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Calculating the environmental cost of uranium mining

Nuclear power is receiving growing attention from governments seeking ways to cut greenhouse gas (GHG) emissions. However, there is little detailed analysis of the true carbon costs of the nuclear industry. A new analysis suggests that eco-efficiency of uranium mining and milling, a key aspect of the efficiency of nuclear power generation, depends on the amount of uranium in the rocks being mined.

Nuclear power could be used as an alternative to fossil fuels to meet Europe's growing energy needs. But debate rages over how carbon friendly the industry really is. Uranium mining, milling, enrichment and fuel manufacture all contribute to GHG emissions and need to be taken into account when weighing up the potential for nuclear power in climate change mitigation strategies.

A detailed analysis of the environmental costs of uranium mining and milling in terms of energy, water and chemical consumption, as well as GHG emissions, was conducted. The study used company sustainability and technical reports and historical records of uranium finds. The results show that the environmental costs of uranium mining and milling are highly dependent on ore grade (the concentration of uranium), with more heavily concentrated, richer deposits of rock typically consuming fewer resources.

Energy consumption was calculated based on direct energy input, for example diesel and electricity consumption and was typically in the region of 200-400 GJ/t U_3O_8. This is around two and a half times the amount of energy used by the average EU citizen each year. The researchers point out that this fails to take account of other sources of energy consumption, such as the energy needed to produce the chemicals used in mining and milling. They point out that full sustainability reporting needs to include reagents (substances used to cause a chemical reaction) with major embodied energy costs, which they calculate could add a further 6 per cent to the energy consumed in nuclear fuel production.

Analysis showed significant differences in water consumption, depending on the type of mining operation and particularly on the quality of the ore grade. This ranged from under 50 to over 8,000 KL/t U_3O_8. Carbon dioxide emissions also varied from 10 to 50 t CO_2/t U_3O_8 and there is a gradual increase of CO_2 emissions over time. It takes about 200 tonnes of U_3O_8 per year to keep a large (1000 MWe) nuclear reactor running; mining and milling uranium to feed such a plant would, therefore, emit 2000-50000 t CO_2 each year. This is similar to the total CO_2 emission from the Falkland Islands in 2004.

Exploiting uranium reserves suggests that these environmental costs will increase over time as high grade ore deposits decline and the industry turns to lower grade ore or deeper deposits. Extracting uranium from lower grade ore not only means higher energy costs and greater CO_2 emissions, but is likely to increase pressure on water resources.

Nuclear power already contributes 30 per cent of Europe's electricity and the EU 27 are home to 152 nuclear reactors. However, planned phase-out of nuclear reactors in some member states may see the share of energy provided from nuclear sources drop in future.

Source: Mudd, G.M. and Diesendorf, M. (2008). Sustainability of uranium mining and milling: toward quantifying resources and eco-efficiency. *Environmental Science and Technology*. 42:2624-2630.

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