Role of e-fuels in enabling a resilient mobility transition

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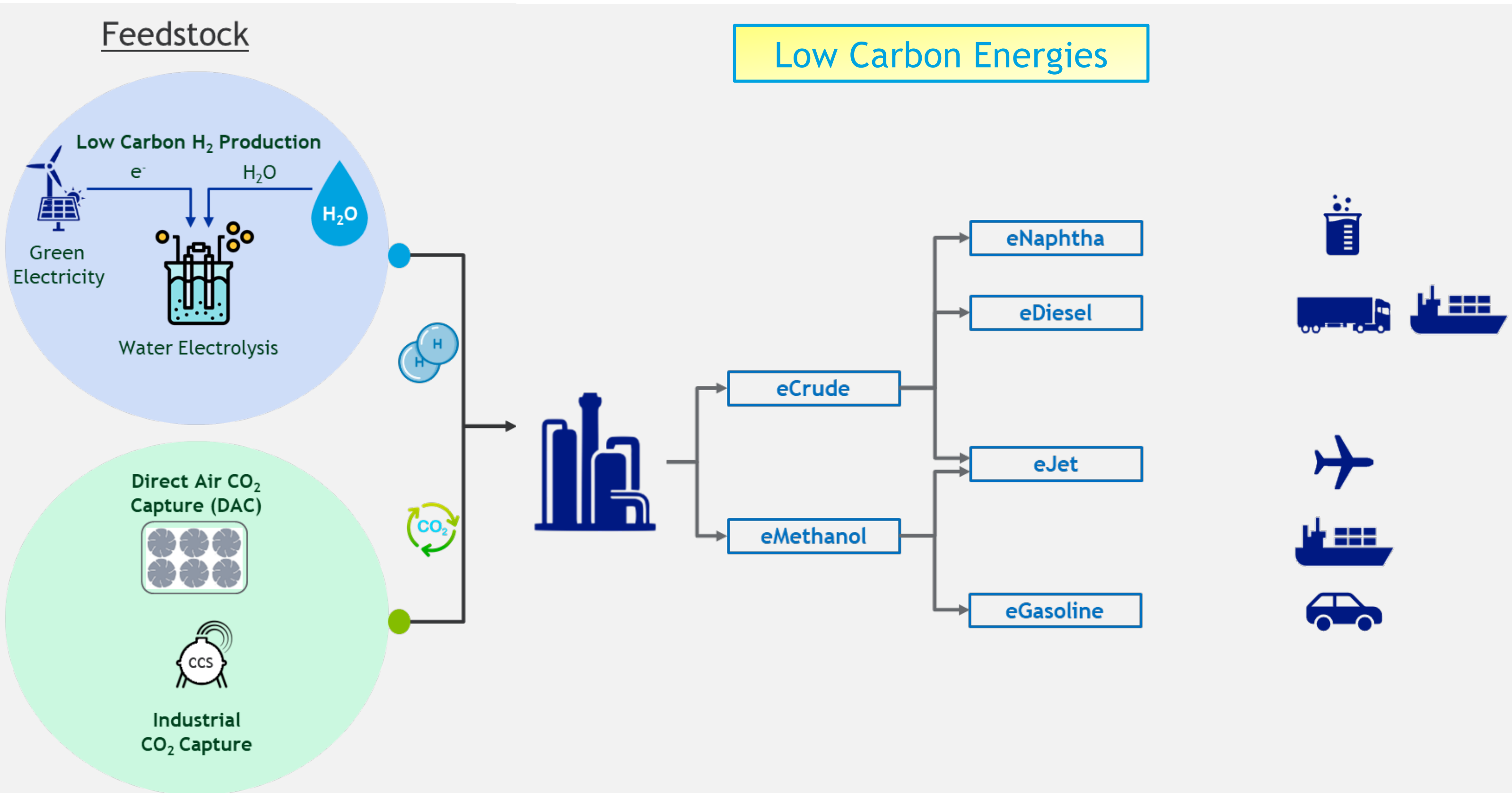
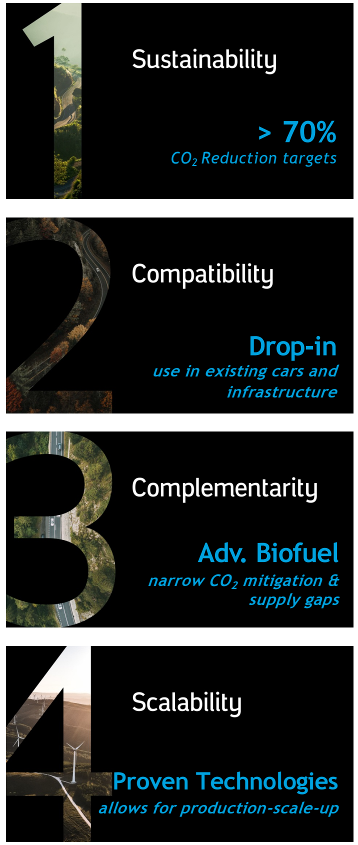
Dr. Amer Ahmad Amer, Transport Chief Technologist

