Still Minding the Gap: An Assessment of Canada's Greenhouse Gas Reduction Obligations

April 2016

A Paper prepared by the Canadian Deep Decarbonization Pathways Project Team

Dave Sawyer, EnviroEconomics.org **|** dave@enviroeconomcis.ca
Dr. Chris Bataille, IDDRI **& SFU |** cbataill@gmail.com

Overview

With the signing and expected ratification of the Paris Agreement and the conclusion of the first round of federal-provincial and territorial negotiations on a national climate plan expected in 2016, now is a good time to take stock of Canada's greenhouse gas (GHG) emissions trajectories, and importantly, ask what federal-provincial and territorial promises may deliver on the way to achieving Canada's GHG aspirations.

We've been asked to use modeling and analysis to provide a touchstone for discussion about what Canada's collective GHG emission trajectory might look like, what current policies are delivering, and what the raft of announcements bracketing the Paris conference are likely to deliver in terms of emission reductions.[1] This short brief presents the first phase of a modeling initiative to take stock of Canada's GHG aspirations versus emission trajectories. Phase 2 will identify areas where the federal government and the provinces and territories can potentially work together to deliver policy aligned with long-term decarbonization aspirations.

We ask a simple question, but one that is loaded given the lag in political will we have witnessed in Canada over the years: what would Canada's emission trajectory look like if the federal government and the provinces and territories implemented their policies as announced? We are generous in our interpretation of these promised policies but also realistic in how we assess the potential. We make clear where policies are already delivering reductions, what policies under development are likely to deliver, and also which policies are less certain. Brought together in an integrated macroeconomic modelling framework, these policies provide a view of Canada's progress toward the 2020 and 2030 greenhouse gas reduction (GHG) targets.

We estimate that the current gap to the 2020 target is 76 Megatonnes (Mt) and 91 Mt in 2030. We conclude that current Canadian GHG mitigation policies can deliver significant reductions that will increase over time, with the raft of developing policies bracketing the United Nations Paris climate conference having the potential to further lower emissions. However, gaps in policy coverage in some jurisdictions remain that will limit Canada's ability to close the gap to our 2030 target of 30% below 2005 levels.

There is, therefore, scope for the federal Government and the provinces to work together to better align policy. A first priority includes reducing costly distortions within the federation caused by misaligned carbon policies. The federation can then look for ways to ramp up policy stringency to position Canada for long-term, cost-effective decarbonization.

[1] This analysis and modeling was prepared by the Canadian Deep Decarbonization Pathways Project Team, funded by the **Climate Action Network Canada, Pembina, Equiterre** and **Environmental Defense**. Special thanks to Louise Comeau, Erin Flanagan and Dale Marshall for comments on successive drafts. This paper is the third in a series developed by the Canadian Deep Decarbonization Pathways Project Team.

The Basis of the Assessment

Our approach is conceptually straight forward. We use an economic model[2] to forecast economic activity, energy supply and demand and GHG trajectories to 2030 under alternative oil price scenarios[3] with no climate policies at all, and then layer in current, developing, and speculative policies as follows:

- A "**no climate policies case**", where we simulate no GHG measures and allow the economy and emissions to grow unconstrained.
- A "**current policies**" scenario reflecting carbon policies implemented prior to September 2015, similar to Environment Canada's 2nd Biennial Report[4].
- A "**developing policies**" scenario, reflecting recent firm announcements since September 2015.
- A "**speculative policies, federal floor"** scenario, including plausible policies that have been publically supported by some jurisdictions, as well as a federal policy floor to smooth misaligned carbon policies between jurisdictions.

For each of these scenarios, we then assess progress towards Canada's Nationally Determined Contribution of 30% below 2005 GHGs in 2030, while assessing the 2020 Copenhagen target along the way. We also provide a view on Canada's progress towards a longer-term objective of deep decarbonization.

Still Minding the Gap

We start with a **no policies scenario** to serve as a reference from which to compare current and possible progress on emission reductions. In the scenario, we strip away all carbon policies that have been implemented since 2005 with future emissions growth driven by forecast energy prices in the National Energy Board 2016 Reference Case (NEB, 2016). We allow upstream oil and gas production and energy end-use in the model to adjust to energy prices absent any carbon policy.

Absent carbon policies, Canada's emissions grow substantially. Our "no policies" forecast indicates that absent major carbon policies such as British Columbia's carbon tax, Alberta's Specified Gas Emitter Regulation, Ontario's coal-fired electricity ban and, importantly, federal efficiency standards, Canada's emissions grow to 959 Mt in 2030 or about 28% more than 2005. Relative to the 2020 and 2030 GHG targets that are benchmarked against 2005, the gap is 245 Mt in 2020 and 435 Mt in 2030. The top line in Figure 1 provides the no policy GHG forecast.

[2] We primarily use the macroeconomic model RGEEM, supplemented by information from a techno-economic model CIMS. Special thanks to **Noel Melton** for his help with the CIMS modelling. Both models are regionally and sectorally disaggregated with key technology details to capture energy and GHG policies, and have a long history in Canada of supporting climate policy development and long-term foresight. GEEM, a dynamic recursive CGE model, also includes a US model to capture trade and climate policy interaction effects. Please contact the authors for details.

[3] These scenarios are assessed using the National Energy Board's 2016 Reference price for oil, as well as a $40 a barrel flat real oil price (in 2016 dollars) to 2030, which is about half the NEB price in 2020.

[4] http://unfccc.int/national_reports/biennial_reports_and_iar/submitted_biennial_reports/items/7550.php

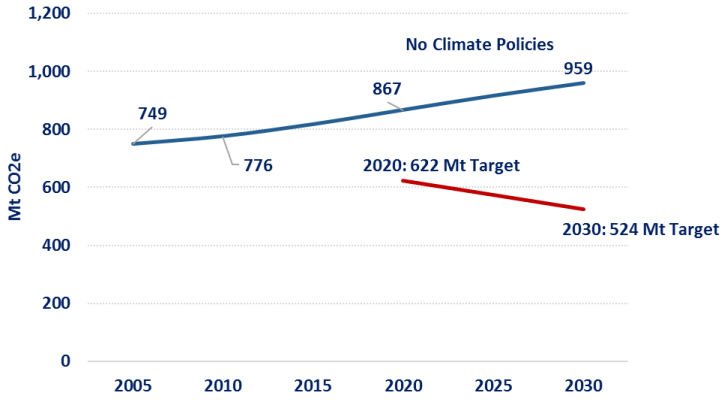

Figure 1: Canada's No Climate Policies GHG Forecast[5]

To this no policy baseline we then add a range of **current policies**. Current policies include British Columbia's carbon tax, Alberta's Specified Gas Emitters Regulation (SGER), Saskatchewan's Boundary Dam carbon capture and storage (CCS) project, Ontario's coal phase-out, Québec's cap and trade system and Nova Scotia's renewable portfolio standard. Landfill regulations are also assessed in each provincial jurisdiction. Federal policies include the coal-fired generation regulation and a long history of vehicle efficiency standards.

