Canada running out of clean, reliable electricity to fight pollution, climate change

Fall 2023 Energy Update

Bob Walker
National Director, CNWC
bwalker@cnwc-cctn.ca — +01 (289) 400 8962
www.cnwc-cctn.ca

Pickering Nuclear plant exit looms, threatening Ontario's reputation for clean electricity

PICKERING'S EXIT IS FAST APPROACHING. Ontario's reputation as a clean energy jurisdiction is in jeopardy, as Pickering—a huge block of zero-emitting power generation—is slated for retirement in sixteen short months. At the very least, the plant must be life-extended. Then, its owner, Ontario Power Generation (OPG), must decide to refurbish it, or replace it with new nuclear capacity.

Alberta is in a direr position As Fig 1 shows, there is little hope of that province dropping GHG emissions to zero by 2030. On its current policy trajectory, the best Alberta can do is slightly reduce the rate at which its electricity generating sector emits GHGs.

Time is of the essence. It makes sense, then, to build zero-emitting generation capacity as quickly as possible, using construction teams that have proven they can deliver projects on time.

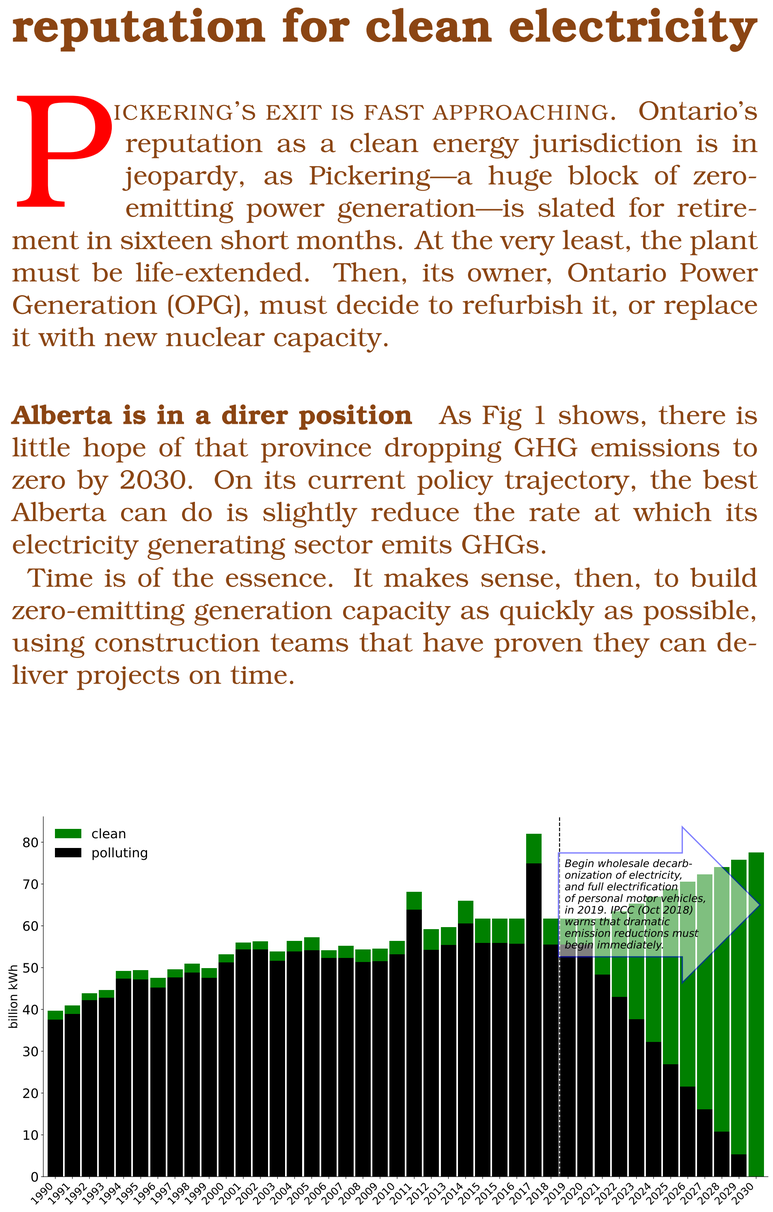

Fig 1: Alberta's GHG reduction challenge, just in electricity generation. In less than 6 years, the province must completely decarbonize electricity, at a pace unprecedented in its history. But that pace was achieved by another province, Ontario. In about a decade, Ontario constructed roughly 7,000 MW of CANDU generating capacity. That amount could nearly completely decarbonize Alberta's baseload electrical supply.

