



Hydrogen: The Swiss Army Knife

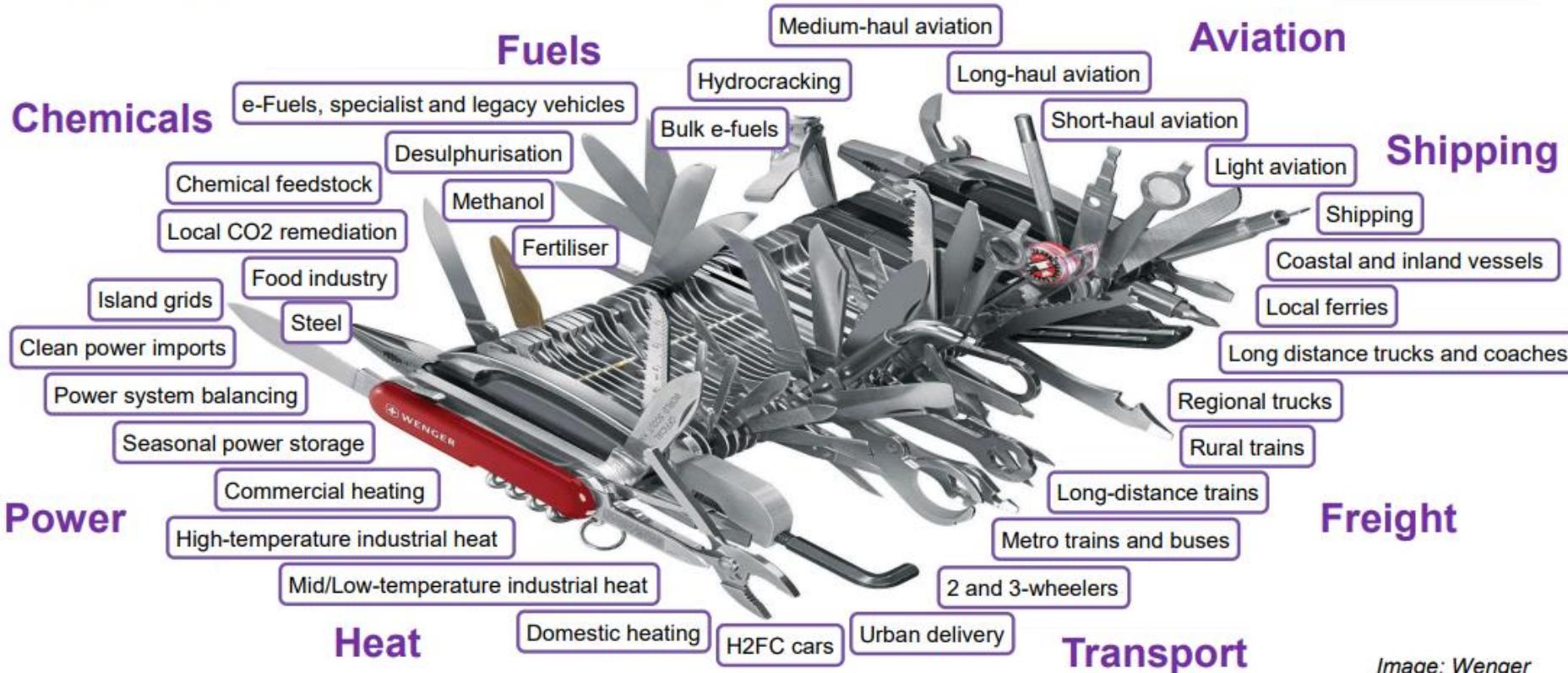
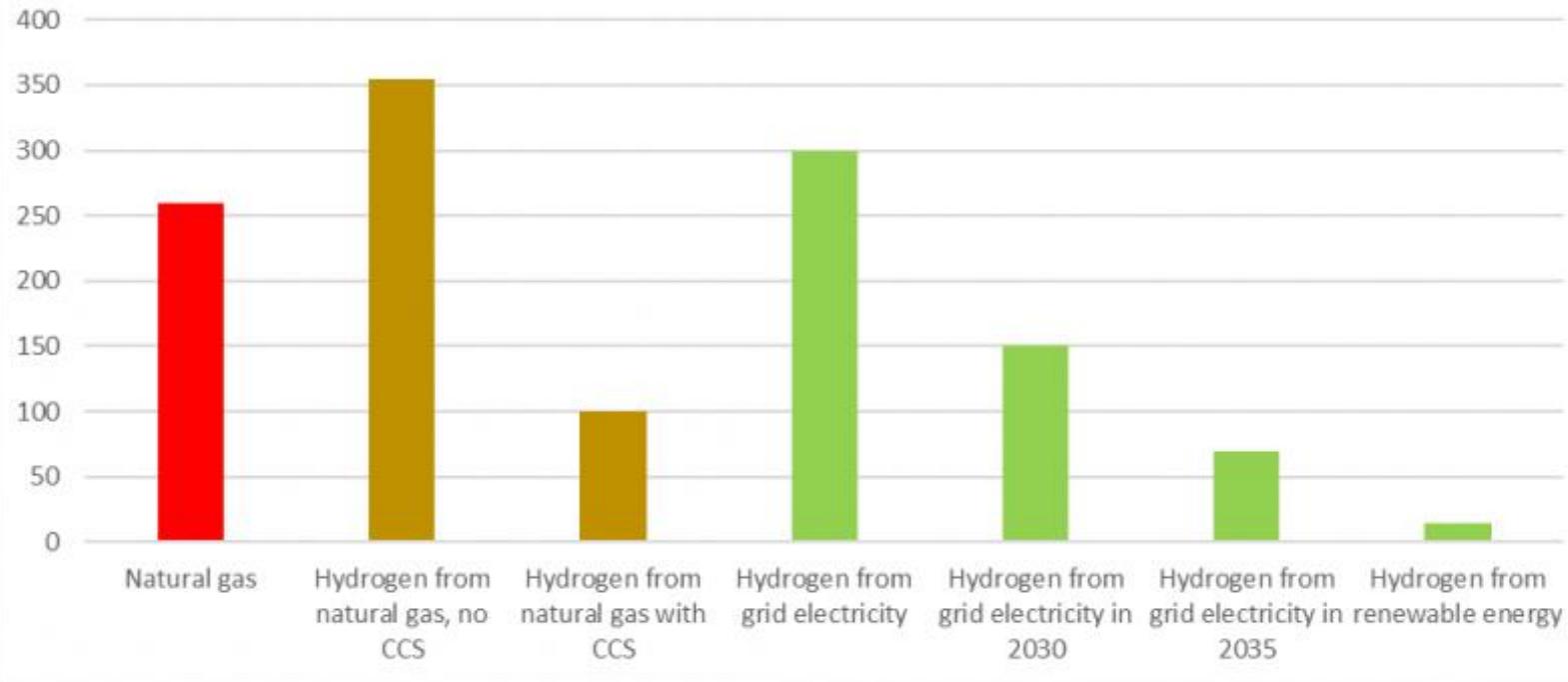


