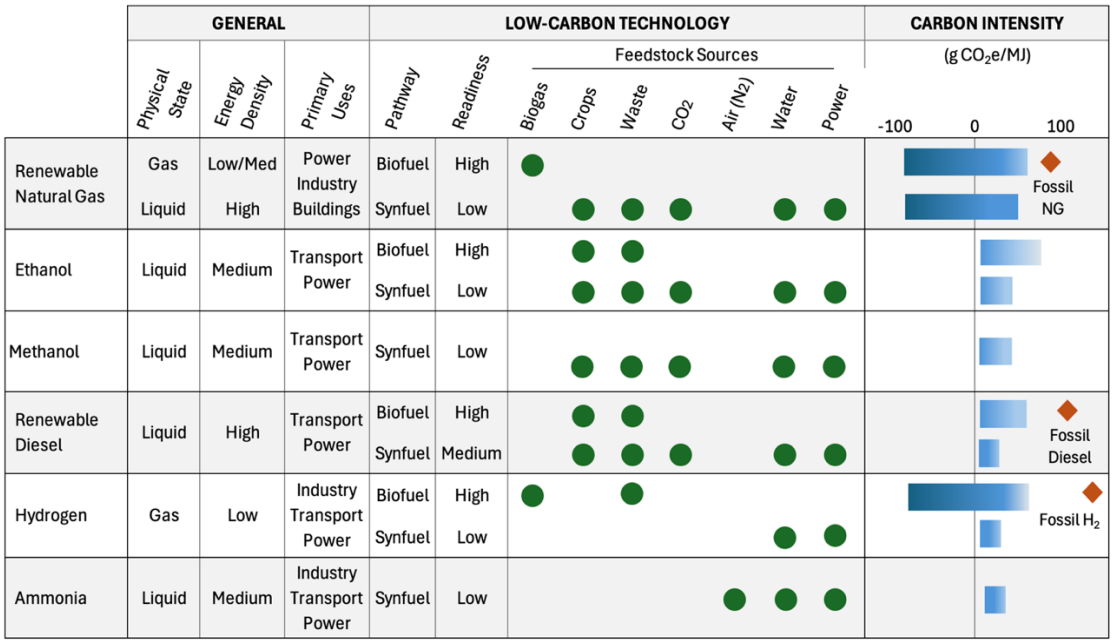
Low-Carbon Fuels Primer

This primer introduces the types of fuels that are shaping the future of energy. The following definitions aim to support discussions and evaluations on the role of fuels in decarbonizing the energy economy.

Low-carbon Fuel	Broad category that when burned, provides thermal energy with lower net emissions compared to fossil fuels.
Renewable Fuel	Low-carbon fuel produced from *renewable* sources, such as biological (plant matter, animal waste), organic waste, captured carbon dioxide, and renewable electricity.
Renewable Natural Gas	Also called *biomethane*, a type of renewable fuel and biogas that is produced from landfill gas, water treatment facilities, livestock farms, food waste, and other organic material. Processed to be a similar quality as fossil natural gas.
Biomass	Organic matter that can be converted into gaseous and liquid fuels.
Biofuel	A class of r*enewable fuel* derived from biological sources and processes. Minor modifications possibly required to accommodate refueling.
Biodiesel	A class of *biofuel* produced from vegetable oils (e.g., soybean, rapeseed, sunflower, palm), animal fats, recycled cooking oil. Specific production process to produce the fuel which is also called FAME (fatty acid methyl esters).
Renewable Diesel	A low-carbon, renewable fuel, produced from vegetable oils, animal fats, and food waste. It is treated to be a similar quality as fossil diesel. Properties are distinctly different than *biodiesel*.
Hydrogen (H_2)	A molecule that when produced with renewable electricity or natural gas with carbon capture and storage is considered to be low carbon. No direct carbon emissions when burned, high energy density by mass but low volumetric energy density.
Ammonia (NH_3)	A molecule that when produced with renewable electricity or natural gas with carbon capture and storage is considered to be low carbon. No direct carbon emissions when burned, NOx mitigation required.
Ethanol	A renewable, low-carbon fuel typically produced from biomass sources such as corn, sugarcane, or cellulosic materials.
Methanol	Can be produced in low-carbon processes from renewable resources like biomass, organic waste, or renewable electricity plus hydrogen and captured CO_2. Historically used in industrial/chemical processes, energy, and transportation applications.
Syngas	Short for *synthesis gas*, a mixture of hydrogen and carbon monoxide that can be used directly as a fuel or to make other fuels and chemicals. Produced from fossil fuels and biomass.
Synfuel	Short for *synthetic fuel*, is produced from *syngas*. Examples in include synthetic natural gas (methane), methanol, naphtha, gasoline, kerosene, jet fuel, and diesel. Commonly produced using Fischer-Tropsch conversion.
eFuel	Short for *electrofuels*, also called *power-to-x fuel*, a class of synfuel including hydrogen, methane, methanol, and liquid fuels that rely on electrolytic hydrogen as a building block.
Sustainable Aviation Fuel (SAF)	A low-carbon alternative jet fuel produced from *renewable* sources (biological, synfuel, and others). Could be blended with conventional fossil-based fuels or used directly if it meets aviation standards.

Characteristics of Select Low-Carbon Fuels



Fuel Use Comparison

In 2022, the US simple cycle gas turbine fleet consumed 1.7 billion MMBtu of fuel. Natural gas was the primary fuel at 1.6 billion MMBtu (1,500 billion cubic feet).

Fuel	Unit of Measurement	Equivalent Fuel Required	Current US Production[1]	Global Production
Ammonia	Million Tonnes	96	14	150
Hydrogen	Million Tonnes	15	10	95
Renewable Diesel	Million Gallons	14,400	3,000	12,000
Renewable Natural Gas	Billion Cubic Feet	1,700	55	200[2]
Ethanol	Million Gallons	22,500	15,400	28,200
Methanol	Million Gallons	30,000	1,900	57,000

Notes: (1) Total production **is** traditional + low carbon (2) Includes biogas
Data sources: EPRI, US DOE, EIA, EPA, IEA, Statista, GREET

EPRI Resources

- *An Introduction to Low-Carbon Fuels* [3002020041]
- *Renewable Fuels Atlas* [https://apps.epri.com/lcri-rf-atlas/en/map.html]
- *Renewable Fuels Interactive Fact Sheet* [3002028341]
- *Assessment of The Economic Supply of Waste Renewable Natural Gas Throughout the U.S.* [3002027970]
- *Hydrogen Blending Demonstration Synopsis: EPRI-Affiliated Testing Summary* [3002028175]
- *Ammonia and Hydrogen Fuel Blends for Today's Gas Turbines—Combustion Considerations* [3002020043]
- *Feasibility Assessment of U.S. E-gas Exports to Japan* [3002028027]

3002031268 October 2024

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