This policy is somewhat aligned with the Environment Canada and Climate Change's 2nd Biennial Report (BIR), falling on the low end of the forecast with roughly the same policies. We are not surprised at this alignment given that we allow our oil production to adjust to the NEB, 2016 reference oil price, which returns lower production than forecast by NEB (2016) and adopted in the BIR.

Current policies have a significant impact on Canada's GHG trajectory. With just these current policies in place, we see significant emission reductions from the "no policies" case, with Canada's emissions falling from 817 to 725 Mt in 2015, 867 to 757 Mt in 2020 and 959 to 778 Mt in 2030. Under this scenario, which reflects the current state-of-play in policy development in Canada, GHGs are projected to more or less stabilize at 2005 levels in 2020, with a gap to the 2020 Copenhagen target of 135 Mt.

For the 2030 target, the remaining gap in our current policies scenario is about 254 Mt or 3% above the 2005-based level of -30%. We have chosen not to include LULUCF (land use, land use change and forestry) accounting that was included in the First Biennial Climate Change Report, given ongoing uncertainty in accounting rules and status.[6] Figure 2 provides our view of the GHG forecast with the "current policies" scenario.

[5] Our GHG forecasts will be higher in this version of the draft. Based on the peer review, we have more tightly calibrated the GHGs included in the model based on information contained in the Environment and Climate Change Canada National Inventory Report, 2015. However, we do not fully calibrate to the PFC and HFC forecasts, which show significant growth to 2030.

[6] There is significant uncertainty in the LULUCF value. Canada's First Biennial Report published a 2020 value of 28 Mt.

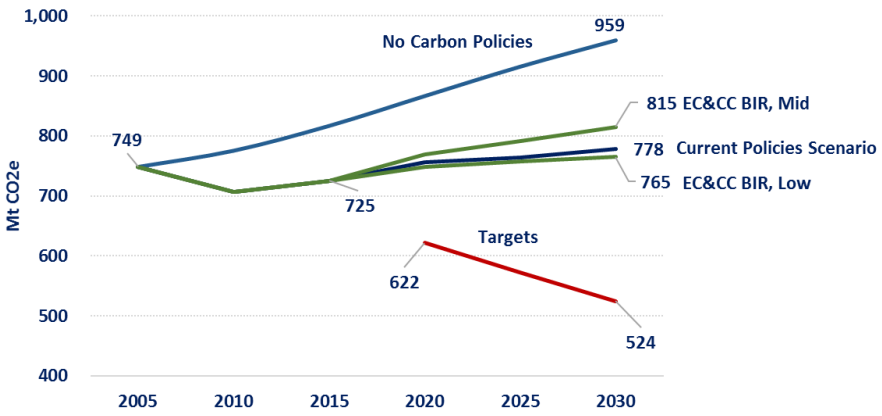

Figure 2: With Current Policies Scenario

To these current policies we add the **developing policies scenario,** including Alberta's Climate Leadership Plan, which looks like stated government policy, Ontario's proposed Cap and Trade Regulation, and Saskatchewan's 50% electricity standard for installed renewable capacity. We also add the recently announced federal methane regulation for the oil and gas sector. Together, these developing policies reduce the gap to 83 Mt in 2020 and 110 Mt in 2030 (Figure 3). Annex A provides our detailed policy assumptions.

The true-up under Ontario and Québec's cap and trade system, currently linked to the Western Climate Initiative (WCI), may or may not occur within Canada but will likely lead to global emission reductions. In Figure 3 below, we break out both Ontario and Québec's true-up, which is the difference between reductions from regulated emitters within the jurisdiction and compliance from flexibility options such as domestic offsets or WCI allowance imports, to their 2020 and 2030 targets using their cap and trade systems. Note that Québec's cap and trade system is included in the current policies scenario above absent the true up to its targets. The difference between the developing policies scenario and these policies with the true-up is the difference between domestic abatement from covered entities with the assumed carbon price, and compliance to the caps using alternative flexibility mechanisms enabled by the cap and trade system, including WCI permit imports, domestic offsets and complementary policies that may be funded directly by proceeds recycling from auction revenue.

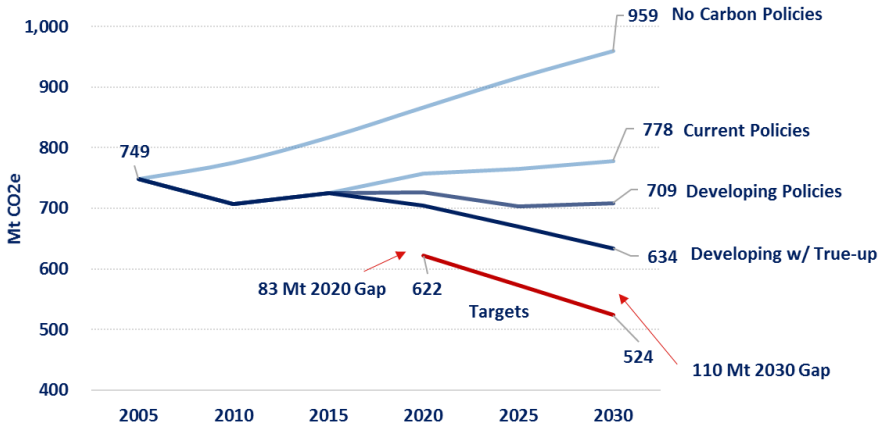

Figure 3: The Current and Developing Policies GHG Forecast

A "**speculative policies, federal floor**" scenario is then added on top of the current and developing policies scenarios to show what announced climate policies might deliver. The significant additions here include a cap and trade program in Manitoba and a carbon pricing regime in the Atlantic region. Finally, we continue the federal vehicle regulations out to 2030 based on their historical intensity improvement.

