Review of Destination Country Policies with Potential to Impact Demand for Canadian Oil Exports

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Executive Summary

Past experience suggests that the next three decades will bring dramatic changes in the environmental laws of both developed and developing countries. A period of less than two decades in the late twentieth century saw developed countries such as Canada, the US, and Japan pass numerous environmental laws, establish new regulatory bodies, and promulgate regulations for a broad range of industrial sectors and product categories, with resulting dramatic reduction of air and water pollution. These countries are now turning their attention to climate change, and it is likely that a similar pace of policy change with respect to fossil fuels and greenhouse gas emissions will occur in the decades to come. The rate of policy change can be expected to be even greater in developing countries, which are just beginning to turn serious attention to pollution control. While these countries have a great deal of catching up to do in establishing their environmental policy regimes, it is striking that rapidly developing countries such as China and India are increasingly matching environmental standards of their wealthier counterparts. The pace of change will be especially rapid to the extent that these countries "leapfrog" to match standards of the industrialized world.

In concrete terms, attention to climate change is prompting governments to demand greater fuel economy from motor vehicles, regulate the life cycle emissions of transportation fuels, actively promote alternate transportation fuels and vehicle technologies, and adopt pricing of carbon emissions across their economies. There is every reason to anticipate that fuel and vehicle standards in place today in the USA, Japan, and South Korea will be regularly strengthened in years to come, and that carbon pricing regimes will be extended with a steadily increasing price. It is thus projected that oil demand will decrease in the US, Japan, and South Korea.

The rate of economic growth combined with historically lower environmental standards in India and China create greater uncertainty with respect to the implications of public policy change for petroleum

consumption in those countries. Although late entrants to environmental regulation, in the last decade both China and India have matched the strictest global standards for fuel efficiency, and they also are actively pursuing low-carbon economic opportunities. Particularly noteworthy is China's recent commitment to cap its greenhouse gas emissions by 2030 at the latest. This will not only prompt rapid policy change in China, but also provides reassurance to developed and developing countries alike, thus increasing the chances of an international climate treaty in late 2015.

If the international community maintains its commitment to limit climate change to 2C, it is projected that international demand for oil will peak as early as 2020 and decline thereafter. In this scenario, it is likely that demand for Canada's bitumen will experience a greater decline than light crudes due to heavy oil's greater cost and higher emissions, both at the point of production and downstream combustion.

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Author's Qualifications and Terms of Reference

1. I have a Ph.D. in political science from the University of British Columbia, Master of Science degrees in political science and chemical engineering from the Massachusetts Institute of Technology, and a Bachelor of Engineering Science degree from the University of Western Ontario. I am a Professor of Political Science at the University of British Columbia, where I have been a faculty member since 1993. I previously worked as a chemical engineer, and as a policy analyst for Environment Canada and the US Congress. I have consulted for the Governments of Alberta and Canada, the National Roundtable on Environment and Economy, the US Congress, and the OECD.

2. I am a specialist in comparative environmental policy, with a focus for the last decade on climate change policy. I am the author or editor of five books and several dozen peer-reviewed journal articles and book chapters. My research has been recognized with two Fulbright Fellowships, a UBC Killam Faculty Research Fellowship, the Gilbert White Fellowship at Resources for the Future, the Edward Clarence Dyason Fellowship at Melbourne University, and the KD Srivastava Prize from UBC Press, among others. My curriculum vitae is attached as Appendix A.

3. I have been retained by the City of Vancouver to review the regulatory frameworks currently in place or proposed by jurisdictions other than Canada to limit or reduce greenhouse gas (GHG) emissions, and the implications that such regulatory frameworks may have for Canada's petroleum exports generally and, more specifically, the long-term economic feasibility of the Trans Mountain Pipeline Expansion Project (TMEP), which is currently under review by the National Energy Board (NEB). Trans Mountain's application anticipates that oil shipped to the coast via the TMEP will be exported to California, Japan, South Korea, China, India, Singapore, and Taiwan. This report reviews existing and

projected public policies in the first five of these jurisdictions that have or are likely to have implications for those countries' oil demand.

4. I have drawn on a variety of data sources, including specialized environmental media, national newspapers, academic literature, government reports and websites, and reports by international agencies and think tanks. Two sources are of particular note. The International Energy Agency provides an online compendium of national policies and measures for energy efficiency, alternative energy, and climate change. Similarly, "transportpolicy.net" provides a detailed breakdown of transportation-related measures by country. Globe International, an organization of former legislators, has been tracking evolution of climate change legislation and regulation since 1997, and also provides periodic summaries of the state of national climate policies.

Global Overview

5. **At the outset, it is important to note that the 30-year economic case for the Trans Mountain Expansion Project, while conservative in terms of the life of a pipeline, is equivalent to several lifetimes of environmental policy. It is thus difficult to say with certainty what the state of environmental regulations will be in destination countries for the next 30 years, other than to say it is inconceivable that it would be stagnant. It is a virtual certainty that legal requirements and regulatory standards will become more stringent over time.**

6. A period of roughly two decades from 1970 to 1990 saw the passage, and in many cases subsequent amendments, of numerous environmental statutes and associated regulations that still form the framework for US environmental policy today, creation of federal and state environmental protection agencies, and dramatic reductions in air and water pollution (Andrews, 2006). Japan and Canada experienced similarly rapid environmental policy development over the same period (Harrison, 2011; Suzuki, Hayashi, & Kato, 2011). In each case, the impetus for action was a combination of high-profile environmental concerns/incidents and increasing economic prosperity.

7. The growing level of public concern with respect to urban air quality, and the rapidly emerging governmental response, suggests that China is poised for a similar period of environmental policy development. However, unlike industrialized economies which developed modern environmental law frameworks at roughly the same time in the 1970s, China and other developing countries are in a position to take advantage of policy approaches and new pollution control technologies to "leap frog" to the same level of environmental protection as their wealthier counterparts. As discussed below, there is evidence that developing Asian economies are not only willing to match OECD countries' environmental standards with respect to the transportation sector, but potentially to surpass them in aggressively pursuing alternative energy sources and vehicle technologies.

8. Developed and developing countries alike will be more inclined to pursue aggressive measures to address the global challenge of climate change if there is international agreement on a successor to the Kyoto Protocol in Paris in the fall of 2015. Already, it is promising that the US and China

reached agreement on climate action targets in 2014, and that COP20 in Lima in December 2014 for the first time yielded agreement that both developed and developing countries will offer commitments to limit their emissions. Any projection of the implications of current, or even currently planned, policies to reduce greenhouse gas emissions thus could easily be overtaken by stronger commitments within a year. The International Energy Agency (IEA) has modeled national and global emissions consistent with limiting climate change to the internationally-agreed target of 2C, which would entail peaking CO2 concentration in the atmosphere at 450 ppm. Underscoring the potential impacts of international action on Canada's exports, this "450 ppm scenario" finds that global oil consumption would need to peak as early as 2020 and decline thereafter, with projected demand in 2035 13% lower than in 2011.

9. As countries move to reduce their greenhouse gas emissions, reduction of petroleum demand is expected to be especially great for fossil fuel sources, such as Canada's oil sands, that are more costly, more emissions-intensive to recover, and more emissions intensive at the point of combustion. A recent analysis by McGlade and Ekins (2015) finds that although one third of the world's known oil reserves are "unburnable" to limit climate change to 2C, 75% of Canada's economically-viable oil reserves, and 85% of its bitumen reserves would be uneconomic to develop. Gordon et al (2015) report that bitumen from Canada's oil sands can result in up to 45% more emissions at the point of combustion. A clear implication of these two studies is that aggressive policies to limit greenhouse gas emissions adopted by the countries to which Canada exports could dramatically reduce demand for Canada's oil.

10. Different policies will affect import demand with varying degrees of directness and stringency. Given the dominant use of oil in transportation, the analysis here will focus on transportation-related policies, though even within that category there is potential for more or less direct impacts on the markets for bitumen from the TMEP. The policies with the most direct impacts are fuel standards that either prohibit or deter sale of fuels with highly carbon-intensive production, such as Canada's oil sands. More indirectly, policies that regulate or tax vehicle greenhouse gas emissions will decrease demand for all forms of oil, including oil sands. However, such policies may have a disproportionate impact on Canada's exports, since reduced demand

could be more readily met with less-costly conventional oil sources. Similarly, government efforts to develop alternative fuels, alternative vehicle technologies, and even public transit can be expected to constrain demand for oil. Finally, broadly applied carbon pricing policies, such as emissions trading and carbon taxes, have the potential to reduce demand for all fossil fuels. However, the fact that a policy has an indirect impact does not necessarily mean that it will have less impact; a high carbon price could have a greater impact on oil consumption than a weak standard for tailpipe CO2 emissions.

11. A question that has received increasing attention is whether governments can employ either policies such as low carbon fuel standards that extend their reach beyond the borders of the jurisdiction in question, or "border tax adjustments" (tariffs) to protect domestic products or processes from competitive disadvantage relative to imports from countries that do not have equally strong measures in place to reduce greenhouse gas emissions. A growing number of legal scholars have argued that well-designed border measures could be sustained by the World Trade Organization (Charnovitz 2002, Epps and Green 2010, Pauwelyn 2013, Low et al., 2012). The potential impact of border taxes on Canadian imports will, of course, depend on the comparative stringency of Canada's regulation of greenhouse gas emissions from oil production and transport. However, the effect of border taxes in destination countries could be significant in decreasing the competitiveness of Canada's relatively carbon-intensive oil exports.

12. The remainder of this section considers global trends and comparisons. Thereafter, the report reviews relevant policies in specific jurisdictions: California, Japan, South Korea, China, and India.

Global Comparisons

13. Recent comparisons of global climate and energy policies find there has been exponential growth of policy development in both developed and developing countries. With respect to transportation fuels, this is evident in a roughly 50% tightening of fuel economy limits in the decade from 2015 to 2025, with a very high degree of convergence between developed and rapidly developing country standards. Policies already announced have the potential to reduce fuel consumption in industrialized countries, while further strengthening of transportation policies in response to international climate agreements and national commitments could yield reductions even in rapidly growing markets in China and India.

14. Globe International, a non-partisan organization of former parliamentarians committed to sustainable development from over 80 countries, has been tracking evolution of climate change legislation and regulation since 1997. Over that period, there has been exponential growth in the stock of climate laws, from 40 in 1997 to 500 in 2013. Moreover, momentum in legislative activity has recently shifted from developed countries to developing and emerging economies (Nachmany et al., 2014).

15. Recent IEA reports offer insight into both the types of policies that might be expected in response to an international climate treaty that limits climate change to 2C, and the implications of those policies for demand for fossil fuels by particular countries or regions. The ambition of such policies far exceeds anything in place today, suggesting potential for dramatic policy change over the next three decades. For instance, the IEA's 450 ppm/2C (see paragraph 8, above) scenario assumes 2035 carbon prices of $100/tonne CO2eq in China, and $125/tonne in the US, Japan, and South Korea. In addition, stabilization of climate change at 2C "necessitates a shift to low-carbon fuels in the transport sector, as vehicle fuel-economy improvements alone will not lead to the steep emissions reductions required. … High expectations rest on the deployment of electric and plug-in hybrid vehicles" (IEA, 2013). In the medium term, IEA assumes motor vehicle greenhouse gas emissions of 60 g CO2/km by 2035, a level that is only about half the 2020 emissions targets for Japan and the EU. Adoption of this slate of policies would have significant implications for global oil imports. The IEA projects that oil

imports would be lower in 2035 by 3.6 million bbl/day for China, 2 million bbl/day for the EU, 1.3 million bbl/day for the USA, and 1 million bbl/day for India (IEA, 2013).

