An innovative concept for Power-to-X application in the South African Maritime Sector

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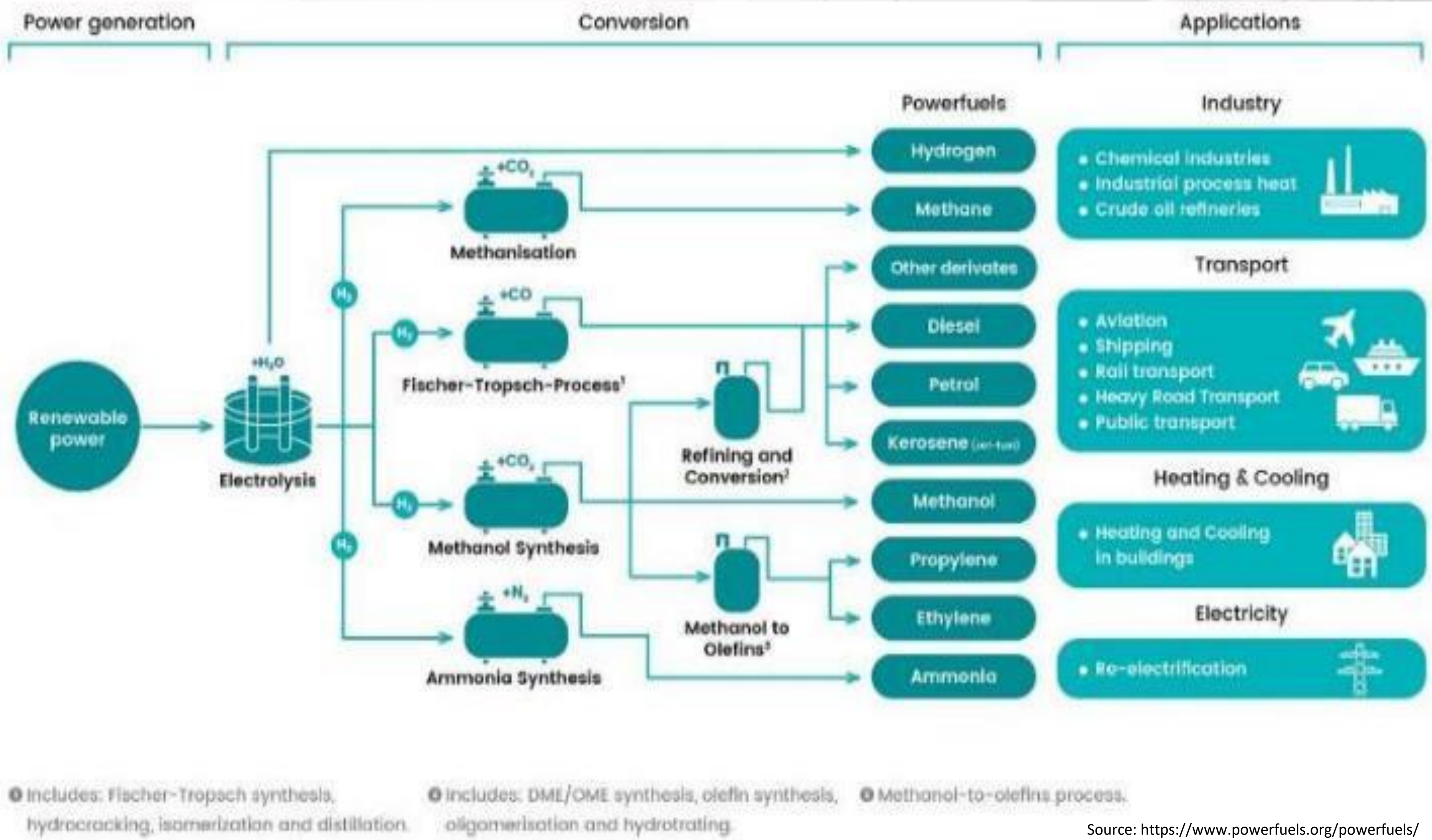
Recap: What is green hydrogen and PtX?

