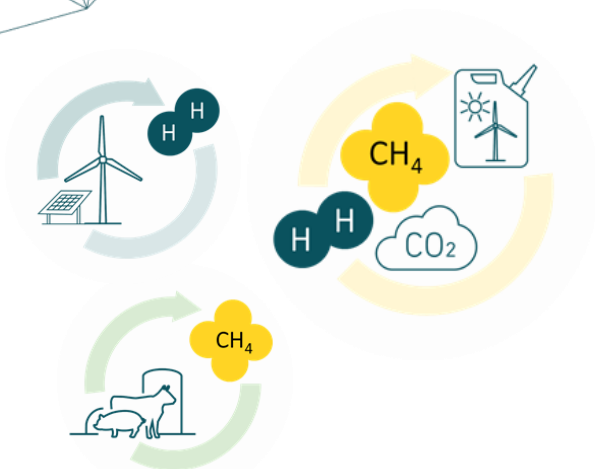# THE DANISH PTX VISION AND SCENARIO

Power-to-X webinar, 10. November 2020

Hanne Storm Edlefsen, Vice President of Strategic Planning, Electricity System Operator, Energinet
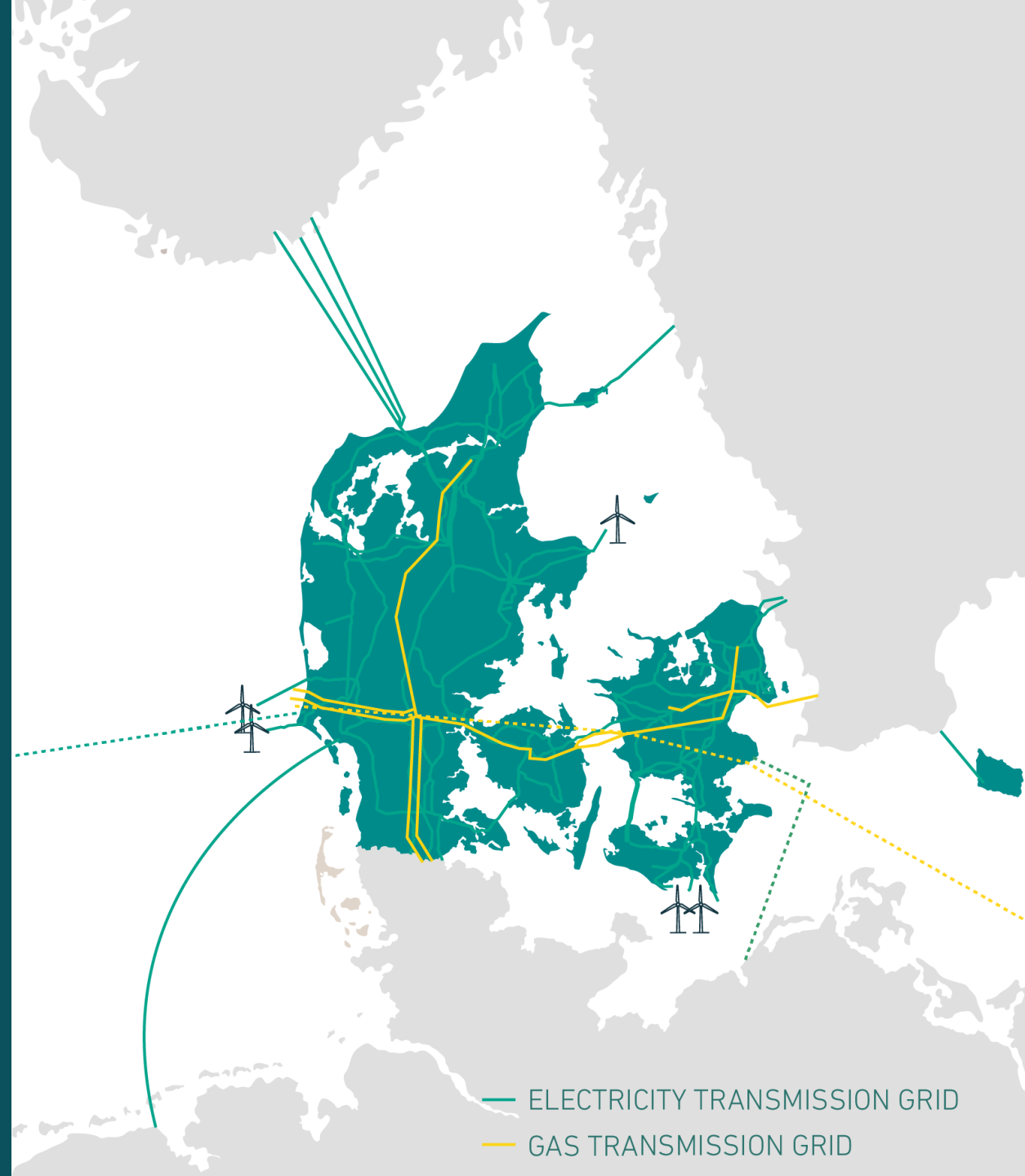
VISION

