

Transportation Recommendations to Climate Emergency Mobilization Work Group for Frederick County and City

a. Recommendation: Incorporate transition to renewable fuels in public transportation fleets-- buses (including existing school buses) and trains-- as well as other public vehicles and equipment as part of their sustainability programs

b. Expected GHG Impact: The GHG impact will depend on the type of renewable fuel that is replacing diesel or other fossil fuel. Carbon intensity for fuel depends on the feedstock, the conversion technologies and other factors.

From delivery trucks to construction and farm equipment to long haul trucks to boat and locomotive engines, diesel (compression ignition) engines are likely to remain with us for a long time, not only because they are so useful for efficient freight transportation and heavy duty work, but also because they last for many years. In addition, economically replacing diesel engines with electric powered-alternatives will take quite a while since only about a third are expected to be replaced by other drivetrains by 2035¹.

Renewable alternative fuel options for compression ignition engines include:

- Biodiesel
- Renewable diesel which goes by many names including:
 - Hydrotreated vegetable oil (HVO)
 - Hydrogenation-derived renewable diesel (HDRD)
 - Hydroprocessed renewable diesel (HRD)
 - and others
- Co-processed diesel
- Straight vegetable oil (SVO)
- Renewable dimethyl ether (rDME)
- Ethanol
- Lignin ethanol oil (LEO)

Each of these will have a different carbon intensity and varied environmental impacts. For example, biodiesel significantly reduces life-cycle greenhouse gas (GHG) emissions. Life cycle analysis using Argonne National Laboratory's GREET (Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model) analysis found that greenhouse gas emissions for B100 are 74% lower than

¹ Clevenger, Seth. "The Dawn of Electric Trucks." Transport Topics, December 6, 2019. <https://www.ttnews.com/articles/dawn-electric-trucks>. and Hurd, Byron. "Report: Long-haul electric semis aren't yet cost-effective." Green Car Reports, October 22, 2019. https://www.greencarreports.com/news/1125634_report-long-haulelectric-semis-aren-t-yet-cost-effective.

those from petroleum diesel. The California Air Resources Board (CARB) reported similar values for its life-cycle analysis of biodiesel from various sources using CA-GREET 2.0².

Renewable diesel has some of the largest lifecycle greenhouse gas reductions with a carbon intensity of about 30 compared to 102 for ultra low sulfur petroleum diesel³. This can vary depending on the feedstock and generally ranges from 50% to 85% lower than baseline diesel fuel⁴.

Biodiesel or renewable diesel are most likely to replace petroleum diesel.

Some buses also run on compressed natural gas (CNG) which can be replaced with renewable natural gas (RNG) or biomethane.⁵ This chart shows the GHG benefit of RNG over fossil natural gas.

Table 2-29: Annual well-to-wheels GHG emissions for selected types of road vehicles (low WTT greenhouse gas emissions scenario)

Vehicle type	Annual well-to-wheels CO ₂ e emissions (tonnes per year)			Percentage change in WTW emissions	
	Petrol/diesel	Natural gas	Biomethane	Natural gas vs petrol/diesel	Biomethane vs petrol/diesel
Passenger car (petrol)	1.70	1.39	0.20	-18%	-88%
Passenger car (diesel)	1.31	1.39	0.20	+6%	-85%
LCV	3.98	4.28	0.82	+8%	-79%
Small rigid truck	18.07	20.43	4.91	+13%	-73%
Large rigid truck 26 t	48.21	55.94	10.61	+16%	-78%
Articulated truck (>32 t)	135.38	136.23	82.00	+1%	-39%
Bus	57.53	60.96	10.10	+6%	-82%
Coach	46.14	53.12	9.60	+15%	-79%

Note: for passenger cars, the baseline comparator vehicle is petrol powered; for all other vehicles, the baseline vehicles are diesel powered.

