Climate Change Considerations with respect to Site C Hydro-electric Project; Supplemental Submission

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Context:

Currently, a Review of the Site C Hydro-electric Project is being carried out by the British Columbia Utilities Commission, at the request of the Government of British Columbia. The options being assessed include: completing the Project, as planned; suspending the Project; or terminating the Project.

In our submission of September 27, 2017, we expressed fundamental concerns with recent reviews of the Site-C project. In summary, our concerns are:

1. The Review is not addressing commitments, and associated obligations, by the Governments of British Columbia and Canada, with respect to reducing greenhouse gas (GHG) emissions. The dominant strategy for achieving progress on climate change is to replace use of fossil fuels and its derivatives (gasoline, diesel, natural gas, etc.) with energy from non-GHG emitting sources. This results in major increases in demand for electricity, and associated increases in electricity supply, dominantly from renewable generating sources, including hydro, wind, and solar.
2. Planning of the electricity supply system, needs to be carried out within a fully comprehensive long-term planning context. This framework needs to include integrated consideration for major, progressive, and rapid reductions in GHG emissions, with associated fundamental transformations of energy systems. Transformation of energy systems will be dominated by major and rapid reductions in use of fossil fuels for meeting energy based demands, and by correspondingly large increases in use of electricity.

In a discussion with a Representative from the BCUC on October 3, it was suggested that our submission should be amplified, in order for the Panel of Commissioners to have a more in-depth appreciation of our Submission.

This document includes additional context and information with the goal of amplifying our stated concerns. This document is prepared as a Supplementary Submission, to the original Submission forwarded on September 27.

In this presentation, we will amplify on contents of a Power Point presentation, which is included in this Submission (see below). This presentation includes key points from the Trottier Energy Futures Project (TEFP), as they pertain to the Review being carried out by the BCUC.

As stated in our original submission, we make extensive reference to the TEFP, primarily as this is the most comprehensive and analytically rigorous study undertaken to date in Canada for deriving minimum cost strategies for meeting both growing energy based demands, and for achieving major reductions in greenhouse gas emissions. However, it is not the only study carried out for deriving cost effective strategies for reducing GHG emissions. All authoritative studies undertaken to date in Canada clearly demonstrate that the dominant strategies for reducing GHG emissions in Canada, in each of the Provinces and Territories requires major and immediate reductions in use of fossil fuels and its derivatives, with corresponding major and immediate increases in use of electricity. These transformations are both massive and urgent, for meeting signed global commitments for reducing GHG emissions, and for contributing to keeping global temperature rise to less than 2 degrees Centigrade.

In the next section of this Supplementary Submission, there will be a “high level” description of the principal results from the TEFP, with primary attention to our stated concerns as they relate specifically to the Site C Inquiry.

<u>Key Perspectives and Observations from the Trottier Energy Futures Project (TEFP):</u>

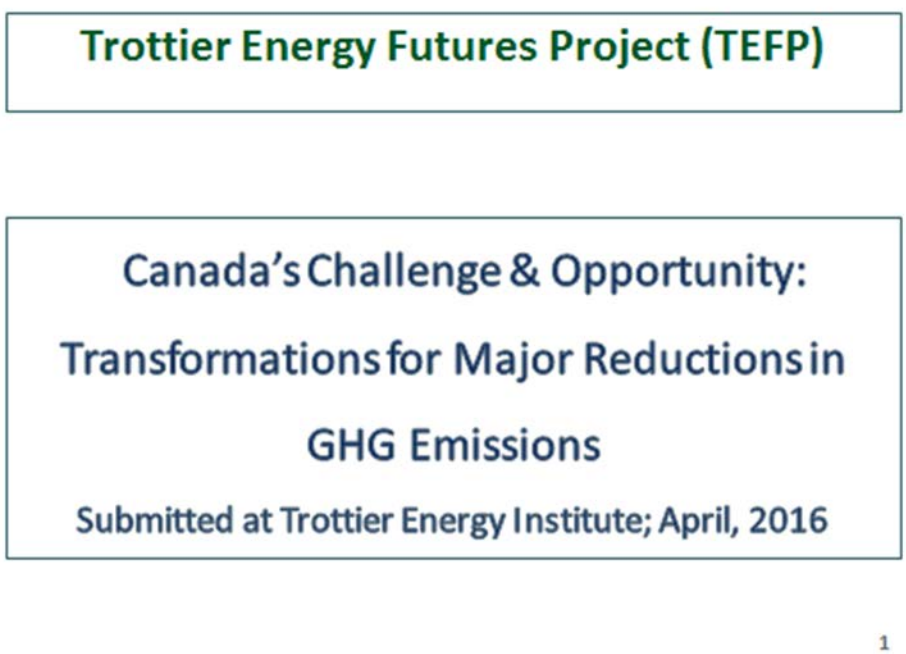
As noted above, this includes a presentation of the principal results of the TEFP, with primary attention to providing additional context and perspectives to our stated concerns.

Reference will be made to each of 22 Power Points, which are included below, with corresponding amplifications of the main points for each of the respective Power Points.

1. **Power Point 1:**

The TEFP was carried out over a 2.5 year period, with results presented at a special event at the Trottier Energy Institute, University of Montreal, on April 5, 2016. The results of the Project are included in three publically accessible Reports; Executive Summary; Project Summary; and Full Technical Report and Modelling Results. These Reports can be accessed on the websites of the Trottier Energy Institute, Canadian Academy of Engineering, and the David Suzuki Foundation.

It is of special note that these Reports have served as valuable reference documents, including for Canada's "Mid-Century Long-Term Low-Greenhouse Gas Development Strategy" Report, presented by the Government of Canada at the COP 22 meeting in Marrakech, Morocco, in November, 2016.



2. **Power Point 2:**

"Historical Highlights" serves to demonstrate the increasing global and national attention being given to climate change. Canada, jointly with the Provinces and Territories, has made major global and national commitments, in recent years, for reducing GHG emissions. This includes achieving major and early reductions in emissions, and for implementing aggressive programs of electrification for reducing use of fossil fuels.

Climate Change
Historical Highlights

1. Rio Earth Summit - 1992
2. UNFCCC - 1994
3. Kyoto Accord - 1997
4. Kyoto Accord ratified (2002); confirmed (2005)
5. Gleneagles G8 Summit - 2005
6. Stern Review "Economics of Climate Change" - 2006
7. U.K. Climate Change Act - 2008
8. Canada formally withdraws from Kyoto Accord - 2012
9. Trottier Commitment - 2010
10. Series of IPCC Assessment Reports; from 1990; Fifth Report – 2014
11. UN – DDPP - 2014
12. TEFP Completed - 2016
13. COP 21 Paris - 2015; Canada; 30% Reduction by 2030, relative to 2005
14. COP 22 Marrakech – 2016; Canada; 70 to 90% reduction by 2050, relative to 2005; and 100% or more, by 2100 (temperature rise limited to 2 degrees C)

