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POLICY BRIEF
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ELECTRICITY DEMAND AND OVERSIGHT IN ONTARIO'S HYBRID MARKET

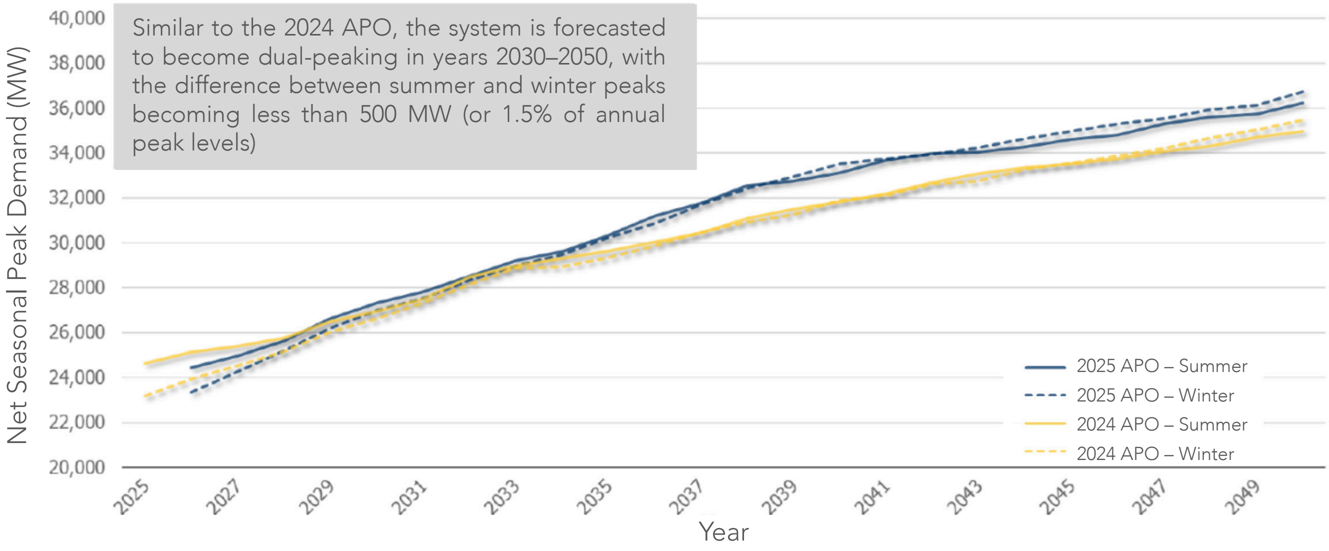
Energy and Electrification Minister Stephen Lecce recently announced that Ontario is expanding the "largest [electricity] procurement in [the] province's history." The Minister directed the Independent Electricity System Operator (IESO) to add another 2,500 MW of generation assets to the previous 5,000 MW target, bringing the total procurement to 7,500MW.

In recent months, Ontario's government has been decisive on the energy file. However, a simple question passed without much attention: is 7,500 MW an appropriate target? What are the chances that 7,500 MW is too much or too little? Answering this requires understanding the dynamics of supply and demand in Ontario's electricity market. Yet, the answer is important, because investing in new supply involves costs that are non-transferrable, long term and must be paid for.

A feature of Ontario's hybrid market is that supply-side uncertainty is minimal. Most generating assets are under long-term contract, so the IESO knows generating capacity. Notwithstanding unplanned maintenance or other surprise events, Ontario projects 27,336 MW of capacity in 2028 and 24,944 MW in 2029. As contracts expire, "net certain supply" decreases heading into the 2030s, a deficit that will be backfilled with the upcoming LT2 procurement.

Unfortunately, forecasting electricity demand is not as simple. In October, the IESO released a preview of the 2025 Annual Planning Outlook or "APO". The APO is the agency's best guess of how provincial electricity demand will evolve over the next 25 years.

The headline from October's announcement is well known: the IESO predicts annual electricity demand will increase 75% by 2050 relative to 2024 levels. The uptick in overall energy consumption is mirrored by an increase in peak system demand as seen in the following figure. The blue lines show estimates for APO 2025 while the yellow lines are from last year's forecast, APO 2024. In APO 2025, peak Ontario electricity demand hits 36,740 MW, 6.5% more than in APO 2024.[1] The 25-year peak-to-peak demand growth equals 53%.