GREEN ENERGY FOR A BETTER WORLD

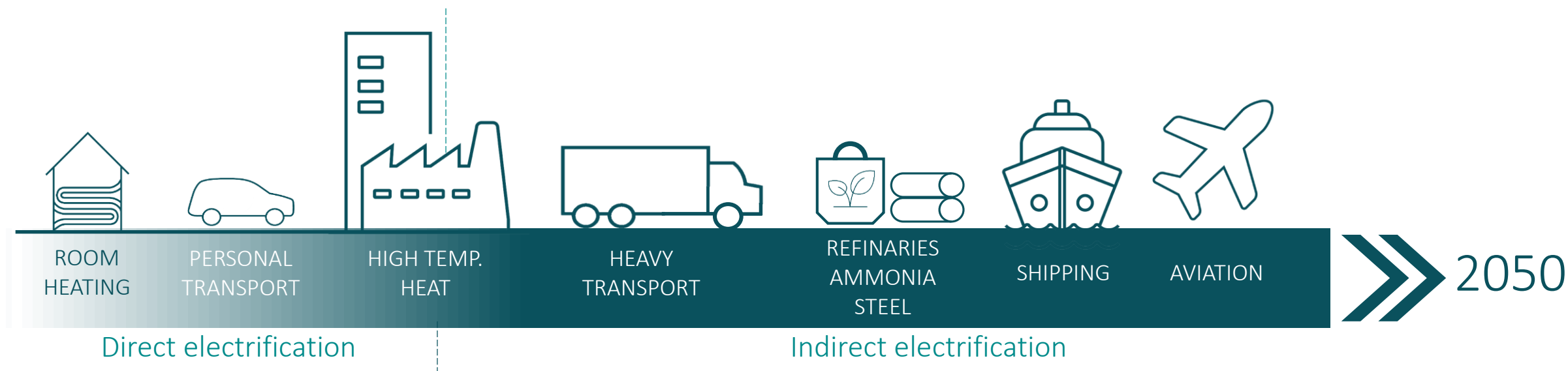Energinet is the TSO (Transmission System Operator) for electricity and gas in Denmark.

We safeguard society's interests as we move to a 100% green energy system.

We are owned by the Danish Ministry of Climate, Energy and Utilities.

ELECTRICITY TRANSMISSION GRID

GAS TRANSMISSION GRID

ELECTRIFICATION AND POWER-TO-X

Denmarks large VRE-potentials can power a direct electrification – and an indirect electrification through PtX to those sectors that cannot be directly electrified.

| ROOM HEATING | PERSONAL TRANSPORT | HIGH TEMP. HEAT | HEAVY TRANSPORT | REFINARIES AMMONIA STEEL | SHIPPING | AVIATION | 2050 |