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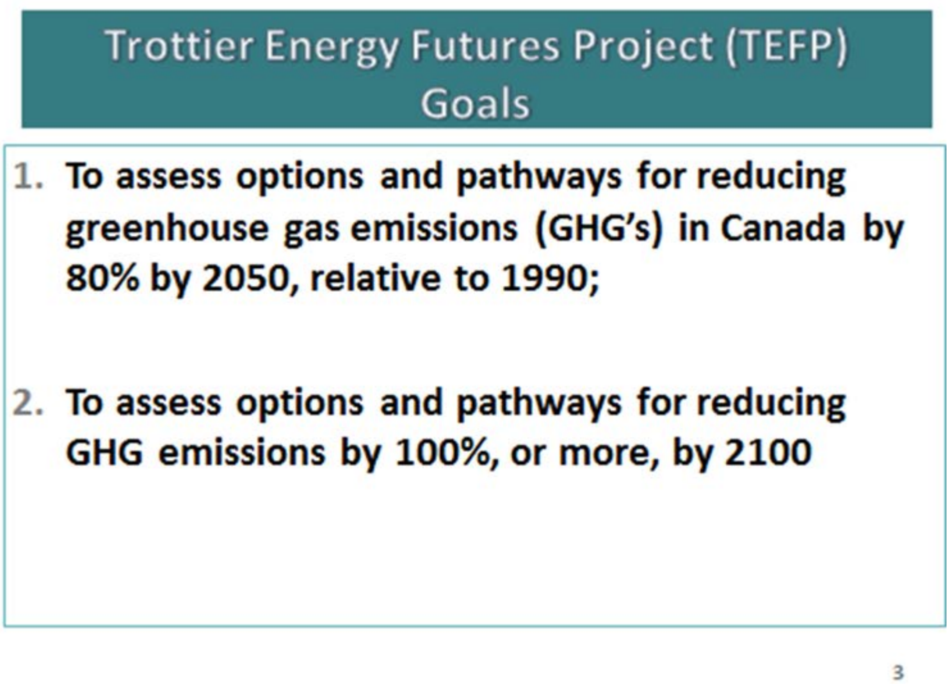
3. **Power Point 3:**

The primary goal for the TEFP was to derive strategies for reducing GHG emissions by 80% by 2050, relative to 1990. It is especially noteworthy that this goal was essentially identical to the goal embodied in an Act of Parliament (Climate Change Act), passed in the United Kingdom (U.K.) in 2008. The U.K. was the first country to pass a national climate change act, with mandated GHG emissions reduction targets.

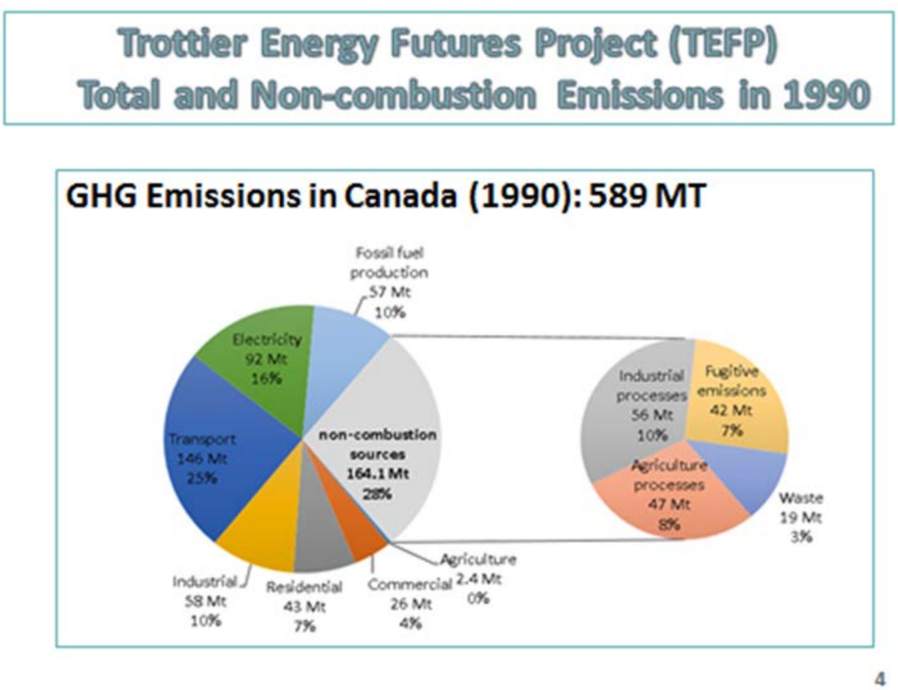
The second goal (to achieve carbon neutrality by 2100) was added in 2013, and was based on growing global awareness, as demonstrated in the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report, that the climate change situation was more serious than reported in earlier IPCC Assessment Reports. By then, it had become very evident that it was not only essential to achieve major reductions in GHG emissions by 2050, but that it was also critically important that carbon neutrality be achieved before the end of the century. This was required for ensuring that global temperature rise would be limited to a maximum of 2 degrees Centigrade.



4. **Power Point 4:**

This Power Point shows GHG emissions for Canada in 1990, as compiled in Canada's annual National Inventory Report, and as presented in accordance with the United Nations Framework Convention on Climate Change (UNFCCC). Key observation and perspectives from this power point include;

- 72% of Canada's GHG emissions are CO2 emissions from the burning of fossil fuels. The other 28% is from non-combustion sources, including industrial process emissions, methane and nitrous oxide from agriculture, and emissions (dominantly methane) from fugitive and waste sources, such as municipal landfill sites.
- Approximately 50% of total emissions are associated with burning fossil fuels for meeting energy-based end uses in the transportation, industrial, commercial, residential and agricultural sectors.
- When considering use of fossil fuels in a comprehensive "wellhead" to "burner tip" context, it is especially important to note that 85% of the emissions are generated in "consumption" of fossil fuels, such as burning gasoline or diesel fuel for transport, or natural gas for heating. The entire "production" supply chain, including extraction, collection, processing, refining, upgrading, transport, distribution and delivery of fossil fuels, collectively, produce only 15% of GHG emissions. This recognition serves to demonstrate the dominant importance of defining strategies for transforming energy-based end uses, especially to electrification, for reducing GHG emissions.



5. **Power Point 5:**

This Power Point includes a summary description of the approach and methodology for ensuring that the Project was comprehensive and analytically rigorous. It was especially important that results were as credible as possible, for demonstrating minimum cost strategies for achieving major reductions in GHG emissions. Selected examples of the overall approach include;

- The approach adopted was based on a "systems methodology" approach, using two large scale complementing mathematical models; the NATEM optimization model and the CanESS simulation model. The NATEM model uses TIMES/MARKAL formulation, which is the state of the art optimization methodology for deriving minimum cost solutions for comprehensive integrated energy-GHG mitigation systems. Its use is coordinated globally by the international Energy Agency (IEA) through its Energy Technology Systems Analysis Program (IEA-ETSAP).
- There were fourteen working papers prepared for analyzing options for energy production and for GHG mitigation, including investment and operating costs, for the respective sectors that produce and/or consume GHG's. All Working Papers were peer reviewed by a specially appointed Expert Review Panel, chaired by Professor Andre Plourde, Energy Economist and Dean, Faculty of Public Affairs, Carleton University. The other members of the Expert Review Panel included Professor Miguel Anjos (energy systems), Dr. Ken Ogilvie (environment), and Dr. John Leggat (technologies).
- There were additional external reviews carried out on inputs for the analyses. The representation for "Electricity Supply and Delivery" was reviewed by the Canadian Electricity Association. Results of the Project were also peer-reviewed by specially appointed Review Panels by the two sponsor organizations; Canadian Academy of Engineering and the David Suzuki Foundation.
- An important consideration was to include detailed options for energy efficiency and energy conservation in the various working papers. This included options, such as improving efficiencies of future technologies, options for switching from use of internal combustion engines to electric motors for motive power (including for transportation) with its higher energy conversion ratios, and options for thermal retention, including insulation, hot water retention, etc.

Trottier Energy Futures Project (TEFP)
A Rigorous Approach and Process

- **Funding; TFF: Sponsors; CAE & DSF**
- **Dozen experts from full range of disciplines**
- **14 Working Papers; System representation, options & costs**
- **Analysis of combustion emissions only in the modelling**
- **Two mathematical models;**
  - NATEM Canada optimization model
  - CanESS simulation model
- **Model upgrading and calibration**
- **Eleven Scenarios**
- **Expert Review Panel**
- **External Reviews**

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6. **Power Point 6:**

This Power Point includes important information concerning "Basis Premises" for TEFP. The following are especially noteworthy, as relating to the BCUC Site C Inquiry.

