CNA FACT SHEET

LIFECYCLE EMISSIONS OF NUCLEAR, WIND AND NATURAL GAS POWER GENERATION

The Future is NU.
Canadian Nuclear Association

A study by Hatch Ltd.

The Canadian Nuclear Association (CNA) commissioned Hatch Ltd. to evaluate current literature on the carbon emitted by nuclear, wind and gas-powered electrical generation.

Hatch Ltd. is a global engineering and management consultancy, headquartered in Toronto, which serves several industries. Hatch's energy unit has nine decades of continuous service in hydro, wind, solar, thermal and nuclear power, and transmission and distribution.

What is a lifecycle analysis (LCA)?

Lifecycle analysis studies an industrial process through all its stages from cradle to grave. It is the most widely accepted, comprehensive measure of environmental performance, as it enables an apples-to-apples comparison of technologies. A specialized field, LCA operates within technical and professional standards such as ISO 14040.

The 2008 CERI study

The CNA commissioned an independent analytical team at the Canadian Energy Research Institute in 2008 to compare technological alternatives for electrical generation in Ontario. That study concluded, "GHG emissions and criteria air contaminants from coal and natural gas power generation are several orders of magnitude higher than those from nuclear." CERI included uranium mining and power generation but excluded exploration, construction, decommissioning and waste disposal. The 2014 Hatch study updates the analysis and fills in these gaps.

Objectives of the 2014 study

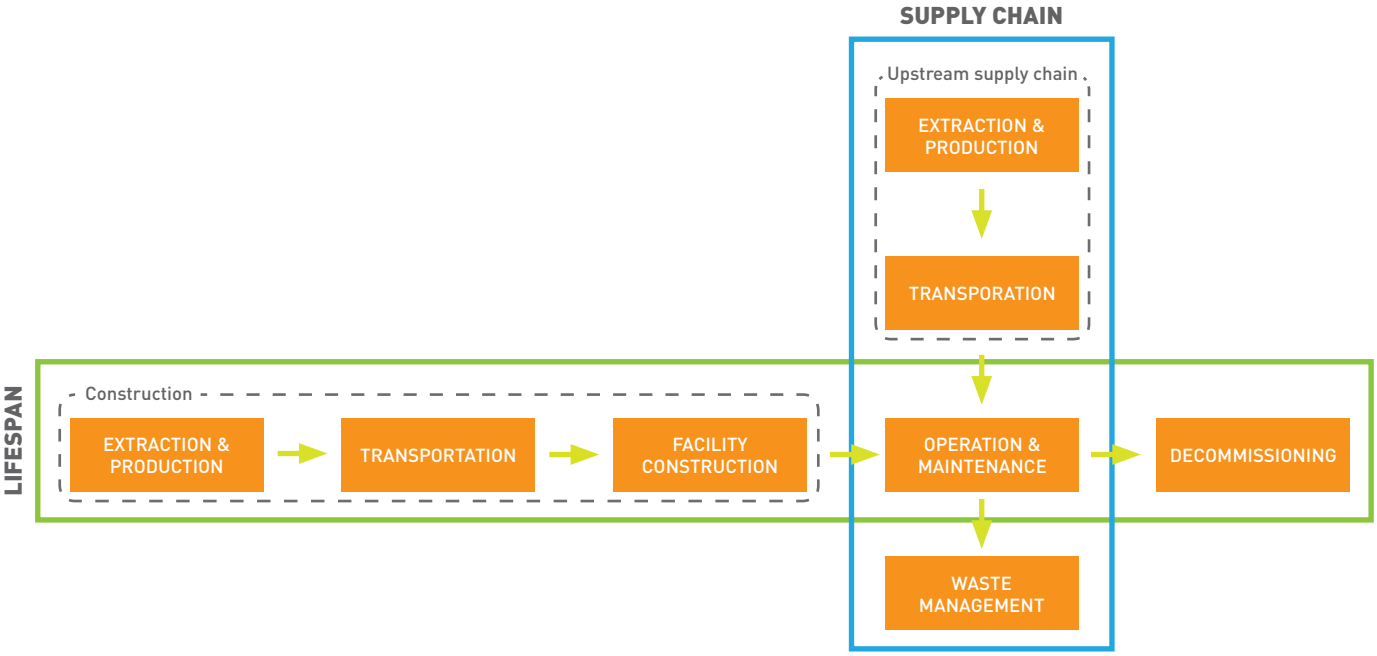
- Gather the best-available, peer-reviewed LCA work on power generation from international sources through a comprehensive literature review.
- Shift the focus of comparison from coal-fired generation to wind generation. Coal's negative environmental effects are now widely appreciated, but wind's environmental effects remain poorly understood, though it is an increasing portion of the supply mix in many jurisdictions.
- Cover the exclusions from the 2008 CERI study insofar as possible.
- Update and verify the information generated by the 2008 study.

Oversight

Hatch analysts conducted their study independently under a CNA-funded research contract.

Scope

The study focused on seeking information of greatest relevance to near-term choices for investments in Ontario's electrical supply. In practical terms, these choices are limited to electrical generation from nuclear energy, wind, and natural gas. (Additional hydroelectric power, a low-carbon alternative, could become available in a longer time with a massive investment in new hydro dams outside Ontario.) This is why the Hatch study did not cover hydroelectricity, solar, geothermal or other power sources.



SCHEMATIC OF THE SYSTEMS TO BE CONSIDERED IN A LIFECYCLE STUDY (FROM HATCH, 2014, P. 6)

System boundaries

Two lifecycles intersect in most industrial processes:

- Lifespan – the lifetime of the power plant from inception to decommissioning.
- Supply chain – the upstream systems associated with fuels and consumables, and the downstream systems associated with management and disposal of wastes.

