partnership to Reduce Global Warming," news release, Oct 29, 2007. Available online at http://www.icapcarbonaction.com/index.php?option=com_content&view=article&id=5%3Awhat-is-icaps-goal&catid=2%3Apress-releases&Itemid=34&lang=en.

(ICAP), "formed to contribute to the establishment of a well-functioning global cap and trade carbon market... ICAP provides a forum to ensure capability of existing and emerging programs and enhance the promise for development of future linked carbon markets."[19]

Both the WCI and the Midwestern Greenhouse Gas Reduction Accord (MGRA) are explicitly seeking linkages with other cap-and-trade systems. Although RGGI contains no explicit provisions for linking, the three regional systems are currently discussing joining into a common system if congressional action fails. Illinois EPA director Doug Scott recently stated: "We believe in trying to move this ball forward. If there isn't any federal cap-and-trade legislation, the work that we're doing takes on that much more importance. The idea that you've got a market, instead of several markets, existing makes a lot of sense to us."[20] Early in 2009, Ontario Ministry of the Environment director Jim Whitestone said that "without a doubt, I think an ideal scenario would be that they [the three regional systems] all eventually merge." [21]

4.5 Alberta

Alberta's system of intensity targets contains no provisions for linking. Furthermore, while allowing unlimited use of offsets, it prohibits offsets from outside Alberta. Alberta ministers have often raised the spectre of wealth transfer out of Alberta or Canada as a result of emissions trading. For example, in June 2009 Alberta's Premier Ed Stelmach stated: "Canada's policy must support investments in clean technology that reduce greenhouse gas emissions here in Canada. It must provide certainty to industry so that companies can plan for necessary, long-term investments in technology that will result in meaningful emissions reductions here in Canada. And we must guard against schemes that allow for non-reciprocal exemptions [or] subsidies that divert investment and benefit other countries or create an unwieldy trading system that lacks full transparency and accountability, or does a run-around the WTO or NAFTA."[22]

4.6 Interaction between national and state/provincial programs

The Government of Canada has for several years expressed interest in negotiating equivalency agreements with provinces, as provided for by the Canadian Environmental Protection Act, under which a provincial policy meeting or exceeding the environmental performance of federal GHG regulations could replace the latter. This raises the possibility of a Canadian national cap-and-trade system having regional "islands" that could have different design elements, including

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[19] International Carbon Action Partnership, *About ICAP*, http://www.icapcarbonaction.com/index.php?option=com_content&view=article&id=52&Itemid=2&lang=en (accessed November 18, 2009).

[20] Evan Lehmann, "Regional carbon regulators could be linked if Congress fails," *ClimateWire,* November 10, 2009, http://www.eenews.net/climatewire/2009/11/10/3/ (subscription required).

[21] Evan Lehmann, "States working to link regional cap-and-trade programs," *ClimateWire*, January 29, 2009, http://www.earthportal.org/news/?p=2124.

[22] *Address to The Banff Dialogue: The Road to Copenhagen*, June 5, 2009. Available online at http://www.premier.alberta.ca/speeches/2009_0506AddresstoTheBanffDialogueTheRoadtoCopenhagen.cfm.

restrictions on emissions trading with other parts of Canada. It remains to be seen whether the government would, in the end, be willing to accept such an outcome (or what the view of the courts would be). For instance, most companies that operate in several provinces would probably prefer to operate within a single set of rules. There are significant political pressures both for a unified national system and for allowing individual provinces like Alberta to continue to "do their own thing."

In the U.S., the Waxman-Markey bill (H.R. 2454) would prevent states from operating cap-and-trade programs during the first six years of the federal program. Both the WCI and the MGRA are explicitly seeking to influence, and even be replaced by national systems. The WCI design recommendations state that "the WCI Partner jurisdictions have designed a program that can stand alone, provide a model for, be integrated into, or be implemented in conjunction with programs that might ultimately emerge from the federal governments of the United States and Canada."[23] The MGRA draft design recommendations make a virtually identical statement, but are also far more explicit about the preference for federal action, noting that "Midwestern Governors and the Manitoba Premier strongly prefer the implementation of an effective cap-and-trade program at the federal level in both countries, rather than a regional program."[24]

[23] WCI, *Design Recommendations for the WCI Regional Cap-and-Trade Program* (WCI, 2008), 14. Available online at http://www.westernclimateinitiative.org/the-wci-cap-and-trade-program/design-recommendations.

[24] MGRA, *Midwestern Greenhouse Gas Reduction Accord: Draft Final Recommendations of the Advisory Group* (MGRA, 2009), 3. Available online at http://www.midwesternaccord.org/GHG%20Draft%20Advisory%20Group%20Recommendations.pdf.

5. Oil trade and linking

A feature of the North American economy particularly relevant to the question of linking cap-and-trade systems is the existence of large trade imbalances in goods whose production is carbon intensive. The clearest example is oil, where Canada and Mexico were respectively the first and third biggest oil suppliers to the U.S. in 2008.[25] Canada's rapidly growing exports to the U.S. from Alberta's oil sands are the biggest contributor to projected increases in Canada's GHG emissions under business as usual conditions,[26] and the main reason why economic modelling indicates that Canada needs a considerably higher carbon price than the U.S. to reduce GHG emissions by a similar percentage relative to current levels.[27]

This creates two possible motivations for Canada to seek to link its cap-and-trade system to a U.S. system. First, as shown in Section 6.2, if Canada has a cap level that represents at least a similar percentage reduction in emissions below current levels to that of the U.S. — e.g., if the U.S. implements the Waxman-Markey bill (H.R. 2454) and Canada's cap-and-trade system is consistent with its current national emissions target — linking will considerably reduce Canada's carbon price (at the cost, however, of a significant financial outflow and a reduced volume of domestic emission reductions). Second, by pursuing an integrated binational cap-and-trade system without a pre-determined Canadian cap level, with harmonized rules for distributing free allowances to industry, and with allowances recycled in their country of origin, Canada might hope to secure not only a reduced carbon price but also an allocation of free allowances large enough to prevent any significant financial outflow.

In the first of these cases it is not clear that linking would be acceptable to the U.S., because it would have to accept a higher carbon price as a result. The price increase would likely be only a few percent (see Section 6.2), given that Canada's emissions are far smaller than those of the U.S. But if the U.S. enacts a cap-and-trade system that is as stringent as is politically feasible, then it might well reject the prospect of *any* carbon price increase as a result of purchase of U.S. allowances or offsets by Canadian firms. Despite being the biggest oil supplier to the U.S., it does not appear likely that Canada can realistically threaten to withold oil as a means of persuading the U.S. to accept a linkage to a Canadian cap-and-trade system, and a consequent increase in its carbon price — even though the production of that oil would be the main reason for the increase.

In the second case, it is extremely unlikely that the U.S. would agree to issue fewer total allowances (i.e., set a tighter cap) in order to allow Canada to issue more (i.e., set a looser cap). So the only realistic scenario would be one in which the U.S. makes no change to its planned cap level but Canada's total allowances represent a smaller percentage reduction in emissions below

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[25] Energy Information Administration, *U.S. Imports by Country of Origin,* U.S. Department of Energy, http://tonto.eia.doe.gov/dnav/pet/pet_move_impcus_a2_nus_ep00_im0_mbbl_a.htm (accessed November 6, 2009).

[26] *Turning the Corner: Detailed Emissions and Economic Modelling* (Ottawa, ON: Government of Canada, 2008), 42. Available online at http://www.ec.gc.ca/doc/virage-corner/2008-03/pdf/571_eng.pdf.

[27] Chris Bataille, M.J. Jaccard and Associates Inc., personal communication. See also Section 6.2.

current levels than the U.S. cap — with the difference likely accounted for principally by the allocation of allowances to Canada's unique oil sands sector. Assuming that the U.S. cap is no tighter than in the Waxman-Markey bill (H.R. 2454) (17% below the 2005 level by 2020), this very likely implies a weaker national GHG target for Canada than the current one (20% below the 2006 level by 2020).[28] The integrated binational cap-and-trade system could thus become a means to justify weakening (or failing to meet) Canada's national target.

[28] As the cap would not cover 100% of Canada's emissions, in theory it would still be possible for Canada to meet the 20% below 2006 target by making much greater reductions in the emissions not covered by the cap — or through government purchase of international offsets. Based on present evidence, either possibility appears highly unlikely.

6. Competitiveness and linking

As noted in Section 2, linking cap-and-trade systems should reduce concerns about the effect of cap-and-trade on industrial competitiveness — both because linking will equalize the carbon price across the different jurisdictions, and because linking will likely require the harmonization of several other system design elements (see Section 3). In this section we examine whether there is, in fact, a strong competitiveness rationale for linking cap-and-trade systems.

Despite long-standing aspirations to link cap-and-trade systems to reduce and smooth costs between jurisdictions, exemplified by the Kyoto Protocol's flexibility mechanisms, the prospect of climate policy fragmentation in the post-2012 world has made climate policy synonymous, in many quarters, with impacts on competitiveness. The likelihood of variation in carbon prices between domestic producers and foreign competitors has fuelled industry concerns over lost market share, production decline, and income impacts; these concerns have been a major influence on climate policy (or the lack of it). The prominence of competitiveness concerns in climate policy debates has been underpinned mostly by predictions of financial hardship and regional economic impact, less by their environmental corollary — displacement of emissions to another jurisdiction or "carbon leakage."

It is no wonder that protectionist tendencies have emerged in major climate policy initiatives and legislation. These tendencies are evident in provisions in both Phase III of the EU Emissions Trading Scheme (EU ETS), which includes the option of applying border measures to redress carbon price differences and leakage,[29] and U.S. bill H.R. 2454 (Waxman-Markey), which includes domestic allowance rebates, a countervailing "international reserve allowance program" to impose carbon costs on imports, and provisions to either delay the move to auctioning of allowances or "implement alternative actions."[30]

To address the risk of countervailing measures and to smooth the competitiveness impacts of different carbon prices, there is a renewed focus on unifying carbon prices across jurisdictions through linked cap-and-trade systems. Indeed, much of the current climate policy debate in Canada now focuses on linking a Canadian cap-and-trade system with the U.S. to avoid competitiveness impacts and countervailing measures. In this section, the importance of linking as a means of addressing competitiveness concerns is explored through two questions:

1. Which sectors are potentially exposed to differential carbon pricing?
2. To what extent does cross-border allowance trade reduce impacts?

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[29] Directive 2003/87/EC of the European Parliament and of the Council (amended up to June 2009), Article 10b(b). Also available online at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2003L0087:20090625:EN:PDF.

[30] *American Clean Energy and Security Act of 2009*, version placed on calendar in Senate (H.R.2454 PCS), Section 401. Available online at http://thomas.loc.gov/.

6.1 Which sectors are potentially exposed to differential carbon pricing?

Existing and proposed climate policies equate competitiveness risk with a displacement of production and hence carbon leakage. The goal of mitigating production and carbon leakage figures prominently in the EU ETS (Phase III), H.R. 2454 and the RGGI. Accordingly, these policies provide operational guidance to test for leakage.