- Information used as input for the models was from various federal and provincial sources. This included National Energy Board (NEB), Statistics Canada, Environment and Climate Change Canada (ECCC), and Natural Resources Canada (NR Can). There was also information from provincial agencies, including B.C. Hydro.
- Projections for population growth, GDP/capita, total GDP, and Gross Output for the respective industrial sectors in the various jurisdictions, was carried out based on NEB projections to 2030, and with further extensions to 2050. Population growth was projected to increase to 48 million by 2050, and national GDP was projected to double, from $1.5 trillion in 2010, to $3 trillion in 2050.
- Special attention was given to ensuring that representation for electricity supply systems satisfied both electricity demand and dependable capacity requirements. There were extensive checks with the simulation model for ensuring that results from the optimization model met "dispatchability" constraints, with an optimum balance of generation supply from low cost intermittent generation supply sources (such as wind, solar and run of river hydro), dispatchable electricity generation, and dependable capacity. This normally included dispatchable hydro, where such potential was available.

- Special consideration was also given to including potential for high voltage inter-connections between neighboring jurisdictions, especially for export of electricity from jurisdictions richly endowed with renewable generation potential (such as British Columbia) to jurisdictions which will need to de-carbonize their thermal-dominated electricity supply systems, such as Alberta and Saskatchewan.

Trottier Energy Futures Project (TEFP)
Basic Premises

- **Objective Function**
- **Population growth**
- **GDP per capita and total GDP growth**
- **Industrial Gross Output (GO) growth**
- **Fossil fuel projections to 2035, and extension to 2050 (NEB)**
  - **Cases: lower projections to 2050**

Special Considerations

- **Dependable capacity**
- **System dispatch**
- **Differential costs for grid supply**
- **Biomass feedstock limits**
- **Cost variations over time**
- **No development constraints**
- **No equity constraints**

7. **Power Point 7:**

For TEFP, there were eleven Scenarios analyzed. These represented different combinations of premises for defining alternative “futures” for GHG mitigation and evolution of energy systems in Canada, from 2011 to 2050. The Scenarios included an initial set of Scenarios, based on production of fossil fuels continuing, as per NEB projections. While use of fossil fuels in Canada would decrease, there would be a corresponding increase in export of fossil fuels. The second set of Scenarios was based on the premise that overall demand for both use of fossil fuels in Canada, and for export, would decline.

For the selected Scenarios, there was progression from considering only “proven” technologies, to increasing consideration of “disruptive” technologies – such as carbon capture and storage (CCS), second generation biofuels, biojet fuel, bioenergy with CCS (BECCS), and effects from changes in “urban form”.

For the analyses, there was an initial Reference Scenario (sometimes referred to as Business as Usual (BAU)), which was based on the premise that there would not be any additional policies or strategies for reducing GHG emissions, from 2011 to 2050. The results of this Scenario then served as a reference for comparison with results with imposed GHG emissions reduction profiles, for the cumulative period, to 2050.

Trottier Energy Futures Project (TEFP)

	Scenarios										
Premises Included	High Fossil Fuel Production								Low Fossil Fuel Production		
	1	2	3	4	5	6	7	8	1a	3a	8a
No Reduction in GHG Emissions	X								X		
Reduction in GHG Emissions		X	X	X	X	X	X	X		X	X
No Additional High Voltage Inter-connections		X									
Additional High Voltage Inter-connections			X	X	X	X	X	X		X	X
Change in "Urban Form"				X							
Addition of Second Generation Biofuels					X			X			X
Addition of Carbon Capture and Storage (CCS)					X			X			X
Additional Electricity Export to U.S.						X					
Addition of Nuclear Generation	X	X	X	X	X	X		X	X	X	X
No Additional Nuclear Generation							X				
Addition of Biojet Fuel								X			X
Addition of Bioenergy with CCS (BECCS)								X			X
Addition of Conventional Large Scale Hydro in B.C.								X			X

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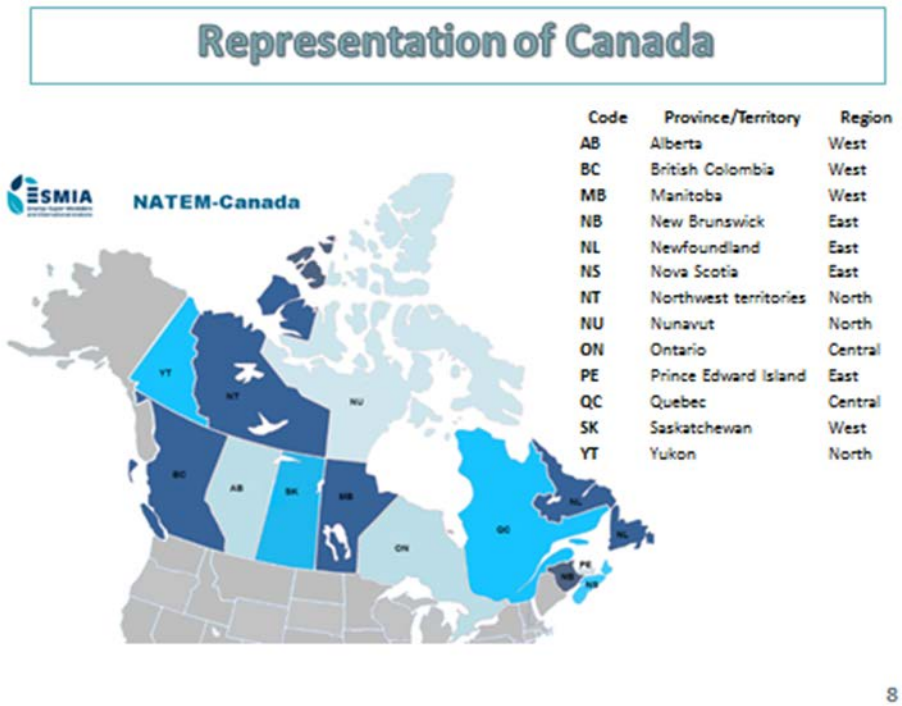
8. **Power Point 8:**

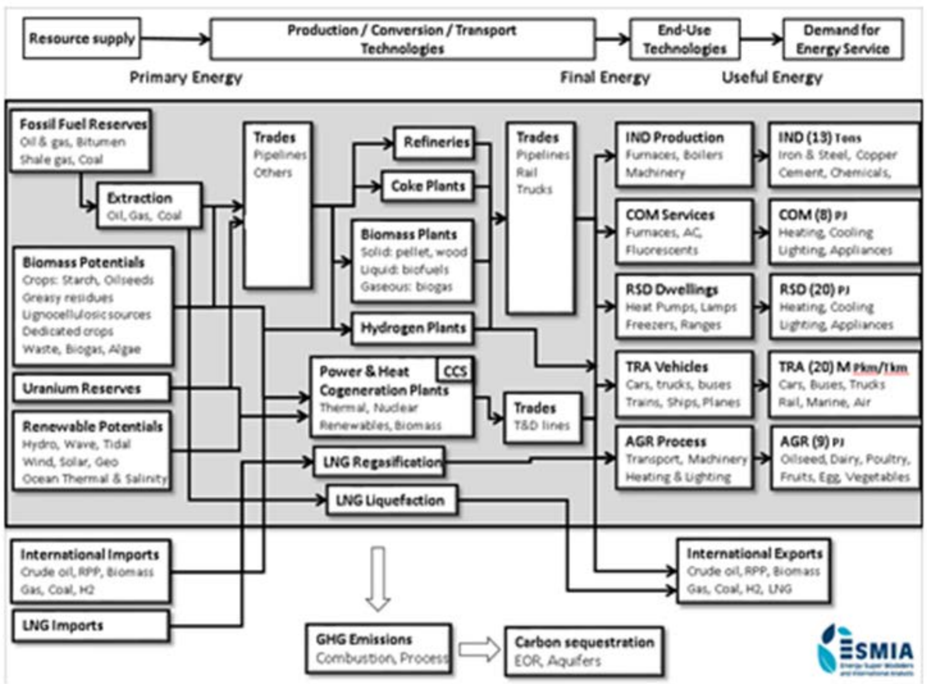
This Power Point shows how Canada was represented in each to the two models. Canada was represented by its thirteen interconnected Provincial and Territorial jurisdictions, with each jurisdiction having a complete representation of the energy-GHG mitigations system within its jurisdiction. Each jurisdiction also had interconnections with jurisdictions outside of Canada, including the United States and the rest of the world.



