NEEDS FOR AND ALTERNATIVES TO (NFAT)

Reference: April 25 GAC Pre-Asks of Manitoba Hydro

Question 2.a. Reference: NFAT Business Case, Chapter 13, p. 45, lines 13-20:

Please provide a comparative table + a chart of plans 1, 5 and 14 with updated assumptions showing the NPVs of each plan (i) with a market valuation exclusive of GHG externalities, (ii) with GHG social costs of Manitoba emissions valued at $40/tonne CO2 in 2014 rising to $80/tonne CO2 in 2048 added in, and (iii) with GHG social costs of global emissions valued at $40/tonne CO2 in 2014 rising to $80/tonne CO2 in 2048 added in.

Response: Social Benefit of Greenhouse Gas Emission Reductions

Overview

The various development plans affect greenhouse gas (GHG) emissions both within and outside Manitoba. Within Manitoba, the plans differ in the amount of natural gas generation added and the associated GHG emissions. With respect to GHG impacts outside Manitoba, the plans differ in terms of Manitoba Hydro's exports and imports of electricity which consequently affects fossil fueled generation and the related GHG emissions in interconnected jurisdictions. This analysis presents a comparison of the net present value (NPV) of select development plans with an approximate social benefit of GHG emission reductions from three perspectives: Manitoba, U.S. and global. The social cost of carbon is used to represent the environmental and social damage costs and risks of global warming and climate change.

This response to Question 2.a utilizes the best available information and contains certain approximations which are judged to not significantly affect the comparisons.

Summary of Results

Figure 1 provides a comparison of the social carbon benefit analysis and NPV economics for Plan 2 (K22/Gas), Plan 5 (K19/Gas25/750 MW), the PDP - Plan 14 (K19/C25/750MW) and Plan 1 (All Gas). This figure clearly demonstrates that the PDP (Plan 14) offers the most benefits from both the lowest GHG emissions within the province and the greatest displacement of emissions outside of the province. The present value of these social carbon benefits are very large relative to the NPV economics. Because only a modest portion of the social cost of carbon is already captured and embedded in Manitoba Hydro's economic analysis, Figure 2 demonstrates that a very significant portion of the total social cost of carbon analyzed remains an economic externality. This indicates that climate policies under consideration would deliver carbon prices that are still modest relative to the cost of the expected damages and risks associated with climate change. In the longer term pressure may continue to push energy and climate policies further towards minimizing this externality. This represents a significant upside opportunity for the development plans with more hydro development and high exports.

