

# Power-to-X Denmark



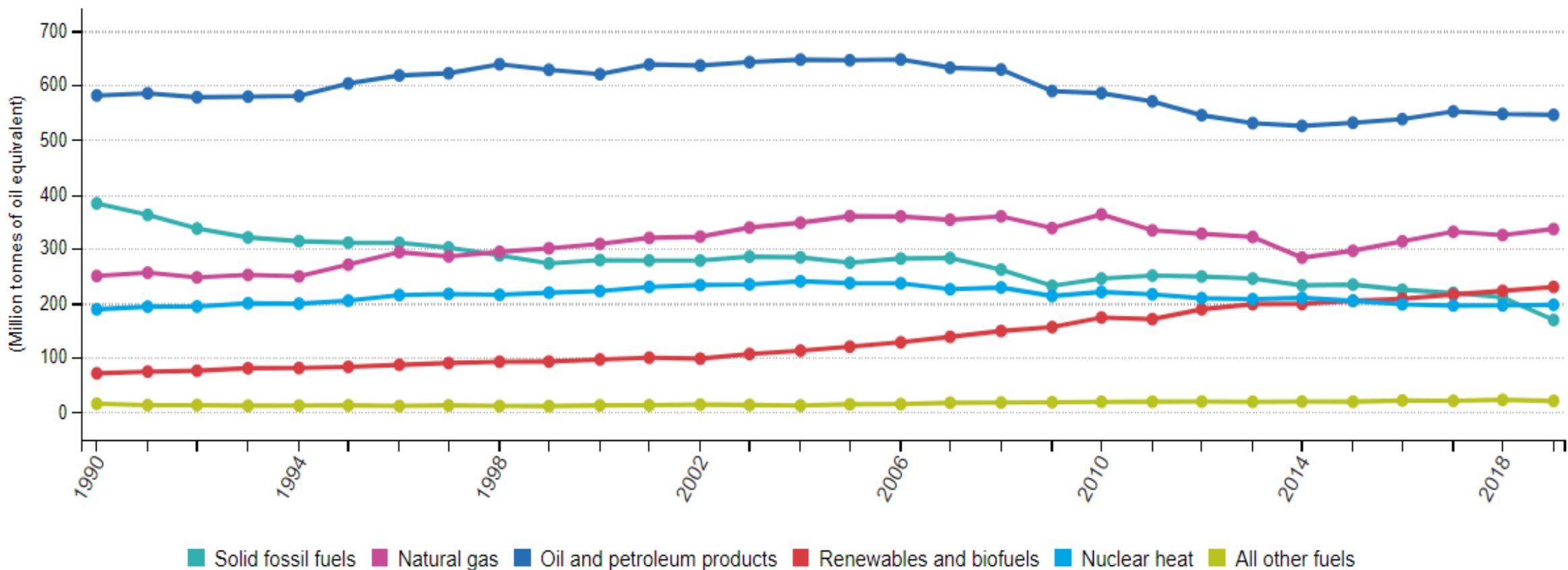
**UDENRIGSMINISTERIET**  
*Invest in Denmark*



**Business opportunities**

# Challenge: Reduction of CO2 emissions

Gross available energy, EU, 1990-2019



Source: Eurostat (online data code: nrg\_bal\_c)

# Part of the solution: Power-to-X

Direct use of green power supply is not suitable for:

1. High temperature industrial processing
2. Airplanes
3. Vessels
4. Long haul trucks and busses
5. Replacement of fossil based hydrogen for the chemical industry etc.
6. In areas where power transmission is a challenge

