Alternative Diesel Fuel Procurement

Substitution of lower-lifecycle climate impact fuels (specifically renewable diesel and biodiesel products) for fossil diesel, represents a significant opportunity to reduce the climate impact of diesel equipment without negatively effecting operations or the quality of services provided. Biodiesel and renewable diesel reduce tailpipe greenhouse gas (GHG) emissions by using plant-based feedstock to produce the fuel instead of fossil petroleum. The carbon contained in these materials is part of the living carbon cycle and therefore has a much lower climate impact than fuels produced with fossil carbon that has been stored in the earth for millions of years.

Biodiesel has been available for many years as a lower-GHG impact substitute for fossil diesel. In recognition of this benefit, the State of Oregon mandated the use of 5% biodiesel in all diesel products sold in Oregon beginning in 2011. Many organizations, including the Oregon Department of Transportation (ODOT) at times, exceed that minimum and use a B20 product (20% biodiesel / 80% fossil diesel) year-round. However, renewable diesel has emerged as the preferred fossil diesel substitute that can be used at much higher blend rates (99% renewable) than biodiesel without additional maintenance or warranty issues that some experience with biodiesel. Renewable diesel (also referred to as "R99", reflecting the blend rate: 99% renewable with 1% fossil diesel) is a drop-in fuel, meaning no equipment or storage tank modifications are necessary because the fuel can operate at the same cold temperatures as petroleum diesel, without the gelling problems experienced with biodiesel.

Real World Examples

Many public entities throughout Oregon are increasing their use of biodiesel or renewable diesel:

- ODOT is already using renewable and biodiesel fuels as fossil diesel replacements through a statewide price agreement. In 2020 renewable and biodiesel fuel use increased to 23% from 3% of diesel fuel in 2019.
- Multnomah County purchases R99 through a price agreement negotiated by the ***Greater Oregon Fleet Cooperative***[1] (GOFC).
- The Port of Portland is using R99 exclusively for owned operations. This policy is planned for expansion to marine vehicles and the Port's vendors. The Port is also in the process of procuring renewable natural gas to fuel its fleet of shuttle buses.

Current Conditions & GHG Inventory Results

Current Conditions

Diesel fuel use by ODOT vehicles and equipment is critical to support the construction, operation, and maintenance of the state highway system. Between fiscal years (FY) 2016 and 2019 ODOT consumed between 2.3 and 2.8 million gallons of diesel fuels annually in owned vehicles and equipment. Fossil diesel is commonly blended with either biodiesel (2% - 20% blends) or renewable diesel (between 20% - 99% blends). On average,

[1] GOFC is a purchasing group comprised of different government agencies throughout Oregon and was formed to leverage public resources to reduce costs. Participants of the cooperative include: school districts, cities, counties, park districts, transit districts, utilities, colleges and universities. For more information visit https://greateroregonfleetcooperative.org

between FY 2016 – 2019, ODOT used 91% fossil diesel, 7% biodiesel, and 2% renewable diesel of all diesel fuels consumed. That said, ODOT increased its use of renewable diesel in FY20 to 23%, up from 3% in FY19 (percentage renewable diesel out of total gallons of diesel blends).[2] Beyond direct fuel use in ODOT owned equipment, fuel used by ODOT contractors was estimated between 1.5 – 2.0 million gallons over the period. Data on fuel type used by contractors was not available.

GHG Inventory Results

ODOT's tailpipe GHG emissions from diesel fuel combustion in owned vehicles and equipment between FY2016-19 averaged 24,200 MT CO2e (range of 22,000 – 27,000 MT CO_2e). Beyond tailpipe emissions, another 6,000 – 9,000 MT CO2e were emitted during the production of diesel fuel used by ODOT. For contracted construction equipment and materials delivery work, the emissions were found to be between 22,000 – 25,000 MT CO2e over the period from tailpipe and fuel production. In total, GHG emissions from ODOT direct and indirect fuel use average over 50,000 MT CO_2e annually.