Estimates of future electricity demand form the backbone of Ontario electricity policy. It is not an overstatement to claim that they drive some of the largest capital investments in the province, including the forthcoming procurement. Yet, despite their importance, the numbers receive little critical analysis. This is all the more curious because, whenever the IESO releases an updated APO, the agency emphasizes a lengthy list of "risks and uncertainties." Indeed, the words "risk" and "uncertainty" occur more than 140 times in APO 2024.

Models are essential for long-term energy planning. They enable the Government to determine that 7,500 MW are needed rather than 5,000 MW. Yet, while the IESO is comfortable releasing its preferred projections from its APO methodology, the information that isn't released may be more important. In particular, the IESO doesn't supply any quantitative assessment of the magnitude of risks and uncertainties associated with its demand forecasts. This means that Ontarians can't answer basic questions such as: what is the probability that Ontario demand will increase by, say, 5,000 MW by 2030? What about 7,000 MW or 3,000 MW? In fact, since its release in October, there has been surprisingly little scrutiny of APO 2025.

In what follows, I introduce risk and uncertainty into the IESO's electricity demand projections. Specifically, I use the median forecasts from two APOs, APO 2025 and APO 2020 (scenario 1), to evaluate a range of potential outcomes that account for moderate levels of risk and uncertainty. My goal is not to provide an alternative forecast of Ontario electricity demand. I assume that the IESO's estimates are right on average. I am exclusively interested in the probability that Ontario demand reaches certain milestones given these numbers.

As a preview, using the APO 2025 as a baseline, my model estimates a 48% probability that Ontario peak electricity demand increases by 5,000 MW by 2035. Using the APO 2020 instead suggests only a 4% probability that electricity demand increases by 5,000 MW by 2035. A rough back-of-the-envelope calculation on how much it would cost a representative Ontario household if the province over-procures (or prematurely procures) 2,500 MW puts the ten-year, present discounted cost of over-procurement at $2,055 per household. (All data and code are available to download. Anyone can explore different scenarios. See the link in endnote 2.)

The main lesson from this exercise, which becomes obvious from a visual inspection of the graphs, is that as the model is pushed out to 2050, the range of prospective outcomes grows. It's easy to forecast demand for two or three years; planning for 2050 requires actively taking steps to accommodate potentially large swings in circumstances. Ontario's long-term energy plans should acknowledge this fact.

TWO BIG UNCERTAINTIES FOR FUTURE ELECTRICITY DEMAND

Many factors influence Ontario electricity demand. The myriad uncertainties can be summarized simply as (i) the pace of economic growth and (ii) the degree to which electricity demand follows this growth. Taken together, these two forces will determine Ontario's future electricity demand.