**The solution: Power-to-X**



# Power-to-X solutions

## 1. Hydrogen for:

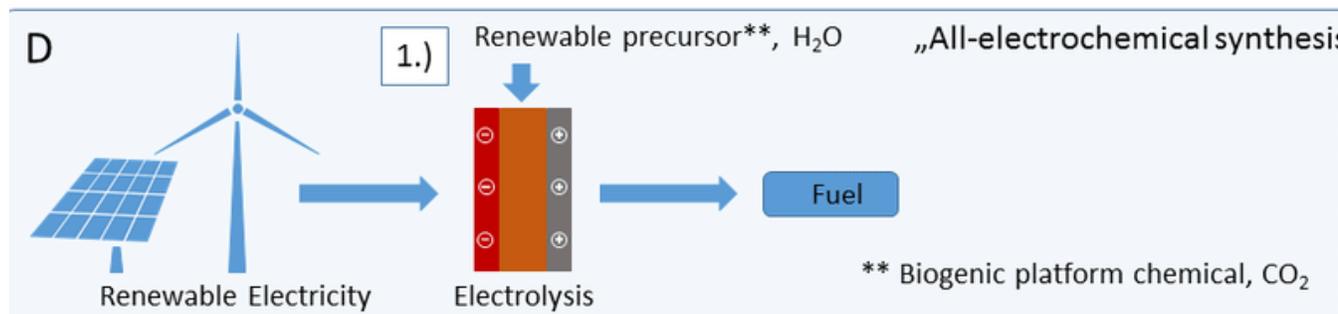
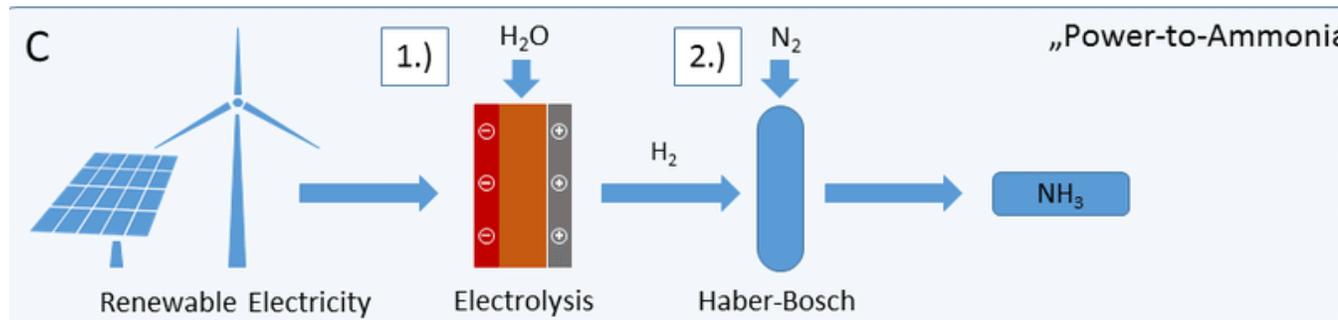
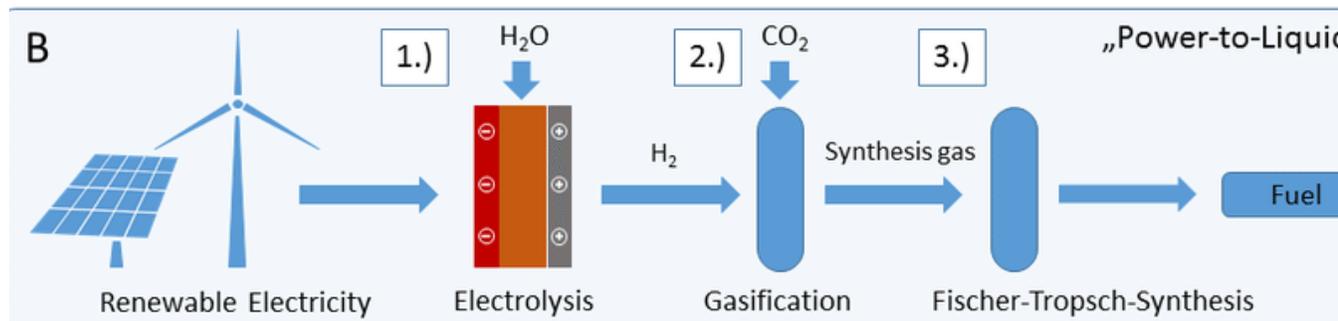
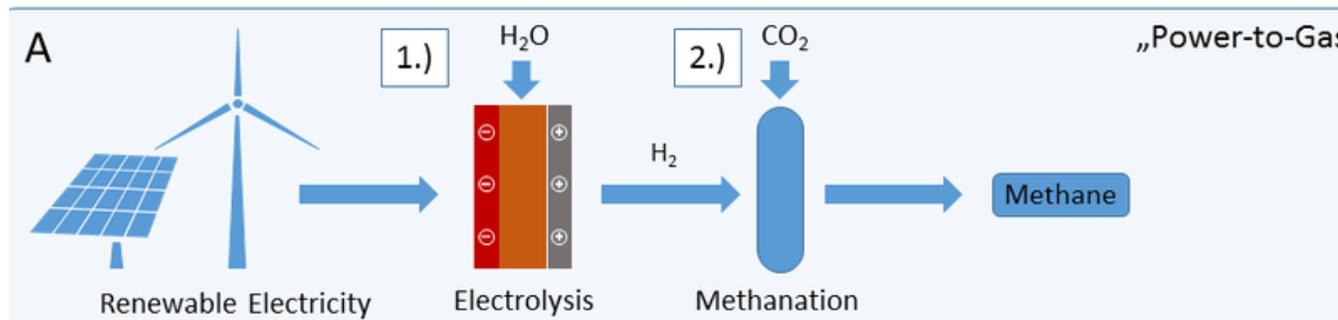
- industrial high temperature processing
- the chemical industry
- trucks, busses, taxis, ferries etc.