Other/Complimentary Alternatives

Actions to compliment use of alternative diesel products include increasing fuel economy. Examples include:

- Use of anti-idle technology[3]
- Procurement of newer vehicles and/or hybrid technology to increase fuel efficiency
- Use of telematics to inform logistics planning and driver performance

Other currently available lower-carbon fuel alternatives include:

- Propane (renewable or fossil)
- Natural gas-based fuels (renewable or fossil)

On the horizon – other lower-carbon fuels include:

- battery electric
- green/renewable hydrogen

These technologies and fuels are on the horizon but are not currently commercially available for many of the vehicle types and end-use needs required by a department of transportation. Use of these fuels may well become best practice in the mid to long term (5-20 years), but do not offer an immediate solution.

Practice Alternative(s): Market Study

Availability and Access

According to the US Department of Energy, there are currently five plants that produce renewable diesel in or for the United States, with a combined capacity of nearly 400 million gallons per year. Renewable diesel availability is expected to grow significantly over the next five years as new plants are constructed. Large domestic and international renewable diesel producers include Green Diamond and Neste. New plants are anticipated to come online over the next two to five years in California and Oregon. In Oregon, those facilities are in Lakeview and Clatskanie. A second related challenge is that renewable diesel is not consistently available

[2] FY 2020 is outside the scope of this GHG Inventory and, thus, the reduction in emissions from the R99 use is not reflected.
[3] Approximately 225 ODOT trucks use anti-idling technology, or, 24% of on-road fleet. ODOT's Sustainability Plan has a goal to increase this amount to 30%.

throughout Oregon and, specifically, is not available at card lock fuel stations. Many of these stations are franchised, individually owned and will likely need to install new tanks to regularly provide other fuels like renewable diesel.

To improve distribution, a minimum annual purchase volume (100,000 gallons annually) is typically required to support card lock operators investing in the addition capital infrastructure. Supplying this fuel via card locks would allow for greater access to smaller jurisdictions and other smalls-scale private business uses. During project interviews, representatives from smaller jurisdictions noted it would be helpful and appreciated if the State of Oregon would lead the charge to help support with regulator options as well as building distribution infrastructure. This could happen through a new price agreement or through GOFC. Distributing renewable diesel at retail stations is not without precedent. California's Propel Fuels operates 32 public fueling stations that offer renewable diesel at a competitive price to conventional diesel.

Cost

Fuel Costs

Between FY 2016 – 2019, ODOT paid the following per gallon for the various diesel fuels used by fleet operations:

- $1.64 - $2.34 for B5
- $1.98 – $2.48 for B20
- $2.40 - $2.58 for R20
- $1.96 - $4.33 for R99

In FY21, the R99 price per gallon was $1.95, versus $2.16 for B5 (a $0.21 savings per gallon for R99).

Fuel costs also include a markup for delivery. R99 delivery costs can be greater than for B5 due delivery distances from Portland. Most fuel suppliers do not currently have storage capacity for R99 at their satellite locations and need to pick it up in Portland for delivery. ODOT's fleet and fuel experts believe this will change in the next few years. In Eastern Oregon, per gallon delivery costs are between $0.20 (truck and trailer delivery) to $0.39 (tank wagon delivery). ODOT would likely pay the higher end of the cost range in more rural areas due to limited tank size which doesn't support bulk delivery via a truck and trailer. With the higher delivery cost, net cost for R99 can be greater than B5.

Infrastructure Costs

ODOT-owned fueling sites typically have one dedicated tank for diesel fuel. The type of diesel in each tank depends on price, location and any specific needs of the district. It is unlikely ODOT would install additional tanks to have multiple diesel types. ODOT is on track to using R99 exclusively when there is sufficient supply at a cost-competitive price. Because R99 is a drop-in fuel, there are no anticipated infrastructure costs for ODOT.

Fuel suppliers, retailers and cardlock operators may need to invest additional funds for extra storage tanks to have the ability to carry multiple diesel types to meet the needs of their customers. It was made clear during project interviews the current demand for R99 is not significant enough to warrant conversion of a fossil diesel tank to renewable diesel. Thus, expanded tank infrastructure may be needed to supply ODOT and, potentially, the agency's contractors with R99. Market research indicated a new 1,000-gallon tank costs approximately $13,000 and a 2,000-gallon tank is approximately $26,000. These costs do not include installation, electrical, and other development and permitting costs which can vary greatly by location and circumstances.

