Dan Botkin's Newsletter

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Keystone Pipeline: Environmental good or Evil?

The Alaskan Oil Pipeline,OOne of the most controversial to be built in the United States. Oil began flowing through this pipeline on June 20, 1977.

As I write this on January 12, the House of Representatives has passed a bill approving the construction of the Keystone XL pipeline and the Senate Energy and Natural Resources Committee approved legislation last Thursday to authorize construction of the Keystone XL oil pipeline. Next, the full Senate will vote on the project, opposed by President Obama. Is this pipeline environmentally a good idea? That's today's topic.

The key to the answer is to separate *what is* being transported from *how* it is transported. The Keystone pipeline question therefore becomes: Is the source, the Canadian tar sands, a good source today for petroleum, and is a pipeline the best way to transport that petroleum?

I will answer both questions based on what I know about environmental sciences.

The short answer is: The problem is the source, not the transportation method.

One of the many problems associated with Americans' dependence on fossil fuels is that the places where the fuels originate are usually far removed from where they are most heavily used. For example, East Coast states, with their high human populations, receive 60% of the refined oil products shipped within the nation and almost all the refined oil products imported into the nation.

Pipeline versus rail and truck

Just the Facts, Ma'am
(A Regular Newsletter Feature)
For petroleum alone, there are 55,000 miles of main "trunk" pipelines and 30,000–40,000 miles of smaller "gathering" pipelines in the United States, both underground and aboveground. Petroleum accounts for about 17% of all freight moved in the United States, and the pipelines carry about two-thirds of all that petroleum.

There is such a huge amount of fossil-fuel-carrying pipelines in the U.S. It's hard to imagine how much petroleum is transported. **(See Just the Facts, Ma'am.)** It's another of those giant numbers that populate discussions of energy—but let's try to picture it.

Suppose our nation decided to replace all these pipelines with trucks and trains. Here's one analysis by R. A. Wilson in his book, *Transportation in America.* "Assuming each truck holds 200 barrels (8,400 gallons) and can travel 500 miles per day, it would take a fleet of 3,000 trucks, with one truck arriving and unloading every 2 minutes, to replace a 150,000-barrel-per-day, 1,000-mile pipeline." And if all this were to go by rail, "Replacing the same 150,000-barrel per day pipeline with a unit train of 2,000-barrel tank cars would require a 75-car train to arrive

and be unloaded every day, again returning to the source empty, along separate tracks, to be refilled."

Pipelines have been the safest and cheapest way to transport oil, gasoline, and natural gas.

America's natural-gas pipelines have had a good safety record, but all energy transportation systems are vulnerable to terrorism and accidents, which could have far-reaching effects. (Ironically, the most technologically advanced form of our energy—electricity—has the most outdated, inadequate, and vulnerable transport network, the electric grid. That's another newsletter topic for the future.)

Remarkably, the natural-gas delivery network has been one of the safest forms of transportation of any kind, with only 12 fatalities in one year, 2002, during which there were 42,000 deaths on highways and a total of 2,000 deaths from aviation, boats and ships, and railroads.

According to the American Gas Association, gas companies spend $7 billion a year to maintain these pipelines. Natural gas also travels in a liquefied state, which requires that the gas be highly compressed. This is the way it is also transported across oceans among nations, and it is much more controversial because of the risk of explosions and vulnerability to terrorism.

Like air travel, petroleum transportation has hubs and spokes. New York City is one of the major hubs for importing and transporting oil, as is otherwise little-known Cushing, Oklahoma, along with Chicago, Los Angeles, and several areas along the Louisiana-Texas coast. Oil spills are of particular concern for hubs with high resident populations. It is important to note that not all the U.S. states are connected to each other by pipelines for either oil or gas. California has no pipeline from other states, and New England has no pipeline connection to the rest of the nation—fuel arrives there by barge. This means that a large portion of the U.S. population lives where the least expensive and most efficient oil-delivery system isn't available.

Each form of energy that we use to power our civilization has a transportation network. The networks are huge, and as the accompanying illustrations show, each network is surprisingly complex. (See the full-page map of U.S. pipelines at the end of this issue. It is too complicated to show here in one column.)