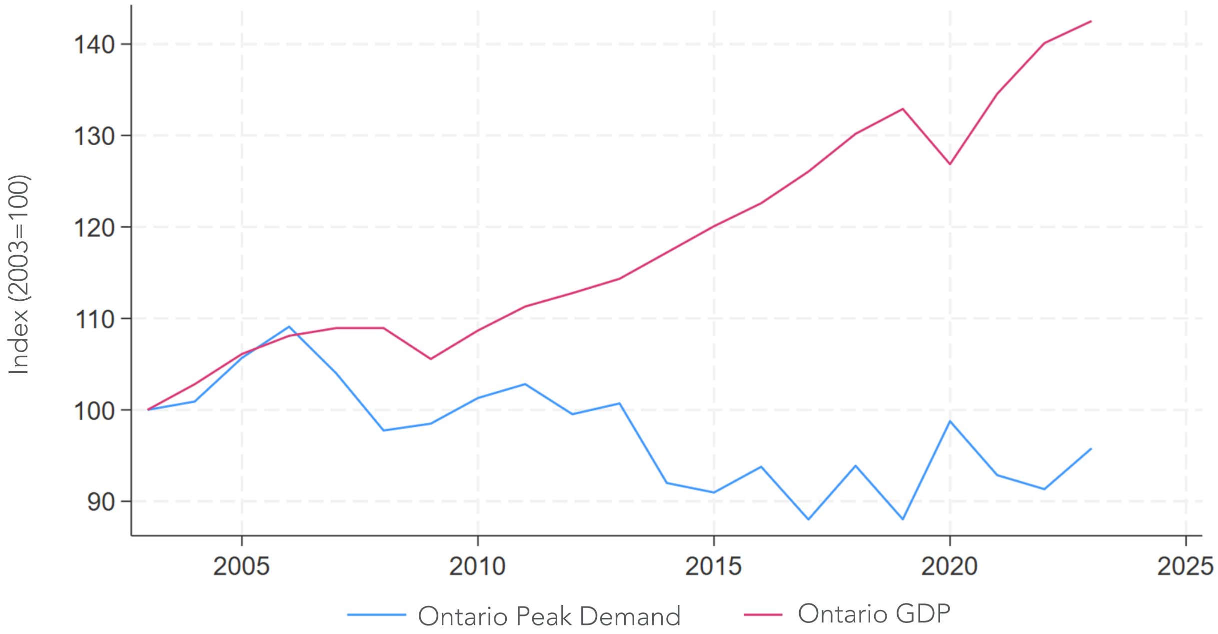
The pace and volatility of economic growth, including changes in population, is the most important factor determining how many electrons will be consumed in 2050. The Ministry of Finance states Ontario real gross domestic product (GDP) is expected to grow by 2.1% on average per year between 2024 and 2046. Since 1981, Statistics Canada data show growth averaged 2.5% per year with a standard deviation of 2.8%. Growth is rarely smooth, however. Some years are above trend, others below.

The IESO, of course, considers economic growth in its projections. The difference between the IESO's APOs and my simulation is how uncertainty around trend growth is treated. The IESO's model is deterministic, with uncertainty addressed via scenario analysis. In my model, risk dynamically compounds over time: that is, the forecast twenty years from now depends on what happens nineteen years from now which depends on what happens eighteen years from now and so on. The further into the future we forecast, the more history matters. (Scenario analysis can also be applied to my set-up.)

Next, "recoupling" is the second big uncertainty facing Ontario electricity demand growth. Recoupling refers to the extent that electricity demand growth tracks economic growth.

Recent trends are shown in the following figure. Ontario's economic growth is the magenta line, while Ontario peak electricity demand is in blue. Both series are normalized so that they equal 100 in the year 2003.

Figure 2: Decoupling of GDP and Electricity Growth, 2003-2023



This figure demonstrates how the two series tracked each other from 2003 to 2005. From that point, Ontario peak demand decoupled, or followed a different trend, from Ontario economic growth. Decoupling means that Ontario's economic growth continued its upward trend, while Ontario electricity growth remained flat. A wedge developed between the purple and red lines.

Several explanations account for this decoupling. First, Ontario's economy underwent structural transformation. The province's economic engine shifted from manufacturing towards services such as finance, consulting and technology. The energy intensity per dollar output of services is less than for manufacturing. The second reason is that huge improvements in energy efficiency enabled Ontarians use fewer energy inputs while sustaining a reasonable growth rate.

Further, in 2011, the province introduced the Industrial Conservation Initiative or ICI. The ICI provided strong incentives for customers with large loads to reduce demand during peak demand periods. The magnitude of the ICI is estimated to represent 1,727 MW during peak hours (pg. 27).

Finally, the *Green Energy and Green Economy Act 2009* encouraged greater investment at the distribution level. The figure illustrates demand at the transmission level. More embedded generation translates into less demand at the transmission level. Including distributed generation would show slightly less decoupling (although the growth in embedded generation has been fairly limited over the past decade).

The IESO's numbers indicate that they expect that fifteen years of decoupling will end. Stated differently, electrification will cause recoupling to reappear. APO 2025 highlights that economic growth and load growth will follow a similar path. Specifically, over the 2026-2050 period, the IESO expects annual electricity demand will have a compound annual growth rate equal 2.2% (APO 2025, slide 9) slightly more than the 2.1% economic growth forecast by the Ministry of Finance. Thus, the IESO sees full recoupling over the next 25 years.

