HOUSE SELECT COMMITTEE ON NUCLEAR ENERGY

QUESTIONS ON NOTICE

Hearing #3

Q – 7/11/24

Professor Mark Winfield.

1. Your honesty, about a lack of information regarding Australian energy prices was much appreciated. Understanding you were not aware of the fact energy prices in Australia were as high as AU .56c kWh, do you agree that your assessment and comparison between Ontario energy prices – where people pay around AU.18c kilowatt hour – was misguided and will you acknowledge that perhaps there is in fact something that can be learnt from the Ontario energy story after all for countries such as Australia which rely on 60% of coal to power its grid currently and are seeking cost effective and climate friendly options to decarbonise?

You have also said previously that the Ontario energy story is not something other nations should aspire to follow. Yet, Ontario alone managed to build around 20 zero-emissions nuclear reactors within a 22 year period creating one of the world's cleanest energy grids in the world and enabling Ontario to retain and grow its industrial base.

RESPONSEs

Question 1:

Thank for the opportunity to respond to these questions. The question consists of several parts, which I will respond to through the following sub-headings.

Ontario Nuclear Construction Timelines and Outcomes

The claimed 22 year construction period is incorrect even in terms of a very narrow interpretation of the construction timeline. Construction on the Pickering A plant, the first of the three power plants built in Ontario, began in June 1966, and construction of the Darlington Plant, the last completed, ended in June 1993 - a period of 27 years in total.

In addition, I would emphasize that initiation of construction on a nuclear power plant usually represents a mid-point in the development process, as construction is preceded by typically lengthy planning, design and technical, economic and environmental approval phases. In Canada's case, the Canadian civilian nuclear program has its origins more than 20 years before construction began at Pickering, starting with Canada's participation in the Manhattan Project in the mid-1940s. From start to completion the timeline for the Canadian nuclear program from a standing start, analogous to Australia's current situation, exceeds half a century.

It is also crucially important to consider where Ontario stood at the end of the end of the initial nuclear buildout with the completion of the Darlington Plant in the mid-1990s:

- The provincial utility Ontario Hydro, was $38 Billion in debt ($65 billion in 2024 Cad dollars) and effectively bankrupt principally due to cost overruns on the nuclear construction program. More than half this debt ($21 billion in 1998 dollars) had to be "stranded" - i.e. effectively transferred to provincial

taxpayers and electricity ratepayers, in order the render Ontario Hydro's successor corporations, particularly Ontario Power Generation (OPG), which took over ownership of Ontario Hydro's generating assets, including the nuclear plans, economically viable.

- In December 1994 there had been a loss of coolant accident at Pickering A Unit 2, described as the 'most serious nuclear accident in Canadian history' by the Standing (Canadian) Senate Committee on Energy, the Environment and Natural Resources
- By the end of December 1997, 8 of the 20 reactors built during the initial construction period, specifically at Pickering A and Bruce A, were out of service, 7 having had to be taken out of service virtually overnight due to operating and maintenance failures as part of what was termed a 'nuclear asset optimization plan (NAOP).' The remaining unit at Bruce A had been damaged earlier in a maintenance accident.
- The sudden "laying-up" of the 7 reactors led to the recommissioning and ramping up of the province's coal-fired plants, many of which had been mothballed without modern air pollution control equipment as a result regulations needed to deal with acid rain in the 1980s. The resulting dramatic growth in emissions led to a public health crisis in Southern Ontario , with the Ontario Medical Association attributing at least 1800 premature deaths per year to poor air quality, particularly due to summer smog episodes, to which the coal plants were identified as the leading contributor.
- The refurbishments of the 'laid-up' themselves units went badly. Two ended in write-offs (Pickering 2 and 3), and the four that were completed (2 each at Pickering A and Bruce A) ran years behind schedule and billions over budget. These costs were major contributors to the rise (approximately 3x for the electricity commodity component) in Hydro rates that took place through the 2000s and 2010s.
- Maintenance on the transmission and distribution system had also been deferred during the nuclear construction period in the attempts to keep rates low. Dealing with the resulting backlog of deferred maintenance was also a major factor in increasing overall electricity costs for consumers.