H.R. 2454 initially screens for leakage risk based on energy or emissions intensity and trade exposure (but not carbon costs), and when thresholds are met, allowance rebates are provided (in proportion to production, i.e., output-based allocations). The bill also contains a secondary test for comparable stringency and design of foreign climate policy that could then trigger border measures or reduce domestic stringency. The EU ETS includes a similar process except that carbon exposure must be initially demonstrated along with trade exposure; this places more emphasis on proving impact by quantifying carbon costs relative to economic activity. Then border adjustments may be enabled if the carbon costs of competitors are not similar.

Assessing the competitiveness impacts of unlinked climate policies is, then, a two-stage process that first identifies the potential for exposure to differential carbon pricing and then (in the case of the EU ETS) assesses whether the exposure could lead to leakage given relative carbon costs. We have used this two-stage approach to assess the risk to Canadian industry of both linked and unlinked Canadian and U.S. cap-and-trade systems using two sets of data:

- historical Canadian data disaggregated at the four-digit NAICS level for 2005, and
- Canadian baseline data and climate policy impacts in 2020 determined using an energy technology model, CIMS, and a general equilibrium model, GEEM (see Appendix C for details of the modelling methodology).

The detailed formulae for the screening criteria to test for the potential for competitiveness impacts in H.R. 2454 and the EU ETS, and the results of applying them, are provided in Appendix C.

Using the metrics from H.R. 2454, and applying these against baseline 2005 Canadian industry data at the four-digit NAICS level, about 60% of industrial emissions are energy or emissions exposed *and* trade exposed under H.R. 2454's definition (Table C1):

- **Most industrial emissions[31] (97%) come from sectors that are either energy or emissions intensive.** 12 of the 21 industries are energy intensive, with no sectors beyond these 12 being emissions intensive. In fact, only 2 of the 21 sectors pass the emissions intensive test, but these two have 40% of industrial emissions.
- **All sectors are trade exposed as defined by H.R. 2454, with the exception of electricity.** The 20 trade-exposed sectors represent about 60% of total industrial emissions.

Under the lower EU ETS threshold for trade exposure (10% instead of the H.R. 2454 15%), electricity is potentially trade exposed, in which case trade-exposed sectors would account for

[31] We define industrial emissions to cover all major energy users and producers.

about 95% of Canadian industrial emissions. However, only oil and gas extraction, electricity, agricultural chemical manufacturing, cement/concrete manufacturing and foundries meet the EU's test for carbon exposure (Table C3). This is further discussed in Section 6.2 below (see Figure 3).

Figures 1 and 2 provides an overview of these results at the more aggregated three-digit NAICS level. The forecast results in 2020 (baseline from GEEM) provide very similar results (Table C2).

Perhaps the most important observation from above is the broad presumption of possible leakage risk using the H.R. 2454 definitions. If Canada adopted these definitions, a large portion of Canadian industry would be eligible for preferential treatment regardless of linked allowance trade with the U.S.. A closer look is therefore required to determine if the potential risk could lead to a significant level of production leakage in the absence of linked allowance trade.

Figure 1. Energy or Emissions Intensity >5%? Canadian Industry Using H.R. 2454 Metrics (2005)

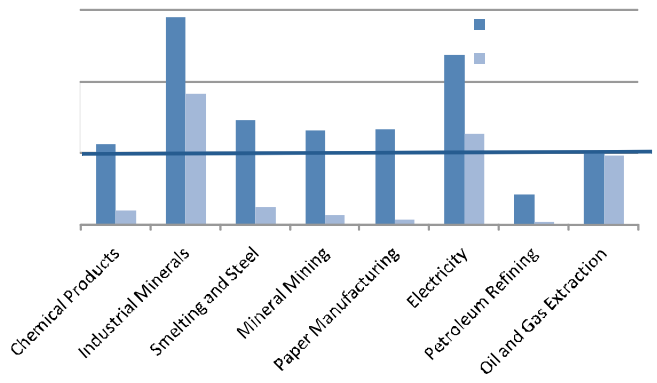
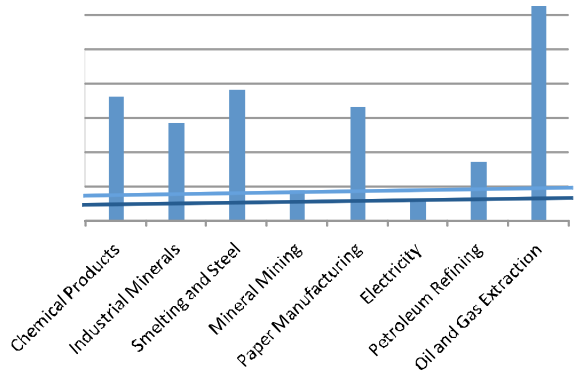


Figure 2. Trade Exposure? Canadian Industry Using H.R. 2454 and EU ETS Metrics (2005)



6.2 To what extent does cross-border allowance trade reduce impacts?

As discussed above, linked allowance trade will alter the allowance prices as well as the compliance mechanisms used. To measure the carbon exposure from Canadian carbon policy with and without cross-border allowance trade, current Canadian and U.S. climate policy proposals were modelled for the year 2020 as follows (see Appendix C for details of the modelling approach):

- For Canada, a stylized version of the federal *Regulatory Framework for Greenhouse Gas Emissions* (see Table B1) was modelled to determine carbon cost in 2020. In this scenario, Canadian industrial emitters seek compliance of 20% below their 2006 emissions in 2020.[32] Compliance options include a mix of abatement, allowance trade with other industrial sectors, unlimited domestic offsets from agriculture and waste management, and 10% of compliance from international offsets. Allocations are proportional to economic output.
- For the U.S., H.R. 2454 is implemented with a target of 17% below 2006 emissions in 2020, covering about 80% of emissions. Compliance includes 30% offsets split equally between domestic and international purchases.

Under these scenarios, the carbon prices that emerge in 2020 with no cross-border allowance trade are about \$60/tonne CO_2e in Canada and \$30/tonne in the U.S.[33] With linked cap-and-trade systems, the allowance cost settles at \$31, reflecting a small Canadian demand for U.S. allowances relative to the overall U.S. market. This halving of the allowance price with linking has a beneficial impact on a number of key economic indicators. Notably, the reduction in Canadian GDP (under a policy covering approximately half of national emissions), relative to a no-policy case, is halved from 0.46% in 2020 to 0.2%. The impact on the trade surplus (net exports) is more than halved, reducing the impact from a deterioration (relative to the no-policy case) of 0.19% in 2020 to 0.03% with linking. This relatively small impact on the trade surplus, even in the case of no linking, suggests a very small risk of leakage even when carbon prices are not aligned.

These seemingly small impacts do mask some sectoral differences in both GDP and trade (Table 2). Large deteriorations in the trade surplus (net exports) in steel and aluminum, mineral products and refined petroleum products all imply leakage risk in the absence of linking. Most sectors fare better with linking, with GDP impacts on industrial minerals, mineral products and oil and gas more than halved. Interestingly some sectors (electricity and paper products) fare less well with linking, as lower cost allowances in the U.S. mean they are no longer allowance sellers. With linking, allowance imports from the U.S. are about \$900 million per annum in 2020, which is the price for the improved competitive position of segments of the economy and a lower national GDP impact.

[32] This is modelled not as an intensity target but rather a hard cap.

[33] \$2005 Canadian dollars.

Table 2. Economic Impacts of Canada-U.S. Cross-Border Allowance Trade 2020[34]

	Change in GDP from No Policy Case		**Change in Net Exports** from No Policy Case	
	No linking	**Linking**	**No linking**	**Linking**
Chemical Products	0.2%	0.3%	0%	-1%
Industrial Minerals	-1.0%	-0.3%	-2%	1%
Steel and Aluminum	-2.7%	-0.5%	-18%	-4%
Mineral Products	-3.4%	-0.9%	-11%	-3%
Paper Products	5.9%	3.0%	12%	6%
Electricity	10.3%	5.6%	25%	11%
Petroleum Products	-1.9%	-1.1%	-11%	-6%
Oil and Gas	-7.5%	-3.9%	-6%	-3%
Total Economy	**-0.5%**	**-0.2%**	**-0.19%**	**-0.03%**

But are these impacts the result of production leakage due to increased imports and decreased exports or are they reflective of structural change to decarbonize the economy? Two lines of inquiry support the conclusion that the leakage risk with or without linked trade is small.

Following the Stern Review, export and import ratios are combined from our modelling to provide a view of the leakage risk.[35] In Table 3, the change in the "Stern trade intensity ratio" is presented for the linked and unlinked scenarios relative to the no climate policy case. With the exception of electricity, which benefits from a move towards electrification due to carbon pricing in Canada and the U.S. (a positive ratio), there are only small changes across the board in the trade intensity of Canadian production under both linked and unlinked cap-and-trade scenarios. That is, exports and imports remain somewhat unaffected relative to total domestic demand and production. The main driver of adverse economic outcomes would appear to be a drop in demand for energy intensive goods — not leakage.

[34] Source: GEEM modelling results.

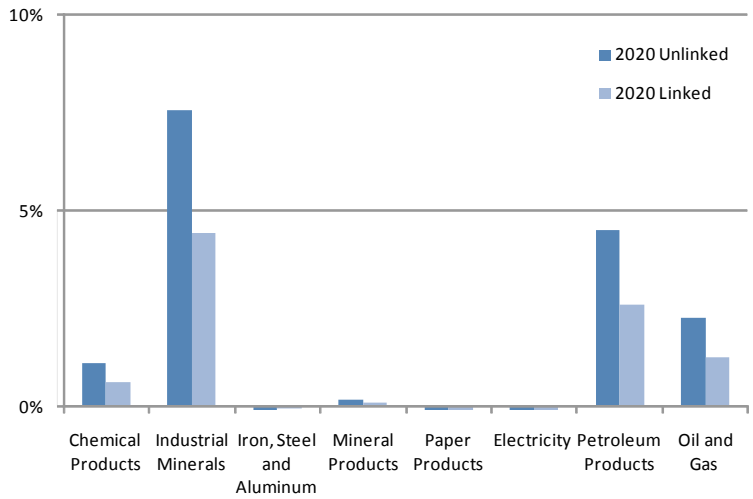
[35] Stern, Part III, Chapter 11. Trade intensity is defined as total exports of goods and services as a percentage of total supply of goods and services, plus imports of goods and services as a percentage of total demand for goods and services.

Table 3. A Low Leakage Risk in 2020: Change in Trade Intensity Ratio from No Policy Case[36]

	Unlinked	Linked
Chemical Products	-0.3%	-0.1%
Industrial Minerals	-0.5%	-0.3%
Metal Smelting	-0.2%	0.0%
Mineral Mining	-1.8%	-0.4%
Paper Manufacturing	0.3%	0.3%
Electricity	12.5%	5.7%
Petroleum Refining	-0.5%	-0.3%
Oil and Gas Extraction	1.2%	0.7%

Using the EU ETS metric of carbon exposure,[37] the carbon price differential of $30 does not imply many sectors are at risk of carbon exposure and hence leakage. Figure 3 shows that it is only industrial minerals (cement, accounting for about 5% of industrial emissions) that is carbon exposed according to this metric, with linking reducing the risk significantly. However, sub-sector impacts may be masked using this aggregated data, with iron and steel, and foundries in particular being possibly exposed regardless of linking.[38]

Figure 3. Effects of Linked Allowance Trade on Canadian Industries, EU ETS Carbon Exposure threshold, >5% Exposed



[36] Source: GEEM modelling results.

