Introduction:
Is Vegetable Oil Right for Me?

In this chapter, we will lay out the argument for using vegetable oil as an alternative diesel fuel. We should note, first of all, that vegetable oil can only be used in diesel engines. If you don't have a diesel engine, then you also need to be convinced that it is worthwhile to invest in a diesel, in addition to being convinced that vegetable oil is a worthy choice.

There seem to be four different factors that motivate people to use vegetable oil as a fuel: environmental concerns, cheaper fuel costs, geopolitical concerns, and an interest in tinkering.

Environmental Reasons

The use of straight vegetable oil reduces the carbon contribution of a diesel engine significantly or completely, depending upon whether the oil is fresh or used. The tailpipe emissions of vegetable oil are probably comparable to that of biodiesel, which means that it is better on many measures and worse on some.

Fossil Fuel Efficiency

There has been no thorough life-cycle energy and carbon analysis of vegetable oil fuel, but we can make some extrapolations from work that had been done on biodiesel. In a 1998 study, the National Renewable Energy Lab looked at how much energy from fossil fuels it took to get biodiesel to the fuel tank, including how much energy it took to grow the crop, transport

the crop, crush the crop into oil, transport the oil, convert the oil into biodiesel, and transport the biodiesel.[1] They found that every megajoule (MJ) of biodiesel at the pump took .311 MJ of fossil fuel energy to get there. This gives a fossil fuel efficiency of 3.215. In other words, by producing biodiesel we can turn one MJ of fossil fuel energy into 3.215 MJ of energy.

The fossil fuel efficiency of straight vegetable oil should be better than that, since, unlike biodiesel, it does not require fossil fuel inputs as raw material, or require an energy-intensive chemical transformation. How much better is impossible to say with current data, but if we use the NREL data, and subtract out these two inputs, we can get an upper estimate of 6.4 for the fossil fuel efficiency of vegetable oil. [2]

Carbon Contribution

According to the same study, replacing petrodiesel with biodiesel would reduce the total lifecycle carbon dioxide contribution by 78 percent. This reduction does not happen at the tailpipe where both fuels release about the same amount of carbon dioxide, but is because most of the carbon contained in the biodiesel and released in the process of getting the biodiesel from the crop to the fuel tank is carbon that was pulled out the atmosphere by the original oil crop, as opposed to petrodiesel where all the carbon associated with this fuel was pumped out of the ground. The total carbon dioxide produced by production, transportation, and burning of biodiesel is 679.78 grams per brake horsepower-per-hour (bhp-h). Of that, 543.34 grams is carbon dioxide that was absorbed by plants to produce the oil. That leaves 136.45 grams from fossil fuel sources.

Again, vegetable oil should reduce carbon even more because it requires less energetically demanding processing and also because it does not require methanol as an ingredient, as biodiesel does; the vast majority of methanol is produced from natural gas by refiners. The study says that the conversion of oil to biodiesel makes up about a third of the total lifecycle carbon dioxide contribution from fossil fuel sources. By leaving out this step, vegetable oil can reduce the carbon dioxide contribution by perhaps 85 percent.

Waste Oil

The above calculations are based upon the assumption that the oil is being produced for use as fuel. If the oil is a waste product, the energy costs

and carbon produced up to the point where you pick up the oil from a restaurant can be treated as sunk costs. The amount of energy and carbon dioxide released in the production of the oil does not depend upon how the restaurant chooses to dispose of it. With waste oil, the only carbon dioxide you have to be concerned with is from fossil fuel energy inputs that are required to pick up the oil, process it into a usable fuel, and get it into your vehicle, and the petrodiesel you burn in order to bring the vehicle up to temperature in a two-tank system.

