Chapter 7
Distributing Drop-in Fuels: The Fastest Road to Something Else

It is almost impossible to exaggerate the importance of our transportation system. Take a deep breath and think about this: the United States is locked-into $1.11 trillion dollars of transportation vehicles supported by $4.62 trillion of transportation infrastructure comprising 12 % of all the wealth in the nation (U.S. Commerce 2012).

Ships, locomotives, and trucks with diesel engines can last up to 40 years and travel a million miles. It would take decades to replace them. Therefore, the best alternative fuel is one that doesn't require getting rid of them—a "drop-in" fuel. Otherwise, we face the chicken-or-egg problem of no one buying a new-fuel vehicle because of a lack of stations that sell the new fuel, so not many alternative vehicles are made, and service stations won't add the new fuel if there aren't enough customers (GAO 2011).

A drop-in fuel would be able to use the nation's incredibly cheap and energy efficient 190,000 mile oil pipeline system, which distributes oil to 1350 distribution terminals for delivery to 160,000 service stations. Interstate petroleum pipelines transport 31 million barrels (1.3 billion gallons) of crude and refined oil every day (NACS 2013). It would take 39,500 rail cars or 162,500 trucks to move this amount of oil daily.

Pipelines are by far the cheapest way to move oil at 1.5–2.5 cents per gallon per thousand miles. Rail is five times more expensive at 7.5–12.5 cents, and trucks about 20 times more, 30–40 cents (Curley 2008).

Unfortunately, ethanol and biodiesel (which aren't drop-in fuels), can't travel in oil pipelines because:

1. Designing pipelines that could carry either oil or biofuels requires overcoming another obstacle: Oil leaves behind some water and impurities. Both ethanol and biodiesel are good solvents, and would pick up and mix with this water and impurities, and these contaminants could destroy engines.
2. Biodiesel can contaminate oil with methyl esters, making jet fuel unsafe (APEC 2011).

A.J. Friedemann, *When Trucks Stop Running*,
Energy Analysis, DOI 10.1007/978-3-319-26375-5_7

3. Ethanol corrodes and cracks steel, damages seals, and lets water into oil pipelines. For that reason, the existing 190,000 mile oil pipeline network is off limits to ethanol. Few ethanol pipelines exist because they cost $4 million per mile (GAO 2011; Melaina 2013).
4. Oil can travel only one-way, which is mainly from coastal refineries inland, yet most biofuels move from the Midwest outward.

Instead of being moved by cheap and efficient pipelines, ethanol travels on trains, trucks, and barges. Diesel, twice as energy dense as ethanol, is used by locomotives to haul 60 to 70 % of ethanol in 304,000 30,000-gallon tank cars (1 % of all carloads) traveling 34.3 billion ton-miles (AAR 2015). Half a million trucks haul 29 % and the remaining 5 % goes by barge every year.

Hydrogen is not a drop-in fuel—it can't be burned by existing engines—and can't travel in oil (or natural gas) pipelines because it requires special steel that won't become brittle and crack or fissure.

Natural gas is not a drop-in fuel, though natural gas can be delivered by natural gas pipelines to service stations and turned into compressed natural gas (CNG) to power trucks set up with special tanks and engines. Liquefied natural gas (LNG) needs to be delivered by truck. Methanol or dimethyl ether made from natural gas requires too many fueling and vehicle infrastructure investments.

Next Stop: Service Stations

A new LNG station can cost up to $2 million, and there are only 73 public and 38 private LNG stations in the U.S. A new CNG station costs up to $1 million. About half the 1500 CNG U.S. stations service private fleets of buses, garbage trucks, and delivery vans.

Adding E15 (15 % ethanol, 85 % gasoline), E85, or biodiesel can cost $100,000–$200,000 (underground tanks and pumps need to be replaced), too much for mostly Mom and Pop operations, where more profits are made from junk food than fuel.

This is why E15, biodiesel, hydrogen, CNG, and LNG are sold at less than 1 % of service stations and E85 at less than 3 % of them.

Nearly all heavy-duty vehicles have diesel engines, which are very fussy, and can only burn #2 diesel which is made to very exact specifications. They can't burn gasoline, nor diesohol (diesel and ethanol), and only a small amount of biodiesel, since heavy-duty diesel engine warranties typically allow B5–B20 biodiesel at most, and biodiesel is often avoided entirely because it can shorten engine life (Borgman 2007), and gets less mileage.

Ships and aircraft are reluctant to use biodiesel, or any non-drop-in fuel, because it's dangerous and potentially fatal if their engines fail. Railroads don't want to risk stranding a locomotive, since few spare locomotives exist (Voegele 2011).

Cost to Create Drop-in Fuel

Even if a drop-in fuel can be created, it may be too expensive. Many energy-intensive steps are needed to turn biomass, oil sands, coal, and natural gas into drop-in fuels due to their chemical and physical properties being so different from crude oil in viscosity, lubricity, water content, flashpoint, cetane number, carbon chain length, ash content, cloud point, and other factors.

Natural gas is not a drop-in fuel, but can be converted to one in a Gas-to-Liquid (GTL) plant. These are built near locales with decades of cheap gas (NRC 2009). The $19 billion GTL plant in Qatar only produces 140,000 barrels/day with profits mainly from high-value chemicals, not fuel.

Railroads Can't Afford to Replace Their Locomotives

As an efficient mover of freight, rail has a lot of advantages going for it. It also has an invisible disadvantage.

Trucks, airlines, and barges use highways, airways, and waterways mostly paid for by taxes and the government. Roads get 62 %, airports 13 %, and water transport 5 % of federal government transportation money. Railroads get nothing.

Railroads are privately owned and spend more capital than nearly all other businesses to maintain what they have, yet are less profitable than the average enterprise. Locomotives burn diesel and only diesel. A non-drop-in fuel would require spending $50 billion to replace 25,000 locomotives worth $2 million each, and billions more for a new distribution system. Railroads are already spending over $12 billion dollars to comply with the Rail Safety Improvement Act and meet EPA Tier 4 emissions standards. Additionally, there's a risk that freight would shift to trucks due to time lost swapping locomotives, refueling more often, and having to charge higher rates.

Conclusion: Time Is Running Out

Finding alternative liquid fuels for military transportation will be even harder than for trucks, rail, and shipping. The U.S. Navy uses 187 types of diesel engines, 30 kinds of gas/steam turbine engines, 7,125 different motors, several types of nuclear reactors in aircraft carriers and submarines, and turbojet, turboprop, turboshaft, and turbofan engines in aircraft. Each of them needs just the right combination of energy content in both mass and volume (CNA 2009).

In an oil shock, trucks, rail, and ships need to be able to run on something else, and post fossil fuels the "something else" needs to be renewable. The next chapters look at fuel options that are already commercial or might be available within 10 years.

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