



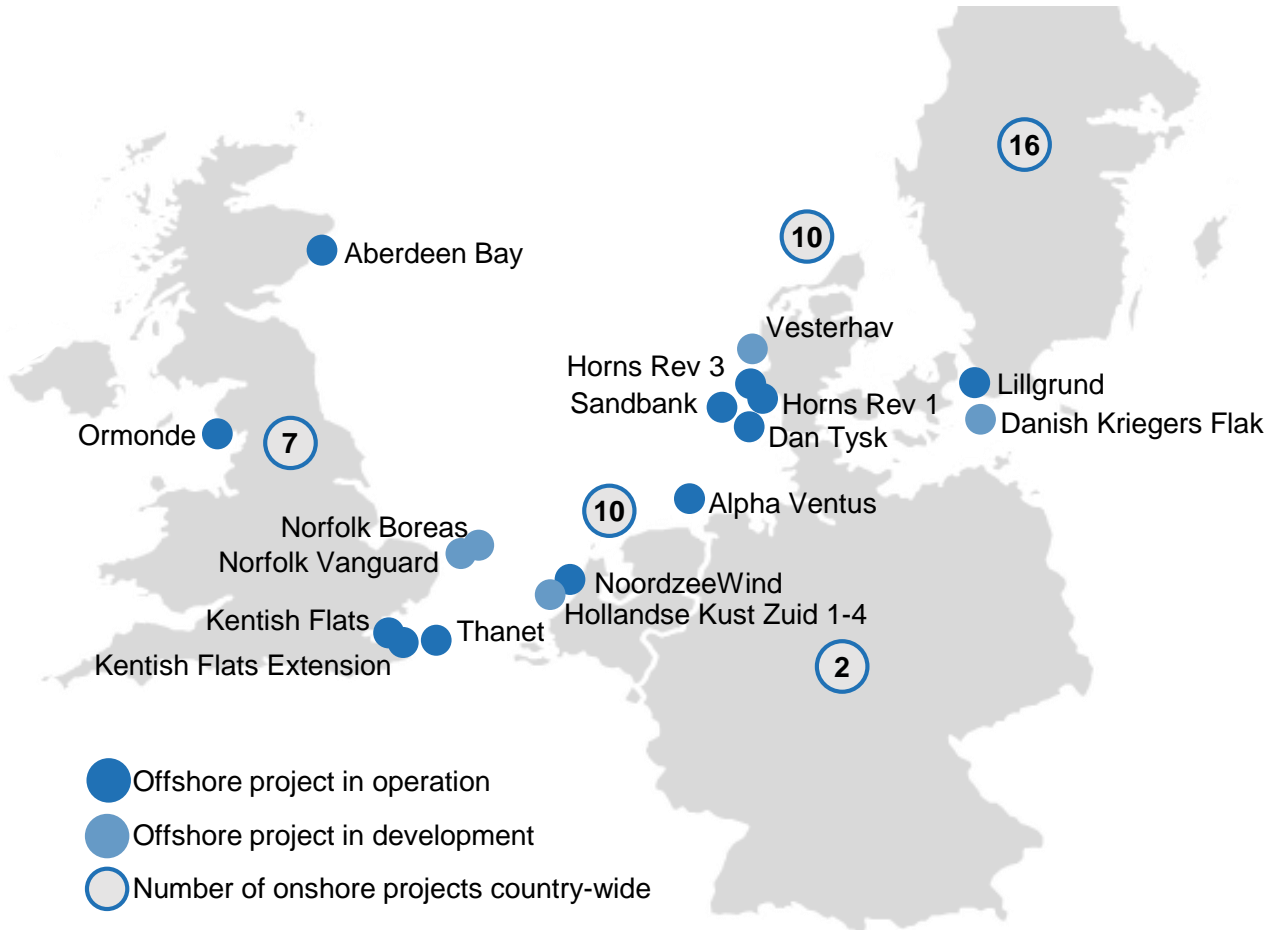
# EIN STARKES GEMEINSCHAFTSPROJEKT: WASSERSTOFF PRODUKTION AM KRAFTWERK MOORBURG

6. Mai 2021

Oliver Weinmann  
Vattenfall Innovation

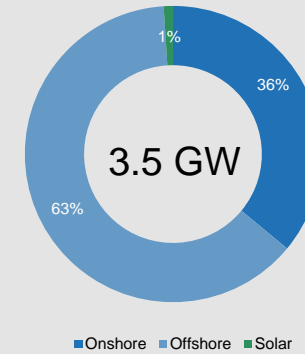
# Vattenfall - significant growth in renewable power generation

