Presentation to NB Standing Committee on Climate Change and Environmental Stewardship

By Tom McLean, CRED-NB, September 27, 2023

{A Clean Affordable Electrical Grid for New Brunswick}

Good afternoon. Thank you for your invitation. My name is Tom Mclean and I'm with the Coalition for Responsible Energy Development in New Brunswick. After retiring from the software industry, I decided to focus on how the production and use of energy can support climate change action. I've been a part of the CRED-NB community for several years and now volunteer as a member of the core group and Steering Committee.

Major international institutions point to renewable energy as the most affordable and fastest transition path to a clean energy system. The accelerating adoption of renewable energy confirms that it will be the dominant energy source, and quite possibly the only source, in a low emissions world. Today I will review the evidence which leads to those conclusions and describe how NB has the natural resources it needs to build an affordable reliable electrical grid which achieves its greenhouse gas emission reduction goals

{Joel Barker}

I think this quote from Joel Barker, a futurist and author, is a good description of the state of energy industry at this time. A paradigm shift is underway as the energy industry shifts from getting energy by burning extracted materials to collecting energy when natural forces provide it.

{Levelized Cost of Energy}

This is the levelized cost of energy (LCOE) for wind and solar PV for the period 2010-2021 as provided by the International Renewable Energy Agency (IRENA). Even the most leisurely reduction is a drop of over 50% in the cost of onshore wind power in eleven years. These drops in the cost of solar PV and wind turbines, supported by the dramatic fall in the cost of grid-scale battery storage, have driven their rapid adoption.

{NB Levelized Cost of Energy}

Lazard Ltd reports are an authoritative voice on the global cost of electricity production. The 2023 Lazard report shows how low the costs of wind and solar have fallen. The NB Power 2023 IRP confirms that those low costs are realised in New Brunswick. The LCOE list in the NB Power IRP does not include nuclear power so one might wonder if the cost of NB nuclear power falls in the rather expensive range provided by Lazard.

{World Wind Generation vs IEA Optimistic Projections}

The incredible advances in solar, wind and battery technology have driven remarkable global rates of adoptions. This graph displays the figures published in the annual World Energy Outlook report produced by the International Energy Agency (IEA). The black line is the actual amount of electricity generated by wind. The other lines are the IEA projections.

{World Solar PV Generation vs IEA Optimistic Projections}

This graph shows the amount of electricity generated by solar. The IEA projections which were reasonably accurate for wind seemed to be repeatedly too low for solar until 2017.

{World Nuclear Generation vs IEA Optimistic Projections}

This graph shows the amount of electricity generated by nuclear. The IEA projections for nuclear were repeatedly too optimistic. The IEA may still be trying to recalibrate its projections in the context of the major paradigm shift underway.

{World Wind and Solar vs Nuclear Generation 2006-2021}

Wind and solar have grown so quickly that in 2021 they collectively generated more than nuclear power. The IEA predicts 2023 and 2024 will be more record-breaking years for wind and solar growth. More evidence that a shift Is clearly underway.

{2050 electricity generation World and Canada}

Wind, solar and hydro will dominant electricity generation as they continue to push out more expensive producers. The IEA 2022 World Energy Outlook describes the Net Zero Emission by 2050 scenario. In this scenario, solar and wind provide 69% and all renewables together provide 88% of electricity generation. Yesterday, the IEA published an update to this scenario which bumped up those percentages to 71% for solar and wind, and 89% for all renewables.

The Canada Energy Regular (CER) also includes a Net-Zero scenario in their 2023 Canada Energy Futures report. In this scenario, the generation of electricity in Canada from wind & solar would grow to 30% and from all renewables to 77% by 2050.

The Canada Energy Futures report and the NB Power 2023 IRP both note that if nuclear SMRs fail to meet expectations then solar and wind capacity would be used to compensate for the shortfall. It would seem prudent to start deploying wind, solar, and storage now to ensure New Brunswick achieves its emission reduction goals regardless.

{Reliable Renewables}

A concern often raised when discussing moving to a 100% renewable grid is reliability. Supply must always match load no matter what the weather. Here are some of the tools available to ensure an electrical grid remains reliable. This list is based on the Energy Systems chapter in the latest IPCC Assessment Report. I'll describe each briefly.

{Reliable Renewables - Demand Response}

Demand response is the ability to shift electricity demand, or load, from a time of peak demand to a non-peak time. The options range from asking customers to manually shift their use of power to automatically lowering the power demand of appliances. Such automatic events would be so brief that customers would not notice.

{Reliable Renewables – Transmission}

Transmission both within the province and with neighbouring jurisdictions is another key tool. The more diverse the locations of the wind farms and solar arrays then the more likely it is that at any given time enough of them are generating power to meet the current load. Energy trading agreements between jurisdictions allow all participants to share the benefits.

{Reliable Renewables – Storage}

Storage is certainly a key ingredient in any strategy to balance wind and solar energy. Although the most commonly used storage in the world is pumped hydro, lithium-ion batteries have an increasingly commanding presence in grid storage. They are cost-effective, modular, scalable and can even provide multiple grid services in addition to providing for 1-12 hours of storage. Currently, the largest battery storage site holds 3,000 MWh of energy and can produce 750 MW of power.

As the saying going, to make a battery dirt cheap, make it out of dirt. Storing thermal energy or heat in boreholes reduces peak winter loads by supporting district heating of households using energy collected during other seasons. In Canada, this type of storage has been successful working at Drakes Landing in Okotoks Alberta for the last 15 years. Also, the University of Toronto is currently in the process of installing boreholes to both heat and cool one of its campuses.