Direct electrification

Indirect electrification

ENERGINET

WORLD'S FIRST OFFSHORE WIND ENERGY ISLANDS

"With the establishment of the world's first offshore wind energy islands, we embark on a whole new era in the Danish wind adventure. We are massively increasing the amount of offshore wind, and at the same time we will make it possible to use the green power in the tanks of trucks, cargo ships and aircraft."
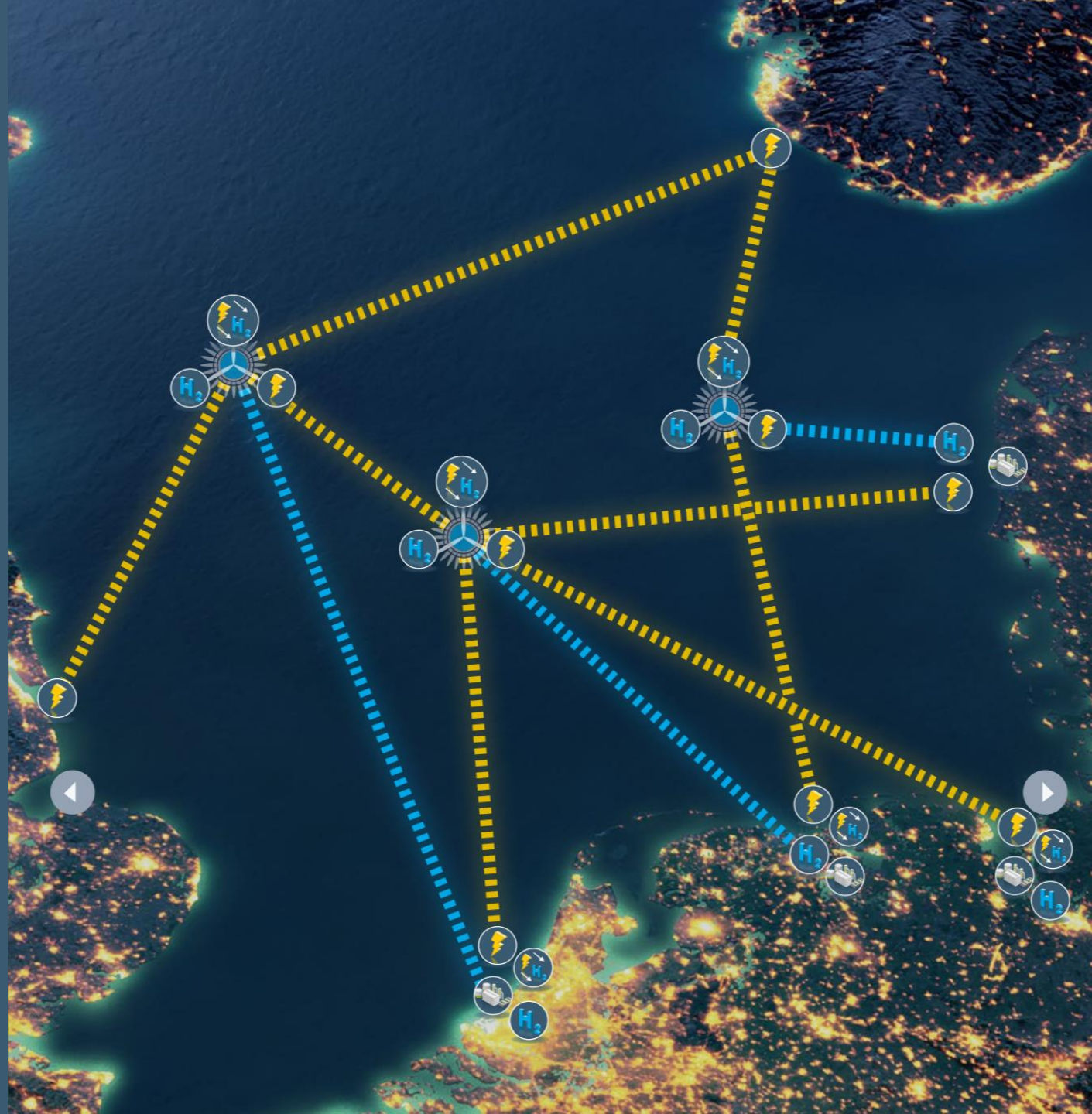
Dan Jørgensen
Minister for Climate, Energy and Utilities