## Geographical overview

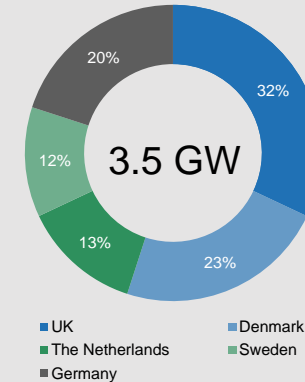


## Operating assets

Split by type of generation



Split by geography



## Under construction and pipeline

> 3 GW

Wind projects under construction

> 6 GW

Wind projects in development

> 1 GW

Solar projects in development

60 MW

Batteries pipeline

as of June 2020

# **Industrial Decarbonization**

**Sector coupling as key to decarbonize industry**

**Assessment on Vattenfall's core markets**

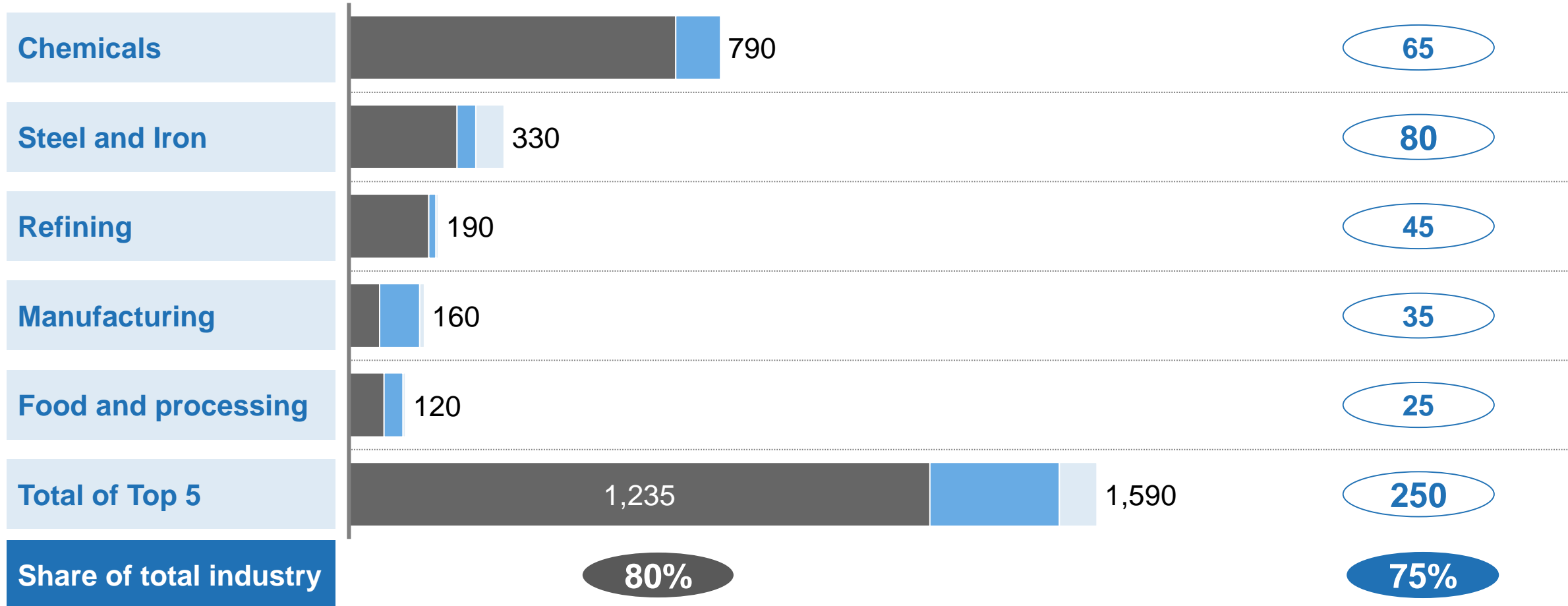


# Top 5 industries consume 80% of the fossil fuel (1,235 TWh) and emits 75% of the CO2

■ Fossil fuel ■ Electricity ■ Other

Energy consumption, TWh

Total CO2 emission, MTons

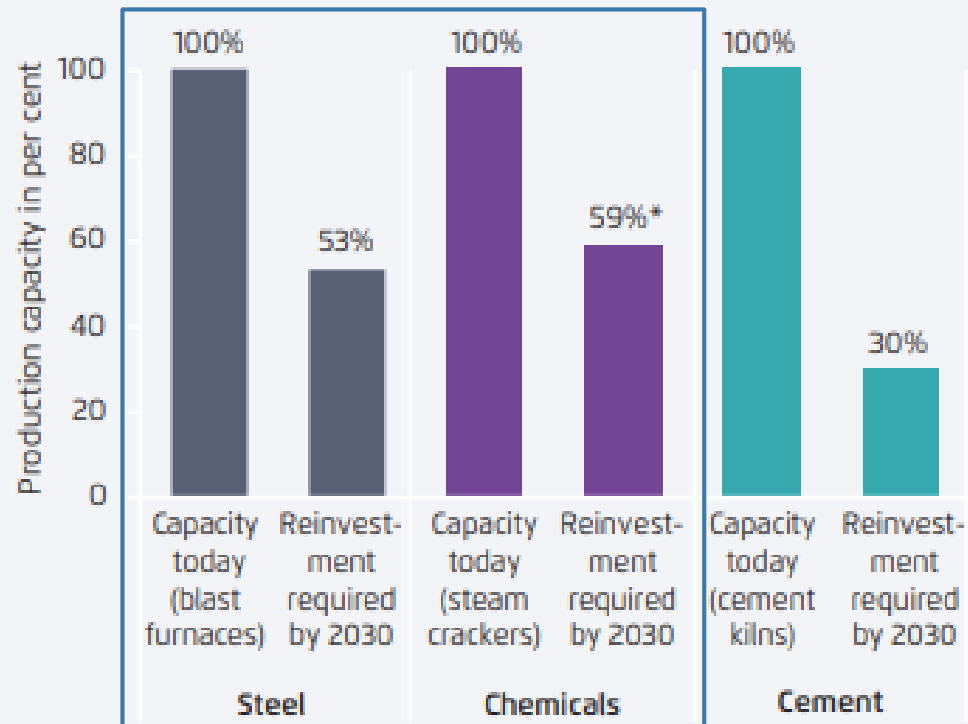


SOURCE: Voorstel voor hoofdlijnen voor het Klimaatakkoord

# Industrial investment needs

## Push for decarbonisation efforts across German industries needed

REINVESTMENT REQUIREMENT OF PRIMARY PRODUCTION CAPACITIES IN GERMANY BY 2030 \*



- Chemical and Steel Industry and Steel with high investment needs short- to mid-term.
- Investment cycles for furnaces 30-40 years – new assets will reach far into a potentially carbon-neutral future. Likely to trigger a strong push for high sustainability requirements
- Investment cycles for chemical assets approx. 15 years – less danger of "stranded assets" due to increasing sustainability requirements

