

Esbjerg H2 ECOSYSTEM



Teaser – Project Overview Green Hydrogen Esbjerg

Green Hydrogen Hot Spot - Esbjerg

H2 Energy Europe
Copenhagen, March 2022

- **'Green Deal' triggers Energy Transition**
- **Implications of the 'Green Deal'**

The **European Green Deal** set the blueprint for a transformational change:

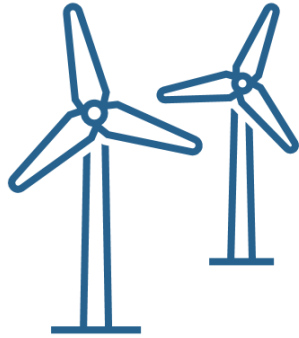
All 27 EU Member States committed to turning the EU into the first climate neutral continent by 2050. To get there, they pledged to reduce emissions by at least 55% by 2030, compared to 1990 levels

1
Generation of new renewable energy sources
(and retiring current fossil sources)

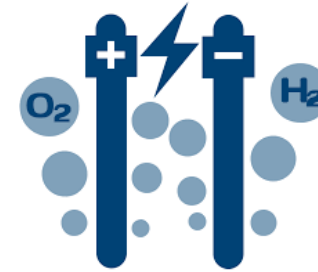
2
Realization of new **energy distribution networks**

3
Decarbonization: enabling energy consumers to run on non fossil energy carriers

- 1.) Generation of new renewable energy sources
- **Hydrogen: Catalyst to additional renewable Energy infrastructure**



Win+
Win



Renewable Energy Production needs

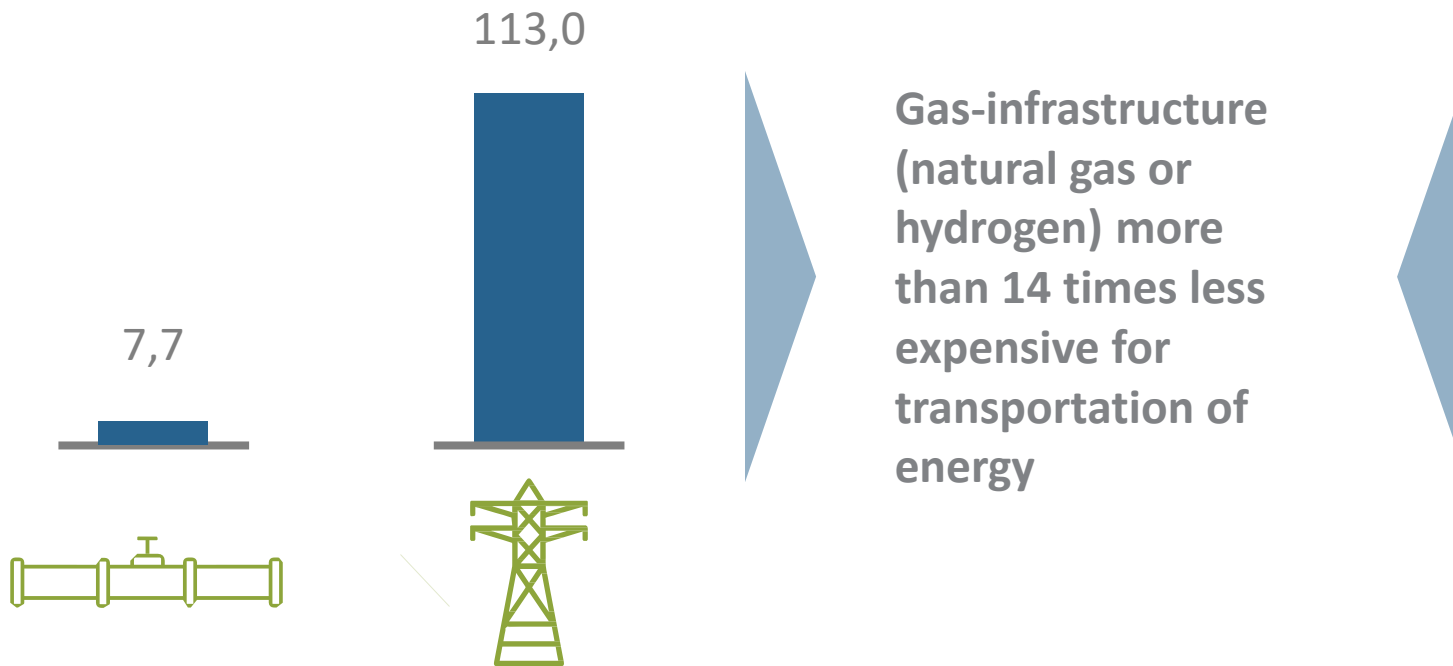
- Investment security
- Green energy off-take
 - PPA
 - Certificates
- Long term reliability
- Overcoming grid congestion
- Flexibility to fluctuating energy