16. Analysis of transportation technologies suggests that such reductions are feasible, but demand significant policy change. The Global Fuel Economy Initiative (GFEI), a research organization whose members include the International Energy Agency and the United Nations Environment Program, tracks transportation fuel-economy policies and performance internationally, and provides practical support for countries in strengthening their fuel economy policies. GFEI has set a target to reduce new car fuel consumption globally by 50% relative to 2005 by 2030, a target also embraced by the UN High Level Panel on the Post-2015 Development Agenda. The US National Academy of Science projects that by 2050 internal combustion engines could achieve fuel economy between 2.0 and 2.5 L/100 km, three to four times more fuel-efficient than the current 2015 US standard, based on "aggressive extension of technologies already available on the market." Moreover, the fleet average fuel use could be further reduced to 1.0 to 1.5 L/100 km, through greater reliance on non-petroleum fuels, including biofuels, compressed natural gas, battery-electric vehicles, and fuel cells (Global Fuel Economy Initiative, 2014). GFEI projects that electric- and fuel cell-powered vehicles, which do not rely on oil, will be price-competitive with conventional oil-driven vehicles sometime between 2030 and 2040, within the life of the TMEP.

17. Table 1 summarizes the most recent fuel economy standards for passenger vehicles adopted by the US, China, South Korea, Japan, and India. The graphical presentation of this data in Figure 1 reveals two striking features. First, there is a significant trend in more demanding standards, with a roughly 50% tightening of fuel economy limits in the decade from 2015 to 2025. Second, there has been a high degree of convergence. Although unlike the US and Japan, South Korea, China, and India do not have decades of experience with regulation of vehicle fuel economy, in adopting their first fuel economy standards in the last decade, they matched the most demanding standards among OECD countries. This has been, and is likely to continue to be, facilitated by two factors. Global trade means that vehicles intended for sale in countries with world-leading regulatory standards often originate in other countries, including those in the developing world. When local

manufacturers are already producing state-of-the-art clean vehicles, it is easier for the home jurisdiction to establish similar regulatory mandates within its own jurisdiction. Second, international organizations, such as the Global Fuel Economic Initiative, actively facilitate transfer of regulatory expertise, as discussed below in the cases of China and India.

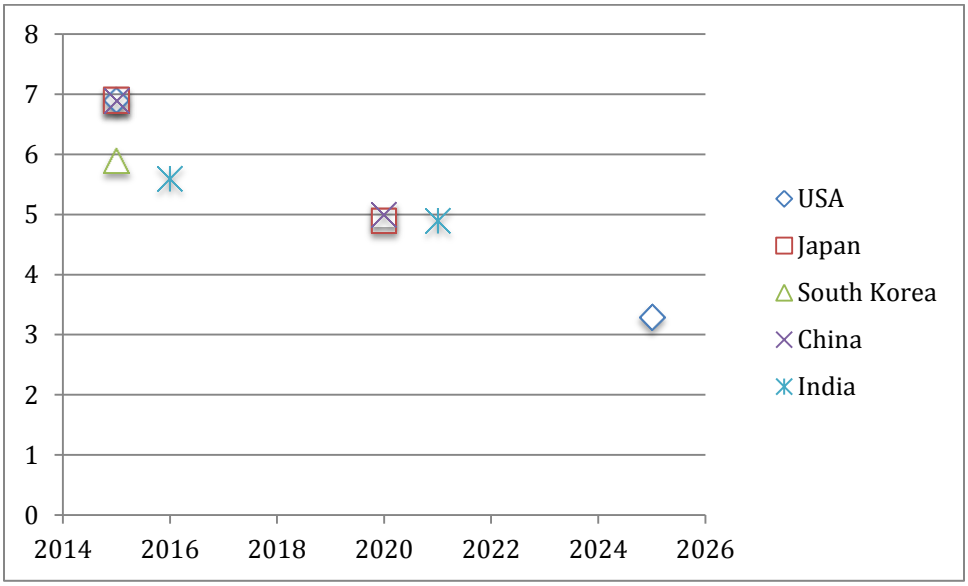
18. Regulatory stringency is also advancing for heavy-duty vehicles, which tend to contribute a greater share of transportation fuel use and emissions in developing countries. As discussed in greater detail below, Japan adopted the first heavy duty vehicle fuel economy standards in 2005, setting a deadline for 2015. The US followed in 2011 with standards that will be phased in between 2014 and 2018. China followed in 2012. All three jurisdictions are now engaged in development of stricter standards for freight vehicles. GFEI projects that adoption of standards that rely on already available technologies could stabilize heavy duty vehicle emissions globally by 2020 to 2025 and yield emissions (and fuel consumption) reductions thereafter (Global Fuel Economy Initiative, 2014)

Table 1 – Comparison of National Fuel Economy Standards

Country	Target Year	Standard Type	km/L	g CO2/km	L/100km
USA	2016	Corporate avg, cars + light trucks	34.1 mpg 14.5 km/L*	250 g/mi 158 g/km*	6.9
USA	2025	Corporate avg, cars + light trucks	49.1 mpg 29.9 km/L*	165 g/mi 104 g/km*	3.3
Japan	2015	Corporate avg, cars	16.8	106*	6.9
Japan	2020	Corporate avg, cars	20.3	114*	4.9*
South Korea	2015	Corporate avg, cars + SUVs	17	140	5.9*
China	2015	Class-based + corporate avg, cars + SUVs	14.5*	160	6.9
China	2020	Class-based + corporate avg, cars + SUVs	20.0*	116	5
India	2016	Corporate average, cars	17.8*	130	5.6*
India	2021	Corporate average, cars	20.4	113	4.9*

Source: GFEI, 2014. India updated reflecting final standard adopted in 2014. Items marked by an asterisk (*) are the author's calculations based on data in other columns.

Figure 1 - Corporate average fuel economy limits for passenger vehicles (L/100km)



USA

19. California is a global leader in addressing greenhouse gas emissions. The state pioneered regulation of GHG emissions from motor vehicles, low carbon fuel standards, and aggressive mandates for production and sale of zero emission vehicles. In 2015, it became the first jurisdiction to extend its cap-and-trade program to transportation fuels. Oil consumption declined by 20% from 2002 to 2014, and it is projected to decline a further 9 to 13% by 2020. Nondiscretionary mandates for regulators to achieve legislative emissions targets can be expected to yield continually more stringent standards and continually declining demand for oil.

Targets

20. Since the United States, like Canada, is a federal system, economic activity in the state of California is potentially subject to both state and national policies. In the case of climate and transportation-related policies, there is significant overlap and, indeed, interactions between the two orders of government.

21. The US climate target, adopted at COP15 in Copenhagen, was to reduce US greenhouse gas emissions to 17% below 2005 levels by 2020. However, in November 2014, President Obama signed a US-China climate agreement in which the US stated its intent to further reduce emissions, to 26 to 28% below the same 2005 basement by 2025. Announcement of a non-binding target by a President facing a hostile Congress prompts obvious questions of credibility. However, the new US target, like the previous Copenhagen one, is reinforced by an unusual confluence of features of the US Presidential system of government.

22. When the Congress passed and the President signed ambitious environmental statutes, such as the US Clean Air Act, in the 1970s, Congress delegated significant regulatory authority to the executive branch (typically exercised by the Administrator of the EPA, who is appointed by the President). Indeed, the non-discretionary regulatory mandates of the US Clean Air Act, reinforced by citizen suit provisions that authorize citizens to sue the EPA Administrator for failure to meet those mandates, effectively *require* various regulatory actions. For

instance, once the EPA administrator makes a determination that a pollutant "endangers" public health or welfare, it sets in motion various actions to control emissions from mobile and stationary sources. EPA's publication in 2009 of an "endangerment finding" for greenhouse gases thus triggered emission standards for motor vehicles and regulation of the electricity and other sectors. It is ironic, given the multiple veto points of the US legislative system, that it has been impossible for even a hostile Congress to prevent adoption of executive actions under the mandate of Congress 45 years ago.

23. In sum, the Administration has ample authority to regulate US sources of greenhouse gases and it has begun to exercise that authority with a series of regulations concerning motor vehicle emissions and proposed standards for the electricity generation sector. Although the Administration has not yet unveiled its plan to meet the 2025 target, it has conceded that additional regulatory measures will be required beyond the mobile source standards already adopted and the draft power plant regulations released in 2014. New standards for heavy-duty vehicles already under development present an obvious next step.[1]

24. The state of California historically has led US states, and often the federal government, in environmental policy. That dynamic has clearly emerged once again with respect to climate change. California has been a first mover in pressing the federal government on vehicle GHG emissions and pioneered new approaches, including a low carbon fuel standard and (starting in 2015) inclusion of transportation fuels in an emissions trading system. In 2006, California passed Assembly Bill 32 (AB32), also known as the Global Warming Solutions Act, which requires that the state reduce its greenhouse gas emissions to approximately 15% below 1990 levels by 2020, and 80% below 1990 by 2050. In pursuit of the longer-term goal, in April 2015 Governor Brown directed state officials to devise additional strategies to achieve a target of a 40% reduction below 1990 levels by 2030. With transportation accounting for 40% of California's greenhouse gas emissions, policies to curb petroleum consumption have been and will continue to be central to California's emission control strategies.

[1] Emily Holden and Evan Lehmann, US-China Climate Deal Will Create Some Stormy Political Weather, E&E News, 13 November 2014.

Fuel Economy and GHG Emissions from Motor Vehicles

25. The US has established standards for corporate-average fuel economy and greenhouse gas emissions to 2025, which are the most demanding international standards on record to date. The impetus for amendment of the US fuel economy standards after decades came from California. In recognition of California's more severe air quality challenges and longstanding leadership in regulating motor vehicle emissions, the US Clean Air Act allows that California can depart from national standards in establishing its own state-level emissions standards for motor vehicles with approval from the US EPA. Although the Act grants that authority only to California, it does allow that other states can choose to adopt either California or federal standards. This legislative framework provides a mechanism for both leadership by the greenest of the US's state governments and for diffusion of California's initiatives to other states and, ultimately, the national level. The frequency with which this phenomenon has occurred has led academics to coin the term, the "California effect" (Vogel, 1995).

26. As in the past, the California effect played out with respect to regulation of greenhouse gas emissions from motor vehicles. In 2002, California passed the Pavley Global Warming Bill, which called on the California Air Resources Board to set tailpipe standards for greenhouse gases. The standards were announced in 2004, and 15 other states committed to match California's limits even before they approved by the EPA. Diffusion to other states became a moot point in 2009, however, when President Obama announced that his administration would adopt a new fuel economy and GHG emission standard that effectively applied the California standards nationally.

27. In 2010, the US established new corporate average fuel economy standards and for the first time CO2 standards for passenger vehicles and light trucks.[2] The standards were phased in from 2012 to 2016, at which point fuel economy would be 29% higher and CO2 emissions 26% less than in 2009. In 2012, the US established follow-on standards for 2017 to 2025, to achieve an additional 45% increase in fuel economy and 35% reduction in greenhouse gas emissions. US national passenger vehicle

[2] http://transportpolicy.net/index.php?title=US:_Light-duty:_Fuel_Economy_and_GHG

standards are summarized below. The combined effect of these standards is to essentially double new-car fuel economy and halve CO2 emissions from 2009 to 2025.

	2009 fleet performance	2016	2025
Passenger Vehicle/light truck avg fuel economy, mpg	26.4	34.1	49.6
Passenger Vehicle/light truck avg CO2/mile	337	250	163

28. In 2011, the US also adopted the first-ever fuel economy and CO2 emissions standards for heavy-duty vehicles. The regulations take effect in 2014 with increasingly stringent standards to 2017, at which point emissions will have been reduced from 2 to 23% relative to 2010, depending on the class of vehicle.[3] The US EPA is currently engaged in consultations with respect to phase 2 standards for heavy-duty vehicles, which can be expected to further improve fuel economy for 2018 and later model years.

