

# Emissions Produced by 1 Kilowatt-hour of Electricity Based on Life-Cycle Analysis

Generation Option	Greenhouse gas emissions gram equiv. (in CO <sub>2</sub> /kWh)	Sulfur dioxide emissions (in milligrams/kWh)	Nitrogen oxide emissions (in milligrams/kWh)	NMVOC (in milligrams /kWh**)	Particulate matter (in milligrams /kWh)
Hydropower	2 – 48	5 – 60	3 – 42	0	5
Nuclear	2 – 59	3 – 50	2 – 100	0	2
Wind	7 – 124	21 – 87	14 – 50	0	5 – 35
Solar photovoltaic	13 – 731	24 – 490	16 – 340	70	12 – 190
Biomass forestry waste combustion	15 – 101	12 – 140	701 – 1,950	0	217 – 320
Natural gas (combined cycle)	389 – 511	4 – 15,000[*]	13 – 1,500	72 – 164	1 – 10
Coal – modern plant	790 – 1,182	700 – 32,321	700 – 5,273	18 – 29	30 – 663

[\*] The sulfur content of natural gas when it comes out of the ground can have a wide range of values. When the hydrogen sulfide content is more than 1 percent, the gas is usually known as “sour gas.” Normally, almost all of the sulfur is removed from the gas and sequestered as solid sulfur before the gas is used to generate electricity. Only in the exceptional case when the hydrogen sulfide is burned would the high values of sulfur dioxide emissions occur.

\*\* NMVOC means non-methane volatile organic compounds.



Source: “Hydropower-Internalized Costs and Externalized Benefits,” Frans H. Koch, International Energy Agency (IEA)-Implementing Agreement for Hydropower Technologies and Programs, Ottawa, Canada, 2000.