Hydrogen Production offers

- Transport and storage of energy
- Reliant and flexible consumer of renewable electricity
- Range of purposes of use
- Long term investment
- Additionality

- 2.) Realization of new energy distribution networks
- **Hydrogen: most efficient energy transmission – example Switzerland**

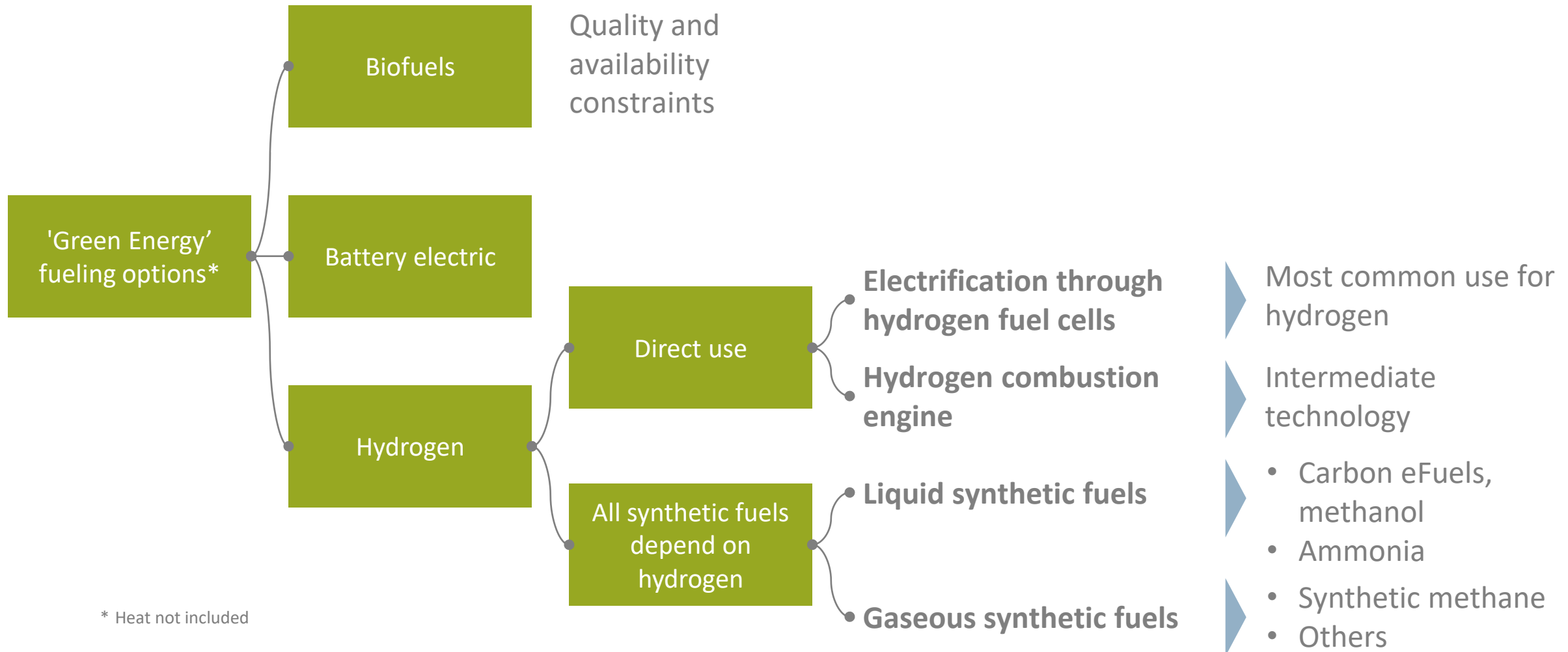
**Transmission cost per MWh, full cost
comparison in Switzerland**
in CHF/MWh