where energy is opportunity™

Synthetic e-fuels combine renewable hydrogen with CO2





Energy-dense liquid electro-fuel is a stable and portable (around the World) renewable electricity storage medium, which can facilitate greater electrification of transport

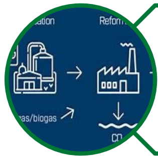
Synthetic e-fuels supply scale-up - Policy and technology needs

- Expansion of renewable energies - clear incentives for investment and level-playing field for all emission reduction technologies
- GHG intensity reduction targets are most effective in realizing the greatest CO2 mitigation (compared to energy-based targets)
- [eFuel Alliance] Blending just 5% e-fuels with conventional fuel will save 60 Million tons of CO2 emissions annually
    - Equivalent to taking 40 Million vehicles off the road for a year

Low Carbon Energy Hubs

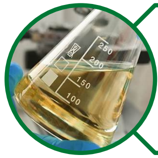
Synthetic e-fuels – GEN 1:

Full value chain demonstration (technical feasibility and commercial viability)



Value chain optimization:

Low CAPEX intensity – Retrofitting and co-processing



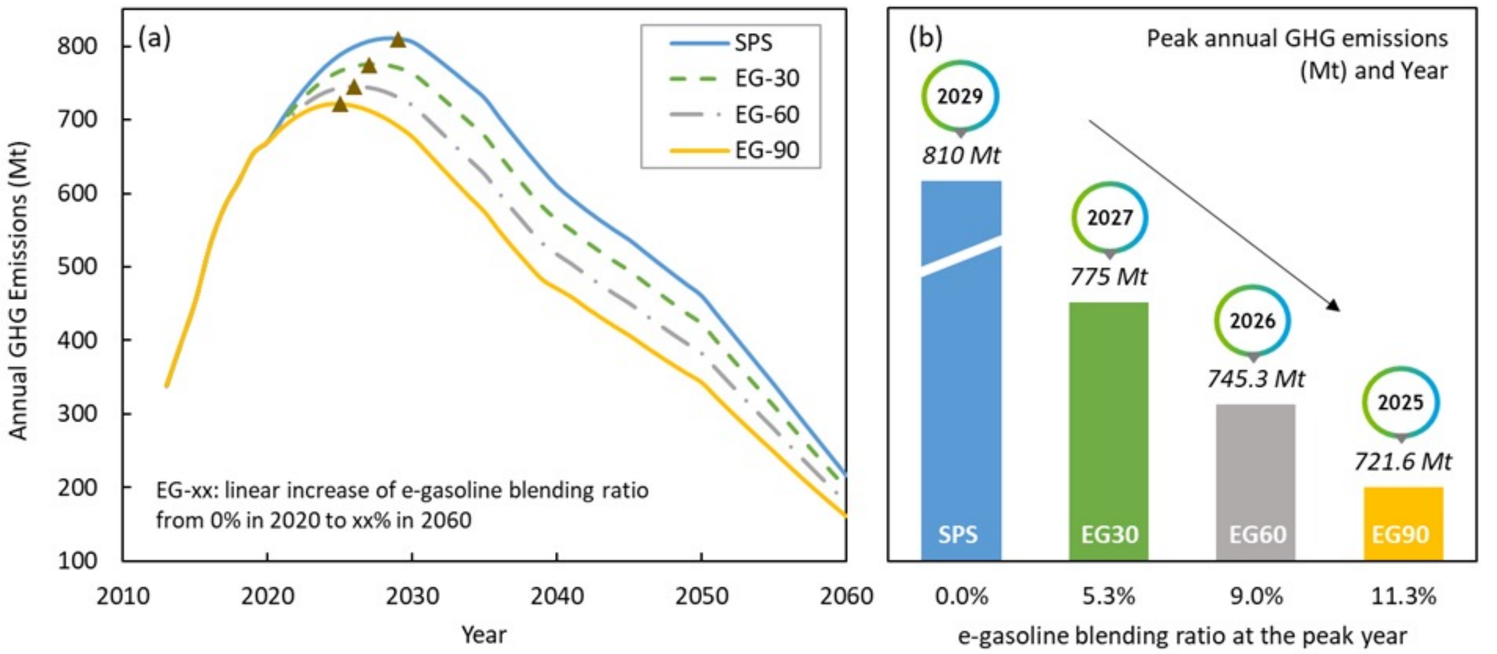
Synthetic e-fuels – GEN 2:

