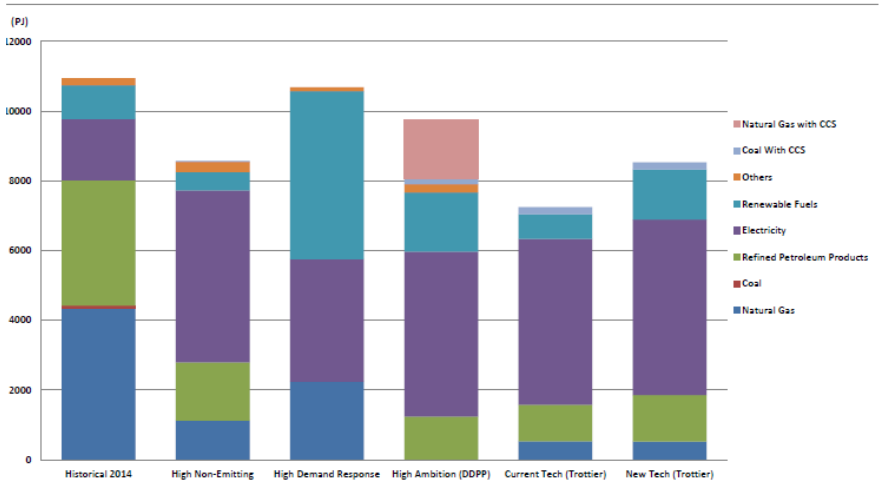
Comments on Recent Draft Material for the 2017 LTEP

Scenarios for Lower Electricity System Emissions to Inform the Development of the 2017 LTEP (IESO August 14, 2017)

- This paper shows that the cost of removing that last few MT of carbon emissions from the power system with a combination of wind and storage are high. Maintaining CO2 emissions from the electricity system flat at 2017 levels through to 2035 has a cost of $215/tonne on average to 2035 and to eliminate gas-fired generation entirely costs about $1400/tonne. The estimates are considered conservative in that they capture only the direct generation costs of additional wind and storage facilities and do not include the costs of connection and backup to maintain reliability.
    - While the $/tonne costs of the lowest scenario are high relative to the projected cap and trade price, to put the $215/tonne result into context, it is at the low end of the $/tonne cost of additional wind, solar and storage projects, and higher than the cost of nuclear and some of the more cost-effective potential hydro options.
    - The very high costs derived for eliminating the final gas production result from the very low capacity factors on the storage facilities in those few remaining hours and the large amount of wind capacity required given its low coincidence with system peak hours, the times when gas is ultimately required.
    - Essentially, because gas generation has low cost access to a storable fuel, it is very expensive to displace with options that require expensive electricity storage. Most electricity storage schemes only become remotely cost-effective when they can go through a charge/discharge cycle every day of the year, rather than a few days a year.
- Presumably, an all wind and storage alternative scenario was selected because it has lower cost per tonne than options that included some blend with solar, or an all solar plus storage option. I would expect this is because the amount of storage required with solar is higher. It would be useful to have on the record the explanation why a scenario with solar was not selected as it might highlight some of the issues with solar performance in Ontario's geographic location.
- In a world where electrification of space-heating results in a winter-peaking system in Ontario, elimination of gas back-up would have an even higher $/tonne cost.
- The use of a $/tonne measure for the cost effectiveness of carbon abatement measures is correct in this context and should be used consistently to rank the resources committed to any plan intended to meet CCAP emission reduction targets.
- I would recommend that the plan declare victory in reducing the gas generation on the system to the level it has for the current electrical demand profile and associated supply mix.
    - Achieving the 2030 emission reduction target will probably require additional electricity supply resources to meet the loads created by electrification of transportation and heating systems. However, the amount of additional gas-fired generation production need not increase dramatically. The mix of baseload resources selected is key.
- One thing not considered in this study is the impact that a day-ahead market and other related elements of market renewal proposed by the IESO will have on the displacement of natural gas by existing peaking hydro facilities. Current dispatch rules favour the commitment of gas generation ahead of hydro facilities. Once market renewal (as proposed) is in effect, existing peaking hydro resources should displace a portion of the gas-fired production under current market rules. OPG may have some estimates of this as they have been lobbying for these changes for some time.

