



ΣΥΝΔΕΣΜΟΣ ΥΔΡΟΓΟΝΟΥ ΚΥΠΡΟΥ
CYPRUS HYDROGEN ASSOCIATION

0

10^ο Ενεργειακό Συμπόσιο Κύπρου

ΚΥΠΡΟΣ: ΕΝΕΡΓΕΙΑΚΟΣ ΚΟΜΒΟΣ ΣΤΗΝ ΑΝΑΤΟΛΙΚΗ ΜΕΣΟΓΕΙΟ

Σύνδεσμος Υδρογόνου Κύπρου (ΣΥΚ)

Πρόεδρος ΣΥΚ, Μάκης Κετώνης

What is hydrogen ?

Hydrogen

atomic number — 1

symbol — H

electron configuration — $1s^1$

name — hydrogen

atomic weight — [1.00784, 1.00811]

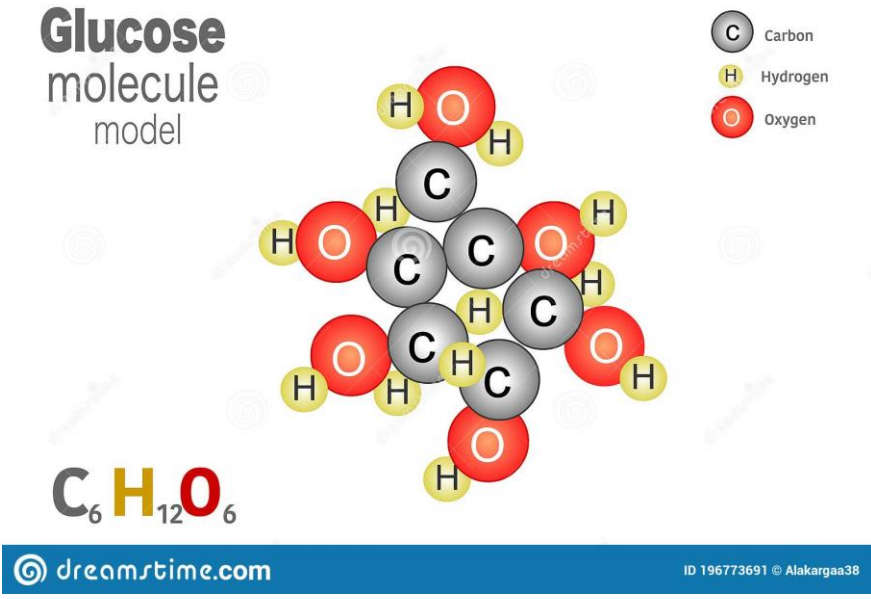
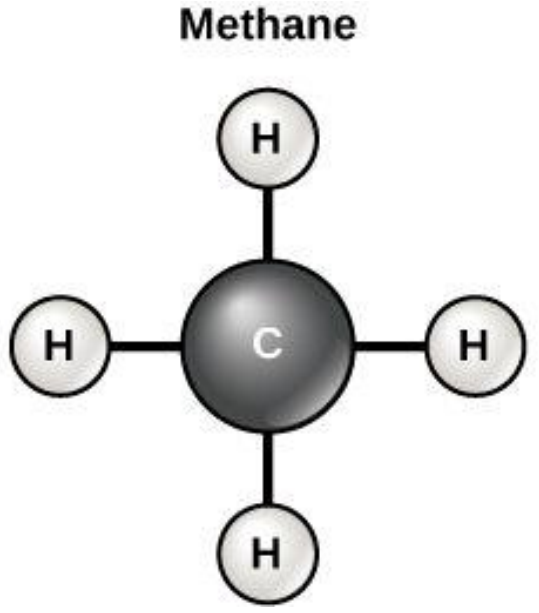
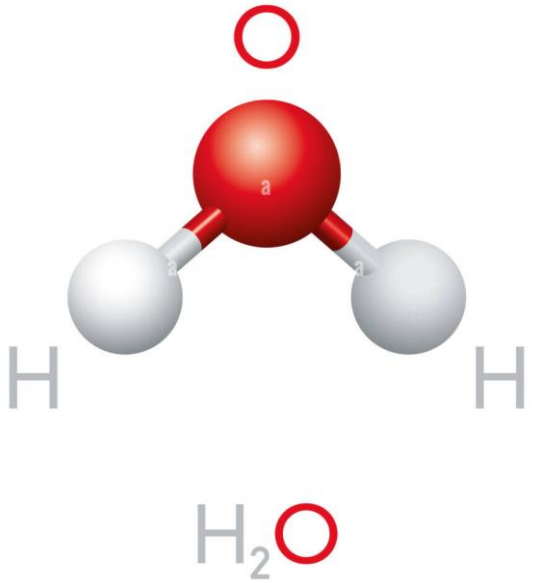
acid-base properties of higher-valence oxides — (circle with diagonal line)

crystal structure — (hexagonal unit cell)

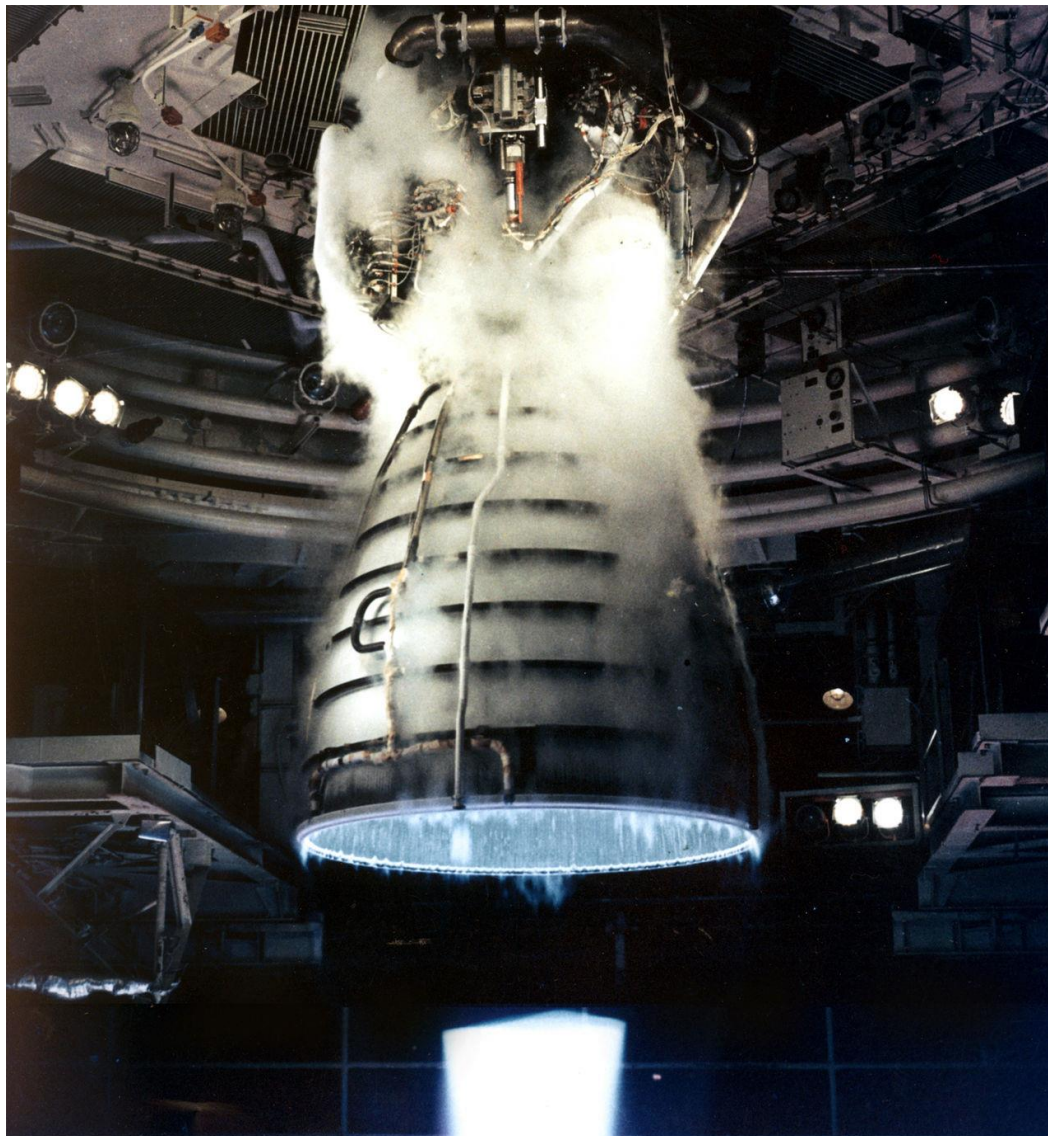
physical state at 20 °C (68 °F) — (dotted line)

