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**Advanced Biofuels USA Response and Addendum to Maryland Biofuels Task Force Report**

Advanced Biofuels USA, an educational nonprofit based in Frederick, Maryland, is offering this addendum to the Maryland Biofuels Task Force Report in order to equip public and private decision-makers with a deeper understanding of the development and potential of sustainable renewable fuels and to broaden the discussion to include aviation fuel (SAF), bioCNG/RNG, renewable diesel, heating fuel and other renewable fuels — especially those applicable to aviation and marine sectors which are of great importance to Maryland's business and transportation sectors.

1. Overview of supply, demand, feedstocks, technology, and cost of production.
2. Technologies being researched in Maryland.
3. Technologies developed or used in Maryland.
4. Projects in other states.
5. Special policies and incentives

## 1. Overview of supply, demand, feedstocks, technology, and cost of production

1.a. Renewable Fuels: **What Are They?** How Are They Used? How Are They Made? — In Maryland and Around the World

Renewable fuels are fuels used to power cars, trucks, equipment (farm, construction, mining, forklifts), trains, planes, ships, boats and machinery.

All these uses except mining are very important in Maryland.

Renewable fuels are used in blends with fossil fuels and alone.

*Examples of renewable fuels are:*

Ethanol/bioethanol
Biodiesel/ also known as FAME (Fatty Acid Methyl Ester)
Renewable Diesel/ often in the form of HVO (hydrotreated vegetable oil)
Biogas
CBG (compressed biogas)
bio-LNG (bio Liquified Natural Gas)
Renewable Natural Gas/methane/Compressed renewable natural gas
Pyrolysis oils (bio-oil)
Methanol
Hydrogen
Ammonia
Sustainable Aviation Fuel (SAF)

1.b. Renewable Fuels: What Are They? **How Are They Used**? How Are They Made?

Renewable fuels can be used in many types of engines for mobility (planes, trains, automobiles, buses, trucks, ships, boats, race cars).

They can also be used for heating, cooking and to power machinery.

Some engines can use a variety of fuels.

*Here are some examples of engines that use renewable fuels:*
Internal combustion engines
- Spark ignition ('gasoline' engines)
- Compression ignition (diesel)
- Hydrogen combustion engines
- Fuel cells
  - Ethanol fuel cells
  - Hydrogen fuel cells
  - Polymer electrolyte membrane (PEM) fuel cells
- Jet engines
- Rocket engines
- Missile engines

Note: The MARYLAND AVIATION ADMINISTRATION SUSTAINABILITY PLAN 2024

1.c.1 Renewable Fuels: What Are They? How Are They Used? **How Are They Made?** (**Feedstocks,** Logistics, Conversion Technologies)

Here are some examples of things used (or being researched for use) to make sustainable, renewable fuels. The ones in *italics could be available in Maryland*. The ***bold*** ones are ***very likely to be in Maryland***, although sustainable availability in adequate amounts is not guaranteed.

Agave
***Agricultural waste/residues***
***Algae***
***Animal fat/tallow***
***Atmosphere/Air***
*Bamboo*
***Brewers waste***
*Cactus (nopales)*
***Carbon dioxide (CO2)***
Cashew apple
Cassava
***Chicken/Poultry manure***
***Coffee grounds***
***Construction waste***
***Corn stover***
***Corn cobs***
*Coppice willow, poplar*
Cotton seeds/husk
*Cyanobacteria*
Date palm pits/seeds/waste
***Distillers waste***
***Duckweed (lemna)***
Energy cane
Energy tobacco
***Grasses*** such as
Arundo
Giant reed
***Miscanthus***
Napier/Elephant Grass
***Phragmites***
***Switchgrass***
***Grease (yellow, brown)***
***Food processing waste***
***Forestry waste/residue***
***Halophytes***
***Hemp/Cannibus biomass***
***Hydrogen (H2)***
***Industrial waste gases***



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***Municipal Solid Waste (MSW)***
Paper/pulp mill waste
Kenaf
***Landfill gas/methane***
***Manure***
***Nitrogen***
Nut shells
***Oil Seed Crops***
*Camelina*
*Carinata*
*Canola/Rapeseed*
Castor bean
Croton
Jatropha
Jerusalem artichoke
Jojoba
Moringa
Safflower
***Soybeans***
*Sunflower*
Olive pits/water
***Orchard prunings***
Palm oil; POME (Palm Oil Mill Effluent)
Rice (broken, hulls, straw)
*Sawdust*
*Seaweed (kelp, beached sargassum)*
Sisal bole
***Sorghum (grain/milo; forage; biomass)***
***Straw (barley, wheat, oat)***
*Sugar beets/Energy beets*
Sugarcane (molasses)
Sugarcane bagasse
Tall oil
*Tires*
***Used cooking oil***
***Vinyard waste***
***Vinasse***
***Water***
Whey
Woody biomass

*More information about each of these can be found in tags at www.AdvancedBiofuelsUSA.org*

1.c.2 Renewable Fuels: What Are They? How Are They Used? **How Are They Made? (**Feedstocks**, Logistics**, Conversion Technologies)

As more research has been done, practical problems became apparent. For example, unwanted rocks and dirt got harvested along with agricultural residues that used to be left on the field or burned on the field. Engineers and farmers got together to figure out better ways to harvest this new product.

Similarly, the new feedstock product needed to be stored without spoiling or bursting into flames. And it had to be chopped to the proper size.

Moving feedstock and finished product requires a mixture of traditional and innovations in trucks, tankers, barges, pipelines.

Consider the gathering (aggregating), sorting, transporting, and think about the tracking, measuring, monitoring and verification needed to assure sustainability and true carbon footprint, greenhouse gas emissions and pollution reduction.

Maryland's location, transportation options, natural resources, it's agricultural and forest resources, along with its extensive life sciences experience make it an idea location for development and use of renewable fuels.

1.c.3 Renewable Fuels: What Are They? How Are They Used? **How Are They Made? (**Feedstocks**,** Logistics, **Conversion Technologies**)

There are many ways to turn feedstocks into fuels. Some new, some old, many still being developed. The trick is to convert feedstocks into useable fuels as efficiently, effectively, affordably, and safely as possible.

Here are some technologies being used to turn the feedstocks listed earlier into useful fuels.

Anaerobic Digestion
Gasification
Pyrolysis
Hydrothermal Liquefaction (HTL)
Enzymatic Hydrolysis
Enzymatic Catalysis
Photosynthesis
Plasma arc gasification
Thermochemical conversion of sugars
Electrolysis
thermal depolymerization
Synthesis of hydrogen and CO2
Reforming processes for biogas to hydrogen
Steam Methane Reforming (SMR)
Dry Reforming (DRM)
Autothermal Reforming (ATR)
Partial Oxidation (POX)
Plasmonics
Fischer-Tropsch

*More information about each of these can be found in the tags at* www.AdvancedbiodfuelsUSA.org

To make aviation fuel that can be put into the marketplace, it must meet ASTM qualifications.
https://www.caafi.org/fuel-qualifications/#approved-fuels

**Current Renewable Jetfuel Pathways in the ASTM D4054 Qualification Process**

| Pathway | Max. incorporation ratio | Year of certification |
|---|---|---|
| Fischer-Tropsch Synthetic Paraffinic Kerosene (FT-SPK) | 50% | 2009 |
| Hydro-processed Ester and Fatty Acids Synthetic Paraffinic Kerosene (HEFA-SPK) | 50% | 2011 |
| Synthetic Iso=Paraffinic (SIP) | 10% | 2014 |
| Fischer-Tropsch Synthetic Paraffinic Kerosene with aromatics (FT-SPK/A) | 50% | 2015 |
| Alcohol-to-Jet Synthetic Paraffinic Kerosene (AtJ-SPA) | 50% | 2016 (updated 2018) |
| Catalytic hydro-thermolysis Synthetic Kerosene (CH-SK) | 50% | 2020 |
| Hydrocarbon-Hydro-processed Ester and Fatty Acids (HHC-HEFA) | 10% | 2020 |
| Alcohol-to-Jet Synthetic Kerosene with Aromatics (ATJ-SKA) | 50% | 2023 |

Research and development continue. For example, this illustrates pathways actively pursuing certification at various stages in the process, as well as related task forces developing additional specifications for 100% drop-in and 100% non-drop-in fuels and D1655 coprocessing as of October 2025.

In addition, co-processing of renewable or recycled hydrocarbon molecules (biocrude) along with petroleum crude oil is gaining traction as a near-term solution for introducing renewable material into the aviation fuel system. This method allows existing refineries to produce partially renewable fuel without requiring extensive infrastructure changes or investments, making it a cost-effective and efficient solution for increasing the renewable content of the fuel.

A key objective in transitioning to renewable fuels, reducing life cycle carbon emissions resulting from transportation, heating and cooking can be measured and compared. Regulations related to enforcing the US Renewable Fuel Standard include methods for assessing renewable fuels participating in that program. Because there are the great variety of feedstocks, conversion technologies and other elements of producing renewable fuels, the carbon footprint varies substantially.

This chart prepared by Boston University Institute for Global Sustainability based on US Environmental Protection Agency information shows how emissions from some fuel pathways exceed those from conventional petroleum fuel, for example, when coal is used in the production process. Others, such as switchgrass and corn stover, sequester carbon taken from the atmosphere during photosynthesis and stored in roots which contributes to additional reduction of carbon emissions.



