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HIGHLIGHTS

- This note summarizes analysis done by M.K. Jaccard & Associates, on behalf of the Pembina Institute and the David Suzuki Foundation, on the economic impact of hitting two different targets for reducing GHG emissions in Canada.
- TD does not endorse any particular target or set of policies related to GHG emissions.
- The modelling done by MKJA shows the policy and regulatory actions likely required to achieve the Government's current intent to lower GHG emissions by 20% from the levels in 2006 by 2020 or the requirements to reach a more ambitious target of lowering emissions by 25% from their level in 1990 by 2020.
- The macroeconomic impact is significant, but does not derail the economy. However, the breadth, depth and urgency of the policy response is remarkable. The headline impact masks substantial regional economic consequences and major industrial restructuring. The fiscal transfer involved is enormous.

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ANSWERS TO SOME KEY QUESTIONS ABOUT THE COSTS OF COMBATING CLIMATE CHANGE

A summary of the Pembina/David Suzuki Foundation paper

Climate change is a widely discussed policy issue that continues to rank high in public opinion polls. It is also a key international political concern, as evidenced by the forum to be held in Copenhagen, Denmark in December, in which Canada will be a participant. One of the key goals of this gathering is to answer the question of how much industrialized countries are willing to reduce their emissions of greenhouse gases.

TD has become increasingly concerned that the environment debate is largely conducted without objective analysis of the economic impacts (on a national, regional, and sectoral basis) or an appreciation of the breadth and depth of the measures that would be required to achieve the objectives.

To this end, TD helped provide funding to conduct research on what it would take to achieve the federal government's target, how much it would cost, and who might bear those costs. The authors of the report – the Pembina Institute and David Suzuki Foundation (DSF) – were also interested in examining the costs associated with the deeper target, supported by environmental non-government organizations (ENGOs). M.K. Jaccard and Associates Inc. was engaged to do the formative analysis using an energy economy simulation model and a macroeconomic general equilibrium model.

It is important to note upfront that TD does not endorse the Pembina/DSF report, or a particular target or set of policies related to GHG emissions. However the analysis done by M.K. Jaccard and Associates (MKJA) appears to be robust. And this report will help fill an information gap and further a productive debate on environmental policy. No doubt alternative assumptions and models could produce different results that might also be realistic. TD hopes that the release of the analysis will provoke alternative research into the economics of addressing climate change. In our opinion, an informed national debate is warranted on the policy options and the associated costs.

While the assumptions and models used shape the outcomes, TD believes that the findings provide one set of answers to some of the key questions that are at the core of the climate change policy debate.

What targets might Canada pursue?

The MKJA analysis assesses the economic impact of two different targets. First, the Government of Canada has announced a commitment to reduce greenhouse gas (GHG) emissions by 20% from the levels in 2006, which constitutes a 3% reduction from the level in 1990. Second, environmental non-government organizations (ENGOs) have argued for a more ambitious target of lowering emissions by 25% from their level in 1990 by 2020. This call is broadly consistent with the Intergovernmental Panel on Climate Change (IPCC), which argued that the industrialized countries need to reduce their GHG emissions to 25-40%

below the 1990 level by 2020 if they are to make a ‘fair’ contribution. The principle of ‘fair’ reductions reflects the fact that developing countries were not the main contributors to the emissions in the past and their economic development should not be unfairly diminished by efforts to reduce emissions – which will be a key issue discussed at the upcoming forum in Copenhagen.

Can the targets be achieved?

The MKJA modelling suggests that either target can be met, but there is a material economic cost to each. And, the cost is naturally much deeper with the more stringent target. There is a strong regional and sectoral dimension to the costs, as they are not spread evenly across the country. There is a variety of approaches that could be taken to achieve each outcome. The MKJA analysis presents the outcomes under one set of assumptions provided by Pembina and DSF, who felt that the selected policies were the most efficient and equitable combination that achieved the targets at the least cost to individuals, businesses and society.

Can Canada pursue a more stringent emissions target than other countries?