Tailpipe Emissions

Unfortunately, nothing definitive can be said about the tailpipe emissions of diesel engines fueled with adequately heated vegetable oil. Of the studies that have been done on the emissions of an engine burning vegetable oil, most of these did not adequately heat the oil, and the results are not valid. Of the few studies that have been done, the results vary widely, probably as a result of differences in testing protocols. From a theoretical standpoint, a diesel engine burning adequately heated vegetable oil should have emissions very similar to biodiesel. Carbon monoxide and particulates should be lower than that of diesel, and NO_x may be slightly higher.

At the end of the day, it must be recognized that no matter whether we are burning petrodiesel or vegetable oil, we are burning hydrocarbons that are very similar at a molecular level, and so the tailpipe pollution is also going to be similar. Using vegetable oil as fuel will not markedly improve the local air quality.

Destruction of Wilderness

There is a hidden cost to using any biofuel, and that is that it increases the commodity prices of oilseed crops, prompting the conversion of environmentally important "waste" lands to the cultivation of oil-producing crops. In the past few years, encouraged by high oil prices, thousands of square miles of rainforest and bogs have already been destroyed in order to cultivate oil crops in Indonesia, Malaysia, India, Brazil, Columbia, and other countries, at the cost of millions of tons of carbon Dioxide being released into the atmosphere, the loss of biodiversity, and the destruction and displacement of local communities. The expansion of oil crop plantations

into wilderness is projected to increase dramatically over the next twenty years, prompted by increased demand for biodiesel.

If this concerns you, there are no easy solutions. Buying fresh oil, no matter the country of origin, increases total oil demand and raises commodity prices worldwide. Using waste oil can be much less problematic, but in the US, waste oil is sold by rendering companies as yellow grease, and to a certain extent yellow grease is a substitute for fresh oil. By increasing demand for waste oil, that raises the price of yellow grease, which in turn also raises the cost of fresh oil. In most parts of this country, the supply of used cooking oil by restaurants is only very loosely connected to the commodity price of yellow grease and a handful of people using waste oil will have no real effect. This is changing though, and in some cities, the supply of used cooking oil is tightly connected to biofuels economy.

Personally, I feel that in communities where restaurants have to pay to have their oil taken away, using waste oil as fuel is still a relatively uncomplicated environmentally responsible act, since the local oil supply has not been effectively connected to the global oil economy.

Economic Reasons

Using waste oil as fuel can save you a significant amount of money, depending upon how much you value your labor, your oil collection and processing setup, the fuel economy of your vehicle, and your driving habits.

The savings can be calculated using this formula:

$$Savings = \frac{Miles\ Driven \cdot Percent\ of\ Miles\ Running\ Vegetable\ Oil \cdot (Cost\ of\ Petrodiesel - Cost\ of\ Vegetable\ Oil)}{Fuel\ Economy\ of\ Vehicle} - Initial\ Cost\ of\ Conversion\ and\ Collection\ and\ Processing\ Equipment$$

As you can see, savings are dependent upon a number of factors that don't have much to do with the fuel, but instead depend upon driving habits and fuel economy. If you have a very fuel efficient vehicle that you drive for less than 5,000 miles per year, mainly for short trips during which the engine is warm enough to use vegetable oil for only a small portion of

the time, then you may never save any money. If you are more like the average driver, and drive around 12,000 miles a year on trips of varying duration, and spend most of the time burning vegetable oil, you'll probably make back your initial investment of $2,000 to $3,000 after two years or so. If you are a high-mileage driver, then you can start saving money within months of conversion.

As important as fuel economy and driving habits is the real cost of vegetable oil fuel. It's easy to figure out the price of fresh oil, but figuring out the cost of waste vegetable oil can be more difficult. Obviously, included in the costs should be the electricity, disposable filter, and supplies that are part of your collection and processing setup. Perhaps less obvious, you should also probably count the labor cost that goes into collecting and processing every gallon of waste oil. Most people spend about an hour or so for every forty gallons of fuel they collect. If your time is worth $12 an hour that means the fuel costs $0.30 in labor per gallon. If your time is worth $80 an hour, the labor cost of the fuel is $2.00 per gallon.

