

# What makes waterpower a clean energy source?

As Canada builds toward a net-zero emissions electricity supply by 2035, we have a “clean power advantage.” Sixty percent of all electricity in Canada is generated from hydropower — an affordable, reliable, renewable, and ultra-low greenhouse gas (GHG) emitting energy source. Hydropower keeps Canada as one of the cleanest electricity grids among G20 countries.

## Hydropower is a “renewable energy” resource

Hydropower converts kinetic energy in falling or flowing water, into mechanical energy, and then into electrical energy (or “hydroelectricity”). While there are several ways to generate power from moving water, in all cases the energy is “renewable” (“derived from a natural process that is replenished at a rate that is equal to or faster than the rate at which they are consumed”<sup>1</sup>). Water is not consumed, depleted or wasted in the process.

## Hydropower has ultra-low lifecycle greenhouse gas emissions

All sources of electricity result in greenhouse gas emissions during a generation asset's lifecycle from: manufacture of structures and components; construction; transportation; changes in land use; operation; and decommissioning.

GHG emissions from the land-use of hydropower reservoirs have been studied extensively in Canada. Canadian expertise in this field is demonstrated by: more than 500,000 measurements<sup>2</sup>; more than 100 published peer-reviewed scientific articles; more than 300 scientific presentations; and more than

60 Masters and Doctorate theses. Research partners include several universities, utilities, consulting firms, government agencies and NGOs.

Lifecycle Analysis (LCA) evaluates the environmental effects associated with any given industrial activity from the initial gathering of raw materials from the earth until the point at which all residuals are returned to the earth or “cradle-to-grave.” LCA enables the comparison of the GHG emissions implications of different electricity generation options on a per unit of generation basis across the entire lifetime of the projects.



Photo: Innergex

<sup>1</sup> Natural Resources Canada:  
<https://www.nrcan.gc.ca/our-natural-resources/energy-sources-distribution/renewable-energy/about-renewable-energy/7295>

<sup>2</sup> Hydro-Québec, Greenhouse gas emissions and reservoirs:  
<https://www.hydroquebec.com/sustainable-development/specialized-documentation/ghg-reservoir.html>

## Did you know?

**Waterpower generation, on average, emits 35 times less greenhouse gas emissions than a natural gas generating station and about 70 times less than coal-fired power. This is comparable to those from wind-powered electricity generation.**

Recent LCA studies examining the emissions per unit of generation over an electricity generation asset's lifetime for different options have repeatedly demonstrated that the lifecycle GHG emissions from Canadian hydroelectricity (considering all greenhouse gases including carbon dioxide and methane) are negligible in comparison to fossil-fueled electricity generation, and are comparable to those from wind-powered electricity generation (see table below).

### Comparison of Lifecycle GHG Emissions for Several Electricity Generation Options

Electricity Generation	Lifecycle Greenhouse Gas Emissions <sup>3</sup> (t CO <sub>2e</sub> / GWh)
Canadian Hydroelectricity	2 – 17 <sup>4,5,6,7</sup>
Wind	12
Nuclear	9 – 110
Solar Photovoltaics	< 50
Natural Gas	461 – 465
Coal	1,001

While there are variances from facility to facility, a range of 2 – 17 t CO<sub>2e</sub> / GWh is representative of the majority Canadian hydroelectricity generation fleet. This is comparable or even lower to those from wind-powered electricity generation, for example, which is 12 t CO<sub>2e</sub> / GWh, and significantly lower than fossil fuel generation.

**Cold well-oxygenated water means that methane emissions from Canadian hydropower are lower than in other parts of the world.**



Photo: Columbia Power

It is a common misperception that Canadian hydropower reservoirs are significant sources of the powerful greenhouse gas methane. Both natural and artificial waterbodies do emit methane. But methane production is a function of climate and oxygenation. Hydropower reservoirs in Canada are colder and more oxygenated than the global average. Therefore, and for example, the methane emissions from boreal and northern hydropower reservoirs in Canada cannot and should not be equated to those in the balmy tropics.

*WaterPower Canada is the national voice of the waterpower industry, advocating for the responsible development and use of waterpower to meet our present and future electricity needs in a sustainable manner. Learn more at [waterpowercanada.ca](http://waterpowercanada.ca).*

<sup>3</sup> Median value presented in National Renewable Energy Laboratory (NREL)'s "Lifecycle Assessment Harmonization" project.

<sup>4</sup> Pembina Institute (2013) "Needs For and Alternatives To, Life Cycle Greenhouse Gas Assessment Overview (Appendix 7.3)" found Keeyask Generating Station to have lifecycle GHG emissions of 2.5 tonnes CO<sub>2e</sub> / GWh, and Conawapa project to have 1.4 tonnes CO<sub>2e</sub> / GWh.

<sup>5</sup> Stantec Consulting Ltd. (2012) "Site C Clean Energy Project: Greenhouse Gases Technical Report" found Site C to have lifecycle GHG emissions of 10.5 t CO<sub>2e</sub> / GWh.

<sup>6</sup> McCulloch, M., Vadgama, J. (2003) "Life Cycle Evaluation of GHG Emissions and Land Change Related to Selected Power Generation Options in Manitoba" found Wuskwatim Generating Station to have lifecycle GHG emissions of 4 tonnes CO<sub>2e</sub> / GWh.

<sup>7</sup> International Reference Center for Life Cycle of Products, Services and Systems (2014) "Technical Report, Comparing Power Generation Options And Electricity Mixes" found the entire Québec hydropower generating system to have average LCA GHG emissions of 17 tonnes CO<sub>2e</sub> / GWh.