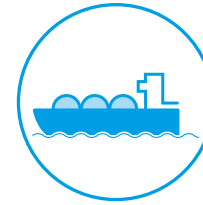
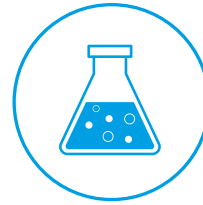


# Hydrogen, hydrogen derivatives and e-fuels



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	Hydrogen Gas	Liquid Hydrogen	Liquid Ammonia	Liquid Methanol	Liquefied Natural Gas (LNG)	Synthetic Aviation Kerosene (SAF)
Ideal universal reaction	Compressed H <sub>2</sub>	Liquefied H <sub>2</sub>	$3\text{H}_2 + \text{N}_2 \rightarrow 2\text{NH}_3$	$3\text{H}_2 + \text{CO}_2 \rightarrow \text{CH}_3\text{OH} + \text{H}_2\text{O}$	$4\text{H}_2 + \text{CO}_2 \rightarrow \text{CH}_4 + 2\text{H}_2\text{O}$	$10\text{CO}_2 + 31\text{H}_2 \rightarrow \text{C}_{10}\text{H}_{22} + 20\text{H}_2\text{O}$
Hydrogen yield	100 %	100 %	100 %	4/6 = 67 %	4/8 = 50 %	22/62 = 35.5 %
Volumetric energy density, LHV (MJ/L)	2.43 - 6.8	8.52	12.7	15.7	22.2	35
Gravimetric energy density, LHV (MJ/kg)	120	120	18.6	19.9	48.6	42.2
Infrastructure readiness for large scale deployment in mid-term	Low	Low	High	High	High	High
Transportation and storage temperature	Ambient	-253 °C	-33.3 °C	Liquid at ambient temperature	-162 °C	Ambient
Transportation and storage phase and pressure	Compressed gas at 250 to 700 bar	Liquid at atmospheric pressure	Liquid at atmospheric pressure	Liquid at atmospheric pressure	Liquid at atmospheric pressure	Liquid at atmospheric pressure
Density	0.017 kg/L	0.071 kg/L	0.68 kg/L	0.79 kg/L	0.46 kg/L	0.83 kg/L
Toxicity	Non toxic	Non toxic	TWA 25 ppm	TWA 200 ppm	TWA 1,000 ppm	TWA 30 ppm
Flammability (% in air)		4-74 %	14.8-33.5 %	6.0-36.5 %	4 - 15 %	0.7 - 4.8 %