## 2. E-fuels for:

- vessels (except short distance ferries)
- airplanes
- combustion powered cars, busses, trucks etc.
- plastic production etc.

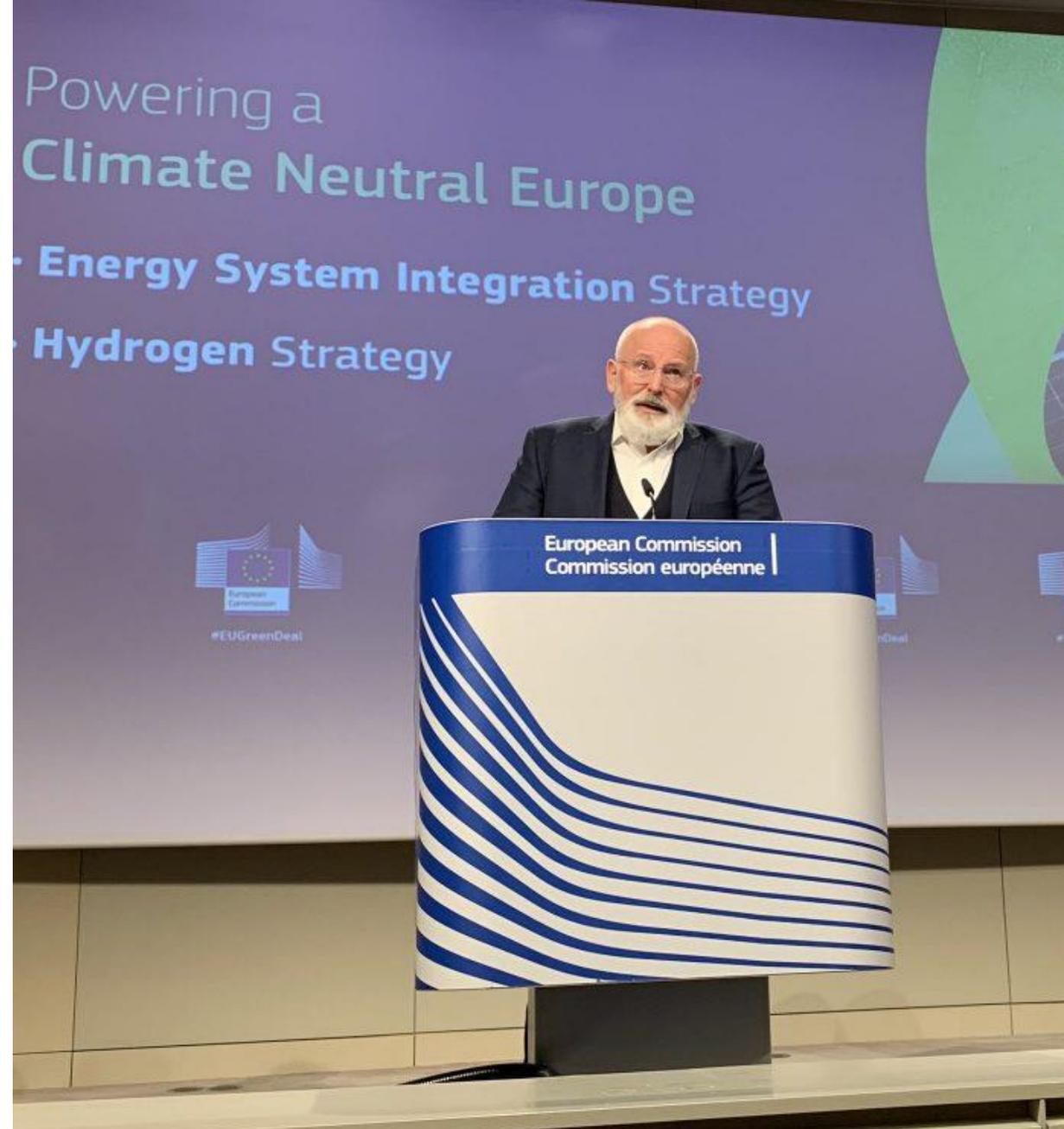
## 3. Green ammonia for:

- the agricultural sector
- freight vessels



# The EU PTX strategy

- ... the EU can turn **clean hydrogen** into a viable solution to decarbonise different sectors over time ...
- ... installing at least **6 GW** of renewable hydrogen electrolyzers in the EU by **2024** and
- ... and **40 GW** of renewable hydrogen electrolyzers by **2030**



# PtX - Why Denmark?

- **Wind power world leader** (48% wind power, 2020)  
– and fast increasing wind and solar power capacity
- Some of the **lowest power prices in Europe** (non-household consumers)
- **70% CO2 emission reduction target by 2030**
- **Green power** and sites available for PtX
- Salt caverns available for green hydrogen **storage**
- **Strong players** working with PtX
- **Develop** in Denmark – implement globally
- Bordering with **the future huge German market for green hydrogen**
- Make use of PtX **waste heat** for district heating (improved business case)



# VERY COMPETITIVE DANISH COST OF POWER

Electricity prices for non-household consumers, first half 2021  
(EUR per kWh)



All Danish power expected to be renewable by 2027 (wind, solar, biomass)

Note: data not available for Sweden

(\*) This designation is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo Declaration of Independence.

Source: Eurostat (online data codes: nrg\_pc\_205)

# The Danish PtX Strategy

- DKK 1.25 billion for PtX fuel production support
- 14 initiatives to strengthen the use of PtX fuels
- Increased production and consumption of PtX fuels to be used for transport, industry and **export**
- Denmark has excellent conditions for production of PtX fuels, based on availability of green power
- The Government aims at establishing 4 - 6 GW of PtX capacity by 2030