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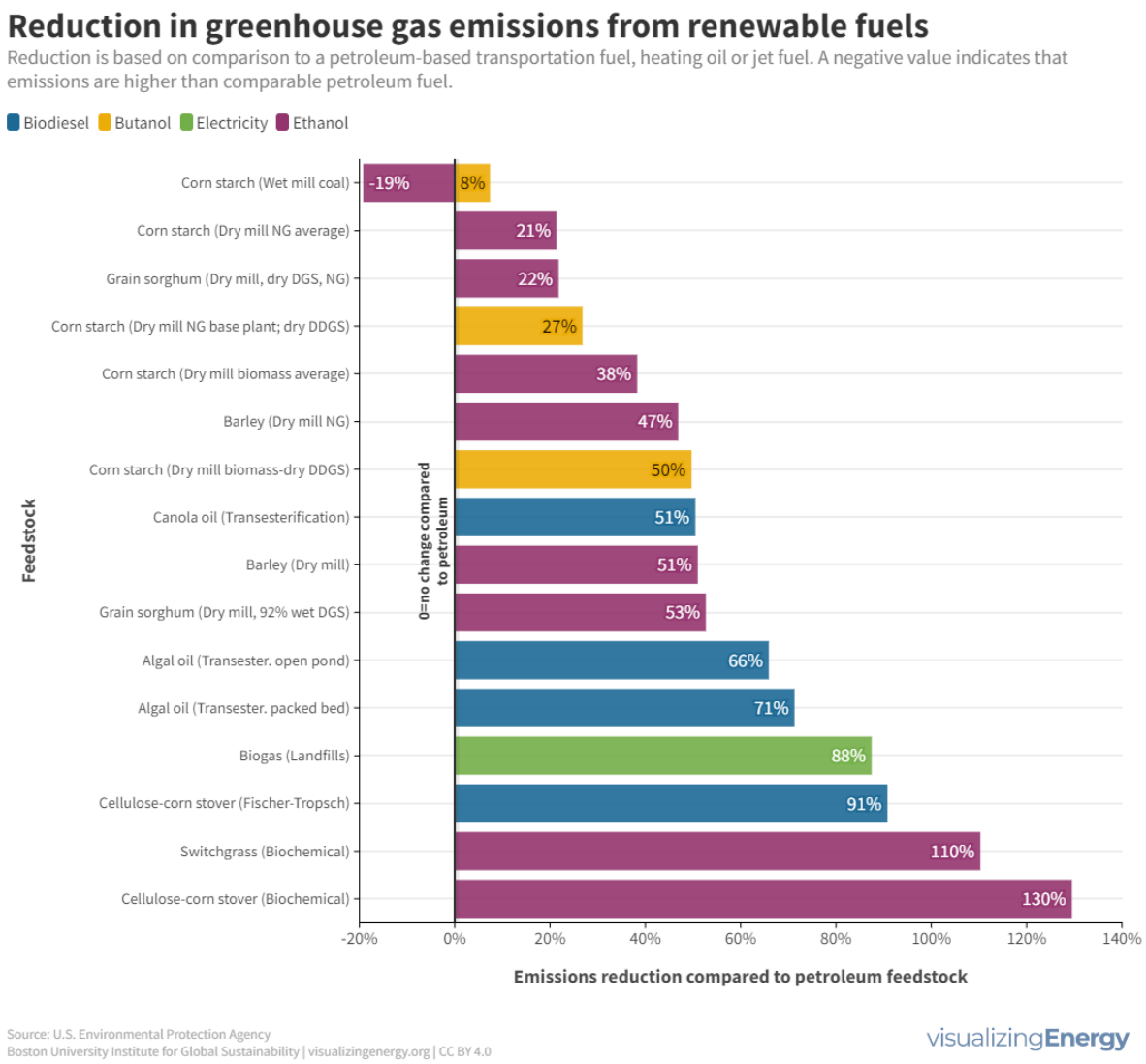


The next chart, also prepared by Boston University Institute for Global Sustainability and based on US Environmental Protection Agency information, shows life cycle greenhouse gas emissions and, has interactive options in the original location, https://visualizingenergy.org/what-renewable-fuels-have-the-largest-climate-benefit/ It illustrates the significant avoidance of greenhouse gas emissions that can be achieved by using renewable fuels instead of petroleum fuels.



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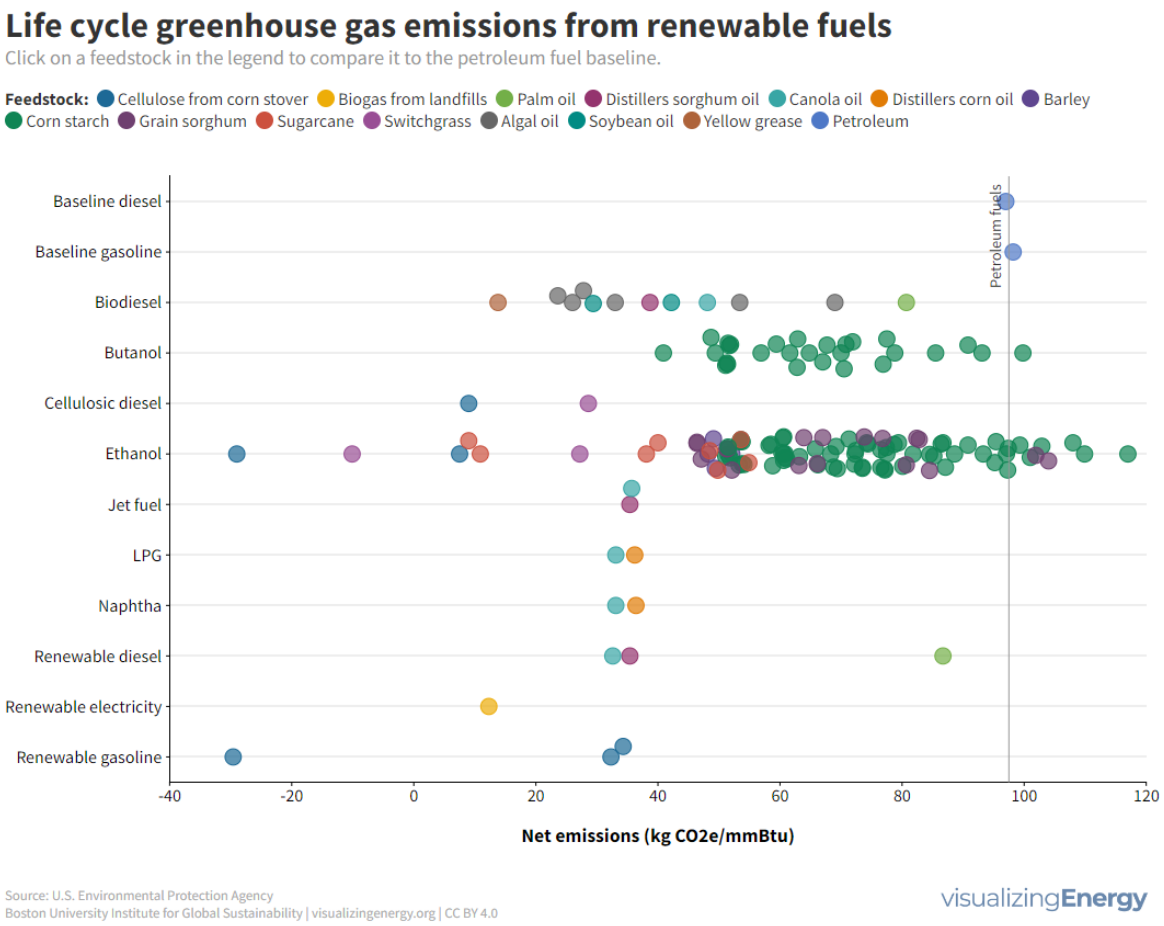


### 1.d Overview: Cost of Production

It is hard to project costs of production as they will differ by feedstock, location and conversion technologies. Also, many of these feedstock/conversion projects are still being developed, so current cost of production will not reflect cost of production on a mature commercial scale.

According to the International Energy Agency, costs for many technologies are currently high, but expected to fall significantly as deployment drives economies of scale for key technologies, along with greater standardization, innovation, more competitive markets and lower financing costs.

Efficiency and affordability are key aspects of feasibility and sustainability that are so important to development of useful, beneficial renewable fuels.

### 1.e Jobs and Careers

**Many Jobs Are Essential to the Renewable Fuels Value Chain**

It takes a wide variety of workers with a myriad of skills to make a successful transition to sustainable, renewable fuels. Here are some examples throughout the value chain/supply chain.