9. **Power Point 9:**

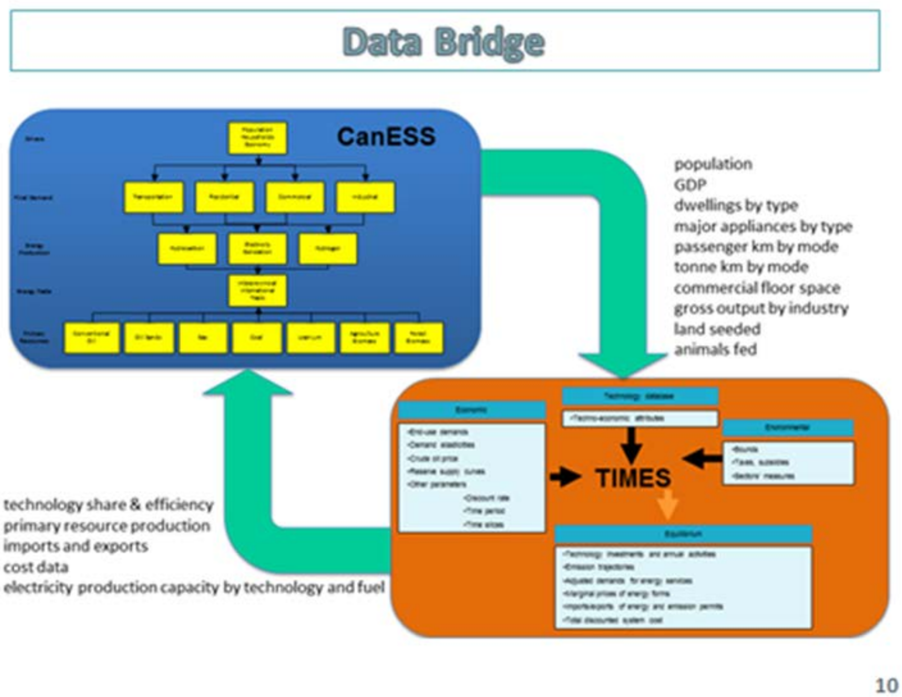
This Power Point includes a schematic representation of the energy system within each jurisdiction. This begins with defining resource availability for each of the various sources of primary energy supply, within its jurisdiction. The schematic then includes the various options for production, conversion, transport, and delivery to satisfy end uses in the various end use sectors.

For both mathematical models, end uses were defined for each end use sector, in each jurisdiction, for each of a series of future time periods. These demands were defined in generic terms, such as passenger miles for each of different classes of transport vehicles, or heating requirements for each of a series of building classes.



10. **Power Point 10:**

One of the unique contributions from TEFP was the development of a special Data Bridge between the two models. Both models were very large, with a need for large volumes of data being transferred between the two models. Representations of the Canadian energy-GHG mitigation systems in the two models were different, in order to fully reflect the respective complementary contributions from the respective models. As one example, the CanESS model was structured to represent detailed dispatchability of electricity supply in the respective jurisdictions, while the NATEM optimization model had more aggregated representation for different classes of electricity supply within the respective jurisdictions, to reflect the entire energy-GHG mitigation system for all of Canada.



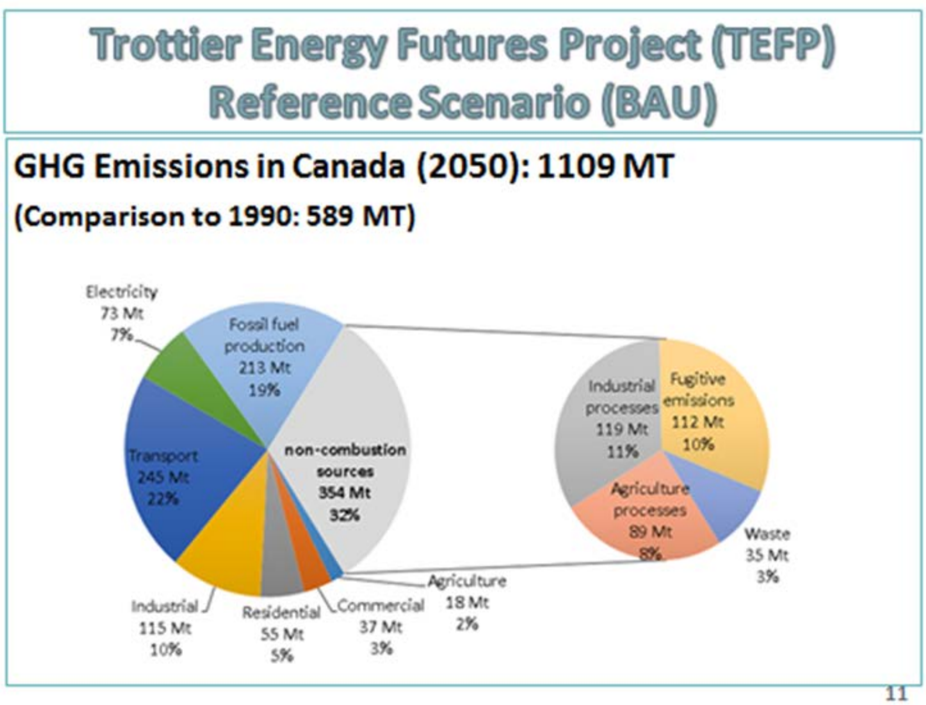
11. **Power Point 11:**

This Power Point shows projected emissions in 2050 for the Reference (BAU) Scenario.

Key points from this Scenario are as follows.

- From comparison with results of emissions for 1990, as presented in Power Point 4 (see above), there is an overall increase in emissions, but no major difference in the overall mix of emissions from the various sources. This will be discussed further for Power Point 15 (below).
- Total emissions increased from 692 million tonnes (MT) of CO2 equivalent in 2010, to 1,109 MT in 2050. Combustion emissions increased from 503 MT in 2010 to 755 MT in 2050, an increase of 50%. Non combustion emissions are almost double, increasing from 189 MT in 2010, to 354 MT in 2050.

  It is noteworthy that combustion emissions increased by 50%, while GDP increased by 100%. This relatively slower rate of increase in emissions arises from the impact of imposed CAFÉ regulations in the transport sector, and projected full realization of all cost effective energy efficiency and conservation programs, by 2050.



12. **Power Point 12:**

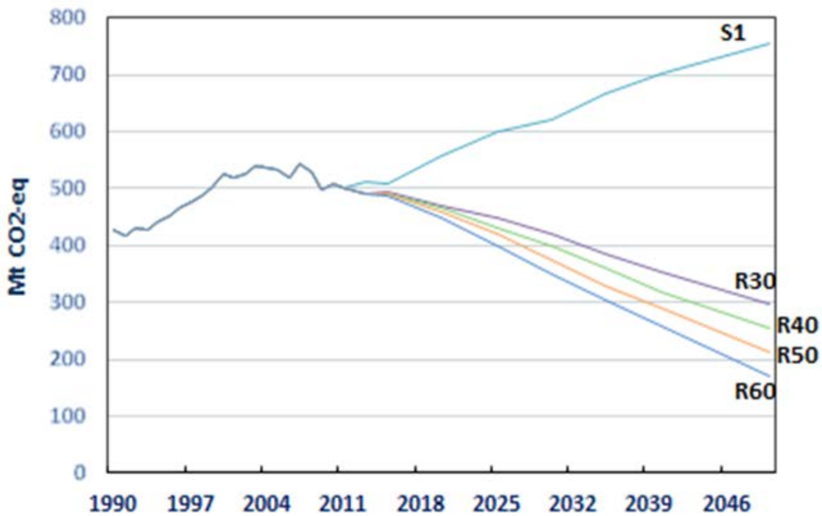
Power Point 12 contains information on the emissions reduction profiles used for the various analyses. The profiles are for combustion emissions, as reported in the annual National Inventory Reports for each of the respective years, from 1990 to 2010. The selected emissions reduction profiles were essentially linear, from the actual value of 503 MT in 2010, to different targeted values in 2050. These were based on progressively reducing emissions from 2010 to 2050, with variation in 2050 varying from 30% to 60% reductions below the 425 MT value in 1990 (represented as R30 to R60).