Fuel based on H_2 from electrolysis of water using renewable electricity



Source: https://www.powerfuels.org/powerfuels/

Starting point

Why is green hydrogen important?

1) Climate: regulatory and financing pressure

Global	EU	SA
Paris Agreement (keep warming well below 2℃, preferably below 1.5˚C) Finance activism (exit fossils, esp. coal) IMO (2023 MEPC 80: net zero @ 2050)	European Green Deal EU net zero by 2050 CBAM 6 products: NH_3 / fertilizer, iron / steel, aluminium, cement, electricity, H_2	JETP $8.5 bn Donors: EU, US, DE, F, UK Decarbonization, electric vehicles, GH_2

2) Economics: Declining costs of RE in good areas - competitive since ~2014

3) Green electricity has limits: GH_2 is needed to decarbonize “hard-to-abate” sectors…..

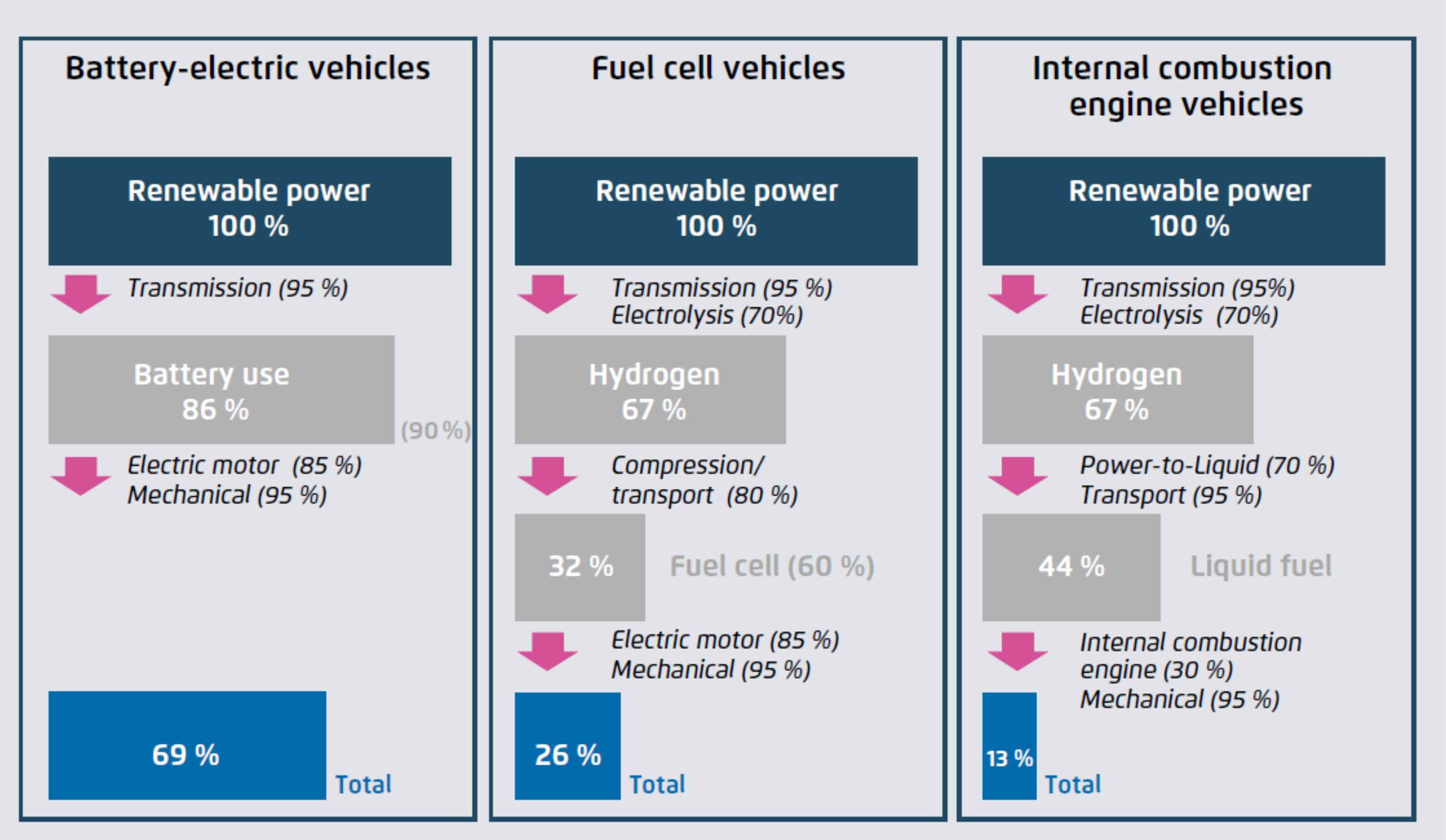
PtX: H_2 reality check

If alternatives exist, H_2 should not be the 1st choice, for reasons of efficiency and cost

