



EMBASSY OF DENMARK
Seoul

POWER-TO-X (P2X) IN DENMARK

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BEFORE WE DIVE DEEP...

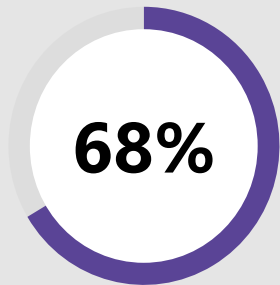


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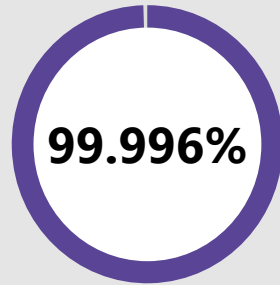
CLEAN AND STABLE ELECTRICITY SUPPLY

STATUS

RENEW POWER IN POWER
CONSUMPTION



SECURITY OF
SUPPLY

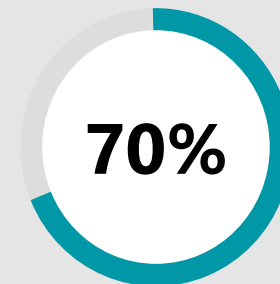


TARGETS

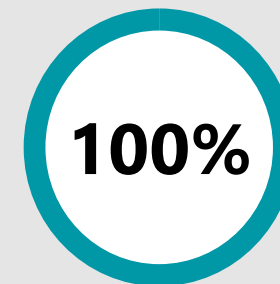
GREEN POWER
IN 2030



CARBON REDUCTION
IN 2030



CLIMATE NEUTRALITY
IN 2045



CARBON REDUCTION
IN 2050



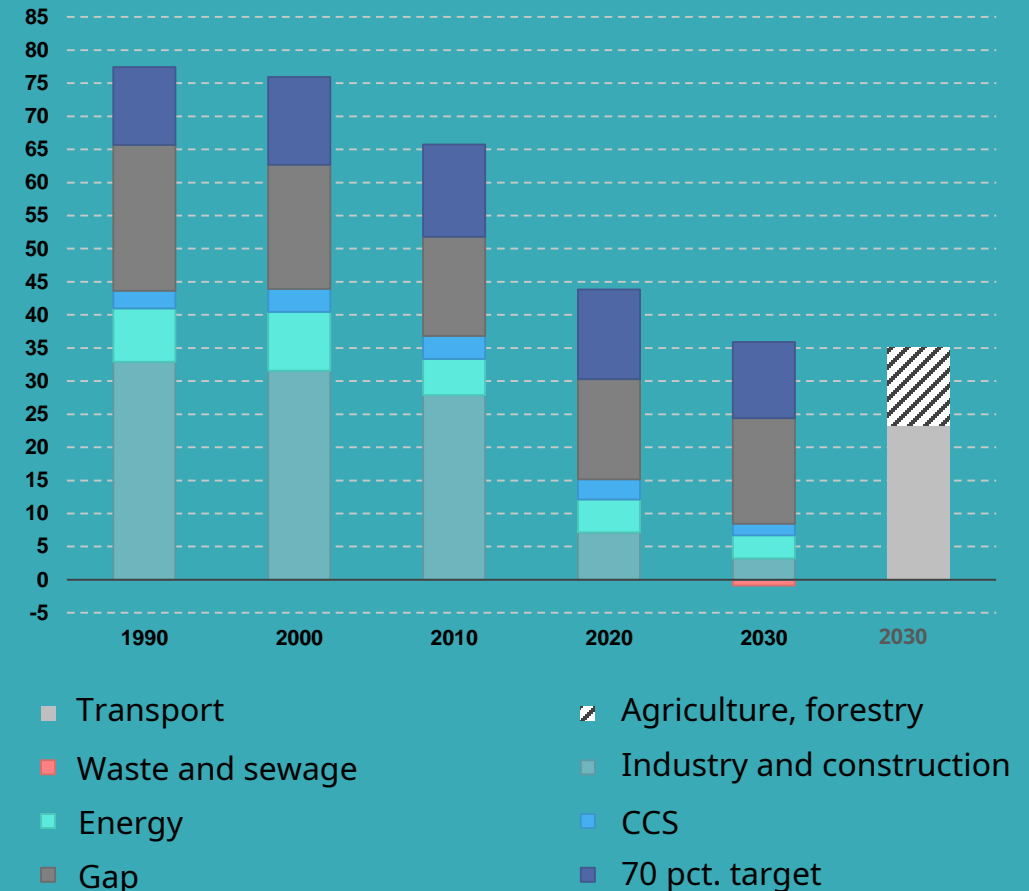
EMISSIONS ARE DECLINING

- But not in all sectors

- The green transition is progressing in the **energy sector** and in the **industry**
 - Further reductions in these sector are limited and costly.
- Reaching the targets in 2030, 2045 & 2050 requires reductions or compensation in hard-to-abate-sectors especially **transport** and **agriculture**