Figure 1

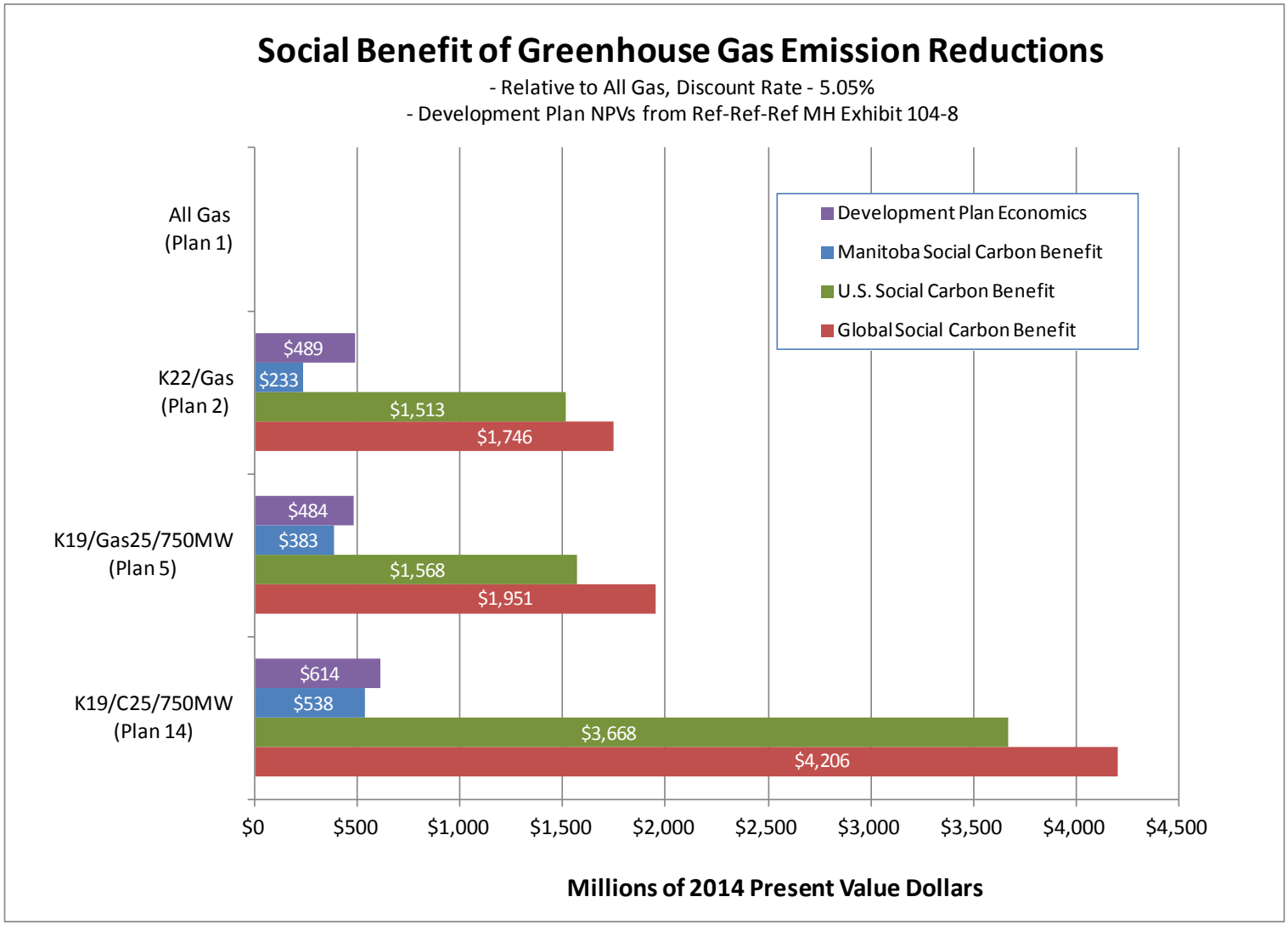
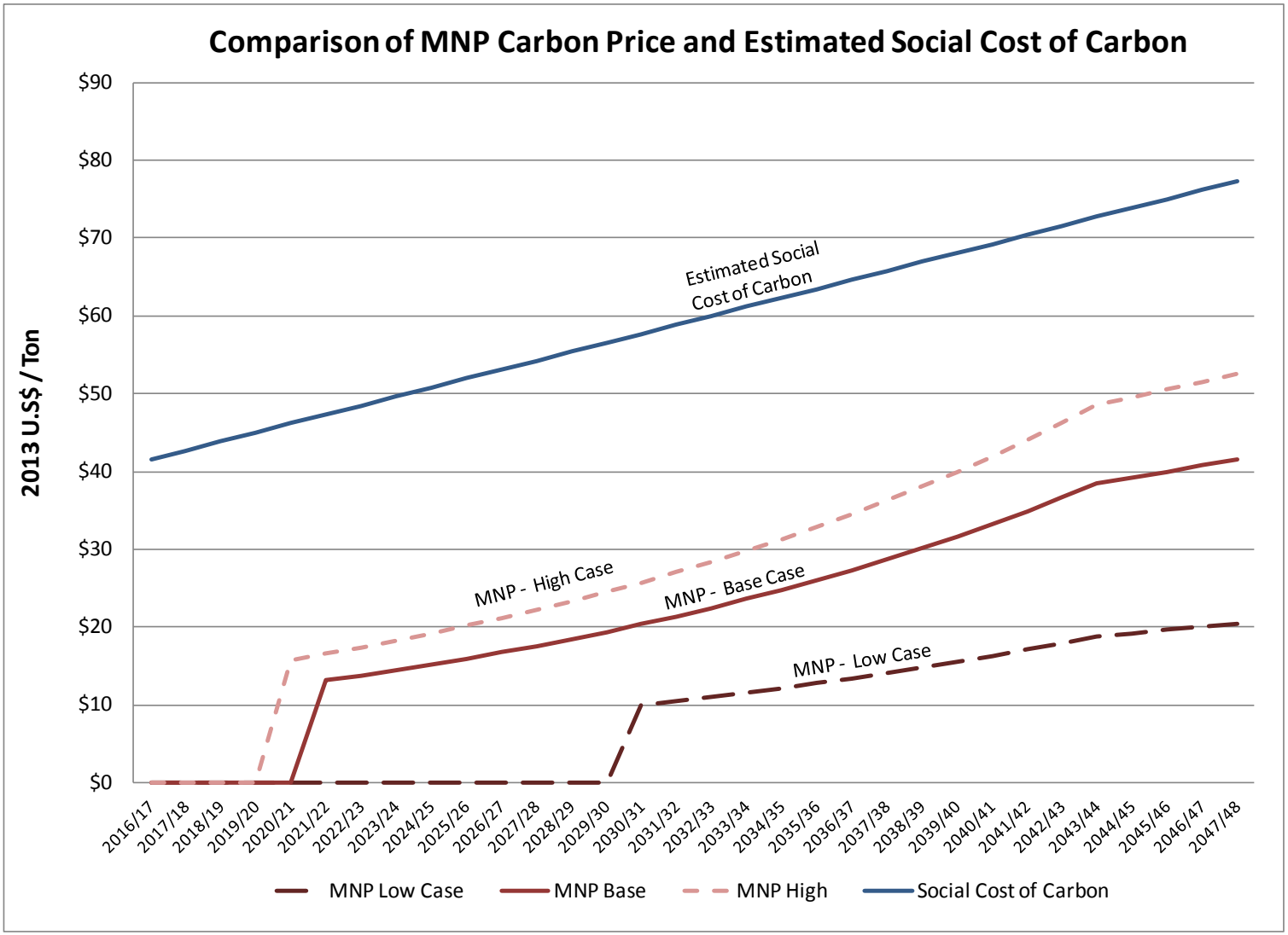