Well-to-wheel comparison of CO₂ emissions / Source: The role of natural gas and biomethane in the transport sector

² Alleman, Teresa L, Robert L McCormick, Earl D Christensen, Gina Fioroni, Kristi Moriarty, and Janet Yanowitz. Biodiesel Handling and Use Guide (Fifth Edition). Alternative Fuels Data Center. U.S. Department of Energy, 2016. https://afdc.energy.gov/files/u/publication/biodiesel_handling_use_guide.pdf. And S. Patricia Batres-Marquez, "Readoption of the California Low Carbon Fuel Standard," Agricultural Marketing Research Center. <https://www.agmrc.org/renewable-energy/renewable-energy-climate-change-report/renewable-energy-climate-change-report/may-2016-report/readoption-of-the-california-low-carbon-fuel-standard>

³ U.S. Energy Information Administration. "Renewable diesel is increasingly used to meet California's Low Carbon Fuel Standard." U.S. Environmental Information Administration, November 13, 2018. <https://www.eia.gov/todayinenergy/detail.php?id=37472>.

⁴ Leonard, Jon, and Patrick Couch. "The Potential - and Challenges - of a Renewable Diesel Fuel for Heavy-Duty Vehicles." GNA - Clean Transportation & Energy Consultants, 2017. <https://www.gladstein.org/the-potential-and-challenges-of-renewable-diesel-fuel-for-heavy-duty-vehicles/>

⁵ "Renewable Natural Gas Project in Spain Targets Use for Transportation" <https://www.ngvglobal.com/blog/renewable-natural-gas-project-in-spain-targets-use-for-transportation-1221> and Scania, "Biogas buses are the Green Solution for Cities" <https://euinmyregion.blogactiv.eu/2016/07/04/biogas-buses-are-the-green-solution-for-cities/>

A case study done using a Thomas Experiment to compare the relative GHG benefits to cost of replacing school buses with electric buses to retrofitting existing diesel school buses to operate on 100% biodiesel found that, for the amount of funds expended, carbon reduction was greater from retrofitting buses using the Optimus Technologies system than from buying new buses.⁶

B100 conversion – \$15,000
 Electric bus- \$400,000
 Standard diesel bus- \$50,000

Figure 5.0: The Thomas Experiment

Type of vehicle	Number available to purchase with \$1.2 million	Emission reductions from standard diesel per bus	Total emission reduction
Standard Diesel Bus	24	0 lbs CO2	0 lbs CO2
B100 Conversion	80	3,315.2 lbs CO2	265,216 lbs CO2
Electric Bus	3	14,000 lbs CO2	42,000 lbs CO2

School buses in the Twin Rivers Unified School District near Sacramento switched 75 school buses from petroleum diesel to renewable diesel fuel provided by Neste. As a result, the district’s fleet is now fully fossil free and one of the cleanest in the country. Because Neste MY Renewable Diesel is a drop-in fuel, the transformation was practically immediate⁷.

c. Recommended Timeline for Action: We recommend that the city proceed as quickly as possible to encourage and facilitate transition to renewable fuels for public transportation.⁸

d. Rationale:

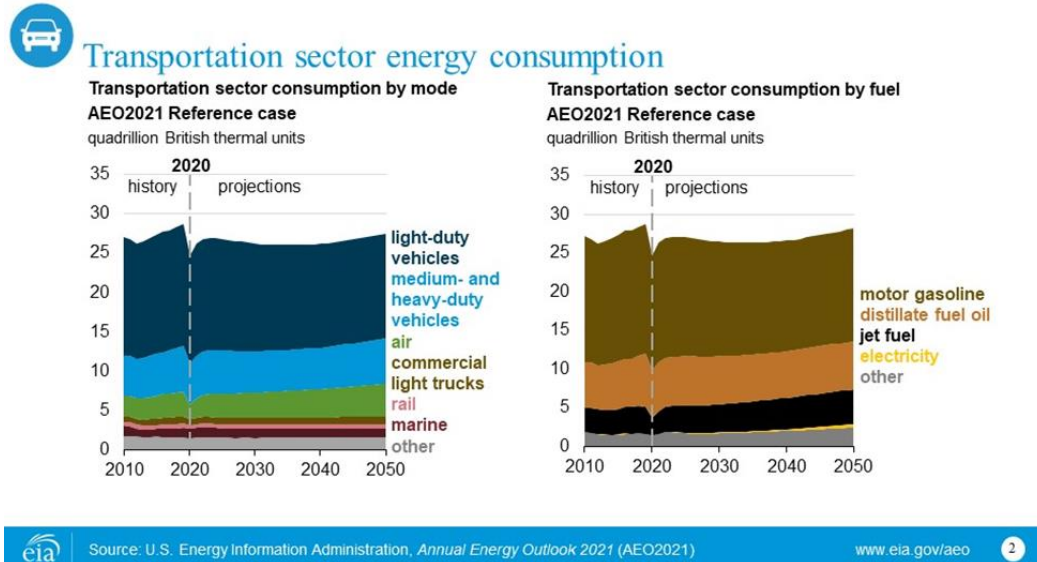
d1 Findings are based on research and data: For research related to specific statements, see footnotes.