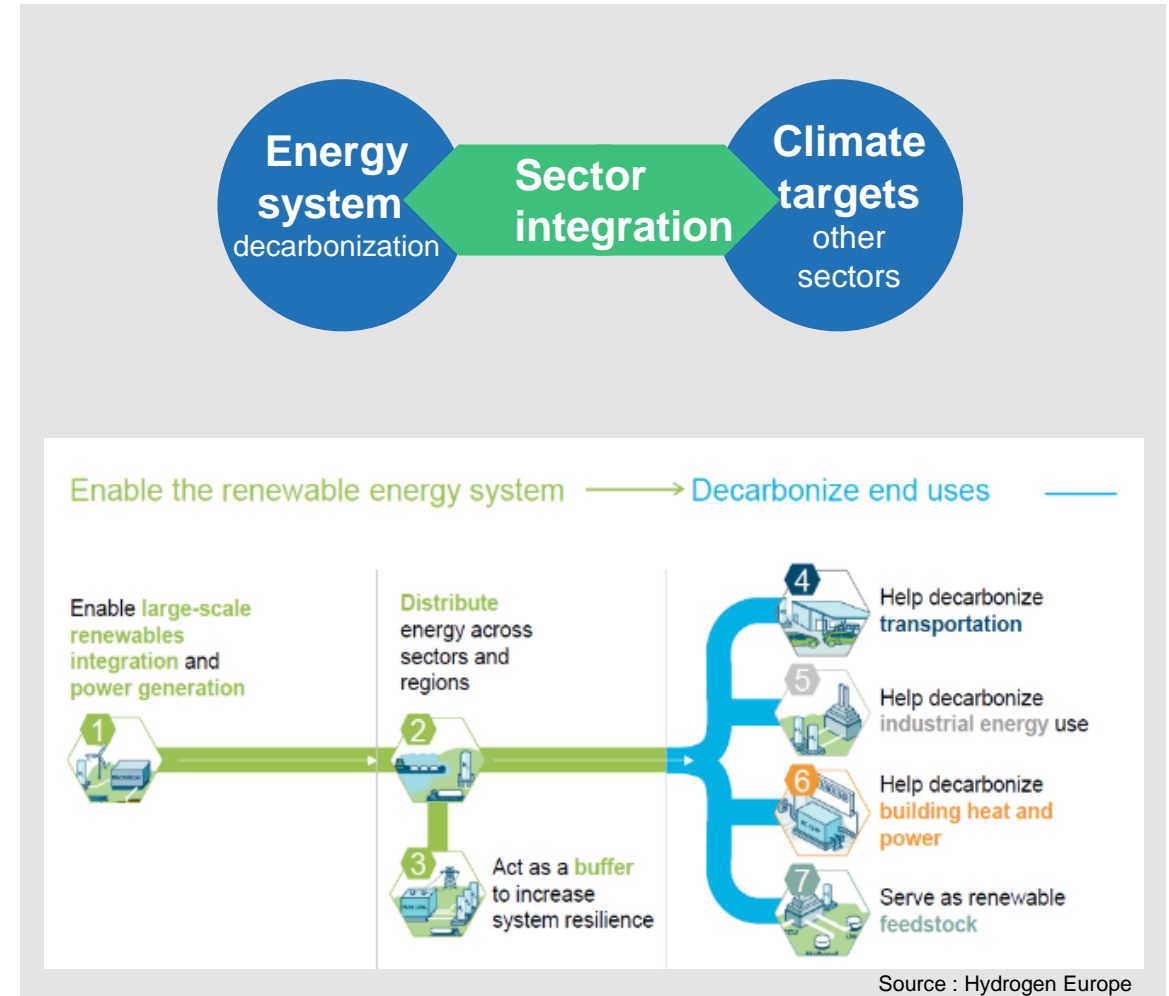
\* Agora Energiewende, Climate Neutral Industry, 12.2019 ([link](#))

# **Focus area: Green Hydrogen**

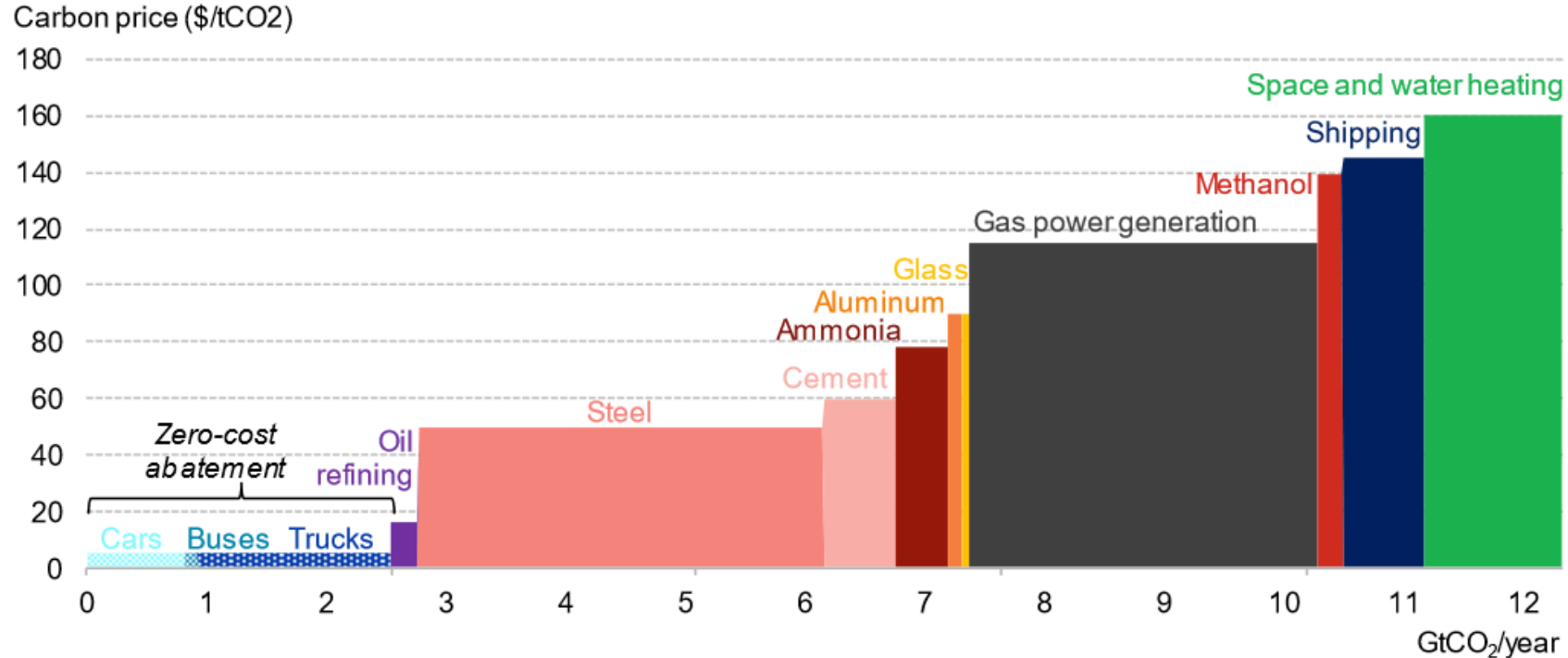
**Green Hydrogen as carbon free energy / feedstock**