The "**possible federal carbon price floor"** is applied to all combustion fuels, pegged to the price trajectory of the WCI allowance price.[7] This price floor would primarily affect Saskatchewan but also would pull up Alberta's proposed carbon price after 2027 as our WCI price forecast begins to exceed the scheduled rise in Alberta's price under the Climate Leadership Plan. The same holds for British Columbia where its tax trajectory is overtaken by our assumed WCI price around 2026.

Figure 4 provides the assumed carbon price schedules, in real 2015 CDN dollars. The fixed British Columbia carbon tax rate is falling in real terms at the rate of inflation whereas the proposed Alberta rate rises at 2% real.

The alignment of all provinces on a WCI allowance price trajectory, either through a federal price floor or of their own accord and continued vehicle efficiency standards, would add another 7 Mt of reductions in 2020 and 19 Mt in 2030 (Figure 5).

[7] We envision this price floor to align with current federal taxation authority, as in the case of the gasoline tax, but also envision an expanded authority to tax all combustion fuels such as natural gas, as well as process emissions. We do not envision a national cap and trade system that pre-empts current provincial policies, although a national carbon offset system would be one approach to provide indirect linking across fragmented subnational jurisdictions.

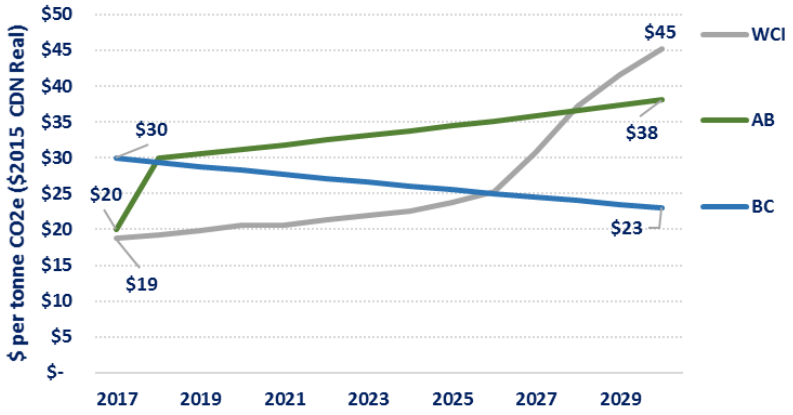

Figure 4: Assumed carbon price schedules in 2015 CDN dollars (real)

A national carbon price floor aligned with current policies is just that, a floor. Given provincial efforts, its purpose is to provide a foundation for longer-term, cost-effective decarbonization. The limited reductions under the federal price floor are not surprising given the broad coverage of carbon policy in place or developing in the major provincial economies. Still, to ensure equity across regions, reduce carbon leakage and drive innovation, it is essential to have a broad-based carbon policy somewhat aligned across all Canadian jurisdictions.

Figure 5 shows how emission reductions under the various scenarios play out, indicating a gap to the 2020 target of 76 Mt and 91 Mt to the 2030 target. These gaps basically assume that policies will be implemented as currently promised, which we recognize is a stretch assumption. Still the implications are clear. Even if all announced policies plus a reasonable set of aspirational policies are implemented in the short-term, Canada can still expect a significant gap to both the 2020 and 2030 targets. Figure 6 indicates the size of the remaining gap in 2020 and 2030.

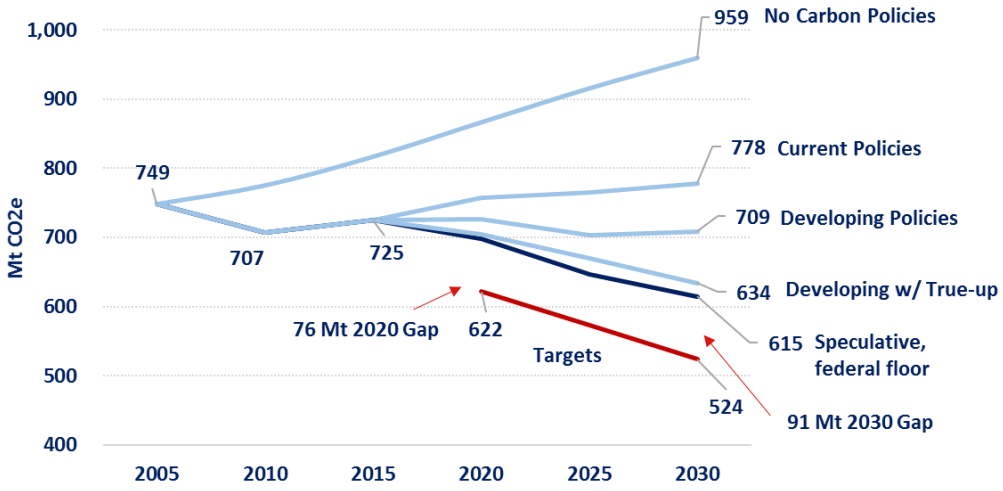

Figure 5: GHG Trajectory with All Policies (Mt)

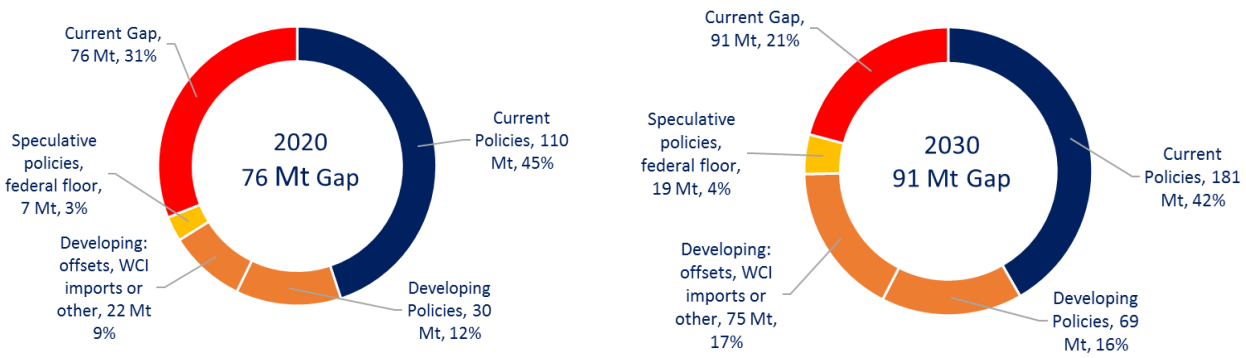

Figure 6: Still Minding the Gap

Carbon Policies and Oil Shocks

In this section we assess the current and developing policies scenario with a $40 oil price,[8] or roughly half the NEB value in 2020 used above. This scenario provides a view of how a low oil price environment might affect upstream production and downstream end-use GHG growth (e.g. transport demand and emissions) under the current and developing federal and provincial policies.