Social Benefit of Greenhouse Gas Emission Reductions
- Relative to All Gas, Discount Rate - 5.05%
- Development Plan NPVs from Ref-Ref-Ref MH Exhibit 104-8
All Gas (Plan 1)
K22/Gas (Plan 2)
K19/Gas25/750MW (Plan 5)
K19/C25/750MW (Plan 14)
$489
$233
$1,513
$1,746
$484
$383
$1,568
$1,951
$614
$538
$3,668
$4,206
Development Plan Economics
Manitoba Social Carbon Benefit
U.S. Social Carbon Benefit
Global Social Carbon Benefit
$0
$500
$1,000
$1,500
$2,000
$2,500
$3,000
$3,500
$4,000
$4,500
Millions of 2014 Present Value Dollars

Figure 2


Comparison of MNP Carbon Price and Estimated Social Cost of Carbon
2013 U.S$ / Ton
$90
$80
$70
$60
$50
$40
$30
$20
$10
$0
Estimated Social Cost of Carbon
MNP - High Case
MNP - Base Case
MNP - Low Case
2016/17
2017/18
2018/19
2019/20
2020/21
2021/22
2022/23
2023/24
2024/25
2025/26
2026/27
2027/28
2028/29
2029/30
2030/31
2031/32
2032/33
2033/34
2034/35
2035/36
2036/37
2037/38
2038/39
2039/40
2040/41
2041/42
2042/43
2043/44
2044/45
2045/46
2046/47
2047/48
MNP Low Case
MNP Base
MNP High
Social Cost of Carbon

Detailed Results

The NPV values shown are based on the Ref-Ref-Ref economic analysis results contained in MH Exhibit 104-8. This exhibit provided an updated economic uncertainty analysis from that presented in Chapter 10 of the NFAT submission. Most pertinent to the values shown in Figure 1, the economic uncertainty analysis as provided in Manitoba Hydro's Exhibit 104-8 for Plan 5 and Plan 14 are shown with no WPS investment in the new 750 MW U.S. interconnection, updated capital costs for Keeyask and Conawapa and updated treatment of common factors (costs and revenues common to all alternatives).

As shown in Figure 1, the PDP (Plan 14) offers both the lowest GHG emissions within the province and the greatest displacement of emissions outside of the province. The global benefits shown aggregate both the Manitoba and U.S. social carbon benefits. From a global perspective, the relative GHG emission reductions associated with the PDP (Plan 14) has an estimated social value of $4.20 Billion (2014$). The largest contributing factor to the global social carbon benefit is the significant positive impact of Manitoba Hydro exports on the displacement of GHG emissions in other jurisdictions. Development plans with higher exports will have proportionally larger GHG emission displacement potential.

From the Manitoba perspective, Plan 14 offers the lowest reliance on new natural gas generation and therefore has the lowest social carbon cost within Manitoba. This is reflected in the Manitoba social carbon benefit of Plan 14 of $0.54 billion (2014$) shown in Figure 1.