The MKJA modelling suggests that Canada can achieve either target without other countries following suit. One of the surprising results from the modelling is that the overall economic cost is not materially higher if Canada pursues

ACTIONS TAKEN TO REDUCE EMISSIONS UNDER THE ENGO ^(a) TARGET, Mt CO ₂ e (2020)		
	Canada Goes Further	OECD Acts Together
Baseline (BAU ^(b)) emissions	848	848
Emissions after application of domestic policies	514	535
<i>Domestic emissions reductions:</i>		
Output reduction	64	36
Other GHG control	52	46
Fuel switching to nuclear	1	1
Fuel switching to renewables	33	35
Fuel switching to electricity	33	33
Fuel switching to other fuels	10	11
Carbon capture and storage (CCS)	76	84
CCS energy efficiency penalty	9	10
Energy efficiency	57	58
International permit purchases	80	101
Target (remaining emissions)=Baseline-domestic emissions reductions-permit purchases	434	434

^(a) ENGO=Environmental NGO; ^(b) BAU=business as usual.
 Source: MK Jaccard and Associates Inc.

targets that are more stringent than other nations. However, the pursuit of a more aggressive Canadian target does have an impact on some of the policy actions, such as requiring the purchase of more international permits and affects the regional and industrial impact, since there is a greater burden borne by Canadian carbon-intensive industries and energy-rich provinces.

Is a carbon price part of the policy solution?

Pembina/DSF, and the MKJA modelling, use a core assumption that a carbon price is applied in order to evoke a change in behavior on the part of consumers and businesses. The purpose of the carbon price is to lower demand for high GHG emitting activities or products. For example, the application of the carbon price raises the cost of fossil fuels relative to the cost of other energy sources. The carbon dioxide and carbon dioxide equivalent emissions charge could take the form of either upstream cap-and-trade system or a carbon tax – the modelling by MKJA is agnostic between these two alternatives. For the government target, the MKJA analysis used a charge of \$40/tonne CO₂e starting in 2011 and rising to \$100/tonne CO₂e in 2020. For the ENGO target, a charge of \$50/tonne CO₂e starting immediately in 2010 was used, rising to \$200/tonne CO₂e in 2020. While these carbon prices curtail GHG emissions, they do not achieve the targets on their own.

ACTIONS TAKEN TO REDUCE EMISSIONS UNDER THE GOVERNMENT TARGET, Mt CO ₂ e (2020)		
	Canada Goes Further	OECD Acts Together
Baseline (BAU ^(a)) emissions	848	848
Emissions after application of domestic policies	626	643
<i>Domestic emissions reductions:</i>		
Output reduction	36	21
Other GHG control	43	38
Fuel switching to nuclear	0	0
Fuel switching to renewables	22	22
Fuel switching to electricity	30	29
Fuel switching to other fuels	10	10
Carbon capture and storage (CCS)	30	32
CCS energy efficiency penalty	5	5
Energy efficiency	49	49
International permit purchases	56	73
Target (remaining emissions)=Baseline-domestic emissions reductions-permit purchases	570	570

^(a) BAU=business as usual.
 Source: MK Jaccard and Associates Inc.

Are regulations required on top of carbon prices?

Pembina and DSF assume the application of complementary regulations by the Federal and Provincial governments. These are deemed necessary on the grounds of efficiency (i.e. they are less costly than relying purely on carbon prices) and some of them address market failures. With one exception, the Pembina/DSF recommended set of regulations are the same regardless of which target is pursued. The regulations used in the MKJA analysis that are implemented by 2011 include:

- Elimination of non-safety related venting and flaring in the upstream oil and gas sector, with a carbon charge applied on the safety emissions.
- Increased energy efficiency for all new buildings. New commercial buildings to be built to LEED Gold standard or higher. Residential buildings to be 50% more energy efficient than current standard practices. There is an added assumption that all new buildings in British Columbia, Manitoba and Quebec are restricted to using electric heating.
- All new vehicles sold to meet the California GHG emissions standards, with these standards being gradually tightened over time. As of 2011, 'white good energy efficiency standards' for all appliances to be raised to the most efficient commercially available that existed in 2008 and then improved over time.
- All landfills to be covered and the landfill gas flared or used to produce electricity and heat.

Under the more stringent ENGO target, there is one additional regulatory assumption in terms of the use of carbon capture and storage (CCS). Specifically, CCS is regulated for most emissions from new natural gas processors, new hydrogen production facilities, and new coal fired electricity plants, oil sands facilities and upgraders starting in 2016.

Are international permits required to meet the target?