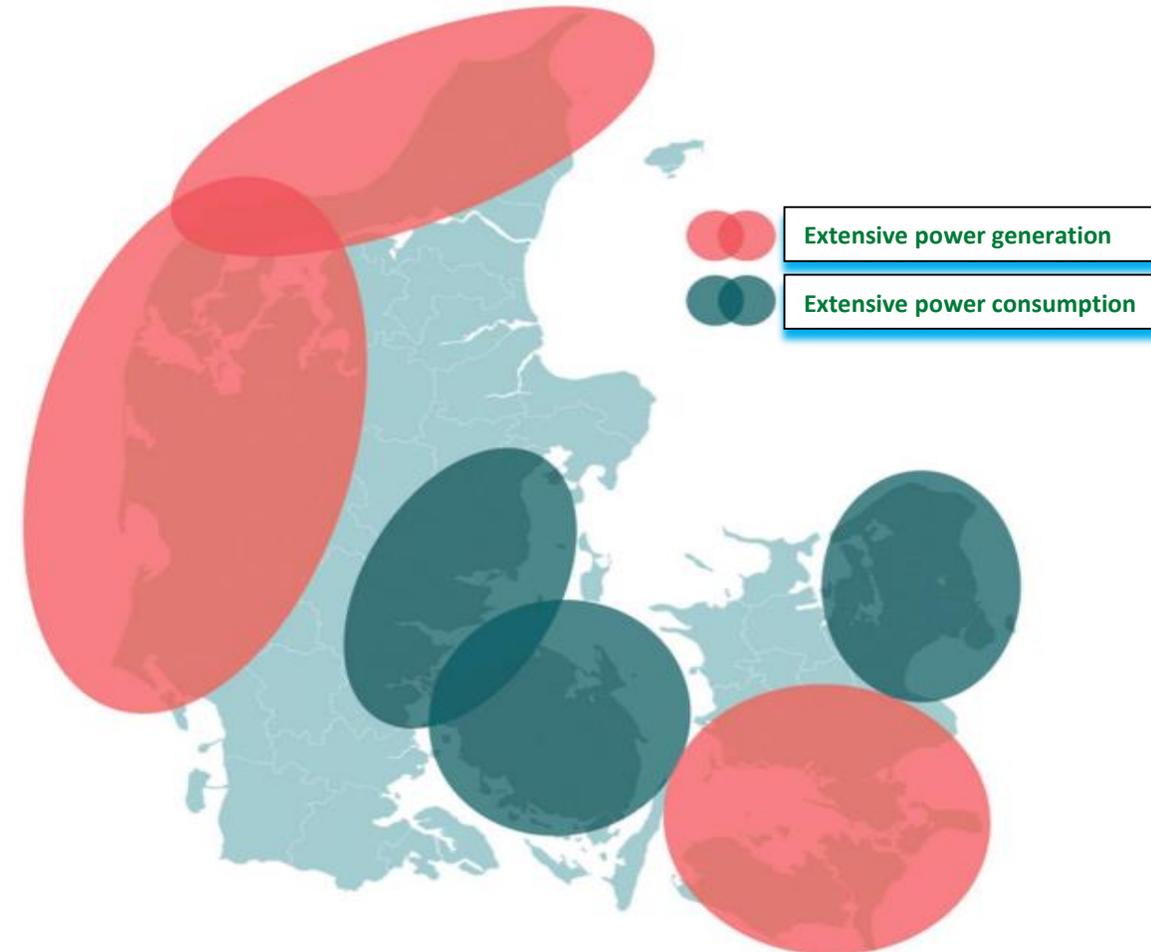


“The world is crying out for green fuels. The demand for being able to sail, fly and produce climate-friendly is enormous, and Denmark has the potential to deliver. We are now investing heavily in technology that can convert our wind turbine power into fuels that can be poured into the tank of a ship or an airplane. It is a crucial step for Denmark's green transition, but the goal is also to help the rest of Europe to say goodbye to fossil energy,” says the Danish Minister of Climate, Dan Jørgensen.

# 14 Danish PtX initiatives

1. DKK 1.25 billion for PtX fuel production support
2. Improved EU PtX regulation
3. Safety regulation etc. to be adapted to PtX projects
4. **Establishment of hydrogen pipelines**
5. Energinet (power and gas TSO) and Evida (gas distribution grid operator) to be in charge of the hydrogen pipelines
6. DKK 344 million for PtX development
7. Improved access to funding and export financing
8. Support for PtX development cluster in South Denmark
9. Support for international PtX collaboration
10. Support for the EU “Fit-For-55” ambitions
11. **Support for biogenic CO2 capture and usage etc.**
12. Analysis of the potential for green fuels for Danish ports
13. **Lower power tariffs at sites with easy access to power**
14. **Direct power lines from solar and wind farms to PtX facilities**

Source: Future Green Fuels (DK Government PtX Strategy), Dec. 2021.



