THE *CARBON* COSTS OF ENERGY (CCE) – metric units

How many kilograms of CO_2 are emitted[a] to generate ***a kilowatt-hour*** *of electricity?*		*How many kilograms of CO_2 are emitted[a] to generate electricity for* ***one household*** *for one month?*			*How many kilograms of CO_2 are emitted[a] to generate electricity for* ***100,000 households*** *for one month?*	
Renewable[b] sources in italics		*Average household* ***kWh/month****:[4,5]* ***Arizona*** *= 1,095,* ***U.S.*** *= 920,* ***World*** *= 240*				
Origin	**kg/kWh**	**Arizona**	**U.S.**	**World**	**U.S.**	**World**
Municipal Solid Waste [c,d,1]	1.355	1,484	1,247	325	124,692,826	32,528,563
Coal [c,1]	1.020	1,117	939	245	93,853,469	24,483,514
Oil [c,1]	0.758	830	698	182	69,774,566	18,202,061
Natural Gas [c,1]	0.515	564	474	124	47,364,912	12,356,064
Biomass [c,d,2]	0.452	495	416	109	41,606,006	10,853,741
Geothermal [2]	0.030	33	28	7	2,795,990	729,389
Landfill Gas [c,d,2]	0.020	21	18	5	1,794,442	468,115
Solar Thermal/CSP [b,c,e,1]	0.000	0	0	0	0	0
Nuclear [b,c,1]	0.000	0	0	0	0	0
Hydroelectric [1]	0.000	0	0	0	0	0
Solar PV [f,1]	0.000	0	0	0	0	0
Wind [1]	0.000	0	0	0	0	0
Micro-Hydroelectric [1]	0.000	0	0	0	0	0
Average [3]	0.587	642	540	141	53,962,615	14,077,204

Available at: HarvestingRainwater.com/water-energy-carbon-nexus

CCE FACTS

Approximately **7% of electricity generated in the U.S. is lost** during transmission/distribution (U.S. EIA). In 2007, the **CO_2 emissions** associated with this loss **weighed 170 million metric tons**.[3]

Of the **total United States greenhouse-gas emissions, electric power generation accounts for 34%, transportation 28%, industry/commerce 26%, agriculture 8%,** and **residential use 5%.**[6]

Selected 2009 **per-capita CO_2 emissions**, in metric tons:[7] **World average**: 4.5
Afghanistan: 0 | **Jordan**: 3.2 | **China**: 5.8 | **France**: 6.3 | **Japan**: 8.6 | **Germany**: 9.3 | **U.S.**: 17.7 | **Australia**: 19.6 | **Qatar**: 76.4

CCE NOTES

CO_2 = Carbon dioxide, at generation only. Data do not include climate-change potential of other greenhouse gases, or emissions associated with extraction of raw energy sources & lifecycle of infrastructure.

a. All regions' emissions are calculated based on U.S. carbon-emissions data and region-specific energy-consumption data. However, each region's actual average emissions will vary based on its own power-generation specifics.

b. Some of the zero-carbon benefits of nuclear and solar-thermal power generation are offset by their high water intensity.

A typical nuclear plant creates 20 metric tons of toxic spent nuclear fuel per year, which can take thousands of years to degrade.[8]

Utility-scale concentrated solar power (CSP), if situated in remote locations, requires transmission buildout to bring generated power to populated areas. Such buildout typically costs between $1.2 million and $2.4 million per kilometer.[9]

In 2007, non-biomass renewable fuel sources generated 7% of U.S. electricity & produced less than 0.1% of U.S. CO_2 emissions.[6]

c. Thermoelectric power plants, which provide 90% of U.S. electricity, heat water to create steam to turn turbines that generate power. The heat comes from burning municipal solid waste, coal, oil, natural gas, biomass, or landfill gas; concentrated sunlight; or a nuclear reactor.[10]

d. Biomass is a fuel category whose subtypes include landfill gas, agricultural byproducts, plant-based component of municipal solid waste (estimated at 2/3 of total materials), wood/wood waste, etc. EPA considers biomass to have zero net atmospheric CO_2 impact, as amount of CO_2 used by growing plants is equal to that released upon their combustion.[11] This view does not account for the *rate* at which CO_2 is released via combustion vs. gradual decomposition.

e. CSP = concentrated solar power, a form of solar-thermal energy that uses solar-tracking mirrors or lenses to focus a large area of sunlight onto a small area. The light energy is converted to heat, which is used to generate electricity via conventional thermoelectric methods (see note c, above).[12]

f. Solar PV = on-site photovoltaic solar panels, which use semiconductors to convert solar energy into direct-current electricity.[13]

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