- Is the Ministry of Energy confident that biomass crops are net negative for GHG emissions. My understanding is that this is controversial.
- I would have expected a greater role for electrified mass transit to be described in this LTEP. The load implications of electrified rail systems are not large in the scheme of things, though the capital costs are significant. Paying for them is clearly a matter of on-going negotiation, though I thought the province had a $30B plan. The benefits to the economy of decongesting roadways to give faster trip times for people to work and for moving goods on trucks are significant and would reduce the $/tonne cost of the investments in mass transit.
- The approach taken to attempt to meet all Building heating needs through conservation will be seen as radical. The Federal Government's Canada's Mid-Century Long-term Low-Greenhouse Gas Development Strategy (issued in December 2016) compiles results from three recent major studies of decarbonization in Canada: their own Energy, Economy and Emissions Model scenarios for Canada; the Deep Decarbonization Pathways Project (DDPP, based on the CIMs model developed at Simon Fraser and currently run by Navius Consulting); and, the Trottier Institute's 'Energy Future's Project'.
    - Total and sectoral results are summarized in the graphs below from the Gov't of Canada report. Electricity demand increases significantly in all studies, especially in the buildings sector. These bar charts are for 2050, but the trends would apply to 2030 as well. Where the studies often differ is whether the source of incremental electricity can be purely wind and solar, the extent that hydro development occurs and whether new nuclear is considered.

Figure 7: 2050 Projections of Total Energy Consumption by End Use Fuel



CANADA'S **MID-CENTURY LONG-TERM LOW-GREENHOUSE GAS** DEVELOPMENT STRATEGY

Figure 10: 2050 Building Sector Energy Use Projections

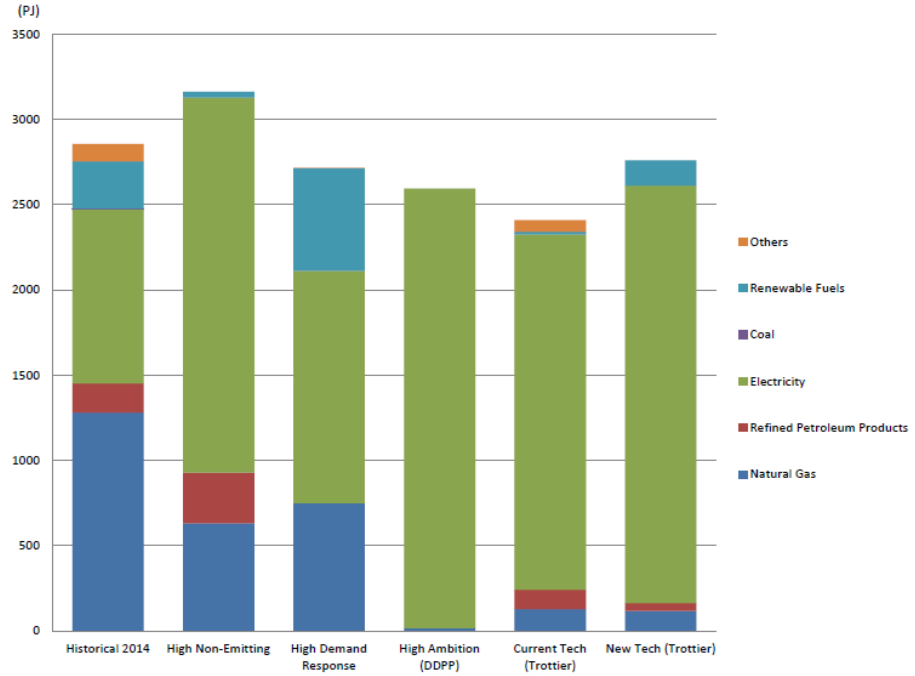
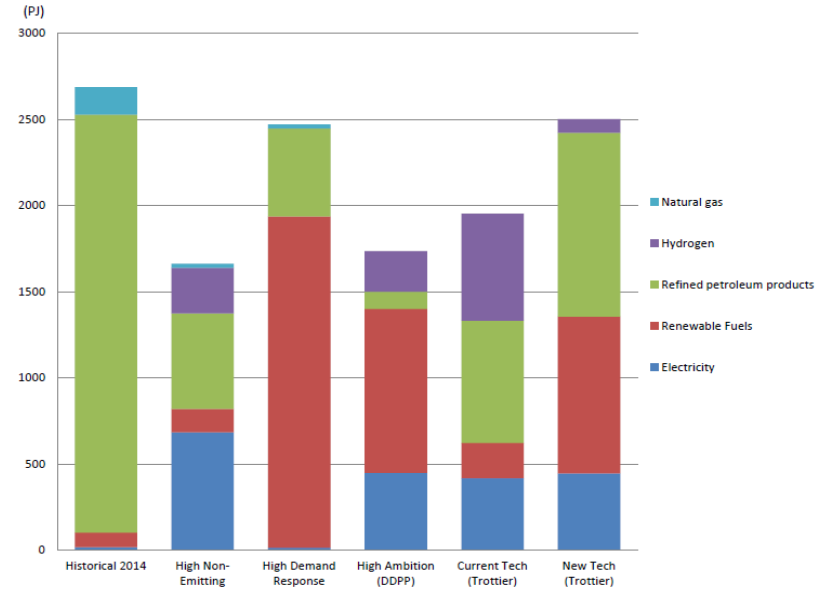