# Why is sector integration with green hydrogen important?

- Enable decarbonization in hard to abate sectors like industry, transport, (heat)
- Increase volatile renewable production implies grid congestion and increasing demands for flexibility -> hydrogen production with electrolysis
- Green hydrogen production offers additional value stream for green electricity



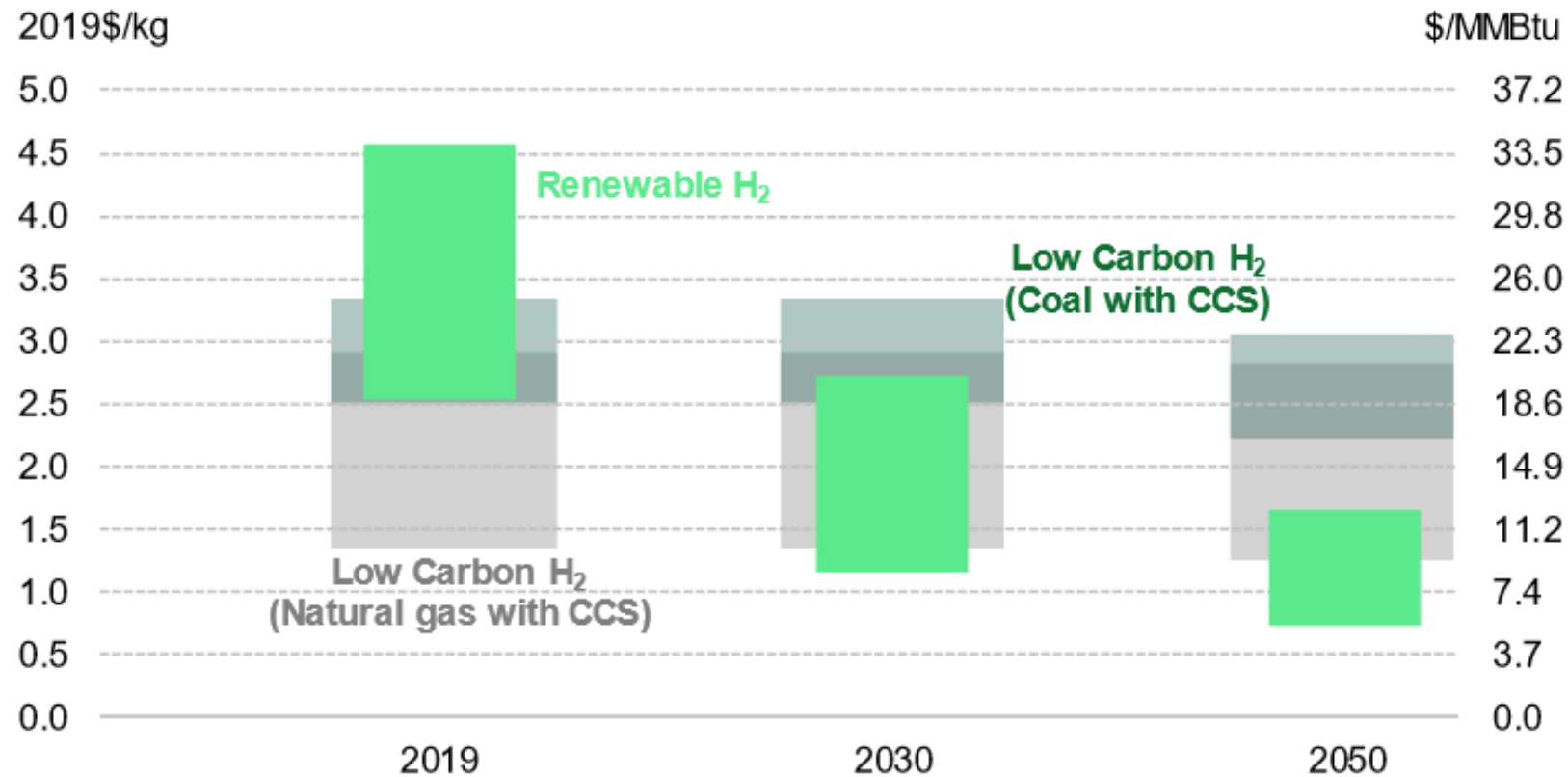
# Marginal abatement cost curve from using \$1/kg hydrogen for emission reductions, by sector in 2050



Source: BloombergNEF. Note: sectoral emissions based on 2018 figures, abatement costs for renewable hydrogen delivered at \$1/kg to large users, \$4/kg to road vehicles. Aluminum emissions for alumina production and aluminum recycling only. Cement emissions for process heat only. Refinery emissions from hydrogen production only. Road transport and heating demand emissions are for the segment that is unlikely to be met by electrification only, assumed to be 50% of space and water heating, 25% of light-duty vehicles, 50% of medium-duty trucks, 30% of buses and 75% of heavy-duty trucks.



# Forecast global range of levelized cost of hydrogen production from large projects (BloombergNEF)



Source: BloombergNEF. Note renewable hydrogen costs based on large projects with optimistic projections for capex. Natural gas prices range from \$1.1-10.3/MMBtu, coal from \$30-116/t.

# Applications for clean hydrogen

*„Electric where possible, hydrogen where needed“*

## TRANSPORTATION



Green hydrogen as fuel for

- ✓ **Public Fuel cell busses**
- ✓ **Fuel cell trains**
- ✓ **Heavy duty trucks**
- ✓ **FCEV Passenger vehicles**

## REFINERIES



- ✓ **Substitution of biofuel additives (e.g. RME) in conventional fuel production by green hydrogen (REDII)**
- ✓ **Synthetic fuels**

## INDUSTRIES



Substitution of industrial process gases by green hydrogen

- ✓ **Steel production**
- ✓ **Ammonia production**

# Vattenfall Initiatives and Projects

# Vattenfall's engagement in hydrogen projects

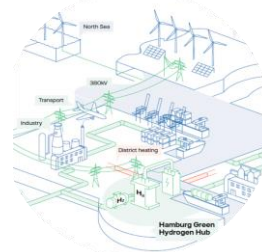
## Partnership between Vattenfall and the industry

