

Clean hydrogen potential from MENA

Frank Wouters
Worley
VP Global Business Development - Hydrogen

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Frank Wouters

30 years energy transition experience

- MSc Mechanical Engineering
- 1993 – 2009: various roles within ECONCERN, last as CEO of Evelop
- 2009 – 2012: Director of Masdar's Clean Energy Business Unit
- 2012 – 2014: Deputy Director-General of IRENA

Now:

- VP Global BD Clean Hydrogen at Worley
- Director EU-GCC Clean Energy Technology Network
- Chairman MENA Hydrogen Alliance
- Chairman Dii Desert Energy Advisory Board
- Director Gore Street Capital – London
- Board Advisor VAST Solar – Australia
- Fellow Payne Institute, Colorado School of Mines



Flow

Hydrogen in the Energy Transition

The hydrogen economy in Europe

The hydrogen economy in the MENA Region



01

Hydrogen in the Energy Transition



How do we make hydrogen?

SMR: grey hydrogen



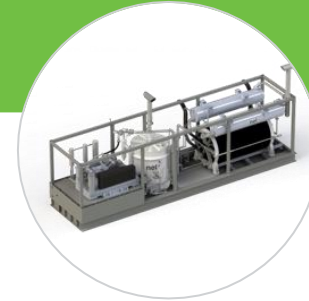
- Steam methane reforming of natural gas
- 95% of all current H₂ production
- 9-10 kg of CO₂ emissions for each kg of H₂
- SMR: TRL 9

SMR + CC(U)S: blue hydrogen



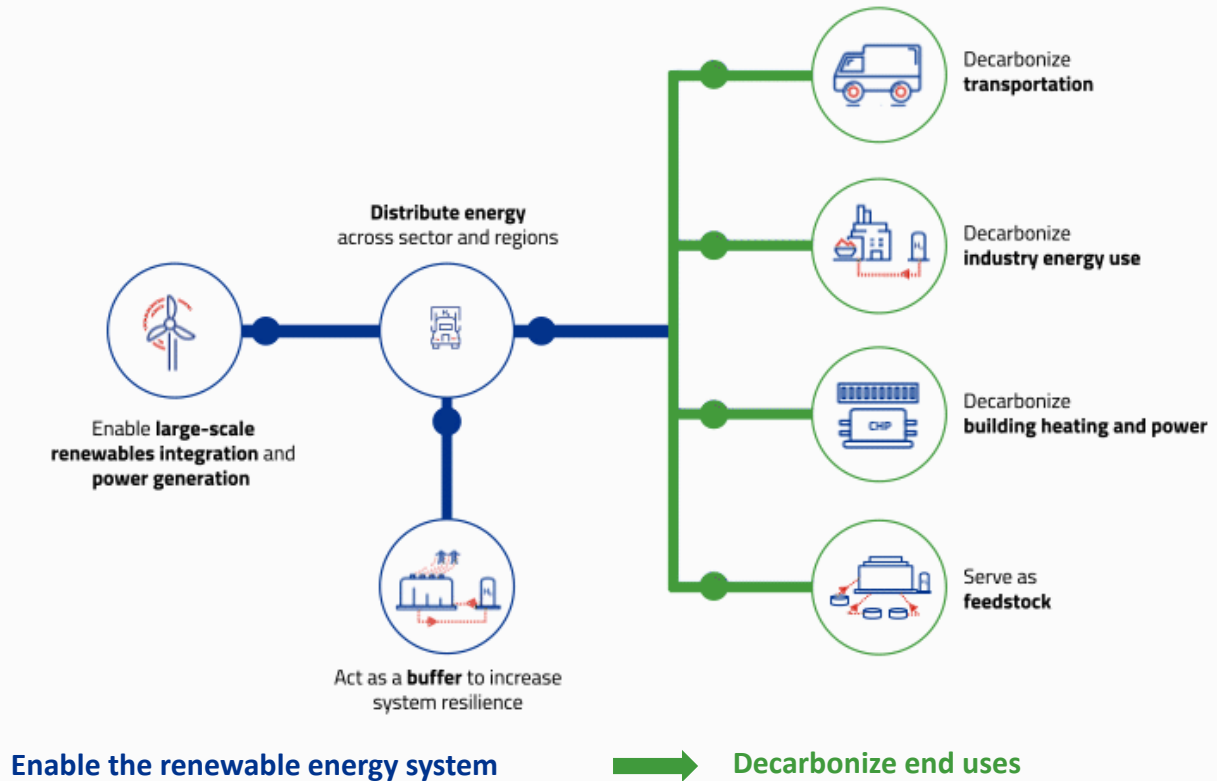
- Not yet practiced, but significant attention lately
- CC(U)S: TRL 8

Electrolysis: green hydrogen



- Water electrolysis is a derivative of proven chlorine electrolysis, with decades of experience

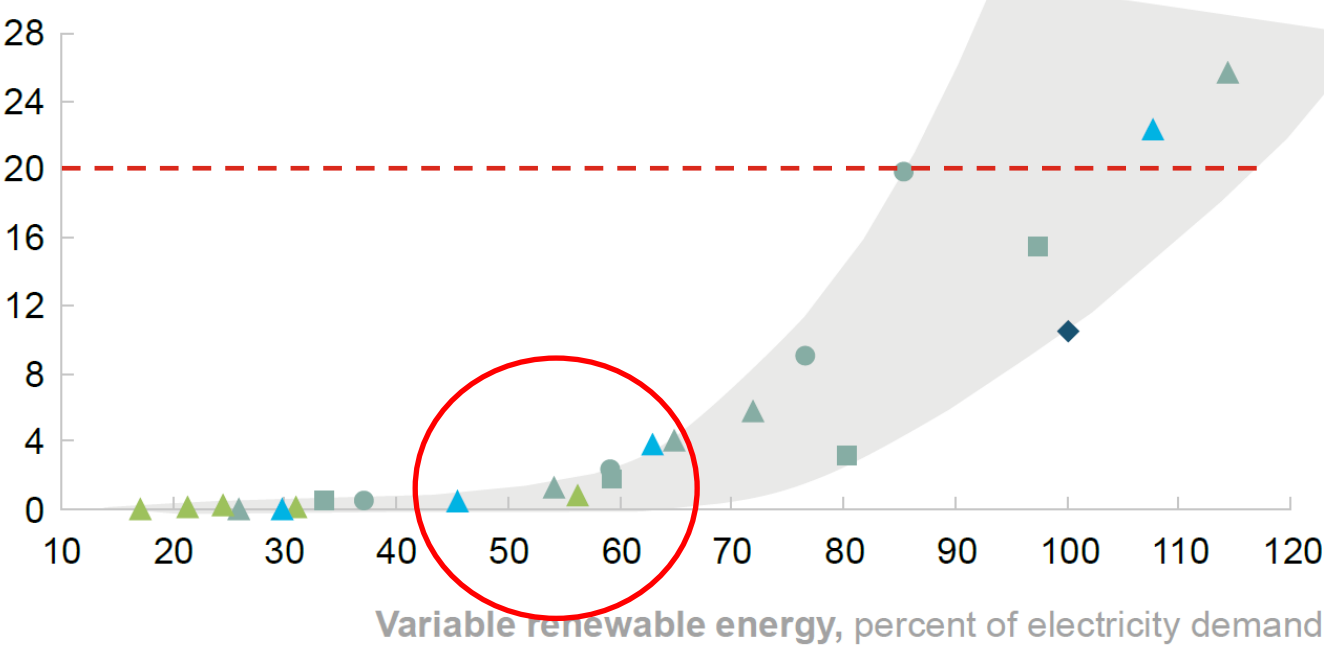
The role of hydrogen in the energy transition