These developments and outcomes are discussed in detail in Chapters 2-6 of Winfield *Blue-Green Province: The Environment and the Political Economy of Ontario* (University of British Columbia Press 2023 – available via UBC Press on an open access basis).

Industrial Development

With respect to Ontario's industrial base, it is important to understand that this was built on the basis of the availability of hydroelectric power from Niagara and other locations between the 1900s and the 1960s. The province's industrial base actually began to decline from the mid-1970s onwards, at the same time nuclear became part of the electricity supply mix, and electricity costs began to rise dramatically. With the shift to nuclear from hydroelectricity the province began to lose its comparative advantage in electricity costs, although the process of economic transformation from an industrial to increasing service and knowledge base was propelled by other factors as well. See H.V. Nelles *The Politics of Development: Forests, Mines and Hydro-Electric Power in Ontario 1849-1941* (McMillan Canada, 1975); T.J. Courchene and C.R. Telmer, *From Heartland to North American Regional State: The Social, Fiscal and Federal Evolution of Ontario* (University of Toronto 1998); C.N.Collier and J.Malloy, eds., *The Politics of Ontario (2nd Ed)* (University of Toronto Press, 2024), esp. Graefe (Ch.2); Winfield (Ch.14).

Electricity Costs

With respect to electricity costs, it is important to note that current electricity costs in Ontario are based on the 'stranding' of a significant portion of the capital costs associated with nuclear construction through the breakup of Ontario Hydro, and subsidization of rates through the availability of legacy hydroelectric assets whose primary capital costs were amortized many decades ago and whose operating costs are virtually nil. The costs of the partial refurbishments of the Bruce and Pickering A plants were significant factors in the major increases in electricity costs through the 2000s and 2010s. Rates are now rising again to cover the next round of nuclear refurbishments at Darlington and Bruce, and the costs of gas fired electricity to cover the lost output from out of service units at those plants. The current rates do not reflect the costs of new nuclear construction.

The costs of new units would be most relevant to Australia. Here the actual costs of recent projects in the US and Europe suggest likely delivered electricity costs in the 40 cent per Kwh range at best, offering no advantage over current electricity costs, and embedding a series of very significant economic, accident, security risks that Australia currently does not face. Current cost estimates for renewables (wind and solar) with storage for Ontario are in the range of cdn10cents/kwh.

It is important to note that no new build nuclear construction projects have been actually initiated in Canada the three decades following the completion of the Darlington project in 1993. There is some site preparation work taking place now on the proposed reactor project at Darlington but there is no reactor construction licenced at this point, and no cost estimate has been provided by OPG or the province on the Darlington new build. Recent analysis from the Tennessee Valley Authority in the US suggests capital costs in the range of Cad$25 Billion for the Darlington four 300MW reactor project. In terms of conventional new build, I note that final costs on the 2200MW Vogtle Project in Georgia, USA, completed in the summer of 2024, amounting to USD$35 Billion. It has been described as "the most expensive power plant on earth," Extrapolating the Vogle costs to the proposed 4800 MW new build plan at Bruce would give a cost in the range of Cdn$100 billion. M.McClearn, "As construction of first small modular reactor looms, prospective buyers wait for the final tally" *Globe and Mail*, December 27, 2024 (attached in PDF), gives a good overview on SMR costs. On Vogtle costs see A.Ridley, "Plant Vogtle may be the most expensive energy plant in the world—and Georgians are paying for it," WUGA, June 8, 2024.

2. Given your criticism would you have instead opted for Ontario to continue burning coal in the 1970's?

Options in 1970s.

This is a hypothetical question of speculative history, but raises some interesting questions about decision-making around nuclear energy in Ontario.

By the early 1970s very serious questions began to be asked about the direction being taken by the province in terms of costs, accident risks, waste management and the lack of meaning planning processes or oversight on Ontario Hydro's nuclear program. Significant debates took place from mid-70s onwards around the role of nuclear in Ontario, particularly whether the Darlington project should proceed. These debates ultimately culminated a Royal Commission of Power System Planning (a.k.a. the Porter Commission) whose report marked the beginning of the end of Ontario Hydo's nuclear construction program.