- Direct electrification solves part of the challenge in **transport sector** and **industry**
 - However there is a need for renewable fuels
- **P2X** is expected to play a large role within **shipping, aviation and some industries**

Total national emissions

million ton CO₂e





THE DANISH P2X-STRATEGY



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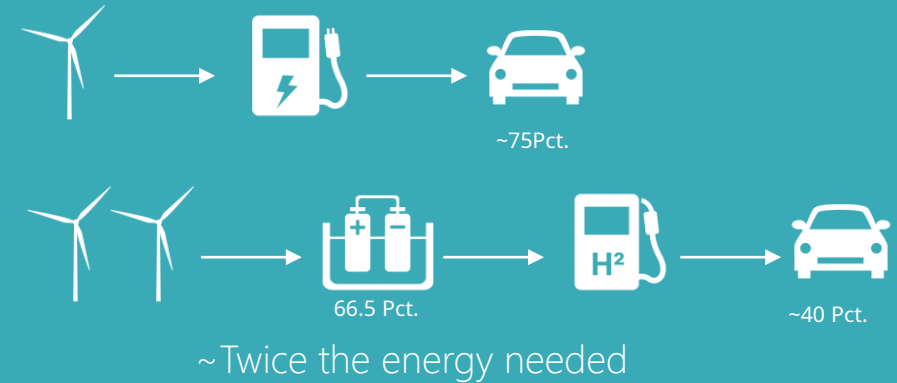
P2X OR DIRECT ELECTRIFICATION?

EXAMPLES OF ENERGY EFFICIENCY THROUGH ELECTRIFICATION

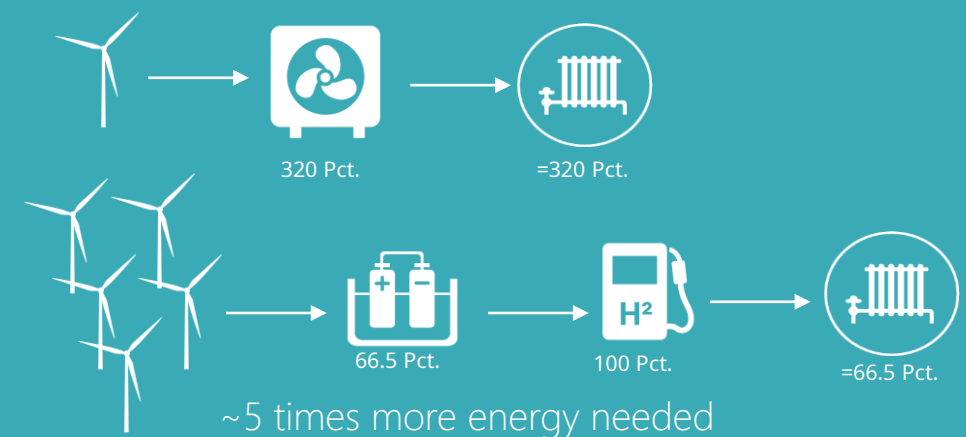
- DIRECT ELECTRIFICATION IS THE MOST ENERGY-EFFICIENT AND COST-EFFICIENT OPTION WHEN POSSIBLE
- ENERGY DEMAND FOR ELECTRIFICATION AND P2X
 - A hydrogen powered vehicle requires more than double the energy compared to an electrical vehicle
 - A hydrogen boiler for space heating requires five times the energy compared to a heat pump