Research project for a carbon dioxide free steel industry

**HYBRIT**  
FOSSIL-FREE STEEL

**LKAB**  
**SSAB**  
**VATTENFALL**

Green Hydrogen Hub Hamburg



**VATTENFALL**



Use of CO<sub>2</sub> neutral hydrogen in flexible gas plants



**VATTENFALL**

Large-scale electrolysis as feedstock for industries



**VATTENFALL**

Cooperation in large scale bio-diesel production

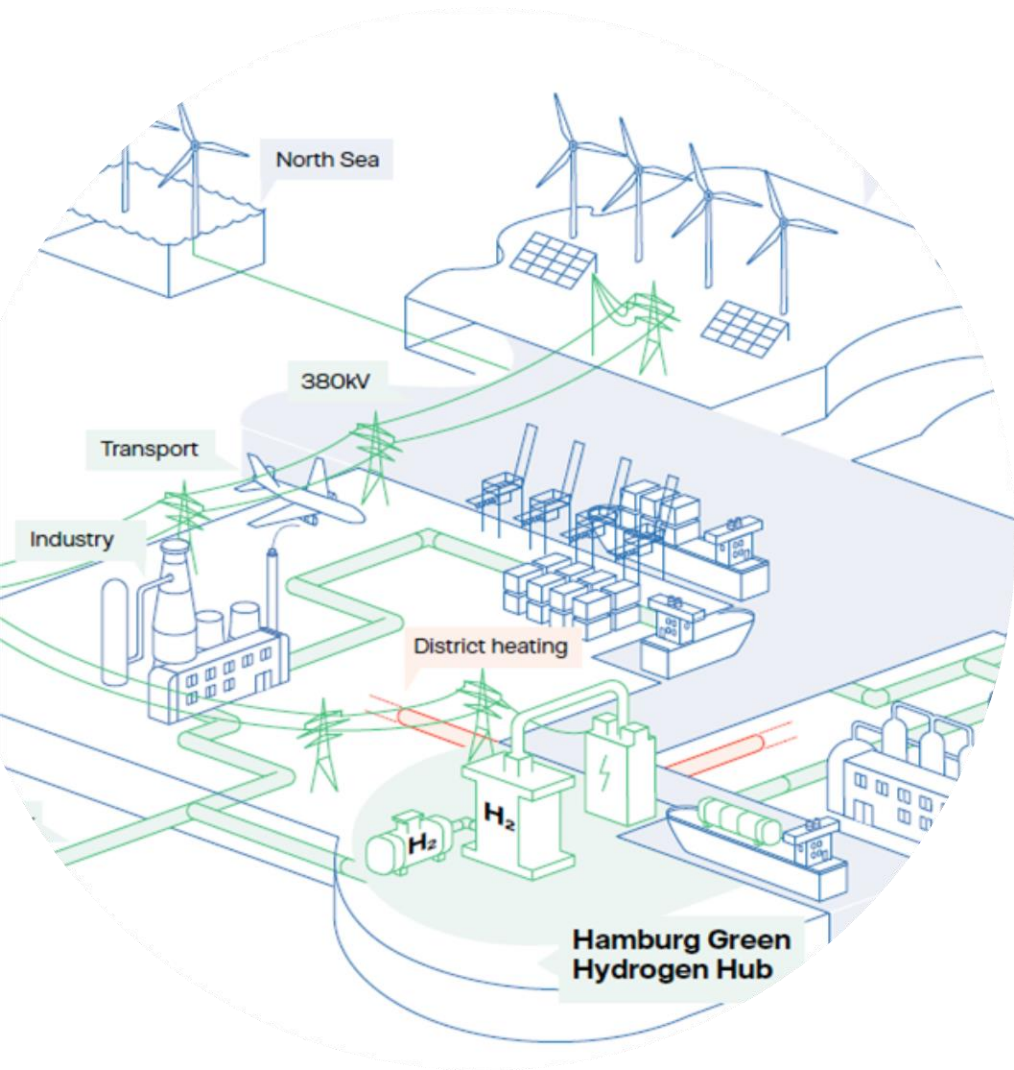


**VATTENFALL**

Various green hydrogen applications for transportation sector



**VATTENFALL**



# Hamburg Green Hydrogen Hub

# Metropolregion und Hafen Hamburg

## Einzigartige Voraussetzungen für hocheffizienten Nucleus der Wasserstoffwirtschaft

Ballungsgebiet für  
Produktion, Schwer-  
und Grundstoff-  
industrie

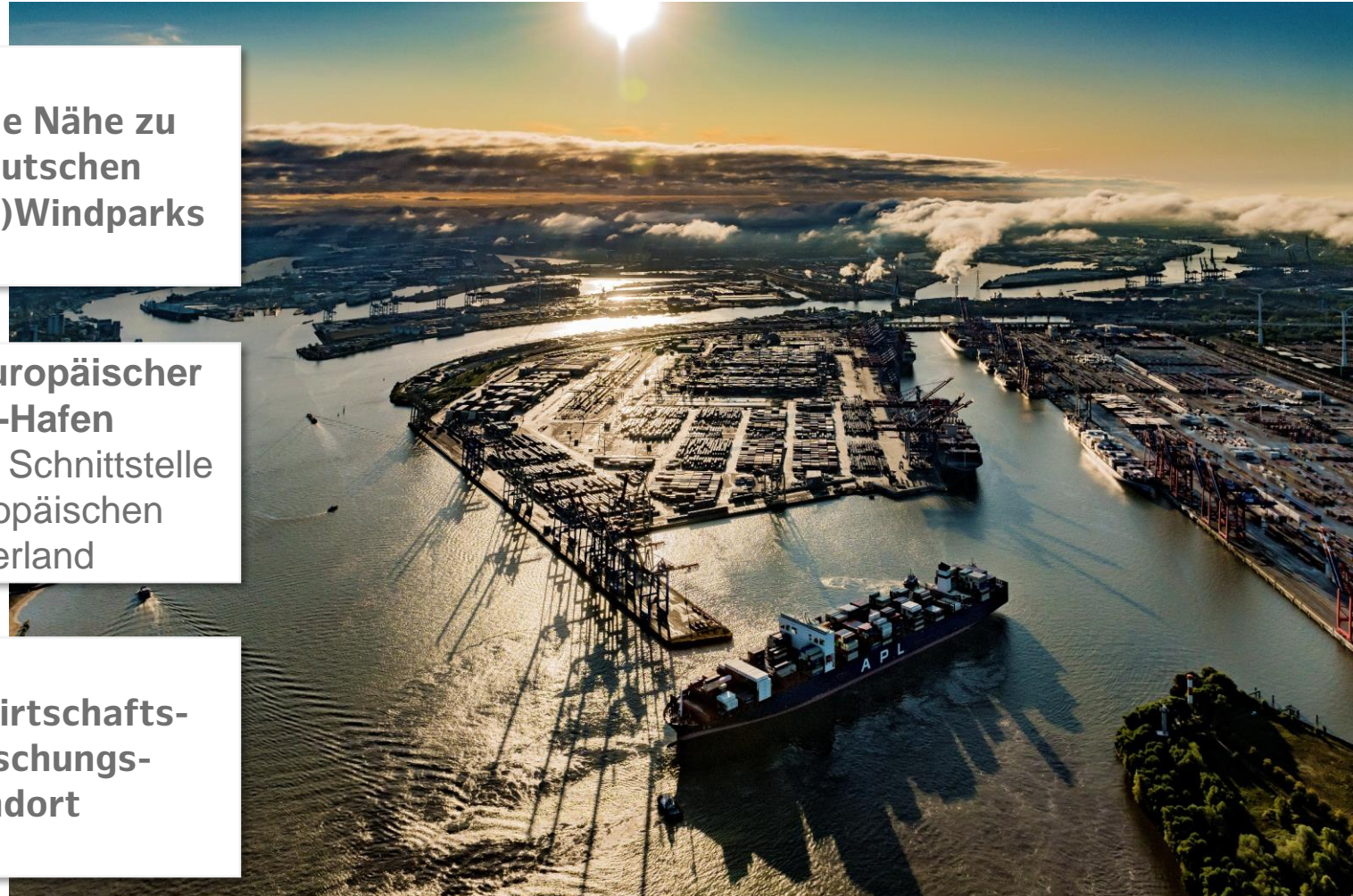
Räumliche Nähe zu  
norddeutschen  
(Offshore-)Windparks

Infrastruktur für See-  
und Pipelineimporte  
von Wasserstoff  
Hafen, European  
Hydrogen Backbone

Größter europäischer  
Bahn-Hafen  
nachhaltige Schnittstelle  
zum europäischen  
Hinterland

