

Shades of Grey: Electricity and Environmental Questions

There are environmental questions about all these methods of generating renewable electricity, and of transmitting. We begin with wind energy.

One objection sometime made is that wind generators kill birds. It is true that badly located, designed, and sited turbines may kill endangered raptors; but this is easy to avoid.

Other than that - existing wind generators kill about 6,400 birds per year. If every bit of our current electricity demand (not reduced, but current) was met by wind about 1 million additional birds would die a year. In contrast, collisions with buildings kill 100 million birds a year; cell phone towers kill 40 million birds a year; human infrastructure and activities in general kill from one to four million birds a day in the United States²⁸⁸. Feral and outdoor cats kill at least hundreds of millions annually²⁸⁹. Next to efficiency, wind is the most environmentally benign energy source there is.

I will note that these objections are raised by the fossil fuel industry much more often than by environmentalists. In some cases people object that wind generators spoil their view; my reaction is "you want to burn more coal, give more miners black lung so as not to spoil your view? You want all of us to suffer more deaths from respiratory disease - including lung cancer so as not to spoil your view? You want more tornadoes, more hurricanes, more disease, more crop failures, more floods, and more droughts from global warming so as not to spoil your view? Get over yourself!"

There are slightly more serious objections to geothermal electricity. Hot water taken from sources can end up contaminating the freshwater table with salts and toxins. Huge amounts of cooling water are often used in water cooled geothermal plants. In modern plants, such as the Mokai Geothermal plant in New Zealand²⁹⁰, these impacts are reduced to a negligible level:

...geothermal fluid is completely contained from production to reinjection, with the only emissions being negligible quantities of steam emitted by the steam traps and the non-condensable gases emitted above the air coolers.

The plant has a relatively larger footprint but a much lower profile than a conventional condensing steam turbine with an underslung condenser. The air cooler structures have a significantly lower profile than wet cooling towers and have the advantage of never producing a visible plume. In addition to its low profile, the plant has no water or chemical consumption and no blow-down of contaminated cooling tower water...

Normally greenhouse emissions from geothermal plants are considered to be about one sixth that of natural gas per unit of power. That might not be acceptable on a large scale, but as a small percentage of electricity production should prove no problem. In the U.S., where most feasible remaining untapped reserves are moderate temperature in any case, we will probably use close cycle air cooled binary technology almost exclusively, further reducing emissions.

A brief description of possible geothermal side affects and current mitigation technology can be found at the U.S. national park service web site²⁹¹.

Also, environmental effects may come from large scale HVDC transmission lines. These effects, if they exist, may not be minor. The question of what effect EMF from transmission lines have is controversial. The majority of studies have shown no effects. A minority, however, have shown links between exposure to powerline EMF and leukemia, brain tumors and other forms of cancer. WHO is concerned enough to classify EMF as a possible carcinogen.

The December, 2001 issue of Environmental Health Perspectives included a review of the literature on the subject²⁹². Of those studies that showed effects, the most extreme seem to be in ranges increases in number of deaths from various cancer from low to high tens of people per million. One way to look at that is (according to the most pessimistic studies) that if we exposed 50 million people to greatly increased EMF, somewhere between zero and an additional <10,000 people per year would die. Any number above zero is quite horrible, of course.

In contrast, fine particle pollution from coal burning electric power plants we run now are, by themselves, responsible for at least 24,000 deaths per year in the U.S.²⁹³. According to the same study, all fossil fuel based power plants particulates combined kill 30,000 per year. And this is particulates alone, without including NOX, Sulfur and other non-particulate air pollution, not to mention mining, mercury and global warming affects.

So even in the very unlikely worst case – high voltage transmission lines would still do a great deal less harm than the fossil fuel emissions they displace.

In addition, if such effects do exist, high voltage DC transmission line produce fields much more similar to the earth's natural field than AC lines do – meaning the body should be more adapted to them. So you would expect effects on the low rather than high end. Put it this way; reduce the number of large diesel trucks running through my neighborhood spewing toxins into the air, and as far as I'm concerned you may run a high voltage DC line past my house.

This brings to an important point to consider when weighing environmental effects. There is no kilowatt fairy, no BTU bunny. Everything we do has environmental affects. Solar cells are made with highly toxic metals. Fluorescent lights contain mercury (less than produced by coal to produce the electricity they displace though). I'm not saying it is the absolute optimum possible; it is a compilation, and I'm sure there are wonderful technologies out there I've overlooked. But without inexpensive electricity storage (something we do not yet have) any renewable scenario is going to require some additional high voltage lines.