Image: Wenger

COLOUR	DESCRIPTION: FEEDSTOCK
Grey	Grey: natural gas reforming without CCUS
Brown	Brown: brown coal (lignite) as feedstock
Blue	Blue: natural gas reforming with CCUS
Green	Green: electrolysis powered through renewable electricity
Pink	Pink: electrolysis powered through nuclear energy
Turquoise	Turquoise: methane pyrolysis
Yellow	Yellow: electrolysis powered through electricity from solar
Orange	Orange: electrolysis powered through electricity from wind

Carbon intensity of hydrogen compared to natural gas (gCO₂/kWh)

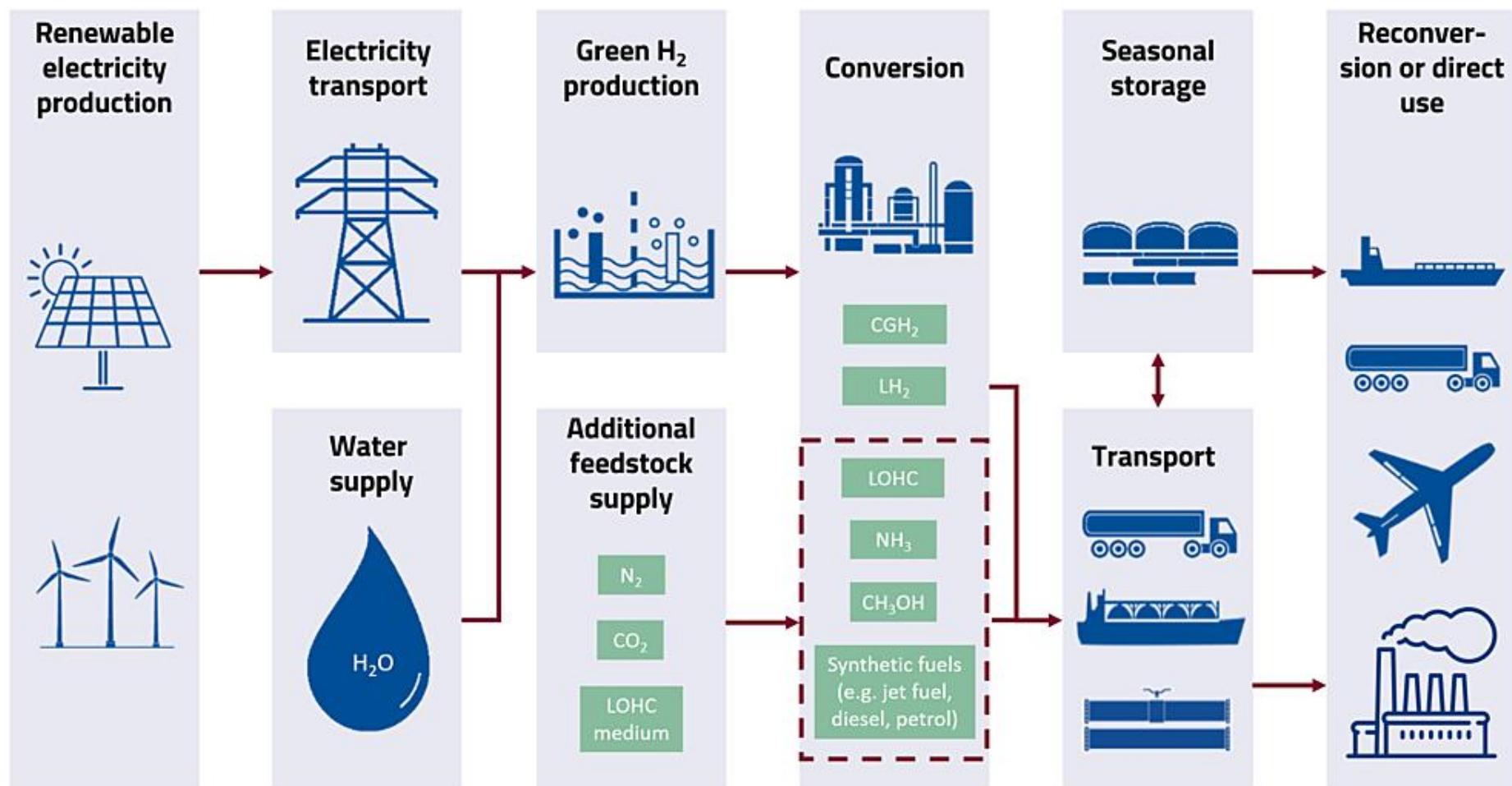


For Water Splitting

$$285.8 \times 10^3 \frac{J}{mol} \times \frac{1 mol H_2}{2.016 g} \times \frac{1000 g}{1 kg} = 141.8 \frac{MJ}{kg}$$