Direct CO2 hydrogenation to fuels – Less complexity and improved economics

Enabling technologies:

Hydrogen production, ammonia cracking, electrified SMR and DAC

Fleet level GHGs assessment of synthetic e-fuels



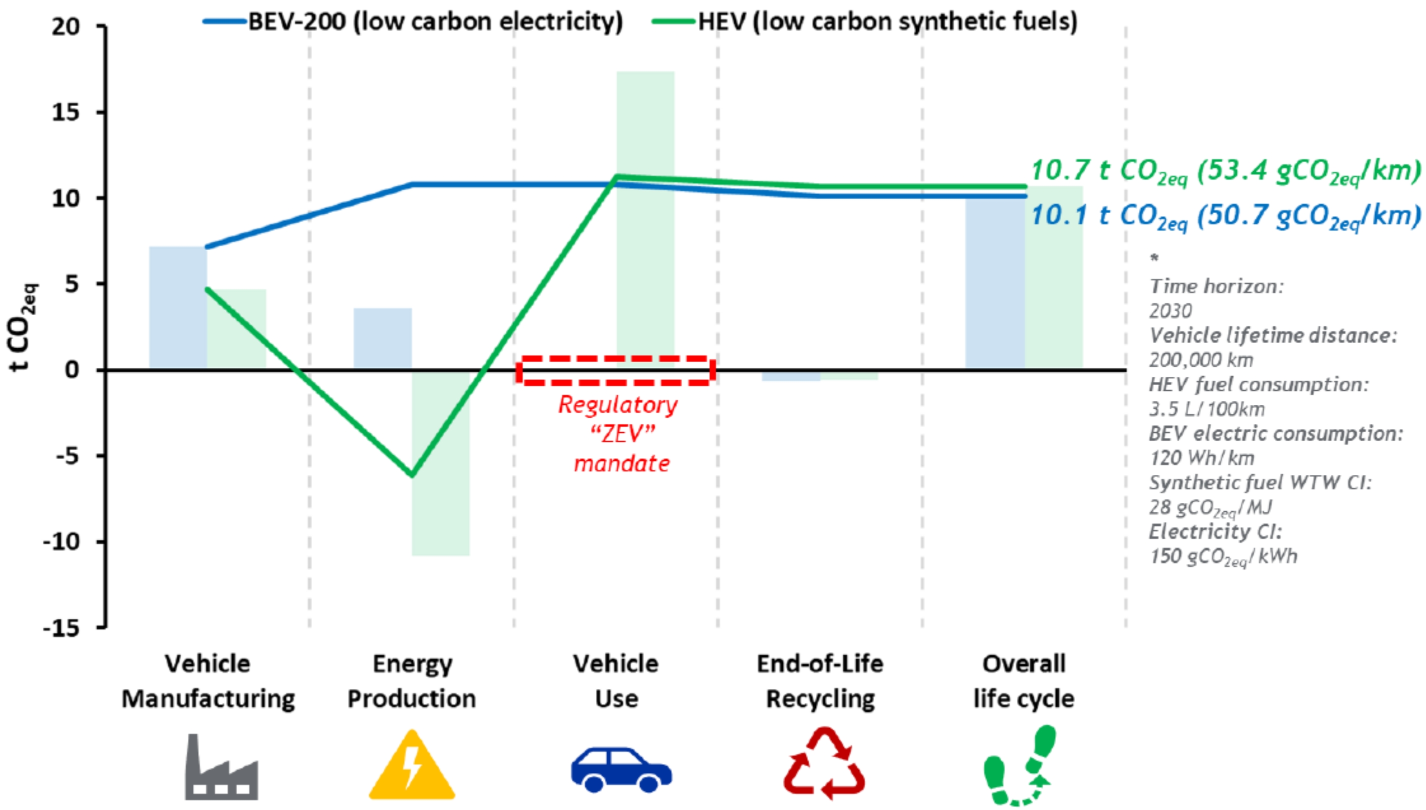
Impact of e-gasoline deployment on the annual life-cycle GHG emissions of China's passenger vehicle fleet under the Stated Policy Scenario