Hydrogen as an enabler of variable low-cost electricity

Overview of study results

Hydrogen demand, percent of electricity production



Colors

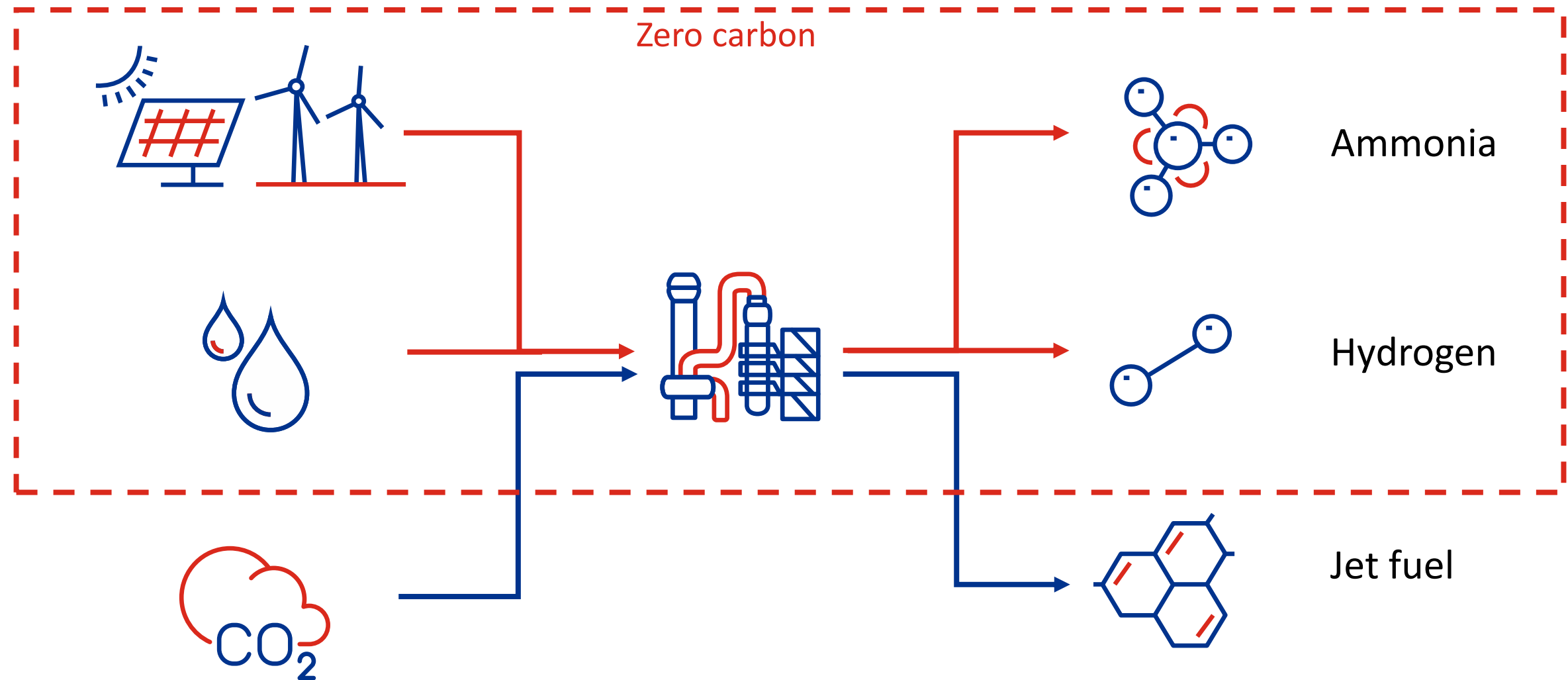
- Germany
- Sweden
- Spain
- Europe

Shapes

- Fraunhofer (storage and sector coupling)¹
- McKinsey
- RWTH Aachen (power only)²
- Sternier/Stadler (mean)

At increasing rates of variable renewable energy, demand for hydrogen grows exponentially

How to make hydrogen fuels?