UNCERTAINTY AND ONTARIO ELECTRICITY DEMAND IN 2050

The IESO uses a bottom-up, end-use model to determine future electricity demand in Ontario. The model describes base year electricity demand at high resolution and then aggregates over energy uses, sectors and geographical units to obtain province-wide load. This base year profile is then adjusted for future years using what the IESO calls the Delta method.

My model is top-down. It is also explicitly stochastic, with random shocks causing demand to evolve according to a process known as Geometric Brownian motion. The model is calibrated so that, *on average*, it matches two scenarios the IESO's APO 2025 and APO 2020.[2] Results from this exercise can be seen in the following two graphs.

The first figure is APO 2025. Each line on the figure represents one potential path for Ontario electricity demand starting in 2025 and ending in 2050. The figure includes 50 distinct paths where the average across these paths matches the APO 2025 forecast. The red line illustrates the 2050 winter peak demand of 36,740 MW in APO 2025.

There's a lot going on in this graph; I'll summarize five points.

1. The IESO's demand trajectories are smooth. The IESO deliberately removes idiosyncratic variation. The paths in my model are jagged. Jaggedness is more realistic. Small fluctuations reflect the many little shocks, such as weather, economic activity, etc., that influence peak demand. Averaging across these realizations would yield a smoother prediction like the APO.

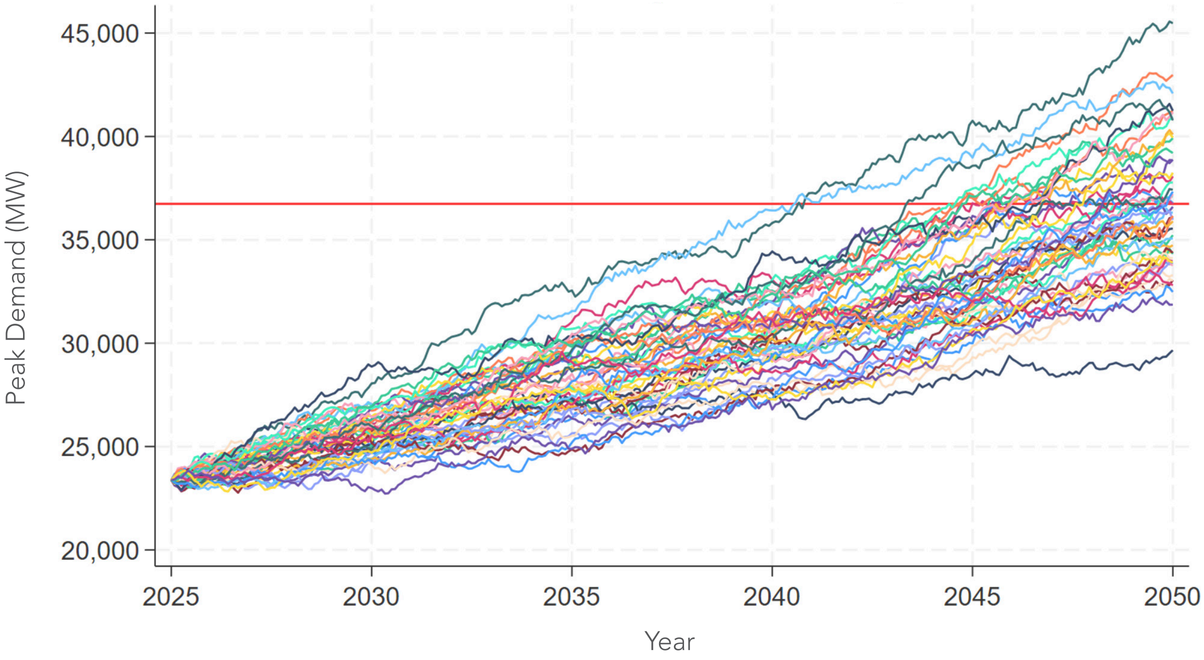
2. The IESO's growth paths from APO 2020 and APO 2025 track each other in the early years. The paths in my simulation are likewise bunched together in the short-term. Moving further into the future, however, technology, economic growth, industrial development and population become more uncertain. As such, the prospective demand scenarios "fan out." It is this fanning out that visually illustrates the "risks and uncertainties." Moreover, it is this fanning out that is missing from the IESO projections. It is easy to hit near term targets. As we look farther into the future, the breadth of prospective outcomes grows. Demand could be very high or very low.