[37] If compliance costs are greater than 5% of value added the risk of production or emissions leakage is high.

[38] See Table C3 for estimates of carbon exposure at the four-digit NAICS level.

6.3 Conclusions on competitiveness and linking

In exploring if there is a strong competitiveness rationale to link cap-and-trade systems, some important conclusions arise from the analysis above:

- The screens of potential competitiveness risk, as in H.R. 2454, likely overstate the actual carbon exposure. These metrics seem overly inclusive, with H.R. 2454 identifying 60% of industrial emissions at risk. This then leads to the misperception that the competitiveness risk is likely large. Only after closer examination is it evident that production accounting for only about 5% of industrial emissions seem to be at risk if Canadian carbon prices are significantly higher than those in the U.S. This risk then disappears with linked allowance trade that equalizes carbon prices between the U.S. and Canada.
- However, there seems to be evidence of greater levels of exposure at the sub-sector level, even with linked allowance trade reducing impacts. The chemical sector is a good example: at the three-digit level the sector is not at risk, but at the four-digit level, using the EU's test for carbon exposure, one of the five sub-sectors might be at risk, representing about 40% of the sector's 2005 emissions (Table C3).
- Linking cap-and-trade systems does significantly reduce overall GDP impacts, especially for the oil and gas sector which has high abatement costs and will fully utilize any cost containment measure available, including cross-border allowances.
- It is not clear that all sectors are left better off with linked trade. Notably, allowance sellers in Canada would be worse off as allowance trade with the U.S. would likely reduce allowance prices.

Is there a strong competitiveness rationale for linking cap-and-trade systems? Most likely not. While linking likely reduces the risk of production leakage, it likely does not do so significantly. Instead, the primary effect of linking is to lower overall carbon costs, which in turn lowers the transitional costs of decarbonizing the economy. This suggest repositioning the debate over linking with the U.S. to be one about lowering overall costs and less about mitigating competitiveness impacts.

7. Conclusions: possible outcomes for linking

The development of GHG cap-and-trade systems in North America is still at a relatively early stage, with many political decisions to be taken before nationwide systems are in place, let alone links between them. A wide range of possible outcomes therefore remains for linking national cap-and-trade systems between the three countries.

In Table 4 below we outline four possible outcomes for linking, ranging from a single integrated North American system to separate national systems with minimal linkage. The outcomes are informed by our evaluation of which design elements need to be harmonized (Section 3), and take account of the actual systems that are emerging (Appendix B) and policymakers' current stance (Section 4). Given that national systems are currently expected to take effect in 2012, each of the four possible outcomes should be thought of as applying in or around 2015−16 — so as to allow a reasonable period of time for linking arrangements to be agreed and implemented. It appears likely that the emerging regional cap-and-trade systems will by then have been overtaken by, or integrated into, national systems.

In theory, national cap-and-trade systems can be designed to be linked from the outset, as is the case with the state- and provincial-level systems comprising North America's three emerging regional systems. Outcome 1 below includes both this possibility as well as that of linkage a few years later.

Outcomes 1A and 1B have the highest degree of linkage, and outcome 3 the least. Outcome 2, with a modest degree of linking, is intended to be a "best guess" at what might currently be most likely. In each case the U.S. implements a system similar to the Waxman-Markey bill (H.R. 2454), since that is our current best indication of what is most likely in the U.S., and because the U.S. appears extremely unlikely to alter its system based on considerations of linking with Canada or Mexico. Further rationales for each outcome are provided in the table below.

Table 4. Possible outcomes for linking national cap-and-trade systems in North America

Possible outcomes	Rationales
Outcome 1: • an integrated North American system, with a single "currency" of freely traded North American allowances • a single set of rules for offsets, mechanisms to constrain the carbon price, and all key design elements other than coverage and distribution of allowances, similar to those in bill H.R. 2454 (Waxman-Markey) • identical economy-wide coverage in the U.S. and Canada, as per H.R. 2454, but narrower coverage of a few key industry sectors only in Mexico. **Sub-outcome A:** • each facility in a given sector receives free allowances according to the same agreed formula regardless of which country it is in. **Sub-outcome B:** • free allowances are allocated by each national government according to formulae that vary from one country to another, but the total number of allowances issued by each government has to be agreed to be consistent with its target for total national GHG emissions.	This outcome is modelled loosely on the EU ETS, with sub-outcome A corresponding to EU ETS Phase III (2013−20), and sub-outcome B to EU ETS Phase II (2008−12). Canada pursues its current emphasis on harmonization with the U.S. to its logical endpoint — full acceptance of U.S. policy design.[39] Mexico opts to implement a system of comparable stringency to the U.S. for key industry sectors. The U.S. agrees to full linkage to both Canada and Mexico given (i) their acceptance of key U.S. design elements, and (ii) equal stringency[40] based on identical allocation formulae (sub-outcome A) or overall cap level (sub-outcome B). (Sub-outcome B implies that Mexico would have a mid-term national GHG target acceptable to the U.S.) The U.S. opts not to limit use of foreign allowances for compliance, based on an expectation of relatively small net cross-border allowance flows.

[39] We assume that unless Canada designs and implements cap-and-trade in advance of the U.S., it will have minimal influence on U.S. policy design.

[40] Here we are speculating on the U.S.' interpretation of "stringency," which will not necessarily be the same as the meaning we have given to the term in this paper up to here (carbon price level).

Possible outcomes	Rationales
Outcome 2: • a U.S. system similar to that of bill H.R. 2454 (Waxman-Markey) • a Canadian system with an absolute cap but significantly more generous allocation of free allowances (particularly in the oil and gas sector) than the U.S., and the option of making payments into a technology fund, at a price tied closely to the U.S. carbon price, for some maximum proportion of each firm's compliance • a Mexican system with an absolute cap, covering a few key industry sectors only, with the cap set a little below business-as-usual emission levels • Canada allows limited use of U.S. allowances for compliance (although this option may not be used much if firms can comply at the same price largely through the technology fund) but the U.S. does not allow use of Canadian allowances • both the U.S. and Canada link to Mexico by purchasing Mexican allowances as sector-based international offsets.	This outcome is a "best guess" at what might currently be most likely. Canada relinquishes the much-criticized intensity cap approach, but persists with (i) an allocation to the oil and gas sector that grows considerably over time (in light of anticipated oil sands expansion) and (ii) the technology fund compliance option (to meet the demands of some industry sectors and Alberta). Canada "harmonizes" with the U.S. not through full linking but via the price of technology fund payments. But the U.S. deems Canada's allocation, or its technology fund, or both, to disqualify Canadian allowances from being acceptable for compliance in its system on grounds of insufficient stringency/comparability of Canada's system. The U.S. also deems Mexico's system to be insufficiently stringent to allow full linking, but, with an eye to encouraging more non-Annex I countries[41] to take on caps, accepts Mexican allowances as sector-based international offsets.[42]

[41] I.e., developing countries according to the definition of the UN Framework Convention on Climate Change.

[42] If free allowances are allocated to each sector in the Mexican system at a level a little below business-as-usual sectoral emissions, and emissions are reduced, as a result of the carbon price, to below the allocation level, then emitters' surplus allowances resemble sector-based offsets.

Possible outcomes	Rationales
Outcome 3: • a U.S. system similar to that of bill H.R. 2454 (Waxman-Markey) • a Canadian economy-wide system with an absolute cap designed to ensure Canada meets the Government of Canada's target for total national emissions (20% below 2006 by 2020), a substantial proportion of allowances auctioned, no use of offsets or foreign allowances for compliance but price caps set at levels estimated to be consistent with meeting the target. • a Mexican system with an absolute cap, covering a few key industry sectors only, with the cap set at or very close to business-as-usual emission levels for the first few years • the U.S. does not allow use of Canadian allowances for compliance • the U.S. allows use of Mexican project-based offsets but does not allow use of Mexican allowances.	This outcome assumes that both the U.S. and Canada are focused on meeting their targets for total national emissions in 2020 (20% below 2005 in H.R. 2454 and 20% below 2006 in Canada); and that Canada does not find it acceptable to close more than one-fifth of the gap between business-as-usual emissions and the national 2020 target using foreign emission reductions.[43] To achieve this, Canada is estimated to need a carbon price rising from C$40/tonne CO_2e in 2011 rising to C$100/tonne in 2020.[44] These prices are higher than expected in the U.S. and elsewhere, so to maintain them, Canada opts not to allow the use of offsets or foreign allowances for compliance. Instead, price caps are necessary to provide industry with a cost containment mechanism. To fund major public investments that are also necessary to meet the national target, Canada auctions a substantial proportion of allowances. The U.S. does not allow use of Canadian allowances for compliance because of Canada's price caps, even though they are set at a relatively high level; and does not allow use of Mexican allowances because (i) the Mexican system is not viewed as sufficiently stringent and (ii) the allocation of free allowances in the Mexican system is considered too generous for them to qualify as sector-based international offsets.

We have already indicated that outcome 2 is more likely than outcomes 1A/B or 3. But what do the preceding sections of this paper tell us about the prospects for each of the four possible outcomes?

Outcome 1 would require Mexico to implement a system that would be viewed by the U.S. as equally stringent as its own. It is not clear whether this is a politically feasible option for Mexico in the near term. As for Canada, the acceptance of most of the same key design elements as the U.S. would likely meet with strong opposition in the oil industry and Alberta, which continue to favour intensity caps and the compliance option of payments into a technology fund. The question of whether outcome 1A would allow an allocation of free allowances to the oil sands sector more or less generous than under previous Canadian policy proposals is open to

[43] This appears to be a reasonable assumption, given the present Canadian government's skepticism about international emissions trading.

[44] Matthew Bramley, Pierre Sadik and Dale Marshall, *Climate Leadership, Economic Prosperity* (Drayton Valley, AB and Vancouver, BC: The Pembina Institute and David Suzuki Foundation, 2009). Available online at http://climate.pembina.org/pub/1909.

interpretation because of the uniqueness of that sector, but the answer to that question would be an important factor in determining the prospects for this outcome — and the likelihood of Canada meeting its current national GHG target for 2020. Outcome 1B appears a less likely prospect than 1A for two reasons. First, varying use of allowance value could be an obstacle to linking. Second, outcome 1B would require Canada to demonstrate that its cap-and-trade system were consistent with its national emissions target, which would require a much higher carbon price than currently expected in the U.S.[45] This is not something that the present Government of Canada appears ready to accept, and it would also require the U.S. to accept an increase in the carbon price as a result of linking. Although this increase would be small (see Section 6.2), it might be viewed as unacceptable. (Depending on its interpretation, outcome 1A might also require the U.S. to accept an increase in the carbon price.)

