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James Conca Contributor

I cover the underlying drivers of energy, technology and society.

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Pick Your Poison For Crude -- Pipeline, Rail, Truck Or Boat

Comment Now

Crude oil is moving around the world, around our country, around pristine wilderness, around our cities and towns. It's going to keep moving, will undoubtedly increase during our new energy boom, so what is the safest way to move it?

The short answer is: *truck worse than train worse than pipeline worse than boat* (Oilprice.com). But that's only for human death and property destruction. For the normalized amount of oil spilled, it's *truck worse than pipeline worse than rail worse than boat* (Congressional Research Service). Different yet again is for environmental impact (dominated by impact to aquatic habitat), where it's *boat worse than pipeline worse than truck worse than rail.*

So it depends upon what your definition is for *worse*. Is it death and destruction? Is it amount of oil released? Is it land area or water volume contaminated? Is it habitat destroyed? Is it CO2 emitted?

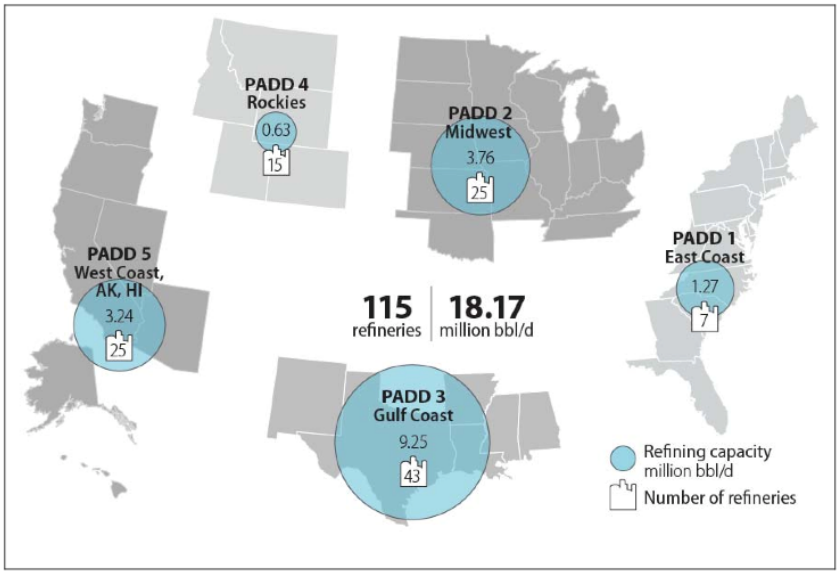
In both the United States and Canada, more crude oil, petroleum products, and natural gas are transported in pipelines than by all other modes combined, using the unit of ton-mile which is the number of tons shipped over number of miles (The Fraser Institute).

In the U.S., 70% of crude oil and petroleum products are shipped by pipeline. 23% of oil shipments are on tankers and barges over water. Trucking only accounts for 4% of shipments, and rail for a mere 3%. In Canada, it's even more lopsided. Almost all (97%) of natural gas and petroleum products are transported by pipelines (Canadian Energy Pipeline Association).

Amid a North American energy boom and a lack of pipeline capacity, crude oil shipping on rail is suddenly increasing. The trains are getting bigger and towing more and more tanker cars. From 1975 to 2012, trains were shorter and spills were rare and small, with about half of those years having no spills

above a few gallons (EarthJustice.org). Then came 2013, in which more crude oil was spilled in U.S. rail incidents than was spilled in the previous thirty-seven years.

Crude is a nasty material, very destructive when it spills into the environment, and very toxic when it contacts humans or animals. It's not even useful for energy, or anything else, until it's chemically processed, or refined, into suitable products like naphtha, gasoline, heating oil, kerosene, asphaltics, mineral spirits, natural gas liquids, and a host of others.



Sources: Congressional Research Service; Energy Information Administration.

Note: PADD = Petroleum Administration for Defense Districts, five districts established by executive order during World War II for gasoline rationing.

U.S. Refinery Capacity by PADD (Petroleum Administration for Defense Districts) in 2012. Source: Congressional Research Service; Energy Information Administration

Every crude oil has different properties, such as sulfur content (sweet to sour) or density (light to heavy), and requires a specific chemical processing facility to handle it (Permian Basin Oil&Gas). Different crudes produce different amounts and types of products, sometimes leading to a glut in one or more of them, like too much natural gas liquids that drops their price dramatically, or not enough heating oil that raises their price.