29. It is noteworthy that the IEA's 450 ppm/2C policy scenario suggests that significant additional tightening of both the passenger/light truck and heavy duty vehicles will be required to limit global warming to 2C. The IEA's 450 ppm policy scenario assumes 96 g CO2/mi for light vehicles by 2035, and 45% more efficient freight vehicles.

30. Although California now harmonizes its GHG emissions standards with the federal government, the state Air Resources Board in 2008 did adopt a Heavy Duty Vehicle Greenhouse Gas Emissions Reduction Regulation, which requires that long haul truckers undertake measures to improve fuel economy including installing aerodynamic devices and fuel-efficient tires on their trailers.[4]

[3] http://transportpolicy.net/index.php?title=US: Heavy-duty: Fuel Consumption and GHG

[4] http://www.arb.ca.gov/msprog/truckstop/trailers/ttghg_regorder.pdf

Renewable/Low Carbon Fuels standards

31. Traditionally, fuel standards have included limits on contaminants such as sulphur or lead to address local air quality. However, in the last decade a new form of fuel standards have emerged designed to reduce greenhouse gas emissions.

32. The US first adopted a renewable fuel standard ("RFS1") to promote biofuels in 2005, but significant amendments were undertaken in response to the 2007 Energy Independence and Security Act. "RFS2" establishes target volumes of various kinds of biofuels. It does not directly limit or discourage blending of unconventional oil, such as that derived from Canada's bitumen. However, the mandate to increase biofuels will reduce consumption of all forms of petroleum, including bitumen.[5]

33. The California Low Carbon Fuel Standard (LCFS), adopted in 2009, is the first fuel standard globally to limit carbon emissions from transportation fuels on a "well to wheels" (or "seed to wheels") basis. The regulation establishes carbon-intensity scores for various transportation fuels, with lower scores for biofuels and higher scores for unconventional oil, such as that derived from tar sands. Retailers are mandated to meet a schedule for declining carbon intensity to achieve a 10% reduction by 2020. The LCFS allows fuel retailers flexibility, for instance to offset higher-intensity petroleum with lower-intensity biofuels, but the combination of higher scores for Alberta's bitumen (with three or more times greater production-related emissions than many conventional crudes)[6] and the mandate to reduce carbon-intensity of the blend over time will tend to deter reliance on higher-intensity sources such as Canada's bitumen. Following the mandate of AB32 to achieve an 80% reduction below 1990 emissions by 2050, California is planning for deeper reductions in carbon intensity of transportation fuels after 2020, but has not yet set the next phase targets.[7]

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[5] http://www.epa.gov/otaq/renewablefuels/420f10007.pdf

[6] A schedule for different fuels can be found on p. 68 of the following rule: http://www.arb.ca.gov/fuels/lcfs/CleanFinalRegOrder112612.pdf

[7] Anne C. Mulkern, "Calif.'s pioneering low-carbon fuels rule could see multiple changes," Climate Wire, 12 March 2014.

To that end, it is noteworthy that a 2015 report found that the carbon intensity of different petroleum sources extends beyond the production stage to the transportation, refining, and combustion stages. For instance, the authors report that refined oil from Canada's oil sands has *combustion* emissions 40 to 45% higher than several convention crude oil sources. In other words, the more of the life cycle that is considered, the greater the differences between Canada's bitumen and conventional crude oil sources. The authors report that Canada's bitumen yields life cycle emissions of between 720 and 810 kg CO_{2eq}/bbl, compared to many conventional crude oils with life cycle emissions below 500 kg CO_{2eq}/bbl. To the extent that the assumptions underlying California's low carbon fuel standard reflect these further differences, the competitiveness of Canada's bitumen will be even more negatively affected relative to conventional oil sources (Gordon et al., 2015).

34. The California LCFS' mandate on carbon intensity of fuels regardless of their origin prompted legal challenges from farmers, oil companies, and other state governments, arguing that the bill violated the US constitution's commerce clause. However, the standard was upheld in 2013 by a US Appeals Court and in 2014 the Supreme Court denied leave to appeal.[8] The stage is thus set for California's approach to be mimicked by other states, many of which had previously indicated their intention to adopt low carbon fuel standards. Oregon, Washington, and Massachusetts are now moving to follow California's lead.[9]

Policies to advance Zero Emission Vehicles

35. California has once again led the US in pressing for development of alternatives to the internal combustion engine, dubbed "zero emission vehicles" (ZEVs) in state policy. California Executive Order B-16-2012 set a target of 1.5 million ZEVs on California's roadways by 2025. The 2013 ZEV action plan establishes minimum proportions of ZEVs in the new vehicle fleet from 2018 to 2025, ramping to 22% in 2025 (including up to 6% "transitional ZEV").[10] California also provides rebates of up to

[8] Jeremy P. Jacobs, "Supreme court won't hear appeal of Calif. fuels standard," Greenwire, 30 June 2014.
[9] Colin Sullivan, "Top enviro official says Mass. is moving forward on clean fuels for Northeast," Energy Wire, 15 September 2014; Tiffany Stecker, "Biofuels groups fault Northwest states' plans for low carbon standard," Greenwire, 11 November 2014.
[10] http://transportpolicy.net/index.php?title=California: ZEV

$2500 for plug-in electric and ZEVs,[11] and in September 2014 Governor Brown signed a package of new laws to promote ZEVs. Senate Bill 1275, the Charge Ahead California Initiative, seeks to increase the number of ZEV from the current 100,000 to 1 million by 2023.[12] Senate Bill 1204 funds development of zero or near-zero trucks and buses. Assembly Bill 1721 and Assembly Bill 2013 create preferential access for ZEVs in HOV lanes (highly valuable on congested California freeways). Assembly Bill 2565 mandates that landlords allow renters to install charging stations.

Fiscal and other measures

36. The federal government provides a variety of tax credits for fuel cells and plug-in electric vehicles, subsidies for biofuels, and Department of Energy loans for advanced vehicle manufacturing.[13] The US federal government also requires labeling of new vehicle fuel economy, and in 2013 revised its labeling rules to include rankings for fuel economy and GHG emissions.

Carbon Pricing

37. California is again leading the US in carbon pricing, having established a cap and trade program in partnership with the Canadian province of Quebec. In the first seven auctions the price was consistent around $10/tonne CO2. Initially, California's emissions trading system followed the lead of other jurisdictions in applying caps only to large stationary sources. However, in 2015, California and Quebec became the first jurisdictions to extend their cap-and-trade scheme to transportation fuels, a potential model for other emissions trading systems. The resulting price incentive will apply in addition to the various regulatory measures

[11] Anne C. Mulkern," Waiting list forms for Calif. green car rebates," Climate Wire, 31 March 2014.
[12] Anne C. Mulkern, "Bill accelerating push to 1M electric cars becomes law," Greenwire, 22 September 2014.
[13] A list of transportation-related measures can be found in IEA's climate change "policies and measures" for the US:
http://www.iea.org/policiesandmeasures/climatechange/

concerned vehicle fuel economy and fuel carbon intensity discussed above.

38. As noted above, Gordon et al (2015) report that heavy oil derived from Canada's oil sands not only has higher production emissions but also higher combustion emissions per barrel. This is because the mix of oil products derived from heavier crudes typically has a greater proportion of more carbon-intensive fuel products. The implication is that carbon pricing, whether via cap and trade or a carbon tax, in a destination jurisdiction will not only deter oil consumption from all sources, but disproportionately impact demand for Canada's bitumen.

Impact

39. In 2014, Bloomberg New Energy Finance released projections of the impact of this suite of federal and state policies on oil demand in California, concluding that in the six-year period from 2014 to 2020, demand would fall by 9 to 13%, even as the state's population grew from 38 million (2012) to 40.6 million and vehicle miles travelled increased from 350 to 400 billion. The fact that oil demand in California has already declined by 20% from 2002 to 2014 adds to the credibility of this estimate.[14] Bloomberg projected the greatest impact from federal fuel economy standards, the state's ZEV mandates, and the low carbon fuel standards. The analysis did not include the extension of the California cap and trade program to transportation fuels, which would be expected to yield further, if more modest, reductions via a gasoline price increase of approximately $0.10 per gallon. Nor did it include projections for continued tightening of each of these policies post-2020, which can be expected based on both the national 2025 target and California's longer term goals in AB32.

[14] Anne C. Mulkern, "U.S., state rules seen forcing 13% plunge in Calif. fuel use by 2020," Greenwire, 18 March 2014.

Japan

40. The closure of nuclear reactors in response to the Fukushima disaster has prompted Japan to rethink its greenhouse gas emissions targets. However, this reduced ambition applies only to the electricity sector and is not evident with respect to the motor vehicle sector and transportation-related emissions, where Japan's green innovation-oriented industrial policy and environmental goals remain tightly linked and mutually supportive. Japan continues to tighten its fuel economy standards, which are reinforced by a host of fiscal measures, incentives for development of electric vehicles, and investments in transit and urban design to promote alternative modes of transport. These measures are expected to yield a decline in petroleum consumption.

Targets

41. As host of the third Conference of the Parties to the Framework Convention on Climate Change (COP3), which yielded the Kyoto Protocol, Japan was quick to ratify the treaty and also to ensure compliance with its obligation to reduce its GHG emissions to 14% below 1990 levels by 2008 to 2012. As the end of that period approached, Japan proposed a new target to reach a 25% cut below 1990 by 2020. However, the 2011 Fukushima nuclear disaster, which resulted in closure of some 50 nuclear power plants in Japan, prompted a revised medium-term target. Japan's current pledge, announced at COP19 in Warsaw, is a 3.8% reduction below 2005 levels by 2020, equivalent to a 3.1% increase above the 1990 baseline.

42. What are the implications of this relaxation of ambition for Japan's oil consumption, virtually all of which is imported? Achievement of Japan's climate targets historically has rested on two pillars: increased energy efficiency and expansion of nuclear power (Schreurs, 2014). The closure of nuclear power plants directly affects the latter (though the Abe government is now proposing to begin reopening of nuclear plants), but not the former. Japan's push for energy efficiency dates to the OPEC oil crisis of the 1970s, and is integral to its industrial strategy, which advances competitive advantage and energy security via leading edge pollution control and energy efficiency. Since 1998, this has been reinforced by the "top runner" approach (under the auspices of the 1976

Law Concerning the Rational Use of Energy), in which the leading product in each category, including motor vehicles, is identified every few years and that level of performance is then demanded of all manufacturers.

43. While the nuclear disaster has prompted a shift toward fossil fuels in Japan's electricity sector, with corresponding emissions increases, there is no indication of a change of course with respect to oil consumption and transportation emissions. Japan's push for greater vehicle fuel economy simultaneously advances Japan's climate goals, its energy security, and the competitiveness of its economically important automobile manufacturing sector.

Vehicle Emissions Standards

44. The coincidence of new pollution control targets for motor vehicle in the US' 1970 Clean Air Act Amendments, Japan's own shift in attention to pollution from the transport sector in the early 1970s, and the emergence of the Japanese auto manufacturing sector yielded a compatible environmental and industrial strategy in which Japan has for decades been a leader in both environmental policy targets for the auto industry and vehicle performance (Suzuki et al., 2011). This leadership has benefited not only air quality in Japan, but also other countries, which have been able to build on Japan's policy standards and resulting vehicle performance. Although this leadership was original focused on conventional pollutants, such as CO, NOx, and particulates, since 2000 Japan has also been at the leading edge with respect to fuel economy and development of alternatives to the fossil fuel-dependent international combustion engine. This is reinforced by the "top runner" regulatory approach, as well as the 2010 Next Generation Vehicle Strategy, which set a target that "next generation vehicles" (hybrid, electric, fuel cell, plug-in hybrid, clean diesel, and natural gas) will comprise achieve 50 to 70% of new vehicle sales by 2030 (Maruyama, 2014).