Electrification with RE is <u>always</u> best decarbonisation choice: cheapest & most efficient

H_2 & PtX is 2nd best choice: more expensive & less efficient, but only remaining option for:

- RE-constrained territories (like Japan)
- "Hard-to-abate" sectors
  - Heavy-duty, long-distance transport:
    - Aviation
    - Shipping
    - Long-distance trucking
    - Rail*
  - Industry:
    - Iron for steelmaking
    - Cement
    - Ammonia
    - Plastics



Source: Agora, 2018

Starting point

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4) Public policy support for imports of PtX

- Japan: 300 kt/y from 2030, 5-10 Mt/y by 2050
- Germany: ~3 Mt/y by 2030, but only 420 kt/y in-country, remainder from RE-rich partner countries
- EU: Invasion of Ukraine: REPowerEU to reduce Russian gas, increase EU GH2 imports by 10 Mt/y

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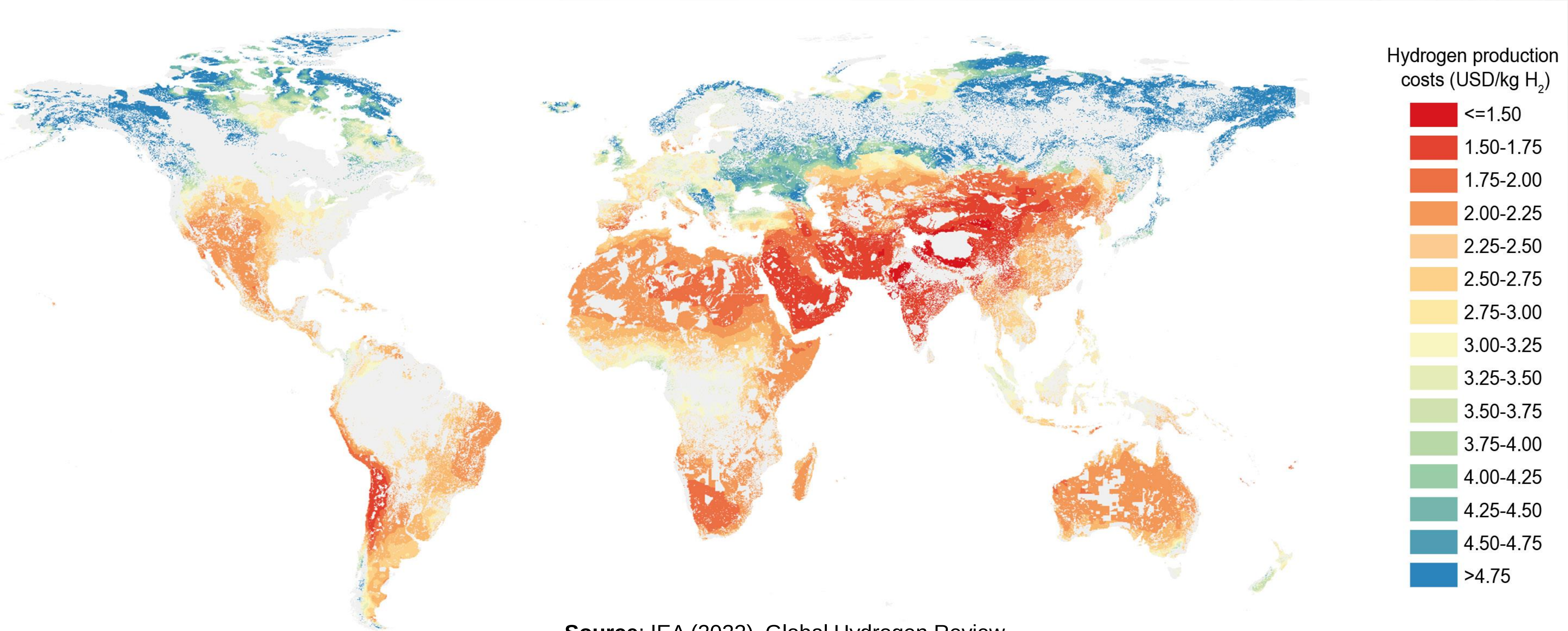
South Africa can export sunshine and wind