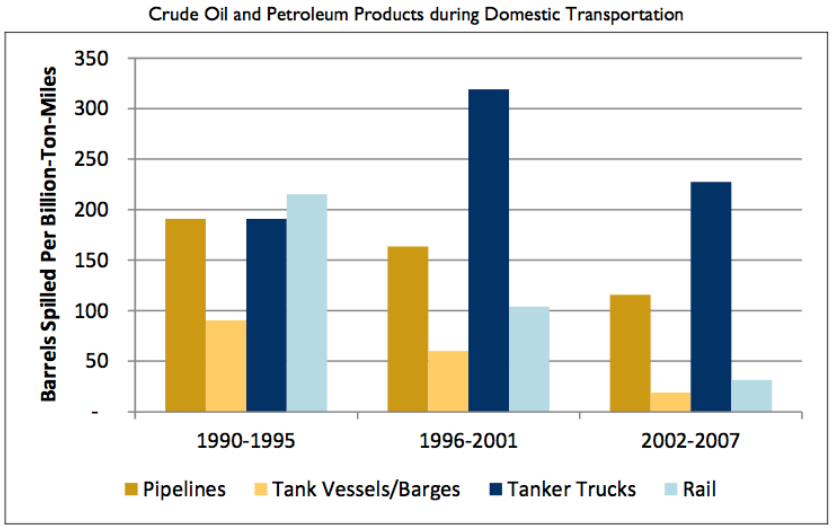
As an example, the second largest refinery in the United States, Marathon Oil's GaryVille Louisiana facility, can handle over 520,000 barrels a day (bpd) of heavy sour crude from places like Mexico and Canada but can't handle sweet domestic crude from New Mexico.

Thus the reason for the Keystone Pipeline or increased rail transport – to get heavy tar sand crude to refineries along the Gulf Coast than can handle it.

The last entirely new petroleum refinery in the United States opened in 1976 (Congressional Research Service). Since then, the number of refineries has steadily declined while refining capacity has concentrated in ever-larger

facilities. 25% of U.S. capacity is found in only eleven refineries. Recently, Shell's Baytown refinery in Texas, the largest in the nation, was expanded to 600,000 bpd. Most of the big refineries can handle heavy crude, but many smaller refineries can process only light to intermediate crude oil, most of which originates within the U.S.

Thirty-three states have refineries, and most refineries can handle tens-of-thousands to hundreds-of-thousands of barrels per day, but the largest capacity sits around the Gulf Coast and in California where the oil boom in America began. However, in the 1990s after production of sweet domestic crude had significantly declined from mid-century highs, the big companies like Exxon, Shell, CITCO and Valero spent billions upon billion of dollars to retool their refineries to handle foreign heavy crudes.



Source: Prepared by CRS; oil spill volume data from Dagmar Etkin, *Analysis of U.S. Oil Spillage*, API Publication 356, August 2009; ton-mile data from Association of Oil Pipelines, *Report on Shifts in Petroleum Transportation: 1990-2009*, February 2012.

Notes: Pipelines include onshore and offshore pipelines. The time periods were chosen based on the available annual data for both spill volume and ton-miles. The values for each time period are averages of annual data for each six-year period.

Oil spill volume per billion-ton-miles compared among transportation modes. Source: the Congressional Research Service

With the number of refineries decreasing, and capacity concentrating in fewer places, crude usually has to be moved some distance. There are four ways to move it over long distances: by pipeline, by boat, by truck, or by rail. Each has its unique problems and none is without harm.

The question is: which is safest and which should we invest in most? Take two spills for comparison.

The Quebec train wreck last year killed 47 people and spilled 1.5 million gallons of crude onto land (Bloomberg.com). The Enbridge pipeline rupture in 2010 spilled over a million gallons of similar crude into the Kalamazoo River but did not kill anyone (Wikipedia).

Contamination of water is generally much worse for the environment than contamination of land as it spreads quickly over more area and impacts more species and habitat. But killing people makes a big difference. I don't want to put a price tag on human life, but the Government has, and it's about $8 million a person (NYTimes).