Energy demand for direct electrification and P2X

Electric vehicle vs hydrogen vehicle



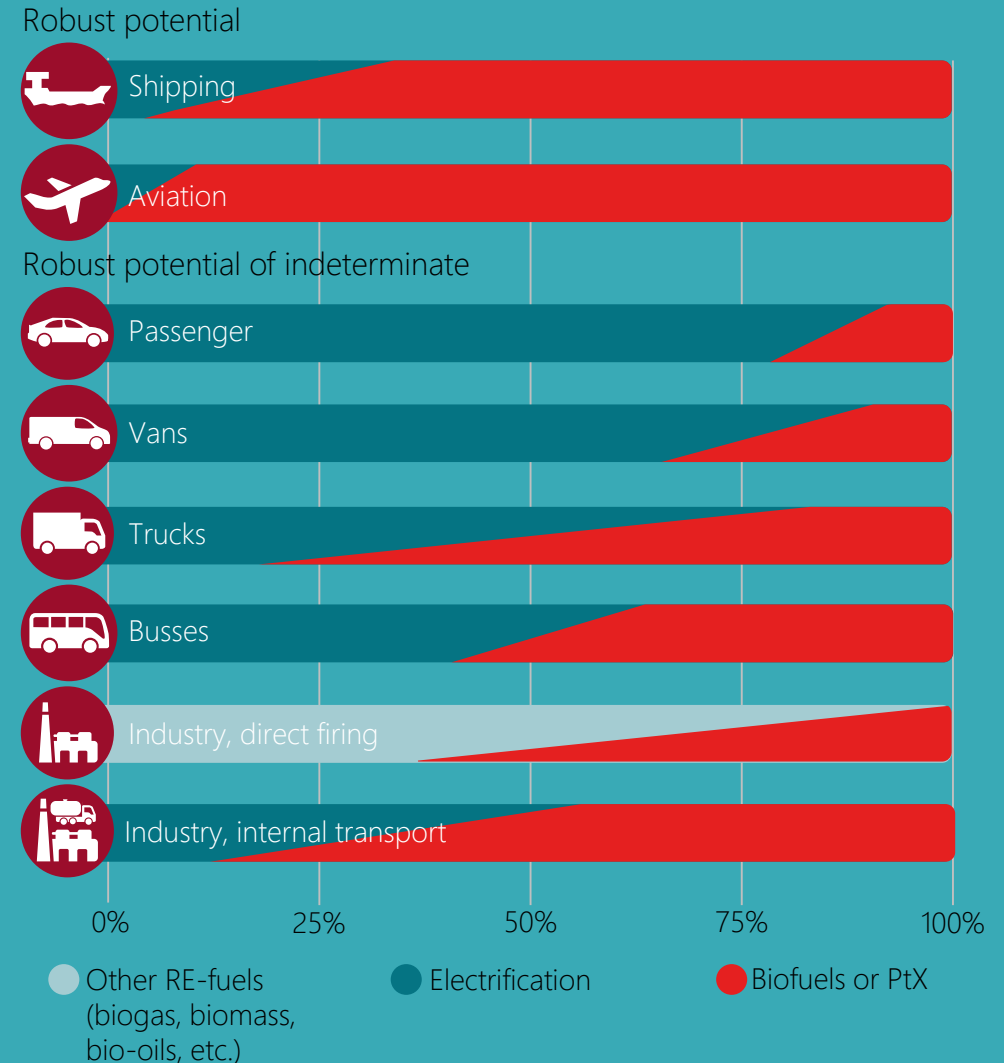
Space heating: Heat pumps vs hydrogen boilers



UTILIZATION OF PTX IN DENMARK

- Power-to-X will remain more expensive than direct electrification where that is applicable.
- Green hydrogen and e-fuels are expected to become cheaper than advanced biofuels (medium-long term).
- Fairly certain of dominant position within shipping and aviation.
- More uncertain in other parts of land based transportation, industry, and agriculture.
- No role in heating or electricity generation in Denmark as cheaper options exist:
 - Heat pumps and district heating for space heating
 - Biogas for peak electricity production

Transition potential:



4 OBJECTIVES OF THE P2X-STRATEGY (2021)

The strategy presents four objectives for the roll-out and utilization of Power-to-X in Denmark

1. P2X to **cost-effectively** contribute to reaching the targets of 70% GHG emission reductions in 2030 and 100% in 2045.
2. **Regulatory framework** and **infrastructure** to enable the development of P2X to become competitive with biofuels and P2X suppliers from abroad on market terms.
3. P2X to be well **integrated** with the Danish energy system incl. **electricity markets**, utilisation of **waste heat** and **geographical** coordination.
4. **Export** P2X products and technologies to develop the industry and create jobs.