{Reliable Renewables – More Storage}

More storage solutions are on the horizon such as electric vehicles and iron-air batteries. A technology called vehicle-to-grid or V2G allows EV owners to sell energy back to the grid when the grid needs it. Utilities in Ontario and Nova Scotia are currently piloting this technology. The power utility benefits by not having the upfront expense of buying the batteries. EV owners receive payments for providing the service. This service could provide thousands of MWh of storage.

Iron-air batteries can provide up to 100 hours, or 4 days, of power and may cost as little as **10 times less** than lithium-ion batteries. They are cheap because the main ingredients are cheap: iron and air. In 18 months the first large deployment of these batteries, 1,000 MWh, will be online in Minnesota.

{Reliable Renewables – Dispatchable zero emissions generators}

Every grid needs to have reserves. Ideally, those are dispatchable zero-emission generators which are able to fill long gaps in supply and cost very little when not in use.

Eavor, an Alberta company, has developed a closed-loop geothermal system which is deployable almost anywhere and provides both electricity and heat on demand. The first commercial deployment is underway in Germany and expected to be fully operational by 2027.

Another option is green hydrogen. Turbines or fuel cells use hydrogen to generate electricity without emissions. Just as salt caverns are used to store natural gas, they can also be used to store hydrogen. Producing green hydrogen locally from cheap renewable energy and selling any excess would minimize the cost of supply.

New Brunswick has the right geography for salt caverns and so does Salt Lake City. A facility is being installed near Salt Lake City which will store 150 GWh of hydrogen in salt caverns, produce 1 GW of power, and provide hydrogen for industrial and transportation applications. The facility will be fully operational by 2025.

Note, that nuclear power is not a good fit for this role since, to be economical, it needs to be in use almost all the time.

{Wind and Solar Integration}

As this graph shows, countries are learning how to integrate large amounts of wind and solar into their grids. Denmark has the highest level, but at 61% they are off the top of the chart.

Some states have also integrated large amounts of wind into their electrical grids. Wind generated 55% of the electricity in South Dakota in 2022. In Maine 27%. In Texas 24%.

{South Australia 100% Wind and Solar}

The leader is definitely South Australia as it set a record in December 2022 by running for over 10 days on just wind and solar power.

{New Brunswick Wind Resource}

New Brunswick has an abundance of wind for electrical generation. The red, yellow and orange areas on this map have annual average wind speeds which are sufficient to generate power economically. Yves Gagnon, an accomplished professor of engineering at the Université de Moncton, identified over 41 GW of New Brunswick wind power potential in a 2008 study. For comparison, the peak power load in New Brunswick last winter was 3.7 GW.

{Nova Scotia Wind Resource}

The provinces of Atlantic Canada have lots of wind power to share and trade to balance the grid.

{New Brunswick Solar Resource}

Although not as potent as the wind resource, the solar potential in New Brunswick is still significant. The south half of the province has capacity factors which fall within an economic range.

{Integrating Wind and Solar into the New Brunswick Grid}

Many tools are available for the transition.

Efficiency. Minimize the amount of energy needed by continuing to deploy and support efficiency measures such as heat pumps and better building sealing and insulation.

Diverse Locations. Deploy wind farms and solar arrays in diverse locations so most of the time sufficient sites are producing power to match the grid load. The Energy and Environmental Economics study referenced in the NB Power 2023 IRP speaks to the benefit of balancing wind resources across a broad area. To maximize diverse locations, negotiate energy trading agreements with neighbouring jurisdictions and deploy the infrastructure, such as the Atlantic Loop initiative, needed to support them.

Demand response. Provide a range of options to customers to enlist their help in "beating the peak" and ensure they share in the benefits.

Storage. Monitor storage technology developments as costs and technology options are changing rapidly. Identify opportunities to deploy robust district heating solutions to capitalize on cheap thermal storage and closed-loop geothermal.

Green Hydrogen as a Reserve. Investigate the potential for generating and storing our own supply of green hydrogen as a grid reserve. Green hydrogen is an expensive commodity but carefully planned production, storage, and power generation could provide a clean and cost-effective grid reserve.

{Doing It Together}

Here are some ways to ensure we all move forward together.

First Nations Engagement. Work in partnership with First Nations in the planning and deployment of wind, solar and storage sites.

Community Engagement. Develop a community sensitive process for deploying grid scale wind and solar. See the November 2022 study "Why do wind energy projects fail?" from the Conservation Council of New Brunswick. Also, continue to support community and household wind, solar and storage to improve system robustness and increase public support.

Atlantic Canada Cooperation. The Atlantic Canada region has a wide selection of diverse locations for generation of power from wind and solar. Deploying sufficient transmission capability, through initiatives such as the Atlantic Loop, is key to maximizing the synergy which brings more reliability and lower costs for all.

{Summary}

Over the last decade or so, the costs of wind and solar electricity generation have fallen dramatically. Globally, wind and solar have become the most economic choices among all types of electricity sources, both clean and not.

Many countries and states have embraced these technologies and have already integrated large shares of wind and solar onto their electrical grids. Even the world at large moved from less than 2% in 2010 to 12% in 2022 and that pace is accelerating. The trend is clear that renewable energy will be the dominant energy source, and quite possibly the only source, in a low emissions world

New Brunswick has the renewable resources needed to power its electrical grid. By working cooperatively with its neighbours, New Brunswick can build an affordable reliable electrical grid which achieves its emission reduction goals.

{Questions?}