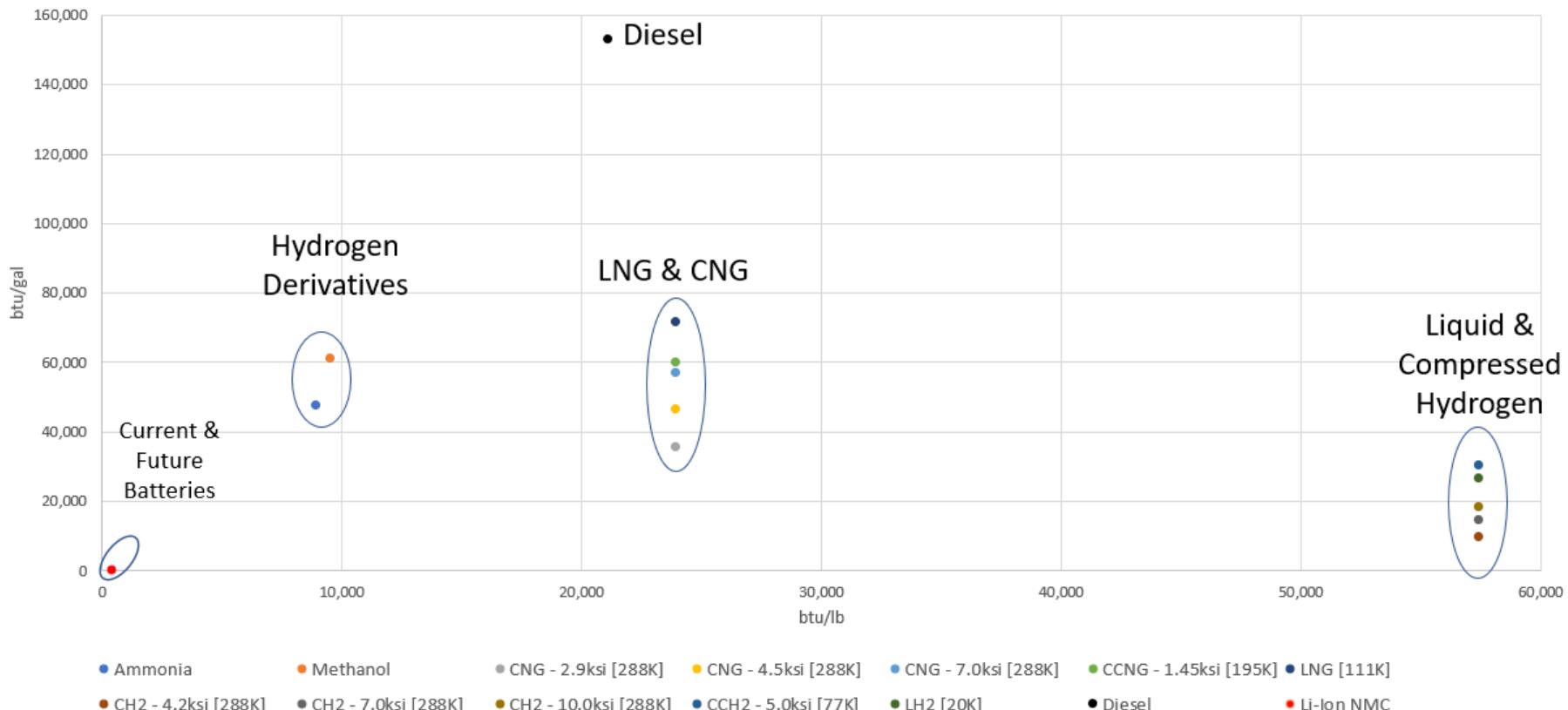
$$141.8 \frac{MJ}{kg} \times \frac{1 Watt.sec}{J} \times \frac{1 kW}{1000 W} \times \frac{1 hr}{3600 sec} = 39.4 \frac{kWh}{kg}$$