The good news: Although the amount of material moved is huge, the cost per barrel or gallon is low. For example, in 2001 it cost only about 2.5¢ per gallon to send gasoline from Texas to New Jersey through pipelines.

The cost is much higher by train, truck, and even by barge, as is the amount of energy expended to move the fuel by those means. In case you were wondering, oil moves about 3 to 8 miles per hour in the pipelines, so it takes two to three weeks for oil to get from Houston to New York City. This lag might create supply problems in an emergency, an argument in favor of going the electricity route.

So, if you're going to transport petroleum from a new source, the safest and cheapest way is a pipeline. For the major new petroleum finds in North Dakota, which are in the common form of mineral deposits, a new pipeline is the way to go.

The problem is the Canadian tar/oil sands.

The Canadian tar sands (also called oil sands) are the source of petroleum the Keystone Pipeline will transport to the U.S. These tar or oil sands underlie more than 54,000 square miles of Alberta's northern (boreal) forest --- that's an area the size of New York State.

The tar in the sands is just what it sounds like, a mixture of bitumen, which is the heavy compo-

nents of petroleum, and sand. Bitumen is familiar to us in what we call "blacktop" or "macadam" roads, bitumen mixed with sand (making what we call asphalt), combined again with more sand and/or gravel.

Bitumen is a semi-solid and doesn't flow at normal "room" or outdoor temperatures, so it has to be heated to separate it from the sand and gravel and get it to move. (Well, OK, on a hot summer day in Alberta, some bitumen does ooze from the deposits onto river valleys.) The oil sands are strip-mined, the most destructive form of fossil-fuel mining, as the long U.S. experience with coal strip-mining has shown. And even where U.S. laws require that strip-mined land be "reclaimed," I know of no cases where such land once so treated returns to anything like it was before.

To get it to move and become a usable source of fuel, takes 2.5 -- 4 barrels of water and about 1000 cubic feet of natural gas to make one barrel of bitumen. (That amount of natural gas is about as much as in 2 ½ of those small propane tanks people use for their BBQs.) So it takes energy just to get the tar to flow from the mine, and then it takes even more energy to get the bitumen to flow down the pipeline.

If built, the Keystone Pipeline is expected to transport 800,000-900,000 barrels per day of Canada's oil sands petroleum to Nebraska, and from there this petroleum would continue to Gulf Coast refineries. That's 10% of current U.S. oil production of about 9,000,000 barrels per day.

To make those 9 million barrels of transportable petroleum would require 9 billion cubic feet of natural gas and between 23-46 million barrels of water a day. That's 3.3 trillion cubic feet of natural gas a year, or about 1¼ % of the total 26.13 trillion cubic feet of natural gas used in the U.S. in 2013. In other words, 17% of the energy stored in the tar or oil sands is required just to get the stuff to flow in the pipeline.

Why use this source of petroleum fuels when there is now so much natural gas available from fracking in the U.S. 48 states and so much liquid petroleum in the geological formations concentrated in North Dakota? If the Alberta tar/oil sands were the last remaining source of petroleum fuels available to the United States, then perhaps one could make an argument for mining the Canadian sources. But if we needed to take an alternative to U.S. based fossil fuel mining, I have shown in my book *Powering the Future: A Scientist's Guide to Energy Independence* that it would be possible to replace 50% of projected 2050 U.S. use of petroleum with wind and solar, 100% with additional considerable energy conservation.

And there are other problems.

The Nebraska Supreme Court Case

A group of Nebraska citizens filed a lawsuit that challenged a 2012 state law allowing the governor to empower a Canada-based TransCanada private corporation to force people to sell their property for the pipeline's right of way, without allowing individuals to stop that taking of their land. In January 2015 the Nebraska Supreme Court rejected that citizen lawsuit against the state on what appear to be technical grounds. My specialty is ecological science, so I cannot speak with any expertise about such legal actions, but it does appear to be an indirect subsidizing of a private Canadian corporation at the expense of American citizens. If you support the Keystone Pipeline, it would seem you would have to be in favor of that kind of taking without allowed private ownership opposition.

Wildlife and biological conservation in the tar sands area

The Athabasca River, which starts in the glacial outwash of Canada's Jasper National Park, flows through the tar/oil sands region. This is

one of the most beautiful rivers I have ever seen, and one of the problems with mining the tar and oil sands is the protection of the great river, which flows through that mining area.