Excellent solar & wind resources in Southern Africa→ bulk GH_2 costs competitive to other coastal countries

Relatively few competitors, and the market is large



Source: IEA (2022), Global Hydrogen Review

3 classes of H_2 market for SA

Each with different characteristics

1) **Export market: competing on price delivered in EU, Far East**

2) **Local market inland: who will pay the premium?**
   - Where costs are less important: Mining rather than classic logistics
   - Where costs are competitive: Fertiliser?

3) **Border market:** Refuelling aviation and shipping calling at SA

- Aviation: PtL kerosene from FT infrastructure at Sasol & PetroSA. Carbon source an issue (RED II)!
- Shipping:
  - Market created by IMO MEPC 80 (July 2023) - Net-zero by 2050, 5% zero-carbon by 2030.
  - Large GH_2 Volumes: For 2018 port calls to be 100% green: 504 kt/y for SB + CT, 247 kt/y for PE + Coega
  - Saldanha Bay Green Corridor
    - being organized by Freeport Saldanha, Anglo American, Tata Steel, Engie, CMB, Vuka Marine
  - Ports can form H_2 hubs:
    - Export & Bunker fuel → HRSs → Heavy road transport, rail, & port equipment

- New Fuels for New engines & vessels:
  - Green Ammonia NH_3 (CMB)
  - Green Methanol CH_3OH (Maersk)
- Fuels for Existing fleet:
  - Green Fischer-Tropsch (Sasol and PetroSA)
  - Biofuels

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PetroSA presents a very specific opportunity

1) **It is a State-Owned Enterprise with an uncertain future**
   - The NG reserves of its ocean gasfield have become depleted, halting synthesis operations
   - Approx 500 staff have been retrenched
   - National Treasury has repeated made clear its reluctance to support distressed SOEs.
   - Purchasing NG on the international market in dollar-denominated terms, converting it into product in a regulated terrestrial transport market is not attractive
   - A future with electric vehicle uptake further threatens its business case

2) **That said, it:**
   - Is an existing Fischer-Tropsch facility, located at the coast, in a region with good solar and wind resource, on a major shipping route
   - Has a staff complement (current and recently retrenched) skilled at Fischer-Tropsch synthesis
   - Is of convenient size for repurposing: at 45 000 bbl/d, it is smaller than the vast majority of refineries in Western Europe
   - It has a 1000 bbl/day pilot plant, ideal for a starting green fuel pilot

3) **If it were to switch to make green maritime fuel (e-diesel), it would**
   - Sell a green drop-in fuel to a very large potential customer base, requiring no ship modifications
   - Move from a regulated to a premium market with no competitors

Uses for green FT bunker fuel

1) **Its fuel could be blended with fossil-based bunker fuel**
   - This allows vessels to decarbonize progressively over time rather than all at once, easing price shocks
   - It can be supplied by standard bunkering equipment and vessels

2) **It can be used by existing vessels without modifying engines or vessels**
   - TNPA tugboats can decarbonize without affecting operations, safety or warranties. This gives DoT and TNPA an early win.
   - Instead of less that 100 methanol-compliant vessels, the customer base is more than 500 000 legacy vessels worldwide
   - In previous engagement session, a potential concept of cruise vessels was using this fuel was proposed

3) **Since it is the diesel fraction that is used, it leaves the kerosene fraction for aviation**

Thank you