The MKJA analysis finds that the use of international emission permits is required to avoid excessively high domestic carbon prices and to take advantage of lower emission reduction costs abroad. The traditional case for the use of international permits is that from a climate point of view what matters are global emissions – not the location of where the emissions are taking place. The analysis assumes that Canada buys between 56 Mt and 73 Mt CO₂e of permits in 2020 to achieve the government target – with the lower number being applicable if Canada has a more stringent target than other countries and the higher number

if the OECD countries have similar policies. The reason for less permits being purchased in the case where Canada has a tougher target is a reflection of the fact that output growth by carbon-emitting industries is reduced under this scenario. To hit the ENGO target, between 80 Mt and 101 Mt CO₂e of permits are required in 2020, again depending on whether other countries are pursuing similar policies to Canada or not.

Will the government reap huge tax windfalls from carbon prices?

The MKJA modelling estimates that government revenue from applying the carbon price assumptions made above to hit the government target would be at least \$40 billion per year in 2020. The revenue generated from hitting the ENGO target is estimated at least \$70 billion in 2020. However, the modelling shows that in order to achieve the GHG emissions reductions at the least economic cost, the carbon-related revenues should be fully recycled into the economy.

The assumptions of Pembina/DSF and applied in the MJKJA modelling are that the recycled funds are used to:

- Invest in public transit, with usage increasing by 35% compared to what would otherwise occur.
- Upgrade the electricity emissions grid to allow greater use of intermittent renewable electricity generation, with the latter to reach 25% of generation in some regions.
- Provide refunds to the two most adversely affected manufacturing industries (industrial minerals and metal smelting) to maintain their output at the level recorded in 2008. More on this later.
- Fully refund individuals for the resulting higher household energy costs.
- Purchase verifiable domestic agricultural offsets.
- Purchase the needed international emissions permits.
- Once all of the above are accomplished, the remaining funds are used to lower personal income taxes to provide a boost to economic activity in order to soften the impact of the climate change policies.

It may seem odd to readers that carbon prices are applied and then that a couple of industries and all consumers receive rebates or tax reductions. The analysis shows that the combination of these actions raises the cost of high carbon-emission activities relative to low carbon-emission activities. This lowers demand for the former and raises demand for the latter, which leads to a reduction in GHG emissions.

One could argue that the policies to reduce GHG emis-



sions are, in effect, a massive fiscal transfer that leads to a major industrial realignment. A tax (either directly or indirectly) is being applied to carbon-emission heavy activities, and then fiscal transfers are made to reduce the economic impact, which acts as a boost to low carbon-emission activities.

Does action need to be taken immediately?

The Pembina and DSF assumptions include a carbon price being applied in 2011 to reach the government target and applied in early 2010 to reach the ENGO target. All other policy actions begin in 2011, with the exception of regulations for Carbon Capture and Storage (CCS) in the ENGO target that takes effect in 2016. The modelling shows clearly that if the actions are delayed, the cost to achieve the same target will increase materially.

What is the national economic impact of reaching the targets?

Under the assumptions made by Pembina and DSF, and compared to an environment where no policy action is taken, MKJA concludes that achieving the government target reduces the level of Canadian real GDP by approximately 1.5% by 2020. Achieving ENGO target lowers real GDP by 3.2%. The cost is equivalent to a significant recession of varying magnitude depending upon the target. Unlike recessions, however, the lost economic output would not be recovered by a subsequent economic rebound.

However, it is important to stress that unlike recessions, the economic impact would be gradually felt over a decade. Under a scenario where no policy action is taken, the modellers assume that the Canadian economy would expand by 27% over the 2010 to 2020 period – or 2.42% per annum. Under the assumptions made above, the MKJA estimates that the government target can be achieved and the economy would grow by 25% (regardless of whether Canada has the same policies as other countries or more stringent ones), which is an average annual growth rate of 2.26% per year, or 0.16 percentage points less per annum than the business as usual case. MKJA finds that hitting the ENGO target would allow the economy to grow by 23% over the decade, or 2.09% per annum, and again is regardless of the policies taken by other countries.

Are some industries more impacted by the required policy actions?

The analysis by MKJA shows that economic growth continues while hitting both targets, but the carbon prices and regulations ultimately lead to a major structural change in the Canadian economy, away from heavy carbon emit-

CHANGE IN LEVEL OF GDP IN 2020 FROM BUSINESS AS USUAL (%)								
	BC	AB	SK	MB	ON	QC	ATL & RoC	Canada
GOVT OAT ^(a)	-2.2	-7.3	-1.2	1.9	0.6	-0.7	-0.5	-1.4
GOVT CGF ^(b)	-2.5	-8.5	-2.8	2.1	0.9	-0.3	-0.1	-1.5
ENGO OAT	-4.2	-11.9	-4.7	2.7	0.0	-1.3	-2.5	-3.0
ENGO CGF	-4.8	-12.1	-7.5	2.1	0.0	-1.3	-1.9	-3.2

^(a) OAT=OECD acts together; ^(b) CGF=Canada goes further.
Source: MK Jaccard and Associates Inc.

