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5 May 2016

Ms. Lynn Gordon
Committee Clerk
The Senate
1053 Édifice Chambers Building
40 Elgin Street
Ottawa, ON K1A 0A4

Dear Ms. Gordon:

Undertakings from the National Energy Board's 12 April 2016 appearance before the Senate Energy, Environment and Natural Resources Committee's study on transitioning to a low-carbon economy.

During the meeting of the Senate Energy, Environment and Natural Resources Committee on 12 April 2016, we committed to provide the Committee with additional information to supplement our testimony. We are pleased to provide you with the attached information in response to these undertakings.

We would like to thank the Committee for the opportunity to appear before it to participate in the study on Canada's transition to a low carbon economy.

Should you have any questions, or require more information, please contact Michael O'Mahony at 403-299-3723 (michael.o'mahony@neb-one.gc.ca).

Yours truly,

Jim Fox
Vice President, Integrated Energy Information and Analysis

Shelley Milutinovic
Chief Economist

Attachment

Undertaking #1: Pricing of renewables into the future

> ***Senator Mitchell:*** *Again, maybe this is too specific, but could you give us some idea of the magnitude of the cost improvements and how much more competitive renewables you're considering might become with oil and gas?*

NEB Response #1: The cost for renewable forms of generation has fallen significantly in recent years. For instance, according to the International Energy Agency prices for solar panels dropped from C$ 10.70 per watt in 2000 to C$ 0.95 per watt in 2013[1].

In all of the *Canada's Energy Future 2016* projections, we assume a moderate improvement of technology. This lowers the cost for new forms of generation, but at a more moderate pace than the dramatic declines that have taken place over the past decade. As a baseline projection, we believe this is reasonable, as these rapid declines – such as the 90 per cent decline in solar panel costs – are unlikely to be sustainable as the technology matures. Following from this assumption, although non-hydro renewable capacity increases significantly in the projections, a large amount of natural gas generation capacity is expected to be added as well.

That said, we do note that faster paced development and falling costs of renewables are a key uncertainty in the projections. Improved solar economics are boosting solar investments. New wind units are also improving with longer rotor diameter and tower height to increase potential power from each station. Further technological improvements, cost declines, and future policies could promote the development of non-hydro renewables beyond levels projected in this report.

Storage technology could have a significant impact on electricity generation, transmission and distribution. Breakthroughs in reducing the cost of batteries could provide a more efficient platform for storing electricity during periods of low demand and dispatching the power during periods of high demand. Storage is also a key element in the implementation of decentralized systems where small-scale generation from renewables can be integrated into the power system without compromising reliability.

Undertaking #2: Impacts of carbon taxes on GHGs and economic growth

> ***Senator Massicotte:*** *Could I ask you to come back to us with an assumption that you get a doubling of green energy? Could you come back to say: If you double it or triple it, what is the consequence on GHGs, and the second hypotheses is, if you assume a carbon tax of, say, $50 or $70, what is the impact on GHGs and economic growth? Can you get back to us on that?*

NEB Response #2: As we noted during our appearance, the impact of a large increase in renewable energy, or the impact of a carbon tax, is not a simple modeling exercise. There are a variety of factors one must consider, such as: the level of technological development and cost impacts that would be associated with a higher penetration of renewables; whether or not other jurisdictions are implementing similar policies; the response of Canadian consumers and businesses to those changes;

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[1] Noted in an NEB *Market Snapshot* "Declining Solar Panel Costs Result in Record Capacity Additions" International Energy Agency Reports: International Energy Agency Reports: Trends 2014 in Photovoltaic Applications and National Survey Report of PV Power Applications in Canada 2013.

and the level of technological development that something like a carbon tax of that magnitude would inspire.