Objective 1

Power-to-X must be able to contribute to the realisation of the objectives in the Danish Climate Act

Objective 2

The regulatory framework and infrastructure must be in place for Denmark to utilise its strengths and allow Power-to-X to perform on market terms in the long run

Objective 3

The integration between Power-to-X and the Danish energy system must be improved

Objective 4

Denmark must be able to export Power-to-X products and technologies

AGREEMENT ON HYDROGEN AND P2X

Adoption of the strategy by Parliament

Content of the agreement:

- Target of 4-6 GW electrolysis capacity by 2030
- Tender of 170 M€, as a production subsidy for 10 years open. Closes on September 1st.
- Direct connections of RE-production and consumption
- Geographically differentiated electricity tariffs
- 7.5 M€ in 2022-2026 for a P2X-taskforce
- First steps towards establishing a hydrogen infrastructure enabling export to Germany

Green reform (June 2022):

- Renewable energy package (done)
 - Ensuring sufficient green electricity and zoning for RE and P2X
- CO₂ tax on industry and domestic transportation
 - Support schemes for transition in industry and transportation

Upcoming national proposals (2022-23):

- Hydrogen infrastructure package – first steps
- Policy proposal for green road transport (passengers and heavy transportation)
- New proposal on CO₂ tax on flights

New EU-legislation (Fit-fo-55):

ReFuelEU Aviation – blending mandates

ReFuelEU Maritime – blending mandates

Renewable Energy Directive II – CI-demands

POWER-TO-X TENDER

- *"A tender to support [...] Power-to-X plants should contribute to reduce production costs of green hydrogen".*
- 1.25 billion DKK (approximately EUR 168 million) has been made available in state support for the production of PtX in the form of green hydrogen.
- Only hydrogen production that is produced from renewable energy sources and meets the EU's documentation requirements for green P2X fuels is eligible for support.
- State aid rules do not allow demand for use of PtX products in Denmark when have received state aid.
- Operational support for Danish production of PtX products.
- Fixed price premium for up to 10 years.
- Competition on support for quantity of hydrogen – no matter the end product.
- Contributing to industrialize and reduce the costs of PtX technology and PtX products.