Further advantages of gas versus electrons

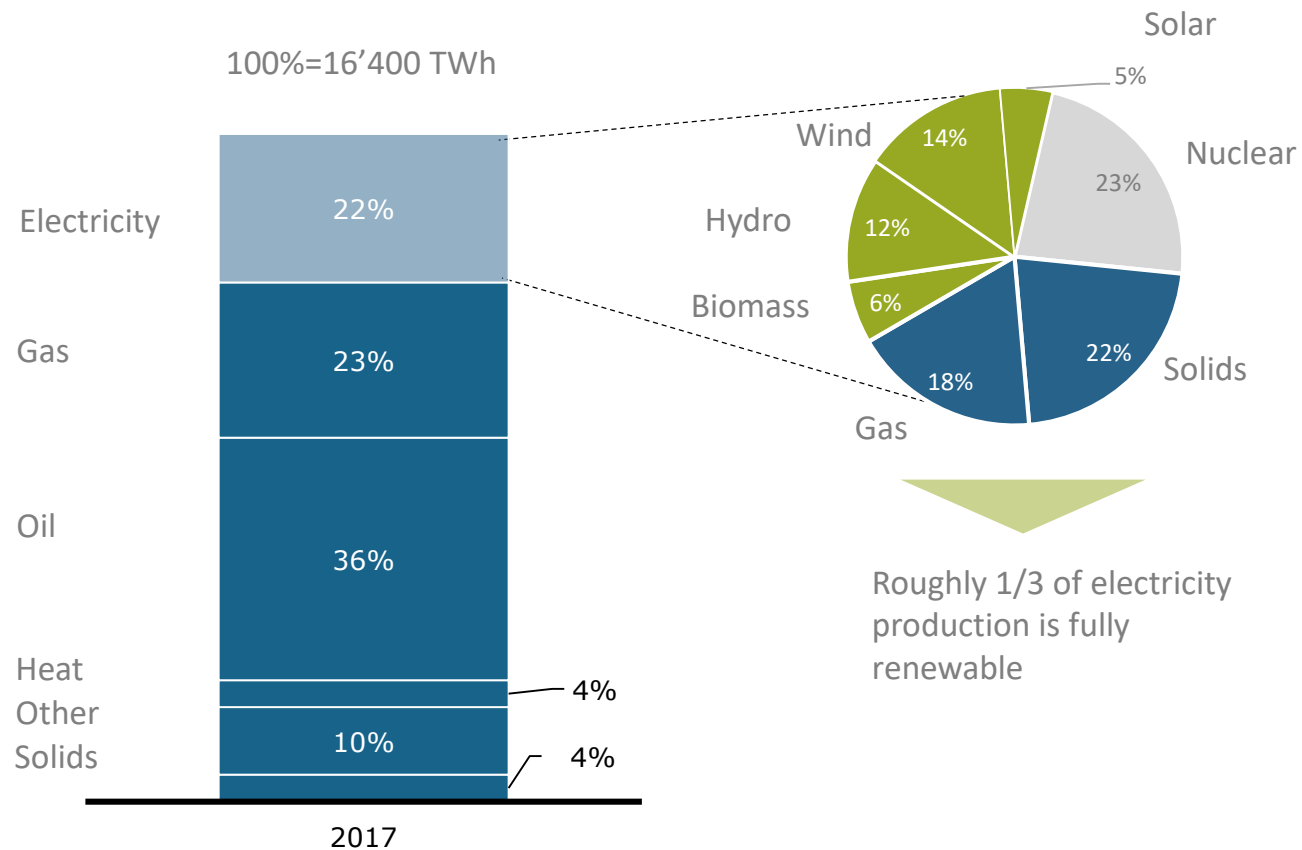
- Storage function
- Infrastructure mostly underground
- Footprint: higher power-density of transport/lower land need
- Lower exposure to weather variance, natural hazards
- Faster permitting processes
- Political acceptance
- Faster/immediate ramp-up possible

- 3.) Decarbonization
- **Hydrogen plays key role – high variety of hydrogen products**



- Successful execution of 'Green Deal' requires 2'000-2'500 GW of additional renewable power generators and 1'000-1'300 GW of hydrogen production