The traditional view in Canada on oil price swings has been that higher prices will drive significantly more emissions growth primarily from the upstream oil and gas sector, offset somewhat by increased end-use conservation and efficiency in buildings, vehicles and industry. But with the addition of a number of carbon policies, including a comprehensive policy in Alberta, we test this assumption by replacing the NEB oil price forecast with a lower, long term $40 per barrel scenario.

It may no longer be the case to assume higher oil prices drive significantly more GHGs nationally. When we look at upstream oil and gas production in Alberta under the low oil price $40 scenario, we indeed see lower emissions of 10 Mt in 2020 and 41 Mt in 2030, and *vice versa; but* Alberta's total emissions do not really change. With the Climate Leadership Plan addressing combustion and methane emissions, the growth in oil and gas GHGs under the NEB case is somewhat muted relative to the growth in production, with our analysis indicating that the growth in oil production in 2030 is 1.6 times larger than the growth in emissions.

Complementing GHG controls on upstream oil and gas is an economy-wide carbon price addressing transport, building and electricity emissions. These controls temper GHG emission swings associated with oil price movements, basically slowing GHG growth in either oil price scenario. By 2030, there is virtually no difference in Alberta GHGs between the scenarios we assess, as a sort of balance emerges where oil swings move end-use and upstream production in completely offsetting directions. Figure 7 highlights this dynamic.

[8] The $40 oil price mirrors not only current oil price levels, but also a consensus view from global experts canvassed for the Deep Decarbonization Pathways Project (www.deepdecarbonization.org), reflecting how global carbon policy might suppress oil demand and hence prices in the long-term.

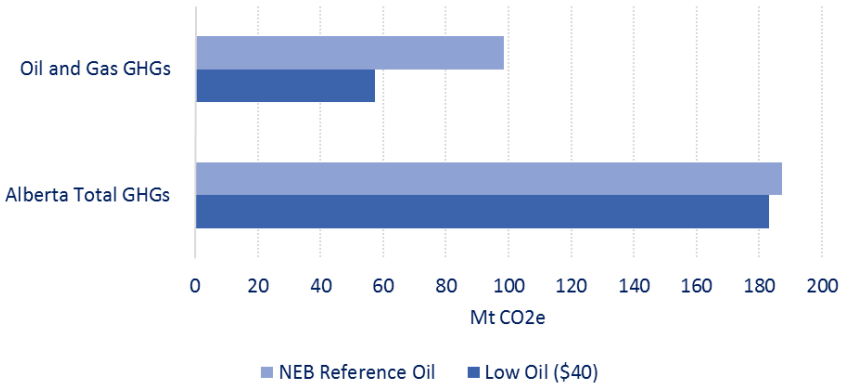

Figure 7: Impact of Oil Price Shocks on Alberta GHGs under Climate Leadership Plan, 2030

With the oil prices we have modeled, any growth in upstream oil and gas production is more than offset by a contraction in energy end-use emissions and *vice-versa*. The net effect of lower oil prices is to increase Canada's overall effort to reach the 2020 and 2030 targets on the order of 42 and 43 Mt respectively. It also raises significantly the compliance obligation under the WCI cap and trade programs, as end-use emissions rise yet the Ontario and Québec targets are fixed. Clearly, target attainment cuts both ways with oil prices, but given policies in place or being developed, the upside risk on emissions may now sit squarely in vehicles and buildings and less so in industry.

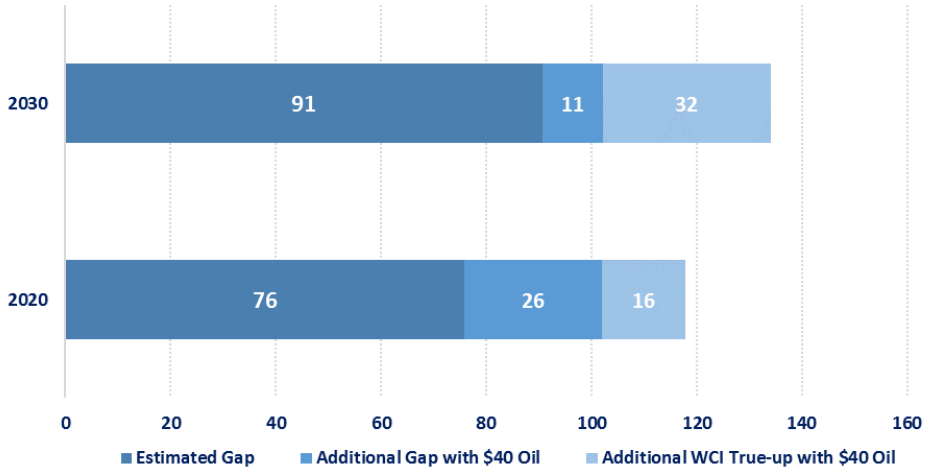

Figure 8: Impact on Canada's GHGs Targets under a $40 Oil Price (Mt)

Holes in policy coverage in some jurisdictions are revealed by oil price shocks. This sort of detente between end-use emissions and upstream emissions interacting with oil price swings under the Alberta policy package does not bear out in the remaining jurisdictions. Under the current and developing policies scenario, there is a mix of policies that interact with the oil price swings very differently:

- In jurisdictions such as Manitoba, Saskatchewan and the Atlantic region, where there are no policies on energy end-use emissions, we see the lower price drives significantly more emissions. The Atlantic region is a case in point, where the modeling indicates the likelihood of significant swings in total emissions in the energy price scenarios with no countervailing GHG

policies.