45. Japan has regulated fuel economy since 1979, with regular revisions of its standards that have continually raised the bar for auto industry performance. Table 2 reveals progress in standards for cars (accompanied by standards for light trucks typically about 1 km/L less demanding). The

pace of change is striking. Japan's 2015 standards demanded a 23.5% improvement in fuel economy relative to 2010, followed by the 2020 standard which demanded a further 21% relative to 2015 (Mahlia, Saidur, Memon, Zulkifli, & Masjuki, 2010). Japan's standards have since been overtaken by the US passenger vehicle standards for 2025, leading industry observers to anticipate that more stringent post-2020 standards will soon be forthcoming.

Table 2: Japanese passenger vehicle fuel economy standards, km/L

1995	2010	2015	2020
12.3 km/L	15.5 km/L	16.8 km/L	20.3 km/L

46. Japan adopted the first regulatory program for medium and heavy duty vehicles in 2005, which will see fuel economy standards for trucks (7.1 km/L) and buses (6.3 km/L) fully in force in 2015.

Fiscal and Other Measures

47. Japan's regulatory standards and "next generation" vehicle targets are complemented by a complicated scheme of tax incentives and subsidies. Japanese vehicles are taxed at every point in the life cycle, from initial purchase to licensing to fuel purchase. At each of these stages, tax rates are roughly aligned with fuel economy to discourage purchase and operation of less fuel-efficient vehicles (Maruyama, 2014). For instance, next generation vehicles and internal combustion vehicles that perform 20% above the 2015 standard qualify for tax reductions, exemption from the tonnage tax initially and a 50% discount at the time of the 2nd inspection, exemption from the acquisition tax, and a 50% reduction from the vehicle property tax. (Kuramochi, 2014) The tax system not only provides financial incentives for consumers but also manufacturers, who in the past have met regulatory requirements several years early, thus ensuring that consumers qualify for subsidies or tax concessions for their vehicles (Alhulail & Takeuchi, 2014).

48. Since 2004, Japan has provided consumers with additional information about vehicle fuel economy, and thus opportunities for fuel savings, via a mandatory labeling scheme that identifies vehicles performing 5%, 10%, and 20% above national standards (Mahlia et al., 2010).

49. Finally, Japan is pursuing a variety of complementary policies to ensure that future electric vehicles will be powered by renewable energy, including via a successful feed-in tariff, the proceeds of which are directed (among other projects) to electric and fuel cell vehicle development (Kuramochi, 2014). The Low Carbon Planning: Act on Promotion of Low Carbon Cities is investing in measures such as rail and other transit, infrastructure for electric vehicle charging, transit-oriented community planning, road pricing and parking charges (Schreurs, 2014; Suzuki et al., 2011)

Carbon Pricing

50. Broad-based carbon pricing has potential to reinforce transportation-specific policies. In 2012, Japan's Tax Reform Act established a carbon tax on petroleum and coal, two fuels already covered by existing excise taxes (Kuramochi, 2014). The tax is being gradually increased from JPY95/tonne CO2 in 2012 to JPY289/tonne CO2 (or just under US$3/tonne) in 2016. The level is thus relatively low at present and thus would be expected to have relatively minor impacts on petroleum consumption, but the potential is there for further increases in the tax rate in order to achieve Japan's stated goals for greenhouse gas emissions and reduction of reliance on imported oil. In additional, revenues – expected to reach $2.6 billion/year in 2016, are earmarked for investments in renewable energy, including next generation vehicle battery development.

51. Since 2007, the Tokyo Metropolitan Government has operated a cap and trade program that covers some 1400 facilities (1100 buildings, 300 factories) (Kuramochi, 2014). The Tokyo emissions trading system does not cover transport fuels, but in future could follow the example of California in extending coverage to these sources.

Impacts

52. The slate of Japanese policies to reduce petroleum consumption by motor vehicles is already having significant impact. Hybrid vehicles were already 19% of the Japanese passenger vehicle fleet in 2012, allowing Japan to surpass its fuel economy targets for 2015 several years early and indeed to approach the 2020 target (Global Fuel Economy Initiative,

2014). GHG emissions from passenger vehicles increased from 1990 to 2002 but since then have been trending downward, reflecting the impact of more fuel efficient conventional vehicles and growing numbers of hybrids (Suzuki et al., 2011). GHG emissions from freight vehicles have been in decline since 1990. Given continually tightening fuel economy standards, regulations and fiscal policies encouraging development of electric and fuel cell alternatives to the internal combustion engine, and concerted efforts to rethink urban design and mass transit, it is likely that Japan will see continued decline in reliance on petroleum imports for its transportation sector.

South Korea

53. South Korea has adopted ambitious greenhouse gas emissions and energy efficiency targets. As in the case of Japan, these broad goals are reinforced not only by specific regulations, but also by an industrial strategy that seeks to reduce reliance on imported fuels and to establish comparative advantage in exports based on low carbon innovation, including for the motor vehicle sector. South Korea's oil consumption was relatively stable in the first decade of the 21st century, and is projected to decline in coming decades.

Targets

54. South Korea has demonstrated leadership in Asia on both climate change broadly and transportation emissions more specifically.

- The government has committed to spending 2% of national GDP on the transition to a low carbon economy (Nachmany et al., 2014).

- The National Strategy for Green Growth, 2009-2030, seeks increased energy independence through reduced reliance on imported fossil fuels. This was translated into law via the Framework Act on Low Carbon, Green Growth in 2010. The national goals include a 27 to 30% reduction below the 2005 business as usual projection for 2030 (consistent with South Korea's 2009 Copenhagen target to reduce emissions 30% below what emissions would be in 2020 under a business as usual scenario) and matching the energy efficiency performance of OECD countries.[15]

- The first National Energy Master Plan, for 2008 to 2030, set complementary goals to reduce energy intensity by 47% relative to 2006 by 2030 and to reduce dependence on oil imports by 2030 by 33%.

- The 5-yr growth plan for 2009-2013 included some 600 projects related to green growth.

[15] IEA, climate change Policy and Measures database.

- The 2009 Sustainable Transportation Logistics Development Act, amended in 2013, directs state and local authorities to develop 10-yr implementation plans to reduce GHG emissions from transportation consistent with national targets concerning mass transit, traffic management, and promotion of carbon-free transportation options (Nachmany et al., 2014).

Fuel Economy and Transport GHG Measures

55. South Korea first adopted fuel economy standards in 2005, setting "Average Fuel Economy" targets of 12.4 km/L for vehicles with engines larger than 1.5L and 9.6 km/L for those with smaller engines. Compliance was mandated by 2006 for domestic vehicles and 2009 for imports.[16] The 2009 "Framework Act" (noted above) established a requirement that *all* new passenger cars and SUVs (i.e., rather than the corporate fleet average) must meet a fuel economy/GHG emission target of 17 km/L, equivalent to 140 gCO_2/km, by 2015. The 2012 fleet average of 152 gCO2/km was well on the way to the 2015 target (Global Fuel Economy Initiative, 2014). The OECD-sponsored Global Fuel Economy Initiative anticipates that new targets for 2020 will be broadly aligned with EU and Japanese standards.

56. Mandatory fuel economy measures are supported by a labeling requirement adopted in 2006 to provide consumers with information on vehicle energy efficiency.

Renewable Fuels

57. In 2009, South Korea set a target that 11% of its energy needs should be met through renewable energy sources by 2030 (Huh, Kwak, Lee, & Shin, 2014). However, transport fuels are subject to a more demanding target of 13.2%. As a first step, legislation adopted in July 2013 mandated 5% renewable content in fuels by 2020.

Green Car Strategy

58. Consistent with the emphasis on integration of innovation as an economic strategy with environmental goals, South Korea is actively promoting

[16] www.transportpolicy.net

development of alternatives to internal combustion vehicles. The 2004 Act on the Promotion of Development and Distribution of Environmentally Friendly Automobiles, last amended in 2011, directs the Minister to prepare a master plan for cleaner vehicles, including electric, hybrid, fuel cell, and natural gas. IEA notes that deployment of greener cars is advanced via reduction of acquisition and registration taxes, as well as subsidies and tax reductions for vehicle charging stations. The goal is to deploy 1.3 million green cars by 2020, supported by 1.35 million charging stations for electric vehicles and 168 hydrogen charging stations ("Energy Policies of IEA Countries - Korea 2012 Review - Korea2012SUM.pdf," n.d.).

Carbon Pricing

59. Transportation accounts for a smaller share of oil consumption, at 30%, than in most other countries, with industrial consumption accounting for a proportionately greater share. South Korea's introduction of an emissions trading system is thus particularly important in reducing greenhouse gas emissions from other sources burning petroleum and other fossil fuels. South Korea announced in 2012 that it would launch the first emissions trading system in Asia.[17] Trading began in 2015. The ETS initially covers only large stationary sources, but is nonetheless expected to apply to 75% of national greenhouse gas emissions, including the majority of emissions from combustion of oil (Bloomberg 2013).

60. IEA's modeling ("current policies" scenario) projects that South Korea's cap and trade system will yield a net reduction in emissions of 5% below 2005 levels by 2020, with a price of $15 in 2020, rising to $30 in 2035. IEA projects that to meet the goal of a 30% reduction below business as usual would require a higher price of $20/tonne in 2020 rising to $40 in 2035 (IEA, 2013).

Impacts

61. South Korea's oil consumption was relatively flat from 2000 to 2011, with slight increases in gasoline and diesel consumption counteracted by

[17] Kathy Chen and Stian Reklev, "China's national carbon market to start in 2016 – official," 31 August 2014, Reuters.

declines in other applications. In 2012, IEA projected that South Korea's oil consumption would decrease by 5% by 2035 ("Energy Policies of IEA Countries - Korea 2012 Review - Korea2012SUM.pdf," n.d.). However, this projection was based on policies announced by 2011. Further policy development since that time can be expected to yield steeper decline in oil imports and consumption.

China

62. With a rapidly growing economy and historically weak environmental standards, China's fossil fuel imports and greenhouse gas emissions have been growing steadily. However, China recently committed that its emissions will peak within 15 years and decline thereafter, which will require capping of oil consumption as well. In 2014, China's Premier declared "war on pollution." That has been extended beyond local air pollution to climate change, with China's commitment in the US-China Climate Agreement to cap its emissions growth by 2030 at the latest. It is important to bear in mind that such targets are taken very seriously in China's control economy, including through translation to mandates for state and local governments in 5-year plans. Already, China has begun to match globally-leading fuel economy standards, aggressively promote electric vehicles, and commit to national carbon pricing, all of which will be essential to meeting its emerging climate targets.

Climate Change Targets

63. As the country with the world's largest population, greatest greenhouse gas emissions, and a still-developing economy, China is critical to global efforts to limit climate change. China's economy and GHG emissions will need to be decoupled, as has already occurred in developed countries. Under IEA's 450 ppm scenario, global greenhouse gas emissions and, more specifically, oil demand peak by 2020 (International Energy Agency, 2013). Although emissions from developing countries peak somewhat later than OECD countries under the 450 ppm scenario, China's emissions will need to peak not long thereafter. And when that occurs, China's consumption of oil can be expected to decline significantly.[18]

64. China is still at a relatively early stage in developing environmental policies after a succession of leaders who pursued economic development essentially without constraint. However, as in European and North American countries, China is now confronting the environmental

[18] Under IEA's 450 scenario, China consumes 3.6 million barrels per day, or roughly 40 percent, less oil in the 450 ppm scenario than under the "new policies" scenario in 2035 (IEA, 2013a).

consequences of uncontrolled externalities, particularly in the form of extremely poor air quality. The decline in air quality coupled with increase in incomes has prompted a sharp rise in public protests (Dong, Ishikawa, Liu, & Hamori, 2011). In response, the Chinese government has turned its attention to environmental policy. In 2013, President Xi Jinpeng stated, "We have to understand that to protect the environment is to preserve our productivity and to improve the environment is to develop our productivity." Similarly, in 2014, Premier Li Keqang declared a "war against pollution."[19] In the first instance, attention is focused on air pollutants from burning of coal, but transportation fuels are also a significant source of urban air pollution, contributing over 30% of air contaminants in Beijing.[20] As in Western Europe and North America, it seems likely that attention to air pollution from motor vehicles will closely follow control of the most immediately egregious pollution from coal combustion.