In terms of specific system options, the province needed to take an integrated resource planning approach, considering the full range of demand and supply options available to it, which it did not do. By the mid-1970's demand side management options, including energy efficiency and demand response were becoming serious options. These were areas where there had been no attention given in Ontario under its 'supply planning' system model. I attach an article by Amory Lovins from 1978 as an example of the debates around these themes in Ontario at that time. The debates from the 1970s – 1990s around the role of nuclear energy in Ontario have been described in numerous publications over the years. These include the report of the Porter Commission itself, Neil Freeman's *The Politics of Power: Ontario Hydro and its Government* (UTP 1996), R.Danels (ed*) Ontario Hydro at the Millenium – Has Monopoly's Moment Passed?* (Queens-McGill UP 1996); J.Swift and K.Stewart, *Hydro: the Decline and Fall of Ontario's Electric Empire* (Between the lines 2004) and Chapters 2-3 of *Blue Green Province*. See also MacWhirter, R., and M.Winfield, "The Search for Sustainability in Ontario Electricity Policy." in G.Albo and R.MacDermid eds., *Divided Province: Ontario Politics in the Age of Neoliberalism* (Kingston/Montreal: Queens-McGill University Press 2019)

In terms non-coal supply options that might have been considered, particularly in light of what was later learned about nuclear costs and performance, these might have included:

- Development of additional hydro-electric resources in Northern Ontario, and the optimization of existing resources in southern Ontario (e.g. Niagara); and

- Given that Quebec was engaged in a major hydro-electric development program in Northern Quebec, enabled by the 1975 James Bay and Northern Quebec Agreement with the Cree and other Indigenous peoples in Northern Quebec, there would have been the possibility of engaging in negotiations with Quebec over access to the resulting electricity supplies, and shifting Quebec's focus from exports to the US to Ontario. Similar discussions may have been possible over the earlier Churchill Falls project in Labrador, and around hydro resource development in Northern Manitoba although that would have been more difficult due to the lack of interconnections and distances involved.

It is important to consider at the time of the inception of the Ontario nuclear construction programs, demand side measures, renewable energy, energy storage and grid management technologies that now exist were not available. Decision makers in the current context have a much wider range of technological options available to them. The costs of those options, particularly renewables and storage have shown major reductions over time. In contrast, the costs of nuclear energy have continued to rise. The absence of cost reductions as a result of a 'learning curve' effect as technologies mature and experience is gained, is one of the defining features of nuclear energy relative to other energy options (see M.V. Ramana, *Nuclear is not the Solution: The folly of atomic power in the age of climate change* Verso Books 2024).

One of the defining features of Ontario's approach to electricity system development during the nuclear development and construction program was the absence over any planning or oversight framework that would have required the consideration of these types of options as alternatives to the nuclear focussed pathway the province did pursue (see references on this period above). The above options could have avoided the massive nuclear debts incurred by Ontario Hydro's nuclear construction program, and would have likely resulted in substantially lower electricity costs.

3. Other than hydro power, which Canada is also blessed with, can you point to a country that has decarbonised its grid faster with wind and solar as Australia is attempting to do?

See the International Energy Agency - https://www.iea.org/news/renewable-power-on-course-to-shatter-more-records-as-countries-around-the-world-speed-up-deployment for information rates of renewables adoption in different countries.

4. Even within Canada, is there any other province that you can compare Ontario to that does not also have large availability of hydro?

See generally the regional case study chapters in M.Winfield, S.Hill and J.Gaede, *Sustainable Energy Transitions in Canada* (UBC Press 2023 – open access).

New Brunswick, Alberta, Saskatchewan, Nova Scotia and Prince Edward Island all meet these criteria, although their supply mixes vary significantly and are evolving, particularly away from coal. A coal phase-out was completed in Alberta at the end of 2023 on the basis of a combination of fossil gas and renewables. Federal regulations require the phase-out of unabated coal-fired generation by 2030 in all provinces. PEI frequently operates on an all-wind regime.

New Brunswick is the closest to Ontario in supply mix with a significant contribution from nuclear and a mix of fossil and hydro resources. New Brunswick Power has suffered severe economic problems flowing from the construction and then refurbishment of the Point Lepreau nuclear plant. At one point the sale to NB Power to Hydro-Quebec was seriously considered in light of nuclear costs and debt.