**Power availability and  
power consumption zones, Denmark**

Source: The Danish Government's Strategy for Power-to-X, Dec. 2021

# DANISH TSO (Power and Gas) strategy

- The potential for offshore wind power capacity is **40 GW** in the Danish part of the North Sea
- By 2040 the Danish electricity consumption is expected to be the equivalent of **13 GW** of offshore wind power capacity

ENERGINET

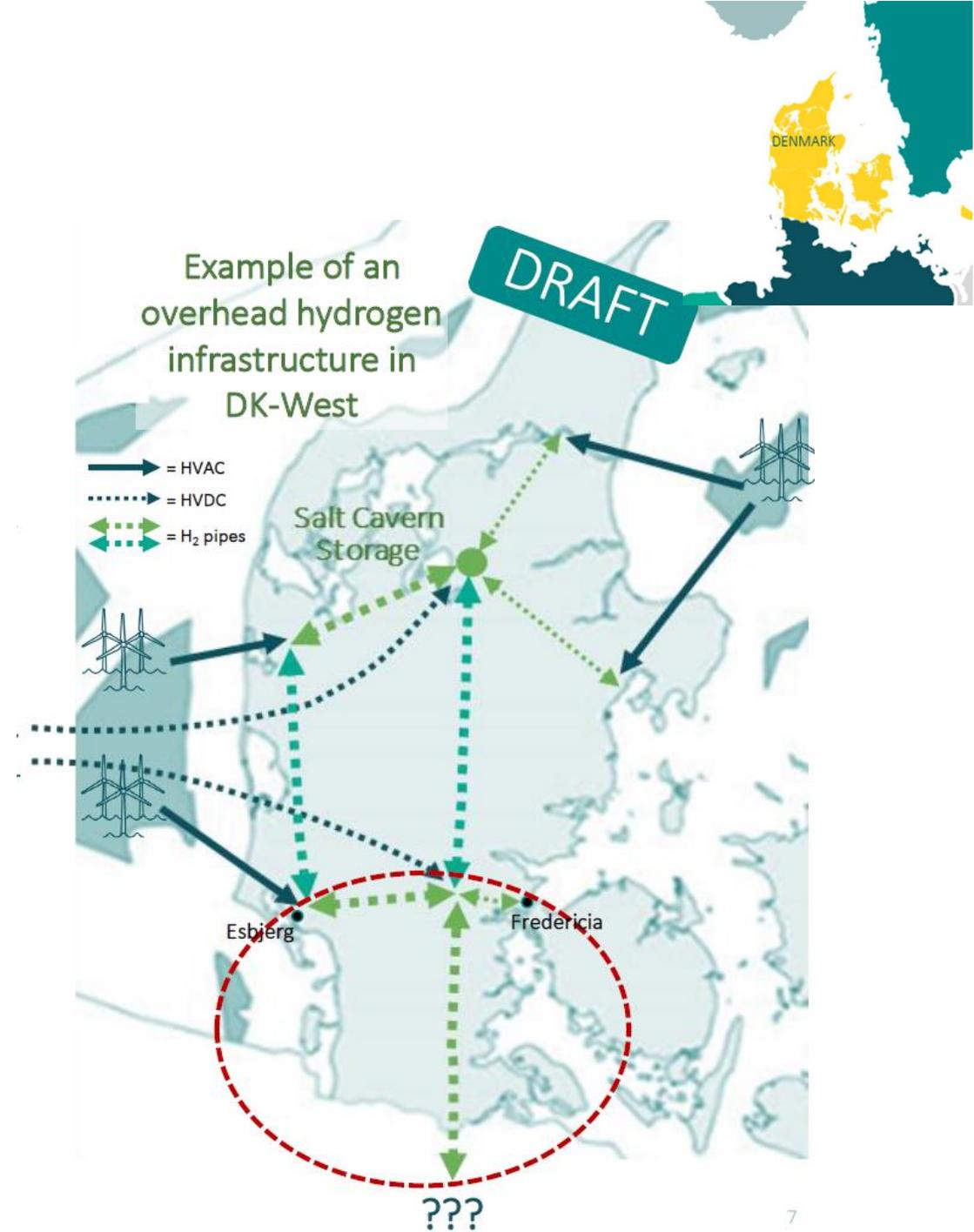
STRATEGY

NEW  
WINDS

# The EnergiNet Action Plan

- **Energy Intense Zones**
  - Large wind projects off the west coast of Denmark
  - Large supply of wind power directly for PtX without the need for transition through the power grid
- **Hydrogen Infrastructure**
  - Construction of a hydrogen pipeline grid
- **Green fuels production**
  - Production of green fuels on the basis of hydrogen and CO2
    - Using CO2 from industries (i.e. biogas plants, concrete production, waste incineration plants etc.)
- **Green Certificates**
  - Insuring that the energy used for producing the hydrogen can be certified 100% green

Source: Energinet presentations



# GREEN HYDROGEN EXPORT TO GERMANY

- Energinet and Gasunie pre-feasibility study, 2021
- Transporting hydrogen via a pipeline from Esbjerg or Holstebro in **Denmark to Germany**
- A connection can be established in a cost efficient fashion by **repurposing existing gas pipelines**
- Gasunie and Energinet want to unlock the **export potential for green hydrogen from Denmark to Germany**
- The analysis indicates that **10-25% of the future German hydrogen demand can be imported from Denmark**

Source: Energinet web-site, 2021



# Ptx Projects IN Denmark

1. **H2RES, 2 MW** (Ørsted, Everfuel, NEL, Green Hydrogen, DSV, Energinet)
2. **Green Fuels for Denmark, 1.3 GW** (Ørsted, CPH, Maersk, DSV, DFDS, SAS)
3. **Power2Met, 10 – 30 MW** (European Energy, AU and partners)
4. **Green CCU Hub, 120 MW** (European Energy, Aalborg Port, Blue World)
5. **Green Hydrogen Hub, 1 GW** (Eurowind, Energinet, Corre Energy)
