

Efficiency and environmental effects in the oil sands of Alberta

One day this past March, I received two interesting pieces of mail: PHYSICS TODAY's March 2009 issue and the March/April issue of *Nature's Voice*, a publication of the Natural Resources Defense Council.

The PHYSICS TODAY issue contains an interesting article, "Physics in the Oil Sands of Alberta" (page 31).

On page 1 of *Nature's Voice* is an article entitled "America's Birds Face New Dangers This Spring," which highlights the potential danger to America's migrating bird populations from oil extraction in the great northern forest of Canada. According to the article, the forest is "one of the planet's largest bird nurseries" and is suffering the on-slaughter of "major oil companies seeking to extract petroleum from its sandy soils for export to the United States."

The loss of habitat will affect "more than half of America's migratory birds," according to the article, and "some 8000 to 100 000 birds of various species die each year in ponds containing toxic mining waste."

That situation affects more than bird populations. The article states that "tar sands mining is also Canada's fastest growing source of global warming pollution."

It seems to me this is another case in which physicists, in choosing a particular project to work on, should consider

the consequences to the natural environment and to mankind.

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Rather than processing oil sands as a petroleum deposit, would it be more cost-effective to manage them as mushy coal? That is, instead of dealing with the processing and refining issues described in the article by Murray Gray, Zhenghe Xu, and Jacob Masliyah, why not build an on-site power plant to burn the crushed oil-sands ore and transport and then sell the resulting electricity? As an added benefit, the waste would probably be a coarse clinker, rather than the water-rich sludge now in the tailings ponds.

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"Physics in the Oil Sands of Alberta" is an educational summary article. The authors' final sentence reads, "Only through understanding the science of bitumen, sand, clay, and water interactions can we effectively and responsibly recover that Canadian resource." The authors should have completed that sentence with "and commit the world to dangerously high concentrations of atmospheric CO₂."

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Gray, Xu, and Masliyah reply: In our article we presented both the underlying science of the operations and a summary of the environmental issues that the oil-sands industry faces. Mining and processing of the oil sands results in greenhouse gas emissions "from well to wheels"—that is, from production through to the vehicle tailpipe—of around 108 grams of carbon dioxide emissions per megajoule of gasoline, compared with 95–105 g CO₂e/MJ for a range of conventional

crude oils imported into the US.¹ Due to the energy required to heat the underground formations, the well-to-wheels emissions from an in situ process are higher: approximately 115 g CO₂e/MJ for both California heavy oil and for bitumen sent from the oil sands to US refineries. In comparison, the highest-emission technology is coal conversion to liquid fuels, at approximately 200 g CO₂e/MJ. Used on a large scale in South Africa, coal-conversion technology is also under development in China and is proposed for use in the US.

Any feasible scenario for growth in production of renewable sources of transportation fuels, in combination with conservation measures, will still require use of petroleum for many years. In our opinion, oil-sands processing is an essential component of a secure energy supply for North America. The oil sands are valuable for the production of transportation fuels, not for combustion for their energy content alone. Natural gas is a much more favorable alternative for generating electricity.

The issue of CO₂ emissions from any use of petroleum is very real, but several environmental groups have targeted the oil-sands industry by combining incorrect information with extreme extrapolation to create alarming scenarios. The most egregious of those claims is the projected impact on migratory birds. By considering the total population of migratory birds crossing northern Alberta, the total area of oil-sands deposits, and unsupported estimates of bird deaths in the tailings ponds, they have projected Armageddon for migrating songbirds and waterfowl. As we wrote in our article, only a small fraction of the total oil-sands resource can be mined. The total area approved for mining is 1520 km², out of Alberta's 661 848 km² area; the approved area represents 0.04% of the Canadian boreal forest. In that zone, the current area of the tailings ponds is approximately 60 km². In

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contrast, Alberta wetlands make up 139 000 km². Remediating the existing tailings ponds and minimizing their future use are essential, but grossly exaggerated claims of impact should not be credited by trained scientists.

Reference

1. Jacobs Consultancy and Life Cycle Associates, *Life Cycle Assessment Comparison of North American and Imported Crudes* (rep. prepared for Alberta Energy Research Institute), Jacobs Consultancy and Life Cycle Associates, Chicago (July 2009), available at <http://eipa.alberta.ca/home/lifecycle.aspx>.

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Integrated approach for efficient buildings

It is neither necessary nor constructive for Leon Glicksman to denigrate renewables to make the case for energy efficient buildings (PHYSICS TODAY, July 2008, page 35). Even without considering climate change, the projected energy gap between supply and demand means we need all fields to contribute. It does no one any service to repeat ridiculous unproven myths. For example, Glicksman says, "There are suggestions that wind-powered turbines numerous enough to meet a large fraction of our energy needs can seriously deplete global surface wind velocities and cause temperature increases."

Such suggestions are based on complete fabrication. Wind turbines can make a large contribution to electricity needs without their covering an excessively large area of land or sea. In fact, the area needed to meet all of the European Union electricity demand by using offshore wind energy is estimated to be 80 000 km², or less than 2% of Europe's sea area, not including the Atlantic Ocean. The turbine footprint, much less than 1% of the total area on land or offshore, allows many types of pre-wind-development activity such as farming to continue without hindrance.

On the first page of his article, Glicksman claims, "Today's cost of energy generation from most renewable sources is too expensive for widespread deployment," but his own article later reports that many forms of renewable

energy are directly cost-competitive with traditional fuels and are therefore not too expensive for wide-scale deployment, even in the short term.

Glicksman's comments regarding transportation fuel efficiency also should be put in context. Average fuel efficiency for vehicles in both Europe and Japan already exceeds 40 miles per gallon (http://ec.europa.eu/environment/enveco/policy/pdf/2007_automotive.pdf) compared with the EPA projection of 20.8 mpg for US cars in 2008 (<http://www.epa.gov/oms/cert/mpg/fetrends/420s08003.pdf>). That fact gives some perspective to the Obama administration plans to order automakers to increase the fuel economy of automobiles sold in the US to 35.5 miles per gallon by 2016 and suggests that rather more urgent action than "serious consideration" is needed.

Improved energy efficiency should be demanded in every forum, particularly for buildings. It is an uphill battle to persuade individuals and standard-setting bodies that even such simple measures as double glazing and better insulation are necessary and (over time) cost-efficient and that they provide a better quality of life inside buildings. Even assuming that battle can be won, replacing and improving building stock has a time frame significantly longer than developing large-scale renewable energy sources.

To provide clean, renewable, and cost-effective energy, we need to get away from competing for the "magic bullet" solution and instead work together using the best available technology in every area.

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Glicksman replies: Some important issues are raised by Rebecca Barthelmie. I couldn't agree with her more that the energy crisis requires an integrated approach comprising both environmentally acceptable supply options and substantial improvements in consumption efficiency. My major point was that most current efforts are heavily weighted toward supply-side solutions. Contrary to her assertion, many economic measures can be accomplished quickly to substantially improve the efficiency of existing buildings. For example, a number of programs to recommission commercial buildings, including actions as simple as reprogramming building controls, have resulted in 15–20% overall energy