⁶ Abdallah, Ahmed, “Case Study of Proposal for 100% Biodiesel School Buses,” Advanced Biofuels USA. <https://advancedbiofuelsusa.info/case-study-of-proposal-for-100-biodiesel-school-buses/>

⁷ Neste, “Neste, Twin Rivers Unified School District Transform School Buses from Fossil Fuel to Fossil Free” <https://www.neste.us/www.neste.us/about-neste/news-inspiration/articles/from-fossil-fuel-to-fossil-free#:~:text=The%20Twin%20Rivers%20Unified%20School,the%20cleanest%20in%20the%20country.>

⁸ Advanced Biofuels USA, How to De-Fossilize Your Fleet: Suggestions for Fleet Managers Working on Sustainability Programs. <https://advancedbiofuelsusa.info/how-to-de-fossilize-your-fleet/>

d2 Equity considerations: This graphic⁹ from the US Department of Energy's Energy Information Administration clearly shows that even in 2050 significant aviation fuel will be used. That fuel should be as low polluting, low carbon and affordable as possible, especially in public transportation vehicles and trains.



<https://www.eia.gov/outlooks/aeo/> Transportation [PDF](#) [PPT](#)

d3 Co-Benefits Cleaner, less-polluting options will be available to residents, businesses and visitors. Diesel exhaust contains substances that can pose a risk to human health and to the environment. Containing more than 40 toxic air contaminants¹⁰, the exhaust itself is a complex mixture of thousands of gases and fine particles. These include many known or suspected carcinogens and other harmful pollutants. Older diesel engines in particular are substantial emitters of particulate matter (PM) and nitrous oxides (NOx), but relatively small emitters of carbon monoxide (CO) and volatile organic compounds (VOCs). New emissions controls reduce all types of emissions and pending US regulations will reduce NOx potentially by another 90%¹¹. Concerns about particulate matter and hydrocarbon emissions from diesel engines which may be toxic and/or carcinogenic are mitigated by use of biodiesel¹². Other environmental impacts

⁹U.S. Department of Energy Energy Information Agency, "Transportation sector energy consumption" <https://www.eia.gov/outlooks/aeo/> Transportation PDF https://www.eia.gov/outlooks/aeo/pdf/05_AEO2021_Transportation.pdf PPT https://www.eia.gov/outlooks/aeo/ppt/05_AEO2021_Transportation.pptx

¹⁰ "Health Effects of Diesel Exhaust." OEHHA California Office of Environmental Health Hazard Assessment, May 21, 2001. <https://oehha.ca.gov/air/health-effects-diesel-exhaust>.

¹¹ Employees and Contractors of Chevron Corporation. "Diesel Fuels Technical Review." Chevron. 2007. <https://www.chevron.com/-/media/chevron/operations/documents/diesel-fueltech-review.pdf>.

¹² Steiner, Sandro, Jan Czerwinski, Pierre Comte, Olga Popovicheva, Elena Kireeva, Loretta Müller, Norbert Heeb, Andreas Mayer, Alke Fink, and Barbara Rothen-Rutishauser. "Comparison of the Toxicity of Diesel Exhaust Produced by Bio- and Fossil Diesel Combustion in Human Lung Cells in Vitro." Atmospheric Environment 81 (September 21, 2013): 380–388. <https://doi.org/10.1016/j.atmosenv.2013.08.059>. Bass, Virginia L., Mette C. Schladweiler, Abraham Nyska, Ronald F. Thomas, Desinia B. Miller, Todd Krantz, Charly King et al. "Comparative

vary depending on the feedstock. For example, recycling used cooking oil for fuel keeps contaminated UCO out of use and prevents it from being dumped into municipal sewer systems where it can cause clogs and additional expense for water treatment.