Agronomists
Farmers
Farm workers
Farm equipment designers
Biologists
Biologists specializing in genetic research
Biologists specializing in plant cells
Chemists
Chemical engineers
Researchers into bioenergy crop development
Agriculture/horticulture experts
Freight railroad operators, engineers, loaders, unloaders
Equipment operators, technicians
Farm product purchasers/traders
Agricultural and Forestry Supervisors
Agriculture Economists
Agricultural Inspectors
Computer Software Engineers
Commodity Traders
Data Analysts
Mechanical Engineers
Systems engineers
Research assistants
Lab technicians
Industrial engineers
Industrial architects
Construction workers, Managers
Truck drivers
Sanitation workers
Plant operations managers
Equipment operators, technicians
Refinery Equipment Manufacturers
Welders
Boilermakers
Pipe Fitters
Public Relations
Economic Development
Marketing/Sales
Elected Officials
Federal Agency Staff
State Agency Staff
County/Local Administrative Staff
Journalists
Writers
Photographers
Broadcast Media Professionals
Teachers
Teaching Assistants
Nonprofit Organization Staff
Advocates
Lawyers
Office Administrative Staff
Book Publishers
Event Organizers
Fundraisers
Investors
Business Development
*And many more*

**2. Technologies Being Researched in Maryland**

Maryland's colleges and universities, as well as private businesses have been researching renewable fuel feedstock and technologies for many years, often with funding from local resources such as Maryland Technology Development Corporation (TEDCO), Maryland Industrial Partnerships (MIPS), and Maryland Energy Innovation Institute (MEI2).

*Here are some examples of renewable fuel-related research in Maryland:*

**Atlantic Biomass enzymatic hydrolysis and ball milling (Hood College, University of Maryland Eastern Shore and Private Company)**

> From Seed … to Sky: Delmarva Energy Beet-to-Jetfuel Project Summary Published
>
> (Advanced Biofuels USA) Advanced Biofuels USA has added a summary of the findings of its USDA-funded feasibility study based on 2016 energy beet project at University of Maryland Eastern Shore. New charts and graphs based on the data developed for … **November 09, 2017** **Read Full Article**
>
> Energy Beet Feasibility Study Finds Navy Best Potential Near-Term Customer for Alcohol-to-Jetfuel Product



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(Advanced Biofuels USA) USDA-funded feasibility study based on 2016 energy beet project at University of Maryland Eastern Shore finds Navy solicitation is best market for economic viability of project followed by advanced ethanol for Mid-Atlantic ground transportation markets. With Norfolk and ,,, **September 14, 2017** **Read Full Article**

Atlantic Biomass Receives Nearly $200,000 US Department of Energy Funding for Biofuel Development

(Atlantic Biomass) The U.S. Department of Energy (DOE) has awarded Atlantic Biomass a $184,000 grant for "Low-Cost Production of Sustainable Aviation Fuels (SAF) from Perennial Feedstocks using Simultaneous Ball Milling and Enzyme Hydrolysis." Work on this project will be performed by ... **July 22, 2024** **Read Full Article** **(***note, due to the SBIR/STTR program not being renewed in this federal legislative year, this team has not been able to apply for Phase 2 grant (around $1Million if the program is ever revived).*

## Algae Research by Students and Faculty at Hood College

BlazerBloom Research Team Named National Champion in U.S. Department of Energy's AlgaePrize Competition. BlazerBlooms's research focused on leveraging algae to produce a carbon-neutral renewable biofuel, a type of fuel which can directly substitute for petroleum-based transportation fuels. BlazerBloom team members gained real-world research experience alongside Hood faculty members while developing cutting-edge ideas to lower the cost of producing algal biofuels and bioproducts. **Read Full Article**

## Conversion of Lignocellulosic Materials Such as Soybean Hulls (Hood College)

**Enzymatic Hydrolysis of Soybean Hull Without Pretreatment and Its Enhancement of Bioethanol Production Using Xylose-Fermenting Escherichia coli (FBR5)**

by Daehwan Kim, Erica Correll, Elisha Kabongo, Soyeon Jeong, Chang Geun Yoo (IMR Press) Lignocellulosic materials, such as soybean hulls, possess a complex and recalcitrant structure that requires efficient pretreatment or enzymatic processing for effective conversion into valuable products. However, pretreatment processes ... **July 11, 2025** **Read Full Article**

## Anaerobic Digestion Research University of Maryland, College Park

Dr. Stephanie Lansing leads the Bioenergy and Biotechnology Lab at the nexus of renewable energy, water quality, waste treatment, and human health. She is committed to understanding the ecological, engineering, and social systems that influence these intertwined areas. Dr. Lansing serves as a Vice Chair of the Maryland Food System Resiliency Council. Her research focuses on strengthening the biocircular economy, **anaerobic digestion**, bioplastic formation from waste, microbial fuel cells, and nutrient management. She has 20 years of experience in renewable energy research, extension education, and conducting sustainability life cycle assessments of waste to energy systems. Her work in bioenergy spans from large to small-scale anaerobic digestion in the US, Africa, and Latin America.

Dr. Lansing is leading two grants totaling >$6 million from the U.S. Department of Energy (DOE) to develop sustainable products, such as biofuels and bioplastics from **food waste**. These grants are aimed at understanding the waste sources we have, particularly the quantities of food waste, and determining what opportunities exist for us to create renewable resources and energy from that waste. One grant is focused on the production of bioplastics from food waste, while the other is focused on characterizing the **municipal solid waste** stream to create biofuels that can replace

liquid fuels like aviation fuel. https://agnr.umd.edu/about/directory/stephanie-lansing/ includes VIDEO

**3. Technology Developed in or Used in Maryland**

The following are examples of technologies are or have been developed or used in Maryland.

**3.a Alchemity** www.alchemity.com

Alchemity is a climate-tech company commercializing a modular, net-zero modular reactor platform that transforms wasted resources and greenhouse gases directly into high-value fuels and chemicals—starting with sustainable aviation fuel (SAF) and renewable diesel. Sustainable liquid fuel production allows the transportation sector to decarbonize. Their modular skid can be deployed at a waste source, replicated for scale, and integrated based on volume demand similar to solar panels or battery skids.

Headquartered in Maryland, they have been working with faculty at UMD College Park, including with Stephanie Lansing, to install their process to make sustainable diesel and SAF directly at anaerobic digester sites in MD.

In general, here's what their technology does:

A turnkey platform system converts biogas from landfill, agricultural, and municipal waste directly into clean drop-in fuels with zero $CO_2$ emissions.

Compared to conventional chemical processes, this technology consumes up to 3x less energy, delivers 3× higher efficiency, and enables sustainable fuel production at half the cost, offering SAF to market at price parity to conventional jet fuel ($7/gal), significantly below the current $9–13/gal market price.

The founding team brings over 70 years of combined expertise in materials science, engineering, commercialization, and giga-scale project development, with a history of successful ventures. Backed by $1.7M in non-dilutive funding and an exclusive license to a 32-patent portfolio developed at the University of Maryland and University of Florida (supported by $20M in R&D), Alchemity has advanced its platform to TRL 5 and is now scaling to TRL 7 through a pilot deployment in Maryland.

The pilot project team is fully assembled—including aerospace and chemical industry leaders, system integrators, a fuel qualification lab, and a host site with an operating anaerobic digester. Alchemity plans to deploy modular skids at farms, wastewater facilities, and municipal sites. The system's feedstock flexibility and integrated biogas upgrading capabilities allow it to operate independently of location or waste source.

Initial revenue will be generated through skid sales, service agreements, and licensing, with a path toward long-term offtake-backed project development. Alchemity is actively building a project pipeline to decarbonize hard-to-abate sectors through cost-competitive, scalable, and zero-emission fuel production.

Contacts: Emir Dogdibegovic, Rodger McKain and Eric Wachsman

**3.b. BTS Bioenergy, operating The Maryland Bioenergy Center and Maryland Organics Recovery Center**

The Maryland Bioenergy Center is Maryland's premier organics recycling facility. Centrally located in the Maryland Food Center in Jessup, the facility is less than 30 miles from Baltimore and Washington, DC. Within this facility, excess organics produced by the region's food manufacturers and retailers are transformed into renewable energy and fertile soil amendments.

This remarkable transformation both decarbonizes Maryland's waste and energy sectors, enabling our businesses and communities to prepare for a healthy and sustainable future. Contact the Maryland Bioenergy Center 443-782-3414

The Maryland Organics Recovery Center is a specialized intermediate recyclable material processing facility in Halethorpe, MD. We efficiently separate packaging from organic materials, processing palletized, bagged, boxed, and bulk food waste before sending it to the Maryland Bioenergy Center in Jessup.

Serving food manufacturers, distributors, retailers, processors, and haulers, we offer a seamless, cost-effective solution that ensures compliance. By diverting waste from landfills and converting it into renewable energy, we help businesses achieve sustainability goals and support a circular economy. Contact the Maryland Organics Recovery Center 443-836-5515

Contact: Bioenergy Devco Founder and CEO Shawn Kreloff. skreloff@bioenergydevco.com

sdkreloff@gmail.com

**3.c. TRI ThermoChem Recovery International** https://tri-inc.net/

TRI's advanced steam reforming technology transforms everyday wastes into drop-in transportation fuels and renewable chemicals and power. Using garbage, waste wood, agricultural residuals, or energy crops, we can produce gasoline, jet fuels, chemicals, and other renewable energy with carbon intensity scores far below traditional sources. TRI has also adapted its proprietary technology to destroy chemical weapons and forever molecules, and to process mixed contaminated plastic wastes into pyrolysis oils suitable for upgrading.

HydroThermal Devolitalization

TRI has also adapted its proprietary technology to pyrolyze via steam reforming mixed contaminated plastic wastes into high quality pyrolysis oils suitable for upgrading. Most plastics technologies require ultra pure/clean feedstocks - TRI's does not and the technology is readily scalable from 10 to 1,000 tons per day of feedstock.