We can make some overall, general statements on what an increase in renewables might look like in order to highlight the complexity. In our baseline projection, the Reference Case, wind and solar electric generation reaches 47 TW.h in 2040. If this were to triple to 141 TW.h, and assume it replaced fossil fuel generation that averages 420 tonnes of CO_2 per GW.h[2], that substitution of an additional 94 TW.h of clean energy would reduce Canada's GHG emissions by approximately 40 megatonnes of CO_2. However, if this increase in wind and solar also displaced a portion of hydro, nuclear, or carbon capture and storage generation, the GHG reductions from that shift would be less. So the eventual outcome will depend on what kind of scenario would be driving that change, and what the implications of that will be for various energy types considering factors such as relative costs and implications for reliability.

As noted in *Canada's Energy Future 2016,* the NEB will be updating its analysis this fall to take into account the impacts of recent policy announcements made in late 2015 early 2016. Many of these new policies involve carbon pricing and/or shifting towards a higher share of renewables, and these issues are being considered in the analysis which NEB staff are now doing.

[2] The value 420 tonnes of CO_2 per GW.h during a calendar year is consistent with the maximum emission-intensity that new coal fired plants must meet under federal regulations in the *Reduction of Carbon Dioxide Emissions from Coal-Fired Generation of Electricity Regulations* (Reduction Regulations). This is generally consistent with a natural gas combined cycle plant.

Undertaking #3: Total production of energy in Quebec

Mr. Fox: *Yes. We haven't included in the package of information we provided today the total production of electricity in Quebec. We do have it, and we can provide it.*

Ms. Milutinovic: *There are detailed tables showing by-province production of each kind of energy. It's in the data, if you would like us to provide it.*

NEB Response #3: Detailed provincial and territorial projections for all years are available from the NEB's detailed data appendices, available at: https://apps.neb-one.gc.ca/ftrppndc/

Below is a table showing Quebec's electricity generation in the Reference Case for select years, by primary fuel.

Quebec Electricity Generation (GW.h)	2005	2014	2020	2030	2040
Hydro	177959.7	191587.9	200846.6	205835.4	221373.4
Wind	407.27	1674.77	4041.19	5024.45	5364.22
Biomass / Geothermal	600.13	744.5	1240.85	1613.26	1891.94
Solar	0	0.06	0.06	0.06	0.07
Coal & Coke	0	0	0	0	0
Oil	338.8	195.98	201.99	204.43	117.94
Uranium	4321.58	0	0	0	0
Natural Gas	225.4	144.48	148.91	150.71	160.9
Total	**183852.9**	**194347.7**	**206479.6**	**212828.3**	**228908.5**

Undertaking #4: Impact of government policies since 2013 on GHG emissions in 2016 EF Report

Senator Patterson: *When there were at least some new policies in place -- and I'm thinking of the B.C. revenue neutral carbon tax initiative -- I'd like to ask: Compared to the 2013 report, have federal, provincial or territorial policies aimed at addressing greenhouse gas emissions had an impact on the 2016 forecast?*

NEB Response #4: Between the 2013 and 2016 reports, which relied on historical data up to 2011-2012 and 2013-2014 respectively, there were no major policy announcements that had large impacts on the fossil fuel use projections. Key policies such as the federal government standards for coal fired electricity and vehicle emissions, B.C.'s carbon tax, the Quebec-California cap-and-trade system, and Ontario's coal-fired electricity phase out, were all put in place prior to the 2013 report's release. The 2016 report does reflect the latest electricity planning from provincial utilities and governments, such as Ontario's 2013 Long Term Energy Plan (released about a month after our 2013 report).

However, there were several substantial policy announcements in late 2015 and early 2016 that were not included in our outlook. These include the Alberta climate plan, Manitoba and Ontario joining the Quebec-California cap-and-trade system, and Saskatchewan announcing a target of 50 per cent renewable capacity by 2030. Given their significance, we are currently working on an update that will incorporate these policies by this fall.