Größtes Feld für  
Wasserstoff-  
anwendungen im  
Bereich Schwerlogistik

Starker Wirtschafts-  
und Forschungs-  
standort



# Project pitch: Hamburg Green Hydrogen Hub

## Large-scale industrial and transport decarbonisation through the production and utilization of green H<sub>2</sub>



### ACHIEVEMENT:

Pro-active re-dedication of 1,600 MW hard coal plant for industrial decarbonisation

### OUR WINNING FORMULA:

- exchanging grey- with green hydrogen, mainly in industrial applications (steel and refining; backed by long-term Carbon CfD and REDII), but also heavy transport;
- direct matching of renewables assets and electrolyser via 380 kV TSO grid
- optimal utilization of electrolyser 'waste' streams: oxygen for industry and waste heat for the Hamburg district heating grid (80°C, with HP increased to 180°C)

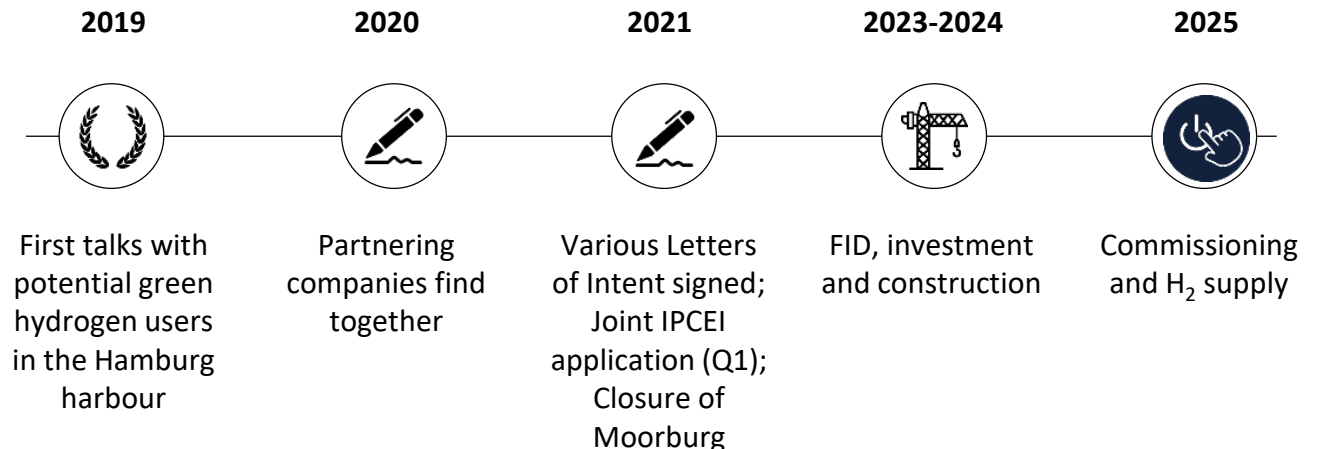
### KEY DATA

Electrolyser capacity	100 MW (+ hundreds of MW scale-up potential)
Grid connection	380 kV (TSO 50Hertz)
Average Production	Ca. 30 tons H <sub>2</sub> per day