I am not sure where the following table comes from but the figures would only relate to Ontario and only consider existing nuclear and do not fully capture the increasing costs of refurbishment. OPG asked the Ontario Energy Board for 16.8 cents/kwh to cover the refurbishment of Darlington. Nuclear refurbishment costs have always been the largest single component of the Global Adjustment from the time of its inception in

2007/8 (see Winfield, M., and Saherwala, A., "The Ontario Coal Phase-Out " in M.Howlett, E. Lindquist, G.Skogstad, G.Tellier and P.'t Hart eds., *Successful Public Policy: Lessons from Canada* (Toronto: Oxford, 2022 – available open access).

The renewables costs here largely reflect Ontario Feed-in-Tariff (FiT) rates, not current market rates required for economic viability, which when combined with storage, come in at around 10cents/Kwh. In Ontario (See Ontario Clean Air Alliance, "Ontario's Electricity Options – A Cost Comparison May 2024 https://www.cleanairalliance.org/wp-content/uploads/2024/03/options2024-march.pdf - this does not include the more recent estimates on SMRs from the TVA or the final costs on Vogtle for large new nuclear facilities – see below). I would note that gas costs are rising dramatically due to the need for large increases in gas-fired generation due to the need to make up supply for retiring and out of service nuclear plants.

As noted above, the estimated commodity cost for new nuclear are running in the 40cents/kwh range in light of the recent actual costs for new builds in the US and EU and estimates on SMRs (e.g. Vogtle (US), Okiluoto (Finland), TVA on BWRX-300).

In	MARKET·PRICE¤	GLOBAL·ADJUSTMENT·(APPROX)¤	TOTAL·PRICE·PAID·TO·SUPPLIERS¤
¤	cents/kWh¤	cents/kWh¤	cents/kWh¤
NUCLEAR¤	5.83¤	4.3¤	10.1¤
HYDRO¤	5.83¤	0.3¤	6.1¤
GAS¤	5.83¤	5.5¤	11.3¤
WIND¤	5.83¤	9.6¤	15.4¤
SOLAR¤	5.83¤	44.4¤	50.2¤
BIOENERGY¤	5.83¤	20.0¤	25.8¤

On a comparative basis, Ontario falls in the middle range in terms of North American electricity rates. The jurisdictions with the lowest rates are those with systems that are largely made up of legacy hydro-electric assets whose capital costs have been long since sunk (e.g. BC, Manitoba and Quebec). Higher cost jurisdictions are fossil and nuclear-based. See Hydro-Quebec 2023 *Comparison of Electricity Prices in Major North American Cities Rates in effect April 1, 2023*. https://www.hydroquebec.com/data/documents-donnees/pdf/comparison-electricity-prices.pdf.

In Ontario electricity costs are moderated by two factors: 25% of the system is legacy hydro assets (e.g. Niagara) whose capital costs were sunk in some cases more than a century ago, and whose operating costs are near zero. These are used to effectively subsidize costs across the board. Secondly, the unrefurbished legacy nuclear assets (e.g. Pickering B and the unrefurbished units at Bruce and Darlington) look inexpensive because their capital costs were largely stranded - i.e. offloaded onto ratepayers and taxpayers through the Ontario Hydro restructuring as a 'debt retirement charge' on hydro bills as described earlier.

Ontario does currently pay higher than necessary rates for some renewables. However that is a function of poor policy design through the Green Energy Act (GEA), particularly making Feed-in-Tariff rates available to commercial scale renewables developers rather than true community-based projects (See *Sustainable Energy Transitions in Canada*, Ch10), than inherent characteristics of the technologies. Those costs will start to fall as the original GEA Feed-in-Tariff contracts begin to run out later in this decade. In the meantime costs are starting to rise significantly both as the costs of the refurbishments of the remainder of existing reactor fleet (Bruce and Darlington - with Pickering B still to come) start to be felt and increasing use is made of expensive gas-fired generation to cover shortfalls due to the out-of-service nuclear plants that are being refurbished and the retirement of Pickering A (2 units) at the end of December 2024. The current situation is in large part a product of the current government's exclusion of other resource options (e.g. conservation and demand management, renewables and storage, distributed energy resources and interjurisdictional arrangements) in favour of a nuclear and gas-focussed pathway.