Outcome 2 seems more likely because it includes a Canadian approach more closely aligned with the views of powerful stakeholders and a Mexican approach that seems likely to be more politically feasible in the near term. The result is minimal U.S.-Canada linking — with Canadian industry's competitiveness concerns met instead through the technology fund mechanism — but a significant U.S.-Mexico link. It is not clear that the current array of political forces is likely to generate more linking that this, although this could change if it was expected that the lack of alignment of Canada's system with that of the U.S. would trigger the application of border measures to Canadian exports. However, H.R. 2454 would not allow border measures (the "international reserve allowance program") before 2020, and Canada would presumably argue that tying the price of payments into its technology fund to the U.S. carbon price would make Canada's cap-and-trade system "at least as stringent" as that of the U.S. — grounds in H.R. 2454 for avoiding border measures.[46]

It should be noted that Canada is very unlikely to meet its current national GHG target for 2020 under outcome 2, because its carbon price would be lowered to the U.S. level, without any compensating import of allowances (representing purchased foreign emission reductions).[47]

Outcome 3 illustrates the apparent consequences of Canada striving to meet its national GHG target for 2020 as seriously as the U.S. would do under H.R. 2454. In this case, there is no U.S.-Canada linking because of the higher stringency of Canada's system and the measures taken (no use of offsets or foreign allowances for compliance, requiring price caps instead) to guarantee that stringency. However, as noted for outcome 1B, the Canadian carbon prices required do not appear to be acceptable to the present Government of Canada, and are considerably higher than those that have been publicly contemplated by most Canadian politicians to date. Outcome 3 also has little U.S.-Mexico linking as a result of an insufficiently stringent Mexican system.

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[45] Ibid.

[46] *American Clean Energy and Security Act of 2009*, version placed on calendar in Senate (H.R.2454 PCS), Section 401.

[47] As the cap would not cover 100% of Canada's emissions, in theory it would still be possible for Canada to meet its national emissions target by making much greater reductions in the emissions not covered by the cap — or through government purchase of international offsets. Based on present evidence, either possibility appears highly unlikely.

Any of the options above could be implemented in part, in Canada, through equivalency agreements where certain provinces take over some of the administration of cap-and-trade on their territory. But we have not considered options where the design elements, and not just the administrative authority, of Canada's system vary from one province to another. This possibility seems most likely as a variant of option 2.

Overall, it should be stressed that linking cap-and-trade systems in North America may not produce the best environmental outcome in the near term, either because it may amplify the lower environmental integrity of a linked system (Section 2), or justify the weakening of a national GHG target (Section 5, and outcomes 1 and 2 above). And despite the strength of the fundamental economic argument for linking cap-and-trade systems — minimizing total costs — the divergent interests, circumstances and ambitions of Canada, the U.S. and Mexico pose significant obstacles to linking. As the UK's Carbon Trust has concluded: "A focus on linking is premature if the underlying systems, including the preferences they express, are too divergent."[48] And: "For the next few years, businesses need to prepare for a scenario of multiple trading systems of increasing regulatory complexity and uncertainty, without much linking."[49]

[48] Carbon Trust, 18.

[49] Carbon Trust, 25.

A. Detailed analysis of which cap-and-trade design elements need to be harmonized to allow linking

Table A1 examines the significance of the obstacles to linking cap-and-trade systems arising from divergences on each of the main design elements of such systems. The table classifies the obstacles in terms of the three possible reasons not to link identified in Section 2, and assesses the extent to which linking requires harmonization of each design element. Harmonization will rarely be a *technical* requirement: technical solutions are available to allow cap-and-trade systems to be linked even when they have divergent designs.[50] However, divergences may nonetheless effectively create a political requirement to harmonize, and that is what is assessed in the table.

As noted in Section 2, varying levels of environmental integrity and varying treatment of sectors are reasons not to link systems only when varying stringency is expected to create a significant net inter-jurisdictional financial flow in a particular direction. The direction of the financial flow in a particular case could mean that there is no requirement to harmonize, but only if there is very high confidence about that direction prior to linking. Our assessments of whether linking requires harmonization, in the right-hand column of Table A1, assume that there is not high confidence about the direction of the financial flow.

[50] Haites and Wang, 4.

Table A 1. Detailed analysis of which cap-and-trade design elements need to be harmonized to allow linking

Design element	If systems differ on this design element, is that an obstacle to linking them?	Type(s) of obstacle	Does linking require harmonization of this element?
Sectors covered and thresholds	In theory, it could be an obstacle if a significant net financial flow is expected towards a jurisdiction with broader coverage/tighter thresholds. For example, if Canada's system covers only industrial emissions, but the U.S. system covers emissions from buildings, Canadian industry could be seen to be paying for efficiency improvements to U.S. buildings (but not to Canadian buildings). In this example, the concern could be removed if Canada's buildings sector were allowed to generate offsets. In the absence of more compelling examples, this does not appear to be a significant obstacle.	Varying treatment of sectors	Likely not
Gases covered	It could be an obstacle if a significant net financial flow is expected towards a jurisdiction with more gases covered. For example, if Canada's system does not cover emissions of PFCs from aluminum production, but the U.S. system does, and if U.S. producers are able to make inexpensive cuts to those emissions, then Canadian producers could be seen to be paying for process improvements by their U.S. competitors.	Varying treatment of sectors	Possibly
Cap type (absolute or intensity)[51]	It will be a serious obstacle if a significant net financial flow is expected towards a jurisdiction with a cap on emissions intensity rather than on absolute emissions. An intensity cap translates into an amount of absolute emissions that expands if industrial production is higher. This means, for example, that if Canada has an intensity cap, but the U.S. has an absolute cap, any Canadian allowances imported into the U.S. will represent only "relative" emission reductions that could be wiped out by higher-than-expected Canadian industrial production. The U.S. is very likely to see this as an unacceptable undermining of its absolute cap. (The allowance-importing jurisdiction could also object to the risk of "liquidity shocks" from the ex-post adjustment of allowance allocations that is necessary in a jurisdiction with an intensity cap.[52]) If, however, in our	Varying environmental integrity	Yes

[51] When we refer here to a cap on emissions intensity, we mean that the level of the overall system cap, in terms of emissions, varies with the level of industrial production. It is possible to distribute allowances to certain sectors or facilities in proportion to production, i.e., output-based allocations, while maintaining an overall cap on absolute emissions. For example, Canada's *Turning the Corner* plan has an intensity cap, while U.S. bill H.R. 2454 (Waxman-Markey) has an absolute cap with some output-based allocation underneath it. (See Table B1.)

[52] Carbon Trust, 16.

Design element	If systems differ on this design element, is that an obstacle to linking them?	Type(s) of obstacle	Does linking require harmonization of this element?
	example, Canada is expected to be a net importer of allowances from the U.S., it is less clear why the U.S. should object, because it will not be importing the lower environmental integrity of Canada's system.		
Timing of compliance periods	It could be an obstacle if a significant net financial flow is expected from a jurisdiction that does not allow borrowing from a future compliance period and whose compliance period ends earlier, towards a jurisdiction with a compliance period that ends later. This is because it could be possible for the first jurisdiction to borrow future years' allowances from the second jurisdiction and use them for immediate compliance. Borrowing is generally considered to undermine environmental integrity (see below). If, however, the first jurisdiction allows domestic borrowing comparable to the interjurisdictional borrowing made possible by linking, there should be no obstacle to linking.	Varying environmental integrity	Possibly
Projected carbon price (in the absence of linking)	It could be a serious obstacle because linking will (i) increase the carbon price in an allowance-exporting jurisidiction – and the higher price could be widely viewed as an unacceptable toughening of domestic policy; (ii) create a net outflow of money from an allowance-importing jurisdiction – resulting in objections to "sending money out of the country," and a lower carbon price – which will be opposed by those seeking stronger domestic environmental action. See Section 2.	Varying stringency	Likely yes
Extent of allowance auctioning	It could be an obstacle if a significant net financial flow is expected towards a jurisdiction that has less auctioning or directs more allowance value to a particular sector. For example, if Canadian steel producers have to buy allowances to cover their emissions, while their counterparts in the U.S. receive allowances free of charge at historical emission levels, and are able to sell some of them after reducing their emissions in response to the carbon price, then Canadian producers could be seen to be subsidizing their U.S. competitors. In another example, if coal-fired power producers in both Canada and the U.S. have to buy allowances at auction, and if there is a net financial flow towards the U.S., and if the U.S. re-invests auction revenues in "clean coal" power production to a greater extent than in Canada, then the Canadian coal-fired power sector could be seen to be paying for modernization of its U.S. counterpart.	Varying treatment of sectors	Possibly
Use of allowance value		Varying treatment of sectors	Possibly

Design element	If systems differ on this design element, is that an obstacle to linking them?	Type(s) of obstacle	Does linking require harmonization of this element?
Additional compliance options:			
Domestic offsets (limits on use)	It will likely be a serious obstacle if a significant net financial flow is expected from a jurisdiction that does not allow or has a tighter volume limit on use of domestic offsets, towards a jurisdiction that allows or has a looser volume limit on domestic offsets. Limiting or prohibiting offsets is motivated to a significant degree by concern for environmental integrity (it is challenging to ensure offsets represent real emission reductions); importing allowances from a system allowing greater use of offsets will be seen as importing and amplifying lower environmental integrity. Disallowance of offsets may also be motivated by a preference for other policies to reduce emissions. For example, a first jurisdiction might mandate landfill gas capture, while a second jurisdiction instead allows landfill gas capture projects to generate offsets. If there is a net financial flow from the first jurisdiction to the second, then the first jurisdiction will effectively be subsidizing a foreign activity that it does not subsidize domestically.	Varying environmental integrity, treatment of sectors	Yes
International offsets (limits on use)	It will likely be a serious obstacle if a significant net financial flow is expected from a jurisdiction that does not allow or has a tighter volume limit on use of international offsets, towards a jurisdiction that allows or has a looser volume limit on domestic offsets. Limiting or prohibiting offsets is motivated to a significant degree by concern for environmental integrity (it is challenging to ensure offsets represent real emission reductions); importing allowances from a system allowing greater use of offsets will be seen as importing and amplifying lower environmental integrity. The concern about subsidizing foreign activities that are not subsidized domestically (see previous row of this table) should be muted if international offsets are sourced from developing countries.	Varying environmental integrity	Yes
Banking	It could be an obstacle because limiting or prohibiting banking will most likely be motivated by a desire to reduce the risk of undesirably low stringency in subsequent compliance periods. Importing allowances from a system allowing greater use of banking could be seen as importing a risk of lower future stringency. However, all the actual systems that are emerging allow banking, so this should not be an obstacle in practice.	Varying stringency	Likely not

Design element	If systems differ on this design element, is that an obstacle to linking them?	Type(s) of obstacle	Does linking require harmonization of this element?
Borrowing	It will be a serious obstacle if a significant net financial flow is expected towards a jurisdiction that allows more borrowing. Limiting or prohibiting borrowing is motivated by concern for environmental integrity, because borrowing creates the risk that firms will not be able to repay, through extra future emission reductions, the extra emissions they are allowed now. Importing allowances from a system allowing greater use of borrowing will be seen as importing and amplifying lower environmental integrity.	Varying environmental integrity	Yes
Offset types and standards	It will likely be a serious obstacle if a significant net financial flow is expected from a jurisdiction that allows more types of offsets and/or has weaker offset standards, towards a jurisdiction that allows fewer types of offsets and/or has strong offset standards. Disallowing certain types of offsets may be motivated by concern for environmental integrity (e.g., offsets from carbon sinks, where carbon storage may not be permanent), in whch case importing allowances from a system allowing more types of offsets will be seen as importing and amplifying lower integrity. Importing allowances from a system with weaker offset standards will also obviously be seen as importing lower integrity. Disallowing certain types of offsets may also be motivated by a preference for other policies to reduce emissions. For example, a first jurisdiction might mandate landfill gas capture, while a second jurisdiction instead allows landfill gas capture projects to generate offsets. If there is a net financial flow from the first jurisdiction to the second, then the first jurisdiction will effectively be subsidizing a foreign activity that it does not	Varying environmental integrity, treatment of sectors	Likely yes