Other nonmetals	Gas
Hexagonal	Equal relative strength

Hydrogen in chemical compounds



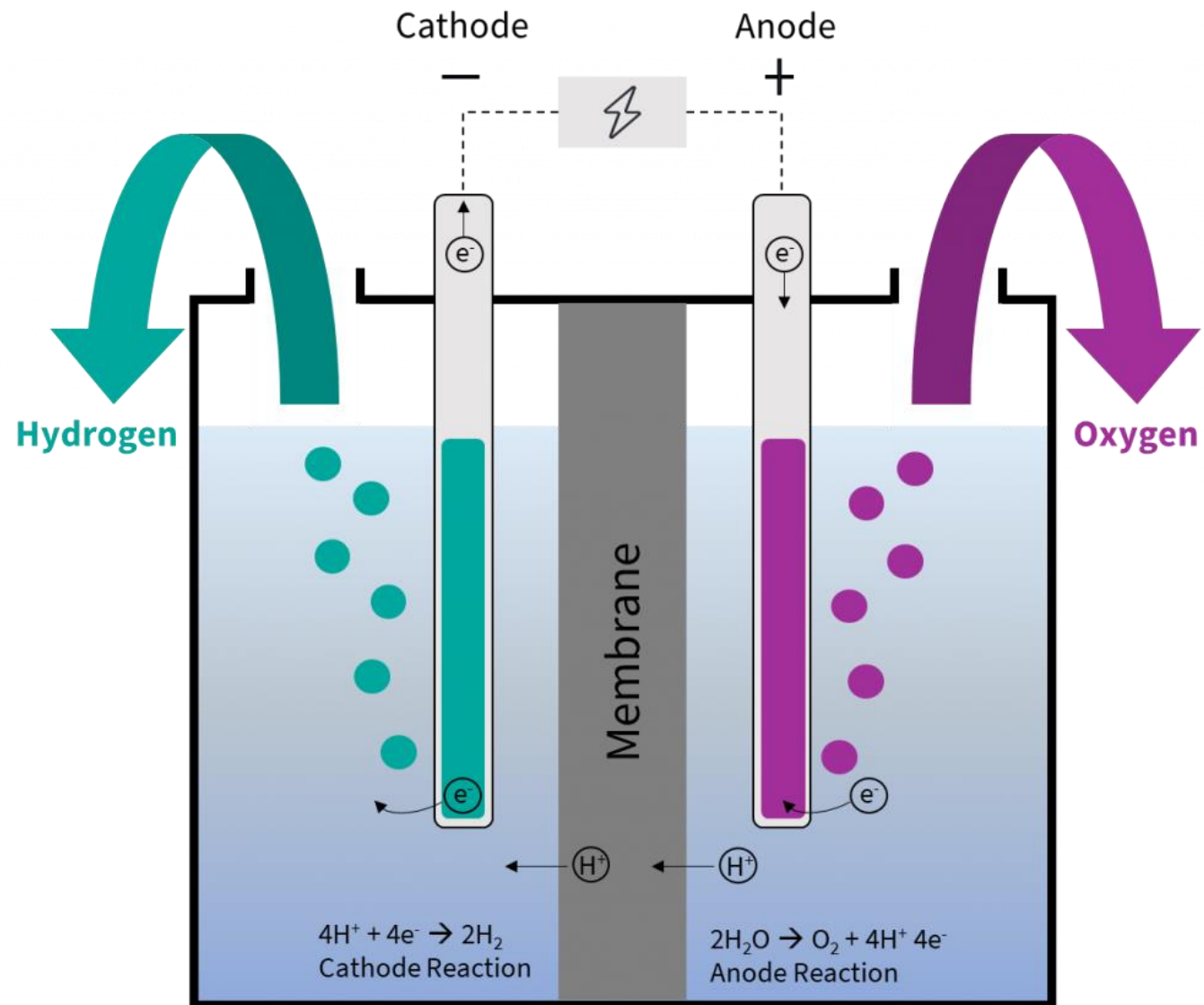
ICE (internal combustion engine)



The colours of H₂



Electrolysis



Source:



KEY FINDINGS

1. Main **consumption sectors** for hydrogen in 2030 are:
 - **transportation** (146 GWhH₂ \cong 3,705 tonnes of H₂),
 - **industry** (4 GWhH₂ \cong 101.5 tonnes of H₂) and
 - **buildings** (0.18 GWhH₂ \cong 4.6 tonnes of H₂)
2. A **dedicated installed renewable electricity capacity** of **15 to 100 MW** is required to produce green hydrogen and cover its estimated hydrogen demand by 2030
3. The **NECP** of Cyprus estimates a production of about 1.5 TWh of renewable electricity in 2030 but **does not consider H₂ deployment** for the period from 2021 to 2030
4. According to the estimated renewable electricity production in 2030, approx. **15 % of renewable electricity** will be used for **production of hydrogen** via electrolysis
5. **Annual costs** for green hydrogen production, development of its transport infrastructure and end-user applications in Cyprus are estimated to amount between **5 to 28 million Euro**
6. The deployment of hydrogen in Cyprus can add value to its economy e.g. by creating \approx **600 potential jobs** in manufacturing, construction and operation of H₂ technologies
7. The deployment of hydrogen in Cyprus can further **reduce greenhouse gas emissions (7-34 kt CO₂/a)** and **fossil energy import dependence (0.03-0.14 TWh/a)** provided we reach our targets.
8. It is currently not possible to use an existing methane infrastructure to transport or distribute hydrogen in Cyprus, as there is **no gas natural network** available
9. **Neither salt cavern natural gas storage sites nor underground salt layers** that could provide **suitable storage** opportunities for hydrogen can be used or found in Cyprus