Grants / Incentives

The Internal Revenue Service (IRS) currently provides a 30% tax credit (up to $30,000) for the cost of installing alternative fuel pumps (Alternative Fuel Vehicle Conversion and Infrastructure Tax Credit). There was previously a federal grant program (Higher Blends Infrastructure Incentive Program[4]) allotting $100 million to aid in the creation of renewable diesel infrastructure (funding to install renewable diesel pumps). The program closed in January 2021 but the program officer at the US Department of Agriculture indicates there is discussion about having another $100 million grant cycle.

In Oregon, the Department of Environmental Quality's Clean Fuels Program launched in 2016 to help reduce the health and climate impacts from diesel emissions. The program provides financial incentives from sale of credits to fuel distributors and others who participate in the program. These funds may be used to lower fuel costs or to offset initial vehicle costs for related infrastructure.

A few of the Clean Fuel Program efforts include:

- Alternative Fuel loans[5]
- Biofuels Production Property Tax Exemption[6] (rural properties used to produce biofuels can receive a tax incentive)
- Phase out for registration of older heavy-duty engines to remove them from the roads starting in 2023
- Diesel Emissions Reduction Task Force to address equity, incentives, and strategies to accelerate the transition away from fossil diesel[7]

Making the Transition (Lessons Learned)

The US Department of Energy states renewable diesel is a biomass-derived transportation fuel suitable for use in diesel engines and meets the ASTM D975 specification for petroleum in the United States. Oregon fuel distributor Star Oil explains that renewable diesel can be used by any diesel fleet without equipment conversion concerns.[8] This is confirmed by a variety of fleet managers around Oregon, including those at ODOT. Renewable diesel has virtually eliminated previous concerns of biodiesel use related to additional maintenance, cold weather performance, and warranty concerns. The most challenging aspect reported for renewable diesel is not having enough supply to meet demand; inability to access the fuel at privately owned card-lock stations; and higher delivery costs compared to conventional fuels.

Practice Alternative(s): Mitigation & Cost Scaling

Life Cycle Considerations

Greenhouse gas pollution from tailpipes is often the focus when considering emissions from vehicles. However, there are also GHG emissions from the production of fuels (i.e., embodied carbon). Biofuels offer significant GHG reductions at the tailpipe, but commonly have greater impacts than fossil fuels during production. This is because the most common feedstock for biofuels are agricultural crops, such as soybeans in renewable diesel. Ideally, biofuels are produced to the largest extent possible with "waste" materials such as used cooking oil or

[4] For program details visit https://www.rd.usda.gov/hbiip
[5] For program details visit https://www.oregon.gov/energy/incentives/pages/energy-loan-program.aspx
[6] For program details visit https://www.oregon4biz.com/Oregon-Business/Tax-Incentives/Renewable-Energy/
[7] For program details visit https://afdc.energy.gov/laws/all?state=OR
[8] For program details visit https://www.staroilco.net/renewable-diesel-portland-or/

tallow. Use of waste material feedstock for renewable diesel offers some of the lowest impact fuels available on the market. Unfortunately, available waste materials are not available in the quantities required to produce the volumes of diesel fuels currently consumed, which is why crop feedstocks are used for production.

GHG Impacts

Measured at the tailpipe, using renewable diesel exclusively offers a roughly 99% reduction in ODOT's owned, Scope 1 GHG emissions. When production emissions are included (lifecycle GHG emissions), R99 still offers a 50-75% lifecycle GHG reduction (Scope 1 (tailpipe) + Scope 3 (upstream production) compared to conventional B5 diesel.[9]

Figure 1, below, is provided by the Oregon Department of Environmental Quality (ODEQ) and compares the climate impact of various fuels and production pathways for various fuel types. Each circle on the graph represents the climate impact from a single pathway. These impacts vary depending on the fuel production raw materials and energy inputs used by the fuel producer. As can be seen, there can be a wide range in impacts depending on these factors. Significant negative values have been found for fuels that use biomethane from dairies which can be seen for compressed natural gas (CNG).[10]

Figure 1: ODEQ graphic comparing the carbon intensity of various fuel types.