The two models were used to derive minimum cost solutions to simultaneously meet two sets of demands;

1. Growing energy based demands, as defined for a growing economy, as shown on Power Point 9 (see above)
2. Increasing GHG mitigation demands, as shown by reducing GHG emissions, from profile S1 in Power Point 12, to satisfying specific GHG mitigation profiles (such as one of the R30 to R60 profiles).

It should be noted that emissions reductions profiles are for combustion-based emissions only, and exclude non-combustion emissions. The longer term intent is to be able to derive minimum cost solutions for mitigating all GHG emissions. At this stage, however, there is inadequate knowledge on options, and lack of credible supporting data, for analyzing options for reducing non–combustion emissions on a quantitative basis. The approach adopted for TEFP was to analyze non-combustion emissions on a qualitative basis, based on results of a comprehensive literature review.

GHG combustion emission targets



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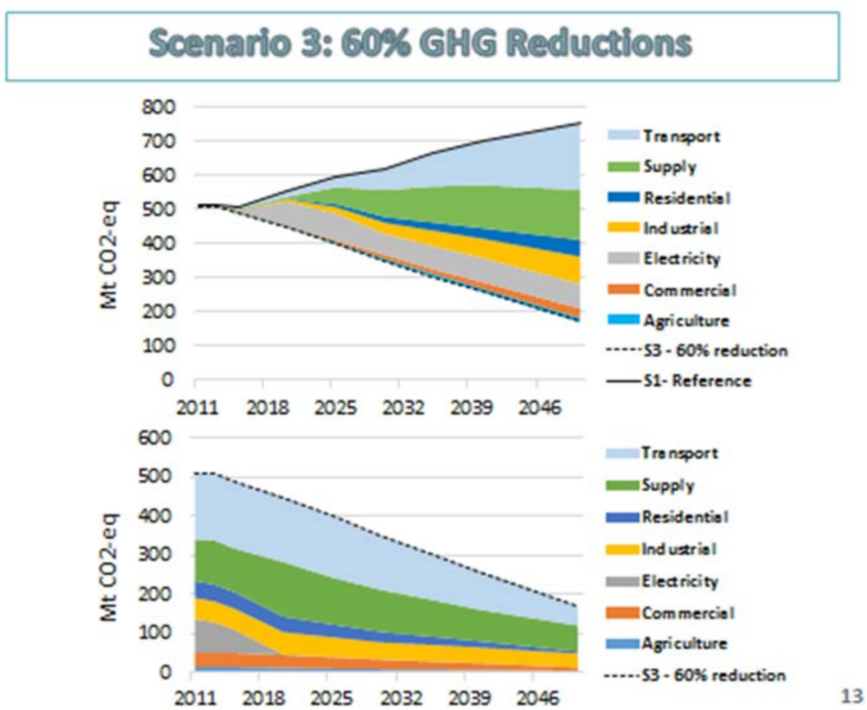
13. **Power Point 13:**

This Power Point is the first of several Power Points with descriptions of important results from TEFP, especially as they relate to the Site C Inquiry. It is also the first of two Power Points with results presented as "wedge diagrams". Key points from this Power Point 13 are as follows.

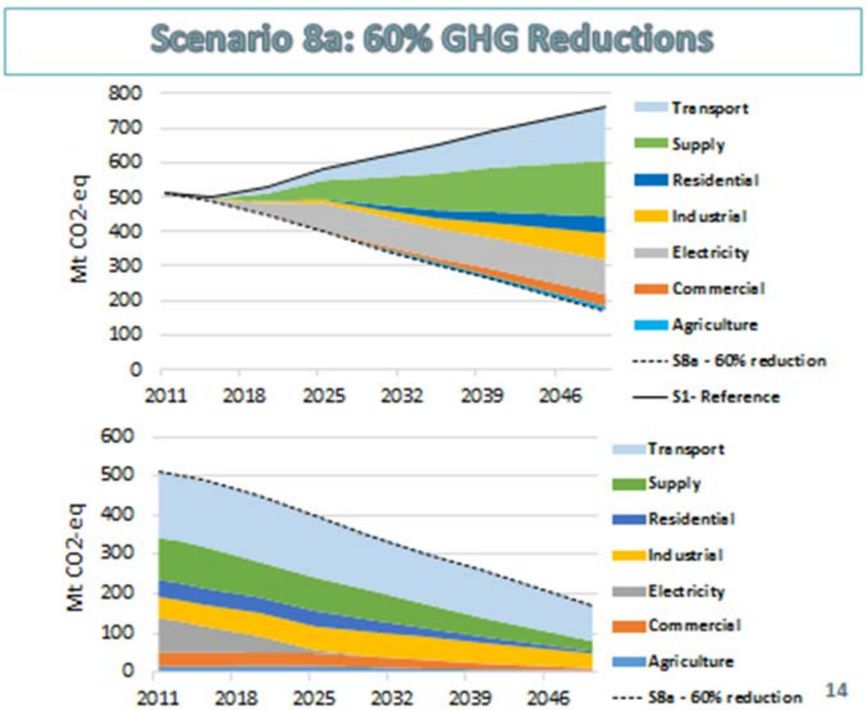
1. This "wedge diagram" shows results for reducing GHG emissions for Scenario 3 (proven technologies only) and the R60 emission reduction profile (Power Point 12). The upper diagram shows time-based reductions in GHG emissions for each of the sectors relative to the Reference Scenario. The lower diagram shows time based results for actual emission in the respective sectors.
2. The first observation is that the minimum cost solution results in immediate and rapid decarbonisation of electricity supply.
3. The second observation is that there is progressive decarbonisation of the various sectors, without any sector being dominant, following decarbonising of electricity supply. The models systematically select the most cost effective technologies for early implementation, with the more expensive options being introduced, progressively, over time.
4. The third observation is that the sectors with largest GHG emissions (transportation, industrial and fossil fuel supply) show the largest reductions in emissions over the planning period. However, by 2050, they still remain as the dominant GHG emitting sectors. The buildings sector (residential and commercial) is effectively fully decarbonized by 2050.



14. **Power Point 14:**

Power Point 14 includes a "wedge diagram" for a very different Scenario. This is Scenario 8a, which represents lower production and export of fossil fuels. It also includes both proven and "disruptive" technologies, as available options for GHG mitigation.