- Average lifespan of cars in some countries can reach 30 years
- Backward compatibility of e-fuels enables a faster decarbonization as it is not limited by the slow vehicle turnover rate

Deployment of e-gasoline lowers GHG emissions significantly AND enables a lower and sooner GHG emissions peak in China

Source: China Automobile Low Carbon Action Plan (CALCP) Research Report 2021

Focus on emissions reduction, not technology elimination



GHG savings of low carbon synthetic e-fuels can be equal to (or better than) BEVs on a full life-cycle basis

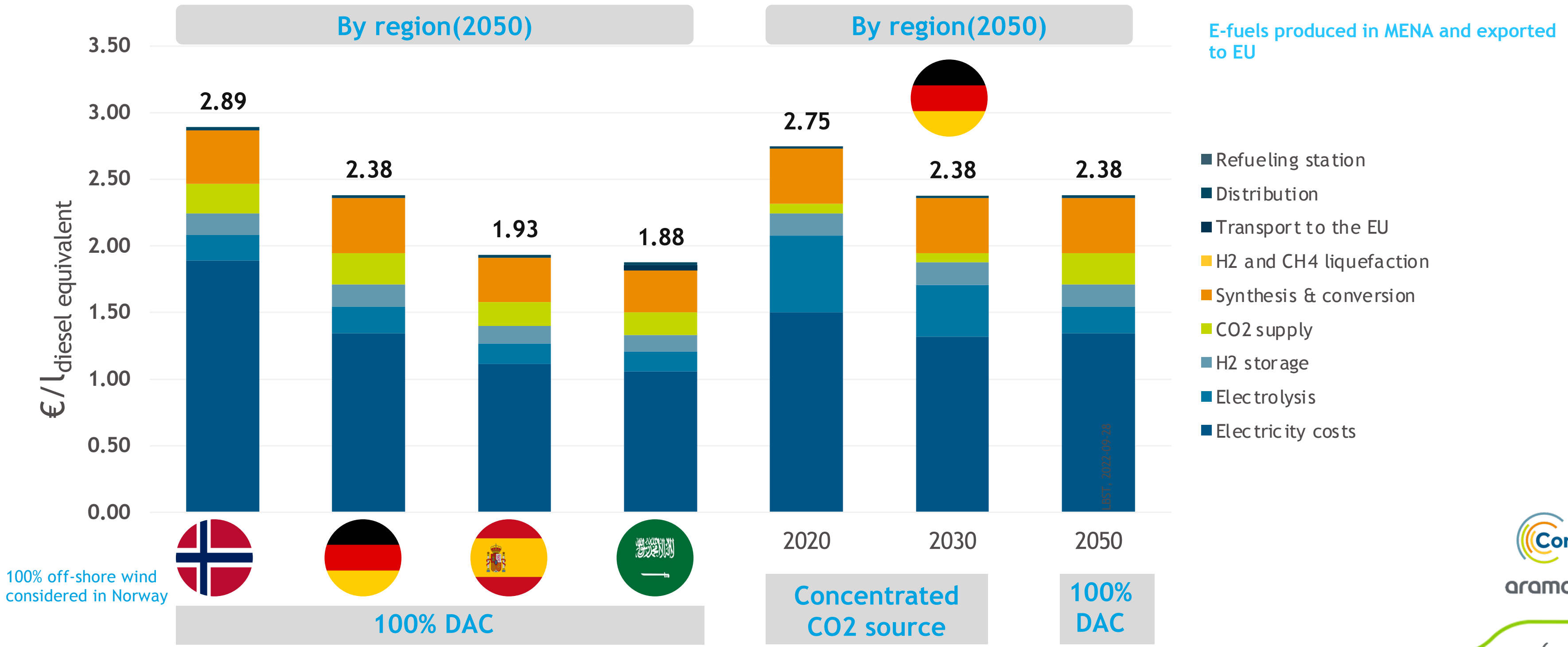
Synthetic e-fuels cost is regional-dependent (example: e-kerosene)

Lowest cost e-fuels costs when produced in MENA and South EU

13% drop in cost by 2050 due to:

- CAPEX reductions - wind & PV plants and electrolyzers
- OPEX reductions - electrolysis efficiency