- In both Ontario and Québec with hard caps on emissions, any growth in end-use emissions due to the lower oil price are contained by the cap and trade system and simply increase the compliance obligation, e.g. through more permit purchases. From a pure quantity GHG perspective, the cap and trade programs could address GHG swings due to oil price volatility.[9]
- An interesting case is British Columbia, where overall emissions growth driven by liquefied natural gas (LNG) production and population growth increase GHGs relative to 2005 in both oil price scenarios. However, the level of the carbon price, which is falling in real terms from $30, is insufficient to contain emissions growth. One of the largest components of emissions from shale gas production for LNG is CO_2 that comes up with the raw gas (formation gas). It is not covered by the British Columbia carbon tax (it would have been included if BC had joined the WCI), but had it been, the price would have been just short of the level needed to cover the cost of carbon capture and storage, about $40 per tonne CO_2e (as done at several Norwegian gas facilities). There are also indications methane emissions from fracking used to access shale gas may be higher than expected, and tight controls will be needed to maintain the announced federal methane regulation.

Figure 9 provides our view of the impacts of the oil price on provincial emissions under the current and developing policy scenario. We report emission changes in 2030 relative to 2005 as Megatonnes and tonnes per capita reduced for both the “current and developing policies” and “speculative policies, federal floor” scenarios.

[9] Note we assume that WCI imports are real and verified GHG reductions, and are credited against Canada’s national inventory (through an as yet to be determined mechanism).

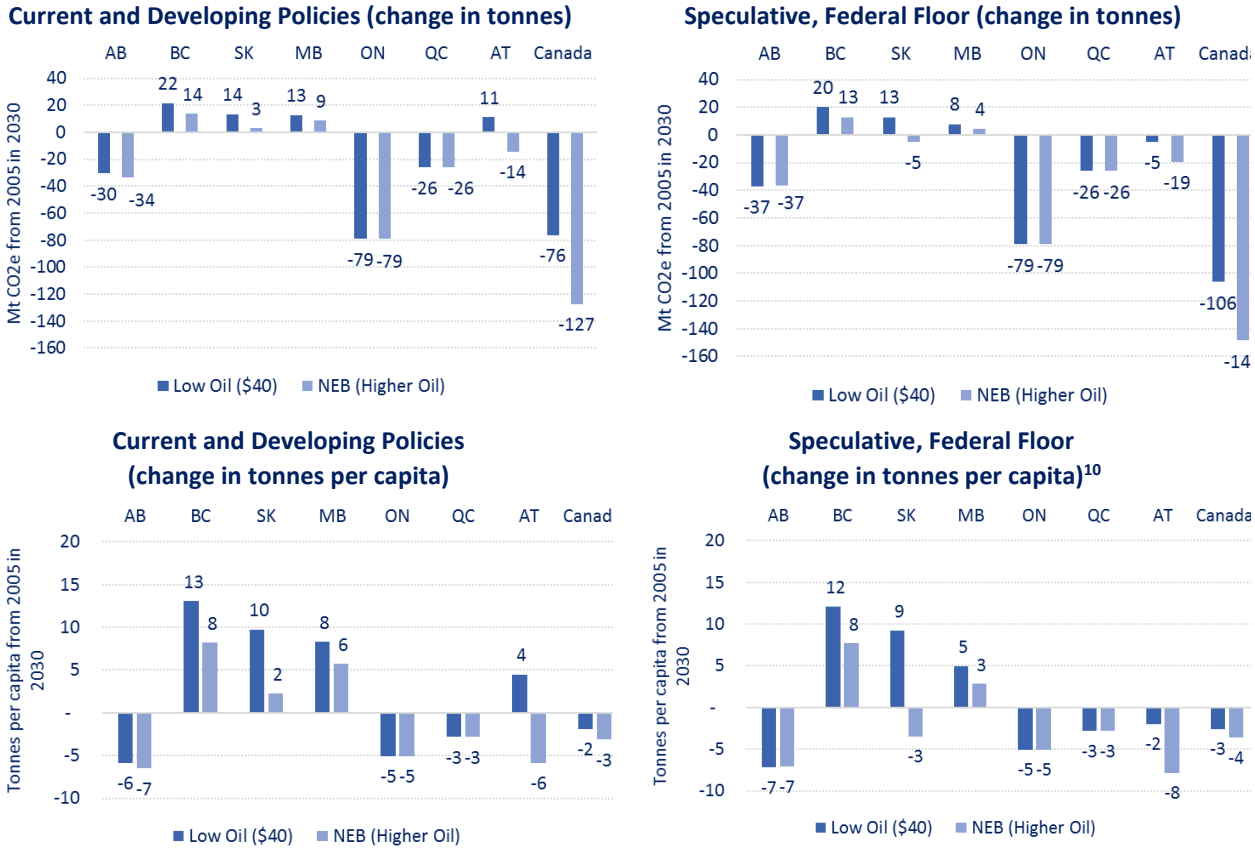

Figure 9: Change in GHGs (including WCI true-up) under Alternative Policy and Oil Price Scenarios Change from 2005 in 2030

[10] 2030 population forecast from Statistic Canada CANSIM Table 052-0005, Projection Scenario M5

Canadian Electricity: On A Deep Decarbonization Pathway?

Canada's electricity sector may now be on a deep decarbonization trajectory, consistent with a 2°C pathway to 2050. In pulling together the multiple layers of jurisdictional policy for this paper, we knew that electricity would be an important source of Canadian decarbonization. We noted in our Deep Decarbonization Pathways Project work that the decarbonized electrification pathway is a low risk priority given that current policies at home and abroad are stimulating innovation, deploying a diverse portfolio of increasingly cost-effective technologies and driving down emissions. Policy induced innovation and learning by doing are making it easier and cheaper to decarbonize electricity but also to electrify various energy end-uses, notably vehicles.

In cataloging the electricity policies within the federation, it is clear that Canada now has a solid foundation of policies that are accelerating the phase-out of coal while increasing renewables penetration. The current policies in Ontario (coal ban) and Nova Scotia (cap and renewable portfolio standard) and developing policies in Alberta (coal-phase-out and renewable procurement) and Saskatchewan (carbon capture and storage and 50% installed renewable capacity standard) are accelerating the deep decarbonization of Canadian electricity. These provincial policies are complemented by a backstop federal regulation that starts to impact large segments of coal generation as it reaches the end of its life after 2025.