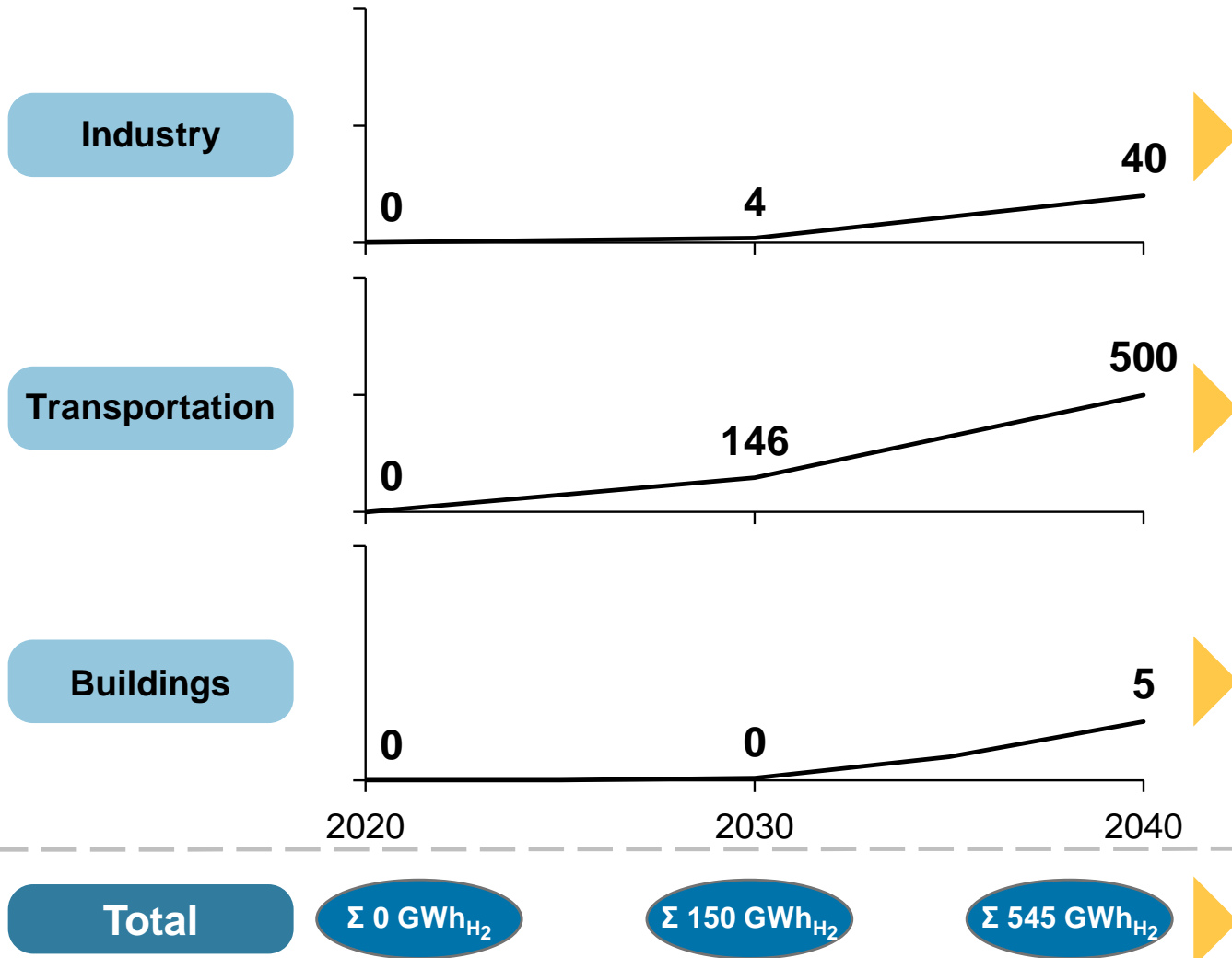
Cyprus roadmap until 2040

Source:



7

H₂ demand development (GWh_{H2})



Key assumptions / findings

- 4 GWh_{H2} industrial energy demand in 2030
- Limited level of opportunity for hydrogen use in industry (currently no natural gas use in Cyprus)
- Potential application: High-temperature process heat (>200°C) as industrial energy demand

- 146 GWh_{H2} demand for transport sector in 2030
- Hydrogen can be a suitable alternative to electric battery driven cars, trucks and buses
- On the medium to long run, hydrogen and derived fuels can be deployed to decarbonize the aviation sector

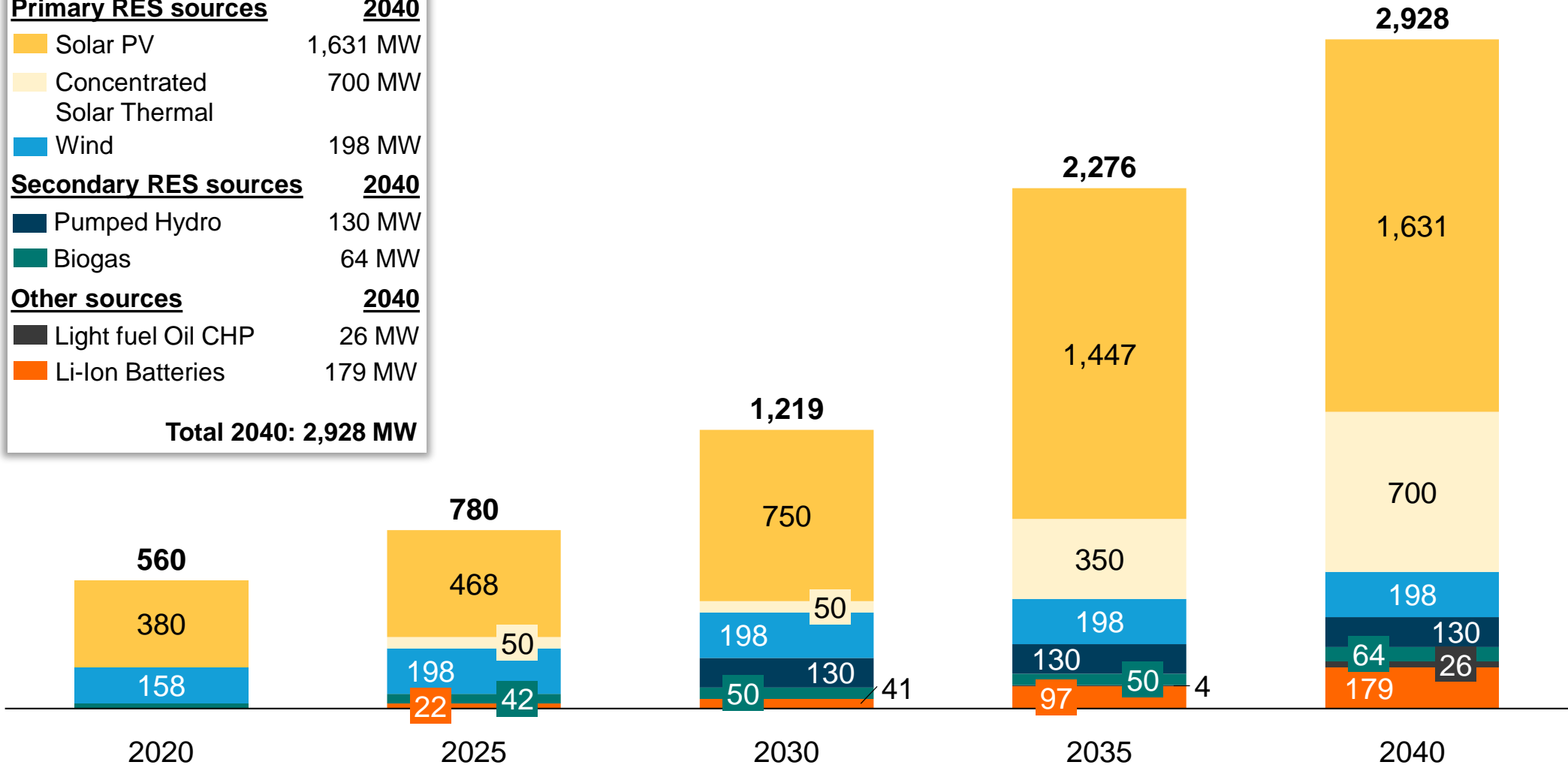
- 0.18 GWh_{H2} demand for heating and cooling in 2030
- Cyprus has no natural gas in its energy mix. However, space cooling is an important energy end-use for buildings
- Hydrogen-based technologies (reversible systems producing electricity and heating/cooling) can be an alternative e.g. for the services sector

- 150 GWh_{H2} in 2030 (0.8% of 2030 final total energy demand)
- 545 GWh_{H2} in 2040 (2.9% of 2030 final total energy demand)