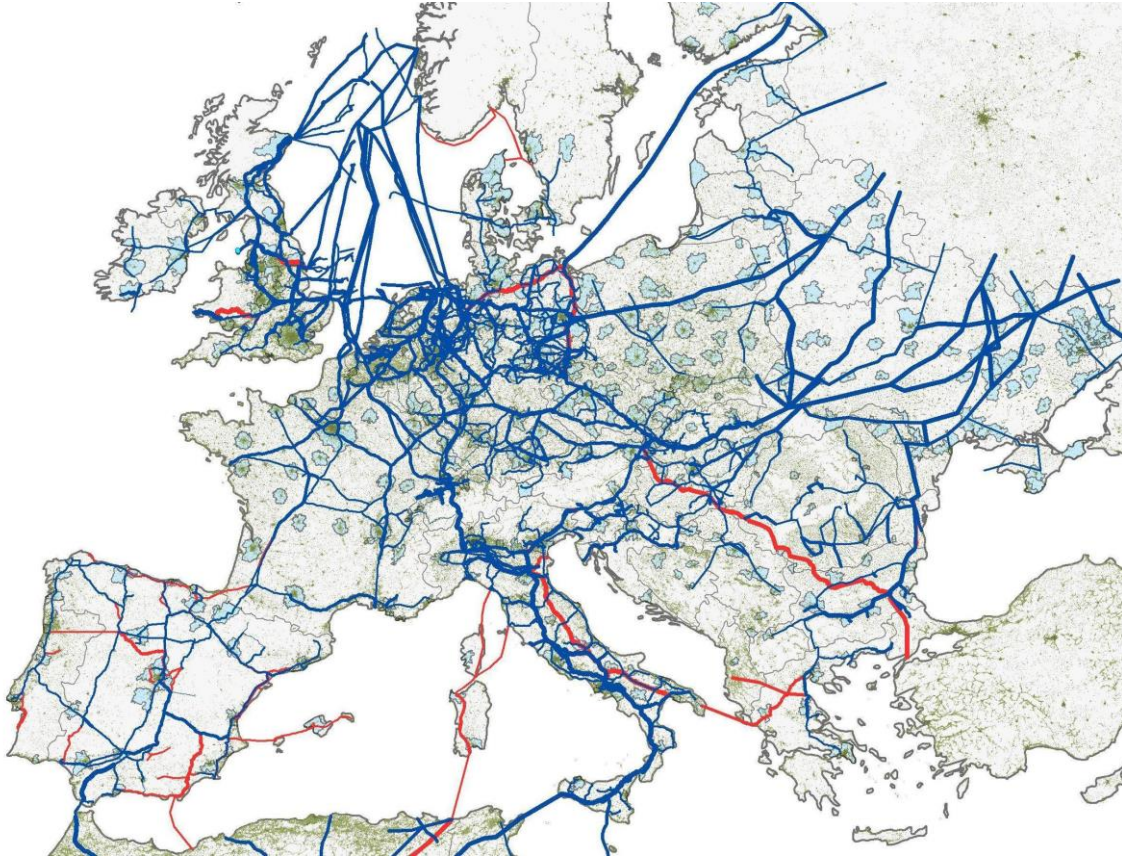


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Hydrogen in Europe



Energy in Europe

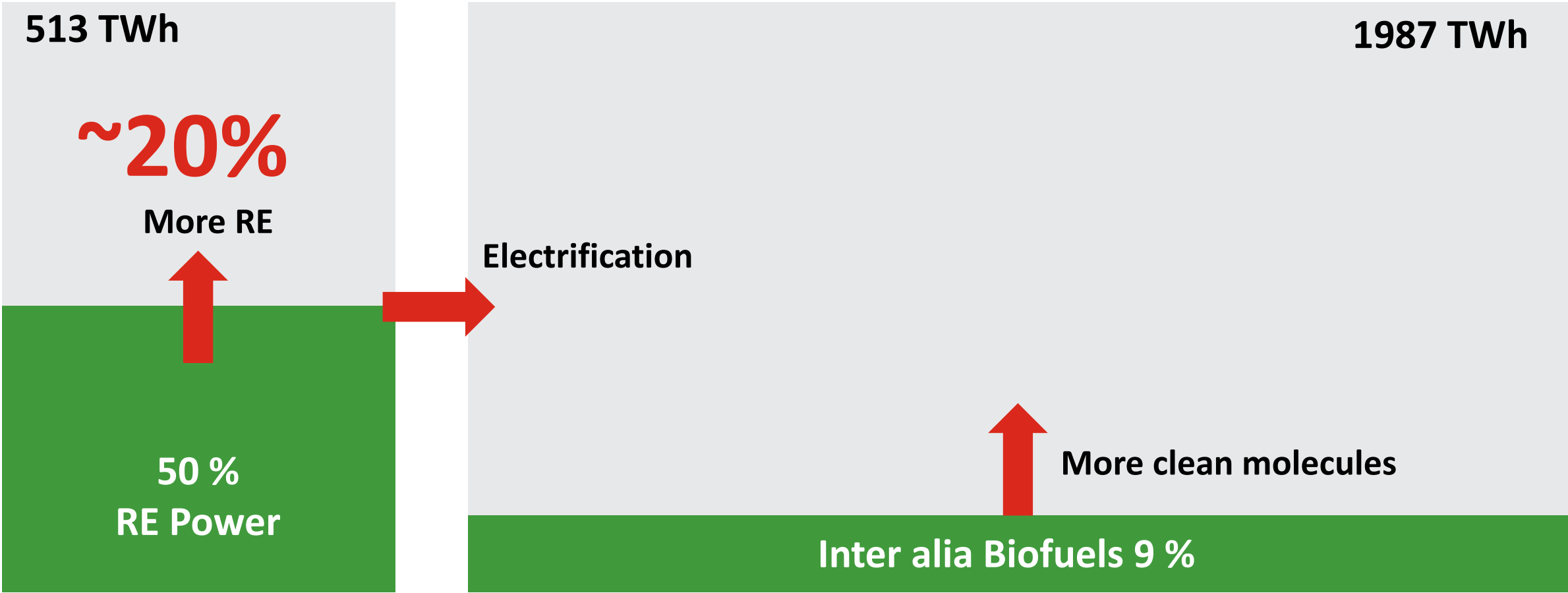


- Europe currently imports 54% of all primary energy
- Europe aims to have a net zero carbon economy by 2050
- Domestic gas production decreasing rapidly
- Europe has 200,000 km of gas grid, the bulk of which can be converted to accommodate hydrogen

Energy in Germany 2020

Electrons

Molecules



Energy in Germany 2050

Electrons

50%

100 % RE Power

Molecules

50%


- Biofuels (limited)
- CCS (limited)
- Green H₂
- H₂ based substances
 - Ammonia
 - Methanol
 - Other e-fuels

100% clean molecules

Frans Timmermans – November 2019



European Hydrogen Strategy – 8 July 2020

- Priority focus on **green** hydrogen, role for blue
 - At least **6 GW** of electrolyzers by 2024 at least **40 GW** installed by 2030.
 - But also 1 million to by 2024 and 10 million ton by 2030
 - Role for **import** (40GW) from neighboring regions
 - By 2030, the Commission estimates that €13-15bn could be invested in electrolyzers across the EU, in addition to €50-150bn for a dedicated wind and solar capacity of 50-75GW.
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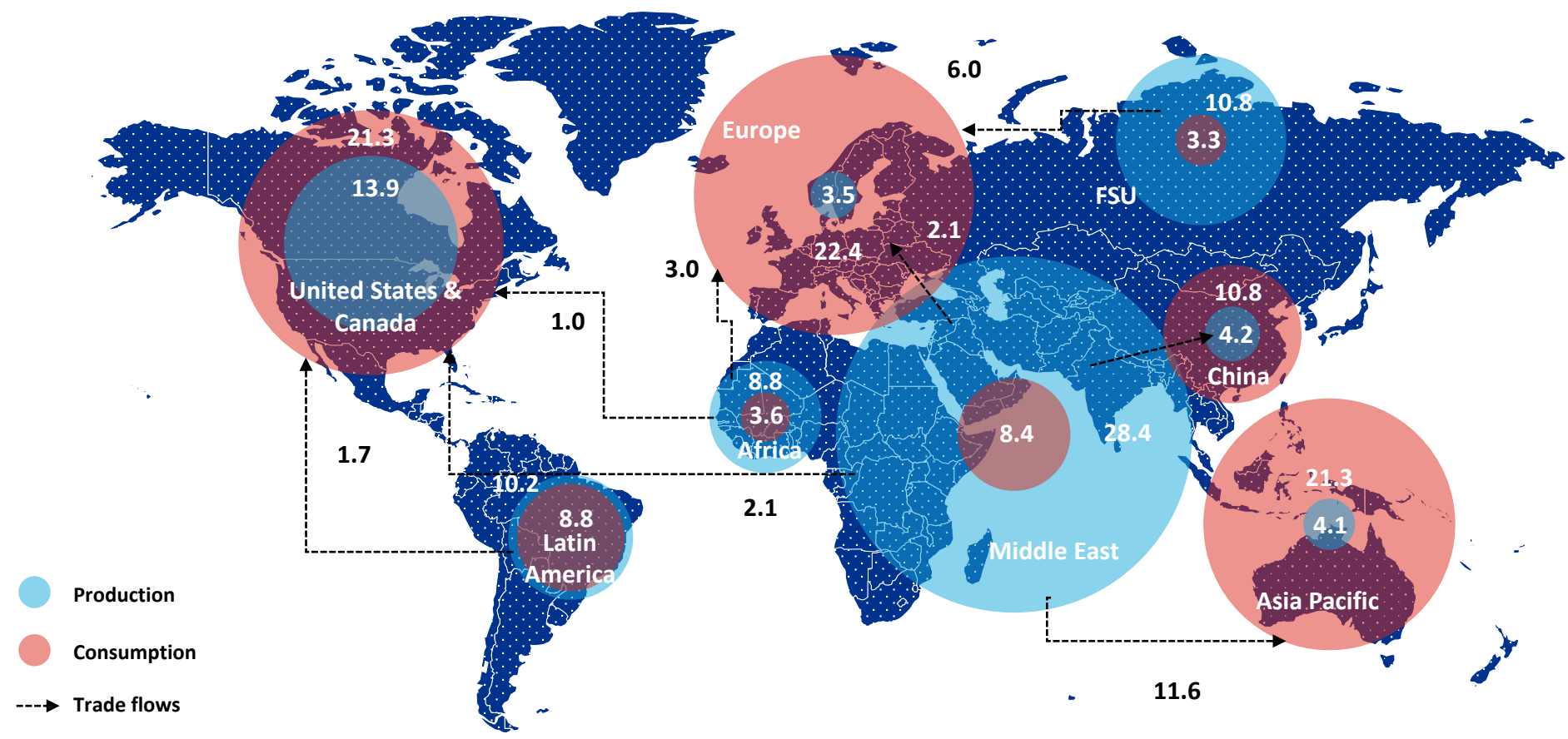
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The hydrogen economy in North Africa and the Middle East