Design element	If systems differ on this design element, is that an obstacle to linking them?	Type(s) of obstacle	Does linking require harmonization of this element?
	subsidize domestically.		
Mechanisms to constrain the carbon price	It will be a serious obstacle if one jurisdiction does not place any ceiling or places a higher ceiling on the carbon price, and another jurisdiction does place a ceiling or places a lower ceiling on the carbon price. Any form of price ceiling reduces environmental integrity because it allows emitters to replace emission reductions by payments, with no assurance that the money paid will secure equivalent emissions reductions. If the carbon price reaches the level of the lowest price ceiling, money will flow towards the jurisdiction with that ceiling, and any linked systems will lose environmental integrity. This will likely be unacceptable to them, as their price ceilings will presumably have been set at a higher level out of a concern for integrity. Divergence between jurisdictions on levels of price floors may or may not be an obstacle to linking, depending on how the floors are implemented. If price floors are implemented via emissions taxes, different floor levels will not be an obstacle to linking; but if price floors are implemented via buy-back of allowances by government, different floor levels will be a serious obstacle because linking will greatly increase the financial exposure of the government with the highest floor level.[53]	Varying environmental integrity	Yes
Emissions quantification standards	It will be a serious obstacle if the regulator in one jurisidiction does not believe that the emissions in another jurisdiction are quantified at least as accurately as its own, and if a significant net financial flow is expected from the first to the second. Accurate quantification is motivated by concern for environmental integrity; importing allowances from a system with worse accuracy will be seen as importing lower environmental integrity. But this does not mean emissions quantification standards need be identical to allow linking.[54]	Varying environmental integrity	Possibly
Penalties for non-compliance	It will be an obstacle if the regulator in one jurisidiction does not believe that the penalties in another jurisdiction deter non-compliance at least as well as its own, and if a significant	Varying environmental	Possibly

[53] Peter John Wood and Frank Jotzo, *Price Floors for Emissions Trading, Research Report No. 36* (Canberra, Australia: Australian National University, 2009). Available online at http://www.crawford.anu.edu.au/research_units/eerh/pdf/EERH_RR36.pdf.

[54] Haites and Wang, 6.

Design element	If systems differ on this design element, is that an obstacle to linking them?	Type(s) of obstacle	Does linking require harmonization of this element?
	net financial flow is expected from the first to the second. Strong penalties are motivated by concern for environmental integrity; importing allowances from a system with weaker penalties will be seen as importing a risk of lower environmental integrity. However, penalties are generally set so high as to result in 100% compliance, in which case some variation in the monetary level of penalties is likely not material. It should be noted that a penalty that consists only of a payment is significantly weaker than a penalty that combines a payment with an obligation to submit missing allowances.	integrity	
Complementary policies applying to covered sources	We define complementary policies as regulatory requirements, or financial incentives/disincentives unrelated to the use of allowance value, that affect the level of emissions by sources covered by cap-and-trade systems.[55] Even if a given sector is affected by different complementary policies in different jurisdictions, and a significant net financial flow is expected towards a jurisdiction with less stringent or more financially generous complementary policies, that is unlikely to be an obstacle to linking cap-and-trade systems. This is because, in this case, the financial flow is not likely to be seen as firms funding their competitors in a linked jurisdiction, or as one jurisdiction providing another with subsidies for actions that it does not subsidize at home. For example, if coal-fired power producers receive subsidies to implement CCS in the U.S. but not in Canada, and there is a net financial flow from Canada to the U.S., the authorities are unlikely to allow the U.S. producers to directly profit from the subsidies by selling allowances. Or if coal-fired power producers are required to implement CCS in Canada but not in the U.S., and if Canada is a net importer of allowances, the U.S. producers are unlikely to be sellers of allowances.	Varying treatment of sectors	Likely not
Quality of enforcement	It will be an obstacle if the regulator in one jurisidiction believes that non-compliance in another jurisdiction is not being detected or penalized, and if a significant net financial flow is expected from the first to the second. Enforcement is motivated by concern for environmental integrity; importing allowances from a system with inadequate enforcement will be seen as importing lower environmental integrity.	Varying environmental integrity	Yes

[55] Examples could include a requirement that coal-fired power plants implement CCS, or provision of financial incentives in exchange for them doing so, in one jurisdiction but not another.

B. Summary of existing and proposed cap-and-trade systems

The following tables outline the key design elements of the cap-and-trade systems that are emerging in North America. (The design elements analyzed are the same, and presented in the same order, as those examined in Appendix A.) Table B1 covers the most significant proposals to date for national systems in the three countries, Table B2 covers the three main emerging regional systems, and Table B3 highlights the most significant provincial carbon pricing policies in Canada, including British Columbia's carbon tax and Alberta's GHG regulations. Although the latter are not cap-and-trade systems, we have included them because they will interact strongly with, and will need to be reconciled with, future provincial or national cap-and-trade systems.

Table B 1. National systems

	Canada[56]	**United States**[57]	**Mexico**
Status of policy	Proposed by the federal government in March 2008 but now subject to revisions, likely major ones[58]	Bill H.R.2454 passed by the House of Representatives in June 2009	In development
Date cap	January 1, 2010[59]	January 1, 2012; some sectors phased	January 1, 2012[60]

[56] Unless otherwise cited, all information is from Environment Canada, *Turning the Corner: Regulatory Framework for Greenhouse Gas Emissions* (Ottawa, ON: Government of Canada, 2008). Available online at http://www.ec.gc.ca/doc/virage-corner/2008-03/pdf/COM-541_Framework.pdf.

[57] Unless otherwise cited, all information is from the *American Clean Energy and Security Act of 2009*, version placed on calendar in Senate (H.R.2454 PCS).

[58] The government has indicated that Canada's approach will change following the shift in U.S. policy with the election of President Obama See, for example, Environment Canada, *A Climate Change Plan for the Purposes of the Kyoto Protocol Implementation Act — May 2009* (Ottawa: Government of Canada, 2009), 8. Available online at http://www.ec.gc.ca/cc/E653A4ED-120F-4185-9494-9B2946CC73F3/KPIA_2009.pdf.

[59] This is the date proposed in Environment Canada, *Turning the Corner: Regulatory Framework for Greenhouse Gas Emissions*. However, it is now clear that this date will not be met.

[60] Center for Clean Air Policy, "Mexican government announces aggressive national goal to reduce carbon emissions by 2050," news release, December 11, 2008. Available online at http://www.ccap.org/index.php?component=news&id=151.

	Canada[56]	United States[57]	Mexico
takes effect		in later (see below)	
Sectors covered and thresholds	All heavy industry sectors: electricity generation (facilities above 10MW), upstream oil and gas (above 3kt per facility and 10,000 bpd/company) other industrial (generally facilities above 50kt CO_2e/yr). Defined fixed process emissions are exempt.	Electricity generators, combustion of liquid fuels including transportation (2012), industrial facilities (2014), remaining combustion of natural gas (2016). The threshold is generally 25kt CO_2e/yr (applied at the wholesale level for liquid fuels and natural gas).	Reports indicate that the oil, cement, electricity and steel sectors will be covered.[61] Thresholds are unknown.
Gases covered	CO_2, CH_4, N_2O, SF_6, HFCs, PFCs[62]	CO_2, CH_4, N_2O, SF_6, PFCs, NF_3[63]	Unknown
Cap level and type	Emissions intensity cap built up from facilitiy-level intensity targets: • existing facilities — 18% below 2006 level in 2010, reduced by 2% each subsequent year (target reaches 33% below 2006 level by 2020) • new facilities (beginning operation 2004 or later) and facilities subject to major expansions — not covered for first three years, target generally then set at "cleaner fuel standard" level, reduced by 2% each year. The intensity cap is estimated to represent a 21% reduction in absolute emissions from covered sources by 2020, relative to the 2006 level. The	Absolute cap: • 17% below 2005 level by 2020 • 42% below 2005 level by 2030 • 83% below 2005 level by 2050	The cap on covered emissions will be influenced by, but will not be necessarily identical to, Mexico's target for total emissions: 50% below the 2002 level by 2050.64

[61] Ibid.

[62] HFCs are hydofluorocarbons; PFCs are perfluorocarbons.

[63] Bill H.R. 2454 covers HFCs under a separate cap-and-trade program that we do not describe here.

[64] Center for Clean Air Policy.

	Canada[56]	United States[57]	Mexico
	government intends to transition to absolute emissions caps in the 2020–25 period.		
Timing of compliance periods	Annual (implied)	Annual	Unknown
Projected carbon price (2012, 2015, 2020)	~C$25/tonne CO_2e in 2012 ~C$40 in 2015 ~C$65 in 2020[65]	US$13–~20/tonne CO_2e in 2015 US$16–32 in 2020[66,67]	Unknown
Extent of allowance auctioning	None	• 27% of allowances in 2012 and 16% in 2016 directly auctioned;[68] • a total of 50% in 2012 and 35% in 2016 either directly auctioned, or allocated to non-covered entities (in which case allowances will be sold to emitters); • a further 38% in 2012 and 40% in 2016 allocated to electricity and	Unknown

[65] Environment Canada, *Turning the Corner: Detailed Emissions and Economic Modelling*, 7. These prices depend on unstated assumptions about the offsets system; it seems likely that prices would be lower given the unlimited use of domestic offsets and the proposed offset rules.

[66] EPA, *EPA Analysis of the American Clean Energy and Security Act of 2009 H.R. 2454 in the 111th Congress, 6/23/09* (Washington, DC: EPA, 2009), 3. Available online at http://www.epa.gov/climatechange/economics/pdfs/HR2454_Analysis.pdf.

[67] Energy Information Administration, *Energy Market and Economic Impacts of H.R. 2454, the American Clean Energy and Security Act of 2009* (Washington, DC: U.S. Department of Energy, 2009), xi. Available online at http://www.eia.doe.gov/oiaf/servicerpt/hr2454/pdf/sroiaf(2009)05.pdf.

[68] The proportion of allowances auctioned falls between 2012 and 2016 mostly because (i) trade-exposed industries and natural gas distributors receive free allowances when industrial facilities and remaining combustion of natural gas are added to the system, and (ii) the proportion of allowance value dedicated to deficit reduction falls.

[69] John Larsen, Alexia Kelly and Robert Heilmayr, *WRI Summary of H.R. 2454, the American Clean Energy and Security Act (Waxman-Markey)* (Washington, DC: World Resources Institute, 2009), 12–20. Available online at http://pdf.wri.org/wri_summary_of_aces_0731.pdf.