So the Quebec train derailment cost over $400 million in human life, and will cost another $150 million or so for clean-up and rebuilding the town. The Enbridge pipeline cost no human lives but will cost about a billion dollars to clean-up and, like the Exxon Valdez, will never really succeed.

Note: using this value of $8 million a person, we 300 million Americans are worth $2.4 quadrillion, hmm...maybe not a good number. If we use our net value for America as a whole, about $75 trillion, divide by 300 million people, then the average value of a human life in America would be $250,000. So the Quebec train derailment cost less than $12 million in human life. Thus the danger of trying to gauge the value of a human life.

These are not easy questions and one's vested interest has a great deal of sway in the answer. You really do need to pick your poison.

Like always, it will probably come down to money. And it won't be about jobs (Pipeline Jobs), regardless of which end of the spectrum you believe, because there just isn't enough jobs to matter compared to the value of the oil itself and the refinery capacity. It's simply cheaper and quicker to transport by pipeline than by rail or by truck. The difference in cost is about $50 billion a year for shipping via the Keystone versus rail, totally eclipsing any economic effect of jobs in either direction.

A rail tank car carries about 30,000 gallons (÷ 42 gallons/barrel = about 700 barrels). A train of 100 cars carries about 3 million gallons (70,000 barrels) and takes over 3 days to travel from Alberta to the Gulf Coast, about a million gallons per day. The Keystone will carry about 35 million gallons per day (830,000 barrels). This puts pressure on rail transport to get bigger and bigger, and include more cars per train, the very reason that crude oil train wrecks have dramatically increased lately.

The Congressional Research Service estimates that transporting crude oil by pipeline is cheaper than rail, about $5/barrel versus $10 to $15/barrel (NYTimes.com). But rail is more flexible and has 140,000 miles of track in the United States compared to 57,000 miles of crude oil pipelines. Building rail terminals to handle loading and unloading is a lot cheaper, and less of a hassle, than building and permitting pipelines.

It isn't acceptable to just say we shouldn't be moving oil, because we will for the next decade or more, no matter what. So, keeping in mind the difference between death/damage to humans and damage to the environment, which would you choose?

Like a few weeks ago, I would appreciate just one comment from each person for the first 24 hours after posting so we can get a tally before we get into the normal animated back and forth debates. Below is some more information on each transportation mode.

Rail

Two seemingly opposite facts –

1) from 1980 to 2012, the train accident rate in the United States fell 80 percent, the rail employee injury rate fell 85 percent and the RR crossing collision rate fell 82 percent, but

2) more crude oil was spilled in U.S. rail incidents in 2013 than was spilled in the previous thirty-seven years.

Huh?

Using data from the Pipeline and Hazardous Materials Safety Administration, 1.5 million gallons of crude oil were spilled from rail cars in 2013. On the other hand, from 1975 to 2012, railroads spilled a total of 800,000 gallons of crude oil (McClatchy; check out their great interactive map of spills over space and time).

Even worse, these data do not include rail accidents in Canada. 1.5 million gallons of crude oil spilled in a single day last year in Lac-Megantic, Quebec, and 47 people were killed. The shipment did originate in North Dakota so take your pick of provenance.

If crude oil shipping on rail is becoming a preferred mode for oil producers in our North American energy boom, this trend is very disturbing. In 2011, crude rail capacity between southern Alberta and the northern U.S. Great Plains tripled to about 300,000 barrels per day, about a third of the Keystone XL capacity. U.S. railroads delivered 7 million barrels of crude in 2008, 46 million in 2011, 163 million in 2012, and 262 million in 2013 (almost as much as that anticipated by the Keystone XL alone). To replace the Keystone XL with rail shipments would mean another doubling of rail capacity, but that would be just another couple of years given this trend.

The Association of American Railroads points out that over 11 billion gallons of crude were shipped in 2013, so these spills account for only one-hundredth of one percent. On the other hand, the environment and people's health don't care about what made it though OK, just what was spilled.

Our railroad infrastructure was not built to handle this mass of crude on its system and doesn't use enough specialty cars. If this trend continues, major infrastructure investments need to occur on both sides of the border, as well as significant changes in protocol and regulation.