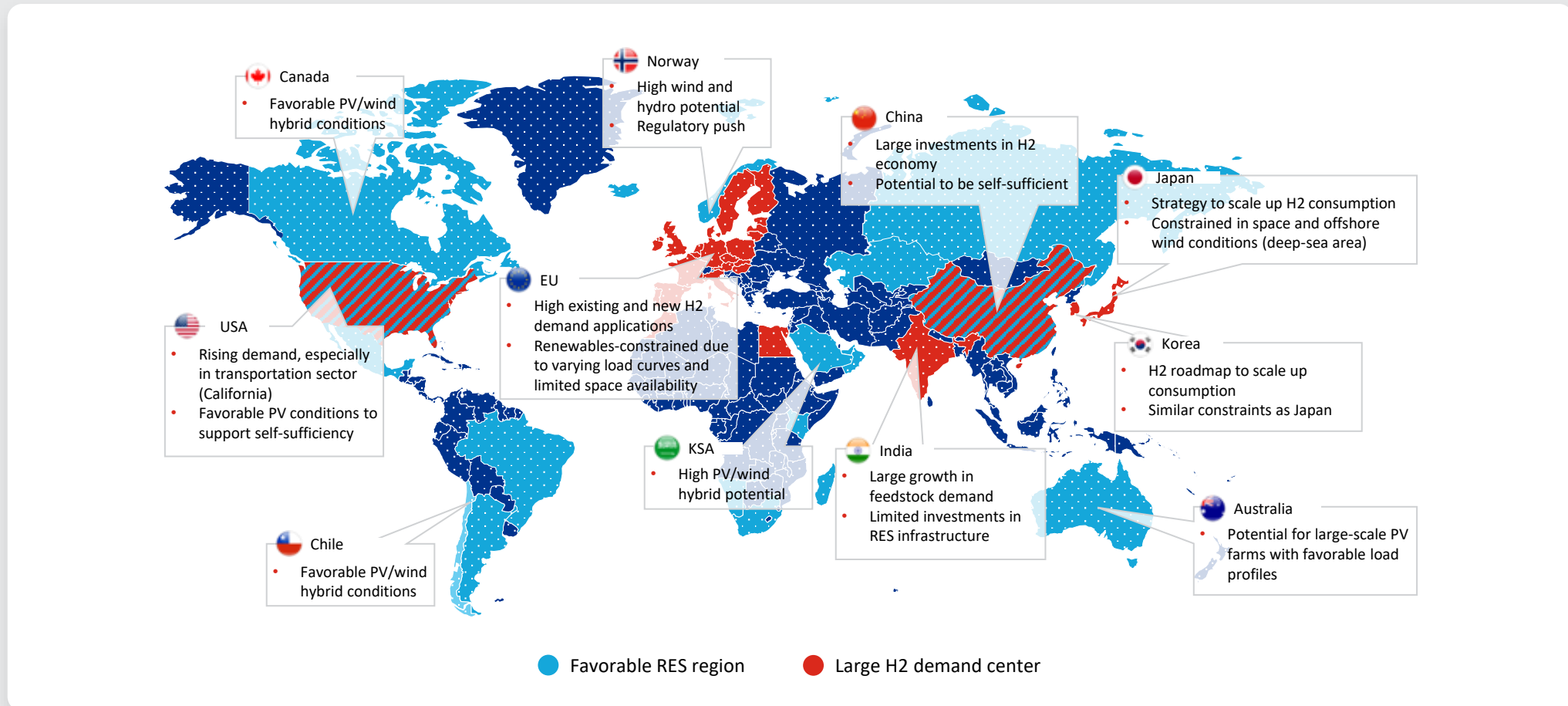
Energy trade

Oil: Global balance of trade



Regions with large potential H2 demand are renewables-constrained; regions with high renewable energy potential have an advantage to produce cheaply at scale

Major H2 offtake demand centers and regions with high potential for green H2 production