	Canada[56]	United States[57]	Mexico
		natural gas distributors "exclusively for the benefit of retail ratepayers" (in which case most allowances will likely be sold to emitters)[69]	
Use of allowance value	100% of allowance value will be distributed to industrial emitters in proportion to production levels.	See previous line; of the remaining 12% of allowances in 2012 and 25% in 2016 that will be allocated free of charge, the most significant allocations are to electricity generators (6% in 2012 and 5% in 2016) and trade-vulnerable industries (2% in 2012 and 13% in 2016) in proportion to production levels, to auto manufacturers and component suppliers to support clean vehicle technology (3% in 2012 and 2016), and for carbon capture and storage (CCS) projects (0% in 2012 and 1.8% in 2016).[70]	Unknown
Additional compliance options	Domestic offsets: unlimited International offsets: CERs[71] (excluding forest sink projects) up to 10% of "each firm's regulatory obligation" Banking: yes for early action credits, not clear otherwise Borrowing: none Other:	Domestic offsets: up to about 15% of an entity's compliance obligation in the early years (more in later years) International offsets: up to about 15% of an entity's compliance obligation in the early years (more in later years)[72] Banking: unlimited Borrowing: unlimited from the following year, and up to 15% of an entity's	Unknown

[70] Ibid.

[71] Credits issued under the Kyoto Protocol's Clean Development Mechanism.

[72] Starting in 2018, international offsets will be discounted at a rate of 1.25:1.

	Canada[56]	United States[57]	Mexico
	• payments into a federal or provincial technology fund (up to 70% of "each firm's... emission reduction obligation" in 2010, declining to 0% in 2018) • pre-certified investments in "large-scale and transformative projects" (included in same limit as technology fund except for CCS projects, where there is no limit before 2018) • early action credits (15Mt will be issued in total).	compliance obligation from up to five years ahead at 8% annual interest Other: allowances from qualifying foreign national or supra-national cap-and-trade systems (see below)	
Offset types and standards	The offset system will cover "as many sectors and... project types as possible." Protocols are subject to approval by Environment Canada, with existing protocols eligible to be fast-tracked. Credits will be issued only for reductions with vintages starting in 2011, but projects that began reducing emissions in 2006 (or earlier in some instances) will be eligible.[73] There are significant concerns about the additionality of credits.[74]	Regulations establishing the domestic offset program, including the eligible project types, are to be made by the EPA,[75] advised by an Offsets Integrity Advisory Board. The USDA[76] will establish the forestry and agriculture offset program (which must include specified project types), advised by a GHG Emission Reduction and Sequestration Advisory Committee. Eligible projects must begin in 2009 or later (with some exceptions).	Unknown
Mechanisms to constrain	Payments into technology funds and pre-certified investments, for	The auction reserve price is set at US$10/tonne CO_2e initially, rising by	Reports indicate that a price cap will be

[73] The most recent draft program rules and guidance documents for the offset system are available online at http://ec.gc.ca/creditscompensatoires-offsets/default.asp?lang=En&n=0DCC4917-1.

[74] P.J. Partington, *Comments on the Proposed Federal Offset System, Canada's Offset System for Greenhouse Gases* (Drayton Valley, AB: The Pembina Institute, 2009). Available online at http://climate.pembina.org/pub/1868.

[75] Environmental Protection Agency.

[76] U.S. Department of Agriculture.

	Canada[56]	United States[57]	Mexico
the carbon price	compliance purposes, will be made at fixed prices (C$15/tonne CO_2e in 2010–12, C$20 in 2013, rising to ~C$23 by 2017).	5% plus inflation annually. Quarterly Strategic Reserve auctions will be held with an initial reserve price of US$28, rising 5% plus inflation annually.[77] If insufficient domestic offsets are available at or below the average allowance price, EPA may increase the allowed ratio of international to domestic offsets to 1.5 (without changing the total offset volume).	applied,[78] but its level is unknown.
Emissions quantification standards	Unknown	To be established by EPA, with a bias towards continous monitoring systems or systems of equivalent quality; reporting will be quarterly	Several Mexican states are members of The Climate Registry.[79]
Penalties for non-compliance	As established by the Canadian Environmental Protection Act (CEPA), including fines up to $1 million per day and imprisonment up to three years[80]	Two times the most recent auction clearing price for every tonne of emissions exceeding allowances held, plus the obligation to retire allowances equal to excess emissions in the following year (or a longer period as prescribed by EPA)	Unknown
Provisions for linking to other systems	The federal government has expressed interest in negotiating equivalency agreements with provinces, as provided for by CEPA, under which a	States are not permitted to operate cap-and-trade programs during the first six years of the federal program.	Unknown

[77] Strategic Reserve allowances may be used to meet up to 20% of an entity's compliance obligation. From 2015, the minimum reserve price will be set 60% above the 3-year rolling average of allowance prices.

[78] Gerard Wynn, "Mexico says to set climate targets, cap and trade," *Reuters*, December 11, 2008. Available online at http://www.reuters.com/article/latestCrisis/idUSLB641735.

[79] See http://www.theclimateregistry.org/

[80] Environment Canada, *Regulatory Framework for Air Emissions*, 20–21.

	Canada[56]	United States[57]	Mexico
	provincial policy meeting or exceeding the environmental performance of federal GHG regulations could replace the latter.[81] In addition, "Canada will actively work with U.S. partners to explore opportunities for linking Canada's emissions trading system with regulatory-based emissions trading systems at the regional and state level, and with any that may be established at the federal level. Canada will also actively explore cooperation on emissions trading with Mexico."[82,83]	Allowances from a foreign national or supra-national cap-and-trade system can be used for compliance (subject to approval by EPA) if it "imposes a mandatory absolute tonnage limit"[84] and "is at least as stringent" as the U.S. system "including provisions to ensure at least comparable monitoring, compliance, enforcement, quality of offsets, and restrictions on the use of offsets." EPA may limit the amount of foreign allowances that an entity can use for compliance.	

[81] Ibid., 8–9.

[82] Ibid., 15.

[83] More recently, the federal government has expressed its desire to "develop and implement a North America-wide cap and trade system for greenhouse gases" (see Section 4).

[84] Allowances from a system lacking an absolute cap are explicitly disallowed.

Table B 2. Regional systems

	Western Climate Initiative (WCI)[85]	Regional Greenhouse Gas Initiative (RGGI)[86]	Midwestern Greenhouse Gas Reduction Accord (MGRA)[87]
Status of policy	Design recommendations have been finalized by state/provincial officials; the "final model trading rule" is due in 2010; state/provincial legislation/regulations are at various stages of advancement.	In effect	Draft Final Recommendations were issued by the Advisory Group, which includes representatives of state and provincial governments, in June 2009.
Date cap takes effect	January 1, 2012; full coverage of fuel combustion starting in 2015	January 1, 2009	January 1, 2012
Sectors covered and thresholds	Electricity generation and other industrial facilities above 25kt CO_2e/yr (2012) (electricity imports are also covered), remaining fuel combustion (including transportation, buildings and other industry, regulated at the wholesale level) (2015)	Fossil fuel-powered electricity generation (facilities above 25MW)	Electricity generation facilities above 25kt CO_2e/yr and 25 MW (electricity imports are also covered), other industrial facilities above 25kt CO_2e/yr, remaining fuel combustion (including transportation, buildings and other industry, regulated at the wholesale level)[88]
Gases covered	CO_2, CH_4, N_2O, SF_6, PFCs, HFCs	CO_2	CO_2, CH_4, N_2O, SF_6, PFCs, HFCs

[85] Unless otherwise cited, all information is from WCI, *Design Recommendations for the WCI Regional Cap-and-Trade Program*.

[86] Unless otherwise cited, all information is from:

- RGGI, *Regional Greenhouse Gas Initiative Model Rule — 12/31/08 final with corrections* (RGGI, 2008). Available online at http://www.rggi.org/docs/Model%20Rule%20Revised%2012.31.08.pdf.
- RGGI, *Overview of RGGI CO_2 Budget Trading Program* (RGGI, 2007). Available online at http://rggi.org/docs/program_summary_10_07.pdf.

[87] Unless otherwise cited, all information is from MGRA, *Midwestern Greenhouse Gas Reduction Accord: Draft Final Recommendations of the Advisory Group.*

[88] Manitoba will include remaining fuel combustion (transportation and buildings) beginning in 2015 only.

Cap level and type	Absolute cap: • approx. 15% below 2005 level by 2020[89] • post-2020 caps will be set no less than three years in advance	Absolute cap: • 10% below 2009 level by 2018	Absolute cap: • 20% below 2005 level by 2020[90] • 80% below 2005 level by 2050
Timing of compliance periods	Triennial (2012–14, 2015–17, etc.)	Triennial (2009–11, 2012–14, etc.)	Triennial (2012–14, 2015–17, etc.)
Projected carbon price signal (2012, 2015, 2020)	US$6/tonne CO_2e in 2015 US$24/tonne CO_2e in 2020	~US$2.50/short ton[91] CO_2 in 2012[92] ~US$3 in 2015 ~US$4 in 2020[93]	Unknown
Extent of allowance auctioning	States/provinces must auction at least 10% of allowances from 2012, rising to 25% in 2020. Jurisdictions are free to set higher levels of auctioning.	States must auction at least 25% of allowances, though most have committed to auction all or nearly all allowances. In 2009, ~90% of allowances were auctioned.[94]	There will be an initial regional auction of ~5% of the allowances. The remaining allowances will be mostly auctioned in some sectors, and mostly allocated at "modest fixed fees" in others. There is to be a transition to 100% auctioning during the fourth-to-sixth compliance periods (2021–29).
Use of	States/provinces must direct an	At least 25% of the allowance value	All allowance value is to be directed to

[89] The WCI regional cap will be an aggregate of all the state/provincial caps. It is expected to be consistent with the WCI goal of a 15% reduction in total emissions below the 2005 level by 2020.

[90] This will fall to 18% below 2005 if all allowances are released from the reserve pool (see below).

[91] One short ton = 0.907 tonne.

[92] At the most recent auction, the clearing price for 2012 vintage allowances was US$1.87. See http://www.rggi.org/co2-auctions/results.

[93] ICF Consulting, *RGGI Preliminary Electricity Sector Modeling Results: Phase III RGGI Reference and Package Scenario* (Fairfax, VA: ICF Consulting, 2006), 8. Available online at http://www.rggi.org/docs/ipm_modeling_results_10.11.06.ppt.