3. By design, the probability that peak demand exceeds the IESO's estimate in 2050 is 48% (with Geometric Brownian motion the median growth rate is less than the average growth rate). Anything above or below the red line are potential outcomes based on moderate levels of risk in Ontario's electricity sector. Volatility is set meaningfully below that for Ontario GDP. The implication is that I have reduced the amount of fanning out compared to a perfectly recoupled scenario.

4. The model demonstrates how uncertainty compounds over time. For example, the highest final path in APO 2025 is shown in dark green. This line represents robust future electricity demand (although still markedly less than forecast in the Pathways to Decarbonization report). As can be seen, this scenario experienced a positive shock in 2032 and then remained elevated throughout the planning period. One good year led to a higher overall level of demand, increasing the likelihood that all future electricity demand will be higher. The same applies on the downside.

5. Understanding how electricity demand dynamically evolves supports longer-term reliability planning. For example, if Ontario wanted to take decisions today to ensure that there was sufficient capacity in 2050 so that there was only a 5% chance that peak demand would exceed domestic resources, we would need to have 42,860 MW of capacity available. Likewise, the probability that peak demand exceeds, say, 28,382 MW in 2030 is only 4%. More directly, planning should be designed so that it adapts to changing circumstances with off-ramps and check-ins.

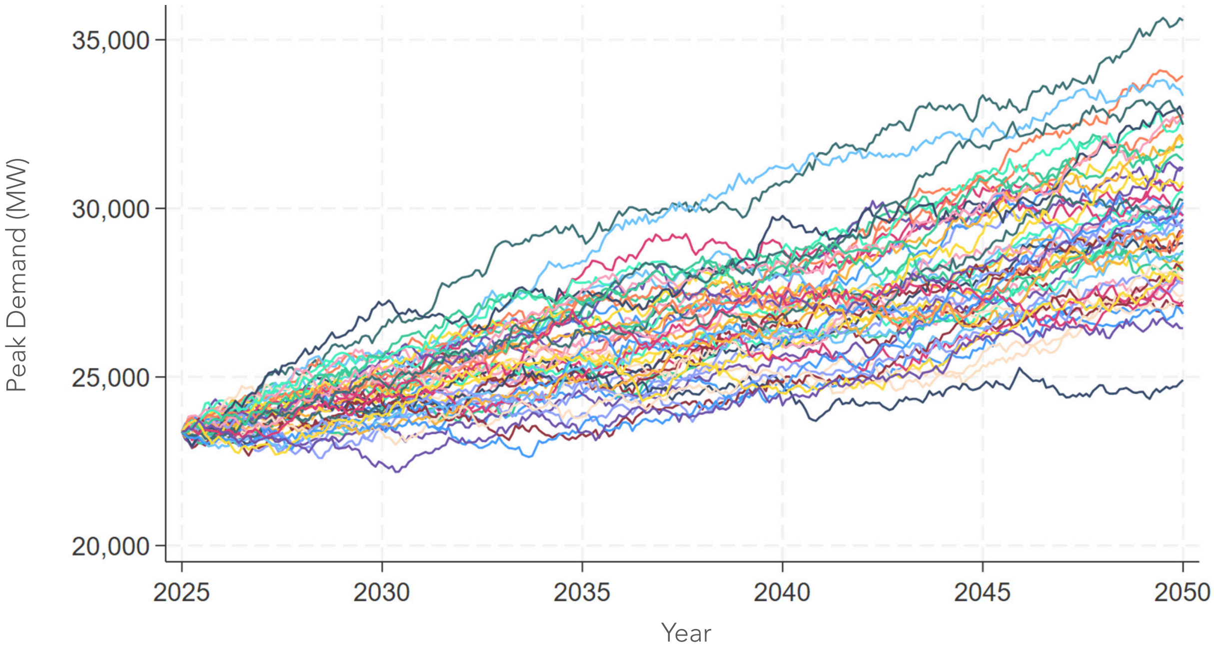
Figure 3: Paths of Ontario Peak System Demand, APO 2025



The next figure shows the results for APO 2020. APO 2020 assumes that peak electricity demand grows at 1% per year, moderately less than in APO 2025. Volatility is mitigated too. In other words, APO 2020 represents a scenario that is substantially pro-electricity growth compared to recent data but has less aggressive assumptions than APO 2025.