Figure 8: 2050 Transportation Sector Energy Use Projections (PJ)



- The plot on page 9 shows *energy* sector emissions below *economy-wide* emissions. They should be by definition. The CCAP Targets are economy-wide, as I understand them. The excluded economy-wide segments (agriculture, waste and non-energy related industrial processes) emit about 40 MT which would make the economy-wide emissions about 130 MT in 2030, which is above the CCAP target of 114 MT.
- In the chart on pg 10, when it says 'with tax', does that mean HST? Is the carbon price already included in the gas price projection? Is the carbon adder derived with a 5% real escalation per year out to 2035, or is it capped at some point?
    - Why is the projection of the bill shown with tax, if it has been removed already? Wouldn't this plot be easier to understand net of inflation?

- On pg 20, is the reduction from 800 to 750 kwh per month part of the difference between pre OFHP and Direct to FAA? If it is, wouldn't it help to start the plot in December 2016 and show the step down when HST is removed? Nonetheless, the bill difference shown is much less than 25% in Nov 2017.
- Pg 21: One can arbitrarily change the inflation forecast, but really what is happening is a 1% per year real increase in the bill from 2016.
    - Not sure whether you can find a reputable published inflation forecast of 3% per year for Canada, especially as the Bank of Canada's job is to intervene with higher interest rates if it looks like the rate is going over 2%. I would expect that Ontario Finance would use 2% per year.
- Pg 24,25 not clear if the residential consumption forecast for billing purposes is consistent with the underlying residential demand forecast in Case F. For instance, there is reference to electrification of space and water heating, which I gather is not included in F. EV's should be included if the forecast average bill is important.
    - Wouldn't it be easier to just present the residential electricity rate, rather than the bill? Customer consumption will likely be less uniform in future. Wasn't it the rate that OFHP said it would cut?

Delivering Fairness and Choice
(Draft as of August 18, 2017)

- Pg 4.
    - 'How We've Heard You' suggests that the LTEP will address all the concerns, even if some have contradictory implications. Was 'What we've heard from you' considered.
    - Responding to high electricity costs is a major theme of this LTEP and differentiates it from the previous two. Not further compounding the cost problem, and so making it easier to repay the short-term roll back in cost recovery, should also be a theme.
    - The 2016 pie chart shows generation was 156.6 TWh (not shown: further excess capability of probably about 8 TWh of SBG). The OPO modules indicate there is currently a significant surplus of capacity and energy in the province which will continue for a few years, until more than one nuclear unit is out of service for refurbishment. This creates an opportunity to temporarily reduce payments for electricity conservation and diminish the transfer of global adjustment costs to non-industrial customers from the ICI.
        - Expenditures on conservation and peak load reduction in this period exacerbate the funding of the OFHP by increasing costs while decreasing the rate base over which to recover costs.
    - The next three years would be a good period to transition from program-driven electricity conservation to market-driven electricity conservation assisted by standards and codes, while ramping up dramatically on program-driven gas/oil/propane conservation.
    - The old concept of using programs to kickstart market transformation and then shift away from administratively burdensome programs to market forces, standards and codes is still valid. The start of the cap and trade system should be exploited as part of this transition.
        - Program-driven conservation subverts the intent of cap and trade, which tries to set an economy-wide market price for emission allowances. Conservation programs lower the market-clearing allowance price by reducing the demand for allowances using funds from outside the market.
- Pg 9.
    - The GA pays all wholesale power system costs not recovered though market prices. It includes the cost of power exported below cost and payments to generators for curtailed surplus baseload generation. These

quantities are increased by conservation that is not required in the short-term. A 15-year conservation measure may have long-term benefits, but the benefits are even greater if all 15 years deliver savings that have value to the system. As with cost-effective generation, installation in advance of need is not the least cost strategy.

