# Nuclear Power is not "carbon-free"

When the nuclear industry claims that nuclear power is "carbon -free", it is basically taking advantage of the fact that many people don't know the difference between a "carbon footprint" and "direct carbon emissions". Our individual direct CO2 emissions are basically limited to whatever CO2 we exhale when we breathe- but our carbon footprint is much larger than those limited emissions. Our individual carbon footprint depends on how much gasoline we use, how much electricity we use, and, in general, how much of anything and everything we consume or use. Studies that show nuclear is carbon-neutral are considering only the direct emissions, not the carbon footprint.

That limited and simplistic approach is scientifically and mathematically incorrect. If we take a good hard look at the carbon-footprint of nuclear power, we discover that it has the largest carbon footprint of any energy source other than the fossil fuels. Very large carbon emissions are generated by various different stages in the production of nuclear energy, thereby increasing CO2 in the atmosphere. Tons of carbon emissions are generated by the following activities which are all necessary in the production of nuclear energy:

**1. MINING** - Uranium (or thorium).

**2. MILLING** – transportation to millworks, taking the raw ore and converting it to "yellowcake" uranium ore.

**3. CONVERSION** - Construction of the uranium conversion facility, transportation of the uranium "yellowcake" to a conversion facility, dissolving it to form UF6, conversion of "yellowcake" to UF6.

**4. ENRICHMENT** - Construction of the uranium enrichment facility, construction of the cylinders used to transport the UF6, transportation of the UF6 to the enrichment facility, enrichment of the uranium.

**5. FUEL PELLETS** - Formation of uranium fuel pellets, transportation of the uranium fuel pellets.

**6. NUCLEAR POWER PLANT CONSTRUCTION** - Construction of the nuclear power plant, with its massive amounts of concrete and steel, which will take several years of using heavy construction equipment to complete. Keep in mind that both steel and concrete production are carbon-intensive.

**7. SUPPORTING INFRASTRUCTURE FOR NUCLEAR POWER PLANTS** – Construction of the necessary infrastructure to support the nuclear power plant (roads, transmission lines, barge canals, etc.)

**8. GENERATORS** – Use of heavy-duty diesel generators to run the cooling system during routine maintenance, refueling, shut downs resulting from increased summertime water temperatures, any SCRAM, and power outage emergencies.

**9. WASTE STORAGE** – Building RadWaste storage facilities, building radwaste storage containers and transporting the waste to the storage facilities. Transfering RadWaste from one geographic location to another,  across the country, or the ocean.

**10. WASTE PROCESSING** – Building reprocessing facilities, transporting the radwaste to the reprocessing facility, reprocessing the radwaste, building storage for the radwaste generated by reprocessing.

**11. WASTE INCINERATION** – Building radwaste incineration facilities, transporting the waste to the incineration facility, incinerating the RadWaste.

**12. WASTE VITRIFICATION** – Building vitrification plants, transporting waste to vitrification plants, vitrifying the RadWaste involving heating the materials to very high temperatures.

**13. MONITORING OF RADIOACTIVE WASTE** – carbon pollution generated by monitoring and guarding the radwaste for eternity.

**14. DECOMISSIONING AND DECONTAMINATION** –decontaminating and demolishing the nuclear plants, reactors, enrichment facilities, and other support infrastructure.

**15. ACCIDENTS** – mitigation and clean-up efforts on nuclear accidents-huge carbon contribution.

**16. DAMAGED REACTORS AND ACCIDENTS** – Building sarcophagus structures around failed nuclear power facilities. Monitoring, securing and periodically re-entombing failed nuclear power facilities for all eternity.

There are more nuclear carbon-footprint considerations than the ones stated here, but this list is a good general start.No one source has actually calculated the carbon footprint for nuclear energy taking into consideration all of the above sources of carbon emissions.

Summary of Sovacool, Lenzen findings:Carbon footprint of nuclear energy Lenzen, M. (2008) Life cycle energy and greenhouse gas emissions of nuclear energy: A review. Energy Conversion and Management 49, 2178-2199. The following information was obtained from a summary table on p.172 of the 2008 study done by Dr Manfred Lenzen,et al. Dr. Lenzen is an international leader in energy life-cycle assessment. In order, most carbon intensive to least carbon intensive, in grams of CO2 emitted per kilowatt hour of electrical power produced: New Sub-critical brown coal 1175 New sub-critical black coal 941 Supercritical black coal 863 Open cycle natural gas 751 Combined cycle natural gas 577 Photovoltaics 106 (note: this study calculated this figure for older photovoltaics) Heavy water reactors 65 Light water reactors 60 Wind turbines 21 Hydroelectric 15 The full text of this study is freely available at http://www.isa.org.usyd.edu.au/publications/documents/ISA_Nuclear_Report.pdf

Valuing the greenhouse gas emissions from nuclear power: A critical survey Benjamin K. Sovacool _ Energy Policy 36 (2008) 2940– 2953 Table 8 (summary of findings) Lifecycle estimates for electricity generators a Technology Capacity/configuration/ fuel Estimate (gCO2e/kWh)

Wind 2.5MW, offshore 9 Hydroelectric 3.1MW, reservoir 10Wind 1.5MW, onshore 10 Biogas Anaerobic digestion 11 Hydroelectric 300 kW, run-of-river 13 Solar thermal 80MW, parabolic trough 13 Biomass Forest wood Co-combustion with hard coal 14 Biomass Forest wood steam turbine 22 Biomass Short rotation forestry Co-combustion w/hard coal 23 Biomass FOREST WOOD reciprocating engine 27 Biomass Waste wood steam turbine 31 Solar PV Polycrystalline silicone 32 Biomass Short rotation forestry steam turbine 35 Geothermal 80MW, hot dry rock 38 Biomass Short rotation forestry reciprocating engine 41 Nuclear Various reactor types 66 Natural gas Various combined cycle turbines 443 Fuel cell Hydrogen from gas reforming 664 Diesel Various generator and turbine types 778 Heavy oil Various generator and turbine types 778 Coal Various generator types with scrubbing 960 Coal Various generator types without scrubbing 1050 The entire text of this report is freely available at: http://www.nirs.org/climate/background/sovacool_nuclear_ghg.pdf

Topic: The Large Carbon Footprint of Nuclear Energy sources Benjamin K. Sovacool, Valuing the greenhouse gas emissions from nuclear power: A critical survey, Energy Policy 36, June 2, 2008.

Nuclear Information Resource Service