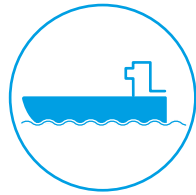
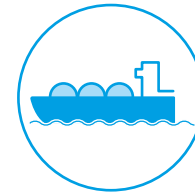
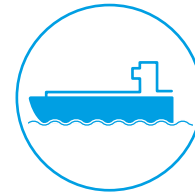
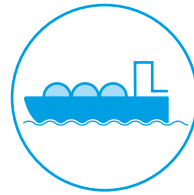
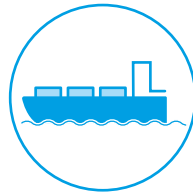
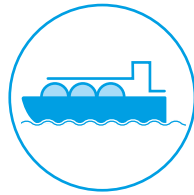


# International shipping of hydrogen, hydrogen carriers, hydrogen derivatives and e-fuels



	Compressed Hydrogen Gas	Liquid Hydrogen	Liquid Ammonia	Liquid Methanol	LOHC – Liquid Organic Hydrogen Carrier (MCH used as an example)	Liquefied Natural Gas (LNG)	Synthetic Aviation Kerosene (SAF)
Temperature for transportation and storage	Ambient	-253 °C	-33.3 °C	Liquid at ambient temperature	Hydrogenation:150-200 °C; Transported at ambient temperature; Dehydrogenation: 250-320 °C	-162 °C	Ambient
Pressure for transportation and storage	250 to 700 bar	Atmospheric pressure	Atmospheric pressure	Atmospheric pressure	Hydrogenation > 20 bar; transport at atmospheric pressure; dehydrogenation < 5 bar	Atmospheric pressure	Atmospheric pressure
Density	0.017 kg/L	0.071 kg/L	0.68 kg/L	0.79 kg/L	0.77 kg/L	0.46 kg/L	0.83 kg/L
Toxicity	non toxic	non toxic	TWA 25 ppm	TWA 200 ppm	TWA 400 ppm	TWA 1,000 ppm	TWA 30 ppm
Flammability (% in air)	4-74 %	4-74 %	14.8-33.5 %	6.0-36.5 %	1.2-6.7 %	4 -15 %	0.7-4.8 %
Volumetric Lower Heating Value (LHV)(MJ/L)	2.43-6.8	8.52	12.7	15.7	5.76-8.5	22.2	35
Gravimetric LHV (MJ/kg)	120	120	18.6	19.9	7.48-11	48.6	43
Infrastructure readiness for large scale deployment in mid-term H/M/L	L	L	H	H	M	H	H
Commercialisation status and pilot projects	Gen2 Energy and Global Energy Ventures developing compressed hydrogen shipping for short / mid-range routes	HySTRA-Hydrogen Energy Supply-chain Technology Research Association – Australia to Japan LH2 shipping	Bulk ammonia distribution and storage infrastructure is mature: 170 ships and 120 terminals worldwide	Methanol is a widely traded commodity with tankers up to 50,000 tonnes	Chiyoda, Mitsubishi and NYK shipped a bulk carrier cargo of MCH loaded with hydrogen from Brunei to Japan in 2020	Many commercial LNG production, distribution, storage and regasification assets worldwide	Refined products distribution and storage infrastructure is mature