- One of the objectives of the incremental capacity auction is to determine the market value at which the current contracts should be extended when their terms expire. The values cited for the transition to a capacity auction in part reflect not extending the life of some assets or incenting their modification into something more useful to the system. As such, the auction may show that the gas, solar and wind facilities originally contracted for may not have the same value after their contracts expire as they do now. Was this factored in to the OFHP calculations?

- Pg 11
  - If natural gas system expansion passes the OEB's economic tests, it should proceed. However, additional government support for natural gas heating, rather than for an air or ground source electric heat pump solution appears inconsistent with CCAP goals.
- Pg. 13
  - The list of 'How We've Heard You' for Chapter 2 starts with 3 bullets that speak to planning a least cost, technology-neutral energy supply system. In an era with a heavy focus on reducing carbon emissions from the use of all energy forms, the measure that facilitates such planning is consistent derivation of the cost of carbon abatement (the implied cost of carbon reduction): $ expended per tonne GHG emissions reduced or $/tonne. This may be derived for both demand and supply resources as: NPV of costs divided by the NPV of GHG emissions reduced.
    - Demand side resources would be costed at the Total Resource Cost to be equivalent to supply-side resources.
    - Where programs, like mass transit, have other societal benefits outside the energy sector (eg reduced cost of commuting time), these should be credited against the total costs of the measure.
  - Correctly trading off between alternative demand/supply options for meeting energy service needs is facilitated by developing supply curves for options so that neutral choices can be made up to an agreed $/tonne level across all options to meet the targeted emission level for the economy, before proceeding to raise the $/tonne ceiling further. Climate change policy models have mechanisms like this to derive 'deep decarbonization pathways'.
    - Having different silos in which costs are incurred does not facilitate least cost, technology-neutral, energy system planning that satisfies emission targets, reliability levels and budget constraints. A $/tonne measure makes it possible to trade off the value of options like electrified mass transit, home-heating systems, distributed solar and nuclear in meeting emission targets. Deriving these values consistently is complex, but of great value.
    - One of the products of an LTEP in future should be that the government sets a cap, for the period covered by the plan, on $/tonne for planning purposes for investments it makes outside the energy market. (in practice that would likely be a number much higher than the allowance clearing price in the cap and trade market, but ultimately, if the emission target is taken seriously, they should converge).
- Pg 15
  - The incremental electricity capacity auction as described in the first paragraph will not select the optimal mix of resources to meet electricity service demands and drive economically to achieve long-term climate change goals unless the 'robust' energy market includes a value for carbon at the long run rate required to achieve emission targets.
  - It will not select long-term clean options over shorter-term less effective ones, if the auction is only buying options for a few years at a time. Instead, a series of short-term measures will be selected, similar to what

happened in the early days of electricity competitive markets when the only new generation built as a result of market forces was gas-fired.
    - The experience in existing capacity markets in the US in a period of surplus capacity (as collected in the Brattle report) is not a good indicator of the cost of capacity nearly 10 years from now.
    - If an 'incremental' capacity market really means a 'residual' capacity market, that is, an auction for the remaining capacity required after all major decisions about nuclear, renewables, imported hydro, demand management, etc have been made, then it could be an efficient procurement mechanism, but it would not be making the big system decisions implied by the current text.
    - Changes to market rules also included in the Market Renewal package, such as to create a day-head market, LMP, and 15 minute prices at the interties are all excellent changes. In particular, the day ahead market will enable existing hydro to be scheduled in a way that allows it to better displace gas-fired Spare Generation on Line (receiving the Generator Cost Guarantee) with existing intermediate and peaking hydro resources, and so displace a significant portion of the gas-fired generation currently occurring. (OPG may have an estimate of the gas that could be displaced).
    - EV market penetration in a world of low gasoline/diesel costs may require much higher carbon prices to be broadly adopted without subsidies. Decreasing battery costs alone may not be enough.
    - Scenarios C and D in the OPO addressed greater electrification of the energy system. Electrified mass transit and shifting off natural gas/oil/propane to electric options for heating will be needed to achieve emission reduction targets. If insufficient analysis of Fuels Technologies has been done to derive a sound supply curve ($/tonne) for demand-side measures in the Fuels portion of the energy system, that should be acknowledged, rather than plan as if electrification is not required going forward. Fortunately, the province can postpone these decisions for a few years.
        - All major studies of how to achieve Canada's 2050 emission targets find a need for increased electricity supply. (see graphs on pages 2,3 of this note). The cost of meeting the target is typically found to be around $200-$300/tonne(real dollars). Substantial public buy-in will ultimately be needed for this shift. The broad implications of achieving the 2030 emission target should be broached.
- Pg 16.
    - The Lake Erie Connector: As stated in the green box on the page, Ontario should not pay any of the costs for this line. This should include not directing OPG to buy a portion of its capacity.
- Pg 18
    - Implementing cap and trade should increase the amount of HQ generation sold into Ontario in response to market forces, without the need for a special contract with Quebec.
    - The benefits of the energy market design changes noted above should be mentioned here.
    - Wind or solar may be challenged to win out in an auction for dependable capacity. They would have to earn a significant margin in the energy market to cover their fixed costs. This would be helped by aggressive allowance pricing in the cap and trade market. That will happen if the market price for allowances is not suppressed by out of market demand/supply programs.
- Pg 23/24 does not flow well. Better ordering of the sentences possible. Not clear what the third Market Renewal point refers to.
- Pg25
    - New technologies are getting cheaper. They will may customer costs lower than they otherwise would have been. Not necessarily lower than they are today.
- Pg 26
    - A time varying GA may give more incentive to customers to conserve and shift loads, though the ratios currently used for the RPP TOU pricing are already shaped and do not reflect the marginal energy costs of the current system.