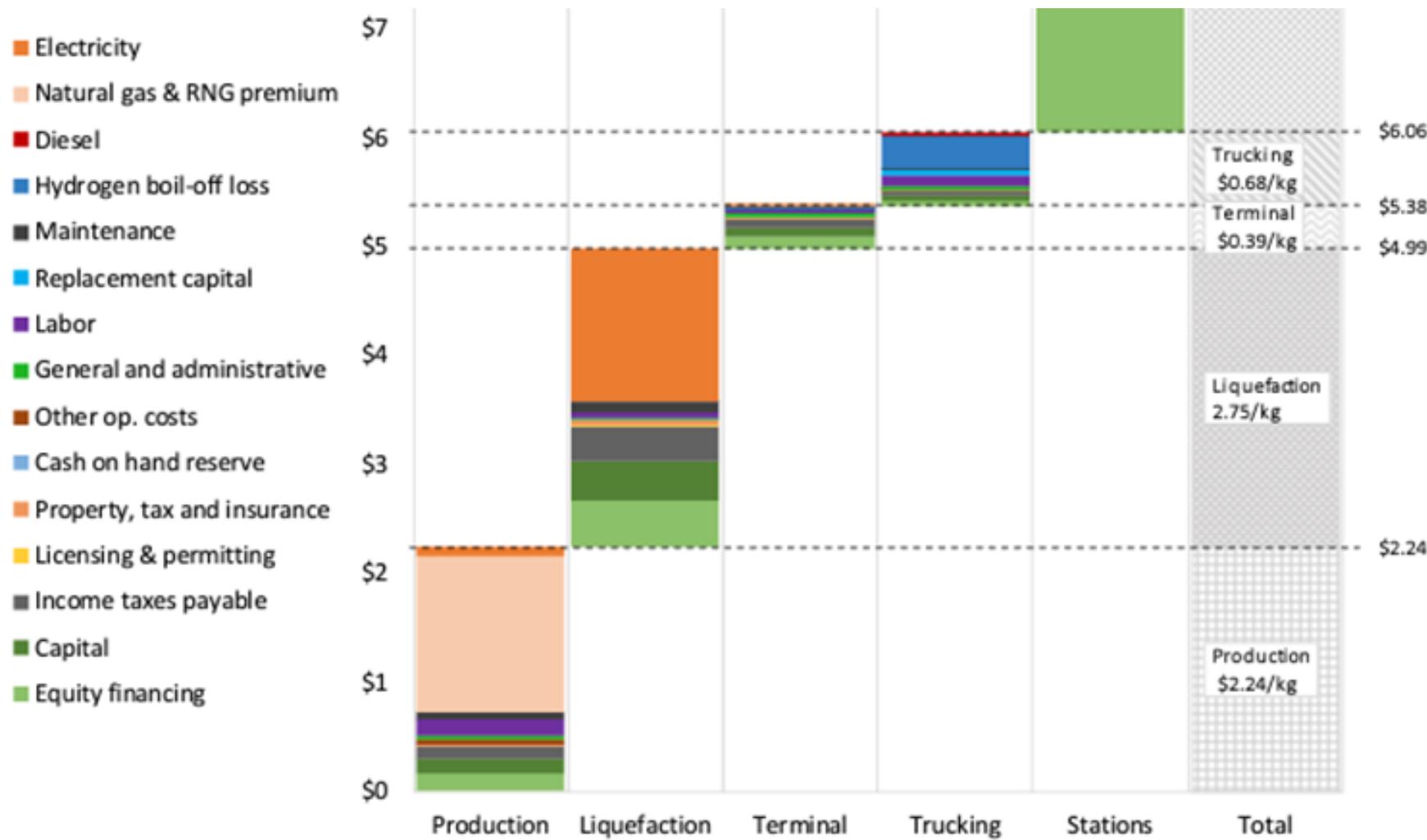
Source: U.S. Department of Energy



Source: <https://www.houu.de/projects/green-hydrogen/pages/3-4-hydrogen-supply-chains>

Energy Density of Fuels for Heavy Duty Applications



