

Electricity Generation and Greenhouse Gas Emissions

Life-Cycle Analysis of Base Load Electricity in Ontario (Nuclear, Coal and Natural Gas)

- All forms of electricity generation produce some greenhouse gas emissions (GHG) whether from mining or milling fuel, building electrical plants, transportation, releases of gases or pollutants during the burning of fuel and/or in the disposal of by-products or wastes.
- The Canadian Energy Research Institute (CERI) conducted a Life-Cycle Analysis (LCA) to identify and analyze current and potential life cycle environmental impacts (GHG emission, other air pollutants, water pollutants and radiation) of base load electricity generation from nuclear, coal and natural gas in Ontario.
- Life-Cycle Analysis (LCA) is a systematic approach used to evaluate environmental impacts associated with electricity generation from different sources over their life-cycle (cradle to grave).
- The LCA took a snapshot of electricity generation activities in 2005 and 2006 in Ontario looking at the fuel supply chain and the operations of the electrical facility within the system boundaries.
- This LCA did not include CO₂ from plant construction of coal, gas or nuclear plants because CO₂ emissions in the construction phase of these various electricity generation technologies is roughly the same for each and proportional to the size of the plant and quantity of materials used.

Construction Emissions of Various Electricity Generation Technologies¹

Power generation technology	Kilo tonnes of CO₂ per TWh	Ratio of construction CO₂ to operations CO₂ (%)
IGCC (coal)	1.10	0.14
SUPC (coal)	1.49	0.18
CCGT (gas)	0.95	0.22
SXC (nuclear)	2.22	6.89

Notes: CCGT: Combined Cycle Gas Turbine, IGCC: Integrated Gasification Combined Cycle, SUPC: Supercritical Coal, SXC: Sizewell C (PWR)

¹Estimating life cycle from Table 2 of: S. Andeseta et al., "CANDU Reactors and Greenhouse Gas Emissions" <http://www.computare.org/Support%20documents/Publications/Life%20Cycle.htm>, retrieved October 20, 2008.

- The LCA did consider CO₂ emissions in the construction phase of other electricity generation technologies (hydro, wind, biomass) and concluded that construction-related emissions are negligible when compared to the emissions related to plant operations and their fuel life cycles. CERI concluded that the inclusion or exclusion of construction-related CO₂ emissions does not significantly effect the outcome of the LCA.

**Material Quantities for Construction of Various Electricity Generation Technologies,
circa 1983²
(Thousands of tonnes per EJ/year)**

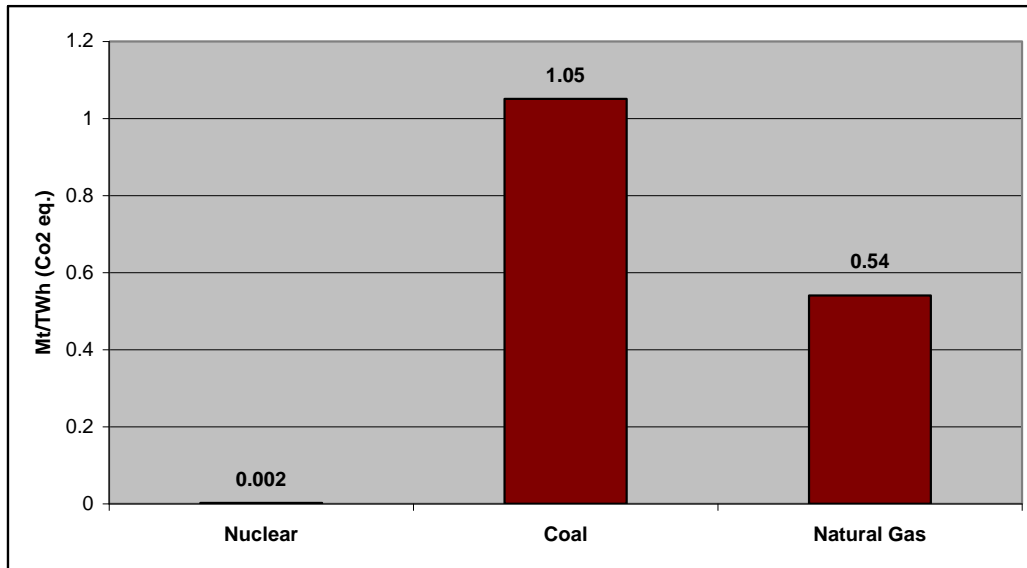
Generation Technology	Steel	Concrete	Other Metals
Coal - Electric	1500	5500	30
Coal - Synfuel	600	*	30
CANDU 900Mwe (1995)	1600	14000	*
LWR	2500	15000	125
CANDU 600Mwe (1995)	1400	18000	*
Hydro	3500	60000	200
Wind	8000	35000	1000
Biomass	4500	12000	*