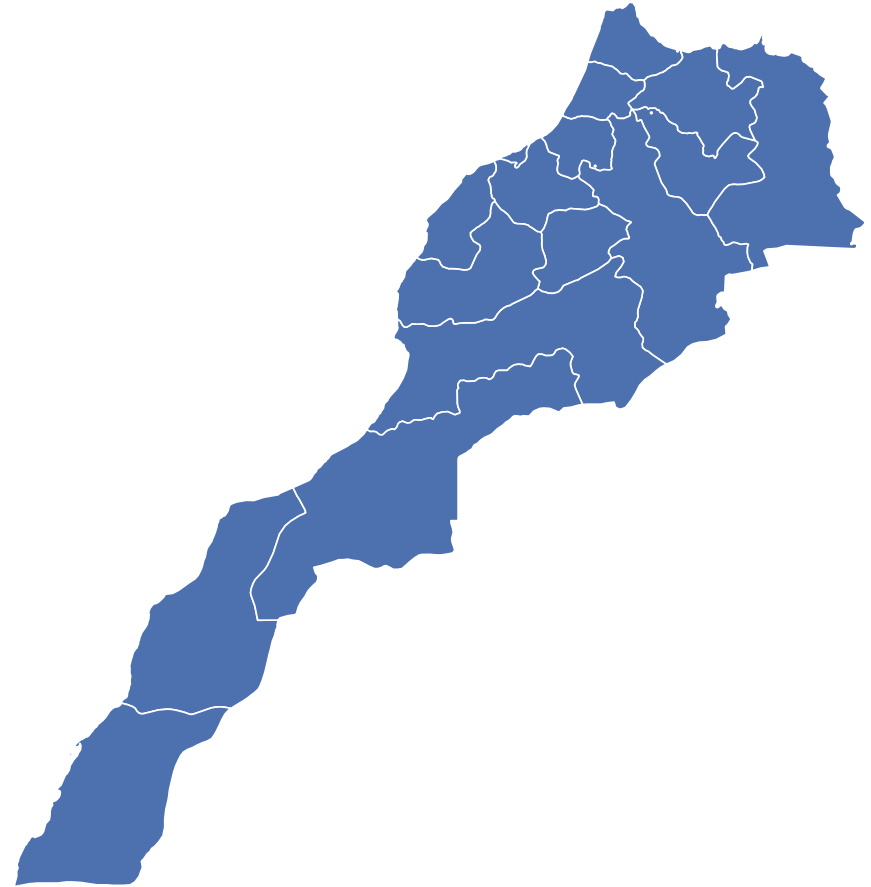


Energy in North Africa

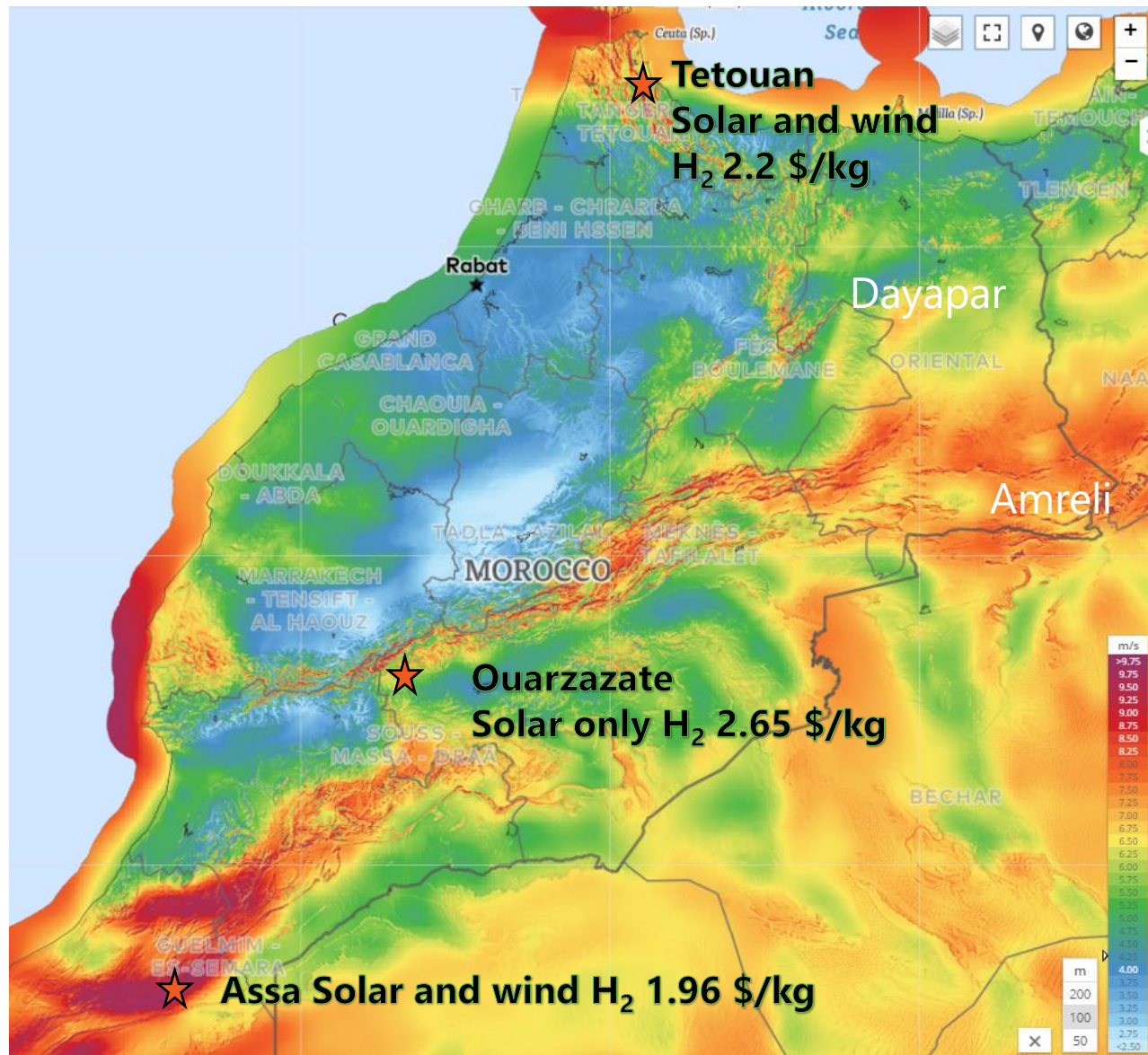


- IRENA estimates that North Africa has a feasible potential for renewable energy of almost 120 GW, with 70 GW wind and the rest solar PV and CSP by 2030
- Competitive green hydrogen produced in North Africa can replace fossil fuels, benefitting both importers (Morocco, Tunisia) and exporters (Algeria, Libya)
- North Africa supplies 13% of Europe's natural gas demand and 10% of oil demand. More than 60% of North Africa's oil and gas exports are sent to Europe (Eurostatgas)

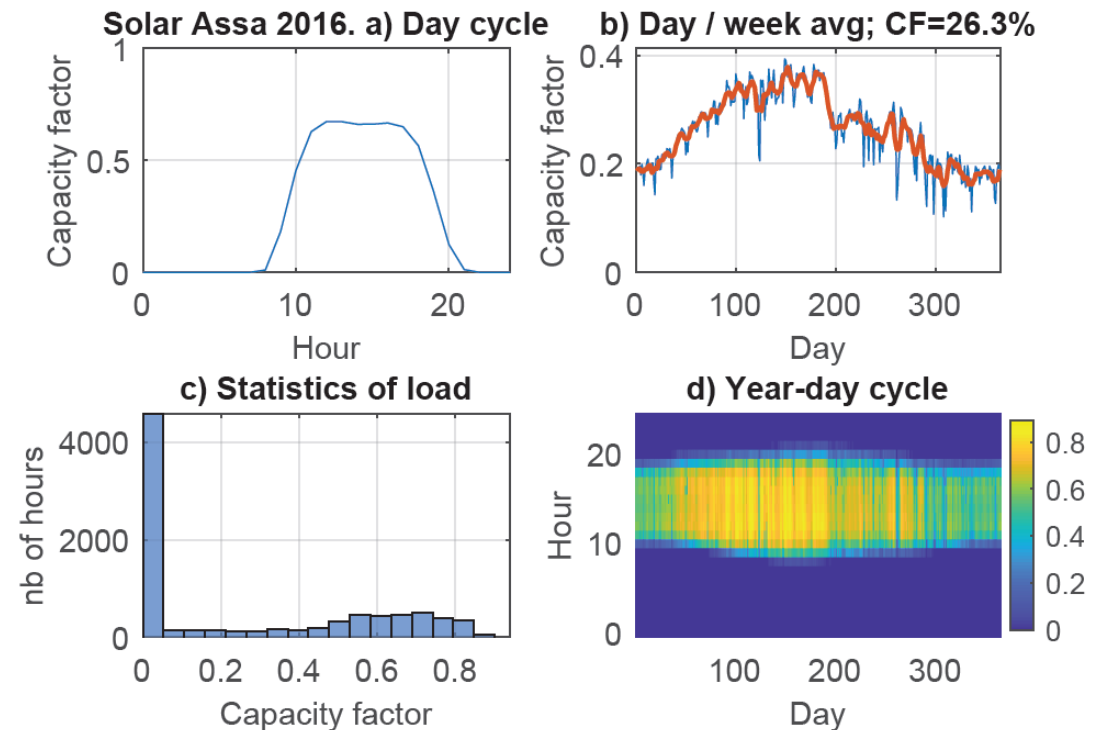
Morocco



Three locations in Morocco with diverse meteo conditions



To assess the costs of producing H_2 , NH_3 , $MeOH$, synfuels, metal iron... from solar and wind, you must look at their variability on all time scales



Source: Global Wind Atlas

OCP - Morocco



- one of the leading exporters of phosphate rock, phosphoric acid and phosphate fertilizers in the world. Established in 1920, HQ in Casablanca. Currently employs 20,000 staff, majority owned by Government of Morocco (95%)

Imports:

> 1,000 kton NH_3 per year

Opportunity:

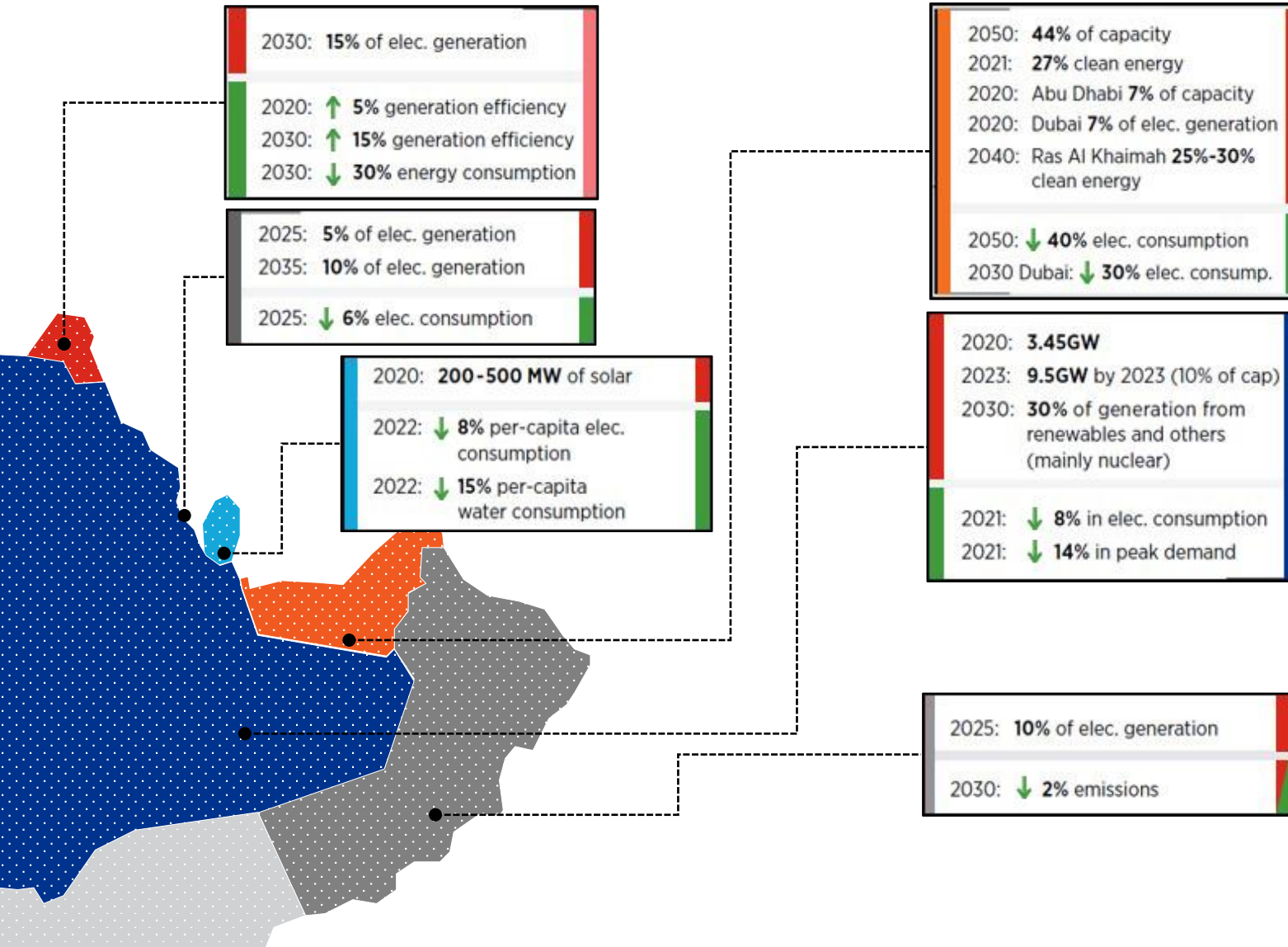
Replace ammonia imports with green ammonia