CANDU for Canada's "fossil" provinces The only hope Alberta, Saskwatchewan, Nova Scotia, and New Brunswick have for decarbonizing electricity is with nuclear. The only commercially available off-the-shelf nuclear technology in Canada is CANDU.

1. **Alberta** requires 8,000 to 10,000 megawatts of non-emitting baseload supply. That's twelve to fifteen CANDU EC6 reactors.
2. **Saskatchewan** requires 2,000 MW nuclear, which could include at least 1 EC6; however, its plan is to adopt the GEH BWR-300 exclusively, once OPG has proven that machine in Ontario.
3. **Nova Scotia** has no current public plan to decarbonize electricity via nuclear (which is its only realistic option), but its best nuclear candidate likely is small modular reactors.
4. **New Brunswick** has the most advanced nuclear plans next to Ontario, and is the only other Canadian province next to Ontario that currently utilizes this power source. It could be an SMR leader.

Power, Cobalt, Moly, Lutetium, Helium: essential ingredients for Canada's present and future

Waste comparison: no comparison What is called "nuclear waste" is actually anything but. Used nuclear fuel contains most of its original energy, and other very interesting–and valuable—substances. These include medical isotopes, like Cobalt-60 and Molybdenum-99, two vital materials that are used millions of times daily in hospitals around the world. A CANDU can also make Lutetium-177, to fight cancer. All CANDUs produce Helium-3, the decay daughter product of tritium; He-3 has a wide variety of applications, including medical imageing, security, cryogenics, and quantum computing. No other power reactor has this capability.