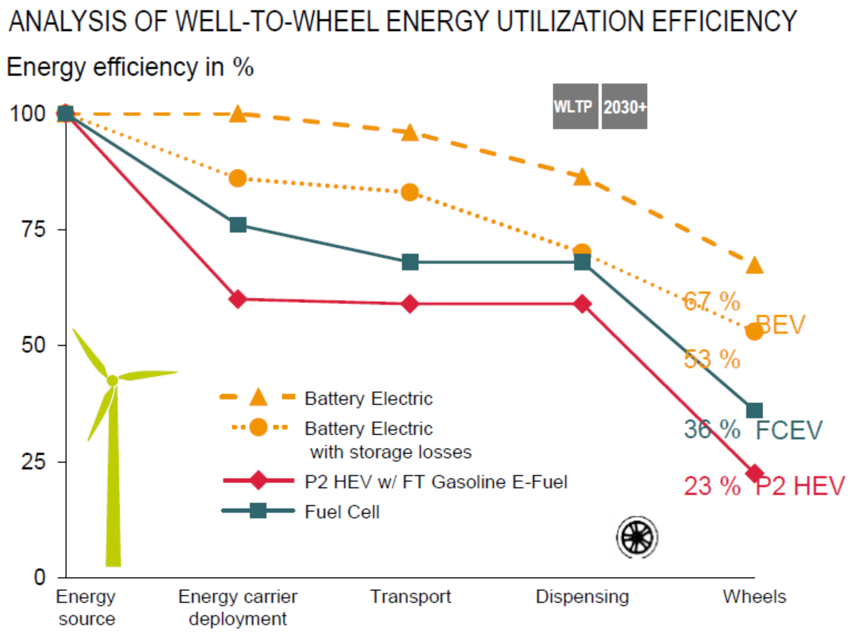
No further reductions in 2050 due to 100% DAC deployment

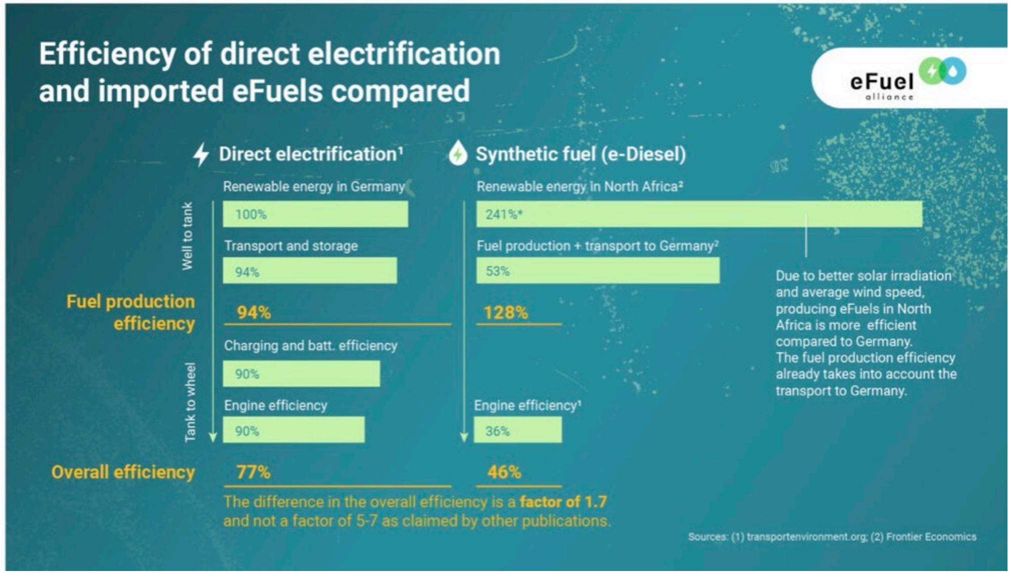


Concawe aramco

Source: E-Fuels: A techno-economic assessment of EU domestic production and imports towards 2050 (CONCAWE Report 17/22) Report no. 17/22

e-fuels produced using hybrid renewable energies (high combined capacity factor) are competitive with alternative technologies





The difference in overall efficiency is a factor of 2.4 (between BEV and a hybrid vehicle running on e-fuel)

The difference in overall efficiency is a factor of 1.7 if renewables are sourced from North Africa

Source: Recycling CO2 into biofuels and synthetic fuels for a carbon neutral mobility and transport, FEV, 2020