65. However, China's attention is not limited to local and short-term pollutants but has extended to climate change as well. In September 2014, Premier Li Keqiang announced, "We have the resolve, the will and the capability to pursue green, circular and low-carbon development."[21] The President's special envoy at the UN Climate Summit announced a commitment to early peaking of China's emissions for the first time.[22] Finally, November 2014 saw the announcement of a landmark China-US climate agreement in which China committed for the first time to capping its emissions, by ensuring that emissions peak by 2030 at the latest and decline thereafter. China also committed that it will get 20% of its energy from non-fossil fuel sources by 2030, which may be the more demanding target of the two.

66. In China, national targets are translated into plans, which then yield increasingly specific programs and policies. In contrast to the Canadian and US experience, in China's command economy, national targets are taken very seriously, as state and local officials fear professional as well as policy consequences should they fail to meet their mandates. In 2007,

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[19] Reuters, "China to 'Declare War' on Pollution, Premier Says," 4 March 2014.
[20] Xinhua, "China scraps polluting vehicles in air cleanup," 26 May 2014.
[21] Xinhua, "China Focus: China approves plan to combat climate change," 19 September 2014.
[22] Xinhua, "China's rearks on emissions peak 'extremely encouraging': US Experts," 25 September 2014.

the "National Leading Group to Address Climate Change and Manage Energy-Saving and Emission Reduction Work," chaired by the Premier, was instrumental in developing China's first National Climate Change Program. That 2007 plan committed to a reduction in energy intensity of 20% from 2005 to 2010. Although the intensity reduction achieved, at 19%, fell slightly short of the target, it is testament to the seriousness of national targets that state and local government actually shut down industries in order to meet their targets in 2010 (Lo, 2012).

67. In Copenhagen, China pledged to further reduce the GHG intensity of its economy by 40 to 45% by 2020 relative to 2005. That target was incorporated in the 12th Five-Year Plan, for 2011 to 2015, which seeks to reduce the GHG intensity of the economy by 17% over that period. The State Council has adopted a package of measures to meet those targets, including binding provincial and local targets (Nachmany et al., 2014). In September 2014, the State Council approved the National Plan for Addressing Climate Change, 2014 to 2020, which includes the target to reduce emissions intensity by 40 to 45% by 2020, relative to 2005, and to increase the non-fossil fuel share of primary energy to 15% by 2020. The latter target is expected to be more demanding.[23] The plan is expected to dictate energy and emissions-related targets in the next 5-year plan.[24]

Regulation of Transport Emissions

68. China first adopted fuel economy standards in 2005, specifying a maximum fuel use for each of 16 categories based on vehicle weight (rather than a fleet average). Since then new targets have been introduced every 3 years, in 2008, 2011, and the most recent (still draft) phase 4 standards, which were released in 2014 specifying a schedule extending to 2020.[25] There is every expectation that standards will continue to be tightened after 2020. Phase 3 standards would achieve an average fleet consumption of 7 L/100 km (equivalent to 167 g CO2/km) by 2015, while the Phase 4 standard would achieve 5 L/100km by 2020 (a target also included in the 2012 Automobile Industry Development Plan).

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[23] http://www.nytimes.com/2014/11/13/world/asia/climate-change-china-xi-jinping-obama-apec.html?_r=0

[24] Coco Liu, "China's planners aim to cap carbon emissions from steel, cement producers by 2020," 6 November 2014, E&E Asia.

[25] http://transportpolicy.net/index.php?title=China:_Light-duty:_Fuel_Consumption

69. China was the third country, after the US and Japan, to adopt fuel economy standards for heavy-duty vehicles. Phase 1 standards took effect in 2012 and Phase 2, mandated for 2015, is expected to achieve an additional 11% drop in fuel consumption by the heavy-duty vehicle fleet, resulting in a reduction of oil consumption by 5 to 6 million tons per year.[26] Under an earlier China-US agreement to collaborate on regulation of transportation emissions, officials began collaborating in 2013 on a 2020 heavy duty standard for China, with a goal to harmonize with the already announced US standards to the greatest degree possible.[27]

Fiscal and other measures

70. China has mandated labeling of vehicle fuel economy since 2010, which is combined with a subsidy program for the purchase of more fuel-efficient vehicles. The label thus displays not only the car's fuel consumption rating but also the value of any associated subsidy, reinforcing the price signal for consumers.[28]

71. Vehicle excise taxes were amended in 2008 and are roughly proportional to fuel economy, with significantly increased taxes for vehicles with engines larger than 3 litres and a decreased rate for those with less than 1 litre engines.[29] A 2012 reform provided a further 50% reduction for "energy saving" vehicles and fully exempts "new energy" vehicles.

72. The International Energy Agency notes that China has begun to phase out fossil fuel subsidies and projects complete elimination of fossil fuel subsidies within 10 years (IEA, 2013).

Alternatives to the Internal Combustion Engine

73. Given the size of China's cities and the potential for significant economic development still to come, it is questionable whether end-of-pipe

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[26] http://transportpolicy.net/index.php?title=China:_Heavy-duty:_Fuel_Consumption

[27] Julia Pyper, "U.S. boosts fuel economy at home, exports lessons learned to China," Climate Wire, 13 December 2013.

[28] http://transportpolicy.net/index.php?title=Global_Comparison:_Fuel_Efficiency_Labeling

[29] IEA climate change policy and measures database.

solutions will be sufficient to alleviate either air quality or extreme traffic congestion challenges. This has prompted speculation by transportation analysis that China will also plan for "peak car," that is to initially reduce growth and later decrease the number of conventional motor vehicles, by leap-frogging to alternatives to the internal combustion engine.[30] Consistent with this, China's Energy Saving and New Energy Automotive Industry Development Plan, finalized in 2012, seeks to promote a *full* transition to electric vehicles, with interim production goals of 500,000 electric and hybrid vehicles by 2015 and 5 million by 2020.

74. A subsequent 2014 transportation action plan committed to scrap 6 million dirty vehicles by the end of the year and 5 million more by the end of 2015. The policy also asserts that, "strengthening control on vehicle emissions will be a major agenda item for the country's energy savings, emissions reductions, and low-carbon development during the next two years."[31] The plan commits to a transition to less-polluting fuels, which is reinforced by tax reductions and exemptions from VAT and import duties for ethanol.

75. A commitment in the 2011 to 2015 5-year plan to increase national reliance on natural gas to 8% of total energy, combined with pressure to improve air quality, also has indirectly prompted local governments to create their own policies to increase reliance on natural gas vehicles. In response, the number of natural gas vehicles has grown dramatically in recent years, including a jump from 1 to 1.5 million vehicles from 2011 to 2012 alone.[32]

76. Efforts are also underway to promote alternative modes of transportation, including piloting of low-carbon transportation systems in 26 Chinese cities (Nachmany et al., 2014).

Carbon Pricing

[30] Joel Kirkland, "What does 'peak car' mean for energy demand?" E&E News, 7 April 2014.
[31] Xinhua, "China scraps polluting vehicles in air cleanup," 26 May 2014.
[32] Saqib Rahim, "Policy is the Muscle Behind Natural Gas Vehicles in China," E&E News, 20 June 2013.

77. The 12th 5-year plan, adopted in March 2011, expressly encourages the use of market mechanisms to achieve greenhouse gas emissions goals. In response 7 provinces and cities (Beijing, Chongqing, Guangdong, Hubei, Shanghai, Shenzhen, and Tianjin), which together account for 18% of China's population and 27% of GDP, are piloting CO2 emissions trading (Lo, 2012). The pilot emissions systems to date cover only point sources, but could be extended in future to transportation fuels, as in California. In August 2014, it was announced that China will launch a national emissions trading market by 2016.[33] Further details emerging in 2015 indicate that the initial target sectors will be power generation, metallurgical industries, nonferrous metals, building materials, chemicals, and aviation.[34]

78. The 5-year plan floated the possibility of adoption of a carbon tax in 2011, a proposal that has been delayed but is reportedly still under consideration for the 2016-2020 5-year plan.[35]

79. It is noteworthy that IEA's 450 ppm scenario assumes that China would need to employ carbon pricing across all sectors, beginning at $10/tonne CO2 in 2020, and rising to $100/tonne in 2035.

[33] Kathy Chen and Stian Reklev, "China's national carbon market to start in 2016 – official," 31 August 2014, Reuters; Coco Liu, "China's planners aim to cap carbon emissions from steel, cement producers by 2020," 6 November 2014, E&E Asia.
[34] Ari Phillips, "China to create carbon market and cap emissions," Climate Progress, 4 February 2015.
[35] Alex Marshall, "Chinese CO2 to peak earlier than expected," 24 September 2013, ENDS Report 464.

India

Targets

80. Among the countries examined in this study, India is at the lowest level of economic development and, not coincidentally, has made the least progress in regulating its still relatively low per capita greenhouse gas emissions. However, India is turning its attention to climate change, and it seems inevitable that targets will increase in stringency in years to come, though the rate with which that will occur is uncertain.

81. India in 2008 adopted a National Action Plan on Climate Change, which established eight "national missions," each with a lead Ministry. The National Mission for Sustainable Habitat includes a commitment to improved fuel economy, as well as reliance on pricing schemes to promote the purchase of more fuel-efficient vehicles.[36] India's 2009 Copenhagen commitment was to reduce greenhouse gas intensity by 20 to 25% relative to 2005 by 2020. This was reinforced by the 12th 5-year plan, for 2012 to 2017, which established a target for a 20% improvement in emissions intensity. The plan also established an expert group on Low Carbon Strategy for Inclusive Growth, which offered a list of recommendations in priority areas, including transportation (Parikh, 2012). Most recently, Prime Minister Narendra Modi committed to India's leadership in addressing global warming, notably via a target to product 10% of India's electricity from solar by 2022, which would entail installation of 100,000 MW capacity.[37]

Transportation Standards

82. As in other countries, India's Auto Fuel Policy, adopted in 2003, has focused initially on gradual tightening of conventional pollutant emissions. However, attention is now turning to fuel economy and GHG emissions. In January 2014, India finalized its first fuel economy

[36] IEA climate change Policies and Measures database.
[37] Krishna N. Das and Swetha Gopinath, "Govt raises solar investment target to $100bln by 2022," Reuters, 2 January 2015; "India can show the way to combat global warming: Modi," Business Standards (New Delhi), 18 February 2015.

standards for passenger vehicles, which will take effect in 2016. The corporate average standards for new cars, at 130 g CO2/km in 2016 and 113 g CO2/km in 2021 are consistent with those announced by Japan and the US for the same period, suggesting that although India is coming late to regulation of fuel economy, it is taking full advantage of the opportunity to leapfrog to global standards.[38]

83. International harmonization is promoted by international organizations, including the International Council on Clean Transportation, which collaborated in development of India's first fuel economy standard.[39] ICCT is recommending that India turn its attention next to regulation of fuel economy from heavy duty vehicles, with a proposal for a 2% annual improvement from 2016 to 2025, and two and three wheelers, with a proposal for 1%/yr fuel economy improvements from 2018 to 2025.