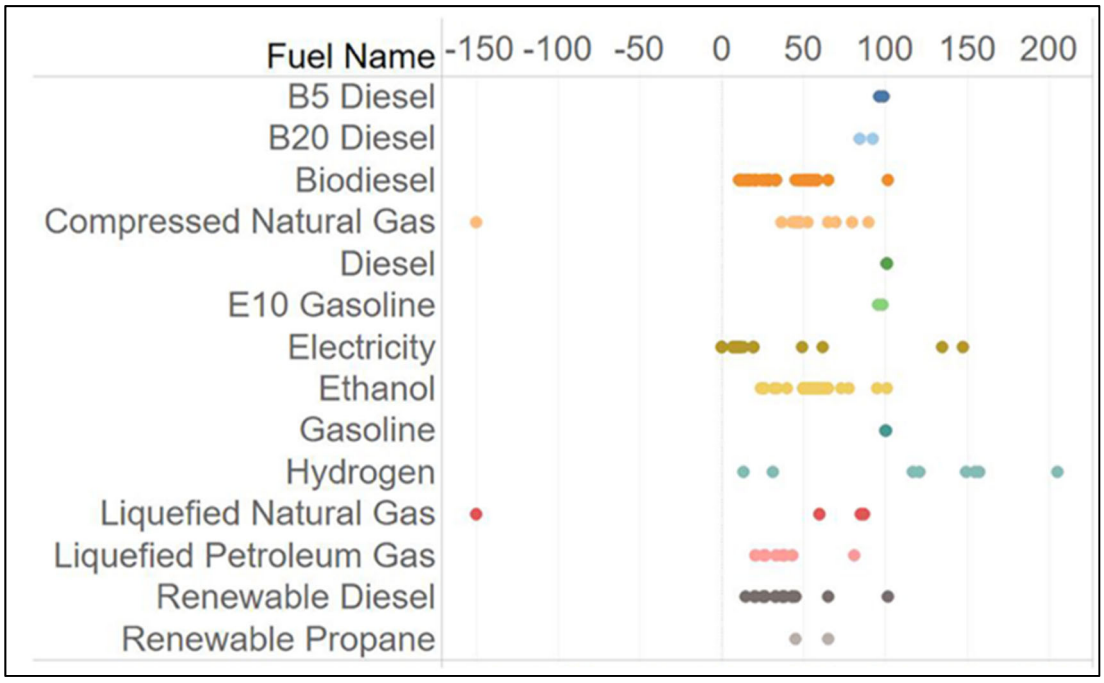


Image Source: https://www.oregon.gov/deq/ghgp/Documents/cfpCarbonIntensityValues.pdf

Image Note: The carbon intensity values for the program are expressed in grams of carbon dioxide equivalents per megajoule of energy (gCO_2e/MJ). B5 diesel and E10 gasoline are the minimum standards required in Oregon.

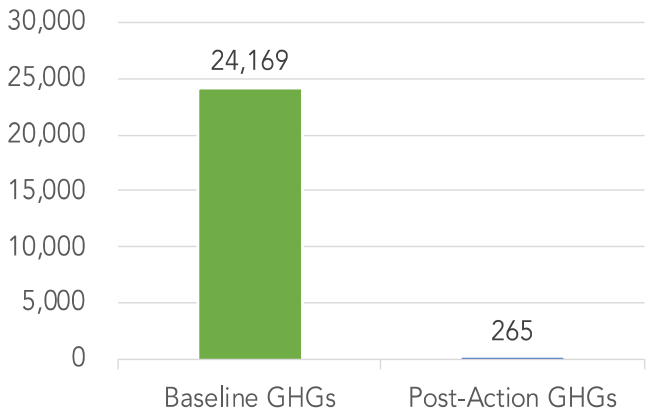
[9] Voluntary GHG inventory protocol accounts for the benefits differently than Oregon Department of Environmental Quality (ODEQ) does in the Clean Fuels Program. GHG protocol – for Scope 1 tailpipe – allows for exclusion of all biogenic carbon dioxide emissions at the tailpipe. For R99 this equates to about a 99% reduction of Scope 1 GHGs. ODEQ looks at Scope 1 and Scope 3 together in its accounting – from that perspective total lifecycle emissions are reduced by about 70% compared to conventional diesel.

[10] Dairy bio-methane can be converted to CNG and LNG and are represented as negative carbon intensity because they prevent fugitive loss of methane to the atmosphere in addition to the production of a biogenic fuel.