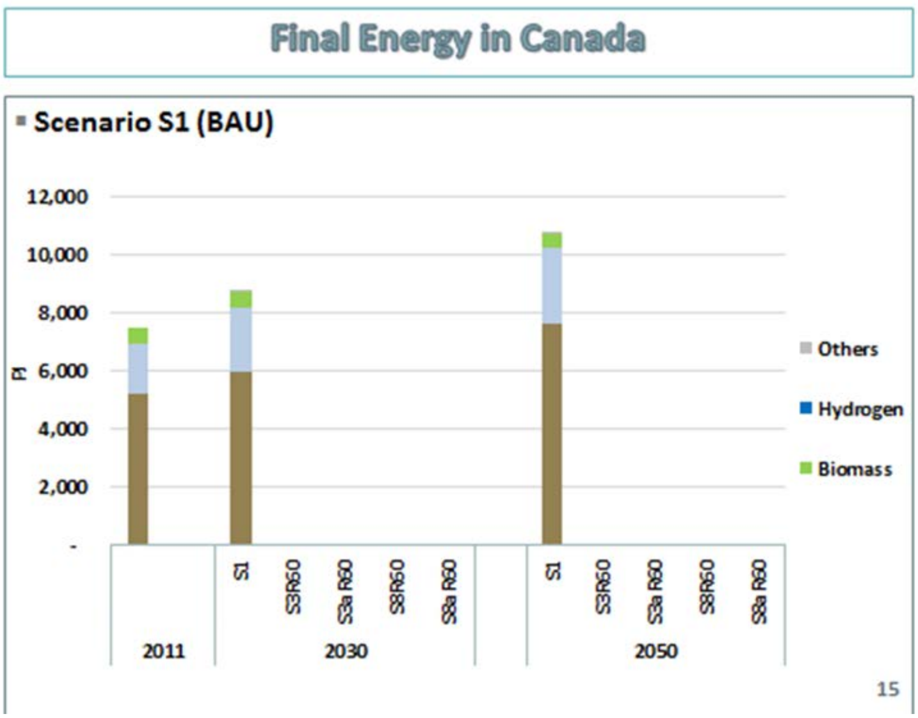
Results from this Scenario are similar, in principle, with Scenario 3 (Power Point 13). Again, electricity supply is decarbonised first, and then the other sectors are progressively decarbonized. Again, the dominant remaining challenges in 2050 are for decarbonising the transport, industrial and fossil fuel supply sectors. The dominant difference, relative to Power Point 13, is that these transformations occur more slowly, as the magnitude for decarbonising is reduced, and there are more options available for GHG mitigation.



15. **Power Point 15:**

Power Point 15 is the first of three Power Points that demonstrate the impact from climate change considerations on the composition of energy supply to meet energy demands at minimum overall cost. This Power Point shows results for the Reference Scenario, which is based on the premise that there will not be any further actions for reducing GHG emissions, other than policies which are already in effect.

The principal result from this Power Point is that, in the absence of GHG emissions reduction requirements, the relative composition of the system remains sensibly constant. Fossil fuels and its derivatives will continue to meet 74% of energy based demands, while electricity meets 22%. The use of biomass and biofuels will continue to meet the remaining 4% of demand.

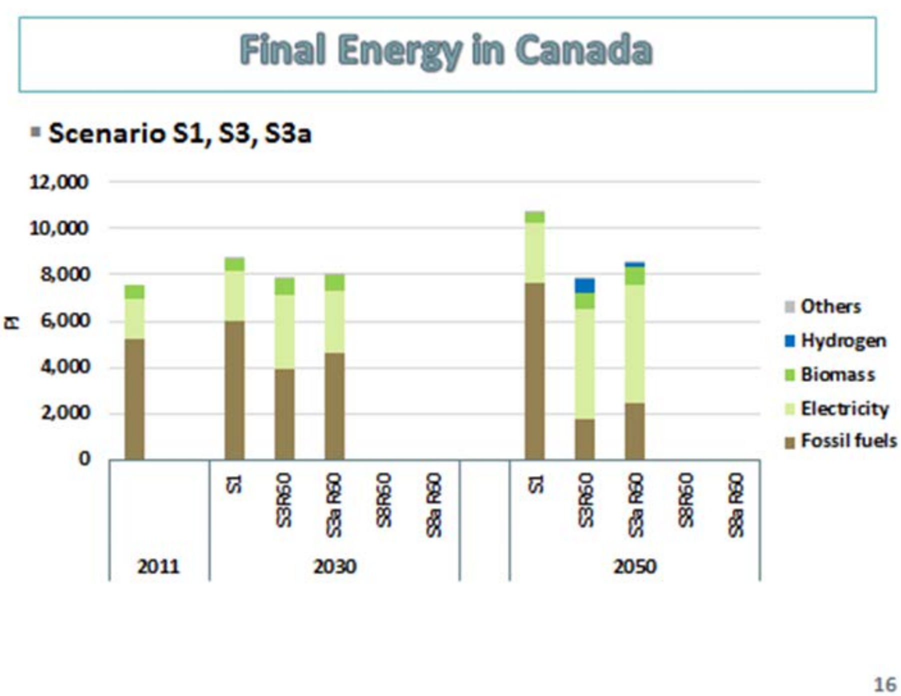


16. **Power Point 16:**

This Power Point shows the effect of imposing GHG mitigation constraints on minimum cost solutions. Results for Scenarios 3 and 3a include proven technologies only. Scenario 3 is for high fossil fuel production, while Scenario 3a is for low fossil fuel production. Both Scenarios are for the 60% reduction target (R60).

The principal results from this Power Point, and from comparison of results with the Reference Scenario (S1) are as follows.

1. Overall demand for energy, when including GHG mitigation requirements, results in an overall reduction in energy supply, relative to the Reference Scenario. In fact, energy demand in 2050 is very similar to energy demand in 2011, even with doubling of national GDP. The dominant factors contributing to this reduction is the progressive replacement of internal combustion engines with electric motors for motive power (including, for transportation) which have higher conversion efficiencies, and additional energy efficiency and conservation options.
2. The energy mix to meet end uses changes dramatically. There are major progressive reductions in use of fossil fuels and its derivatives for meeting energy based demands, with corresponding increases in use of electricity. There is also a significant increase in use of biomass and biofuels.
3. For Scenarios 3 and 3a, hydrogen begins to enter the supply mix in 2050, despite being very expensive. This arises because of limited availability of other options, such as second generation biofuels for heavy freight transport.

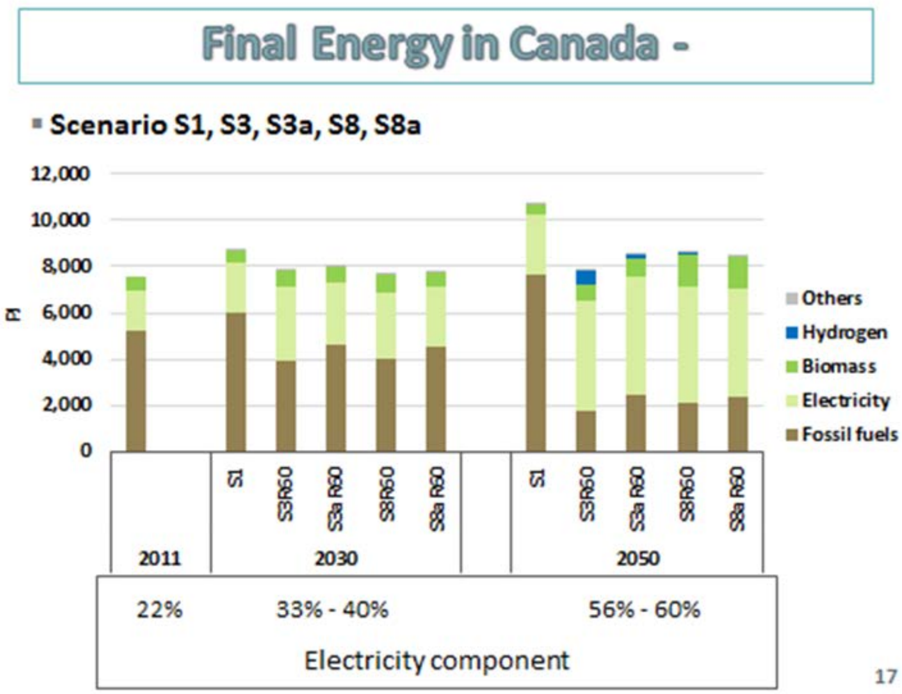


17. **Power Point 17:**

Power Point 17 includes additional results, with including also Scenarios 8 and 8a. These Scenarios include both proven and disruptive technologies. Scenario 8 is for high fossil fuel production, while Scenario 8a is for low fossil fuels production and export.