Green Hydrogen in Cyprus: RES Capacity in the electricity sector until 2040

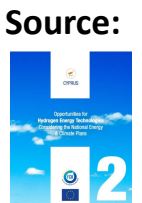
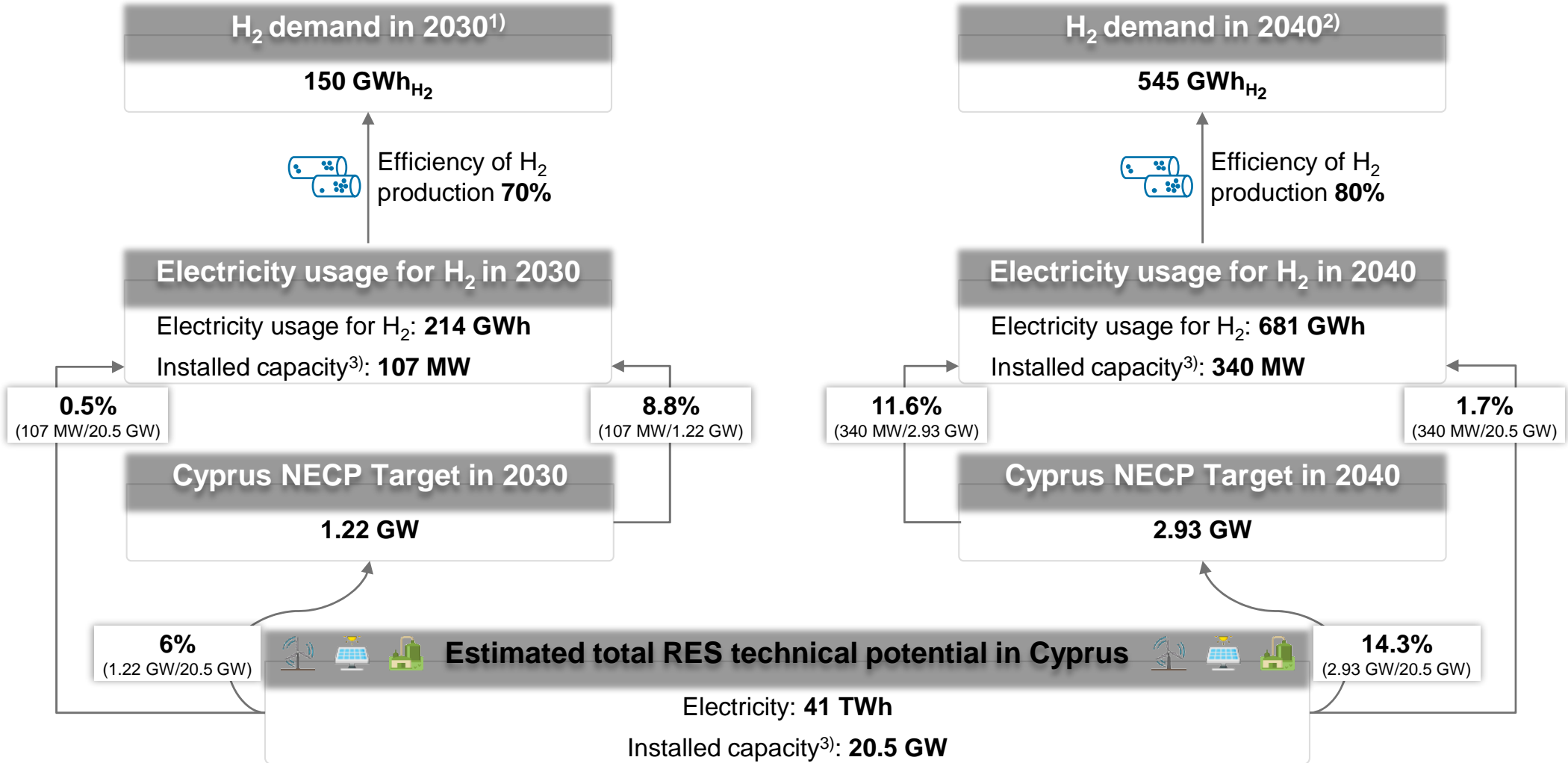
The projected / planned RES capacity in Cyprus by 2040 is of 2,928 MW according to the NECP. These are:

<u>Primary RES sources</u>		<u>2040</u>
Solar PV	1,631 MW	
Concentrated Solar Thermal	700 MW	
Wind	198 MW	
<u>Secondary RES sources</u>		<u>2040</u>
Pumped Hydro	130 MW	
Biogas	64 MW	
<u>Other sources</u>		<u>2040</u>
Light fuel Oil CHP	26 MW	
Li-Ion Batteries	179 MW	
Total 2040: 2,928 MW		



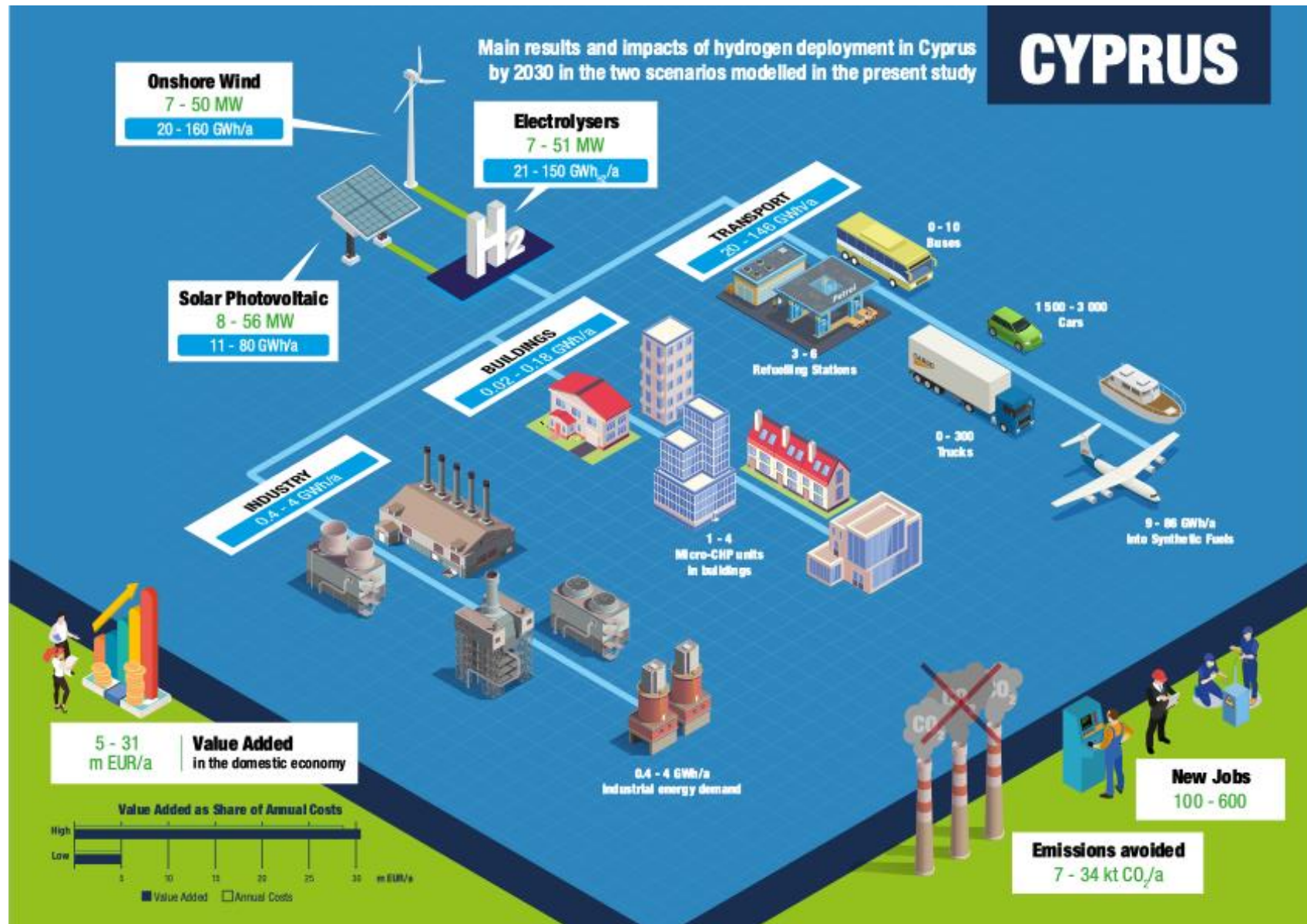
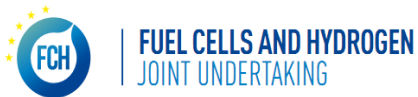
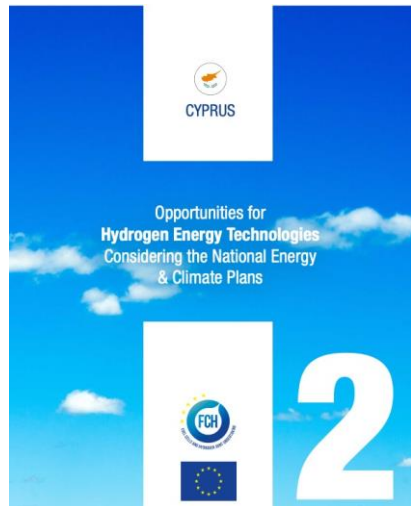
Green Hydrogen in Cyprus: H₂ production for Cyprus in 2030 and 2040

About 9% of RES installed capacity defined in the Cyprus NECP targets would be required to cover the hydrogen demand of Cyprus in 2030, whereas around 12% would be required in 2040