6. **Blue Seal, 50 MW** (Ballard)
7. **Green Lab, 250 MW** (Green Lab and various partners)
8. **HySynergy, 1 GW** (Everfuel, Crossbridge Energy, ...)
9. **HØST, 1 GW** (CIP and partners)
10. **REDDAP, 10 MW** (Skovgaard, Vestas, Haldor Topsøe)
11. **Green HyScale, 100 MW** (Green Lab, GHS, Lhyfe, Siemens, Equinor, ...)
12. **H2 Energy, 1 GW** (H2 Energy)
13. **Eurowind, 2 x 35-50 MW** (Eurowind)
14. **European Energy, 6 – 12 MW** (European Energy)
15. **Linde Gas, 100 MW** (Linde Gas)
16. **European Energy, 100+ MW** (European Energy)
17. **Vordingborg Biofuels, ? MW** (Haldor Topsøe, Biofuel Technology, ...)
18. **Aalborg, 300 – 400 MW** (CIP, RenoNord, Aalborg Forsyning)
19. **HyBalance, 1.2 MW** (Air Liquide, Cummins, Hydrogen Valley, ...)
20. **CCU Biogas, 11 x 36 MW** (Nature Energy, Biogas Clean)

**XXX:** Completed projects, **YYY:** Projects under construction, **XXX:** Announced



# Maersk – Green fuel powered vessels

- AP Moller Maersk to launch the world's first carbon neutral liner vessel by 2023
- Fuel: Carbon neutral methanol
- In Q1 2024, Maersk will introduce the first in a series of 12 large ocean-going container vessels capable of being operated on carbon neutral methanol
- Maersk has decided to install dual fuel engines in all future new builds
- A range of fuels will be available to tackle the CO2 emission challenge. In addition to methanol, Maersk noted the possibility of alcohol-lignin blends and ammonia
- Maersk aims to have cut CO2 emissions by 60% by 2030 and achieved carbon neutrality by 2040



# DFDS - hydrogen ferry Project

- A group of companies is developing a 100% green hydrogen powered ferry for DFDS' Oslo-Frederikshavn-Copenhagen route
- Green hydrogen to be produced by a offshore wind energy-powered electrolyser plant in Greater Copenhagen
- Ferry powered by electricity from a 23 MW hydrogen fuel cell system
- Partnership: DFDS, ABB, Ballard Power Systems Europe, Hexagon Purus, Lloyd's Register, KNUD E. HANSEN, Ørsted and Danish Ship Finance