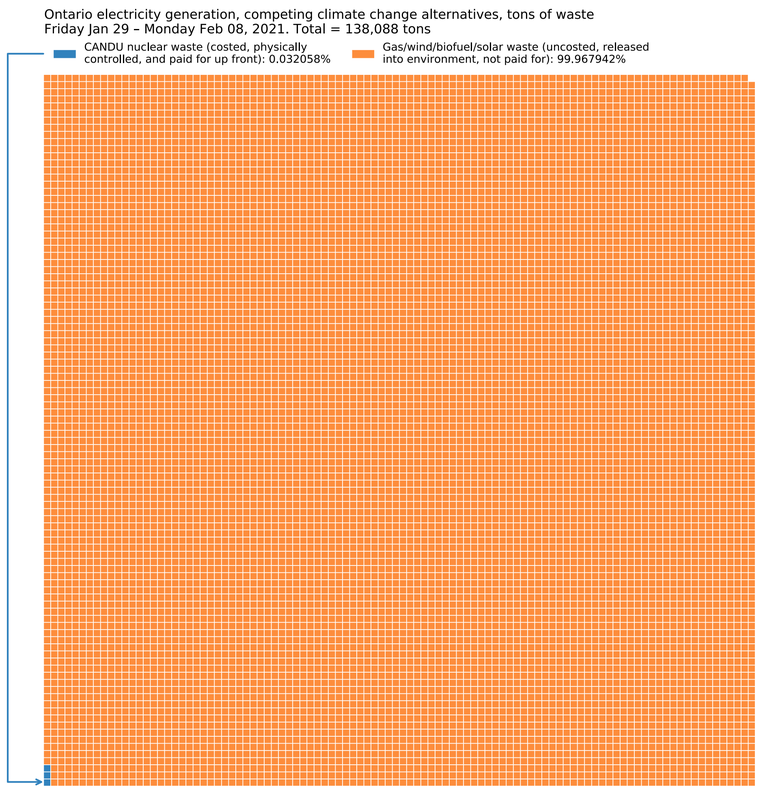

Fig 2: The waste implications of nuclear vs renewable energy balanced with gas, from nine mid-winter days on the Ontario grid. The brown squares represent gaseous waste, which is of no use and simply thrown into the atmosphere. The blue squares represent used nuclear fuel, which is not waste but actually contains a range of extremely important and valuable isotopes. This material is nearly all solid and easily shielded and sequestered. **Note**: this plot shows *mass* difference in WIPK. *Volume*—the amount of space a unit of waste occupies—is a far greater difference, too great to meaningfully represent on a chart.

The CANDU refurbishment workforce: historically proficient, and available today

Darlington 3 complete months ahead of schedule: ready for new build ... at a site cleared and approved for 4,800 megawatts.

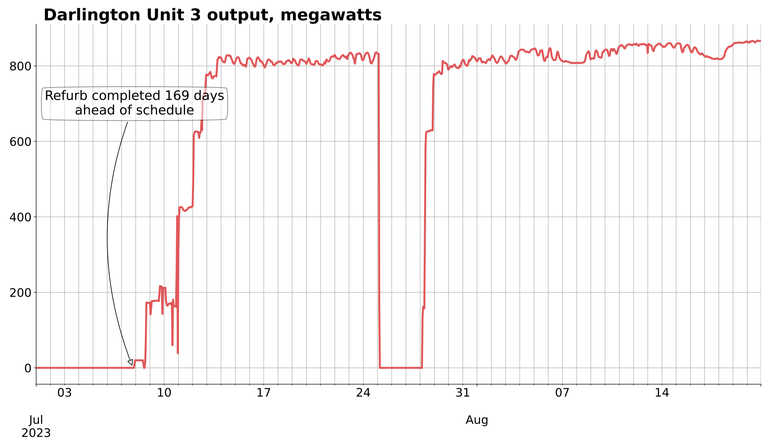

Fig 3: The women and men of the Darlington refurbishment team, and their counterparts at the Bruce site, are the most proficient CANDU workforce Ontario has seen since the early 1990s. The 1990s team was dismantled and scattered, which led to the massive increase in coal for power generation, and 100 million tons of totally avoidable GHGs that are still in the planet's atmosphere. Let's not make the same mistake today. Let's scale up today's workforce so it can meet the next challenge: building tens of thousands of megawatts of new nuclear capacity, including at Darlington, which is cleared for another 4,800 MW.

CANDU: a Swiss Army knife for clean energy, precision medicine, and innovation

Huge power, tiny fuel input and even tinier waste output CANDU's power output is absolutely gargantuan, measured in hundreds of megawatts. At the same time, its waste output (WIPK, or waste per kilowatt hour) is minuscule, measured in milligrams. The next-"cleanest" fuel is natural gas; its WIPK is measured in hundreds of grams. This makes CANDU's waste footprint literally many thousands of times smaller than that of gas; see Fig 2. Gas waste is so massive it is impossible to store.

Nuclear is also thousands of times safer, as Fig 4 shows. No other power generation technology is even close.

As the world gears up for the Third Electrification, safety of energy delivery and use are of paramount concern. Nuclear is far and away the safest method of power generation, and electricity is far and away safer than using combustible fuel like natural gas. This will make nuclear generated electricity the safest form of space heating humankind has ever known.