Renewable diesel can help improve air quality. Based on limited data, the California Air Resources Board (CARB) determined that RD100 can decrease NOx by roughly 10 percent when used in older heavy-duty engines that don't have state-of-the-art emission controls. Preliminary data also indicate renewable diesel can reduce particulates emitted from older diesel engines by about 30 percent. When used in newer engines or vehicles with diesel engines compliant with 2010 standards, the NOx and particulate reduction benefits are likely to be reduced significantly.¹³

Diesel Technology Forum created this graphic to explain how operating trains using new Tier 4 engines with renewable diesel compares to petroleum diesel in older engines.



d4 Experience of other cities and counties: California's state-wide Low Carbon Fuel Standard has provided incentives for cities and counties throughout the state to transition to more renewable fuel options for public transportation including buses and trains. Other countries have also made this transition.

Buses

cardiopulmonary toxicity of exhausts from soybased biofuels and diesel in healthy and hypertensive rats." Inhalation toxicology 27, no. 11 (2015): 545-556. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4768834/>. Shvedova, Anna A., Naveena Yanamala, Ashley R. Murray, Elena R. Kisin, Timur Khaliullin, Meghan K. Hatfield, Alexey V. Tkach et al. "Oxidative stress, inflammatory biomarkers, and toxicity in mouse lung and liver after inhalation exposure to 100% biodiesel or petroleum diesel emissions." Journal of Toxicology and Environmental Health, Part A 76, no. 15 (2013): 907-921. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4671493/>.¹³ [98] GNA. "Renewable Diesel as a Major Transportation Fuel in California: Opportunities, Benefits and Challenges." GNA - Clean Transportation & Energy Consultants, August 2017. <https://www.gladstein.org/wp-content/uploads/2018/05/Final-Report-August-2017.pdf>. And, California Air Resources Board. "Final Supplemental Disclosure Discussion of Oxides of Nitrogen Potentially Caused by the Low Carbon Fuel Standard Regulation." ca.gov, September 17, 2018. <https://ww3.arb.ca.gov/regact/2018/lcfs18/finaldisc.pdf>.

Over a five-year contract, Trillium will provide Los Angeles County Metropolitan Transportation Authority with over 20 million gallons of RNG to two bus terminals. Buses fueled by RNG reduce smog-forming nitrogen oxides to 90% lower than the EPA limit.

In British Columbia, the Public Transit Infrastructure Stream (PTIS) of the Investing in Canada plan will be funding approximately 15 medium-duty buses fueled with CNG or RNG to replace diesel-fueled buses at the end of their useful life.¹⁴

Many other examples of transition to renewable fuel for buses are available [here](#).

Trains

Los Angeles, California's Metrolink and the Bay Area's Capitol Corridor Commuter Rail Service both Invested in new advanced diesel engines powered with 100% renewable diesel. According to [Metrolink](#), the new locomotives and renewable diesel fuel use is part of its first environmentally focused plan. It will invest in near-zero emissions (Tier 4) diesel engines for all of its locomotives with an initial trial of 100 percent renewable diesel fuel in a switcher locomotive with plans to extend 100 percent renewable diesel fuel use to the full fleet.¹⁵

Capitol Corridor is retiring two older F-59 locomotives and swapping them for new, EPA-certified Tier 4 Charger locomotives. As part of its future green initiative, they plan to run trains on renewable diesel fuel by 2022.¹⁶

In the Netherlands, Groningen and Friesland will see 18 new biodiesel trains added to their rail network. The current fleet of 51 Stadler GTW 2/8 and GTW 2/6 diesel multiple-units is to be refurbished and fitted with batteries to enable braking energy to be recovered for reuse, according to the *Railway Gazette*.¹⁷

Articles about other examples of transition to renewable fuel for trains are available [here](#).

d4 Interface with the Livable Frederick Plan and Frederick City Master Plan: The Recommendation is consistent with the objectives of both Plans.

d5 Cost-benefit- analysis:

¹⁴ Infrastructure Canada, "Canada and British Columbia invest in public transit infrastructure to improve capacity, safety, and service in Greater Victoria" <https://www.canada.ca/en/office-infrastructure/news/2021/03/canada-and-british-columbia-invest-in-public-transit-infrastructure-to-improve-capacity-safety-and-service-in-greater-victoria.html>