Although these external social benefits are presented only for a select set of plans at the base DSM level, they are directionally indicative. Plans with increased reliance on domestic natural gas generation would demonstrate relatively higher Manitoba social carbon costs than those reliant on hydropower. Similarly, plans with increased electricity exports would deliver proportionally higher global social carbon benefits. The relative magnitude of the results for other plans and alternative DSM levels could also be inferred based on the in-service dates for hydro or gas generation. For example at Level 2 DSM Plan 5 (K19/Gas31/750MW) the relative global social carbon benefit would be similar to Plan 5 (K19/Gas25/750 MW) shown in Figure 1. The large associated emissions displacements due to Keeyask are unchanged. Increased DSM would contribute somewhat to increase exports and hence further emission displacements and social carbon benefits. Similarly the deferral of gas generation would moderately increase the Manitoba social carbon benefit relative to the All Gas Plan. For Level 2 DSM Plan 14 (K19/C31/750MW) the global social carbon benefit would still be the largest relative to the All Gas Plan, although lower than shown in Figure 1. The deferral of Conawapa would result in the associated GHG emission displacements and U.S. social carbon benefit being further out in the planning horizon and subject to additional discounting in present value terms relative to the All Gas Plan.

Carbon: Market Valuation versus the Social Cost

A modest portion of the social cost of carbon is captured and embedded in Manitoba Hydro's economic analysis within the export price forecast and through assumptions of carbon cost for Manitoba Hydro's fossil fueled generation. The portion embedded in the electricity price forecast cannot be readily separated since these forecasts are not available with and without carbon pricing. Similarly, the Manitoba carbon emission charges are not separated out due to confidentiality. To help illustrate this, Figure 2 compares the assumed social cost of carbon with the carbon price forecasts prepared by MNP. Estimates of the social cost of carbon are typically substantially higher than forecasted carbon prices. As stated above, this indicates that policies under consideration would deliver carbon prices that are still modest relative to the cost of the expected damages and risks associated with climate change.

Analysis Assumptions

The following are the key inputs and assumptions required to complete the social carbon benefit analysis:

- When comparing the NPV values from MH Exhibit 104-8 it is important to note that the present value of the social carbon benefits has been calculated only over the 2014-2047 time period. This understates the social carbon benefits.
- The domestic social carbon benefits are based on the annual Manitoba GHG emissions for each of the plans shown relative to Plan 1 (All Gas).
- The U.S. social carbon benefits are based on the annual export/import volumes for each of the plans shown relative to Plan 1 (All Gas). Manitoba Hydro assumed that its exports displace 0.75 tonnes of CO_2/MWh for the 2014-2047 period.
- Life cycle and upstream GHG implications are not included in this analysis. These would be very difficult to quantify on a consistent basis. However, had they been included, these factors would tend to further increase the social carbon benefit of the hydro preferred development plan.
- As explained in ***Chapter 13 - Integrated Comparisons of Development Plans – Multiple Account Analysis*** the social cost of GHG emissions can be used to represent the environmental and social damage costs and risks of global warming and climate change. For purposes of estimating the social cost of the Manitoba GHG emissions within the multiple account analysis it was assumed that the social cost of GHG emissions would be \$40/tonne CO_2 in 2014, rising to \$80/tonne CO_2 by 2048 (in constant 2012\$) based on recent Canadian and U.S. government estimates. Environment Canada has estimated that the social cost of GHG emissions, based on the present value of expected climate change costs is currently over \$28/tonne CO_2, rising to almost \$60/tonne CO_2 by 2050 (in constant 2011\$)[1]. Similarly, a U.S. government inter-agency team recently estimated the social cost of GHG emissions at \$38/tonne CO_2 in 2015 rising to \$71/tonne CO_2 in 2050

[1] See Environment Canada, *Heavy Duty Vehicle and Engine Greenhouse Gas Emissions Regulation*, section 7.3.3, Feb.22, 2013 (http://gazette.gc.ca/rp-pr/p2/2013/2013-03-13/html/sor-dors24-eng.html#footnoteRef.82118),

(in constant 2007$ US)[2]. The social cost of carbon used for this analysis and in ***Chapter 13*** is broadly consistent with the most recent U.S. estimates, (without any provision to avoid uncertain, catastrophic risks). While Chapter 13 did not value the displacement of GHG emissions in the U.S. the analysis associated with Figure 1 assumes the same social costs of GHG emissions for both Canadian and U.S. emissions.

[2] U.S. Interagency Working Group on Social Cost of Carbon, *Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis – Under Executive Order 12866*, May 13, 2013.