The principal observation from this Power Point is to further demonstrate that the need for GHG mitigation results in major shifts from use of fossil fuels to use of electricity for meeting energy-based demands.

The four Scenarios for meeting GHG mitigation requirements all show major increases in use of electricity; from 22% for the Reference Scenario, to values in the range of 33 to 40% by 2030, and to 56 to 60% by 2050. These numbers represent major and immediate increases in demand for electricity, dominated by massive electrification for GHG mitigation.



18. **Power Point 18:**

Information on marginal costs for the four Scenarios, included on Power Point 17, is presented on Power Point 18.

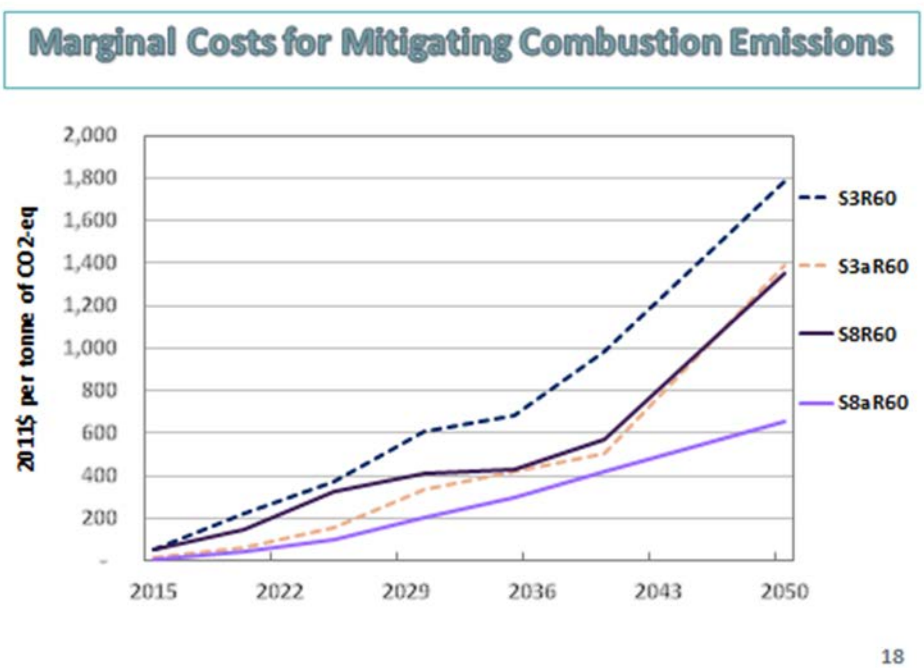
Marginal cost values have special significance for the planning of energy-GHG mitigation systems. First of all, they represent the unit cost for the lowest cost option for the next unit of

GHG mitigation associated with the minimum cost solution. For any Scenario, these values may be considered as being the equivalent carbon price that would be required to achieve the same results for GHG mitigation in a theoretically perfectly responding economy.

These values can be helpful for electricity supply planning, especially when including the value of generating supply options (as distinct to costs) for GHG mitigation.

Some valuable insights from this power point are as follows.

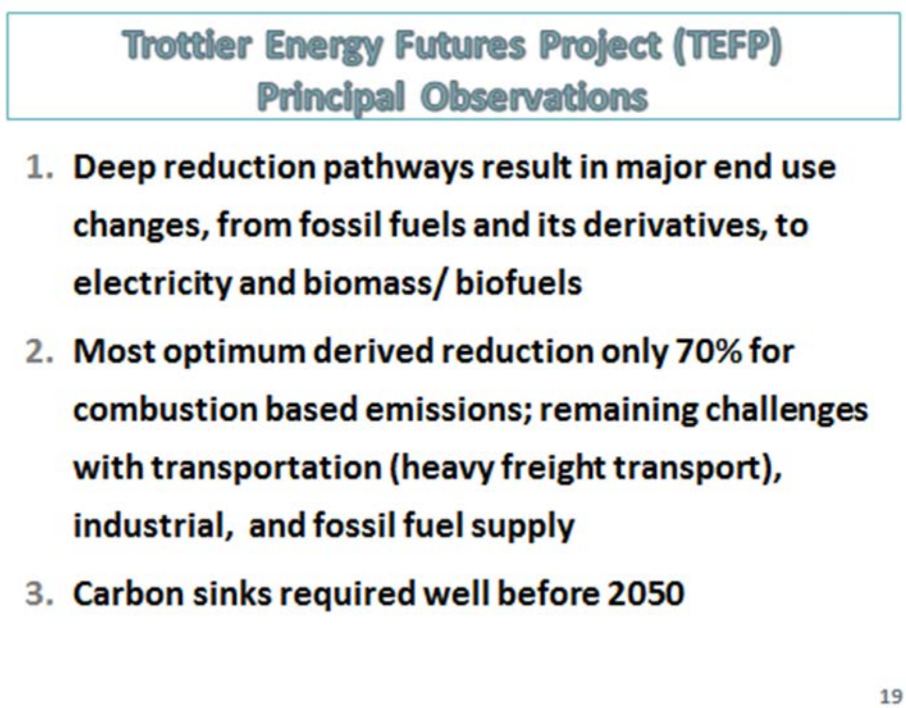
1. Marginal costs increase progressively over time. This reflects that the minimum cost solution systematically selects the lowest cost options for GHG mitigation early with the more expensive options being included later in the planning period.
2. Marginal costs for Scenarios which also include disruptive options (8 and 8a) are lower than for Scenarios with proven technologies only (3 and 3a)
3. Marginal costs for the lower fossil fuel production Scenarios (3a and 8a) are lower than for the high fossil fuel production Scenarios (3 and 8).
4. Marginal costs are high (hundreds of dollars per tonne of CO2), reflecting that overall costs for GHG mitigation are high. Longer term costs may reduce as additional options for GHG mitigation are developed.



19. **Power Point 19:**

Power Point 19 is the first of two Power Points with summarized highlights from TEFP. Key points, as they relate to expressed concerns for the Site C Inquiry, are as follows.

1. Once again, a dominant result for cost effective GHG mitigation is the major transformation of end uses, from fossil fuels to electricity.
2. It is important to appreciate the magnitude of the GHG mitigation challenge. There are additional challenges for reaching the 80% mitigation target by 2050, as well as the 100% plus mitigation target by 2100. This may result in even greater demands for electrification than presented in the TEFP results.
3. To achieve carbon neutrality by 2100, and to achieve 80% reduction by 2050, there will be a need to also include carbon sinks. This can include options for electricity supply, such as electricity generation using biomass with CCS (BECCS), which is a "net GHG sink".



20. **Power Point 20:**

This Power Point includes the remaining principal observations from TEFP. The most important observation, as relating to the Site C Inquiry, is that the required immediate actions are clear and consistent for the various Scenarios. They include;

- Immediate net decarbonisation of electricity supply
- Systematic transformation of end uses and the fossil fuels supply chain, from reliance on fossil fuels to electrification
- In-depth investigation of options for meeting additional longer term GHG mitigation challenges
- Proceed immediately to meet ambitious GHG mitigation commitments, for both 2030 and 2050.