My son Jonathan on the shores of the Athabasca River

Although the Alberta tar sands cover a large area, the land is part of the North American boreal forest, one of the largest forests in the world in terms of area. These forests play a major role in biological diversity, especially for migratory birds of the New World. Any species that is endangered and migrates between Canada and the U.S. is protected under the 1916 U.S. Canada international migratory bird species treaty, the first U.S. international treaty concerning biological diversity.

Many of the birds familiar in the lower 48 states, including those of interest to sport hunters, spend their summers in the Canada boreal forests. In addition to game hunting birds, such as ducks and geese, these include Snow Goose, American Goldfinch, Evening Grosbeak, Great Blue Heron, Common Loon, Northern Pintail, Wood Duck, Siskin, Trumpeter Swan, Cedar Waxwing, and the Pileated Woodpecker.

In addition to the strip mining itself, obtaining the bitumen requires that the water used in the process, heavily contaminated, be stored in holding ponds and not allowed to flow down the Athabasca River. These oily, toxic ponds are taking a toll on migratory birds. There have already been some incidents of the tar/oil sands mining affecting some of these birds, even though the area strip mined is a small part of the total. According to the U.S. National Wildlife Federation,

•In 2008, 1,600 ducks died in Syncrude tailings ponds.

•An October 2010 storm resulted in hundreds of ducks landing on a Suncor tailings pond near Fort McMurray; at least 550 birds were too oiled to save.

•As of 2010, 43 species of internationally protected birds had suffered fatalities from exposure to tar sands tailings ponds.

Destroying a forest the size of New York State raises other questions, given concerns about forests' role in climate, including sequestering carbon.

Forests affect climate in four ways: Their color changes the reflectance from the land surface (northern boreal forests are very dark); they exchange water with the atmosphere; they affect wind flow through "surface roughness"; and of course they exchange carbon dioxide and other greenhouse gases. With all the interest in having forests grow more to store more carbon, strip-mining the tar/oil sands region is unpopular for these reasons as well and works against other climate programs and possible treaties. Whether you agree with these or not, if passed, they will likely place limits or the strip mining of the tar/oil sands.

Putting It All Together, Briefly

- **It is the source of the petroleum, Canadian tar and oil sands, that is the environmental problem, not the pipeline itself.**
- **With the huge amount of natural gas and conventionally pumped petroleum in the U.S. lower 48 states, there is no need for the U.S. to use the Canadian source.**
- **Obtaining useable petroleum from the Canadian tar/oil sands is the most destructive way to obtain fossil fuels, and should only be a last resort, not needed today.**
- **The U.S. energy transport network is huge. Some 90,000 miles of oil pipelines, 2 million miles of natural-gas pipelines, and 700,000 miles of electrical transmission lines transport much of the energy from where it is obtained to where it is used.**
- **America's natural gas and oil pipelines have had a good safety record, but all energy transportation systems are vulnerable to terrorism and accidents, which could have far-reaching effects.**

Who Said That? A Regular Newsletter feature. A lot of pundits make assertions that are supposed to be true, but don't back them up. For those who want to check what I write about, here are the sources for this issue:

Facts about pipelines
All the sources of information about pipelines used in this issue are given in my book *Powering The Future: A Scientist's Guide to Energy Independence.*

Birds and tar/oil sands National Wildlife Federal
http://www.nwf.org/news-and-magazines/media-center/news-by-topic/global-warming/2014/06-11-14-report-interior-must-address-bird-deaths-caused-by-canada-tar-sands.aspx

Basic facts about tar/oil sands
Alberta Government report
http://www.ags.gov.ab.ca/energy/oilsands/alberta_oil_sands3.html

Replacing a pipeline with trains and trucks
R. A. Wilson, *Transportation in America,* 18th edition (Washington, D.C.: EnoTransportation Foundation, Inc., 2001). "How Pipelines Make the Oil Market Work: Pipelines are Key to Meeting U.S. Oil Demand Requirements Allegro Energy Group."

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Special pipeline maps illustration follows

Special Illustration, this issue:

Enlarged maps of U.S. Pipelines.