¹⁵ Diesel Technology Forum, "ALL ABOARD: FROM NORCAL TO SOCIAL, NEW GENERATION OF DIESEL TO DELIVER CLEAN AIR, CLIMATE BENEFITS TO CALIFORNIA RAIL COMMUTERS AND RESIDENTS" <https://www.dieselforum.org/news/all-aboard-from-norcal-to-social-new-generation-of-diesel-to-deliver-clean-air-climate-benefits-to-california-rail-commuters-and-residents>

¹⁶ Diesel Technology Forum, "ALL ABOARD: FROM NORCAL TO SOCIAL, NEW GENERATION OF DIESEL TO DELIVER CLEAN AIR, CLIMATE BENEFITS TO CALIFORNIA RAIL COMMUTERS AND RESIDENTS" <https://www.dieselforum.org/news/all-aboard-from-norcal-to-social-new-generation-of-diesel-to-deliver-clean-air-climate-benefits-to-california-rail-commuters-and-residents>

¹⁷ Biofuels International, "18 new biodiesel fuelled trains coming to the Netherlands" <https://biofuels-news.com/news/18-new-biodiesel-fuelled-trains-coming-to-the-netherlands/>

As Allen Schaeffer of Diesel Technology Forum located in Frederick explained, consumers of biodiesel and renewable diesel fuel will have to pay about the same for their fuel as regular petroleum diesel. Those looking for B20 will typically pay about 21 cents less per gallon compared to regular petroleum diesel, according to the most recent data collected by the Department of Energy as of October 2019 (**Table 1**).

Region	B20 prices (\$/gal)	Diesel prices (\$/gal)	Price difference*
New England	\$2.74	\$3.14	-\$0.40
Central Atlantic	\$2.64	\$2.89	-\$0.25
Lower Atlantic	\$2.52	\$2.93	-\$0.41
Midwest	\$2.90	\$2.95	-\$0.05
Gulf Coast	\$2.78	\$2.69	\$0.09
Rocky Mountain	\$3.03	\$2.91	\$0.12
West Coast	\$3.25	\$3.89	-\$0.64
National average	\$2.87	\$3.08	-\$0.21

*Negative numbers represent average B20 prices that are lower than diesel, on a \$/gal basis.

Since renewable diesel fuel volumes are lower than biodiesel, government agencies do not track prices as they do for biodiesel. Recent surveys of fleets which have made the switch to renewable diesel fuel report that they pay a 21-cent premium above petroleum diesel fuel. Much of the fluctuation in price reflects change in demand. With more interest and demand for the fuel, survey respondents expect that price fluctuation will even out. (Source: [Government Fleet – Renewable diesel still a miracle fuel](#))¹⁸

Because California and other states have enacted low carbon fuel standards or clean fuel standards or policies, fuel producers of limited quantities of renewable diesel are selling into those markets due to the advantage of their incentives. Until more production facilities are built, and unless Maryland also adopts incentive programs for renewable fuels, renewable diesel sources will be limited.

Ethanol blends and biodiesel do not have the same production limitations.

e. Finance:

Transitions to renewable fuels for public transportation should be part of city and county sustainability programs with funding from budgets appropriated for that purpose. However, the transition may pay for itself with savings in fuel prices as described above.

f. Recommended actions:

¹⁸ Schaeffer, Allen, "All the buzz on biodiesel fuels: Fill it up please," Progressive Dairy March 31, 2020 <https://www.progressivedairy.com/topics/barns-equipment/all-the-buzz-on-biodiesel-fuels-fill-it-up-please>

- a. **No Legislative Action Necessary**
- b. **Administrative Action by City and County**
Frederick City and County should incorporate transition to renewable fuels in public transportation fleets, as well as other public vehicles and equipment as part of their sustainability programs.¹⁹
- c. **Encouragement and Facilitation of Commuter Rail Transition to Renewable Fuel**
Encourage and facilitate MARC trains to transition to renewable fuel.

Write-up drafted by Joanne Ivancic

¹⁹ Ivancic, Joanne “How to De-Fossilize Your Fleet Suggestions for Fleet Managers Working on Sustainability Programs,” Advanced Biofuels USA. <https://advancedbiofuelsusa.info/wp-content/uploads/2019/08/Fleets-article-v6-AdvancedBiofuelsUSA.pdf>