Trottier Energy Futures Project (TEFP)
Principal Observations (Continued)

4. **Challenge to achieve 80% reduction in total GHG emissions by 2050 is huge**
5. **Costs for GHG mitigation are high**
6. **Developments coming on line when required is also a major issue (rate of change is extremely high)**
7. **Immediate priorities clear; longer term path requires much more investigation, assessment and research**

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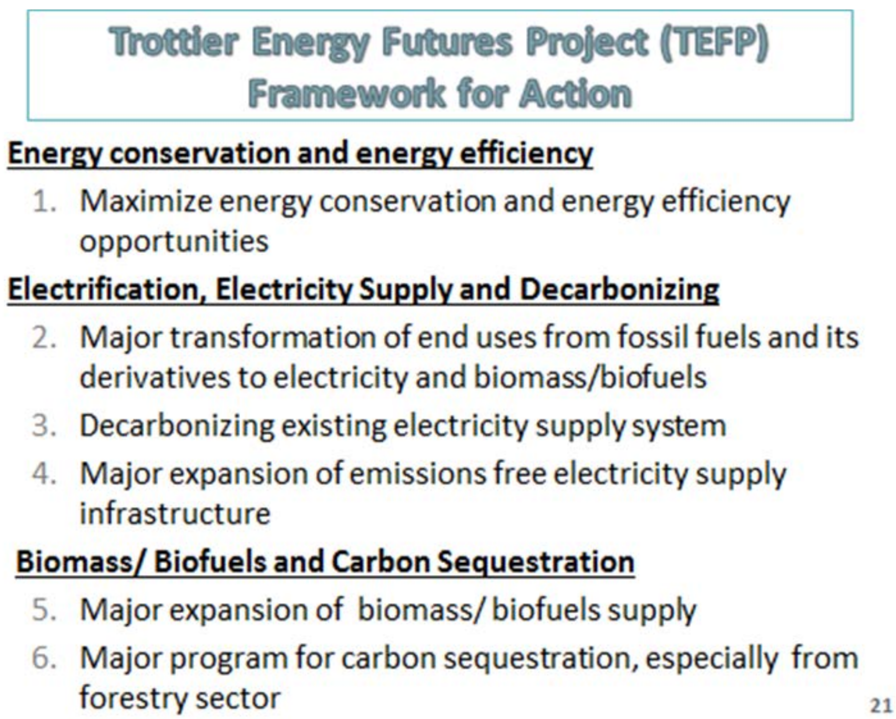
21. **Power Point 21:**

This Power Point 21 is the first of two Power Points for defining a “Framework for Action”, based on result from TEFP.

The dominant actions, as relating to the Site C Inquiry include;

1. The first action, always, should be to take advantage of energy conservation and energy conservation opportunities, some of which are available at low cost. It is especially noteworthy that the results of TEFP resulted in a 50% reduction in energy intensity from 2010 to 2050 (no increase in energy demands with GDP doubling), driven largely by the energy efficiency and energy conservation benefits.
2. The second key point is that there needs to be a major focus on electrification and electricity supply, as already noted.



22. **Power Point 22:**

This is the second Power Point for "Framework for Action".

The most important point from this Power Point is the need for also decarbonising the fossil fuel supply chain, much of which can be achieved again, with replacing use of fossil fuels with electricity. This includes extraction, collection, processing, refining, upgrading, transmission, distribution and delivery to final point of use, or for export. It may also include energy for liquefaction of natural gas, also for export.

Trottier Energy Futures Project (TEFP)
Framework for Action Continued

Effective Reduction of GHG Emissions from Fossil Fuels Supply

7. **Decarbonize fossil fuels "supply chain"**
8. **Elimination of fugitive emissions**

Other Actions

9. **Major reductions in nitrous oxide and methane emissions in agriculture systems**
10. **Major reductions in industrial process emissions**
11. **Fundamental change in developing urban regions, including especially urban "form"**

22

Highlights from TEFP re; Site C Inquiry:

From the summarized "high level" presentation of results from the TEFP, we now present concluding commentary relating specifically to our stated concerns with the Site C Inquiry.

The first concern relates specifically to the importance of including climate change and GHG mitigation, for systematic and cost-effective development of the electricity sector in British Columbia. The key arguments are as follows.

1. It is well established and clearly demonstrated that the dominant strategy for reducing GHG emissions is to reduce burning fossil fuels and its derivatives for meeting energy based demands. The most cost effective option for replacing most of this energy supply is with electricity. This results in major increases in demand for electricity, especially relative to more traditional approaches for electricity supply planning, where climate change considerations have not been included.
2. The large increase in demand for electricity will be driven by major transformations of end uses, from fossil fuels to electricity, in the transportation, industrial, residential, commercial and agricultural sectors; from decarbonising the "fossil fuel" supply chain; and from decarbonising electricity supply.
3. The greatly increased demands for electricity are immediate. The Government of British Columbia, Canada, and the other jurisdictions across Canada, have made very ambitious commitments to reduce GHG emissions by at least 30% by 2030, and by more than 70% by 2050. The most cost effective strategies for meeting these commitments is to increase demand for electricity, and associated supply, by up to 100% by 2030 (only 13 years away) and by up to 200% by 2050.
4. The electricity system in British Columbia is part of the North America integrated electricity system, which is the largest fully integrated electricity system in the world. Considerations of climate change and the rapidly growing role of electricity is becoming an integral part of the process, across North America, for ensuring that future developments of electricity systems also meet the national and international challenges of GHG mitigation. It is vital that British Columbia expands on its earlier established leadership on climate change and GHG mitigation, for ensuring that these considerations are fully integrated for future evolution of British Columbia's electricity system.

The second concern relates specifically to the importance of comprehensive integrated planning in a long term context. The key arguments are as follows.

1. From TEFP, it is evident that when considering cost effective strategies for GHG mitigation, the impacts on energy systems are enormous. The largest impact is on the

shift from use of fossil fuels to use of electricity for meeting energy based demands. There are also other significant impacts, including greatly increased use of biomass and biofuels, and potentially important roles for technology options which are still in early development.

This serves to demonstrate that GHG mitigation is an extremely important consideration for planning energy system, including especially, electricity sub-systems.

2. The future evolution of energy systems, including electricity, will be subject to major and continuing changes over time. This means that there may well be continuing changes in the mix of demand and supply for energy systems, including electricity, in responding to the relatively rapid change in overall composition of energy supply and demand, especially for meeting increasingly stringent GHG mitigation targets.

   This places special emphasis on the importance of planning energy systems in a long term context. This also reflects that many investments for energy and GHG mitigation are capital intensive and have long economic lives.
3. Many of the transformations for GHG mitigation will depend on major and early transformation of end uses, from fossil fuels to electricity. The success in meeting GHG mitigation commitments will, to a large extent, be "driven" by the success in implementing such transformations. This places special emphasis for greater integration of GHG mitigation planning, including its associated "end use" transformations, with electricity supply planning.
4. With the integration of GHG mitigation into energy supply planning, including electricity supply planning, there are additional complexities that need to be fully appreciated in the planning process. This includes recognition that there are benefit values for reducing GHG emissions, which are equal to marginal costs for minimum cost solutions for integrated energy-GHG mitigation systems. From TEFP and other studies, this value can be hundreds of dollars per MT. This has the consequence of producing high benefit values for electricity supply from non-GHG emitting sources. Any attempt at electricity supply planning without considering the marginal benefit value for GHG mitigation, has the potential for producing results that may be seriously flawed.

<u>Concluding Commentary:</u>

The authors of the original Submission, and this Supplementary Submission, again reinforce their concerns as stated in their original Submission and in the introduction for this Supplementary Submission.

1. The Site C Inquiry Review is not addressing commitments, and associated obligations, by the Governments of British Columbia and Canada, with respect to reducing greenhouse gas (GHG) emissions. The dominant strategy for achieving progress on climate change is to replace use of fossil fuels and its derivatives (gasoline, diesel, natural gas, etc.) with energy from non-GHG emitting sources. This results in major increases in demand for electricity, and associated increases in electricity supply, dominantly from renewable generating sources, including hydro, wind, and solar.
2. Planning of the electricity supply system, needs to be carried out within a fully comprehensive long-term planning framework. This framework needs to include integrated consideration for major, progressive, and rapid reductions in GHG emissions, with associated fundamental transformations of energy systems. Transformations of energy systems will be dominated by major and rapid reductions in use of fossil fuels for meeting energy based demands, and by correspondingly large increases in use of electricity.

Respectfully submitted

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