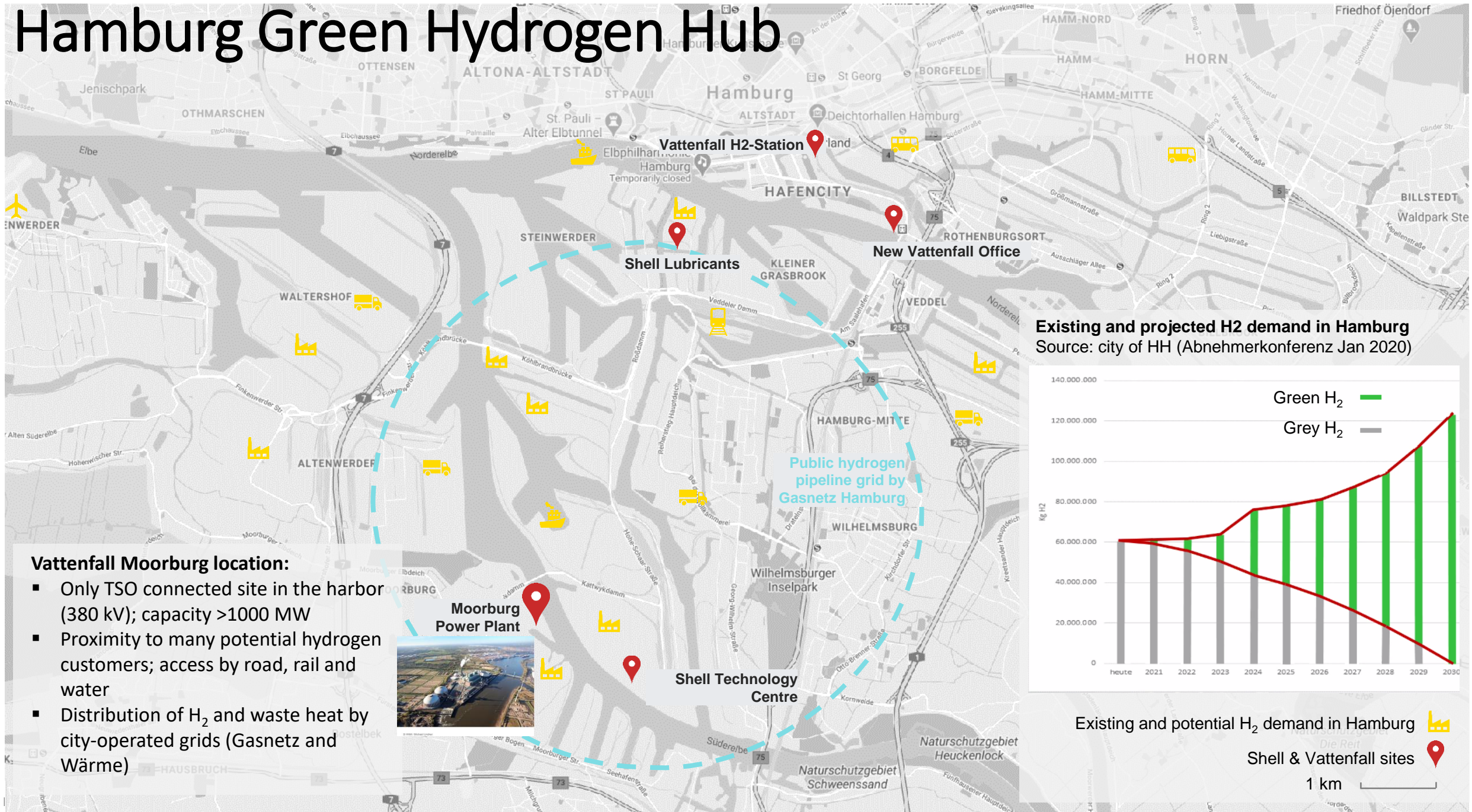
### Four strong parties for success:



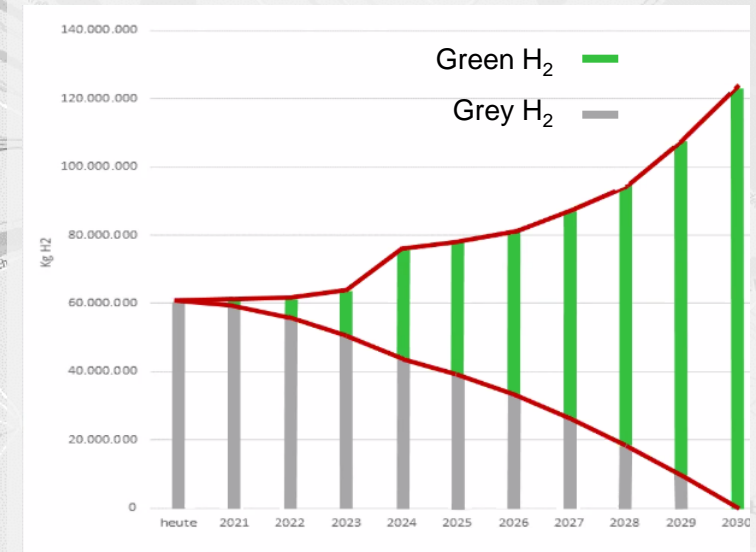
### INDICATIVE TIMELINE



# Hamburg Green Hydrogen Hub



Existing and projected H<sub>2</sub> demand in Hamburg  
Source: city of HH (Abnehmerkonferenz Jan 2020)



## Vattenfall Moorburg location:

- Only TSO connected site in the harbor (380 kV); capacity >1000 MW
- Proximity to many potential hydrogen customers; access by road, rail and water
- Distribution of H<sub>2</sub> and waste heat by city-operated grids (Gasnetz and Wärme)