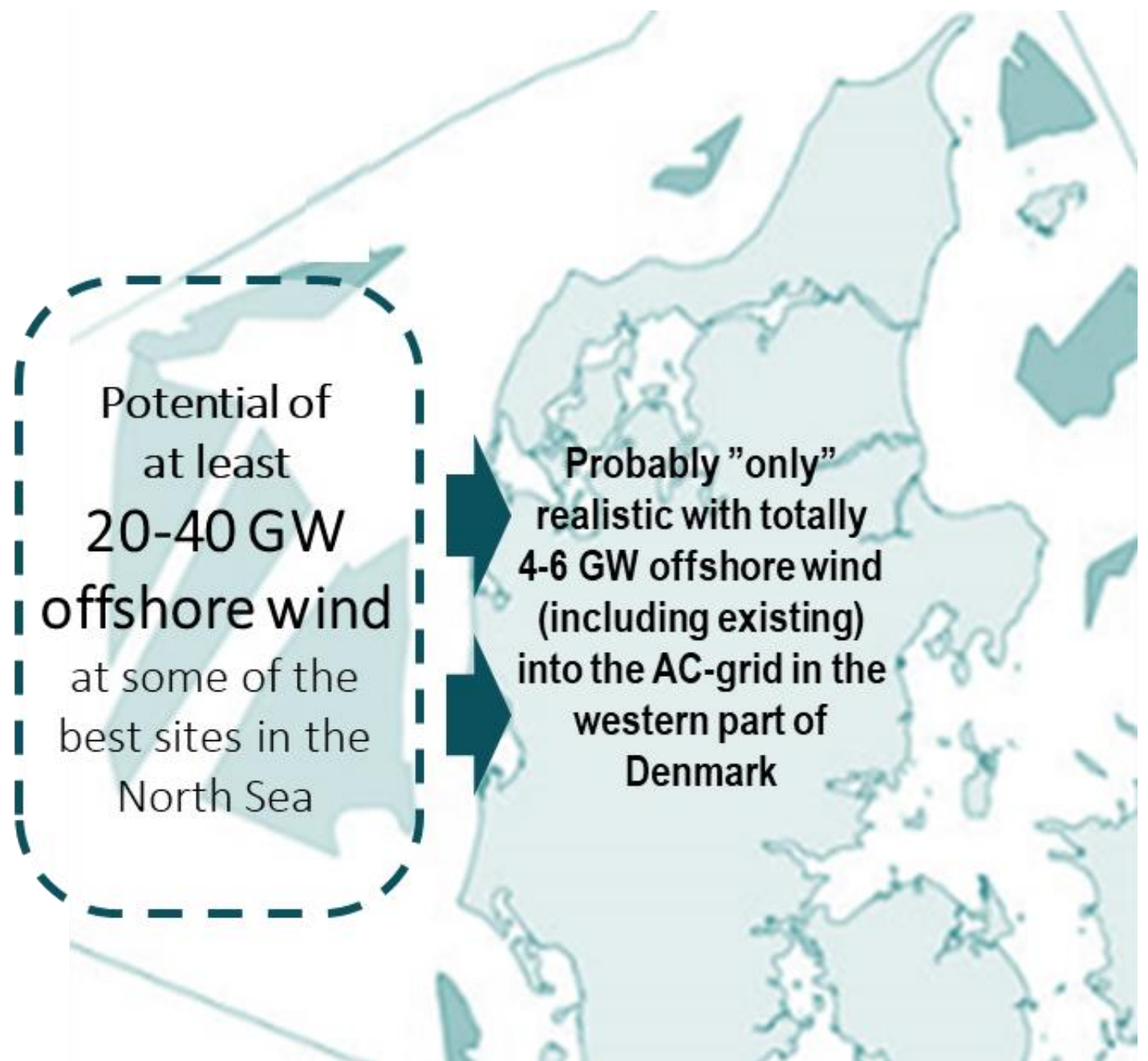3 GW in 2030
Later 10 GW

2 GW in 2030

NORTH SEA WIND POWER HUB

- International massive build-out of North Sea wind (180GW)