Because renewable diesel can be used at very high blend volumes as a substitute for fossil diesel there are dramatic results in tailpipe (Scope 1) emissions reductions. Biodiesel offers similar per gallon reductions, but because it cannot be blended at high volumes, the opportunity for Scope 1 reduction are lower than for renewable diesel.

Figure 2 compares baseline GHGs for diesel fuel use with potential reductions associated with 100% use of soybean-based renewable diesel. As can be seen, if ODOT were to replace 100% of the agency's B5 diesel fuel use with R99 renewable diesel, Scope 1 tailpipe emissions could decrease by about 23,900 MT CO2e annually, or about 99%. Assuming renewable diesel supply is soybean based (most common in Oregon), lifecycle emissions (Scope 1 (tailpipe) + Scope 3 (upstream production) are reduced by about 70% (reduced from 30,000 to 9,000 MT CO2e annually) compared to B5. If used cooking oil is used as the feedstock lifecycle emissions are reduced by about 80% compared to B5.[11]

Figure 2: Compariosn of ODOT baseline Scope 1 GHGs with substitution of 100% renewable diesel.



Cost Impacts

Fuel costs for R99 were lower than conventional B5 diesel during FY20, FY21, and, to date, in FY22. That said, delivery charges for R99 are greater than for B5, bringing the total cost to equal or a slight premium for the climate benefit of renewable diesel. Table 1 compares annual costs and per metric ton (MT) cost of CO2e reduction for two premium levels. A $0.10 per gallon premium per one MT CO2e reduced is about $10 per ton while a premium of $0.20 per gallons premium is about $20 per ton. For a benchmark, regulatory grade carbon offsets currently sell for $20 per MT CO_2e.

Table 1

Category	Fuel Use, 2016 – 2019 average (millions of gallons)	Annual Cost, $0.10 premium	Annual Cost, $0.20 premium	Baseline Scope 1 Emissions (FY16-19 annual average)	Annual Scope 1 Reductions	Cost per MT CO2e reduced, $0.10 premium	Cost per MT CO2e reduced, $0.20 premium
Owned Fleet	2,335,000	$233,500	$467,000	24,196	23,900	$9.75	$19.50

[11] See Oregon Clean Fuels Program website for more information and a downloadable spreadsheet that summarizes the carbon intensity for all fuels used in Oregon. Visit Image Source: https://www.oregon.gov/deq/ghgp/Documents/cfpCarbonIntensityValues.pdf

Co-Benefits

In addition to the GHG benefits, renewable diesel also offers the following benefits:

- Reduction in criteria air pollutants. The Federal Highways Administration and ODOT report nitrogen oxides, particulate matter, carbon monoxide, and total hydrocarbons emissions for renewable diesel are all lower than conventional ultra-low sulfur diesel.[12]
- Future supply will likely be produced from domestic feedstocks and production.
- Green job creation in the U.S.[13]

Recommendations

- Develop partnerships with contractors and vendors to maximize market leverage for Oregon. ODOT should seek 100% renewable diesel as soon as possible for its owned equipment and support its contractors and vendors to achieve equal access and pricing for renewable diesel purchases.
- Join existing public agency efforts, like the Greater Oregon Fleet Cooperative, to increase Oregon's renewable diesel purchasing power and to contract for the largest possible fuel volume as soon as possible.
- Develop owned and shared fuel storage infrastructure as needed to allow for greatest distribution of renewable fuels at the lowest costs.
- Work with private Oregon fuel distributors to develop access to renewable diesel blends at fuel supply/card-lock facilities for ODOT owned equipment as well as vendors and contractor equipment.
- Communicate with US Department of Agriculture be ready for the next funding cycle of the Higher Blends Infrastructure Incentive Program, which can help offset the costs associated with renewable diesel infrastructure.

[12] https://altfueltoolkit.org/wp-content/uploads/2017/11/Renewable-Diesel-Fact-Sheet.pdf

[13] U.S. Department of Energy reports "*Five plants produce renewable diesel in the United States, with a combined capacity of nearly 400 million gallons per year. Production is expected to grow in the coming years due to expansions at existing plants and the construction of new plants.*" For details visit https://afdc.energy.gov/fuels/emerging_hydrocarbon.html.