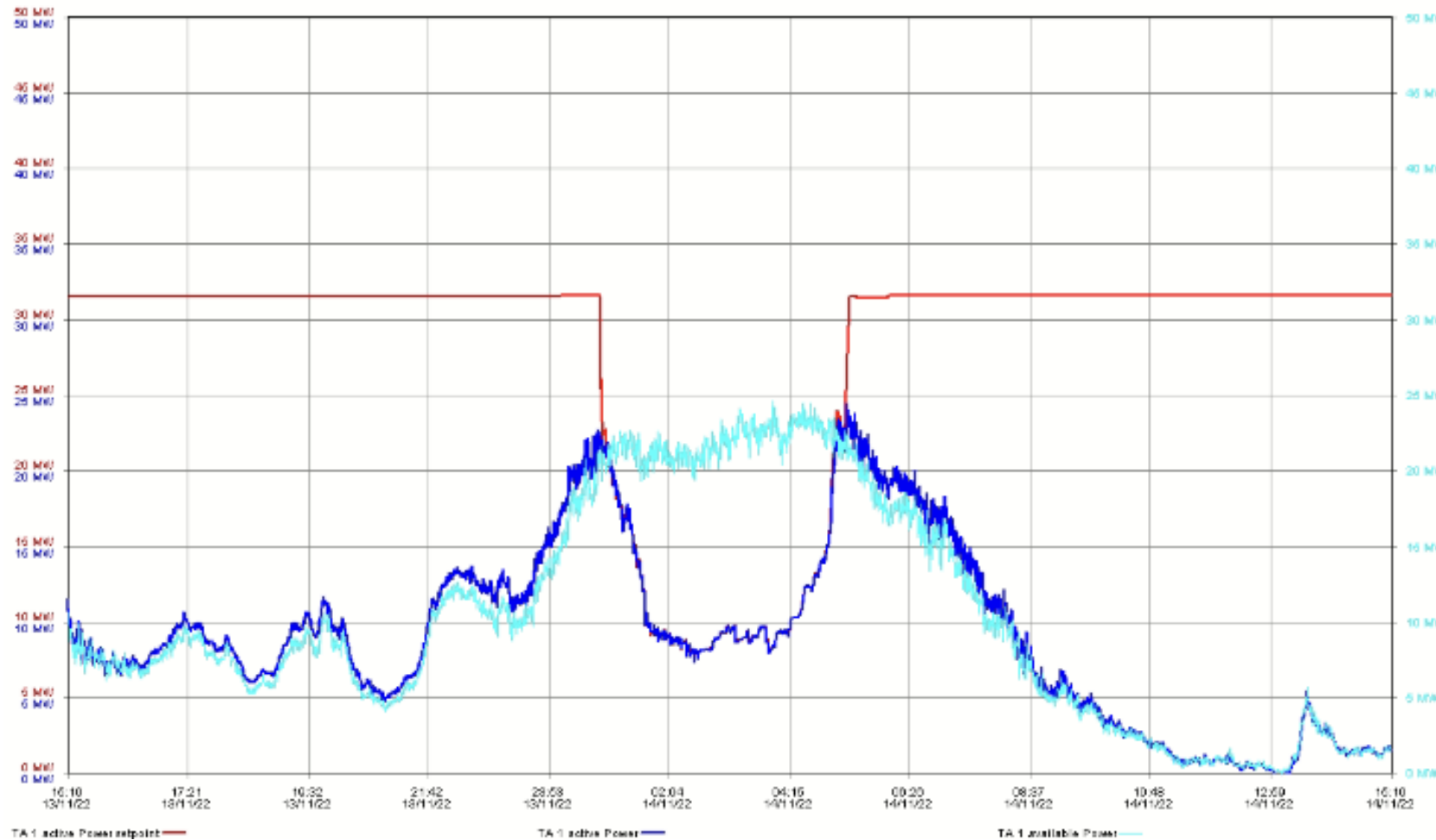


Opportunities for Hydrogen Energy Technologies in Cyprus

Source:



Curtailment of RES

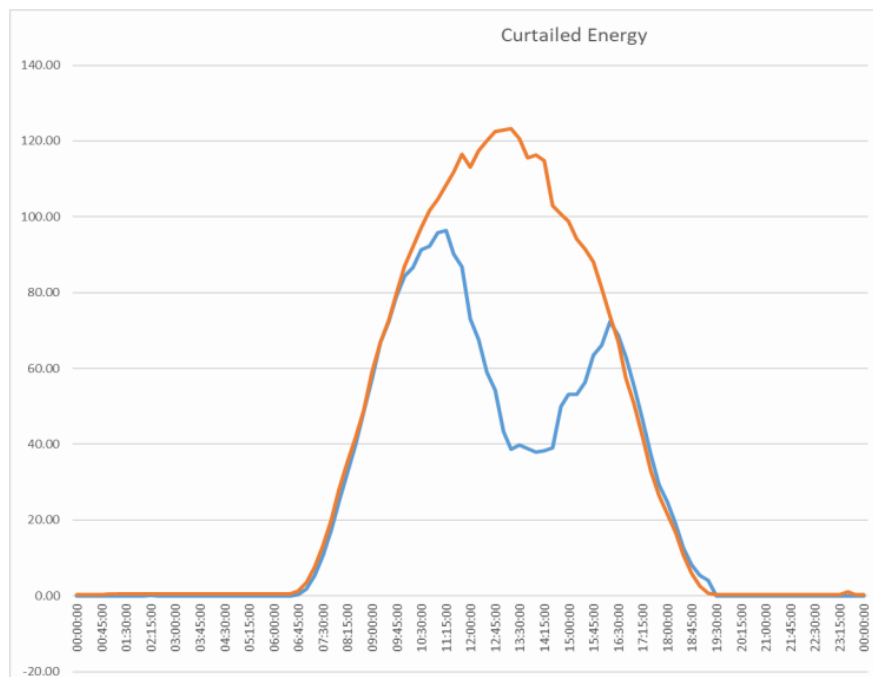
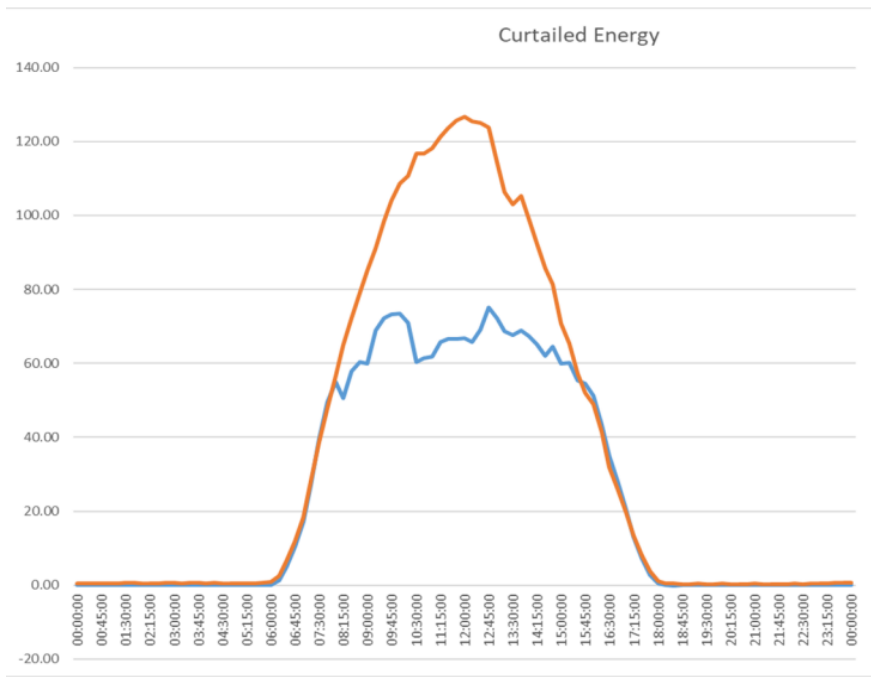