- Essential to meet European contribution to Paris agreement

- Combined wind landing and ICs

- Combined landing/integration with electrolysis

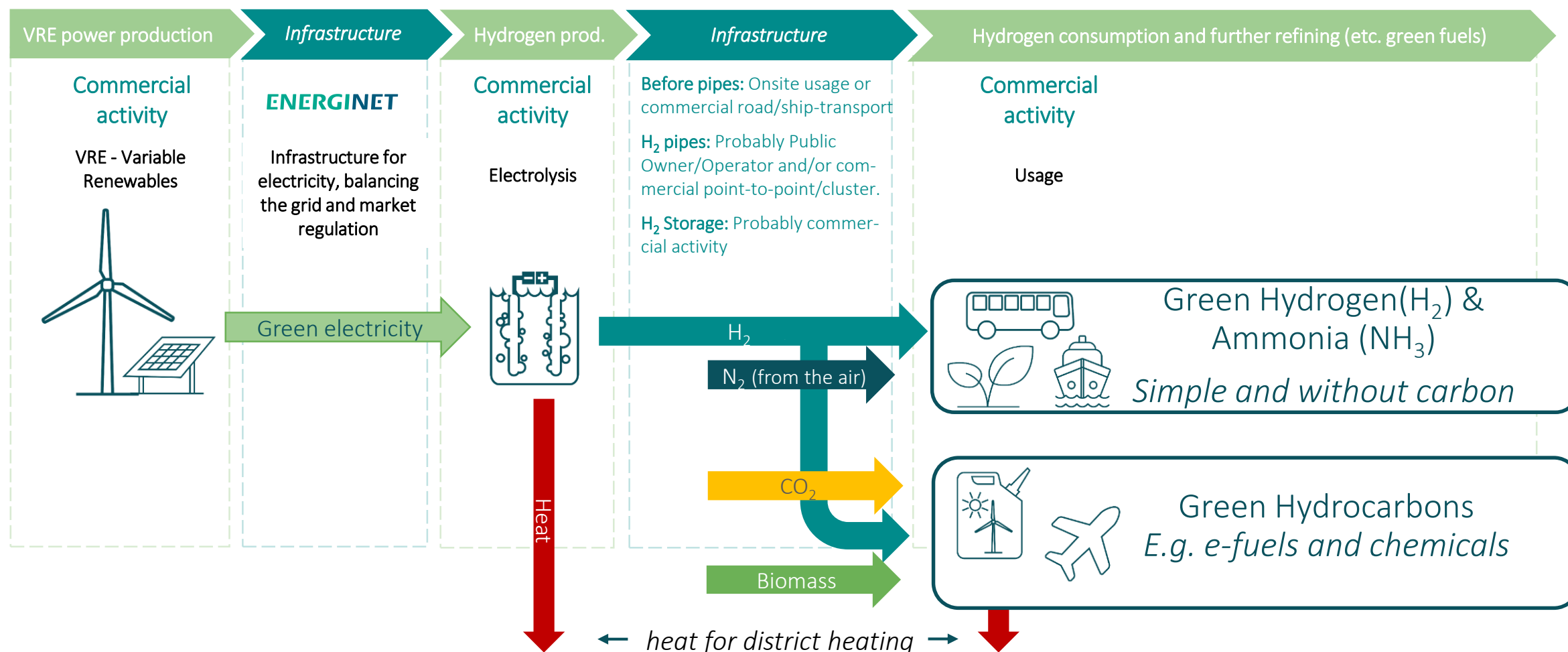- Effective integration in Europe

ENERGINET   gasunie   TenneT

THE ABUNDANT OFFSHORE WIND RESOURCE IN DENMARK

...and the "not so abundant" electrical grid

Potential of at least 20-40 GW offshore wind at some of the best sites in the North Sea

Probably "only" realistic with totally 4-6 GW offshore wind (including existing) into the AC-grid in the western part of Denmark

ENERGINETS ROLE IN THE PTX-VALUE CHAIN

The value chain from green electrons to green molecules!

VRE power production	*Infrastructure*	Hydrogen prod.	*Infrastructure*	Hydrogen consumption and further refining (etc. green fuels)
Commercial activity	ENERGINET	Commercial activity	Before pipes: Onsite usage or commercial road/ship-transport	Commercial activity
VRE - Variable Renewables	Infrastructure for electricity, balancing the grid and market regulation	Electrolysis	H_2 pipes: Probably Public Owner/Operator and/or commercial point-to-point/cluster. H_2 Storage: Probably commercial activity	Usage

Green electricity →

H_2

N_2 (from the air)

Heat

CO_2

Biomass

Green Hydrogen(H_2) & Ammonia (NH_3)
Simple and without carbon

Green Hydrocarbons
E.g. e-fuels and chemicals

← *heat for district heating* →

FOUR CENTRAL PIECES TO THE PUZZLE

Landings Zones

- A "buffer- and conversion zone" between large scale feed in of VRE and the public AC-power grid.
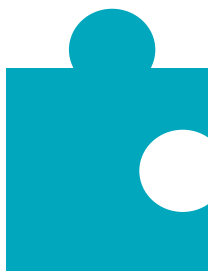
Hydrogen Infrastructure

- Make it possible to efficiently decouple hydrogen production (electrolysis) and hydrogen consumption in time (storage) and geography (pipes).

Distributed PtX

- Electrolysis/PtX where all electricity (VRE) is supplied through the public grid
- Cost based payment for using electricity infrastructure is essential.