Illustration: Biogas and coming PtX plant: GreenLab Skive



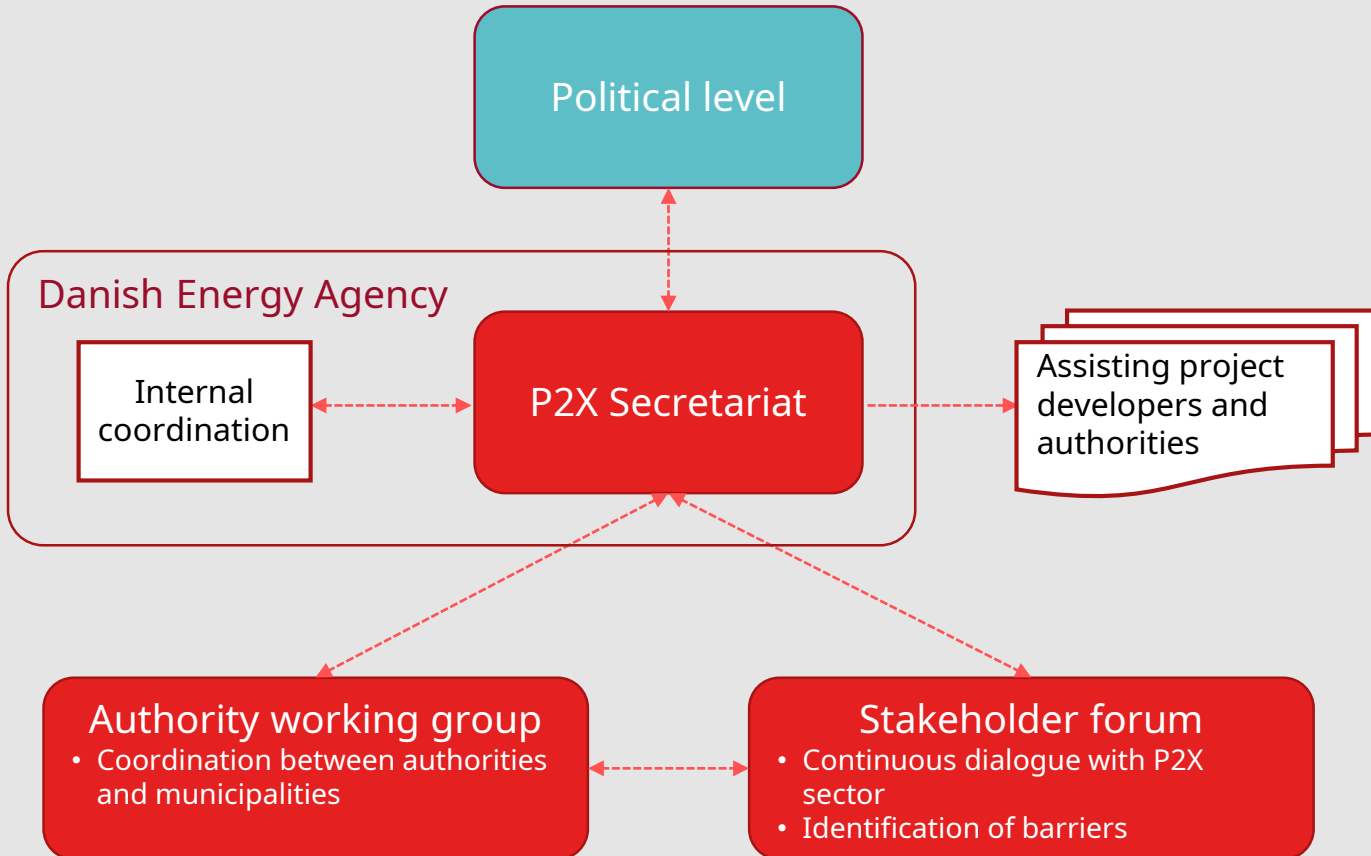
**GOVERNMENT SYSTEM
FOR P2X IN DENMARK**



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P2X-TASKFORCE

P2X-Taskforce



Purpose

- Contribute to coordination between public authorities
- Ensure dialogue between municipalities and the P2X sector
- Identify and solve regulatory barriers for developing P2X projects in Denmark
- Ensure common rules for documentation of green hydrogen
- Develop tools that supports optimal socioeconomic location of P2X plants.
- Part of the P2X-Taskforce is a P2X-Secretariat, which will be point of contact and support project developers and authorities with guidelines regarding permit procedures etc.



