

# Science Policy Outreach Task Force at Northwestern University

## Alternative Fuel Sources (Hydrogen, Biofuels, and Biodiesel)



*SPOTlight: Alternative fuel sources, such as hydrogen, biofuels, and biodiesel, represent opportunities for the electrification and decarbonization of transportation industries.*

### The need for alternative fuels

- Electrification of transportation, especially medium-to-heavy duty vehicles, rail, ships, and aircraft, poses several technoeconomic challenges relating to fleet expenses, charging infrastructure, and range [1,2].
- Alternative fuels such as hydrogen and biodiesel can decarbonize heavy transportation while providing advantages such as faster refueling, higher energy densities, and fewer capital expenses [1].
- The Inflation Reduction Act included \$3B in funding towards reducing greenhouse gas (GHG) emissions and criteria pollutant emissions in water and large land ports through the Clean Ports Program [3].

### Hydrogen

- Hydrogen can be used as a zero emission fuel through combustion in fuel cells [4].
- Hydrogen is lightweight, but occupies more volume than comparable fuels. The tiny molecules can leak from containment vessels and result in hydrogen losses [4].
- Hydrogen produced from reacting hydrocarbons with water is gray hydrogen; capturing the carbon from this process produces blue hydrogen. Using renewable electricity to electrolyze water molecules to directly produce hydrogen fuel is called green hydrogen; nuclear electricity produces pink hydrogen [5].
- Illinois, Indiana, and Michigan were selected as one of seven hydrogen hubs in the US in October 2023, with sites such as the BP Whiting refinery producing blue, green, and pink hydrogen [6].

### Biofuels

- Biofuel is a catch-all term used to describe a variety of liquid fuels derived from biomass (most commonly, plant- and algae-based materials) [7].
- Liquid biofuels are well adapted for and easily used in transportation vehicles, and tend to emit fewer GHG emissions than fossil fuel alternatives [8].
- Cost, water usage, and a conflict between using land for food vs fuel production hinder biofuel implementation [9].
- The two most common forms of biofuels include biodiesel (see below) and bioethanol. [10]
- Approximately 97% of US gasoline contains ethanol to increase octane and decrease emissions [10].
- 2nd and 3rd generation biofuels use non-food based and algal biomass sources to reduce food vs fuel conflicts and water usage [9].
- Recent research focuses on genetic engineering to improve biofuel production and cost efficiency [11].

### Biodiesels

- Biodiesel is commonly used because it can be easily blended with conventional diesel for use in engines [12].
- Biodiesel is categorized by its percentage in a fuel mixture. For example, B20 is 20% biodiesel and 80% conventional diesel, while B40 is 40% biodiesel and 60% conventional diesel [12].
- Blends that are <20% biodiesel can be used in conventional diesel engines without modifications, while higher percentages generally need more significant modifications/specialized equipment [12].
- Emissions from biodiesel are highly dependent on the feedstock used in production [13].

### What are other ports doing?

- The Northwest Seaport Alliance has set the goal of implementing infrastructure to enable a transition to hydrogen-based low emission trucks by 2030 [14].
  - The Port of Houston is moving towards modernizing its truck fleet to meet the Tier 4 EPA nonroad diesel engine standard, representing a 96% decrease in NO<sub>x</sub> emissions from previous generations [15].
  - California has implemented a variety of laws, regulations, and incentives to reduce port emissions, including alternative fuel vehicle retrofit regulations, parking incentives, and low carbon fuel requirements [16].
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