Reducing the growth rate by a small percent per year doesn't sound like much. Yet, the following figure demonstrates how a small change can yield a drastically different perspective of future electricity demand. For example, in this scenario, none of the 50 paths reach the IESO's average peak demand forecast for 2050 (the red line in previous figure). Peak demand is more likely to be in the 30,000 MW range not 37,000 MW. Similarly, the probability that peak demand grows by 5,000 MW by 2030 to meet the most recent procurement announcement is zero.

Figure 4: Paths of Ontario Peak System Demand, APO 2020



An obvious conclusion from this analysis is that we need to view all forecasts with skepticism. The difference between the APO 2025 and APO 2020 scenarios is less than 1% per year, but the long-term conclusions are very different. If APO 2025 is realized, there is a 50% probability that Ontario's peak demand exceeds 35,000 MW in 2050. This outcome is virtually impossible under the slightly milder assumptions from APO 2020.

More importantly, there is a lesson for system planning. When risk and uncertainty are quantitatively and transparently presented, it invites a different perspective on long-term energy planning. Under the IESO's reasonable assumptions, the range of outcome runs from peak demand of 25,000 MW in 2050 to more than 45,000 MW and everything between. A system built for a 25,000 MW peak is unlike a grid built for a 45,000 MW peak. Ontario needs to recognize that both outcomes, while probabilistically unlikely, are possible and, thus, should develop plans that can adapt to changing market conditions.

Third, there is the frequent claim that we need to ensure reliability. As a result, it is better to over-procure capacity even if the probability that it is required is small. However, over-procurement isn't free.

A spreadsheet is included in the attached code and data package. This spreadsheet is a "Cost of Over-procurement Calculator." This "calculator" is exceedingly back-of-the-envelope and used to obtain an order of magnitude estimate only. Values should be interpreted with significant caution. Nonetheless, it shows that the present value of pre-maturely procuring 2,500 MW of wind capacity in Ontario. That is, if Ontario signs long-term contracts for 7,500 MW but only requires 5,000 MW, ratepayers still need to cover the cost of that excess capacity. That calculator shows that the additional costs for a representative Ontario household over a decade equals $2,055, or roughly $200/year. That is a lot of money for many Ontarian families. Over-procuring natural gas generation likely yields even higher costs for ratepayers. To repeat, over-procurement isn't free.

Finally, a fourth insight is deeper and relates to the Government's forthcoming Integrated Energy Plan.

WHO CHECKS THE NUMBERS

Demand forms one half of a long-term energy plan. Understanding how demand evolves is critical to sensible planning.

This model illustrates the implications of risk and uncertainty on long-term energy demand forecasts. The model is simplistic, however, in that it takes as given the APO projections. Best modelling practice, in contrast, involves testing assumptions and probing conclusions to ensure the best available information when formulating plans. In this regard, it is interesting to compare Ontario's in-house approach to how long-term forecasting is done in alternative energy markets.

Most electricity systems fall into one of two categories. There are energy-only markets such as Texas and Alberta. In an energy-only market, private companies compete to provide generation without long-term capacity payments. Procurement is decentralized, with market forces driving investment in generation based on price signals and anticipated profitability. Market forces work to ensure that there isn't too much or too little built.

Vertically integrated utilities, such as in BC, Manitoba and Nova Scotia, comprise the opposite end of the spectrum. These markets require the utilities to submit plans to the regulator, which are then scrutinized in a quasi-judicial and adversarial process. These are long processes that involve expert reports and testimony, which review data and assumptions. They can easily take up to a year from start to finish. US capacity markets also have regulatory review of Independent System Operator demand forecasts and procurement measures.