P2X PROJECTS IN DENMARK

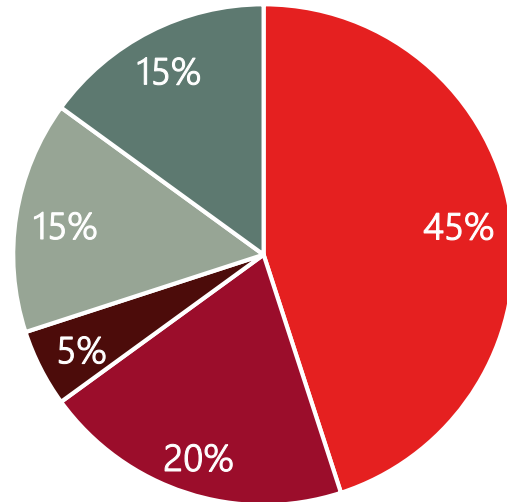


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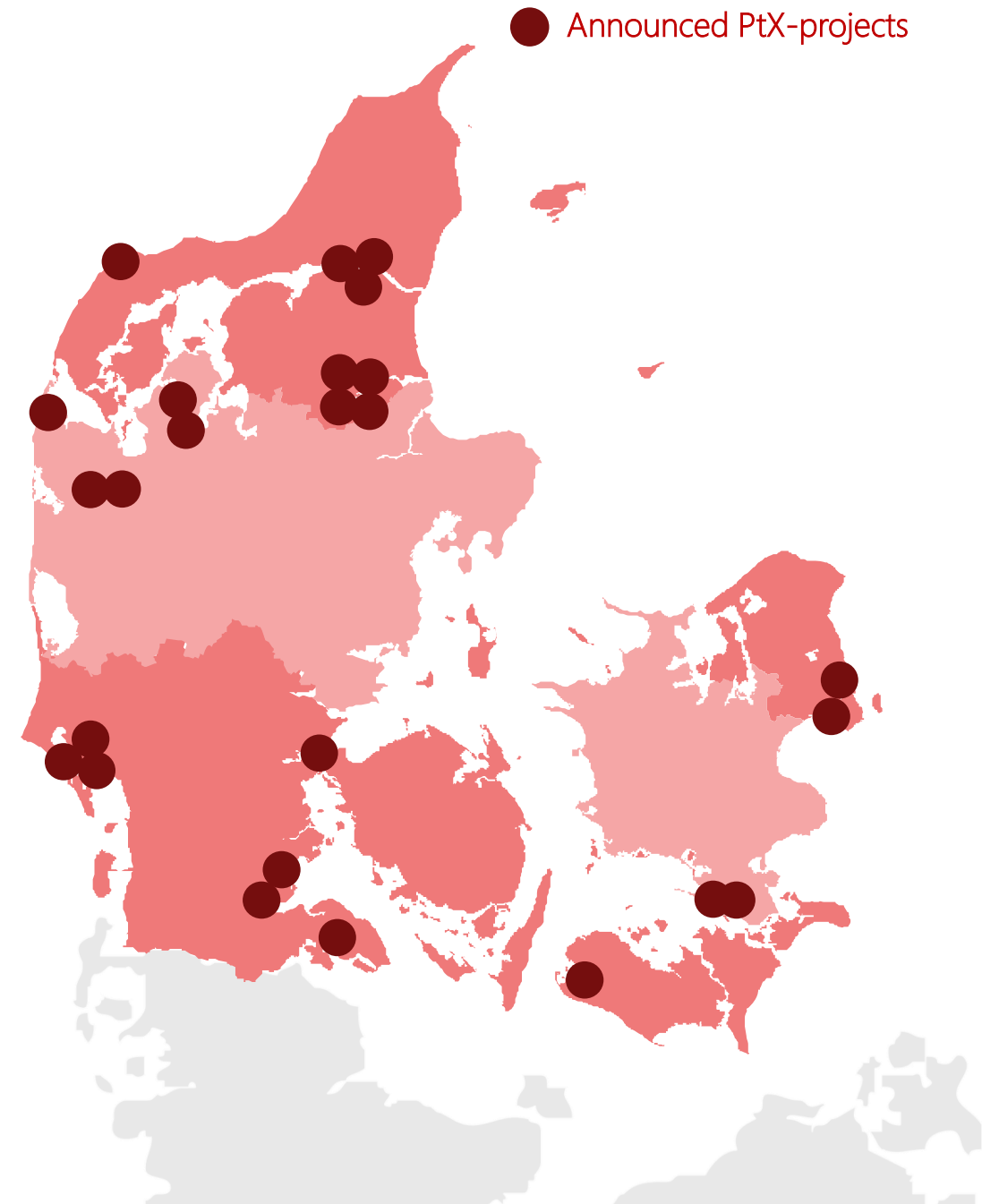
STATUS ON P2X IN DENMARK