84. India is also pursuing increasing penetration by hybrids via a public-private partnership (Central Pollution Control Board, 2010) and a National Mission for electric mobility, which is targeting 6 to 7 million electric vehicles by 2020 (IEA, 2013).

Fiscal Measures

85. India's new regulatory program is complemented by fiscal reforms to promote purchase of cleaner vehicles and to eliminate fossil fuel subsidies. The 2012 budget adjusted tax rates on new vehicle purchases in a manner that further penalized purchases of vehicles with larger (and typically less fuel-efficient) engines.[40] New vehicle taxes lowered the tax for hybrids and totally exempted electric vehicles.

86. In many developing countries, price regulation and subsidies for fossil fuels have had the effect of encouraging greenhouse gas emissions. Price deregulation and elimination of fossil fuel subsides thus is actively encouraged by the IEA and UNEP, and the November 2014 APEC leaders' declaration reaffirmed their commitment to phase out fossil fuel subsidies. For its part, India deregulated the prices of gasoline and diesel

[38] http://www.egazette.nic.in/WriteReadData/2014/158019.pdf

[39] http://theicct.org/sites/default/files/publications/ICCT_Briefing_IndiaPolicySummary_20130703.pdf

[40] http://theicct.org/blogs/staff/india-2012-budget

in 2010, however differential tax rates for gasoline and diesel, combined with a government subsidy for diesel, resulted in a lower effective carbon tax for diesel than gasoline, which encouraged disproportionate purchase of diesel vehicles (Chugh & Cropper, 2014). India began to phase out that subsidy, resulting in a gradual increase in the price of diesel starting in 2013. The International Energy Agency projects that India will completely phase out all fossil fuel subsidies in the next decade (IEA, 2013).

Fuel Shifting

87. India has actively promoted reliance on compressed national gas vehicles (CNG), liquefied petroleum gas, and biodiesel with the most active measures at the state level (Central Pollution Control Board, 2010; Government of India, 2014). For instance, Delhi replaced all diesel buses with CNG in 2002. In 2010, there were already 180,000 CNG vehicles on the roads in India (Bansal & Bandivadekar, 2013). In addition, India is promoting increasing reliance on biofuels, with a requirement for 5% in gasoline in 2003, increasing to 10% in 2008 (with the exception of a few remote states) (Central Pollution Control Board, 2010). In 2009, India adopted a goal of 20% biodiesel and bioethanol by 2017 (Nachmany et al., 2014).

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Mahlia, T. M. I., Saidur, R., Memon, L. A., Zulkifli, N. W. M., & Masjuki, H. H. (2010). A review on fuel economy standard for motor vehicles with the implementation possibilities in Malaysia. *Renewable and Sustainable Energy Reviews*, *14*(9), 3092–3099. doi:10.1016/j.rser.2010.07.053

Maruyama, T. (2014). *Japan's initiatives for the diffusion of next-generation vehicles*.

McGlade, C, and P. Ekins. (2015). The geographical distributions of fossil fuels unused when limiting global warming to 2°C. *Nature*, 517, 187-190.

McLure, C. E. (2011). The GATT-Legality of Border Adjustments for Carbon Taxes and the Cost of Emissions Permits: A Riddle, Wrapped in a Mystery, Inside an Enigma. *Florida Tax Review*, *11*(4), 221–294.

Nachmany, M., Fankhauser, S., Townshend, T., Collins, M., Landesman, T., Matthews, A., … Stezer, J. (2014). *The GLOBE Climate Legislation Study: A Review of Climate Change Legislation in 66 Countries*. London.

O'Brien, J. (2009). The Equity of Levelling the Playing Field in the Climate Change Context. *Journal of World Trade*, *43*(5), 1093–1114.

Parikh, K. (2012). Sustainable development and low carbon growth strategy for India. *Energy*, *40*(1), 31–38. doi:10.1016/j.energy.2012.01.013

Pauwelyn, J. (2013). Carbon Leakage Measures and Border Tax Adjustments under WTO Law. In G. Van Calster & D. Prévost (Eds.), *Research Handbook on Environment, Health and the WTO* (pp. 448–506). Cheltenham: Edward Elgar. doi:dx.doi.org/10.4337/9781781006146

Schreurs, M. (2014). *Climate Change and Nuclear Energy Politics in Japan Post-Fukushima*.

Suzuki, M., Hayashi, Y., & Kato, H. (2011). Japanese Efforts to Solve Environmental Problems with a Focus on the Transport Sector. In W. Rothengatter, Y. Hayashi, & W. Schade (Eds.), *Transport Moving to Climate Intelligence SE - 6* (pp. 73–92). Springer New York. doi:10.1007/978-1-4419-7643-7_6

Trebilcock, M. (2011). *Understanding Trade Law* (pp. 1–204). Cheltenham: Edward Elgar.

Trebilcock, M., Howse, R., & Eliason, A. (2013). Trade and the Environment. In *The Regulation of International Trade* (4th ed., pp. 656–715). Abingdon, Oxon: Routledge.

Veel, P.-E. (2009). Carbon Tariffs and the WTO: An Evaluation of Feasible Policies. *Journal of International Economic Law*, *12*(3), 749–800. doi:10.1093/jiel/jgp031.

Vogel, D. (1995). *Trading up: Consumer and environmental regulation in a global economy*. Wiley Online Library.

World Trade Organization, & United Nations Environment Programme. (2009). *Trade and Climate Change*. Geneva.

THE UNIVERSITY OF BRITISH COLUMBIA

Curriculum Vitae for Faculty Members

Date: March 2015
Initials:_____

1. NAME IN FULL: HARRISON, Kathryn Jo-Anne

2. DEPARTMENT OF POLITICAL SCIENCE

3. FACULTY OF ARTS

4. PRESENT RANK: Professor **SINCE**: July 1, 2006

5. POST-SECONDARY EDUCATION

University or Institution	Degree	Subject Area	Dates
University of Western Ontario	B.E.Sc.	Chemical Engineering	1976-80
Massachusetts Institute of Technology	S.M.	Chemical Engineering	1982-84
Massachusetts Institute of Technology	S.M.	Political Science	1984-86
University of British Columbia	Ph.D.	Political Science	1988-93

6. EMPLOYMENT RECORD

(a) Prior to coming to UBC

University, Company or Organization	Rank or Title	Dates
Shell Canada Ltd.	Research Engineer	1980-82
CBS News	Broadcast Associate	1984
Office of Technology Assessment, US Congress	Policy Analyst	1986-87
Environment Canada	Policy Analyst	1987-88
University of Washington, Graduate School of Public Affairs	Assistant Professor	1992-93

(b) At UBC

Rank or Title	Dates
Assistant Professor of Political Science	July 1993
Associate Professor of Political Science	July 1997
Professor of Political Science	July 2006

Faculty Associate, Institute for Resources, Environment and Sustainability	
Associate Dean, Strategy and Communications, Faculty of Arts	July 2008-July 2011

(c) Date of granting of tenure at U.B.C.: July 1, 1997

7. *Visiting Lecturer (indicate university/organization and dates)*

"Environmental Activism in BC: Divestment and Civil Disobedience," University of Victoria, Environmental Studies and Political Science, 16 March 2015

"A National Energy Strategy for Canada: What About Climate?" BC Sustainable Energy Association, Victoria, 16 March 2015

"International Carbon Trade and Domestic Climate Politics," University of Washington, 27 February, 2015

"The Impact of Civil Disobedience on Public Policy," President's Dream Colloquium on Obedience and Civil Disobedience, SFU 29 January 2015.

"How to Sell Carbon Pricing to Canadians," Canada 2020 Event, April 2013, Ottawa.

"The Politics of Carbon Pricing," CIDE Mexico City, February 2013, and CIDE Aguascalientes, March 2013

"Why has Canada Failed to Address Climate Change, and How can we Fix that?" (community lecture) and "The Politics of Carbon Pricing in Australia, British Columbia, Canada, and the United States" (departmental lecture), Memorial University of Newfoundland, St. John's, March 2013

"The Politics of Carbon Pricing: Lessons from Canada, the US, and Australia," Free University of Berlin, November 2012

"Climate Policies for Real-World Politics," Pacific Institute for Climate Solutions Public Lecture Series, 20 October 2011.

"A Tale of Two Taxes: The Fate of Carbon Taxation in Canada," Simon Fraser University, School of Resource and Environmental Management, February 2011.

"A Tale of Two Taxes: The Fate of Environmental Tax Reform in Canada and British Columbia," University of Toronto, Munk School of Global Affairs, February 2011.

"The Comparative Politics of Climate Change: Why are Some Countries Doing More than Others?", University of Victoria, November 2010.

"Canadian Climate Policy: Challenges and Opportunities," After the G20 Toronto Summit: Canada, China and Global Governance, Shanghai International Studies University, Shanghai,14 November, 2010.

"The Politics of Economic Instruments," Environmental Law and Economics Symposium, University of Michigan, Faculty of Law, April 2010.

"Canada-US Interdependence in Climate Policy: the California Effect vs the Washington Effect," University of California, Berkeley, March 2010.

"A Tale of Two Taxes," Carleton University, 2 March 2010.

"The Comparative Politics of Climate Change," University of Calgary, 13 March 2009.

University of Toronto Faculty of Law, "The Struggle of Ideas and Interests in Canadian Climate Policy," February 2008.

"The Comparative Politics of Climate Change," Simon Fraser University, Public Policy Program, 30 October 2008.

University of California, Berkeley, Center for the Study of Law and Society, "The Comparative Politics of Climate Change," April 2007.

University of California, Berkeley, Canadian Studies Program, "The Path Not Taken: Climate Change Policy in Canada and the United States," 2 November 2006.

"It's Still Not Easy Being Green: The Politics of Kyoto Implementation in Canada," plenary address to the Seventh Annual Global Conference on Environmental Taxation, Ottawa, 23 October 2006.

University of Washington, Program on the Environment and Canadian Studies Program, "The Path Not Taken: Climate Change Policy in Canada and the United States," 10 May 2006.

Yale University, School of Forestry and Environmental Studies, Sustainable Forestry Policy Seminar Series, "Globalization and Environmental Regulation: The Case of the Pulp and Paper Industry," April 2003.