Fully Integrated Process Demonstration Unit (PDU) Processing 4 dry tons per day of biomass, TRI's PDU transforms a wide range of biomass to Fischer-Tropsch liquids (fuels) replicating every unit operation of a fully integrated commercial biorefinery. To date, we have logged over 13,000 hours converting waste feedstock into syngas, and over 5,500 hours converting syngas into renewable biofuels.

Commercialization

TRI has achieved TRL 9 on black liquor gasification and TRIl 8 on MSW. TRI has demonstrated this fundamental technology with over 35,000 hours of operation on multiple sources of biomass. TRI is deeply involved in domestic and international projects that are completing their FEED studies in preparation for FID in 2026. These major projects process 1,500 dry tons per day of feedstock producing 33 million gallons per year of SAF.

**4. Projects in Other States**

Here is a sample of the kinds of projects that could be implemented in Maryland, or that provide examples from other states that can provide models and advice as Maryland expands into developing and using renewable fuels for a wide variety of purposes.

**4.a Woody Biomass**

Due to the closing of the Luke paper mill in Western Maryland, woody biomass which had been used as feedstock, especially in amounts related to maintaining a healthy, sustainable forest industry, could be available as fuel/co-product feedstock.

Examples of woody biomass for these purposes exist with projects at the Pacific Northwest National Laboratory in Washington state, at the USA BioEnergy project in Texas and Strategic Biofuels in Louisiana. Some of these incorporate carbon capture and storage which may not be available in Maryland; although carbon capture and utilization may be an option.

For a presentation on Forest Resources as Feedstock for Biofuel and Co-Products and related market forces:
https://docs.google.com/presentation/d/1jHKdU2ZJCCwYtDm3LsfXkWjT3HNS7MVd/edit?slide=id.p1#slide=id.p1

**4.b Food and Dairy Waste/Manure**

Maryland can look for examples of anaerobic digestion using food waste and animal manure projects that are used for transportation fuel or are fed into existing natural gas systems by Agri-Grid, Vanguard Renewables, Brightmark)

**4.c Government Use of Renewable Fuels**

Here are some excerpts from articles about how other governments have benefitted from transitioning to greater renewable fuel use.

**4.c.1 New York City 67% Decrease Carbon Footprint**

City of New York has reduced fossil fuel usage by 67% percent over the past 13 years, accounting for a reduction of nearly 20 million gallons of fossil fuel per year with the biggest reductions at the New York City Department of Sanitation, New York City Department of Transportation, and NYC Parks.

...

This achievement includes a net reduction in total fuel use and the transition of 99% of all diesel fuel to biofuels, primarily renewable diesel with 5% biodiesel. … The electrification of diesel trucks and off-road equipment will take longer to accomplish than for light- and medium-duty units, and renewable diesel offers a way to make progress for that segment of the fleet now. https://www.nyc.gov/site/dcas/news/020-25/city-new-york-major-fleet-fossil-fuel-reduction

**4.c.2 Westchester County Airport Renewable Diesel Trial Shows Cost Savings**
https://www.westchestergov.com/home/all-press-releases/10637-westchester-county-airport-renewable-diesel-trial-shows-cost-savings

The County tested the bio-based fuel on 64 pieces of ground service equipment through all four seasons, and found that renewable diesel performed seamlessly while saving money.

County analysis shows renewable diesel was 17 percent less expensive than regular diesel in 2025, demonstrating fiscal responsibility for airport stakeholders. With the trial now concluding, the County will fully transition its airport fleet to renewable diesel, replacing traditional fuel with a cleaner and more cost-effective alternative.

**4.c.3 Erie County Launches Renewable Diesel Pilot Program**

Why? In addition to lower greenhouse gas emissions, renewable diesel has lower tailpipe emissions for particulates, sulfur, aromatics, and VOCs, reducing health risks to workers and lowering costs by reducing the amount of Diesel Exhaust Fluid used and the number of particulate filter regeneration cycles burned.

**4.c.4 DC Public Works Converted Heavy Duty Trucks to Use 100% Biodiesel**

DC Gets Grant for B100 Biodiesel Project by Cindy Zimmerman (Energy.AgWired.com) The Greater Washington Region Clean Cities Coalition (GWRCCC) is getting some help toward lower greenhouse gas emissions in the District thanks to a U.S. Environmental Protection Agency (EPA) 2021 Diesel Emissions Reduction Act (DERA) grant. The Project will …October 25, 2021 Read Full Article

12 DC Water Trucks Receive DERA Grant to Run on 100% Biodiesel, June 2021 (Greater Washington Region Clean Cities Coalition) Greater Washington Region Clean Cities Coalition was awarded a U.S. Environmental Protection Agency grant through the 2021 Diesel Emissions Reduction Act (DERA) program. In partnership with the DC Department of Public Works and DC Water,August 27, 2021 Read Full Article

Renewable Energy Group and Optimus Technologies Collaborate to Deliver Biodiesel to Fleets Nationwide (Renewable Energy Group/Business Wire) Fleets Immediately Reducing Carbon Emissions with 100% Biodiesel -- Fleets across the nation are improving their emission reductions by implementing B100 (100% biodiesel) technology into their fleets. Renewable Energy Group (REG) (NASDAQ: REGI) fleet customers in Iowa, April 01, 2021 Read Full Article

Biodiesel-Powered Vehicles Wrap and Roll (National Biodiesel Board) "Better, Cleaner, Now" message delivered from coast to coast -- Newly branded vehicles highlighting biodiesel's sustainability and emissions reduction benefits are rolling along city streets and interstate highways from the nation's capital, to Texas oil country, up September 22, 2020 Read Full Article

DC Public Works Expands Biodiesel Truck Fleet with Advanced Fuel Systems (Renewable Energy Group) Optimus Systems, Paired with 100% Biodiesel from REG, Allows the Department to Easily Achieve Sustainability Goals -- The D.C. Department of Public Works (DPW) increased the number of heavy-duty fleet vehicles capable of running on renewable pure June 25, 2020 Read Full Article

#### 4.c.4.1 Other Cities that have done the same

**City of Ames Grows Sustainable Fleet with Partners Renewable Energy Group and Optimus Technologies**

**Biodiesel Drives Fleet Operations to Be Better, Cleaner, Now!**

**Renewable Energy Group and Optimus Technologies Collaborate to Deliver Biodiesel to Fleets Nationwide**

**Iowa Fleets Make '100 Best' List with Biodiesel**

**1.3-Million-Mile Evaluation Proves 100% Biodiesel Is Effective at Decarbonizing Heavy-Duty Trucking**

### 4.d Examples of Use of Sustainable Aviation Fuel, Airports Which Provide SAF

SAF availability is important to businesses and individuals looking for ways to decrease their Scope 1, 2, and 3 emissions, to comply with company ESG (environment, social and governance) goals for freight as well as travel. As Maryland airports look to meet these needs, they can look to these and more examples:

**Snapshot of SAF Initiatives** (international Air Transport Association/Biofuels International) In the UK, Jet2.com began using sustainable aviation fuel (SAF) on flights from Bristol Airport earlier this year (2025). The airline purchased over 300 tonnes of SAF from Q8Aviation, which has been used to add a 1% SAF blend on to a number of departing flights from the West Country airport.

...

Following Ryanair's purchase of 500 tonnes of SAF from OMV last October, the airline has announced that it has taken an additional 500 tonnes of SAF from OMV this year.

The low-cost airline also announced that it had purchased 1,000 tonnes of SAF from Shell, which will be supplied to the airline at its Stansted Airport base.
https://advancedbiofuelsusa.info/snapshot-of-saf-initiatives

**Delta Partners with Shell and the Port of Portland for first commercial-scale SAF uplift at Portland International Airport** (Delta Airlines) Delta Air Lines, in collaboration with Shell and Portland International Airport (PDX), has taken delivery of Sustainable Aviation

Fuel (SAF) into the PDX fuel system, marking the first commercial-scale SAF uplift at PDX. This achievement not only expands Delta's ... September 08, 2025 Read Full Article

**DHL Express and Cathay Group Sign New Sustainable Aviation Fuel (SAF) Deal to Drive Production and Uptake in Asia** (Cathay) DHL Express purchases 2,400 tonnes of SAF from Cathay Group to be used on flights operated by Air Hong Kong, an express all-cargo carrier and wholly owned subsidiary of Cathay. The SAF will be used on Air Hong Kong flights departing ... August 18, 2025 Read Full Article

**Denver Terminal Joins Avfuel's Growing SAF Supply Chain** (Avfuel/Canadian Biomass) Strategic location improves SAF accessibility across the United States -- Avfuel Corporation, the leading independent supplier of aviation fuel and services, is expanding its sustainable aviation fuel (SAF) footprint with the addition of a new, strategic supply point in Denver, ... July 30, 2025 Read Full Article

**Million Air Albany and Albany County Airport Authority Now Offering Sustainable Aviation Fuel (SAF) to Support Greener Skies** (Avfuel) Million Air Albany (KALB), an Avfuel-branded fixed-base operator (FBO), and the Albany County Airport Authority are proud to announce the availability of sustainable aviation fuel (SAF), providing a meaningful solution for operators seeking to reduce lifecycle greenhouse gas emissions from ... July 28, 2025 Read Full Article