Curtailment Alexigros wind farm, 14.11.2022

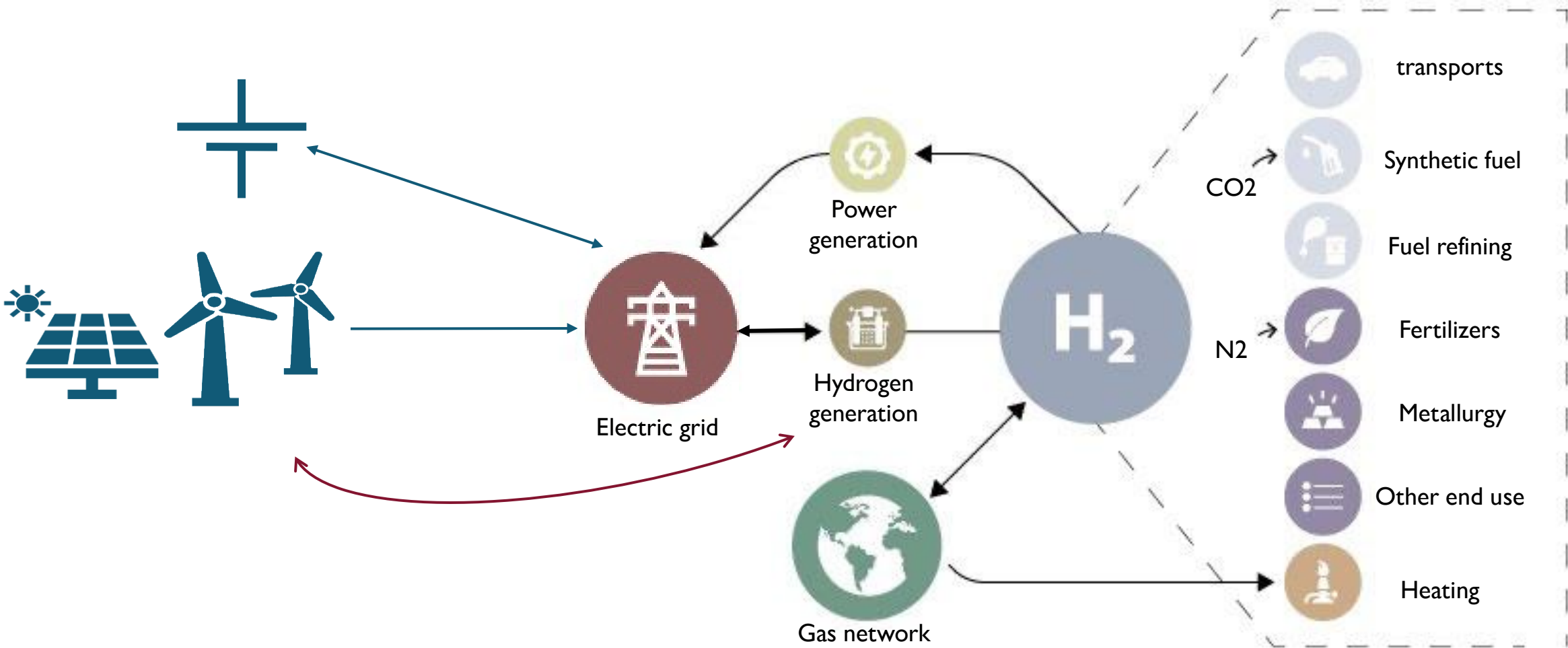


Curtailment of RES

Examples of actual days with substantial PV Curtailment



The value chains of green hydrogen



H2 filling station



Refueling with Hydrogen



H2 filling station



<https://www.weh.se/refuelling-components-hydrogen/h2-car-dispensers.html>

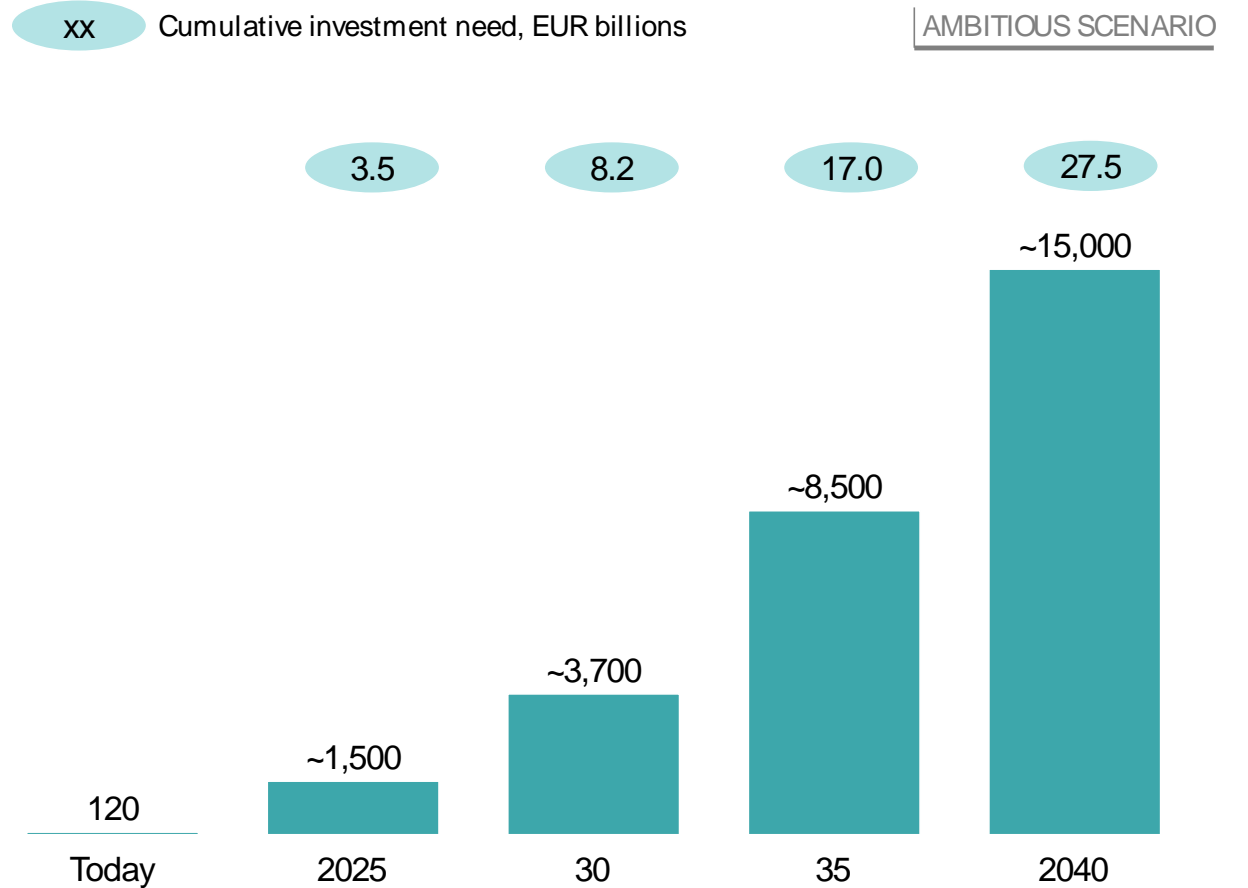


<https://www.fiedlergroup.com/architecture-engineering-project-recaps/shell-opens-san-francisco-first-hydrogen-stations/>