University of Alberta, Environmental Research and Studies Centre Lecture Series, "Globalization and Environmental Regulation: The Case of the Pulp and Paper Industry," Feburary 2003

University of Alberta, Department of Rural Economy Colloquium, "Incentives for Pollution Abatement: Regulation, Regulatory Threats, and Non-Governmental Pressures," February 2003

"Too Close to Home: Contamination of Breast Milk and the Political Agenda," Department of Political Science, Australia National University, May 2000

"Ideas and Environmental Policy," Department of Political Science Colloquium Series, University of Melbourne, Melbourne, Australia, March 2000

"Science and Environmental Regulation," Resources for the Future Lecture Series, Washington, DC, January 2000

"Ideas and Environmental Standard Setting: International Regulation of the Pulp and Paper Industry," Queen's Schools and Policy Studies and Environmental Studies, November 1998

"Passing the Buck," University of Victoria, Faculty of Law, October 1995

University of Alberta, Eco-Research Chair Lecture Series, "Risk, Science, and Politics," September 1995

"Risk, Science, and Politics," School of Public Health, University of Washington, January 1993

12. AWARDS AND DISTINCTIONS

(a) Awards for Teaching (indicate name of award, awarding organizations, date)

(b) Awards for Scholarship (indicate name of award, awarding organizations, date)

Larry Kreiser Prize for scholarly contributions to the advancement of environmental taxation, Global Conference on Environmental Taxation, 2012
JCPA-APPAM prize for the best paper on comparative policy analysis at the 2007 APPAM Annual Meeting, with Lisa Sundstrom
UBC Killam Faculty Research Fellowship, 2006-7
Canada/US Fulbright Fellowship 2006-7
Gilbert White Postdoctoral fellowship, Resources for the Future, 1999-2000
Edward Clarence Dyason Fellowship, Melbourne University, 2000
Canada/US Fulbright Fellowship, 1999-2000
K.D. Srivastava Award, UBC Press, 1996
John Vanderkamp Prize for the best article published in *Canadian Public Policy*, in 1994 (with George Hoberg)
Doctoral Fellowship, Social Sciences and Humanities Research Council of Canada, 1988-92
Mass Media Fellowship for Science Journalism, American Association for the Advancement of Science, 1984
Ida Green Graduate Fellowship, Massachusetts Institute of Technology, 1982-83
Postgraduate Fellowship, Natural Science and Engineering Research Council of Canada, 1982-84
Valedictorian, University of Western Ontario, Faculty of Engineering, 1980
Medalist for placing first in Chemical Engineering class, University of Western Ontario, 1980

(c) Awards for Service (indicate name of award, awarding organizations, date)

Undergraduate Engineering Society Honour Award, University of Western Ontario, 1980

(d) Other Awards

THE UNIVERSITY OF BRITISH COLUMBIA

Publications Record

Date: March 2015

NAME IN FULL: HARRISON, Kathryn Jo-Anne

Indicate with an asterisk (*) those publications you consider of primary importance.

1. BOOKS

(a) Authored

R* *Passing the Buck: Federalism and Canadian Environmental Policy*, (Vancouver, UBC Press, 1996), pp. x, 228.

R* *Risk, Science, and Politics: Regulating Toxic Substances in Canada and the United States*, (Montreal: McGill-Queen's University Press, 1994), with George Hoberg, pp. xiii, 235.

(b) Edited

R* *Global Commons, Domestic Decisions: The Comparative Politics of Climate Change* (Cambridge: MIT Press, 2010), co-edited with Lisa McIntosh Sundstrom.

R* *Racing to the Bottom? Provincial Interdependence in the Canadian Federation*, (Vancouver: UBC Press, 2005).

Managing the Environmental Union, (Kingston: Queen's University School of Policy Studies, 2000), co-edited with Patrick Fafard, pp. ix, 227.

(c) Chapters

Kathryn Harrison and Tyler Bryant, "The Provinces and Climate Policy," in Christopher Dunn, ed., The Provinces: Canadian Provincial Politics, 3d ed., Toronto: University of Toronto Press, forthcoming.

R Werner Antweiler and Kathryn Harrison, "Environmental Regulatory Incentives Underlying Canadian Industrial Performance" in Zhiqi Chen and Marc Duhamel, eds., Industrial Organization in Canada: Empirical Evidence and Policy Challenges, (Kingston: McGill-Queen's University Press, 2011).

R* Kathryn Harrison and Lisa McIntosh Sundstrom, "Introduction: Global Commons, Domestic Decisions," in Kathryn Harrison and Lisa McIntosh Sundstrom, *Global Commons, Domestic Decisions: The Comparative Politics of Climate Change* (Cambridge: MIT Press, 2010).

R* Kathryn Harrison, "The United States as Outlier: Economic and Institutional Challenges to US Climate Policy, in Kathryn Harrison and Lisa McIntosh Sundstrom, *Global Commons, Domestic Decisions: The Comparative Politics of Climate Change* (Cambridge: MIT Press, 2010).

R* Kathryn Harrison, "The Struggle of Ideas and Self-Interest in Canadian Climate Policy," in Kathryn Harrison and Lisa McIntosh Sundstrom, *Global Commons, Domestic Decisions: The Comparative Politics of Climate Change* (Cambridge: MIT Press, 2010).

R* Kathryn Harrison and Lisa McIntosh Sundstrom, "Conclusion: The Comparative Politics of Climate Change," in Kathryn Harrison and Lisa McIntosh Sundstrom, *Global Commons, Domestic Decisions: The Comparative Politics of Climate Change* (Cambridge: MIT Press, 2010).

R Kathryn Harrison, "Multilevel Governance and Carbon Pricing in Canada, the United States, and the European Union," in Thomas Courchene, ed. , Canada: the State of the Federation 2009 – Carbon Pricing and Environmental Federalism, (Kingston: McGill Queen's University Press, 2010).

"Challenges and Opportunities in Canadian Climate Policy," in Steven Bernstein, Jutta Brunnee, David G. Duff, and Andrew Green, eds., A Globally Integrated Climate Policy for Canada (Toronto: University of Toronto Press, 2008).

R "Intergovernmental Regulation and Municipal Drinking Water," in Bruce Doern and Robert Johnson eds., Rules, Rules, Rules: Multilevel Regulatory Governance in Canada, (Toronto: University of Toronto Press, 2006), coauthored with Carey Anne Hill.

*R** "Provincial Interdependence: Concepts and Theories" in Kathryn Harrison, ed., *Racing to the Bottom? Provincial Interdependence in the Canadian Federation,* (Vancouver: UBC Press, 2005).

R* "Follow the Leader and Dominoes: Games Provinces Play in Tobacco Taxation," in Kathryn Harrison, ed., *Racing to the Bottom? Provincial Interdependence in the Canadian Federation,* (Vancouver: UBC Press, 2005).

R* "Races to the Bottom vs. Races to the Middle: Minimum Wage Setting in Canada," in Kathryn Harrison, ed., *Racing to the Bottom? Provincial Interdependence in the Canadian Federation,* (Vancouver: UBC Press, 2005), coauthored with David Green.

R* "Are Canadian Provinces Engaged in a Race to the Bottom? Evidence and Implications," in Kathryn Harrison, ed., *Racing to the Bottom? Provincial Interdependence in the Canadian Federation,* (Vancouver: UBC Press, 2005).

R "Promoting Environmental Protection through Eco-Labelling: An Evaluation of Canada's Environmental Choice Program," in Kernaghan Webb, ed., *Voluntary Codes, Private Governance, the Public Interest, and Innovation,* (Ottawa: Carlton University Press, 2004), pp. 273-298.

"Passing the Environmental Buck," in Miriam Smith and Francois Rocher, eds., *New Trends in Canadian Federalism, 2d ed.*, (Peterborough: Broadview Press, 2003), pp. 313-352.

R "Evolving Patterns of Environmental Governance," in Janine Brodie and Linda Trimble, eds., *Reinventing Canada: Politics of the 21st Century*, (Peterborough: Broadview Press, 2003), pp..

R "Challenges in Evaluating Voluntary Programs," in Paul Stern, ed., *New Tools for Environmental Protection: Education, Information, and Voluntary Programs,* (Washington, DC: National Academy Press, 2002), pp. 263-282.

R* "Voluntarism and Environmental Governance," in E.A. Parson, ed., *Governing the Environment: Persistent Challenges, Uncertain Solutions*, (Toronto: University of Toronto Press, 2001), pp. 207-245.

Translated as "Volontarisme et Gouverne Environnementale," in E. A. Parson, ed., Gérer l'environnement : Défis persistants, solutions incertaines, (University of Toronto Press, 2001), pp. 209-248.

R "Federal-Provincial Relations and the Environment: Unilateralism, Collaboration, and Rationalization," in Robert Boardman and Debora Van Nijnatten, eds., *Canadian Environmental Policy: Context and Cases*, (Toronto: Oxford University Press, 2001), pp. 123-144.

R* "In Search of a Minimum Winning Coalition: The Politics of Species at Risk Legislation in Canada," in Karen Beazley and Robert Boardman, eds., *Politics of the Wild*, (Toronto: Oxford University Press, 2001), with William Amos and George Hoberg, pp 137-166.

"Conflict, Cooperation, Or Something Else Again," in P, Fafard and K. Harrison, eds., *Managing the Environmental Union,* (Kingston: Queen's School of Policy Studies, 2000) pp. 3-21.

* "The Origins of National Standards: Comparing Federal Government Involvement in Environmental Policy in Canada and the United States," in P.

Fafard and K. Harrison, eds., *Managing the Environmental Union,* (Kingston, Queen's School of Policy Studies, 2000), pp. 49-80.

R "Retreat from Regulation: Evolution of the Canadian Environmental Regulatory Regime," in G.B. Doern, M.Hill, M. Prince, and R. Schultz, eds., *Changing the Rules: Canadian Regulatory Regimes and Institutions,* (Toronto: University of Toronto Press, 1999), pp.122-143.

R "Environmental Protection in British Columbia: Post-Material Values, Organized Interests, and Party Politics," in R.K. Carty, ed., *Politics, Policy and Government in British Columbia,* (Vancouver: UBC Press, 1996), pp. 290-309.

R "Federalism, Environmental Protection, and Blame Avoidance," in Miriam Smith and François Rocher, eds., *New Trends in Canadian Federalism*, (Peterborough: Broadview Press, 1995), pp. 414-438.

Reprinted in Allan Greenbaum, Alex Wellington, and Ron Pushchak, eds., *Environmental Law in Social Context: A Canadian Perspective*, (Concord, ON: Captus Press, 2002), pp 66-75, 449-451.

Reprinted in Allan Greenbaum, Alex Wellington, and Ron Pushchak, eds., *Canadian Issues in Environmental Law and Policy,* (Concord, ON: Captus Press, 2009).

R "Prospects for Intergovernmental Harmonization in Environmental Policy," in Douglas Brown, Janet Hiebert, eds., *Canada: The State of the Federation, 1994*, (Kingston: Institute for Intergovernmental Relations, 1994), pp. 179-199.

2. REFEREED PUBLICATIONS

(a) Journals

* "International Carbon Trade and Domestic Climate Politics," *Global Environmental Politics*, forthcoming.

* "Federalism and Climate Policy Innovation: A Critical Reassessment," *Canadian Public Policy* 39 (2013): S95-S108.

"Multilevel Governance and American Influence on Canadian Climate Policy: The California Effect vs. the Washington Effect," Zeitschrift für Kanada-Studien 32.2 (2012).

"Historical Legacies and Policy Reform: Diverse Regional Reactions to BC's Carbon Tax," *BC Studies* 173 (2012): 95-120, with Chelsea Peet.

* "A Tale of Two Taxes: The Fate of Environmental Tax Reform in Canada," *Review of Policy Research* 29 (2012): 383-407.

* "The Comparative Politics of Carbon Taxation," *Annual Review of Law and Society* 26 (2010): 1-23.

* "The Influence of Institutions on Issue Framing: Children's Environmental Health Policy in the United States and Canada," *Journal of Comparative Policy Analysis* 11 (2009): 287-307, with Katherine Boothe.

* "Canada's Voluntary ARET Program: Limited Success despite Industry Co-Sponsorship," *Journal of Policy Analysis and Management*, 26 (2007): 755-773, with Werner Antweiler.

* "Protecting Endangered Species in the US and Canada: The Role of Negative Lesson Drawing," *Canadian Journal of Political Science*, 40 (2007): 367-394, with Mary Illical.

* "The Road Not Taken: Climate Change Policy in Canada and the United States," *Global Environmental Politics,* 7 (2007) 92-117.

* "Incentives for Pollution Abatement: Regulation, Regulatory Threats, and Non-Governmental Pressures," *Journal of Policy Analysis and Management*, 22 (2003): 361-82, with Werner Antweiler.

* "Toxic Release Inventories and Green Consumerism: Empirical Evidence from Canada," *Canadian Journal of Economics*, 36 (2003): 495-520, with Werner Antweiler.

* "Ideas and Environmental Standard Setting: Environmental Regulation of the Pulp and Paper Industry in Canada, the United States, and Sweden," *Governance, 15 (2002): 65-96*.