**Neste to Supply Sustainable Aviation Fuel (SAF) to DHL Express at Singapore Changi Airport in One of the Largest SAF Deals in the Air Cargo Sector in Asia** (Neste) Supply of 7,400 tons (9.5 million liters) of neat sustainable aviation fuel (SAF) from July 2025 to June 2026; One of the largest SAF deals in Asia in the air cargo sector, and DHL's first SAF purchase for international flights from ... July 16, 2025 Read Full Article

**CLIMBING. FAST.: NBAA Applauds Massport's Commitment to Sustainable Aviation** (Climbing.Fast.) NBAA (National Business Aviation Association) welcomes the Massachusetts Port Authority's (Massport's) recently announced roadmap for increasing the use of sustainable aviation fuel (SAF) in the Commonwealth and across New England. Massport's plan for SAF growth was detailed in a series of ... June 12, 2025 Read Full Article

**Avina to Develop Nation's First On-Site SAF Production Facility at Pittsburgh International Airport** (Avina) Pittsburgh International Airport (PIT) and Avina Synthetic Aviation Fuel (Avina) are partnering to develop the first on-airport sustainable aviation fuel (SAF) production facility utilizing one of the very first alcohol-to-jet pathways in the U.S. Avina will build a state-of-the-art facility to ... June 09, 2025 Read Full Article

**VINCI Airports Offers Sustainable Aviation Fuel and an Electric Charging Station at Annecy Haute-Savoie Mont-Blanc Airport** (VINCI Airports) Annecy Haute-Savoie Mont-Blanc airport, operated by VINCI Airports, has taken a new step in its environmental strategy by providing sustainable aviation fuel (SAF) and an electric charging station thanks to a new fuelling contract with TotalEnergies. A 44 kW ... June 02, 2025 Read Full Article

**4.e Examples of Use of Sustainable Marine/Maritime Fuel (SMF)**

With Baltimore serving as a major East Coast seaport with ships traveling to international destinations and subject to International Maritime Organization regulations, it has many examples world-wide to follow as it explores bunkering a variety of renewable fuels. SMF may also be of interest to cruise ships, ferries and for boating on the Chesapeake Bay.

**'We Are Ready': Major Bunker Supplier Backs Asia's Biofuel Push with New Tanker Fleet** by Huaqing Ma (TradeWinds) Singapore's bunkering industry is well-positioned for a multi-fuel future as infrastructure for methanol and biofuels continues to expand, said Caroline Yang, chair of the shipping policy committee at the International Chamber of Shipping. Speaking to TradeWinds on the ... *October 18, 2025 Read Full Article*

**UK Polar Research Vessel Sails to Antarctica Using Biofuel** (The Maritime Executive) The British Antarctic Survey (BAS) is making major strides in its efforts to decarbonize marine operations as its flagship polar research vessel set sail for a new season in Antarctica. They report the vessel's engines will be running ... *October 18, 2025 Read Full Article*

**OCI Global and VICTROL Partner to Develop Refrigerated Clean Ammonia Bunkering Supply Chain in the Netherlands and Belgium** (VICTROL) OCI Global and VICTROL partner to Develop Refrigerated Clean Ammonia Bunkering Supply Chain in the Netherlands and Belgium -- OCI Global (Euronext: OCI) and VICTROL have signed a Memorandum of Understanding (MoU) to jointly develop a safe, scalable and commercially viable ,,, *October 16, 2025 Read Full Article*

**Towngas Joint Venture VENEX Signs Strategic Green Fuel Supply Cooperation Agreement with Veolia and SIPG Energy to Accelerate Energy Transition of Port and Shipping Industry** (Towngas) In active response to the national dual carbon goals and the strategic requirements for green transformation in the port and shipping industry, VENEX Company Limited (VENEX) – a joint venture established by The Hong Kong and China Gas Company Limited ... *October 16, 2025 Read Full Article*

**Maya Cosulich Launched and Preparing for Operations in Singapore for TFG Marine** (Fratelli Cosulich) On 9 October 2025, we marked a major milestone in our journey towards sustainable bunkering with the launching of Maya Cosulich — the world's first methanol-powered IMO II chemical bunker tanker — at Taizhou Maple Leaf Shipyard. The ceremony was ... *October 16, 2025 Read Full Article*

**Baleària Begins Exclusive BioLNG Use on Three of Its Ships, Which Now Sail with Zero Emissions** (Baleària) The shipping company is using this renewable fuel on all routes operated with the fast ferry 'Margarita Salas' and the ferry 'Abel Matutes', which connect Barcelona-Alcúdia-Ciutadella, as well as the ferry 'Rusadir', which connects Malaga-Melilla The use of this fuel, which *October 09, 2025 Read Full Article*

**P&O Ferries Begins First Biofuel-Based Operations on North Sea Ferry** by Rebecca Moore (Riviera) P&O Ferries' Pride of Hull, has become the first ferry on the Hull–Rotterdam route to permanently run on lower-carbon biofuel blend -- Following a successful trial, Pride of Hull is now running entirely on Biofuel B30 – a blended fuel, containing, ...*September 22, 2025 Read Full Article*

**Who's Bunkering What Where? A Gathering of Articles about Sustainable Marine/Maritime Fuel Markets/Sales** provides a list of bunkering with renewable fuels around the world.

### 4.f Aggregation of Feedstock

Some companies collect or aggregate feedstock and transport it to facilities for conversion into products for the bio- and circular economies. An example of doing this for grease that has found its way into the wastewater system is **Greasezilla,** headquartered just over the border in West Virginia, and a leading cleantech provider in the FOG and UCO separation industries, solving FOG processing and disposal challenges for water recovery facilities, grease haulers, industrial food processors and managed waste sites worldwide.

Greasezilla ecologically processes and repurposes the FOG waste stream into water and clean energy resources, including a low carbon intensity bio feedstock for renewable diesel and sustainable aviation fuel production. Greasezilla systems enhance sustainability measures, help to minimize greenhouse gas emissions, protect wastewater infrastructure and reduce the amount of waste dumped in landfills.

All of Maryland's wastewater treatment facilities should explore adding this feedstock preparation and collection system.

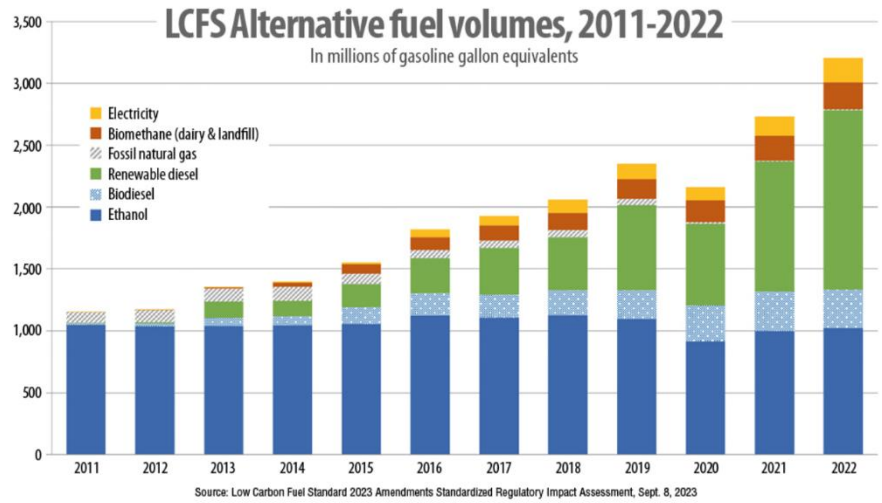
## 5. Policy in Other States

Many U.S. states have biofuel policies or incentives such as tax credits, fuel tax exemptions, and low carbon fuel standards.

The U.S. Department of Energy Alternative Fuels Data Center lists states' laws and incentives related to alternative fuels and advanced vehicles.

Of note, **Oregon, Washington** and **New Mexico** have formal low carbon or clean fuel standards influenced by the California Low Carbon Fuel Standard.

This graph shows how the California LCFS achieved increased use of renewable fuels in transportation.




**Minnesota** has had a biodiesel mandate since 2005, which varies by season to accommodate the properties of the biodiesel fuel. This graph from Clean Fuels Alliance America shows how that legislation has led to increased use of renewable fuels over time.


**Minnesota** also has a sustainable aviation fuel (SAF) incentive program. Minnesota's Legislature approved $11.6 million for  tax credits worth $1.50 for each gallon of fuel that is produced or blended with aviation fuel in Minnesota and sold in the state for use at Minnesota airports. The law also exampts construction related to biofuel for aviation from sales taxes on building materials.  Note that alternative fuel is only eligible for a tax credit if it results in 50% fewer carbon emissions compared to traditional jet fuel.

**Washington state** has a SAF tax credit. The Port of Seattle explains that the law creates a per-gallon incentive for SAF with lifecycle greenhouse gas emissions that are at least 50 percent lower than traditional jet fuel.  The incentive increases for each one percent reduction in lifecycle greenhouse gas beyond 50 percent, up to a potential incentive of $2 per gallon.

The per gallon incentive can be claimed as a tax credit by fuel producers or consumers like airlines, but only once on any gallon.

Incentives will begin when a manufacturing facility becomes capable of producing at least 20 million gallons per year. Currently there is no continuous SAF production occurring in

Washington state.

The bill also requires Washington State University and University of Washington to calculate the emission benefits near Seattle-Tacoma International Airport from the increased use of SAF.