Undertaking #5: Long-term impacts of federal fuel emission standards on fuel efficiency

> ***Senator Mockler:*** *I look at provincial and territorial energy diversity, an important factor in Canadian energy. I'll follow up Senator Ringuette's and Senator Massicotte's questions. We all know how provincial and territorial governments have looked at and promoted efficiency in our energy products. Can you provide us with details on how the federal fuel emission standards have improved the fuel efficiency when we look at vehicles for long term transportation?*

NEB Response #5: Historically, fuel economy standards have led to notable improvements vehicle fuel economy. For example, data from Natural Resource Canada shows the on-road average fuel consumption (L/ 100 km) improved from 10.4 in 1990 to 8.4 in 2013 for cars, and 13.0 in 1990 to 11.5 in 2013 for light trucks.[3]

In the *Canada's Energy Future 2016* projections, the NEB is consistent with Environment and Climate Change Canada's analysis of the current federal fuel emission standards. In their analysis, ECCC finds that the sales-weighted fuel efficiency of new cars is projected to improve from 8.6 L/100 km in 2010 to 5.1 L/ 100 km in 2025, and for new passenger light trucks it improves from 12.0 l/100 km in 2010 to 7.6 l/100 km by 2025.[4]

Undertaking #6: Electricity production flattens out after 2020

> ***Senator Mitchell:*** *I'd like to pursue the point that was raised originally by Senator Massicotte about the doubling. I'd really encourage his point, which is: What if it tripled? To emphasize that, I'm looking at the graph on slide 6. It is a very steep curve from 2005 to roughly 2020, and then the increases in production level off. It seems to me that, given that I think last year was the first year that there's been more money invested in renewable energy in the world than in oil and gas there may be, of course, reasons for that, but there's a lot of money going into renewable energy, and it's being supported now more and more by governments in Canada. Why would the assumption be that it would flatten out more or less at 2020? Why wouldn't that trajectory of renewable capacity increase continue at the very steep curve that's evident from 2005 to 2015? It seems to me that there will be momentum.*

NEB Response #6: In the Reference Case, only policies and regulations that are in place during the time of analysis are included, which includes renewable standards and targets. After 2020, several provinces approach their current renewable energy targets, so our projections see the steep growth flattening out considerably. In Ontario's Long-term Energy Plan, for example, they expect non-hydro renewables to increase from 3 700 MW in 2013 to 10 700 MW in 2020, and then remain at that level until 2030.[5]

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[3] Natural Resources Canada, National Energy Use Database. Available: http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/home.cfm

[4] Environment and Climate Change Canada, Emission Trends 2014. Available: http://www.ec.gc.ca/ges-ghg/E0533893-A985-4640-B3A2-008D8083D17D/ETR_E%202014.pdf

[5] Ontario Power Authority, *Generation and Conservation Tabulations and Supply/Demand Balance 2013 LTEP: Module 3*. January 2014. Available: http://powerauthority.on.ca/sites/default/files/planning/LTEP-2013-Module-3-Supply-Demand-Balance.pdf

Undertaking #7: Anticipated increase in natural gas production to 2040 (in bcf)

The Chair: *Okay. I go to slide 6 and I see the capacity additions and retirements by 2040. Obviously there are some coal retirements which actually will help a lot in our greenhouse gas emissions, some uranium you've already explained that and some natural gas. But I also see a big slice of natural gas there for new generations. How much would that slice of blue represent in natural gas?*

Ms. Milutinovic: *It goes from being 11 per cent of the generation last year to about 20 per cent of the generation in 2040.*

The Chair: *Eleven per cent?*

Ms. Milutinovic: *To 20 per cent.*

The Chair: *. in 2015 to 20 per cent in 2040?*

Ms. Milutinovic: *That's right.*

The Chair: *How many billion cubic feet would that represent? A day, or a year, or . . . ? If you don't have that number, I would appreciate it if you could provide that to the clerk.*

NEB Response #7: The increase in natural gas use for power generation in the Reference Case would add an additional 1.86 bcf/d of natural gas demand in 2040 relative to 2014 levels of 1.7 bcf/d.