A new and rapidly developing agenda

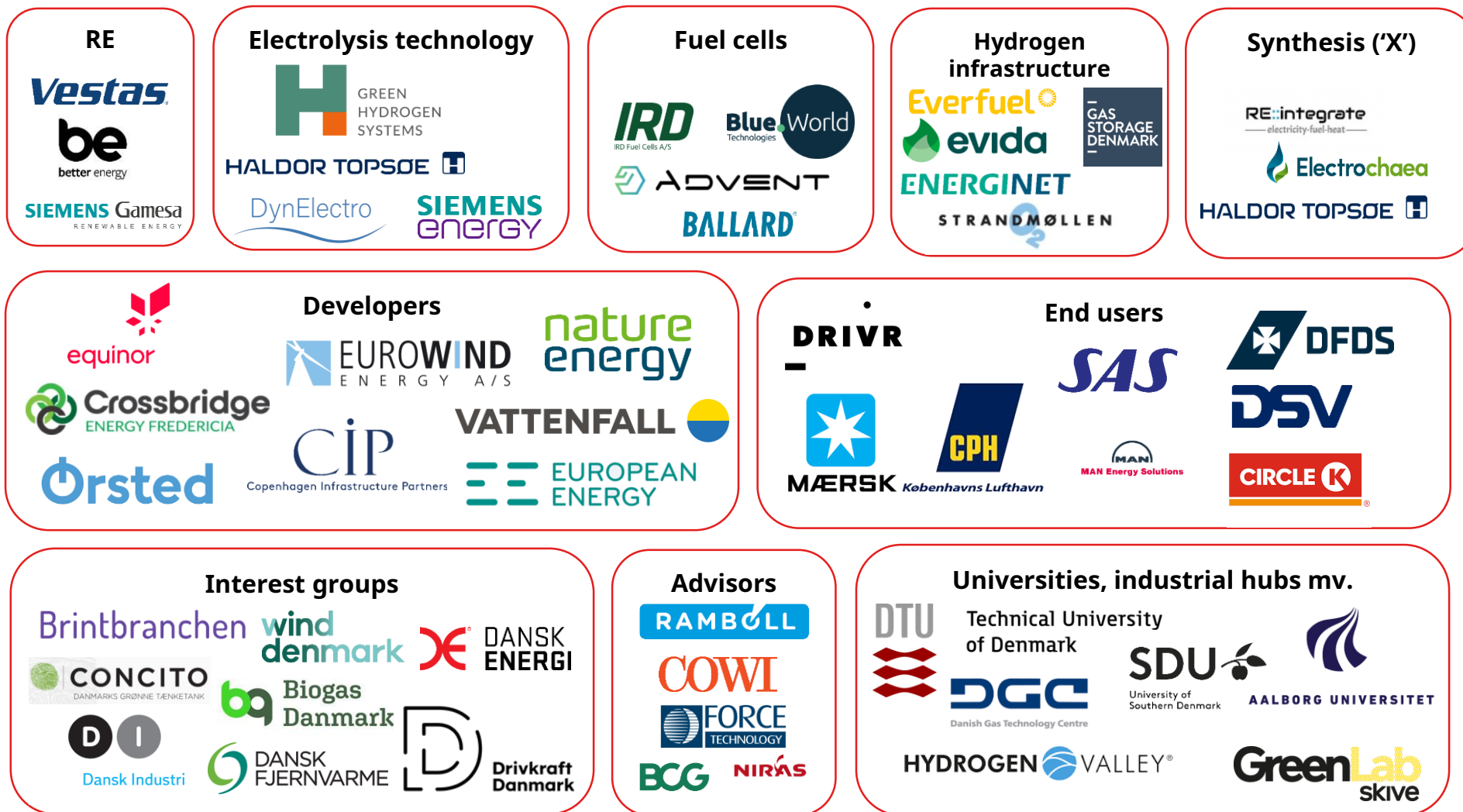
Announced P2X-projects	
Commissioning	2023 - 2030
Number	> 35
Capacity	5 – 2,000 MW
Accumulated capacity	> 9 GW



■ Hydrogen ■ Methanol ■ Metane
■ Ammonia ■ Kerosene



KNOW-HOW IN ALL PARTS OF THE VALUE CHAIN



The list is illustrative and not exhaustive

CASE 1: GREEN FUELS FOR DENMARK



Key facts	
Input (electricity)	100 MW in 2025 250 MW in 2027 1,300 MW in 2030
Input (CO ₂)	CO ₂ from carbon capture from straw-fired CHP in Copenhagen (Avedøre)
Annual output	50,000 tonnes of e-methanol and SAF in 2025



- Location is near by
- Grid connection
 - District heating
 - CO₂ source
 - Airport
 - Harbour