Total European Final Energy Consumption

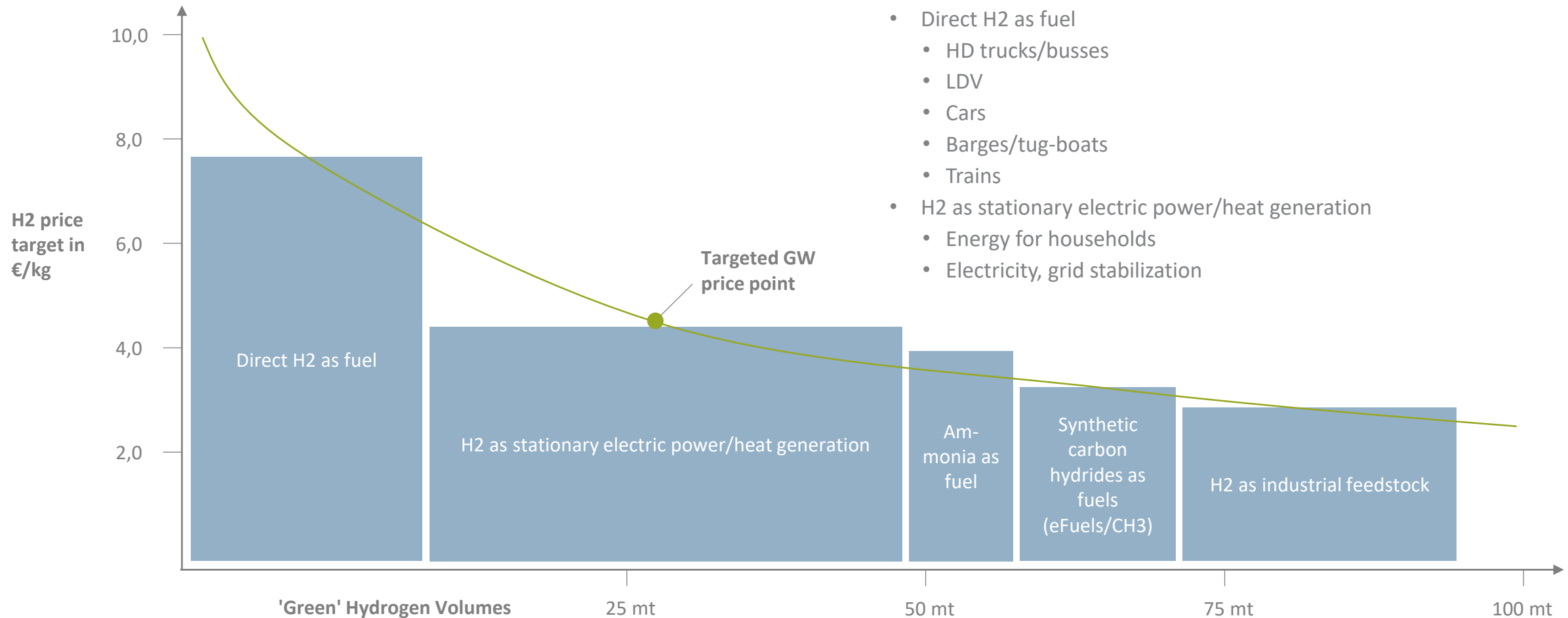


Challenges ahead

- Transform all fossil energy into green energy
- Only four green energy carriers available
 - Biofuels
 - Electricity/batteries
 - Heat
 - Hydrogen (incl. eFuels, eMethanol, ammonia)
- Most of primary energy will have to be produced with electric generators (wind, hydro, solar)
- At least 40-50% to be covered through hydrogen
- Conclusions for Europe
 - 2'000-2'500 GW of additional renewable power generators needed
 - At least 1'000-1'300 GW of hydrogen production and distribution to be installed immediately

- Off-Take Economics – Model Scenarios for Europe in 20 Years
- **Potential ,Green Hydrogen‘ in Europe (total)**

- Demand Curve ‘Green Hydrogen’
- Europe, in million tonnes of hydrogen vs. price in €/kg



Key applications to focus on

- Direct H2 as fuel
 - HD trucks/busses
 - LDV
 - Cars
 - Barges/tug-boats
 - Trains
- H2 as stationary electric power/heat generation
 - Energy for households
 - Electricity, grid stabilization

- **Esbjerg – Hot Spot for first GW Hydrogen Production**

Esbjerg is a seaport town and seat of Esbjerg Municipality on the west coast of the Jutland peninsula in southwest Denmark. By road, it is 71 km west of Kolding and 164 km southwest of Aarhus. With an urban population of 72,044 it is the fifth-largest city in Denmark, and the largest in West Jutland.

Elevation: 11 m

Population: 115,932 (2017) United Nations

According to WEF, Denmark ranks 3rd for the most sustainable countries



- DK is strong regarding
- Political support
- Permitting effc.
- World-leading country in wind energy and wind turbine prod.
- Export ambitions
- Geography

Source: Fostering Effective Energy Transition 2021 edition

Connection to off-takers (HD trucks and shipping): ideal place for pipeline development, 50km to road transportation off-takers, 3km to port of Esbjerg, proximity to Germany/exports