In **Illinois**, as the Illinois Department of Revenue explains, from July 1, 2023, through December 31, 2032, sustainable aviation fuel (SAF) sold to or used by an air common carrier for use in Illinois earns sustainable aviation fuel purchase credit (SAFPC).

The amount of SAFPC earned is $1.50 per whole gallon purchased. SAFPC is earned at the time that SAF is purchased for use in Illinois.

The amount of SAFPC is based on the number of whole gallons of SAF purchased. Partial gallons will not earn a credit. SAFPC may be used by a purchaser at the same time it is earned. SAFPC is applied toward the 6.25-percent state sales or use tax liability on the purchase of aviation fuel.

**Nebraska** has a production tax credit for SAF) which provides a $0.75 per gallon tax credit for the production of aviation fuel that reduces lifecycle emissions by at least 50 percent, which may be calculated based on the most recent version of Argonne National Laboratory's GREET model.

**Illinois** expanded its biodiesel sales tax exemption on the sale of B10 sold at in-state fuel retail locations. Now the tax incentive applies to higher blends of biodiesel escalating over the years. Starting in 2024, the incentive applied to blends of B13 and higher, increasing to B16, B19 and higher in subsequent years.

**Iowa** increased the state's biodiesel production tax credit from 2 cents to 4 cents per gallon while updating the state's Renewable Fuel Infrastructure Program to increase access to higher blends of biofuels. The law maintains a biodiesel fuel tax differential by applying it to blends of B20, rather than B11. It extends current fuel retailer tax credits for B11 and higher, while introducing new credits for higher blends like B20 (7 cents per gallon) and even B30 (10 cents per gallon)—a national first.

**Missouri** incentives include a 2-cent-per-gallon retail incentive for B5 to B10 and a five-cent-per-gallon retail incentive for B11-plus sold at Missouri fuel retailer locations. There is also a two-cent-per-gallon incentive for biodiesel produced in the state.

Many states have **infrastructure grant programs** to increase the availability of renewable fuels in retail establishments which are often partially funded and promoted by agricultural organizations.

### 6. Policy Recommendations

Advanced Biofuels USA policy recommendations are based on those developed for Transportation, All Types of Vehicles/Equipment, Heating, Cooking during the Frederick City and County Climate Emergency Mobilization Work Group which met during 2020 and involved dozens, perhaps hundreds of individuals.

Advanced Biofuels USA recommends that Maryland follow Recommendation 16, Transportation from that CEMWG report:

It is pasted below and available here:
Volume 1:
https://www.mobilizefrederick.org/_files/ugd/793224_86d724fb9047489896e823edf2e1a3f6.pdf

Volume 2:
https://www.mobilizefrederick.org/_files/ugd/793224_f53d2e26479140ffafc15da62ab03562.pdf

Also, as the Maryland Aviation Administration (MAA) is developing a Decarbonization Roadmap that recognizes that airlines will be using sustainable aviation fuel (SAF) to meet their own ESG goals, to address climate change mitigation and to comply with regulations and policies, MAA should work with airlines, private pilots and airplane owners and relevant organizations and businesses such as fuel suppliers to provide infrastructure needed to accommodate SAF at Maryland airports and to facilitate its use to the greatest extent possible.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16

TRANSPORTATION RECOMMENDATION

## Facilitate the availability of renewable fuels for all vehicle types and home heating

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 as active parts of our vehicle fleets for a long time. This is not only because they are so useful for efficient freight transportation and heavy duty work, but also because they last for many years. Until technology advances and provides a future where all engines are powered by electricity, providing a bridge fuel that lowers $CO_2$ emissions through the use of alternative and renewable fuels is a worthy goal, and a means by which many jurisdictions throughout the country are lowering emissions. Use of renewable fuels is a near-term option while plans for fleet transition to electric-only vehicles are developed and implemented.

Renewable alternative fuel options for compression ignition engines include biodiesel, renewable diesel, co-processed diesel, straight vegetable oil (SVO), renewable dimethyl ether (rDME), ethanol, and lignin ethanol oil (LEO). Each of these options emit lower levels of carbon on combustion than fossil fuels, with varied environmental impacts.

Most ethanol in gasoline for spark ignition engines is made from corn, which has a GHG emissions profile 39–43% lower than petroleum gasoline. Light duty vehicles commonly use E10 gasoline (10% ethanol), the main fuel sold in the U.S. Some fueling stations in the region offer E15 (15% ethanol) that, consistent with U.S. Environmental Protection Agency guidance, can be used in vehicles built in 2001 and later, although some automakers dispute the finding.

Beyond emissions reductions, research has found that community availability of alternative, renewable fuels substantially reduces air pollution, preventing premature death, decreasing lost work days and avoiding health care costs. There is only one fueling station in Frederick City or County that offers E15. Increasing the availability of E15 could lower the carbon footprint of the vast majority of vehicles in the City and County. Only two retail stations offer 85% ethanol. Increasing the availability of renewable fuel alternatives would increase availability for compatible long haul freight and light duty vehicles passing through on major highways and stopping to refuel.

The National Energy and Fuels Institute, which represents the nation's retail distributors of liquid heating fuels, ratified a pledge to reduce emissions by 40% by 2030 and deliver a net-zero liquid heating fuel to consumers by 2050. The availability of these alternatives presents possible energy sources for lower GHG emissions for homes heated by oil and gas as retrofits to electric are being anticipated.

### Recommended actions:

- **Begin using renewable fuels** in municipal and County fleets and equipment as soon as possible.
- **Encourage local fuel supply businesses** (heating oil, aviation and retail/wholesale gasoline and diesel suppliers) to increase the renewable fuel options available to private consumers, businesses for fleets and equipment, and for agricultural purposes.
- **Provide consumer education, encouragement, and facilitation** of renewable fuel use in collaboration with the business and agricultural communities.
- **Frederick Municipal Airport** should provide sustainable aviation fuel as soon as possible.

## 16 Facilitate the availability of renewable fuels for all vehicle types and home heating

**Expected GHG Reduction or Climate Adaptation:** Until technology advances and provides a future where all engines are powered by electricity, biofuels provide a bridge fuel that lowers CO2 emissions, a short-term approach many jurisdictions are taking to lowering emissions as a means for meeting interim GHG reduction targets. Biofuels are especially useful for existing vehicles that have many years of useful life remaining. Biofuels should be phased out as soon as clean, renewable energy and associated technology are available at a capacity to meet energy needs. GHGs should decline and reduce the associated impacts of extreme heat, major storms and flooding, and extended dry periods. Tracking can be accomplished through annual reporting of the shift to renewable fuels by numbers of gas stations offering biofuels and sales of biofuel to gas station customers, public fleets, local farms, and at the Frederick Municipal Airport.

**Timeline for Action:** Increasing contributions of ethanol in gasoline and using other renewable fuels in government and private vehicles, home heating, and aircraft should occur over the next five years. Progress metrics should include establishing the tracking database and working with City and County officials and state legislators to establish incentives to encourage renewable fuels in existing vehicles.

**Rationale:**

- *Heavy Duty Vehicles, Buses, Trains, Agricultural, and Other Equipment*

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 in use for a long time because they last for many years. At least a third of these engines are expected to be replaced by other drivetrains by 2035 (Clevenger, 2019; Hurd, 2019).

Renewable alternative fuel options for compression ignition engines include biodiesel, renewable diesel [hydrotreated vegetable oil (HVO)], hydrogenation-derived renewable diesel (HDRD), hydroprocessed renewable diesel (HRD), and several others. Possible alternatives also include co-processed diesel, straight vegetable oil (SVO), renewable dimethyl ether (rDME), ethanol, and lignin ethanol oil (LEO).

Each of these will have a different carbon intensity and varied environmental impacts. For example, biodiesel significantly reduces life cycle GHG emissions. Life cycle analysis using Argonne National Laboratory's GREET analysis found that greenhouse gas emissions for B100 (100% biodiesel) are 74% lower than those from petroleum diesel with similar values for its life cycle analysis of biodiesel from various sources (Alleman et al., 2016; Batres-Marquez, n.d.).

Renewable diesel has some of the largest lifecycle GHG reductions with a carbon intensity of about 30 compared to 102 for ultra low sulfur petroleum diesel (U.S. Energy Information Administration, 2018). This can vary depending on the feedstock and generally ranges from 50% to 85% lower than baseline petroleum-based diesel fuel (Leonard & Couch, 2017). Biodiesel or renewable diesel are most likely to replace petroleum diesel.

- *Light Duty Vehicles*

Light duty gasoline vehicles commonly use E10 gasoline (10% ethanol) as that is the main fuel sold in the U.S. Some fueling stations in the region offer E15 (15% ethanol) that, consistent with Environmental Protection Agency guidance (EPA), can be used in vehicles built in 2001 and later (EPA E15 Fuel Registration). However, some automobile manufacturers do not agree with these findings, in some cases even with 2021 model year vehicles (Renewable Fuels Association, 2021). Flex fuel vehicles can use blends of gasoline and ethanol up to 85% (Department of Energy [DOE]). E85 (Flex Fuel).

Because there is only one fueling station in Frederick City or County that offers E15 (Rutters), increasing the availability of E15 could lower the carbon





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footprint of the vast majority of vehicles in the City and County. Only two retail stations offer E85 (Rutters & W Express).