HALDOR TOPSØE

Everfuel nel

Reference: <https://orsted.com/en/media/newsroom/news/2022/02/20220204476711>



GreenLab

Located at the intersection of national gas and electricity grids

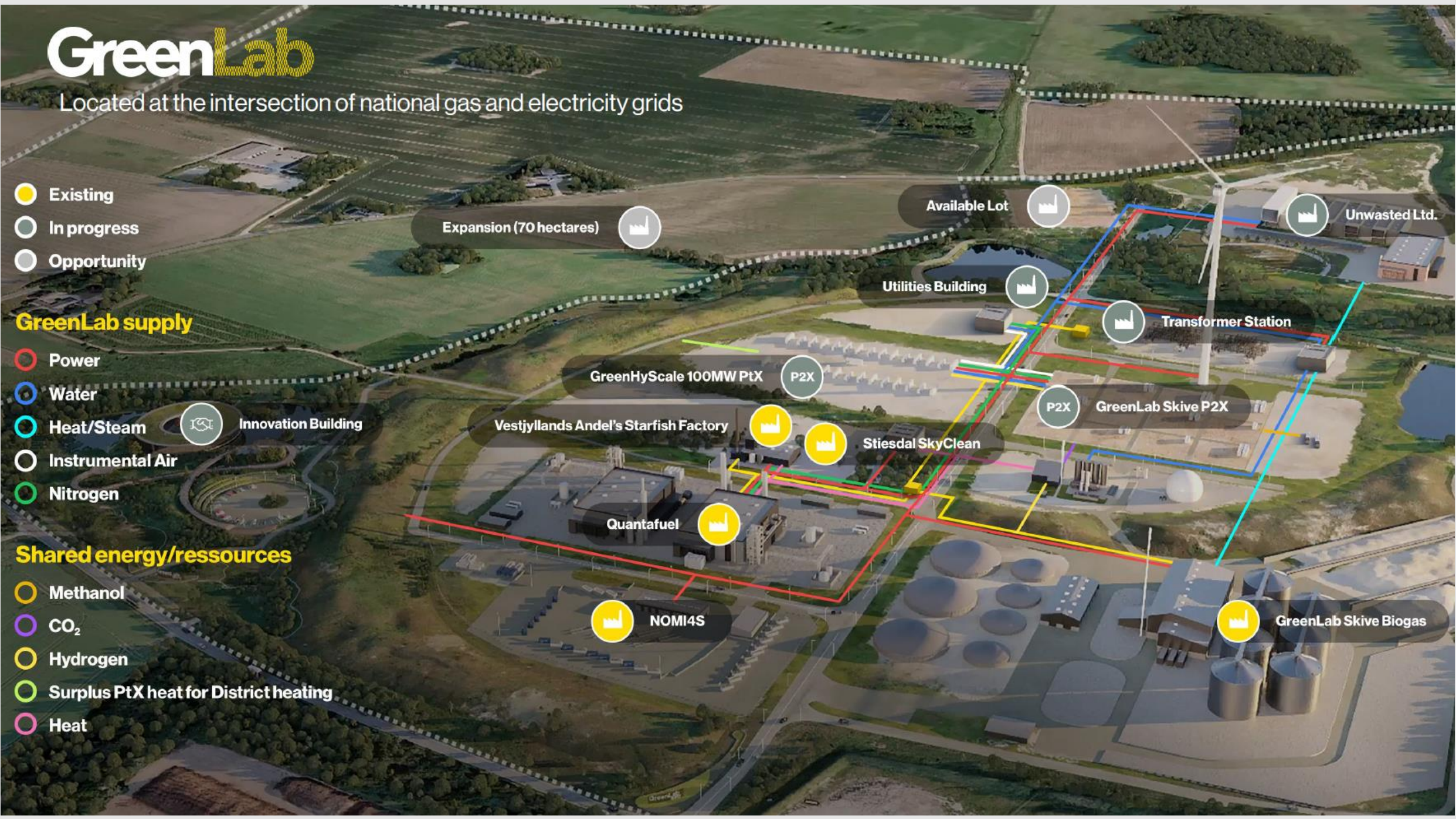
- Existing
- In progress
- Opportunity

GreenLab supply

- Power
- Water
- Heat/Steam
- Instrumental Air
- Nitrogen

Shared energy/ressources

- Methanol
- CO₂
- Hydrogen
- Surplus PtX heat for District heating
- Heat



KEY MESSAGES



Direct electrification beats P2X both in terms of energy and economically

But P2X is needed to decarbonize the hard-to-abate sectors (aviation, shipping, etc.)

Countries with high CO₂ intensity should consider prioritizing scale up of renewable electricity productions first

P2X development requires a whole new level of collaboration between authorities



An aerial photograph of a port area with a large white circle in the center containing the text 'THANK YOU FOR YOUR ATTENTION!'. The background shows a body of water, a large red ship, and several tall cranes. In the foreground, there are stacks of blue and red shipping containers. The sky is clear and blue.

**THANK YOU FOR
YOUR ATTENTION!**



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