Environmental indicators measured included:

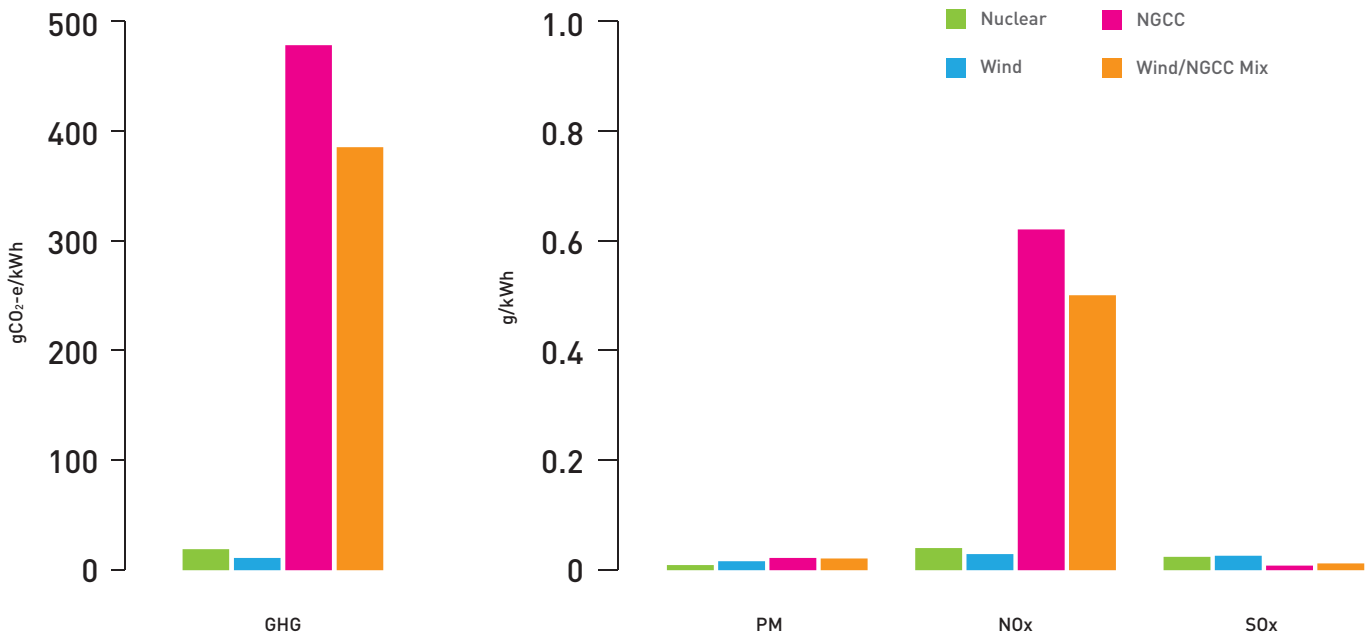
- Greenhouse gases
- Particulate matter
- Sulfur oxides and nitrogen oxides
- Ionizing radiation

Literature coverage

The evaluation considered 246 studies of considerable variety.

Results

Following are key results as stated in Hatch's final report. NGCC refers to gas-fired power generation ("Natural gas combined cycle").



TOTAL LIFECYCLE EMISSIONS OF GREENHOUSE GASES (GHG), PARTICULATE MATTER (PM), NITROGEN OXIDES (NOX) AND SULFUR OXIDES (SOX) FROM POWER GENERATION BY VARIOUS TECHNOLOGIES (FROM HATCH, 2014, P. 47)

"Nuclear and wind power are similar in magnitude for each emission category and an order of magnitude less than natural gas with respect to GHG and NOx emissions." (p. 46)

"The wind-NGCC scenario reflects a potential grid mix based on current grid infrastructure in Canada that (in the absence of energy storage) uses [gas] to compensate for the intermittent nature of electricity generation from wind power." "Emissions from the 20-80 mix of wind-NGCC is more comparable to NGCC, where emissions of greenhouse gases (GHG) and nitrogen oxides (NOx) exceed nuclear." (p. 48)

"The range of GHG and NOx emissions for natural gas and a mix of natural gas and wind power are in every case, significantly higher than for [the nuclear scenario]." (p. 49)

"The results of the assessment show that the lifecycles of nuclear and wind-power generation produce a small fraction of the GHG and NOx emissions of the natural gas combined cycle (NGCC) lifecycle... Emissions of PM were more comparable across generation sources... Emissions of SOx were similarly comparable..." (p. 70)

"When considering wind backed by natural gas power (20%/80%) to compensate for intermittency, emissions from the modified grid mix closely resemble that of natural gas production, diluted by a low-emissions power source." (p. 71)

Conclusions

The Hatch study reinforces four things about electricity-sector carbon emissions:

1. Nuclear is very clean: Its emissions are similar to pure wind, and far lower than natural gas.

2. In the real world today, wind generation does not supply power grids by itself. Because the wind blows intermittently, wind generation must be backed up by another power source guaranteed to be available when needed. Often this backup source is natural gas.

3. To measure environmental effects from power generation, wind power's benefits must be evaluated with an eye to the carbon emissions from natural gas, needed to offset wind's electrical variability. Neither nuclear nor gas can be compared to wind alone. The real choice is between nuclear, gas, and wind backed by gas, its most likely supporter.

4. Because wind's reliability is highly variable, the Hatch study assumed that wind generation would need strong support from natural gas. To enable an apples-to-apples comparison to nuclear-generated electricity, Hatch assumed a realistic mix of 20 percent wind and 80 percent gas. The emissions from this mix are cleaner than straight natural-gas generation, but they are far higher than nuclear power's emissions. Also, even if wind improved its reliability and generated 50 percent of a wind-gas mix, nuclear's carbon emissions would remain substantially lower.