Scale Phase 1:

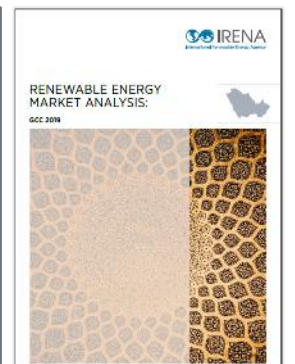
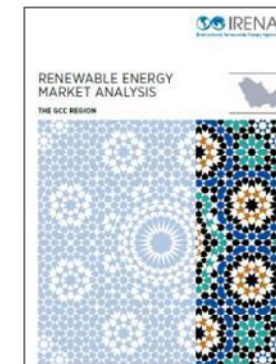
- 600 ktpy NH_3 synthesis plant
- 900 MW solar/wind + electrolyser
- CAPEX (RE+ NH_3) = \$2.6 bn



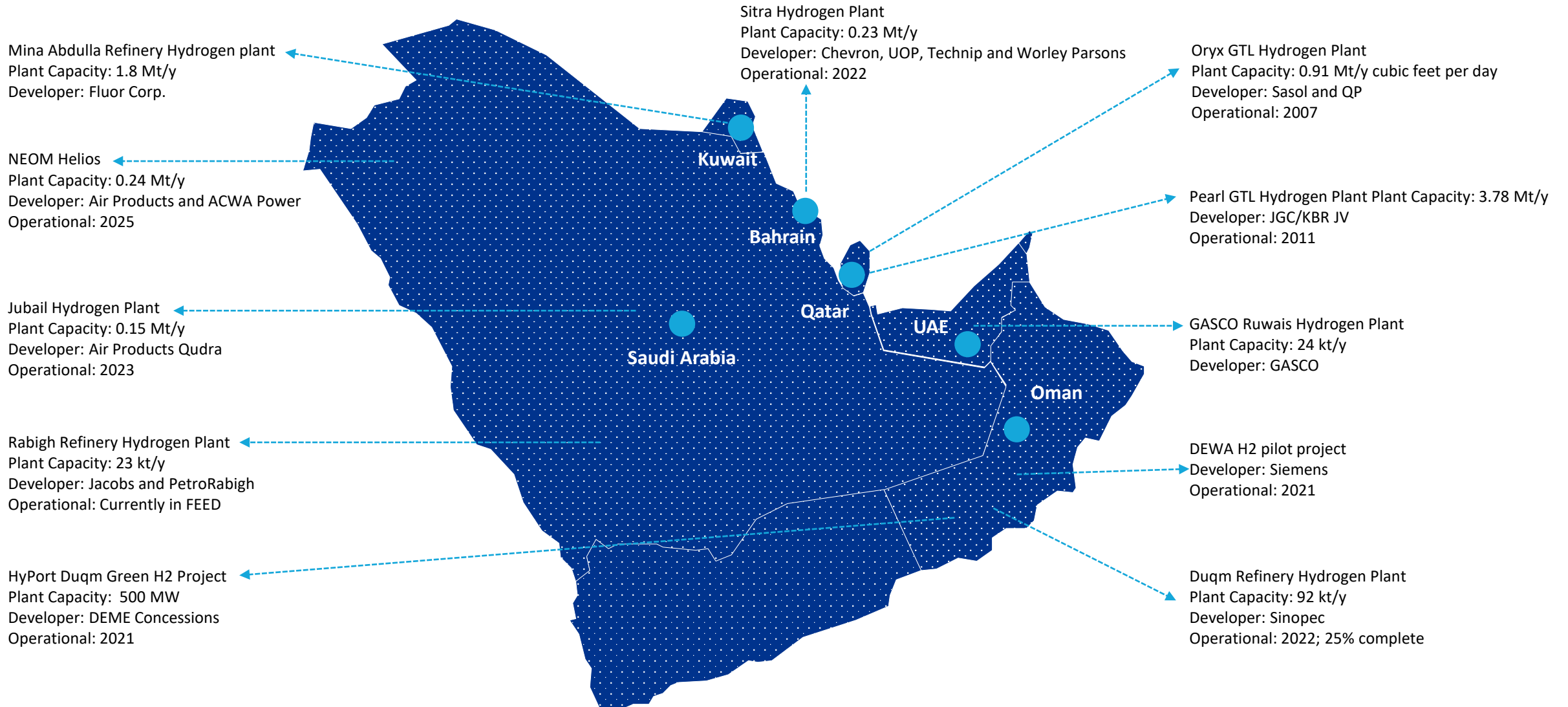
The GCC Energy Transition is Underway



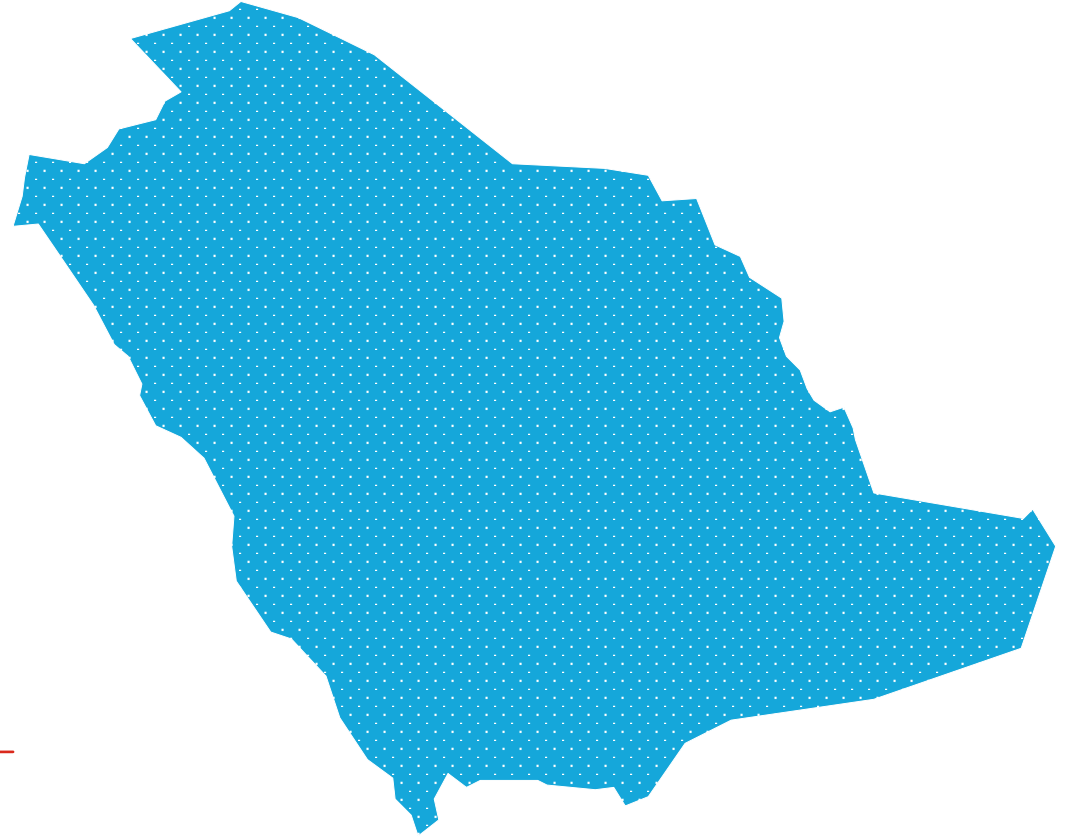
- Strong increase in renewable energy and energy efficiency plans, often integrated in national energy and/or climate strategies
- Many targets not yet part of legislation
- Long-term targets translating into concrete policies and medium-term projects