Ontario's electricity market is unique. It is a hybrid market that combines competitive and regulated elements. However, under its current hybrid structure, long-term energy forecasts face neither a market test nor regulatory scrutiny. The IESO, at the direction of the Minister, manages long-term planning. Ontario, in other words, has an adversarial void when it comes to forecasting the long-term energy sector planning.

Avoiding regulatory scrutiny has a clear advantage. Without regulatory oversight, ambitious, long-term energy plans can be formulated quickly without the costly process of submitting detailed evidence for examination. No one enjoys having bold aspirations dissected.

Unfortunately, Canada has an unhappy record of energy projects that were justified by over-ambitious electricity demand forecasts, e.g., Site C and Muskrat Falls. In his review of the Keeyask Generating Station and the Bipole III transmission line, Commissioner Brad Wall explicitly states "Manitoba Hydro made its decisions … on the basis of a load forecast … of a prospective Large Industrial Load project that did not ultimately occur" (pg. 28). Further, while Manitoba's Needs For and Alternatives To Panel "largely accepted Manitoba Hydro's short-term load forecast, it expressed less confidence in Manitoba Hydro's long-term load forecast because Manitoba Hydro did not address the effects of potential structural changes that could greatly increase or decrease demand" (pg. 53).

A SECOND SET OF EYES CAN LIMIT COSTLY MISTAKES

No one currently oversees the IESO's APO forecasts. To avoid costly missteps like Keeyask or Site C, it would be prudent for the Government to develop mechanism that offered oversight of the province's long-term energy forecasts.

The obvious option for the APO would be to create an Independent Planning Panel (IPP) to evaluate the IESO's model, assumptions and procurement plans. The IPP could issue report on the quality of the IESO's forecasts.

Another example, one applicable to the forthcoming Integrated Energy Plan, would be to create a review function within the Ontario Energy Board (OEB), comparable to Saskatchewan's regulatory model.

Saskatchewan has a single, vertically integrated utility, SaskPower, that owns and controls generation, transmission, and distribution. SaskPower is tasked developing long-term Integrated Resource Plans to ensure reliable energy supply at the lowest cost. These plans account for, among other things, projected demand growth.

SaskPower's plans are subject to scrutiny at the Saskatchewan Rate Review Panel (SRRP). Importantly, however, the SRRP only plays an advisory role. Its recommendations are non-binding. The SRRP functions as an independent body, but its authority ends once it issues a public report to the provincial cabinet. Cabinet maintains final decision-making authority.

With respect to planning, this model is a twist on the existing relationship between the OEB and Ontario's Ministry for Energy and Electrification. In Saskatchewan, the roles and responsibilities are unambiguous. SRRP serves as an intermediary, ensuring transparency and accountability in the planning process. Government retains control. Value for Saskatchewan comes from prudence with ratepayer dollars. Often, another set of eyes is all that is needed to avoid blind spots in planning or modelling assumptions.

No one knows what electricity demand for Ontario will be in 2050. Long-run forecasts are critical for effective decision-making. Ontarians want to ensure that decision-makers make the right energy investments at the right time. Planning for the future involves understanding and managing risks and uncertainty. Prudent government policy, therefore, involves establishing credible processes that act as checks and balances on long-term energy planning decisions. The last thing Ontario wants is a public inquiry on ill-fated and potentially unnecessary energy projects.

END NOTES

[1] The numbers for the 2024 estimates in the 2025 APO slide deck do correspond to those provided in the background materials of the 2024 APO. The latter values are used.

[2] Both the over-procurement spreadsheet and the code used to create Figures 3 and 4 is available at: https://brandonschaufele.com/MWSim.zip. To use this code, follow five steps:

1. Downloaded and unzip MWSim in desired folder. MWSim contains four objects: two folders, a .do file and a README document in .txt. Maintain the existing folder structure and names.

2. Read the Readme.txt file.

3. Open summary.do. summary.do runs all the simulations.

4. Read the preamble to summary.do. There are up to seven (7) items that require attention. Adjust these as needed.

5. Run the code as written.

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