Energy Sources

James Conca , Contributor June 2016 Forbes.

Everyone's heard of the carbon footprint of different energy sources, the largest footprint belonging to coal because every kWhr of energy produced emits about 900 grams of CO2. Wind and nuclear have the smallest carbon footprint with only 15 g emitted per kWhr, and that mainly from concrete production, construction, and mining of steel and uranium. Biomass is supposedly carbon neutral as it sucks CO2 out of the atmosphere before it liberates it again later, although production losses are significant depending upon the biomass. Carbon emissions and physical footprints are known as *externalities* and are those vague someone-has-to-pay-eventually kind of thing it's hard to put a value on. Proposed carbon footprint taxes are in the range of $15 to $40/ton of CO2 emitted, but assigning a physical footprint cost depends on the region, ecosystem sensitivities and importance. A hundred-acre wetlands to be flooded by a new dam is worth more to the planet than a barren hundred-acre strip under a solar array in the Mojave (P. Bickel and R. Friedrich, 2005).

But an energy's deathprint, as it is called, is rarely discussed. The deathprint is the number of people killed by one kind of energy or another per kWhr produced and, like the carbon footprint, coal is the worst and wind and nuclear are the best. According to the World Health Organization, the Centers for Disease Control, the National Academy of Science and many health studies over the last decade (NAS 2010), the adverse impacts on health become a significant effect for fossil fuel and biofuel/biomass sources (see especially Brian Wang for an excellent synopsis). In fact, the WHO has called biomass burning in developing countries a major global health issue (WHO int). The table below lists the mortality rate of each energy source as deaths per trillion kWhrs produced. The numbers are a combination of actual direct deaths and epidemiological estimates, and are rounded to two significant figures.

For coal, oil and biomass, it is carbon particulates resulting from burning that cause upper respiratory distress, kind of a second-hand black lung. Our lungs just don't like burnt carbonaceous particulates, whether from coal or wood or manure or pellets or cigarettes. The actual numbers of deaths in China from coal use exceeded 300,000 last year since they have ramped up coal so fast in the last decade and they usually do not install exhaust scrubbers. The impact on their health care system has been significant in not just deaths, but in non-lethal health effects and lost days of work.

Energy Source	Mortality Rate (deaths/trillionkWhr)	
Coal – global average	100,000	(50% global electricity)
Coal – China	170,000	(75% China's electricity)
Coal – U.S.	10,000	(44% U.S. electricity)
Oil	36,000	(36% of energy, 8% of electricity)

Natural Gas	4,000	(20% global electricity)
Biofuel/Biomass	24,000	(21% global energy)
Solar (rooftop)	440	(< 1% global electricity)
Wind	150	(~ 1% global electricity)
Hydro – global average	1,400	(15% global electricity)
Hydro – U.S.	0.01	(7% U.S. electricity)
Nuclear – global average	90	(17% global electricity w/Chern&Fukush)
Nuclear – U.S.	0.01	(19% U.S. electricity)

It is notable that the U.S. death rates for coal are so much lower than for China, strictly a result of regulation and the Clean Air Act (Scott et al., 2005). It is also notable that the Clean Air Act is one of the most life-saving pieces of legislation ever adopted by any country in history. Still, about 10,000 die from coal use in the U.S. each year, and another thousand from natural gas. Hydro is dominated by a few rare large dam failures like Banqiao in China in 1976 which killed about 171,000 people. Workers still regularly fall off wind turbines during maintenance but since relatively little electricity production comes from wind, the totals deaths are small. Nuclear has the lowest deathprint, even with the worst-case Chernobyl numbers and Fukushima projections, uranium mining deaths, and using the Linear No-Treshold Dose hypothesis (see Helman/2012/03/10). The dozen or so U.S. deaths in nuclear have all been in the weapons complex or are modeled from general LNT effects. The reason the nuclear number is small is that it produces so much electricity per unit. There just are not many nuclear plants. And the two failures have been in GenII plants with old designs. All new builds must be GenIII and higher, with passive redundant safety systems, and all must be able to withstand the worst case disaster, no matter how unlikely. We also must deal with our spent fuel better, something we know how to do (Deep Geologic Nuclear Waste Disposal – No New Taxes).