Moorburg Power Plant

Shell Technology Centre



# Wasserstoffverbund Hamburg

Die gesamte Wertschöpfungskette im Raum Hamburg konzentriert

Erzeugung von grünem Wasserstoff



Infrastruktur zur Vernetzung von Erzeugung und Nutzung



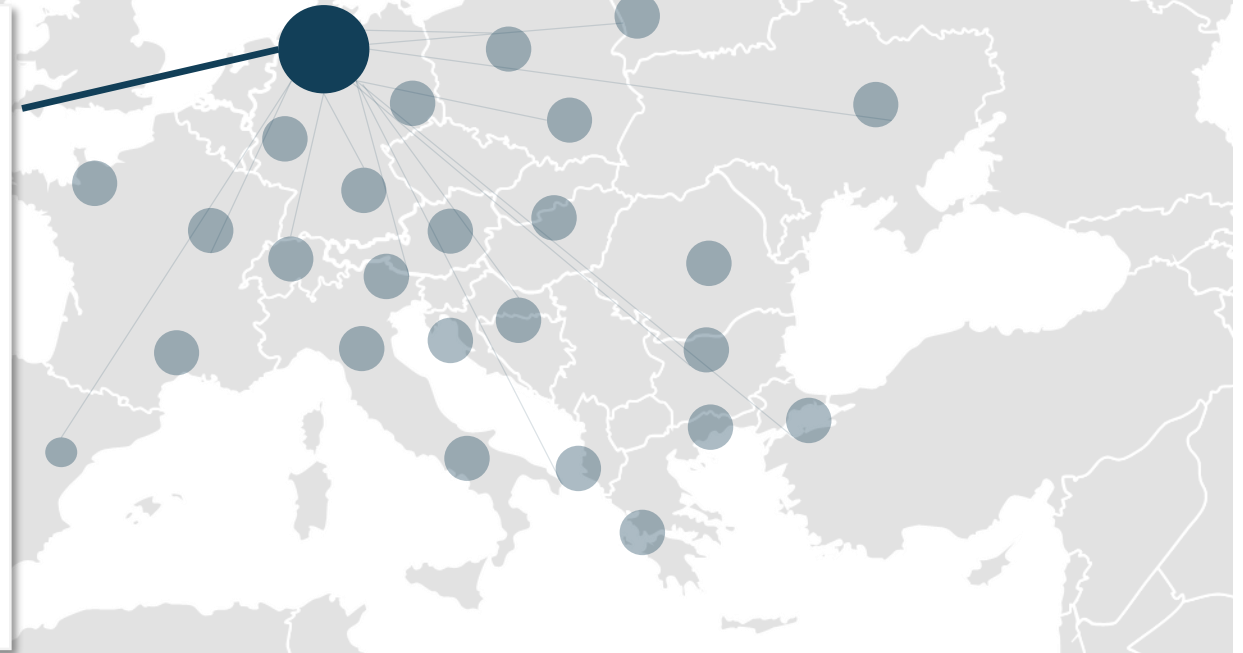
Nutzung von grünem H2 in Industrie sowie Logistik und Mobilität



Alle Mobilitätsbereiche im Verbund: **Straße, Schiene, Wasser, Luft**



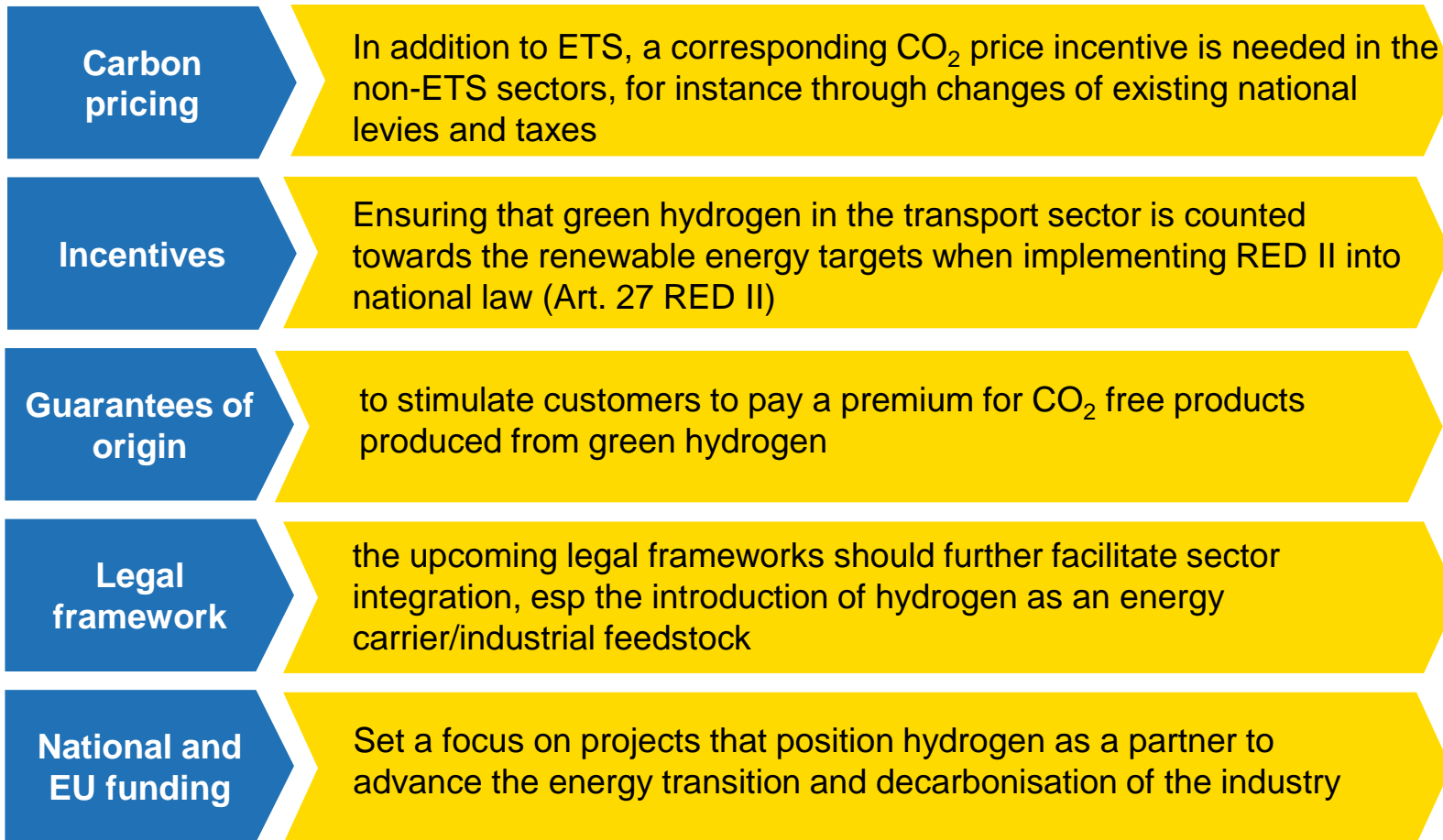
Vorbereitung einer europäischen Skalierung



# What we need

# We are willing to invest into sector integration, but we need a supporting regulatory framework

## Regulatory/funding requirements:



## Market requirements:

- **Sufficient supply (availability) of affordable and fossil-free electricity**
- **Decreasing capex**, eg. cost of electrolysers
- **Demand** for fossil-free hydrogen to expand and mature the market
- **Infrastructure**, such as storage facilities and gas and electricity infrastructure

# Vielen Dank