H2 in GCC



Saudi Arabia



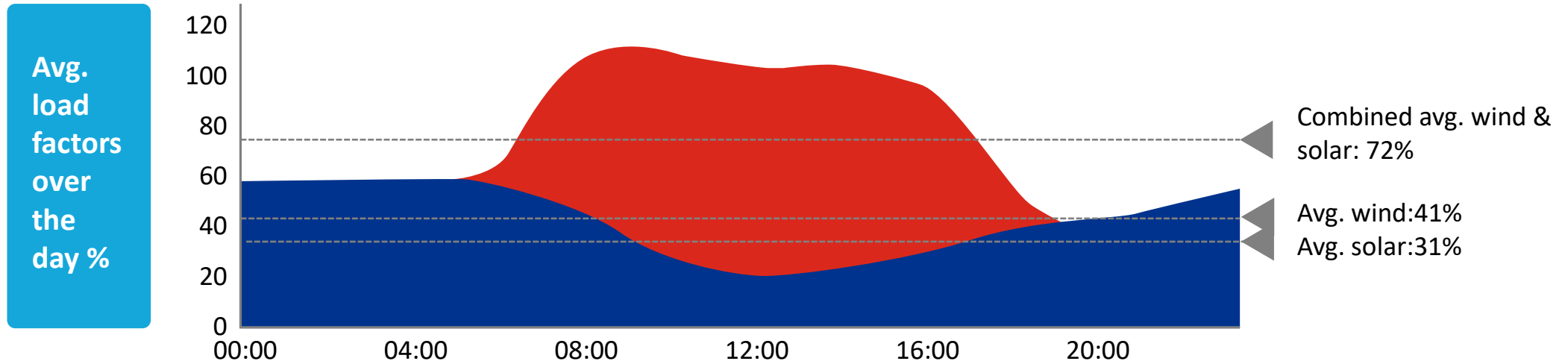
NEOM

- New city, the size of Belgium (26,000km²)
- One of three strategic projects of Saudi Agenda 2030
- Saudi's Public Investment Fund and others have committed \$500 billion
- NEOM will be powered by 100% low-cost renewable energy (40 – 60 GW)
- Given the availability of competitive and low-cost renewable energy, NEOM will produce green hydrogen at scale for local and world markets



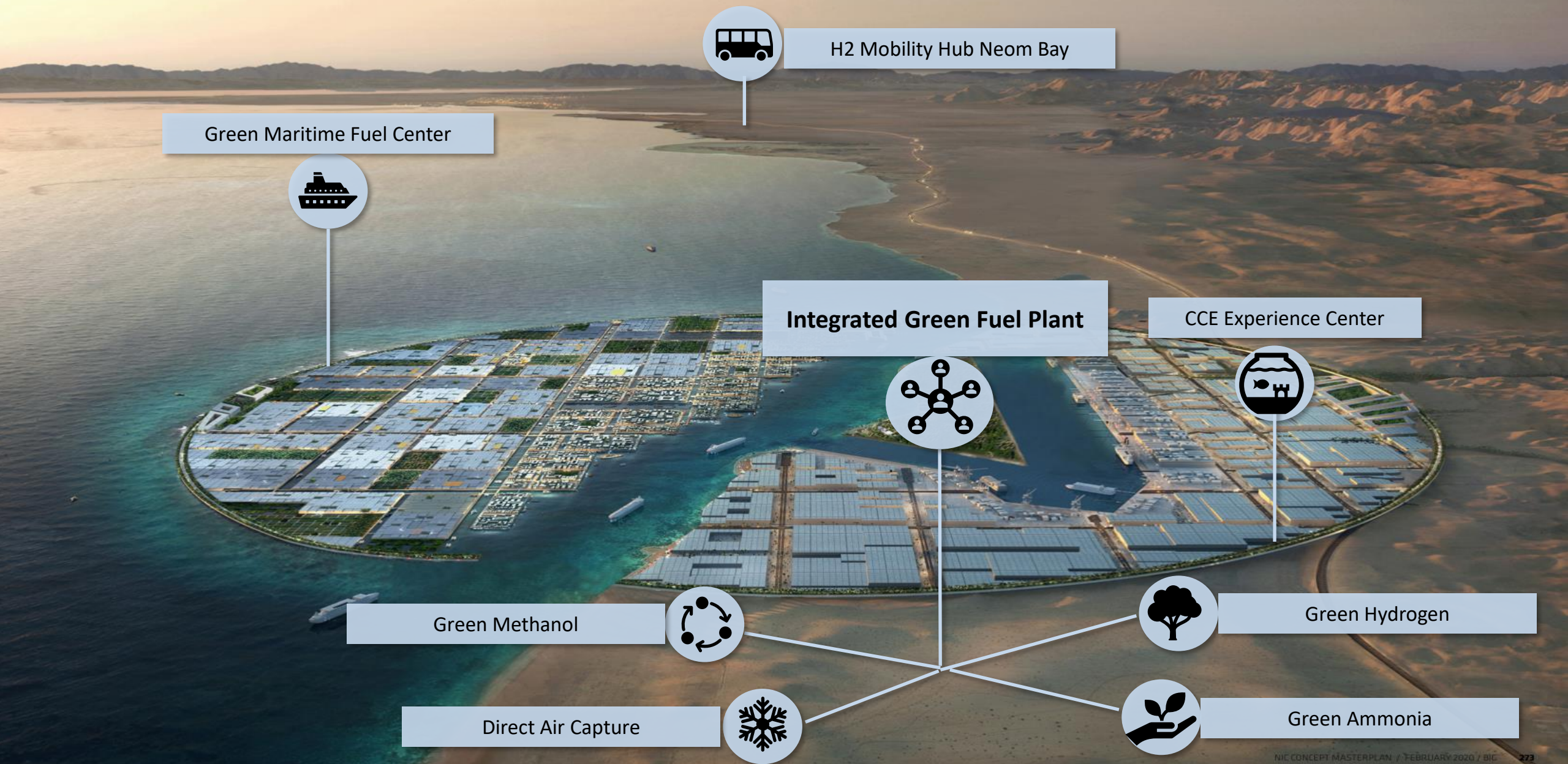
NEOM – Profiles of the solar and wind resource

Hypothetical, for a wind plant of for instance 500 MW plus a solar PV plant of 500 MW, and with a load factor calculated against a plant of 500 MW