* "Too Close to Home: Breast Milk Contamination and the Political Agenda," *Policy Sciences Journal*, 34 (2001): 35-62.

  Reprinted in Rebecca Raglon, Melody Hessing, Catriona Sandilands, eds., *This Elusive Land: Women and the Canadian Environment*, (Vancouver: UBC Press, 2006), pp 213-242.

* "Racing to the Top or Bottom: Ecolabelling of Paper Products in Canada, Scandinavia, and Europe," *Environmental Politics*, 8 (1999): 110-36.

***** "Talking with the Donkey: Cooperative Approaches to Environmental Protection," *Journal of Industrial Ecology*, 2 (1998): 51-72.

  Reprinted in Peter M. Haas, ed., *Environment in the New Global Economy,* (Northampton, MA: Edward Elgar, 2003).

Reprinted in Peter M. Haas, ed. *International Environmental Governance,* (Ashgate, 2008).

Reprinted in Meinhard Doelle and Chris Tollefson, eds., Environmental Law: Cases and Materials, (Carswell, 2009.)

***** "The Regulator's Dilemma: Regulation of Pulp Mill Effluents in a Federal State," *Canadian Journal of Political Science*, 29 (1996): 469-496.

***** "Is Cooperation the Answer? Canadian Environmental Enforcement in Comparative Context," *Journal of Policy Analysis and Management*, 14 (1995): 221-245.

Reprinted in John Jermier, ed., *Corporate Environmentalism and the Greening of Organizations* (Sage, 2013).

***** "It's Not Easy Being Green: The Politics of Canada's Green Plan," *Canadian Public Policy*, 20 (1994): 119-37, with George Hoberg.

***** "Between Science and Politics: Assessing the Risks of Dioxins in Canada and the United States," *Policy Sciences*, 24 (1991): 367-88.

***** "Setting the Environmental Agenda in Canada and the United States: The Cases of Dioxin and Radon", *Canadian Journal of Political Science*, 24 (1991): 3-27, with George Hoberg.

Reprinted in Sheila Jasanoff, ed., *Comparative Science* and *Technology Policy*, (London: Edward Elgar, 1997), 463-487.

Reprinted in Wolfgang Rudig, ed., *Environmental Policy,* (London: Edward Elzar, 1999), pp 233-257.

"Privatization in British Columbia: Lessons From the Sale of Government Laboratories", *Canadian Public Administration*, 33 (1990): 165-97, with W.T. Stanbury.

"Genetically Engineered Microorganisms," *Recombinant DNA Technical Bulletin*, 9 (1986): 1-15 and 69-88, with H. Strauss, D. Hattis, G.S. Page, S.R. Vogel, and C.C. Caldart.

(b) Conference Proceedings

(c) Other

3. NON-REFEREED PUBLICATIONS

(a) Journals

"The Comparative Politics of Climate Change," *Global Environmental Politics* 7 (2007):1-18, with Lisa McIntosh Sundstrom.

"Issue of the Week: What is the appropriate role of the federal government in environmental protection?" www.policy.ca, November 2000

"Issue of the Week: The New Species at Risk Act -- Too Much or Not Enough?" www.policy.ca, March 2001.

"Guarding the Henhouse: Review of Robert Gibson, ed., *Voluntary Initiatives*," *Alternatives*, 26 (Winter 2000).

"The Canada-Wide Accord: A Threat to National Standards," *Canada Watch*, 6 (1998): 13-14.

"Review of Kenneth M.Holland, F.L. Morton, and Brian Galligan, eds., *Federalism and the Environment: Environmental Policymaking in Australia, Canada, and the United States*," *Canadian Journal of Political Science, 24 (1996): 792-3*.

"Response to Comment on 'It's Not Easy Being Green: The Politics of Canada's Green Plan'," *Canadian Public Policy*, 22(1996): 180-3, with George Hoberg.

"Search Strategies for Couples," *Canadian Political Science Association Bulletin*, 24 (1995): 49-50.

"Out of Sight -- Out of Mind: The Absence of Indoor Air Pollution From the Regulatory Agenda," *Technology in Society*, 8(1986): 277-86.

(b) Conference Proceedings

(c) Other

* "The Political Economy of British Columbia's Carbon Tax," OECD Environment Working Paper 63 (October 2013).

"Intergovernmental Relations and Climate Policy: Lessons from Comparative Federalism," National Roundtable on Environment and Economic Working Paper, March 2011.

"Dioxin" and "Canadian Environmental Laws and Policies," in John Barry et al., eds., *Encyclopedia of Environmental Politics and Policy*, (London: Routledge Press, 2001), pp. 129, 66-67..

"Federalism and Environmental Protection: Canada" and "Legislation: Canada," in Robert Paehlke, ed., *The Encyclopedia of Conservation and Environmentalism*, (New York: Garland Publishing, 1995), 274-5 and 403-4.

4. OTHER WORKS

Op-eds

Kathryn Harrison, George Hoberg, David Tindall, "Getting Rid of Petroleum Stocks is a Crucial First Step for Universities," Globe and Mail, 5 February 2014.

Kathryn Harrison, "Oil Sands Phase-Out May be Canada's Greatest Contribution to the World," ACCN Canadian Chemical News, Sept/Oct 2014

David Green, Kathryn Harrison, George Hoberg, "Fossil Fuel Divestment Urged at UBC," Vancouver Sun, 23 October 2014.

Simon Donner, Kathryn Harrison, George Hoberg, "Donner, Harrison & Hoberg: Let's Talk About Climate Change," National Post, 10 April 2014.

"Port Metro Vancouver Should Serve 'Citizens,' not 'Customers,'" *Vancouver Sun,* 17 December 2013

"Can we get the facts right? A recent critique of the province's carbon tax was rife with errors," *Vancouver Sun,* 19 August 2013

"Reform Needed before expanding Coal Shipments," *Vancouver Sun,* 13 June 2013

"LNG: Progressive Change or Regressive Act," *Vancouver Sun*, 4 July 2012, with Tom Pedersen.

"We're Exporting Climate Change Along with Oil," *Vancouver Sun*, 30 March 2012.

"Putting a Price on Carbon" The Mark, July 27, 2011.
http://www.themarknews.com/articles/6198-putting-a-price-on-carbon

David Green and Kathryn Harrison, "The Devil is in the Details of Environmental Policies," Vancouver Sun, 28 April, 2009.

Kathryn Harrison, "Climate of Concern: Where do the Parties Stand on the Environment," UBC Report, 2 October 2008.

David Green, Kathryn Harrison, Nancy Olewiler, John, Richards, "We Shouldn't Axe BC's Carbon Tax," Vancouver Sun 24 June 2008.

Kathryn Harrison, "Open Season on White Males? Hardly," Globe and Mail, 20 September 1996.

Working Papers and Monographs

"Protecting our Future: How Selected OECD Countries deal with Environmental Health Threats to Children," report submitted to Health Canada, October 2006, coauthored with Robert Armstrong, Mary Anne Bobinski, Stuart MacLeod, and Jerry Spiegel.

"Implications of Chemical Use For Exposure Assessment", MIT Center for Technology Policy and Industrial Development, CTPID 86-2, February 1986, with Dale Hattis, 90 pages.

"Direct Release of Genetically-Engineered Microorganisms: A Preliminary Framework for Risk Evaluation under TSCA," MIT Center for Technology Policy and Industrial Development, CTPID 85-3, August 1985, with Harlee Strauss, Dale Hattis, Guy Page, Shawna Vogel, and Charles Caldart, 152 pages.

"Containment of Genetically Engineered Microorganisms: A Comparison of Expected Releases During Greenhouse Trials with Releases in Laboratory Research and Development", MIT Center for Technology Policy and Industrial Development, CTPID 85-2, August 1985, with Dale Hattis, 56 pages.

"Industrial Innovation Based on Undirected Mutagenesis of Microorganisms", MIT Center for Technology Policy and Industrial Development," CTPID 85-1, June 1985, with Guy Page and Dale Hattis, 58 pages.

Conference Papers

"Climate Change Regulation: Lessons from Regulatory Failure," Conference on "Defining and Measuring Regulatory Excellence," University of Pennyslvania, Philadelphia, 19-20 March 2015

"Political Economy of the BC Carbon Tax," Conference on Closing the Carbon Price Gap: Public Finance and Climate Policy, sponsored by the Mercator Research Institute, Berlin, 22-23 May 2014.

"Climate Policy in the US and Canada," National Pathways to Low Carbon Economies, UBC Institute for European Studies, 24 May 2014

"International Carbon Trade and Domestic Climate Politics," Annual Meeting of the Canadian Economics Association, Vancouver, 30 May 2014

"Environment, Economy, and Carbon Taxation in France and Ireland," Global Conference on Enviornmental Taxation, Copenhagen, September 2014, with Pascal Doray-Demers.

"International Carbon Trade and Domestic Climate Politics," workshop on the Global Carbon Supply Chain, UBC, 17 January 2015

"International Carbon Trade and Domestic Climate Politics," presented at the Annual Meeting of the American Political Science Association, Chicago, August 2013.

"International Carbon Trade and Domestic Climate Politics," presented at the Annual Meeting of the Canadian Political Science Association, Victoria, June 2013.

"Carbon Pricing in Australia, Canada, and the United States," presented at the annual Global Conference on Environmental Taxation, Vancouver, September 2012.

"The Politics of Carbon Pricing in Australia, Canada, and the United States," presented at the Annual Meeting of the International Political Science Association, Madrid, July 2012.

"The Politics of Carbon Pricing in Australia, Canada, and the United States," presented at the Annual Meeting of the Canadian Political Science Association, Edmonton, June 2012.

"The Politics of Carbon Pricing in Australia, Canada, and the United States," presented at the Annual Meeting of the American Political Science Association, Seattle, September 2011.

"The Politics of Carbon Pricing in Australia, Canada, and the United States," presented at the General Conference of the European Consortium for Political Research, Reykjavik, August 2011.

"A Tale of Two Regions: Explaining Diverse Regional Reactions to BC's Carbon Tax," presented at the annual meeting of the BC Studies Association, Kelowna, May 2011, with Chelsea Peet, (revised and published).

"A Tale of Two Taxes: The Fate of Environmental Tax Reform in Canada and the Province of British Columbia," presented at the 10th Global Conference on Environmental Taxation, Lisbon, September 2009, (revised and published).

"A Tale of Two Taxes: The Fate of Environmental Tax Reform in Canada and the Province of British Columbia," presented at the Annual Conference of the American Political Science Association, Toronto, September 2009 (revised and published).

"The Comparative Politics of Climate Change," presented at the Annual Meeting of the Association for Public Policy Analysis and Management, Washington DC, November 2007, coauthored with Lisa McIntosh Sundstrom (revised and published).

"Challenges and Opportunities in Canadian Climate Policy," presented at conference on A Globally Integrated Climate Policy for Canada, University of Toronto, November 1-2 2007, (revised and published).

"The Comparative Politics of Climate Change," presented at the Annual Meeting of the Canadian Political Science Association, Saskatoon SK, June 2007, coauthored with Lisa McIntosh Sundstrom (revised and published).

"The Path Not Taken: Climate Change Policy in Canada and the United States," presented at conference "Global Commons and National Interests: Domestic Climate Policies in an International Context," University of British Columbia, Vancouver, June 2006 (revised and published).

"The ARET Challenge: Evaluating a Negotiated Voluntary Challenge Program," presented at the annual meeting of the Canadian Economics Association, May 2006, with Werner Antweiler (revised and published).

"The Struggle of Ideas and Self Interest: Canada's Ratification and Implementation of the Kyoto Protocol," presented at the annual meeting of the International Studies Association, March 2006 (revised and published).

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