Given this diverse set of electricity polices within the federation, it seems evident that significant progress towards decarbonized electricity would be revealed by the models. Still, one of the reasons we like to use integrated models is that they can reveal policy interactions that may not seem so clear at first glance. When the analysis of the combined electricity policies emerged from the models, we were genuinely surprised to see the steepness of the decarbonization trajectory given current and developing policies within the federation. The modeling revealed that Canada "could" be on a very deep decarbonization pathway for electricity.[11]

Figure 10 shows this integrated policy dynamic for Saskatchewan's electricity GHGs to 2050. Under current policies, the Boundary Dam CCS project is delivering about 1 Mt of reductions. Then, as the developing policies scenario kicks in, with Saskatchewan aiming for a system-wide renewable generation capacity of 50% by 2030, or a 28% increase in installed renewable capacity from the no policy forecast of about 39% in 2030, emissions are significantly bent downwards.[12] Then, as older coal plants start to reach their end-of-life after 2025, the federal regulation, which effectively bans coal generation, further drives down emissions. The trajectory of emission reductions in Figure 10 is shown to be consistent in our two models that were run independently but with similar policy packages.

A similar dynamic occurs in Alberta under the developing Climate Leadership Plan, but the phase out of coal is much more aggressive to 2030 (Figure 11). After 2030, some coal generation still exists in the model, but emissions are significantly curtailed with carbon capture and storage obtaining some market

[11] Note that in the DDPP we identified **decarbonized electrification** as a resilient pathway. This decarbonization pathway requires both decarbonizing electricity and electrifying end-uses away from fossil fuels. In this section, we only review half the pathway – decarbonizing electricity.

[12] Using the CIMS forecast, we estimated the installed capacity by type of generation based on typical capacity factors.

share based on the relative costs of generation technologies. To the extent that CCS is economically or technically infeasible, the coal would be replaced with renewables.

If the current policies continue, and the developing policies are implemented as announced, the Canadian electricity sector is on a trajectory to a -80% GHG reduction by 2050. Figure 12 indicates the national picture across economic sectors, comparing the emission reductions in 2050 under current and developing policies relative to the 2005 base year. Taken together, the suite of current and developing policies has placed Canada's electricity sector on a 2°C trajectory, which requires emission reductions in the order of 80 to 90% below current levels by mid-century (Figure 12).

This deep decarbonization outcome for Canadian electricity is not inevitable and will require governments to implement their proposed policies. It does, however reveal a significant shift in climate policy in Canada; ***governments are making promises backed by policy, and not just expounding deep decarbonization targets divorced from action***.

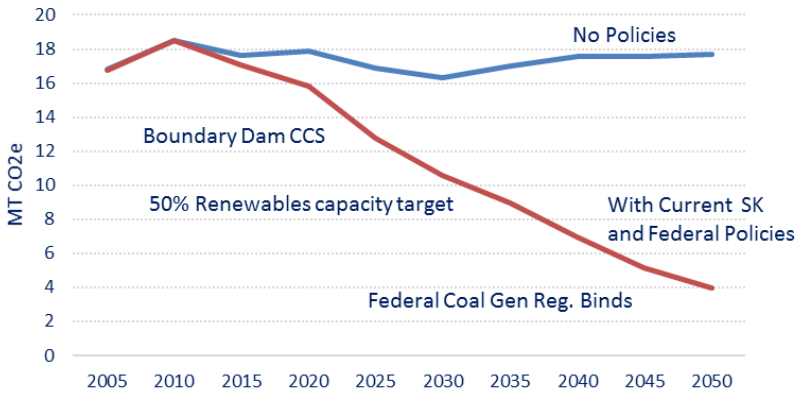

Figure 10: Impact of Current and Developing Electricity Policies on Saskatchewan GHGs

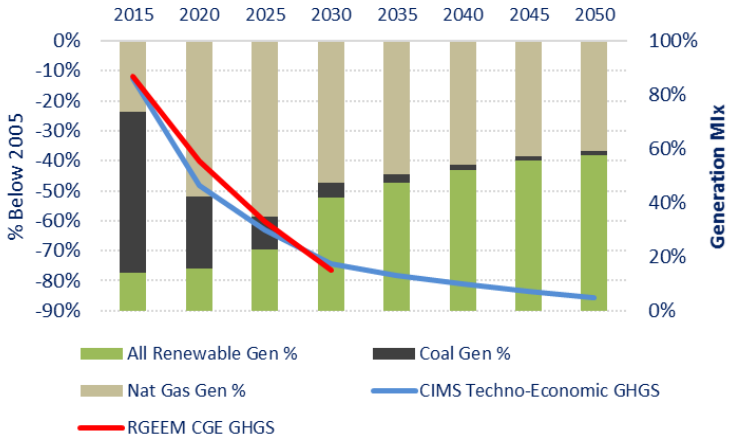

Figure 11: Impact of current and developing electricity GHG policies in Alberta

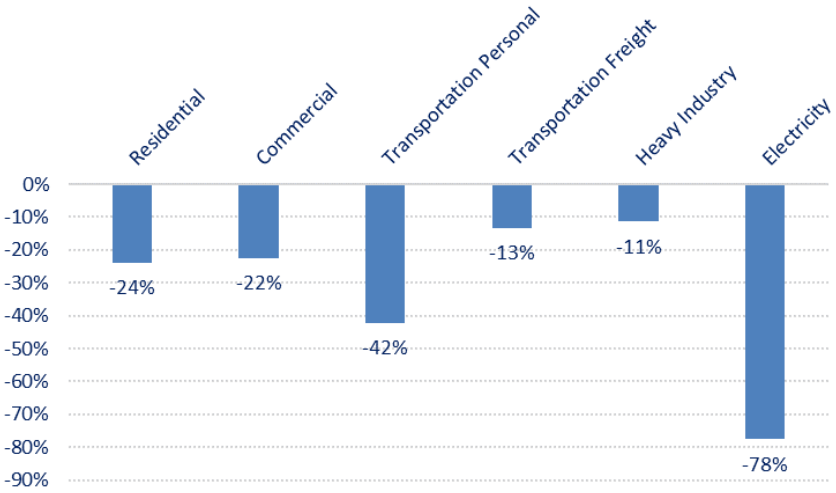

Figure 12: Impact of Current and Developing Policies on Canada's GHG Emissions by Sector Change relative to 2005 in 2050

A Decarbonization Path Forward

Canada is in the fortunate position that our underlying economic growth rate seems to vary around 2% per year, depending on global economic conditions. This growth, however, pushes up our GHG emissions. Vehicle regulations, the Ontario coal phase out, British Columbia's carbon tax, Alberta's Specified Gas Emitters Regulation, and the myriad of provincial electricity regulations have the potential to significantly reduce emissions from what could have been. A raft of developing policies bracketing the Paris conference have the potential to further lower emissions. This is the good news.