“Aha!” say the primitivists. “High voltage lines aren't acceptable. Let's go low-tech instead, and live a simpler life.” How far back exactly do you want to go? To wood lots for heating and cooking, with a population that will stabilize at between 8 and 12 billion? That won't leave you many forests or much land for growing food. “We can have solar panels for heat” chimes in the simple lifer; “we'll just live without electricity”. And how do we make the glass and process the metal for your solar panel? Remember, we don't want to use fossil fuels or wood for that either. I'm not saying it is impossible to come up with a low tech way to support 12 billion people (depending upon how you define “low tech”). I'm betting, though, that any low tech answer will have a higher environmental impact than renewable electricity – even if renewable energy requires high voltage lines.

We need to also consider hydroelectric plants. These have the most serious consequences. Many people question whether they are even a sustainable source. There are ways to mitigate various problems. Fish friendly turbines are under development, as are improvements in small hydro. But fundamentally, pulling a large percent of moving water out of rivers, holding it in reservoirs, and then releasing it at our convenience does tremendous damage. It contributes to erosion, destroys fish and wildlife. The levees and dams that failed to protect New Orleans from hurricane Katrina also prevented the deposit of sediment that would have built up marshlands that had diminished the fury of hurricanes striking on previous occasions.

There are even questions about how carbon neutral hydroelectric dams are²⁹⁴. By flooding areas that were previously dry, dams may help convert CO₂ to methane - a far more powerful greenhouse gas. Even where reservoirs are converted from existing lakes or wetlands, the powerful turbines may force dissolved methane out of the water that would otherwise have been converted by micro-organisms to CO₂. How much occurs is not established fact, but that some of it occurs is unquestionable, especially if plant matter is left in place when the dam is built. The most important variable appears to be acres flooded per watt - meaning that high head hydro where existing plant matter is removed before construction is probably (but not certainly) low emissions. In short, we need (as *Nature* says repeatedly in discussing it), more data.

I will note that modular pumped storage avoids many of these problems. Recirculating the same water over and over again avoids destruction of rivers and lakes. And even if there is initially dissolved organic matter in the water that converts to methane, in a closed cycle this will be a one time occurrence. Once the existing organic matter is used up, there will be no significant source of new carbon to convert.

End Notes

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- ²⁸⁸Mick Sagrillo, "Advice from an Expert -Putting Wind Power's Effect on Birds in Perspective," *Frequently Asked Questions*, 2003, American Wind Energy Association, 24/Jun/2005 <<http://www.awea.org/faq/sagrillo/swbirds.html>>.
- ²⁸⁹John S. Coleman, Stanley A. Temple, and Scott R. Craven, *Cats and Wildlife - A Conservation Dilemma*. 1997, U.S. Department of Agriculture, University of Wisconsin-Extension, Cooperative Extension, 24/Jun/2005 <<http://wildlife.wisc.edu/extension/catfly3.htm>>.
- ²⁹⁰Power Technology, *Power Technology - Mokai Geothermal Power Plantl, New Zealand*. 26/Aug 2003, SPG Media Limited/SPG Media Group, 23/Aug/2004 <<http://www.power-technology.com/projects/mokai/>>.
- ²⁹¹National Park Service - U.S. Department of the Interior - Geologic Resources Division, *Geothermal Energy Overview. NPS Western Energy Summit Jan 21 - 23*. Jan 2003, National Park Service - U.S. Department of the Interior - Geologic Resources Division, 24/Aug/2004 <http://www2.nature.nps.gov/geology/adjacent_minerals/EnergySummit/Geothermal/geothermal%20factsheet.pdf>.p2.
- ²⁹²Anders Ahlbom et al., "Review of the Epidemiologic Literature on EMF and Health," *Environmental Health Perspectives* 109, no. SUPPLEMENT 6 Dec 2001, ICNIRP (International Commission for Non-Ionizing Radiation Protection) Standing Committee on Epidemiology, National Institute of Environmental Health Sciences of the U.S. Department of Health and Human Services, 24/Aug/2004 <<http://www.icnirp.de/documents/epireview1.pdf> ; <http://ehp.niehs.nih.gov/members/2001/suppl-6/911-933ahlbom/ahlbom-full.html>>.pp911-933.
- ²⁹³Ibid 163 p6-2. - Table 6.1
- ²⁹⁴Jim Giles, "Methane quashes green credentials of hydropower", *Nature*, November 30 2006,444:7119. p.524