Currently, most ethanol in fuel is made from corn. The latest report from the U.S. Department of Agriculture (USDA) indicates that corn ethanol's current greenhouse gas emissions profile is 39–43% lower than gasoline, with significant improvements on the horizon (Lewandrowski et al., 2020). Some light duty vehicles in the City and County and many long haul heavy duty vehicles use diesel fuel. It is possible for those to use up to 5% biodiesel (B5) or 100% renewable diesel as a complete replacement for petroleum diesel. Biodiesel up to 5% is considered an additive approved for all diesel engines, although some manufacturers approve biodiesel blends up to 20% (B20) for some engines (DOE, n.d.).

Frederick City and County also have major heavy duty and long haul vehicles and many light duty vehicles passing through on major highways and stopping to refuel.

Some light duty and heavy duty vehicles may also use compressed natural gas. Depending on the source of renewable natural gas, the carbon intensity can be negative, for example, when manure that would otherwise have emitted methane into the air is captured and converted to renewable natural gas (RNG; Sanchez, 2021).

- *Heating Oil/Fuel*

With regard to propane as a heating fuel, a study was done to explore a cost-effective approach to phasing out heating oil and coal in European Union Member States. The study determined that by tapping into the potential of liquefied petroleum gas (LPG) and BioLPG in rural areas, their policy targets could be reached at lower cost. They also emphasize the benefit of finding fuels that can be used in existing infrastructure (Future of Rural Energy in Europe, n.d.).

The graphic below summarizes those findings.

During discussions with several people who use heating oil and propane and with heating fuel providers, the lack of natural gas alternatives and cost of conversion to electricity come up. Renewable alternatives that can be used with existing infrastructure are preferred. Also mentioned, however, are questions about using renewable fuels that may "clean out" old tanks resulting in clogs and problems. Government programs might be needed to help mitigate transition expenses (Tobias, 2018).

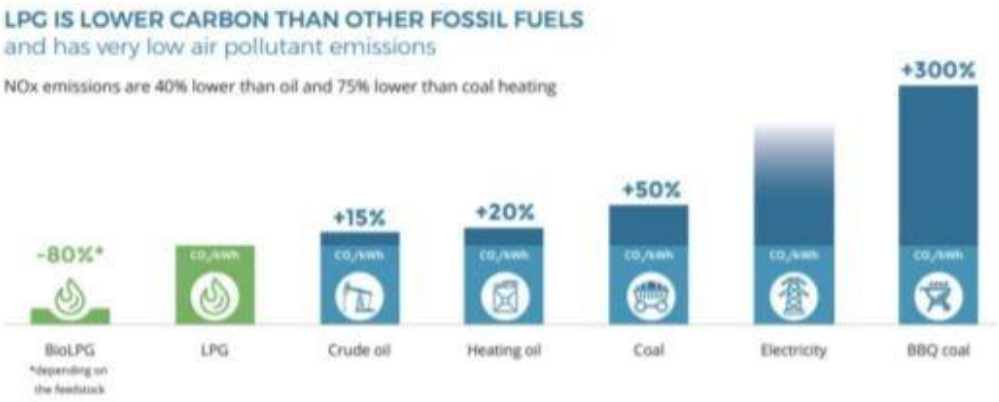


**Fig. 1. LPG vs other fossil fuels**

- *Aviation Fuel*

Aviation fuels are kerosene-based and GHG emissions are high. To reduce these emissions, sustainable aviation fuel (SAF) is being pursued. SAF is produced from sustainable resources such as waste oils from a biological origin. Signature Flight Support, the fixed base operator (FBO) for Frederick Municipal Airport, claims its Signature Renew SAF, certified for use in all jet aircraft, is an economical way to reduce aircraft carbon emissions by more than 25% (Signature Flight Support, n.d.). Signature has a company-wide global sustainability initiative that includes becoming the first FBO worldwide to offer a permanent supply of SAF, Jet A, to business aviation. However, Jet A SAF is currently offered only at San Francisco International Airport and London-Luton Airport and due to the extremely limited supplies, is not likely to be available for a number of years at other airports that are in locations that do not offer incentives.

As fuel producer, Neste, explains "As more states, such as Washington, New Mexico, and New York, progress and adopt clean fuel standards, Neste will be ready to move quickly and supply renewable diesel and sustainable aviation fuel into these markets" (National Academies of Sciences, Engineering, and Medicine, 2016; Neste, 2021a). The GHG impact also depends on the amount of petroleum fuel replaced. For example, by replacing a part of the fossil jet fuel with Neste's SAF on its flights departing from Helsinki Airport, Finnair will reduce its greenhouse gas emissions by 900 tons of CO2 equivalents (Neste, 2021b).

Avfuel Corporation reports that each truckload of SAF that they deliver to Monterey Jet Center will provide a 22 metric ton reduction in carbon emissions over the lifecycle compared to petroleum-based jet fuel—the equivalent of making five passenger vehicles zero emissions for one year (Avfuel Corporation, 2021).

Due to limited production of SAF for jet fuel, a Transportation and Climate Initiative (2021) suggests that the D910 fuel (blended for use in aviation reciprocating engines and meeting ASTM Specification D910 or Military Specification MIL-G-5572a) might be looked at as a fuel to be replaced by renewable fuel in the near-term, not only for carbon mitigation, but because it is a leaded fuel (for which there exist alternatives). The possibility of using E85 in these engines was suggested in conversations with a number of stakeholders and has been studied and considered by the aviation industry (Miller, 2013). Environmental justice benefits would accrue not only to the people working at the airfield and traveling in these planes, but to communities located near the airfield to prevent lead poisoning.

**Co-Benefits:**

*Biodiesel and Renewable Diesel:* Cleaner, less-polluting (Trinity Consultant and National Biodiesel Board, 2021; Skor, 2020; Clark et al., 2021), and less expensive (E85 Prices) options will benefit the health of residents, businesses, visitors and agricultural workers. In the transportation sector, benefits include a potential 45% reduction in cancer risk when heavy-duty trucks such as semis use B100 and 203,000 fewer or lessened asthma attacks (Trinity Consultant and National Biodiesel Board, 2021). Concerns about particulate matter and hydrocarbon emissions from diesel engines which may be toxic and/or carcinogenic are mitigated by use of biodiesel (Steiner et al., 2013; Bass et al., 2015; Shvedova et al., 2013).

Diesel exhaust contains substances that can pose a risk to human health and to the environment. Containing more than 40 toxic air contaminants (California Office of Environmental Health Hazard Assessment, 2001), 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 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 U.S. regulations will reduce NOx potentially by another 90% (Chevron Corporation, 2007).

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





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Renewable diesel can help improve air quality. Based on limited data, the California Air Resources Board (CARB, 2018) determined that RD100 can decrease NOx by roughly 10% when used in older heavy-duty engines that do not have state-of-the-art emission controls. Preliminary data also indicate renewable diesel can reduce particulates emitted from older diesel engines by about 30%. 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 (GNA, 2017; California Air Resources Board, 2018).

In addition, the use of biodiesel and renewable diesel fuel results in improved lubrication, zero aromatics, and minimal sulfur output. It has a very favorable energy balance — the difference between the energy produced by one kilogram of fuel and the energy necessary to produce it — of 3.2 to 1. This means a gallon of biodiesel provides 3.2 times the energy it takes to produce it, which is a higher ratio than most alternative fuels (Gehm, 2021).

The Local Production for Local Use (http://vermontbioenergy.com/local-production-for-local-use-is-the-biofuel-model-that-works-in-vermont/#.VUKHOJNBGAU) model results in two products from one crop: oil and meal (animal feed or fertilizer). By growing oilseed and pressing the seed to extract the oil, farms are creating a valuable livestock feed at home, rather than importing it. The oil can be sold as a food product, or used directly in a converted engine or converted to biodiesel for use in a standard diesel engine. In this way, oilseed crops offer flexibility in the end-use of the products (Vermont Bioenergy Initiative, 2013).

*Heating Oil/Fuel:* Researchers found that switching to 100% biodiesel for home heating oil and transportation would annually bring the 13 communities studied 340 fewer premature deaths, 46,000 fewer lost workdays, and $3 billion in avoided health care costs. When Bioheat® (see below) fuel made from 100% biodiesel is used in place of petroleum heating oil, the study found an 86% reduced cancer risk and 17,000 fewer lung problems. The study also considered the economic cost of premature deaths, asthma cases, reduced activity due to poor health, and work impacted due to sick days (Trinity Consultant and National Biodiesel Board, 2021).

According to the U.S. Department of Energy, when biodiesel is used in boilers or home heating oil applications, NOx tends to decrease because the combustion process is different (open flame for boilers, enclosed cylinder with high-pressure spray combustion for engines; Alleman et al., 2016) .

In a March 17, 2021 announcement, the National Energy & Fuels Institute stated, "Renewable liquid heating fuels are already supplanting millions of gallons of conventional heating oil across the country; thereby increasing energy and environmental security, driving down greenhouse gas emissions, supporting rural economies and local small businesses, and avoiding expensive heating system conversions" (Fuel Oil News, 2021).