You owe road taxes on whatever fuel you burn on public roadways, although many people don't pay these taxes on the vegetable oil they burn. If you plan on complying with the law, you should calculate the road tax into cost of vegetable oil fuel.

Warranties

The dealer will probably use the fact that you have been running vegetable oil as grounds for not honoring any warranty you have on your vehicle, even if the problem is completely unrelated to the alternative fuel. This is not legal in this country, as the Magnuson-Moss Warranty Act requires that the dealer show that the damage was actually caused by the aftermarket alterations in order to deny warranty coverage.

Even the law is on your side, expect to have to fight hard to get the dealer to do what's right. Whether or not that is worth your time, you will have to decide.

Legalities

According to the Environmental Protection Agency, it is currently illegal to convert a diesel to run on straight vegetable oil, without an exemption from that agency, because it constitutes illegal tampering of emissions-related

components. To my knowledge, the EPA has never gone after individuals for illegal tampering, but if you are considering using vegetable oil in your business for a number of vehicles, I would suggest making contact with your local EPA office to ask for guidance.

Other Factors

Besides the time that it takes to process and collect the oil, you should also recognize that if you are using waste oil, this is not the cleanest activity imaginable. Even with the best possible setup, there will be spills, there will be bad smells, and you will get oil on you and your clothes on at least one occasion.

In addition to having a diesel vehicle, the money to convert the vehicle, and the time and inclination to deal with waste vegetable oil, you also need a place to store and process the oil. If you own your own home or shop, then that's not a problem. If you rent, finding a place to deal with the oil can be challenge.

Comparison of Other Alternative Energy Paybacks

Most of our customers report that within two years they saved enough money burning vegetable oil to pay for the initial investment. A two-year payback compares very favorably to other alternative energy options available on the marketplace. The typical payback for a domestic solar hot water system is five to eight years, the typical payback for photovoltaic cells is seven to fifteen years, and a Prius may never pay for itself.

Geopolitics

Many people see using biofuels as a political act, because our country's dependence on oil is seen as making us dependent upon the will of foreign nations, because our dependence on oil leads us into foreign wars at the cost of blood and treasure, or because multinational petroleum industries are seen as malevolent forces.

Certainly, at the present scale, the effect of using waste vegetable oil does have the effect of lessening, very slightly, our dependence upon foreign or corporate sources of energy. However, as biofuels such as biodiesel and ethanol continue to grow, the result will probably be that we will become dependent upon the wills of a different set of nations and somewhat different set of corporations.

Because of questions of scale, using waste vegetable oil will probably continue indefinitely to actually reduce our dependence on foreign nations or corporate interests.

Tinkering

For a certain kind of person, using vegetable oil as fuel can be an extremely pleasurable pastime. The field is very young and it is very easy for an individual to do something new, to make a significant improvement in technology, or to shift our understanding of how to use this fuel. Some people very much enjoy doing things to a vehicle that the manufacturer never intended, in making their own fuel, and in being part of a community of experimenters.

Straight Vegetable Oil vs Homebrew Biodiesel

Using straight vegetable oil shares many of the same advantages and disadvantages of making biodiesel for yourself. Both have the potential to save you money. They have similar environmental and political impacts. Using either fuel is illegal and will give you the same warranty troubles. Both require a space to muck around with and a willingness to get dirty from time to time.

A big difference is that straight vegetable oil has a high initial cost and low operating costs, and homebrew biodiesel has a low initial cost and higher operating costs. Ultimately, which one is right for you probably most depends on what kind of person you are.

Making biodiesel involves a capacity and willingness to safely handle dangerous chemicals: flammable methanol and highly corrosive catalysts. You must regularly make very careful and precise measurements and use good lab discipline, and you must test your fuel much more rigorously. If you are the kind of person that might be interested in brewing your own beer, than this might be a good fit for you.

If working on cars is more appealing to you, then straight vegetable oil may be a better fit, since the action is mainly in the vehicle, and requires much less attention to the chemistry of the fuel.