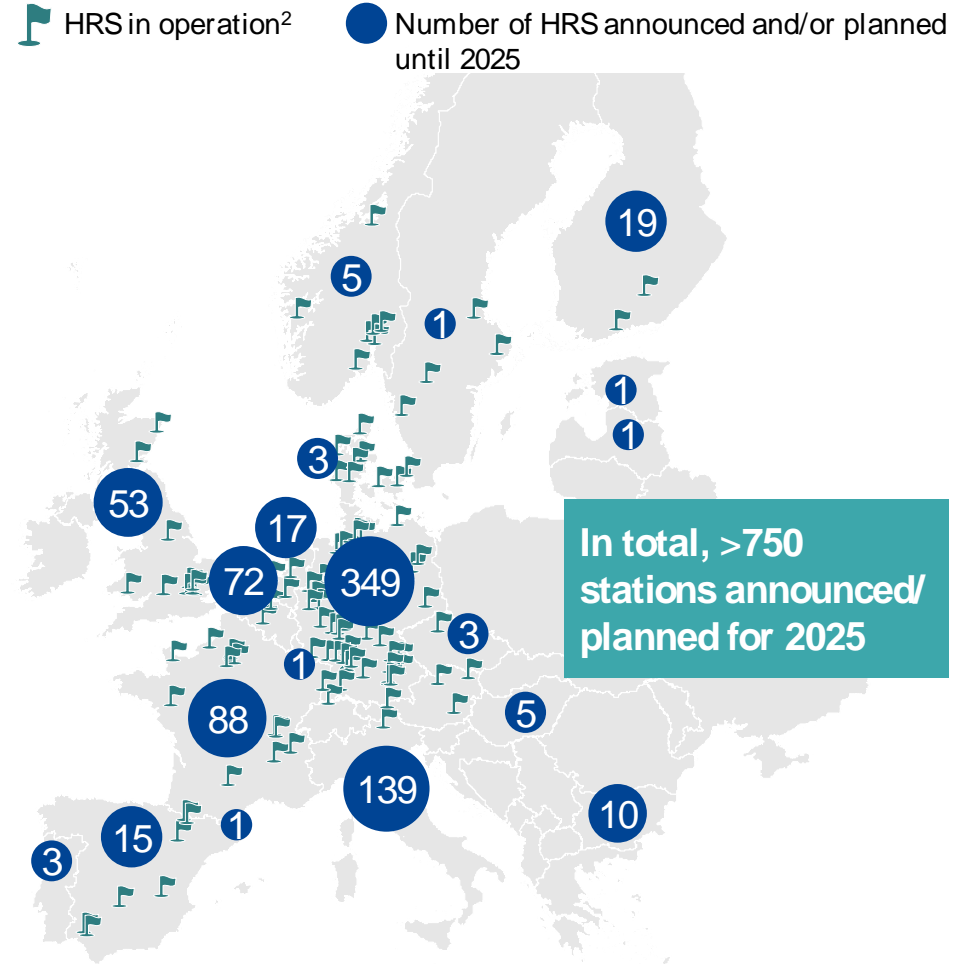
Forecast – Future Hydrogen Refueling Stations [HRS] in Europe

THE EQUIVALENT OF ~3,740 REFUELING STATIONS WOULD BE REQUIRED BY 2030, IMPLYING INVESTMENT NEEDS OF EUR ~8.2 BN

Required large HRS¹, number



Current and planned HRS in Europe

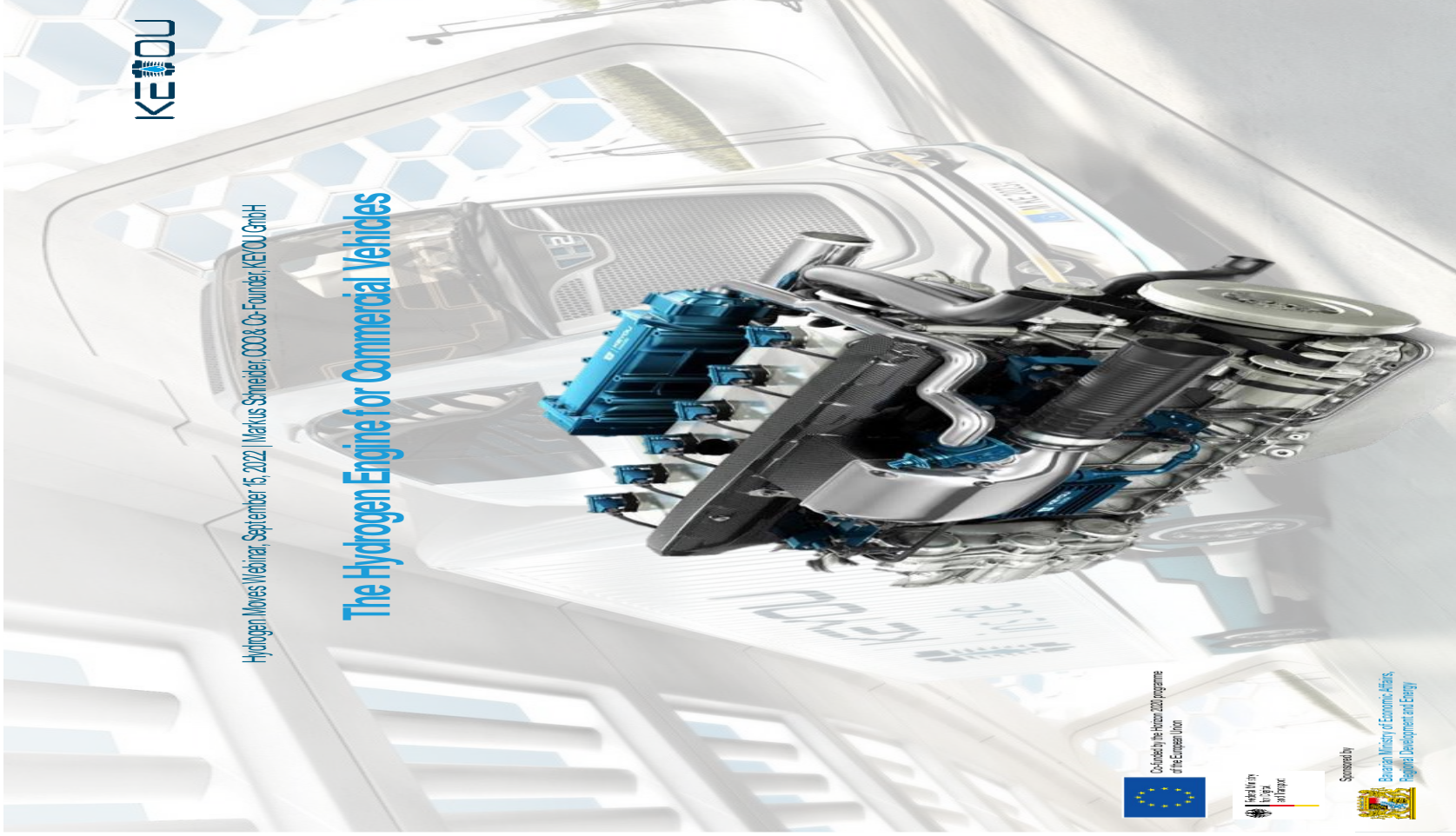


¹ Equivalents of medium HRS (1,000kg daily capacity); utilization relative to steady-state ² Indicative position

SOURCE: European Commission (2017); H2stations.org; press research; Hydrogen Roadmap Europe team

Source: “Hydrogen Roadmap Europe”, FCH





KEPDU

Hydrogen Moves Webinar, September 15, 2022 | Markus Schneider, CEO & Co-Founder, KEPDU GmbH

The Hydrogen Engine for Commercial Vehicles


 Co-funded by the Horizon 2020 Programme
 of the European Union


 Mediterranean
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 Alliance

Sponsored by

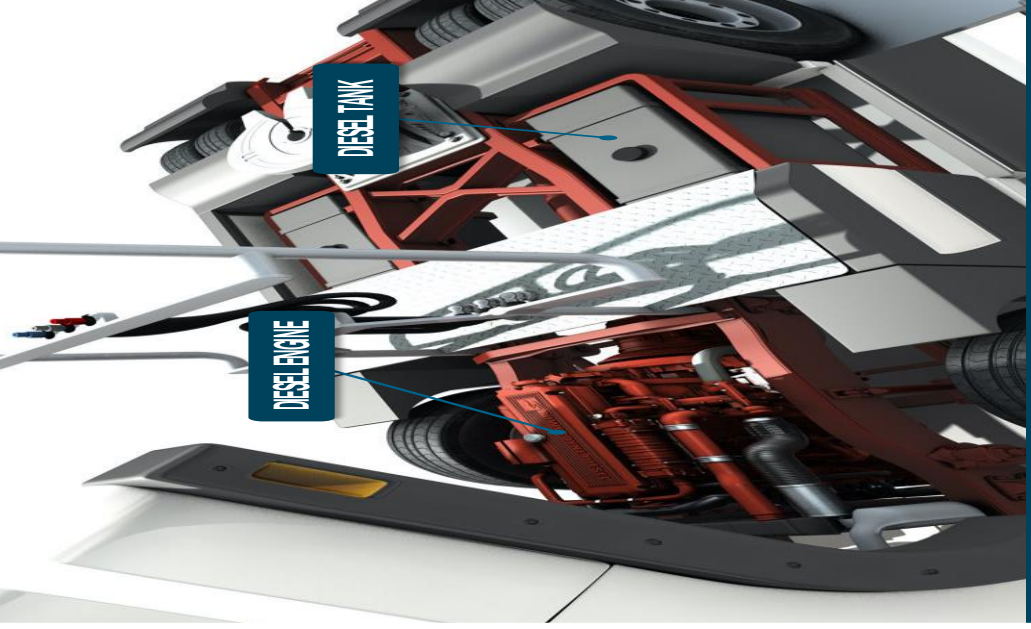
 Cypriot Ministry of Economic Affairs,
 Regional Development and Energy