Notes: * Indicates data not available; - Indicates value is negligible; LWR, Light Water Reactor

²Estimating life cycle from Table 2 of: S. Andeseta et al., "CANDU Reactors and Greenhouse Gas Emissions" <http://www.computare.org/Support%20documents/Publications/Life%20Cycle.htm>, retrieved October 20, 2008.

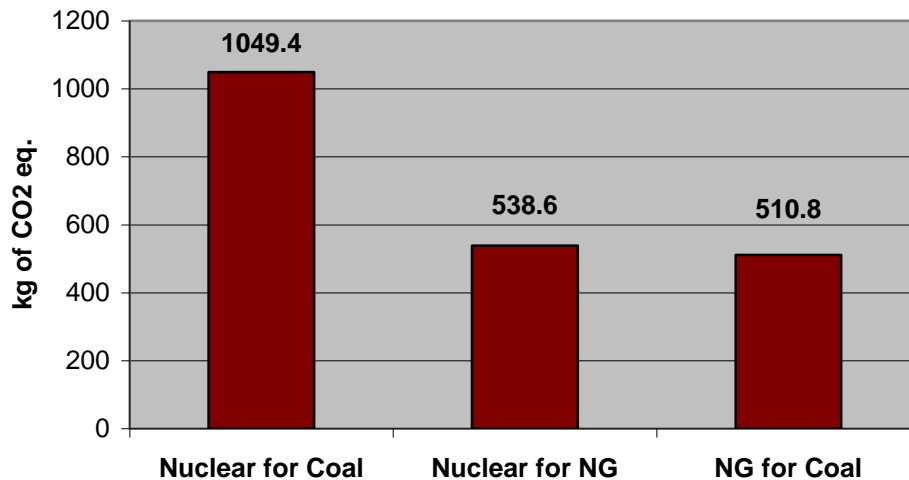
- Ontario power plants included in this study: three nuclear, four coal-fired and fifty-two natural gas-fired.
- LCA analyses, completed in accordance to international standards (ISO 14040 series), can assist with future electricity generation mix decisions.
- The study of the complete life cycle of nuclear power in Ontario found that nuclear power results in the emissions of 1.8 grams of carbon dioxide per kilowatt-hour (g/kWh) of electricity generated. These emissions occur mainly in the mining and refining of uranium fuel, not in the operation of the reactor.
- The study of the complete life cycle of coal in Ontario results in the emissions of 1050 g/kWh, mostly in the burning of coal in the power plant.
- The study of the complete life cycle of natural gas in Ontario to make electricity creates emissions of 540 g/kWh, mostly in the burning of natural gas in the power plant.

Comparative Life-Cycle GHG Emissions for Ontario Electricity Generation Sector



- This study concludes that life cycle GHG emissions per one TWh of nuclear electricity are so small, that they are simply not comparable to other types of base load electricity generation.

GHG Emissions Avoided by Replacing One MWh by Switching Fuels



- If one MWh of coal-fired or natural gas-fired electricity capacity is replaced by one MWh of nuclear electricity, Ontario could have avoided 1049 kg or 539 kg of GHG emissions, respectively.

For complete information and the full “Comparative Life Cycle Assessment (LCA) of Base Load Electricity Generation in Ontario” report please go to www.cna.ca under “Publications”.