Source: NEOM

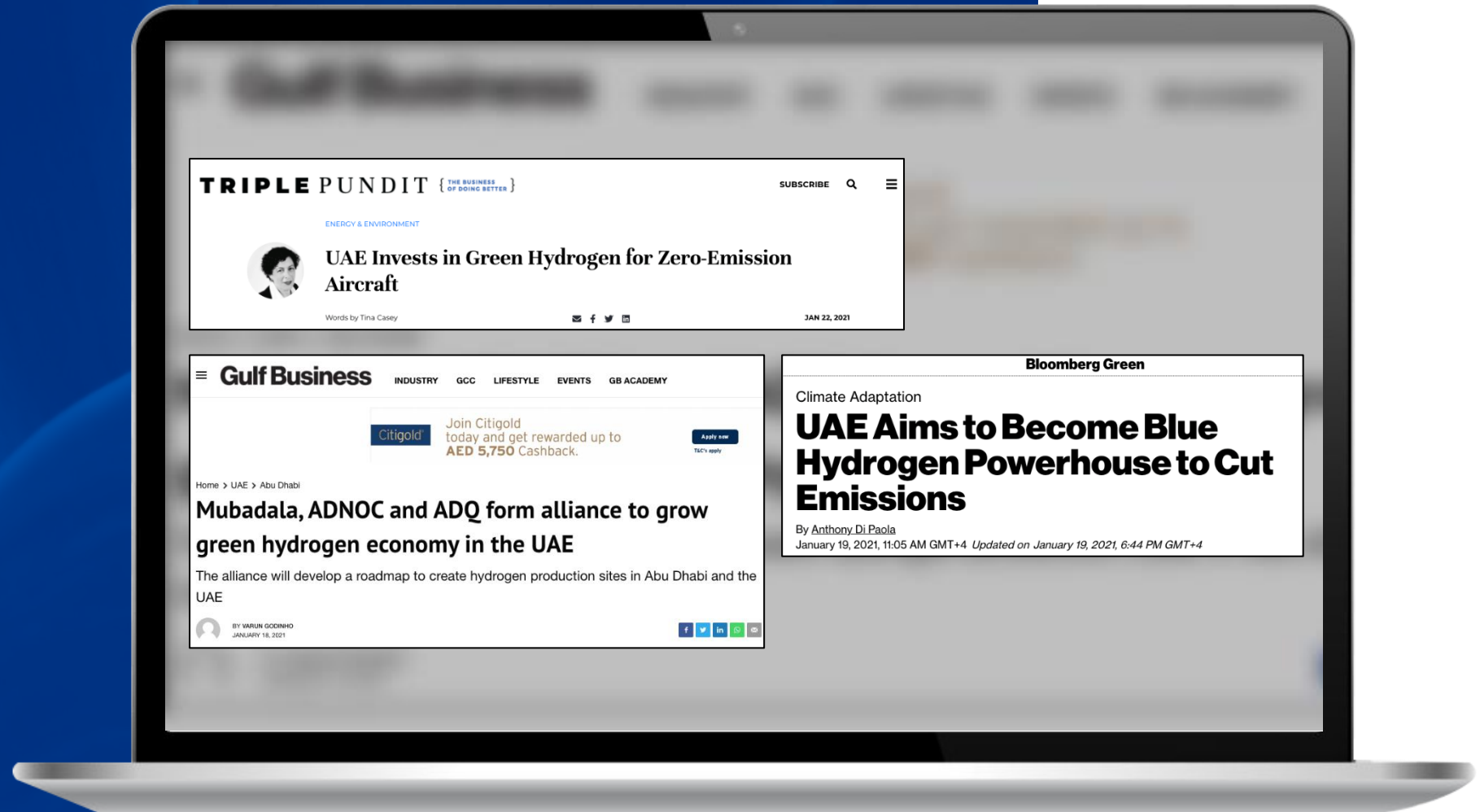
NEOM: the green catalyst for a circular carbon economy in KSA

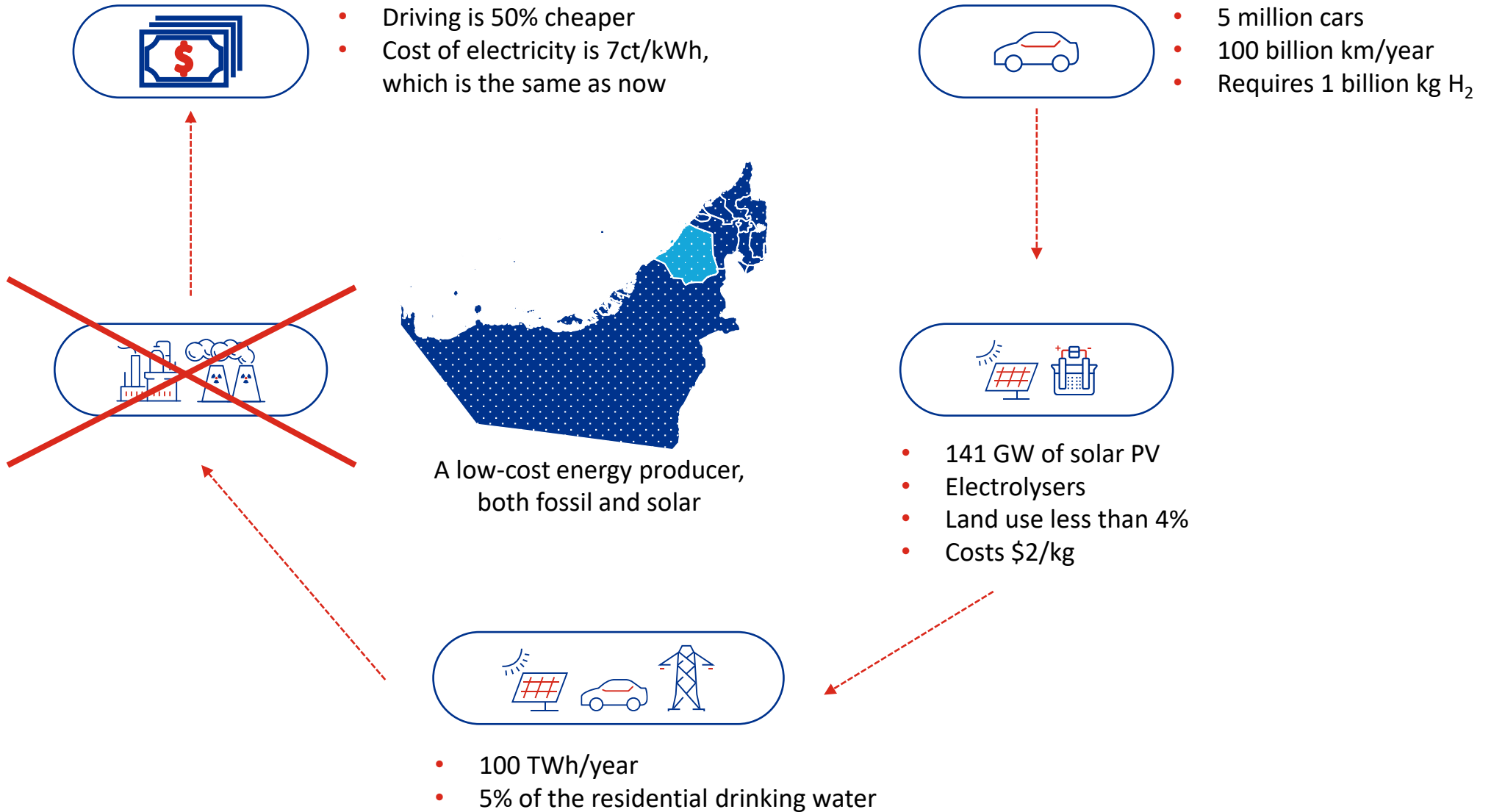


UAE



Recent developments





QA