[94] Environment Northeast, *Cap-&-Trade Comparison: The Regional Greenhouse Gas Initiative (RGGI) vs. The Western Climate Initiative (WCI)* (Rockport, ME: ENE, 2008). Available online at http://www.env-ne.org/public/resources/pdf/ENE_RGGI_WCI_Comparison.pdf.

allowance value	unspecified portion of allowance value to climate-related public purposes. Use of remaining allowance value is at the jurisdictions' discretion.	must be applied to consumer benefit programs. However, nearly all states have committed to apply >90% of the allowance value to public benefit programs, especially energy efficiency.[95]	"climate-related purposes" defined as "(1) accelerating transformational investment; (2) mitigating transitional adverse impacts of the program; and (3) addressing harmful impacts due to climate change." Where allowances are allocated at fixed fees, the Advisory Group recommends that "strong legal mechanisms" be implemented to ensure value is used as intended.
Additional compliance options	"Domestic" offsets (from within the WCI region), "international" offsets (from elsewhere in the U.S., Canada and Mexico, plus CERs[96]) and allowances from other approved cap-and-trade systems: up to 49% of total emission reductions between 2012 and 2020, relative to the 2012 cap level (the 49% limit is recommended to be applied at the entity level[97]) Banking: unlimited Borrowing: none Other: Early Reduction Allowances (for reductions during 2008–12, additional to cap, criteria to be developed)	"Domestic" offsets (from within the RGGI region plus other approved U.S. states): up to 3.3% of an entity's compliance obligation, or 5–10% if allowance price thresholds are crossed (see below) International offsets: CERs and ERUs[98] but only if a price threshold is crossed (see below), counted as domestic offsets when applying the 10% limit (see above) Banking: unlimited Borrowing: none (although the compliance period will be extended to four years if a price threshold is	"Domestic" offsets (from with the MGRA region plus other approved states/provinces): up to 20% of an entity's compliance obligation International offsets: potentially in the second and subsequent compliance periods Banking: unlimited Borrowing: limited from the following two years, with interest Other: none

[95] Environment Northeast, *RGGI Allowance Allocations & Auction Proceeds Distribution Plans* (Rockport, ME: ENE, 2009). Available online at http://www.env-ne.org/public/resources/pdf/ENE_Auction_Tracker_20090921.pdf.

[96] Offsets from elsewhere in the U.S., Canada and Mexico are limited to "projects... subject to comparably rigorous oversight, validation, verification, and enforcement as those located within the WCI jurisdictions" and, in the case of the U.S. and Canada, cannot come from sectors covered by cap-and-trade in the WCI. CERs may also be subject to additional criteria.

[97] WCI, *Offset Limit Recommendation Paper — CSAD 5 Committee Recommendation to Partners* (WCI, 2009), 19. Available online at http://www.westernclimateinitiative.org/component/remository/func-startdown/145/.

[98] Credits issued under the Kyoto Protocol's Joint Implementation mechanism.

		crossed — see below) Other: covered sources may apply for Early Reduction Allowances (for reductions during 2006–08, additional to cap)	
Offset types and standards	States/provinces are to develop "rigorous" standards and protocols collectively. Priority project activities are identified as agriculture, forestry and waste management. Detailed recommendations for offset rules are still being developed.	Offset standards are the respsonsibility of states. Project types are currently limited to landfill gas, SF_6 reduction, afforestation, reduction in fuel combustion from end-use efficiency in the building sector, and agricultural methane.[99]	Standards and protocols are to be developed at the regional level, with all projects subject to approval by states/provinces. "Reductions... must be shown to be 'in addition to' reductions that would have occurred without the incentive provided by [the] offset credit."
Mechanisms to constrain the carbon price	The first 5% of auctioned allowances must meet a minimum reserve price (to be determined). Any allowances not sold at that price will be retired and/or banked by states/provinces.	If the 12-month average allowance price exceeds US$7/ton (initial level), the offset limit is temporarily relaxed to 5% of an entity's compliance obligation. If the 12-month average price exceeds US$10 (initial level), the offset limit rises to 10%, the compliance period is extended to four years, and international offsets are allowed.	If allowance prices are "too high"/"too low," borrowing and offset limits may be expanded/contracted. If allowance prices are "substantially" above/below "the expected range," extra allowances may be issued / allowances may be withdrawn to a reserve pool.
Emissions quantification standards	States/provinces have agreed detailed quantification rules.[100] All covered emissions are subject to third party verification.	Quantification is based on existing U.S. EPA reporting requirements.	The Advisory Group recommends quantification using the Climate Registry Information System.
Penalties for non-compliance	Obtain and surrender three allowances for every tonne of emissions exceeding allowances held (plus any additional	Obtain and surrender three allowances for every ton of emissions exceeding allowances held (plus any additional	System-wide penalty to be determined; states/provinces may apply additional penalties

[99] RGGI, *Offset Project Categories*, http://www.rggi.org/offsets/categories (accessed November 18, 2009).

[100] WCI, *Final Essential Requirements of Mandatory Reporting* (WCI, 2009). Available online at http://www.westernclimateinitiative.org/component/remository/func-startdown/118/.

	penalties that states/provinces may apply)	penalties that states may apply)	
Provisions for linking to other systems	States/provinces will seek linkages with other government-approved cap-and-trade systems, but the criteria for linking have not been decided. In the absence of formal links, any "non-WCI allowances [used for compliance] must meet the rigorous criteria established by the WCI Partner jurisdictions," and are included in the 49% usage limit (see above).	None	The Governors and Premier have committed to design the system "to enable linkage to other jurisdictions' systems to create economies of scale, increase market efficiencies, diversity and liquidity, while reducing costs."[101] The Advisory Group recommends that an effort be made to link the system to RGGI, WCI, EU ETS and "other mandatory GHG reduction programs as appropriate," but without specifying criteria for linking.

[101] Midwestern Governors' Association, *Midwestern Greenhouse Gas Reduction Accord* (MGA, 2007), http://www.midwesternaccord.org/midwesterngreenhousegasreductionaccord.pdf.

Table B 3. Canadian provincial systems

	BC carbon tax[102]	**Alberta**[103]	**WCI member provinces (BC, MB, ON, QC)**[104]
Status of policy	In effect	In effect	Enabling legislation has been passed or introduced in BC,[105] ON,[106] and QC.[107]
Date cap takes effect	July 1, 2008 (tax, not cap)	July 1, 2007	Start date of January 1, 2012 (consistent with WCI) now anticipated for all provinces
Sectors covered and thresholds	All emissions from fossil fuel combustion included in Canada's National Inventory Report for GHGs	All facilities emitting more than 100kt CO_2e/yr.	
Gases covered	CO_2, CH_4, N_2O	CO_2, CH_4, N_2O, SF_6, HFCs, PFCs	

[102] Unless otherwise cited, all information is from British Columbia Ministry of Finance, *Budget and Fiscal Plan 2008/09 – 2010/11* (Victoria, BC: Ministry of Finance, 2008). Available online at http://www.bcbudget.gov.bc.ca/2008/bfp/2008_Budget_Fiscal_Plan.pdf.

[103] Unless otherwise cited, all information is from: Government of Alberta, *Specified Gas Emitters Regulation* (Alberta Regulation 138/2007). Available online at http://www.qp.alberta.ca/574.cfm?page=2007_139.cfm&leg_type=Regs&isbncln=9780779738151.

[104] Only divergences from the WCI's core system design (see Table B2) are noted in this table. For further information on provincial climate policies in BC, AB, ON and QC, see Pembina Institute, *Highlights of Provincial Greenhouse Gas Reduction Plans* (Drayton Valley, AB: The Pembina Institute, 2009). Available online at http://climate.pembina.org/pub/1864.

[105] *Greenhouse Gas Reduction (Cap and Trade) Act of 2008*. Available online at http://leg.bc.ca/38th4th/3rd_read/gov18-3.htm.

[106] Bill 185. Available online at http://www.ene.gov.on.ca/envision/env_reg/er/documents/2009/010-6467%202.pdf.

[107] Project de loi n° 42. Available online at http://www2.publicationsduquebec.gouv.qc.ca/dynamicSearch/telecharge.php?type=5&file=2009C33F.PDF.

	BC carbon tax[102]	Alberta[103]	WCI member provinces (BC, MB, ON, QC)[104]
Cap level and type	n/a	Emissions intensity cap built up from facility-level intensity targets: • Existing facilities — 12% below average intensity for 2003–05 • New facilities (beginning operation in 1999 or later) — not covered for first three years, target then gradually tightened to reach, in the ninth year of operation, 12% below the intensity measured in the third year.	Absolute caps on covered emissions will be influenced by, but will not be necessarily identical to, the targets for total provincial emissions adopted by each province:[108,109] BC: −6% by 2012, −18% by 2016, −33% by 2020, all relative to the 2007 level MB: −6% by 2012 relative to the 1990 level ON: −6% by 2014, −15% by 2020, both relative to the 1990 level QC: −20% by 2020 relative to the 1990 level
Timing of compliance periods	n/a	Annual	
Projected carbon price (2012, 2015, 2020)	C$30/tonne CO_2e in 2012; tax rate not yet determined for subsequent years	Unless the rate of payments into the technology fund (see below) is altered, the carbon price will not exceed C$15/tonne CO_2e.	
Extent of allowance	There are no allowances but the tax is equivalent to a cap-and-trade system	None (there are no allowances but the system is equivalent to one with all	

[108] See Pembina Institute, *Highlights of Provincial Greenhouse Gas Reduction Plans*. For Manitoba, see *The Climate Change and Emissions Reductions Act*. Available online at http://web2.gov.mb.ca/laws/statutes/ccsm/c135e.php. For Quebec, see Ministère du Développement durable, de l'Environnement et des Parcs, "Cible de réduction des émissions de GES," news release, November 23, 2009. Available online at http://www.mddep.gouv.qc.ca/infuseur/communique.asp?No=1591.

[109] The WCI regional cap will be an aggregate of all the state/provincial caps. It is expected to be consistent with the WCI goal of a 15% reduction in total emissions below the 2005 level by 2020.

	BC carbon tax[102]	Alberta[103]	WCI member provinces (BC, MB, ON, QC)[104]
auctioning	with 100% of allowances auctioned.	allowances distributed free of charge)	
Use of allowance value	All tax revenue (equivalent to allowance value) is returned to taxpayers via personal and business income tax reductions.	100% of implied allowance value is distributed to covered facilities in proportion to production levels.	QC: any auction revenue must be used to support GHG emission reductions, mitigate economic or social impacts of emission reduction efforts, raise public awareness, adapt to climate impacts, or support the province's participation in relevant regional or international partnerships.[110]
Additional compliance options	Municipal governments pay no net carbon tax (their tax payments are fully refunded) if they commit to become carbon neutral by 2012 (and publicly report their progress towards that goal).[111]	Domestic offsets: unlimited, but only from projects in Alberta International offsets: no Borrowing: no Banking: unlimited Other: unlimited payments into a technology fund	
Offset types and standards	The offsets used by municipal governments to receive a refund of their carbon tax payments (see above) will presumably have to meet the provincial offset regulation (see right-hand column).	Any measurable emission reduction occurring in Alberta in 2002 or later as a result of an activity not required by law is eligible for offset credits. Protocols are approved by Alberta Environment based on submissions. Reductions occurring for reasons other than the incentive provided by the	BC: A regulation on the offsets system has been finalized. Offset projects must begin active operation no earlier than November 29, 2007, and project proponents must assert "that there are financial, technological or other obstacles to carrying out the project that are overcome or partially

[110] Project de loi n° 42.

[111] Ministry of Community and Rural Development, *Climate Action Revenue Incentive Program (CARIP)*, http://www.cd.gov.bc.ca/lgd/greencommunities/carip.htm (accessed November 18, 2009).