PROJECTED CUMULATIVE ECONOMIC GROWTH BETWEEN 2010-2020 (%)								
	BC	AB	SK	MB	ON	QC	ATL & RoC	Canada
BAU ^(a)	30	57	26	20	21	15	33	27
GOVT OAT ^(b)	27	46	24	22	22	14	32	25
GOVT CGF ^(c)	27	44	22	22	22	15	33	25
ENGO OAT	24	39	20	23	21	13	30	23
ENGO CGF	24	38	16	22	21	14	30	23

^(a) BAU=business as usual; ^(b) OAT= OECD acts together; ^(c) CGF=Canada goes further.
Source: MK Jaccard and Associates Inc.

ting industries (like fossil fuels) and towards lower carbon emitting industries. Because the former also tend to be capital intensive businesses, there is also a shift towards more labour intensive activities – which limits the negative impact on employment (more on this below).

The most adversely affected industries in terms of slower growth are petroleum refining, petroleum and natural gas extraction, and coal mining. Less affected, but still negatively impacted (particularly under the ‘Canada goes further scenario’) are industrial minerals, freight transport, chemical products, paper manufacturing, iron and steel, and metal smelting. As one might expect, the impact is greater under the ENGO target than the government target.

However, a commitment was made by the modellers when formulating the analysis that no manufacturing industry would be allowed to experience lower output than its level in 2008. Only metal smelting had this outcome under the government target. Under the ENGO target, both the metal smelting and industrial minerals sectors failed to meet the pre-established limit. The analysis assumes these industries receive government transfers to bring output back up to the 2008 level.

There are industries that benefit from the carbon prices and the regulatory changes. For example, there is an increased demand for electricity. Ethanol and Biodiesel also experience a dramatic rise in output compared to an

environment without any policy changes. The shift away from capital intensive industry and towards labour intensive industry also creates added growth in the latter.

What is the impact on employment?

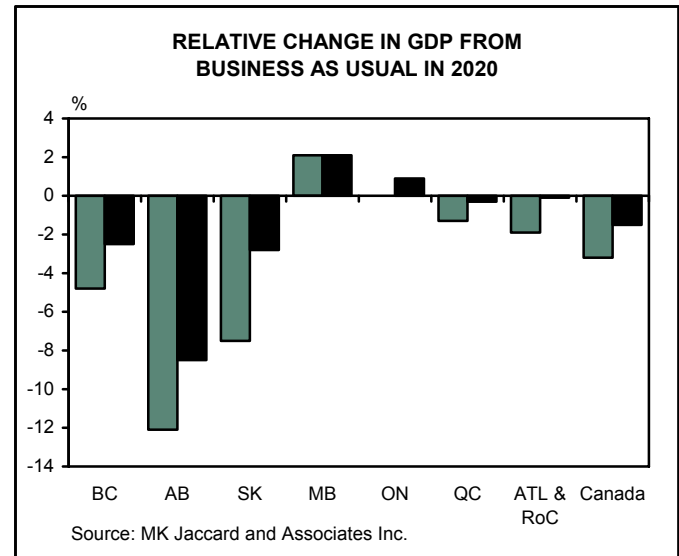
The MKJA models predict that overall employment in the Canadian economy would not be reduced by achieving either target. In fact, the policies might lead to marginally higher employment. TD Economics considers this a surprising result warranting further reflection. The modelling explanation has to do with the recycling of the carbon price revenues. The loss of economic output is accompanied by a decline in wage rates, which encourages firms to hire more workers. The personal income tax cuts are so substantial that after-tax personal income rises, which induces an increase in the supply of labour. There is also a shift away from capital-intensive industry and towards labour-intensive industry, which boosts demand for workers. So, in the analysis done by MKJA, output is lower and employment is largely unchanged – which implies a weaker performance for labour productivity.