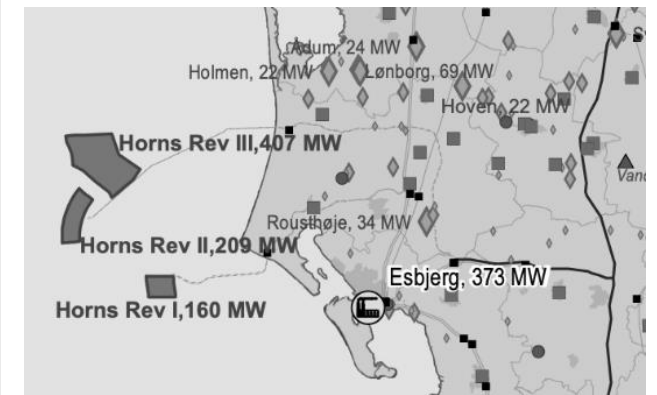
Esbjerg is the central location in one of the two key landing zones in Denmark



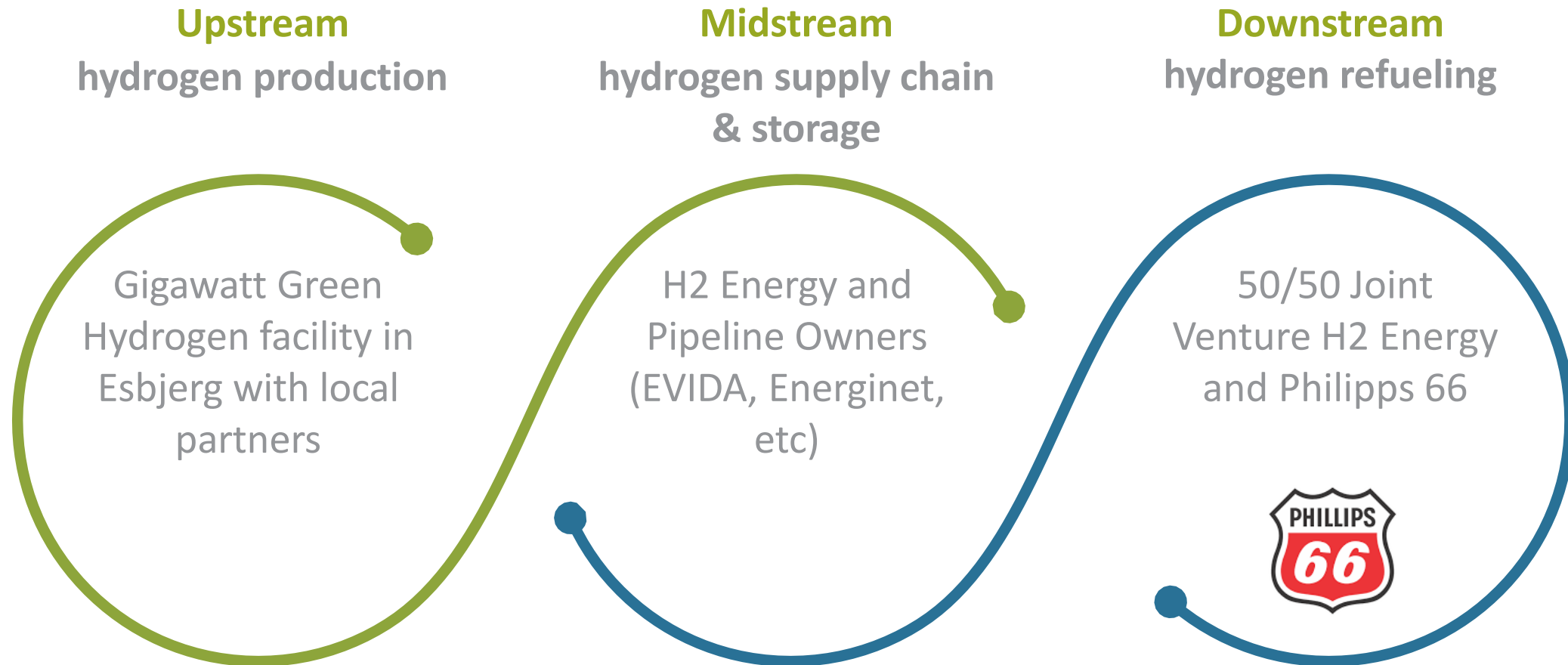
Denmark is located in an area with a shallow seabed and an above-average amount of wind in the North Sea

Denmark has approved a plan to build an artificial island in the North Sea that will be a hub to hundreds of offshore wind turbines, 260m tall, that will generate 10GW, enough energy for 10 million households

Restricted grid capacity of max 0,7GW and power demand leading to electric grid congestions



- Strong European Position with Strong Partners
- **Fully Green Hydrogen Value Chain**



- **Denmark H2 Ecosystem - Overview**
- **Project description**