Building a new Product on the Basis of the most efficient Produced Diesel Vehicle

Cost Efficient Conversion of Diesel Vehicles to Hydrogen

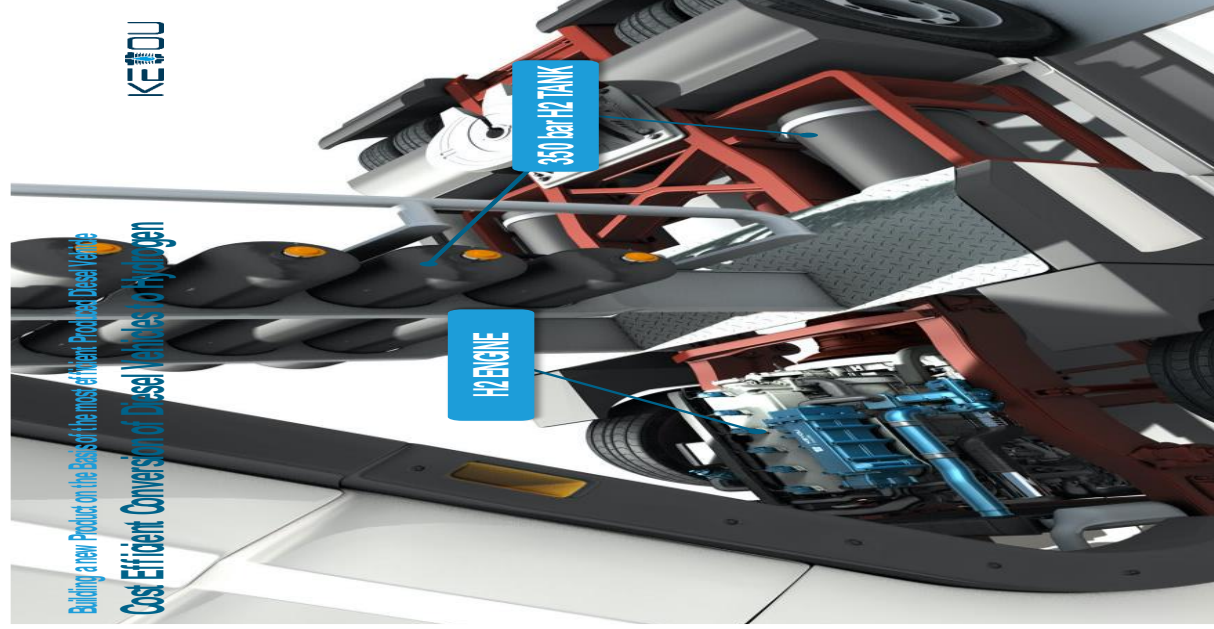
KEITOU



Building a new Product on the Basis of the most efficient Produced Diesel Vehicle

Cost Efficient Conversion of Diesel Vehicles to Hydrogen

KEITOU



Fuel cell vehicle applications



Passenger vehicle



Hydrogen logistic vehicle



Hydrogen heavy duty truck



Hydrogen bus



Hydrogen bin truck



Hydrogen forklift



FCEV Passenger cars



Hyundai ix35



Hyundai NEXO



Toyota MIRAI



Honda Clarity Fuel Cell



Mercedes-Benz GLC F-CELL



FCEV Range Extended Vans



Cost to purchase new: ~50.000 €



Renault Master Z.E. Hydrogen

Cost to purchase new: ~55.000 €



Nissan e-NV200

Cost to purchase new: ~50.000 €



FCEV Heavy Duty Vehicles



Hyzon Hydrogen Heavy Truck

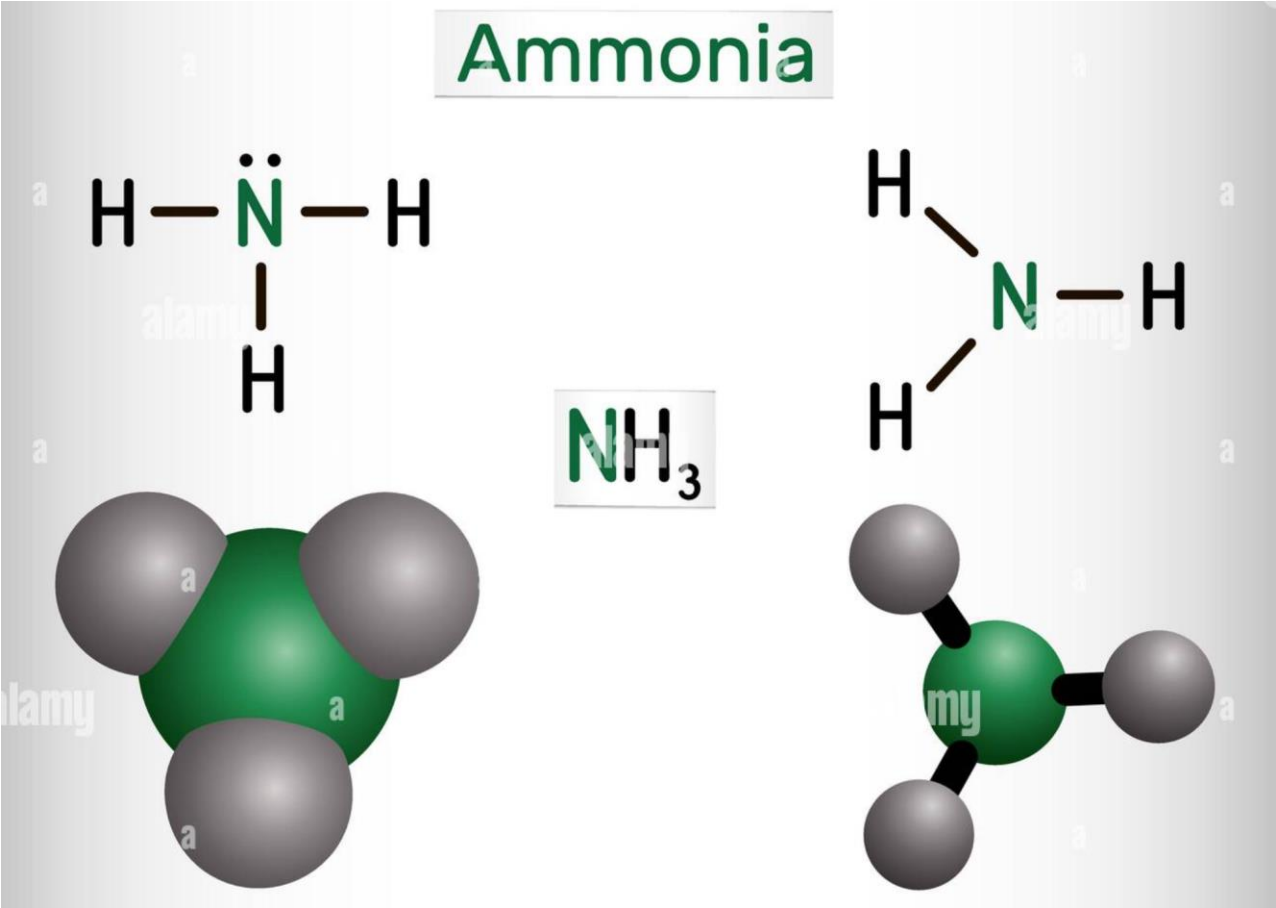


Toyota Hino Profia FC

Cost to purchase new:
~450.000 €



Hyundai Xcient Fuel Cell



Thank you very much for your attention



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CYPRUS HYDROGEN ASSOCIATION

President of CHA,
Makis Ketonis