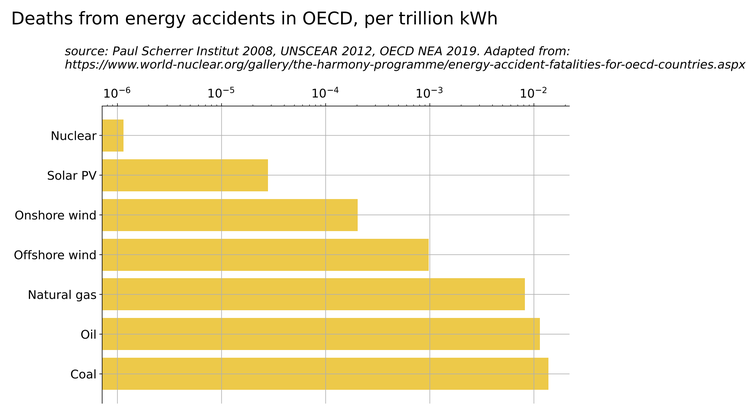

Fig 4: The highly unionized nuclear workforce is an integral reason nuclear is by far the safest energy. Daily interactions between labour, management, and regulator ensure nuclear will remain in first place. **Note:** the x-scale is logarithmic. If it were scaled normally, the nuclear bar would appear empty: it is ten times smaller than the next-largest (solar), and 100 times smaller than the next one after that (wind).

A new CANDU fleet can completely decarbonize space heating in Canada

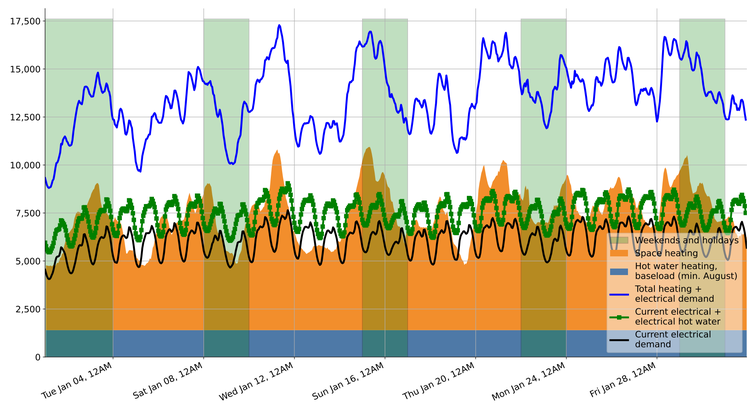

Fig 5: A picture of a Toronto winter electrical peak: Toronto electric power and heating demand, January 2022. Toronto temperatures during that month ranged from −20°C to +4°C. Three-quarters of the 744 hourly readings fell below −2°C. Commercial/residential DHW (estimated to be 800 MW and 600 MW, respectively) are shown in "Current electrical + electric hot water" demand (green line). Together they would require 1,400 MW of baseload supply—roughly the output of 2 CANDU EC6s.

TRADITIONALLY, NUCLEAR HAS BEEN ruled out as a supplier of "ramping" and "peak" demand, i.e., the time-dependent demand that exceeds baseload. However, this is because nuclear capacity has been capped so that other generation technologies can get a "fair share" of the capacity pie, not because nuclear is inherently unable to vary output.

Fleet capacity factor (CF) is the key This is a misguided conception of fairness, which has resulted in a situation in which fossil generation—which we all agree must be phased out—is virtually guaranteed a significant portion of the generation market.

But nuclear *can* supply ramping and peak demand. A nuclear fleet of 20,000 MW capacity, with the capability to throttle output by controlling steam flow to the turbine generator, could cycle down to 60 percent of full power while remaining connected to the grid. This means

- The fleet could provide 12,000 MW of baseload supply.
- The system operator would have the option to dispatch 8,000 MW if and when needed.

That amount would go a long way to meeting the "Total" energy demand in Fig 5.

A nuclear fleet with higher capacity could provide the option of more dispatchable supply—from a tiny land footprint, with zero emissions, while—if it is CANDU—producing invaluable medical and industrial isotopes from a supply chain entirely inside Canada.