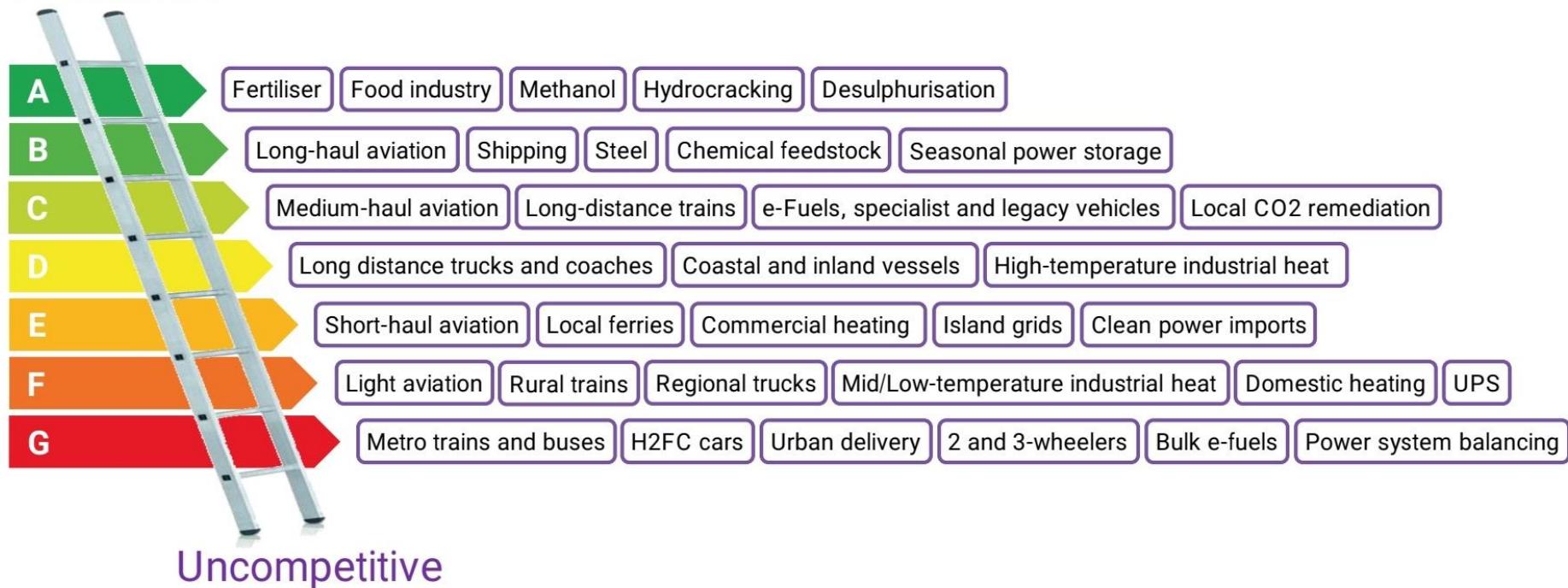


Source: U.S. Department of Energy

Hydrogen: The Ladder

Liebreich
Associates

Unavoidable



Source: Liebreich Associates Concept: Adrian Hiel/Energy Cities