The bad news is even with projected carbon prices of $15 to 30 per tonne CO_2e and spotty regional coverage, emissions growth has been and will continue to be barely held in check. We estimate that the current gap to the Copenhagen target is 76 Mt in 2020 and 91 Mt to Canada's Nationally Determined Contribution in 2030, indicating a 10-year lag in achieving our 2020 target by 2030. The presence of costly distortions caused by a patchwork of misaligned carbon policies within the federation will only make closing this gap more difficult.

Given that we have made important progress on checking emissions growth, but with more to do, is there a path forward? We argue a credible path forward has five elements.

First, **all emitting sectors of the Canadian economy need to be covered by GHG policy**. Some sectors are more amenable to direct regulation (e.g. fugitive methane from oil and gas and building efficiency), some to market based performance regulations (e.g. new transport fleets), and some to carbon pricing (e.g. industry and household equipment purchasing and operating behaviour). A prudent path forward would be to look through provincial GHG inventories to identify policy gaps and then develop policy that incents cost-effective change. For example, British Columbia is missing policy coverage on industrial process and natural gas formation emissions. Saskatchewan, Manitoba and the Atlantic provinces are missing general pricing.

Second, **vehicle and building energy and GHG intensity regulations must become consistently tighter**, both to control current emissions and to send a clear innovation signal to manufacturers. These policies have delivered significant reductions in the past, are more politically palatable because they obscure the effective carbon costs, and can potentially result in net savings over the longer-term for consumers and businesses.

Third, **all regions need a basic level of carbon pricing that rises predictably from current levels of $15 to at least $30 per tonne** to cover general combustion emissions (e.g. from industry, driving, and furnaces). This price serves three purposes: it curbs end-use emissions under low and high energy price scenarios, sends a signal for new investment in known efficiency and fuel switching technologies, and perhaps most importantly, puts a value on entrepreneurial research and development. Carbon pricing also stabilizes the effects of energy price swings; the oil price swing we analyzed revealed significant policy holes that can be filled by carbon pricing covering most emissions. A continued low oil price environment will cause end-use emissions to rebound in those regions without economy-wide carbon pricing.

Fourth, **all regions need to continue current trends towards decarbonized electrification**, setting it up as the first choice fuel for everything that does not move, and if battery costs fall, personal and light freight transport. This is a provincial success story, a good job well done that must be finished. Our analysis suggests that Canada's electricity sector could be on a deep decarbonization trajectory consistent with a 2°C goal of a -80% reduction in GHGs from today.

Fifth, **significantly more innovation support is needed to drive down the future costs of emission reductions**, especially in liquid fuels and industrial emissions. Innovation signals in industry are especially weak at home and abroad, despite industrial emissions being a large component of our national GHG inventory.

Existing and developing policy gets us about three quarters of the way to the 2030 target, and science indicates the eventual targets will need to be deeper. "Ratcheting" down policy effort will be necessary, once the political conditions are in place. These political conditions will include the availability of appropriate technology, equivalent action by our trading partners, and public support. In order to build the national consensus to ratchet, federal policy will be needed to bring up laggards, in order to maintain perceived fairness. Canada may eventually need a national decarbonization authority to set sector-by-sector emissions guidelines, monitor progress, and identify shortfalls. This analysis can be used to set minimum standards, and to clearly define the conditions for mandatory federal action.

Finally, every region needs a comprehensive policy package of its own making that covers all sectors, prices emissions, sends innovation signals, and guides regional industry to a low carbon economy. This package can be designed to meet regional specific needs while playing its part to meet our national emissions reduction targets.

As revealed by the Vancouver Declaration from the March 2016 First Ministers' meeting, Canada has for the most part stopped arguing about the eventual need for deep reductions in emissions. The debate has refocused on policy jurisdiction, timing, the necessary policy packages, and how to fill the policy holes that remain. With those holes plugged, the federation can then move on, looking for ways to increase policy ambition while positioning Canada for long-term, cost-effective decarbonization.

Phase II of this project will explore ways for the federal, provincial and territorial governments to "close the gap" to our announced targets and eventual long-term decarbonization.

Annex A: Detailed Policies Assessed

Our scenarios adopt the National Energy Board 2016 Reference Case for oil prices, while we allow upstream oil and gas production in the model to adjust to the price. For each of these oil price trajectories in the current policies case, we assess the following:

- A "**current policies**" scenario reflecting carbon policies implemented priority to September 2015, similar to Environment Canada's 2nd Biennial Report.
- A "**developing policies**" scenario, reflecting recent firm announcements since September 2015.
- A "**speculative policies, federal floor"** scenario, including plausible policies that have been publically supported by some jurisdictions, as well as a federal policy floor to smooth misaligned carbon policies between jurisdictions.

The assumptions for each are discussed below.

The **current policies** scenario:

- For **British Columbia**, we model the economy-wide carbon tax at a flat rate of $30 to 2030 in today's dollars, which effectively means it is falling in real terms. We apply this rate to new LNG facilities that come online starting in 2019 (consistent with the NEB, 2016) but recognize an intensity standard similar to Alberta's Specified Gas Emitter Regulation would apply under the Greenhouse Gas Industrial Reporting and Control Act (GGIRCA). We therefore may underestimate the GHG reductions from the new 0.5 Mt of LNG GHGs in our Reference Case, specific to the facilities, not upstream emissions.[13] Municipal solid waste reductions are also included. Significant upstream process formation gas (CO_2) and methane emissions are associated with LNG production, but these are not covered under existing policy.

- For **Alberta**, we model the June 2015 announced update to *the Specified Gas Emitter Regulations (SGER)*, with a tightening of the intensity limit and rise in price in 2018 from $30 by 2% (real) annually. Municipal solid waste regulations are also modeled.

- For **Saskatchewan** we include the Boundary Dam GHG CCS project. Municipal solid waste reductions are also included.

- For **Manitoba**, we have no policies in the current scenario, with the coal and coal heating ban likely having a negligible impact on GHGs. That said, municipal solid waste reductions are included.

- For **Québec**, we model the WCI program, assuming coverage of about 85% of total GHGs and a carbon price rising from a real $21 per tonne CO_2e Canadian in 2020 to $45 in 2030. This WCI price reflects public forecasts of the WCI carbon price made by CaliforniaCarbon, using an historical average Canada-US exchange rate of 1.17. We true-up to the provincial targets with WCI imports or domestic offsets when domestic reductions from regulated entities are insufficient to meet

[13] Based on an earlier NEB forecast, the model predicts roughly 2 BCF/day of BC LNG starting in 2019. The current NEB 2016 forecast is 2.3 BCF/day, starting a more slowly and rising to 0.3 higher than our current forecast.