Closing Observations.

Nuclear Energy and Energy System Planning

Important to note that following initial 1966-1993 build-out no new nuclear construction projects have been initiated in Canada. Where proposals for new builds have been advanced and subject to meaningful and substantive review, they have been abandoned in the face of rising cost estimates, and doubts about future energy scenarios. In Ontario's case this has happened on three occasions: the termination of the initial nuclear expansion program in the aftermath of the work of the Porter Commission, the collapse of Ontario's Hydro's demand supply plan before the provincial environmental assessment process in the mid-1990s; the abandonment of new build proposals associated with the Ontario Power Authority's Integrated Power System Planning process in the late 2000s (See Winfield, *Blue-Green Province,* Ch.7). The province's current nuclear expansion plans are characterized by the absense of any meaningful review and oversight processes. Such processes would normally require the examination assumptions regarding costs, performance and future demand and of the environmental and economic performance of alternative pathways to meeting that demand.

Sustainable pathways to decabonization

A sustainable pathway to decarbonization would require recognition of uncertainties and challenges going forward, particularly given the pace of technological change taking place in the electricity sector. In a sustainability context, transitional strategies should prioritize resource options with the lowest negative economic, environmental, safety, security and technological lock-in trade-off risks first, and only consider high trade-off risk options where it can be demonstrated that the lower-risk options have been fully optimized and developed in the planning process (see Winfield, M., "Submission to the Ontario Electrification and Energy Transition Panel," Sustainable Energy Initiative, York University, June 2023). https://sei.info.yorku.ca/files/2023/07/Submission-to-Electricification-and-Energy-Transition-Panel-June-2023.pdf?x60126.)

In this context, the initial emphasis should be placed on demand side measures to increase energy efficiency and productivity and reduce energy demand across sectors. Distributed energy resources (DERs) should be supported and developed to the greatest technical and cost-effective extent possible, and integrated with strategies around the electrification of transportation and space cooling and heating.

Low-impact and risk energy sources, with relatively short planning and construction timelines, and capacity for scalability, such as wind, solar, along with advanced energy storage technologies (subject to technology specific assessment) should follow. Increased Interjurisdictional interconnections may be useful in resource and grid management.

The development of higher-risk, -impact and -cost resources, including new nuclear, should only be considered where it can be demonstrated that the potential development of the preceding options has been exhausted, and significant supply shortfalls still exist. Projects within this category need to be subject to individual, project-specific federal and subnational reviews to ensure a full understanding of their potential technological, economic, environmental and social risks, costs and impacts.

Pathways for Australia

In considering decarbonization pathways for Australia, it is difficult not to observe that the continent is provided with renewable energy resources, particularly wind and solar, of exceptional scale and reliability. This could be seen in some ways as analogous to the accidents of geography that provided some Canadian provinces and territories: Newfoundland and Labrador; Quebec; Ontario; Manitoba; British Columbia; and the Yukon Territory with exceptionally large opportunities for highly cost-effective hydro-electric resource development. These resources provided the comparative advantages in the economic development pathways followed by those provinces, underpinning, for example, the industrial base that developed in Ontario around the western end of Lake Ontario (a.k.a. 'The Golden Horseshoe') from the time of the initial developments at Niagara in the 19th century through to the mid-1970s.

In Australia's case, the exploitation of the comparative advantage provided by Australia's renewable resources in the establishment of a pathway to decarbonization would avoid the enormous economic, technological, security, accident and environmental risks associated with a nuclear-based pathway. This point has been highlighted by the International Energy Agency and others (https://www.afr.com/policy/energy-and-climate/australia-doesn-t-need-nukes-international-energy-agency-boss-20240510-p5jcge) . The key challenges associated with a renewables-based pathway would be largely focused around the need for large scale energy storage capacities, and grid and resource management and integration at multiple scales. The technological revolutions that have taken place in these areas over the past two decades provide a range of well-demonstrated options for managing these challenges.

I would be pleased to respond to any further questions you have regarding these matters.

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