One should note that while aggregate employment is not dampened, and may actually increase slightly according to the modelling, the industrial structural change would lead to a considerable disruption to labour markets in the negatively affected sectors. Many workers in the capital-heavy GHG-emitting industries would experience job losses and they would need to be retrained and supported while moving between industries. The impact on these workers should not be dismissed just because total employment is not reduced. Moreover, pre-tax wages of workers in general are lowered by the policies, reflecting the negative impact on productivity coming from lower output growth but little impact on aggregate employment.

Will different regions be more or less impacted than others?

The MKJA modelling suggests that the structural changes at the industrial level will lead to significant regional implications. As one would expect, provinces with a greater concentration of heavy carbon emitting industries will be the most adversely affected.

For example, according to MKJA, hitting the government target under the “Canada goes further” scenario leads to a 1.5% decline in the national level of Canadian real GDP compared to a business as usual scenario, but output in Alberta falls 8.5%, Saskatchewan drops 2.8% and British Columbia declines 2.5%. Achieving the ENGO target leads to a greater impact. National real GDP drops 3.2%, while



Alberta suffers a 12.1% decline, Saskatchewan loses 7.5% and British Columbia falls 4.8%.

Because the impact is felt over a decade, the MKJA analysis shows that the economies still grow. The average annual growth rate for Alberta, without carbon prices and carbon reduction regulations, was projected to be 4.6% between 2010 and 2020. Hitting the government target and under the “Canada goes further” assumption, Alberta growth slows to 3.7% annual pace. The ENGO target with Canada pursuing more stringent targets has Alberta growing at 3.3% annum. Saskatchewan’s trend growth rates are projected to slow from 2.3% to 2.0% or 1.5% a year, while British Columbia’s trend growth rate slips from 2.7% to 2.4% or 2.2% – under each scenario respectively.

Notably, under the MKJA modelling, the other provinces are significantly less affected. Indeed, Manitoba and Ontario might even see a small increase in output depending on the scenario. The reason is that these provinces have less concentration in GHG-heavy emitting industries and the reallocation of capital away from such industries leads to greater capital investment in these provinces. The modellers treated Atlantic Canada and the Territories as a group, and in aggregate, they are little affected hitting the government target and only moderately negatively impacted reaching the ENGO target, but regions in the composite with significant exposure to the energy sector would likely experience greater weakness than the average, while the others would be little impacted in terms of overall GDP.

Can’t technological change reduce the cost?

Pembina and DSF only assume the use of technologies that exist today, but in some cases they assume wide use of



technologies that have not yet been deployed commercially in a broad based fashion. The main example is carbon capture and storage.

It is true that new technologies can help to reduce GHG emissions. Over the next decade, however, it is not reasonable to expect that technical advances will provide a solution. The MKJA analysis shows that action would be required quickly to achieve the targets. Innovation is unlikely to provide the answer in the 2010 to 2020 time frame. Having said that, new technologies may have a significant role in achieving GHG emission objectives in the long-term, such as the 2020 to 2050 time frame. Indeed, the implementation of the rising price on carbon could prove to be a significant catalyst for the development of new carbon-reduced or carbon emissions limiting technologies.

Is this assessment reasonable?

Based on the assumptions used and the models applied, the impact assessment done by MKJA appears reasonable. The estimate on reaching the government target is broadly consistent with the National Roundtable on the Environment and the Economy (NRTEE) findings on the same subject. For example, the NRTEE analysis suggests that hitting the government target would reduce the level of real GDP by 1% to 3%, lowering the annual pace of national economic

growth by 0.2% per annum into an annual range of 1.5% to 2.0% in 2020. The similarity of the analysis is not an entirely surprising outcome, since some of the same models and assumptions were used in both sets of modelling. However, a comparison between the work by MKJA and the NRTEE shows how assumptions can differ, as the NRTEE allows for a greater use of nuclear power. This simply highlights that there are different paths to reach the same outcome. The key addition to the assessment of hitting the government target by the Pembina/DSF report is to add the critical regional dimension, which was not addressed by the NRTEE. Also, the Pembina/DSF study provides a more in-depth analysis of complementary regulations and public investments, and takes into account the two years that have elapsed since the NRTEE analysis was undertaken.

The key lessons that we take away from the analysis is that the macroeconomic and regional economic impact is significant. The breadth and depth of the policy response is also remarkable. The speed at which progress must be made is also notable, and would require considerable commitment. The structural changes necessary at the industrial level are masked by the more subdued headline economic impact assessment. The fiscal transfer involved is enormous and has a significant impact on the economy.

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