Quebec's 2020 or 2030 targets (-20% and -37.5% below 1990). Municipal solid waste reductions are also included.

- For the **Atlantic region**, we model Nova Scotia's cap on electricity to 2030 under its Greenhouse Gas Emissions Regulations, with no other policies for the other provinces. Municipal solid waste reductions are included however.

- **Federal policies** include the light and heavy duty vehicle regulations which we simulate to decline to 2025 as per the Regulations and then flat line to 2030. We also simulate the federal coal -fired generation regulations which, by requiring the emissions intensity of a typical natural gas generation facility, effectively bans new coal plants and requires shutting down aging ones at the end of their life (unless equipped with CCS, which is more expensive than natural gas generation).

- We have included all residential, commercial and institutional building codes and appliance efficiency policies. We excluded federal and provincial biofuel policies, as well as Ontario, Québec and British Columbia incentives for electric vehicle uptake.

The **developing policies** scenario:

- For **Saskatchewan** we add a 50% renewable capacity standard in electricity by 2030.

- For **Alberta**, we model the recently announced Climate Leadership Plan, including: an output-based intensity standard moving forward for large point source emissions; an aligned carbon tax on liquid fuels and natural gas, starting at $30 in 2018, rising by 2% (real) annually; an orderly coal power phase-out by 2030 and a renewable power requirement of 30%, likely via auction, by 2030; and a methane regulation achieving a 45% reduction from a fixed target in 2005 in upstream oil and gas by 2025 (we assign a starting target of 25% in 2020 rising to 45% in 2025 below 2005). The impact of this policy is to reduce GHGs in 2025 more than 45% below the forecast given the reductions are fixed to 2005, and emissions growth is occurring. This fixed historical target effectively acts like a hard cap on emissions growth from methane. The 100 Mt emissions limit on oil sands does not bind in our analysis because we have included advanced oil sands technologies that reduce emissions intensity significantly, including solvent extraction and direct contact steam generation (down-hole oxy-combustion). Municipal solid waste regulations are also modeled.

- For **Ontario**, we include the proposed Cap and Trade Regulation, with about 82% coverage and the same carbon price trajectory as indicated above for Quebec. A true up to the provincial target with WCI imports is enabled to the extent there is a gap between the domestic abatement with the WCI carbon price and the 2020 and 2030 targets (-15% and -37% below 1990).[14] We also include the coal phase-out in the baseline projection. Ontario's municipal solid waste regulations are also included.

[14] This assumption is likely valid in the short-term where Ontario in its proposed cap and trade regulation has aligned its cap decline factor to its 2020 target. The same applies to Quebec. This assumption is less certain however to 2030.

- **Federal policies** include the light and heavy duty vehicle regulations which we simulate to decline to 2025 as per the Regulations and then flat line to 2030. We also simulate the federal coal -fired generation regulations which, by requiring the emissions intensity of a typical natural gas generation facility, effectively bans new coal plants and requires shutting down aging ones at the end of their life (unless equipped with CCS, which is more expensive than natural gas generation).

  We also add in a methane regulation for oil and gas similar to that contemplated by the United States, but extend its coverage to all fugitives, most importantly NG formation gas.[15] Using Alberta's regulation as a template, we assume a 25% reduction in oil and gas methane and other fugitives by 2020 from a fixed target of 2012, culminating in reductions greater than 45% by 2025 from the baseline forecast given growth in emissions. This policy is particularly important in British Columbia, where fugitive CO_2 formation gas from shale production for LNG is not covered under the current carbon tax or provincial intensity regulation.

A "**speculative policies, federal floor"**

With the current and developing policies scenarios complete, we then add a **"speculative policies, federal floor"** scenario that reflects some less certain yet recently promised policies. We have included this scenario to be generous in our view of the possible policy development to 2030. Again we use the NEB Reference oil price and the $40 flat oil price for comparison. Our assumed policies include:

- For **British Columbia**, we do not adopt the Climate Leadership Team recommendation of increasing the British Columbia carbon tax at a rate of $10 annually. We've seen no evidence that these recommendations are moving to policy, as is the case of Alberta's Climate Action Plan. Still, the Climate Leadership Team recommendations signal a likely movement by British Columbia to increase its carbon tax. In this announced scenario we keep the carbon tax at $30 until it crosses with the WCI price forecast in around 2026, and then we increase the carbon tax at the same rate as the WCI carbon price to end up at $60 in 2030.

- For **Alberta**, we assume that Alberta also links its carbon prices to the WCI to keep pace with new policies given the comprehensive package we include in our current policies scenario.

- For **Saskatchewan**, we do not add any new policies given no new announcements have been made other than the 50% renewable target by 2030.

- For **Manitoba**, we apply an economy-wide WCI carbon policy similar to Ontario and Québec with about 80% coverage and similar carbon prices.

- For **Ontario and Québec** we do not model any additional policies given WCI implementation. We do expect however, Ontario, will announce a new Climate Change Action Plan, but the details of this are not clear yet.

[15] Tri-lateral methane announcement.

- For the **Atlantic region**, beyond electricity regulation in Nova Scotia, there is much talk of late amongst the various premiers and the provinces about some form of carbon pricing. In the speculative policy scenario, we add in a hybrid carbon pricing system, which has a tradeable intensity standard for large emitters and for all other fuels, an upstream carbon price (which could be either a cap and trade system or a carbon tax).

- For the **federal government**, we increase the stringency of the Light and Heavy Duty Vehicle regulations past 2025 to 2030 on a trajectory that reflects the pre-2025 intensity improvements. This assumption reflects the reality that these vehicle efficiency regulations will be strengthened in time.

- A **federal carbon price floor**, we introduce a federal carbon price floor rising from the WCI price forecast of $19 in 2017 (real) climbing at the price forecast discussed above ($21 in 2020 and 45 in 2030). This price never gets above the WCI price floor, and so only triggers incremental reductions from Saskatchewan, Alberta and B.C in this scenario. To the extent the Atlantic region or Manitoba do no implement carbon pricing, the federal floor would bind and trigger reductions. **Note all carbon proceeds are returned fully to the provinces from which they originate in the modeling**.