Like: big oil trains have to go slower, or oil tank cars have to be hazardous material cars.

It turns out that the rail industry recently modified its guidelines in response to the Quebec derailment (Congressional Research Service) as follows:

- restrict train speeds to less than 50 mph
- increase the frequency of track maintenance
- install wayside defective equipment detectors, such as "hot box" detectors, that detect wheels with faulty bearings, every 40 miles, with specific protocols for conductors when defects are indicated
- use only track in good condition to support speeds of 25 mph or higher.

Reducing train speed can reduce the number of cars that derail as well as the likelihood that oil will be released from those cars, or that explosions will result.

Truck

Although the news is filled with comparisons between pipelines and trains, the third vector is trucks. While we can compare relative risks, the issue with trucking is that it takes lots and lots of trucks to move billions of gallons of crude since a single tank trailer only holds about 9,000 gallons or 200 barrels, a little under a third of a rail car. Our present fleet only handles 4% of our needs, so shipping by truck instead of the Keystone XL would take another million-and-a-half tanker trucks. Trucking is the most risky form of transport from an accident standpoint (yes, driving is one of those things, like smoking, that will always be in the top four *most risky things to do* – What's Really Gonna Kill You?) and also from a spill standpoint. However, it is the least impactive from an environmental standpoint since each truck is small and is mainly on land, so large spills to waterways are less likely than any other mode of transport.

What is important to note, however, is that regardless of the long-hauling mode, most petroleum eventually gets onto a truck for the short moves. This limits the tons-mile risk but increases the incident number risk.

In a white paper about the dangers of transporting dangerous goods by truck, the Canadian Trucking Alliance repeats its long-standing position that "*the federal government should introduce a universal mandate requiring all trucks, where the driver is currently required to carry a logbook under the federal hours of service regulations, to be equipped with an electronic recording device; and introduce a manufacturing standard (in lock-step with the United States) requiring all new heavy trucks to be equipped with a roll stability system*" (Canadian Trucking Alliance). In addition, the Alliance wants all Canadian provinces and U.S. states to follow Ontario's and Quebec's lead by requiring truck speed limiters.

Boat

Ship transport is possible along coastal waters and along large rivers and is the method that is used for almost all foreign imports except from Canada. The thing about ships is that they carry a lot of oil per boat and many of the largest spills in history are from boats, such as the Exxon Valdez and the latest one from a collision in the Houston Ship Channel just last month (NOLA).

Five out of the ten largest oil spills in U.S. history were from boats (List of oil spills). Most important is that they have immediate impact on aquatic ecosystems both in the ocean, in rivers, or along shorelines that are usually sensitive habitats. I still don't understand why these keep happening with modern technologies to detect water depth and nearby boats. Human error needs to be better removed from this equation.

Pipeline

The most controversial transport mode today is pipeline, mainly because of the Keystone XL debate and the recent Pegasus and Enbridge pipeline ruptures. The industry points to the generally good safety record in terms of percentages. Among oil pipeline workers, the rate hospitalization was 30 times lower compared to rail workers involved in transporting oil, and 37 times lower than for road transport, between 2005 and 2009, the latest period for which complete data exists (Intermodal Safety in the Transport of Oil).

But pipeline spills are inevitable. About 280 pipeline spills occur each year in the U.S. that are deemed *significant* (USDOT), that is, either there is a fatality or injury requiring in-patient hospitalization, it causes $50,000 or more in total costs (measured in 1984 dollars), there are highly volatile liquid releases of more than 5 barrels or other liquid releases of more than 50 barrels, or there are liquid releases that result in an unintentional fire or explosion.

Again, you'll notice that these measures are in human health and property damage, not environmental effects. Environmental impacts are very difficult to estimate and, in almost all cases, are not even attempted.

In the end, all of these transportation modes can be made safer if stricter regulatory controls and modern technologies are emplaced, but the questions remain – can we make the industry comply and which ones do we want to invest in?

Finally, what brave reader wants to calculate the value of an acre of land destroyed by an oil spill? The EU recently allotted $100 per acre for removing pristine land for energy use, but this seems way too low. My muse suggests you start with Sierra Club, NRDC and EDF.