	BC carbon tax[102]	Alberta[103]	WCI member provinces (BC, MB, ON, QC)[104]
		offset system are eligible. Verification requirements are vague.[112]	overcome by the incentive of having a greenhouse gas reduction recognized as an emission offset." There is no specific limitation of project types.[113]
Mechanisms to constrain the carbon price	The carbon tax fixes the carbon price at pre-determined levels.	Payments into the technology fund are made at a fixed price of C$15/tonne CO_2e.	
Emissions quantification standards	Emissions are quantified as the product of emission factors and fuel volumes.	Emitters are free to use any quantification metholodolgy "widely accepted by the industry to which the facility belongs."[114]	
Penalties for non-compliance	Standard provisions for tax collection.	Fine of "not more than" C$200 for every tonne of emissions exceeding a facility's intensity target. Facility "may" also be required to obtain offsets or emission performance credits,[115] or make payments to the technology fund.	
Provisions for linking to other systems	"By 2012, the WCI Partner jurisdictions will determine the mechanism for integrating the cap-and-trade program with the BC carbon tax."[116]	None	

[112] Partington, 20.

[113] *Greenhouse Gas Reduction Targets Act Emission Offsets Regulation*. Available online at http://www.env.gov.bc.ca/epd/codes/ggrta/pdf/offsets-reg.pdf.

[114] Alberta Environment, *Specified Gas Reporting Standard* (Edmonton, AB: Government of Alberta, 2009), 10. Available online at http://environment.alberta.ca/697.html.

[115] Emission performance credits are issued when a facility's emissions are below its intensity target.

[116] WCI, *Design Recommendations for the WCI Regional Cap-and-Trade Program*, 4.

C. Competitiveness modelling

C.1. Modelling methodology

We first use the CIMS energy technology model to explore the linked and unlinked allowance trade scenarios in 2020. CIMS provides indicators of abatement costs and potential given coverage, stringency and limits on offsets. This then determines the allowance price and the compliance shortfall that international offsets can fill subject to limits.

- The CIMS model simulates the technological evolution of fixed capital stocks in Canada (such as buildings, vehicles, and equipment) and the resulting effect on costs, energy use, emissions, and other material flows of various carbon polices such as pricing and standards. With the carbon policy, old stocks are retrofitted to reflect the increased cost of carbon while new and less emission-intensive capital stocks are acquired at retirement and with growth in stock demand (e.g., rising electricity demand). Market shares of technologies competing to meet new stock demands with the carbon policy are determined by standard financial factors as well as behavioural parameters from empirical research on consumer and business technology preferences. CIMS is maintained by researchers at Simon Fraser University.

To supplement CIMS, and to study the macroeconomic implications for Canada of carbon polices, we use a static computable general equilibrium and emissions model, GEEM. The allowance prices and flows that emerge from CIMS are then fed into GEEM to calculate the macroeconomic outcomes.

- The version of GEEM used for this paper is a static general equilibrium model of the Canadian economy in 2020. In the model, a representative household supplies labour and capital to industrial sectors. The industrial sectors supply intermediate inputs to one another, and final commodities to the household. Imports and exports to the rest of the world are explicitly modelled. All markets interact through relative producer and consumer prices with policy shocks changing these prices, leading to new equilibriums in the various markets. GEEM was developed based on a collaborative research effort between Nic Rivers, Chris Bataille, Jotham Peters (Simon Fraser University) and Dave Sawyer (Sawyer EnviroEconomic Consulting).

Finally, to determine the implications of linked allowance trade between Canada and the U.S., we develop a partial equilibrium model of Canada-U.S. allowance trading.

- Abatement choices in the model are made that minimize compliance costs subject to emission reduction targets, policy coverage, and cost containment measures such as offsets. The model then solves for the equilibrium allowance price in 2020, subject to sector abatement responses and compliance choices. Allowance flows, both between sectors and countries, are then a function of the mix of compliance that comes from abatement and the compliance mechanisms. Canadian abatement cost curves are developed from CIMS. U.S. abatement cost curves are from ten model runs of H.R. 2454 (Waxman-Markey) completed by the Energy Information Administration.

C.2. Competitiveness tests in H.R. 2454 and EU ETS Phase III

H.R. 2454 contains the following tests for competitiveness impact:

1. If the emissions intensity, defined as ($20/tonne[117] × emissions)/ value of shipments, is equal to or greater than 5% or
2. if the energy intensity, defined as costs of fuel purchase divided by the value of shipments, is equal to or greater than 5%;[118] and
3. if the trade intensity, defined as (total value of imports and exports) / (total value of shipments and imports), is equal to greater than 15%;

then sectors qualify for special remedial treatment.

H.R. 2454 excludes petroleum refining from special treatment despite meeting the three criteria above. The implication is that H.R. 2454 is using a fourth qualitative criterion: evidence in refined petroleum markets of passing costs through to consumers.

The EU ETS Phase III method uses trade intensity baseline information but adds the impact of carbon costs to demonstrate carbon exposure:

1. If trade intensity, defined as (total value of imports and exports) / (total value of turnover and imports), is greater than 10%; and
2. if the carbon exposure, defined as direct abatement costs and indirect carbon costs from purchased fuel divided by gross value added, is greater than 5%;

then sectors qualify for special remedial treatment.[119]

The EU ETS goes further in that it adds additional analysis that seeks to determine if investment leakage is possible and if the impacts might change over time. Specifically, the EU states that it will assess
the impact on profit margins as an indicator of investment decisions and relocation and market characteristics (current and projected), including when trade exposure or direct and indirect costs are close to identified thresholds.

[117] The value $20/tonne could be a proxy for a sector's compliance cost, but this is not made clear in H.R. 2454. Since it is a fixed value, it is not that useful to compare costs across sectors. Or if compliance costs are higher or lower, it would not measure the actual impact.

[118] If the emissions intensity or energy intensity is at least 20%, there is no need to demonstrate trade exposure.

[119] Sectors meeting even higher thresholds qualify for additional special treatment.

C.3. Detailed results by sector

Table C 1. H.R. 2454 Competitiveness Impact Tests Applied to Canadian Four-Digit NAICS Industries in 2005[120]

NAICS	NAICS Description	Energy Intensity	Emissions Intensity	Emission or Energy Exposed?	Trade Exposure	Trade Exposed?	Intensive and Trade Exposed?
2111	Oil and Gas Extraction	5%	4.82%	Yes	126%	Yes	Yes
2120	Mining	7%	0.61%	Yes	18%	Yes	Yes
2211	Electric Power Generation	14%	6.30%	Yes	11%	No	No
Pulp and Paper							
3211	Sawmills and Wood Preservation	3%	0.14%	No	66%	Yes	No
3212	Veneer, Plywood and Wood Product Manufacturing	4%	0.14%	No	78%	Yes	No
3219	Other Wood Product Manufacturing	1%	0.14%	No	36%	Yes	No
3221	Pulp, Paper and Paperboard Mills	14%	0.65%	Yes	84%	Yes	Yes
3222	Converted Paper Product Manufacturing	2%	0.13%	No	39%	Yes	No
3241	Petroleum and Coal Products Manufacturing	2%	0.13%	No	34%	Yes	No

[120] Sources:

Statistics Canada CANSIM tables: gross output 381-0009, value added and energy expenditure 152-0005, 301-0006, emissions 153-0034.

Industry Canada Trade Statistics Online.

Chemicals							
3251	Basic Chemical Manufacturing	9%	1.49%	Yes	77%	Yes	Yes
3252	Resin, Synthetic Rubber, Fibres Manufacturing	9%	0.55%	Yes	77%	Yes	Yes
3253	Agricultural Chemical Manufacturing	8%	4.61%	Yes	54%	Yes	Yes
3254	Pharmaceutical and Medicine Manufacturing	1%	0.03%	No	69%	Yes	No
3259	Other Chemical Product Manufacturing	2%	0.03%	No	62%	Yes	No
Industrial Minerals							
3273	Cement and Concrete Product Manufacturing	21%	13.39%	Yes	45%	Yes	Yes
3279	Other Non-Metallic Mineral Product Manufacturing	8%	4.97%	Yes	65%	Yes	Yes
Iron, Steel and Aluminum							
3311	Iron and Steel Mills and Ferro-Alloy Manufacturing	10%	1.2%	Yes	61%	Yes	Yes
3312	Steel Product Manufacturing from Purchased Steel	2%	1.2%	No	65%	Yes	No
3313	Alumina and Aluminum Production and Processing	19%	1.2%	Yes	149%	Yes	Yes
3314	Non-Ferrous Metal (except Aluminum)	10%	1.2%	Yes	138%	Yes	Yes
3315	Foundries	1%	1.2%	No	7%	No	No

Table C 2. H.R. 2454 Competitiveness Impact Tests Applied to Canadian Three-Digit NAICS Industries in 2020[121]

	Energy Intensive >5%	or Emission Intensive >5%	Trade Exposed >15%	Intensive and Exposed?
Chemical Products	4.6%	0.19%	71%	Yes
Industrial Minerals	8.4%	3.44%	45%	Yes
Smelting, Iron and Steel	5.0%	0.22%	73%	Yes
Mineral Products	5.0%	0.25%	57%	Yes
Paper Products	8.4%	0.19%	80%	Yes
Electricity	12.2%	3.60%	13%	No
Refined Petroleum Products	8.0%	0.60%	59%	Yes
Oil and Gas	12.9%	1.37%	71%	Yes

Table C 3. Carbon Exposure for Canadian Four-Digit NAICS Industries ($30/tonne CO_2e Carbon Price multiplied by compliance obligation, divided by 2005 Value Added) [122]

NAICS	NAICS Description	Carbon Exposure >5%?	Carbon Exposed?
2111	Oil and Gas Extraction	7%	Exposed
2120	Mining	1%	Not Exposed
2211	Electric Power Generation	8%	Exposed
Pulp and Paper			
3211	Sawmills and Wood Preservation	0%	Not Exposed
3212	Veneer, Plywood and Wood Product Manufacturing	0%	Not Exposed

[121] Source: GEEM modelling.

[122] Source: GEEM modelling for carbon costs; Statistics Canada for value added. This overestimates the carbon exposure because the value added in 2020 will be significantly larger than in 2005.

3219	Other Wood Product Manufacturing	0%	Not Exposed
3221	Pulp, Paper and Paperboard Mills	1%	Not Exposed
3222	Converted Paper Product Manufacturing	0%	Not Exposed
3241	Petroleum Refining	1%	Not Exposed
Chemicals			
3251	Basic Chemical Manufacturing	3%	Not Exposed
3252	Resin, Synthetic Rubber, Fibres Manufacturing	1%	Not Exposed
3253	Agricultural Chemical Manufacturing	9%	Exposed
3254	Pharmaceutical and Medicine Manufacturing	0%	Not Exposed
3259	Other Chemical Product Manufacturing	0%	Not Exposed
Cement			
3273	Cement and Concrete Product Manufacturing	12%	Exposed
3279	Other Non-Metallic Mineral Product Manufacturing	1%	Not Exposed
Iron, Steel and Aluminum			
3311	Iron and Steel Mills and Ferro-Alloy Manufacturing	2%	Not Exposed
3312	Steel Product Manufacturing from Purchased Steel	2%	Not Exposed
3313	Alumina and Aluminum Production and Processing	1%	Not Exposed
3314	Non-Ferrous Metal (except Aluminum)	1%	Not Exposed
3315	Foundries	5%	Exposed