- Pg 28
    - The plot of household demand on a typical summer day is not clear to me. The demand for the house should peak between 10 am and 4pm, and that period may be totally served by solar with some to spare which is sold to the grid. It is not the case that household demand (the black line) is less during the day than in the evening. If the intent is to show Household demand *from the grid* with the black line, that should go to zero in the middle of the day.
    - What is the payback period for solar under net metering now?
    - It is important to be sensitive to some of the fairness issues that arose in California around grid-connected customers subsidizing the grid backup services that are provided to solar or 'solar with storage' customers that remain connected to the grid.
        - Even with storage batteries, disconnection of solar houses from the grid in Ontario will be very difficult given weak insolation in winter months. It is more challenging still when EV and heating loads are added.
- Pg 35 Clarify the policy re household mini-fossil fueled generators. Is it addressed on pg 57 under behind the meter gen projects?
- Pg 38/39
    - When the hydrogen economy was explored years ago, one limitation was that the existing gas pipelines were too porous to take hydrogen without leaking and the risk of explosion – a new network was considered necessary. Perhaps there is a weak concentration level of hydrogen that moderates this risk?
- Pg 49
    - Declare victory on publicly funded electricity conservation programs, even those discussed for the Green Fund on pg 57. Transition to electricity conservation that is based on prices and standards/codes, aided by information and longer-term financing tools. Shift program emphasis to other fuels. That's where the bang for the buck is now. That message is implicit; it should be stronger in my view.
    - Call out box: the valid comparison between demand and supply-side programs is the total resource cost. Ultimately customers pay the TRC for both demand and supply measures. Marginal economics should also apply for deciding whether to pursue further conservation. Cost curves for the remaining electricity conservation potential are curving up rapidly.
- Pg 60
    - Why so careful about moving off natural gas heating?
- Pg 62/63
    - Comparing MW of installed capacity to the number of homes heated has been abused over the years when the generation profile of the supply source does not match the demand profile of the house. Safe wording: 4800 MW of wind generates the equivalent annual energy to the demand from 1.4 million houses. It is not true that you could 'power' 1.4 million houses with the output of 4800 MW of wind alone. Similar story for solar. The 8800 MW of installed hydro produce about 40 TWh of energy which is enough annual energy for 4.4 million homes, pretty well all of the residential sector in Ontario. (for completeness).
    - The carbon allowance cost under Cap and Trade is not going to make a big difference to the amount of gas-fired generation in Ontario, except to the extent that Ontario hourly prices get to the point where imports from Quebec are redirected from Northeast US markets where less efficient gas or oil-fired generation is used. It will take higher prices than predicted for the Cap and Trade market for quite a few years. Getting better dispatch for peaking hydro would probably do more.
- Pg. 64
    - Does MOECC have the studies to show that the life cycle carbon impact of ethanol and other agriculturally-derived biofuels is neutral?

- How much RNG could be made if all the landfills were tapped for capture of waste gases? Would help to get a sense of the potential.