Bioheat® contains no nitrogen or offensive odors. When one uses biodiesel, NOx, CO, hydrocarbons, sulfur, and PM are reduced. B20 blends reduce $CO_2$ emissions by 15.66%. Pure biodiesel would reduce $CO_2$ emissions by 78%, nitrated polycyclic aromatic hydrocarbons by 80%, unburned hydrocarbons by 67%, CO by 48%, particulate matter by 47%, and sulfates by an impressive 100%. Bioheat® passes the EPA's tier 1 and 2 health effects (http://www.healtheffects.org/Workshops/ACES2003/Costantini.pdf). The biodiesel Tier 2 testing reported no significant exposure-related effects on food consumption, mortality, neuropathology, reproduction, or ophthalmology. Bioheat® is non-toxic and is suitable for environments with children, seniors, and pets. Bioheat® also requires a higher temperature to ignite and burn than heating oil (Smart Touch Energy, 2016).

*Aviation Fuel:* Cleaner, less-polluting options will be available to those who fly in and out of the municipal airport. If the leaded fuel is replaced with less toxic renewable fuel, air quality improvement will benefit residents and businesses in the area as well (Miller, 2013)

*Ethanol:* A review of scientific literature suggests that ethanol-blended fuels result in less toxic emissions from vehicles and present a lower risk to human health than regular gasoline. The study,

a collaboration between The Hormel Institute, University of Minnesota, and the Energy Resources Center, University of Illinois Chicago, shows that gasoline containing ethanol produces lower emissions of toxic chemicals known to cause cancer (Mueller et al., 2021).

**Experience of Other Cities and Counties:** For specific examples of transition to renewable fuels by city public works fleets, see the experiences of Washington, D.C. and Ames, Iowa converting heavy duty vehicles to use B100 (100% biodiesel) using the Optimus System (Renewable Energy Group, 2021). Cities such as Oakland, California, have transitioned to renewable diesel with Richard Battersby, CAFM, CPFP, assistant director of Oakland Public Works saying, "Although at first renewable diesel seemed too good to be true, it truly has proven to be a 'miracle fuel.' Making the switch to renewable diesel is absolutely the easiest alternative fuel implementation I have ever experienced" (Schaeffer, 2020).

*Agriculture:* The Vermont Bioenergy Initiative suggests that the model developed in Vermont and described elsewhere in this recommendation has wider-reaching implications in that this can be replicated in rural farm communities across the U.S., although the specifics will vary (Vermont Bioenergy Initiative, 2013).

*Heating Oil/Fuel:* Since 2013, Rhode Island has had state legislation requiring renewable content in heating fuel with current legislation amending that to require up to 50% renewable content by 2030 (State of Rhode Island General Assembly, 2021). New York has had legislation since 2015 that "requires all heating oil sold for use in any building in Nassau, Suffolk, and Westchester counties on and after July 1, 2018 be bioheating fuel that contains at least five percent biodiesel" (The New York State Senate, 2017). Maine has been heating buildings with B10 since 2004. In 2009, Pennsylvania mandated that every gallon of on-road diesel sold in Pennsylvania must contain 2% biodiesel. In 2010, Connecticut signed into a law a requirement that all heating oil sold in the state contain less than 0.3% sulfur and at least 2% biodiesel.

In 2012, the New York City Council (https://www.smarttouchenergy.com/heating-oil/service-areas/new-york/nyc), with the assistance of the New York Oil Heating Association, mandated the use of B2 blend Bioheat® for oil-heated buildings. At the time, this decision resulted in the replacement of 20 million gallons of petroleum with an equal volume of renewable, domestically produced biodiesel. In 2014, New York City issued a mandate to utilize a B5 biodiesel blend for the city's fleet, and required a B20 blend from April to November beginning in 2016. The city plans to study the possibility of year-round usage of B20 for at least 5% of the city fleet. The city is also considering public biodiesel requirements that may impact private companies. Massachusetts may mandate that home heating oil contain 2% biodiesel (B2), and may eventually increase that number to 5% (Smart Touch Energy, 2016).

*Aviation:* Avfuel Corporation (2021) reports that each truckload of SAF that they deliver to Monterey Jet Center in California will provide a 22 metric ton reduction in carbon emissions over the lifecycle compared to petroleum-based jet fuel—the equivalent of making five passenger vehicles zero emissions for one year. As noted above, Avfuel considers SAF to be the most effective way to reduce a flight's carbon footprint; and, in the future, SAF could deliver up to 80% less greenhouse gas emissions versus traditional jet fuel if used in its neat form (AvFuel Corp, 2021). Also in California, Clay Lacy Aviation offers SAF at the company's two FBOs at Van Nuys Airport and John Wayne Orange County Airport. They have also transitioned to renewable diesel for ground support vehicles (Clay Lacy Aviation, 2021). As noted earlier, Signature's Jet A SAF is currently being offered only at San Francisco International Airport and London-Luton Airport (Signature Flight Support, n.d.).

**Interface with the Livable Frederick Plan and Frederick City Master Plan:** As the goals of the City and County plans are to become more energy efficient and reduce emissions, the recommendation is consistent with the objectives of both and should reduce costs and improve health of local residents.

**Cost-Benefit Analysis:** 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 below).

Since renewable diesel fuel volumes are lower than biodiesel, government agencies do not track prices as they do for biodiesel. Recent surveys of fleets that 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 (Ernst, 2020; Schaeffer, 2020).

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. Use of higher ethanol blends should result in fuel cost savings as higher ethanol blends, up to E30, "the Sweet Spot," do not show significant mileage decrease. Depending on local prices, using E85 may also save fuel costs (E85 Prices). Research done by DOE on optimizing engines and fuels may result in engines that run more efficiently on higher ethanol blends (Jung et al., 2013; EPA, 2021).

| 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.

**Table 1. Biodiesel blends: Biodiesel (B20) relative to diesel**

The costs of Bioheat® are similar to traditional heating oil, although slightly lower. Even when price differences are not considered, Bioheat® burns more efficiently and lasts longer due to the use of renewable energy components from soybeans and other plants. Bioheat® has the highest British Thermal Unit (BTU) content for any alternative fuel, containing 11% oxygen by weight (Smart Touch Energy, 2016).

Use of SAF will likely cost more. As noted above, because California and other states have enacted low carbon fuel standards or clean fuel standards or policies, fuel producers of limited quantities of SAF 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, SAF sources will be limited (Neste, 2021). Without financial incentives, there is a premium price for SAF.

Ethanol blends, similar to E85, to replace aviation gasoline do not have the same production limitations and could be priced lower than Avgas. For current comparisons, see these resources: AirNav.com and E85prices.com.

**Finance:** Many fuel retailers have used state funding and federal USDA funds (currently the Higher Blends Infrastructure Incentive Program) to upgrade tanks and pumps to be able to sell competitive higher blends of renewable fuels (USDA, n.d.).

All transitions to renewable fuels may pay for themselves with savings in fuel prices as described above. This is true for public transportation as part of City and County sustainability programs with funding from budgets appropriated for that purpose. Transitions to renewable fuels also should be part of farm sustainability programs, especially those that are encouraged or required by customers. Fleet transitions and shifts for aviation fuels to renewable fuels fall into this area as well, i.e., as part of City and County sustainability programs with funding from budgets appropriated for that purpose.





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## TRANSPORTATION

**Recommended actions:**

It is recommended that the City and County encourage the public and businesses to explore use of renewable fuels in existing compatible vehicles and building heating systems. It is also recommended that as soon as possible the City and County work with local fuel supply businesses (heating oil, aviation, and retail/wholesale gasoline and diesel suppliers) to increase the renewable fuel options available to private consumers as well as to businesses for fleets and equipment and for agricultural purposes. The City and County are encouraged to work as quickly as possible with civic, business, and agricultural organizations to provide consumer education, encouragement, and facilitation of implementation of renewable fuel. The City should quickly work with Signature to determine what actions would be needed to facilitate obtaining SAF at Frederick Municipal Airport. In addition, the City should work with owners of reciprocating engine aircraft to help them transition to renewable fuel options.

### Local Legislative Action

With regard to heating oil/fuel, legislation from other states and localities listed above should be studied as models for City and County legislation and for encouragement of state legislation. As noted above, priority for limited supplies of SAF is given to states that have low carbon fuel standards or clean fuel standards. As a member of the Transportation and Climate Initiative, Maryland is considering proposals related to a cap-and-invest strategy for on-road transportation fuels, but it does not include aviation fuels (Transportation and Climate Initiative, 2021).

California (California Air Resources Board) and Oregon (Department of Environmental Quality Action on Climate Change) have low carbon fuel standards and Washington state is in the process of implementing a clean fuel policy (Green Car Congress, 2021). Other states such as New Mexico, New York, and Minnesota are considering clean fuels policies (Biotechnology Innovation Organization, 2021), appropriate for Maryland.

### Administrative Action by City and County

Frederick City and County should explore use of renewable fuels in existing compatible vehicles and equipment as part of their sustainability programs.

#### *Obtain Sustainable Aviation Fuel for Sale at Frederick Municipal Airport*

The City airport managers and other City staff should:

- Meet with the FBO and local fuel suppliers to learn from their experiences complying with the referenced requirements for use of renewable fuels.
- Meet with airport users, managers, and suppliers to develop a plan to bring SAF, including unleaded aviation gasoline substitutes, to Frederick Municipal Airport.
- Obtain SAF for the airport.

#### *Encourage and Facilitate Commuter Rail Transition to Renewable Fuel*

- Dialog with MARC train officials on use of renewable fuels should be considered.
- The County and City should meet with local agricultural groups to encourage and facilitate use of more renewable fuel in agricultural equipment.

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