**ABB**

**BALLARD**



HEXAGON  
PURUS



Lloyd's  
Register

**Ørsted**

# The Danish PtX ecosystem – corporate players

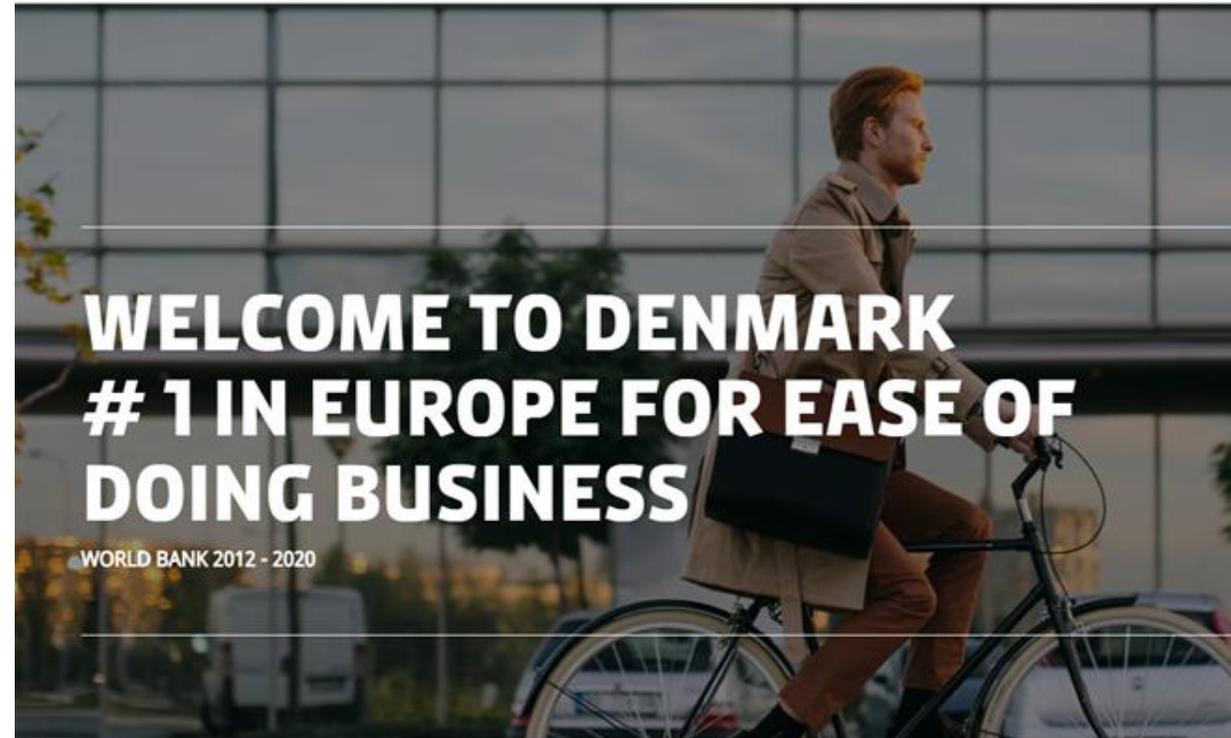
Danish	International



# Our job is to assist you

If you a foreign company (HQ in another country than Denmark), we are at your disposal and our services include:

- Tailor-made **information** and industry insights
- Comprehensive benchmarking **analyses**
- Advice on general and sector-specific **framework conditions** in Denmark
- **Contact to potential partners**, research communities, public authorities and the private sector
- Customised **fact-finding tours**
- **Guidance** on setting up a company in Denmark
- Selected **aftercare** programmes to grow your business once you are here
- Services are **free of charge**



**Maria Hilligsøe  
Stubberup,**  
Special Advisor, PtX



**Kim Schultz,**  
Special Advisor, PtX



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# Q&A

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