Green Value

- The green PtX-product has quite a high premium compared to the fossil based alternative. Therefore it is essential for the investor business case that the green value is kept high all the way from sources to the end product.

WINDS OF CHANGE IN A HYDROGEN PERSPECTIVE

PtX Strategic Action Plan
November 2019

ENERGINET

INTEGRATION OF LARGE SCALE OFFSHORE WIND

...and (semi-) large scale onshore wind and solar PV

Large scale electrolysis/PtX and multi GW offshore wind in Denmark goes together

Example of a Landing Zone with electrolysis

Private Grid

Collective Grid

Coast line

1 GW Exchange Capacity

2 GW Offshore Wind

1 GW Electrolysis

POC Point of Connection
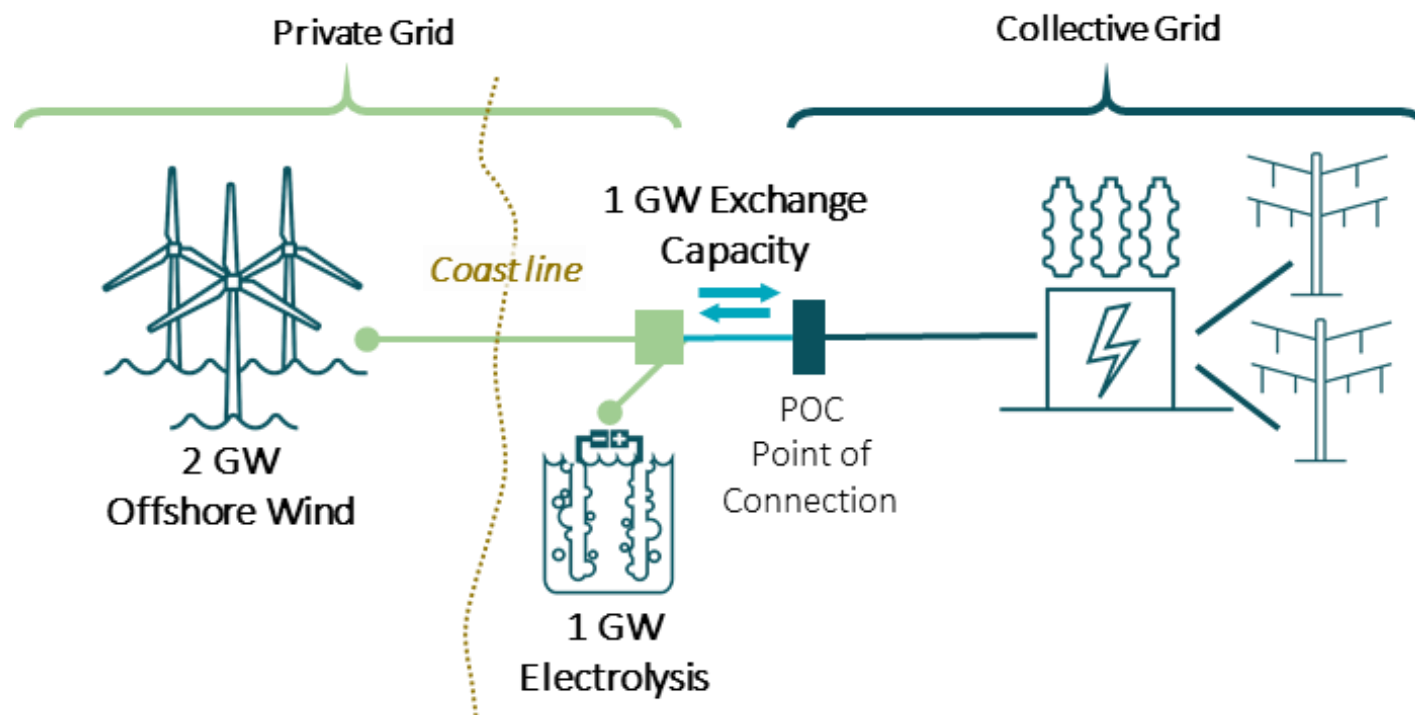
THE CHICKEN OR THE EGG?

Is an overhead hydrogen infrastructure a product of – or enabler for – large scale electrolysis / PtX?

Example of an overhead hydrogen infrastructure in DK-West

Salt Cavern Storage
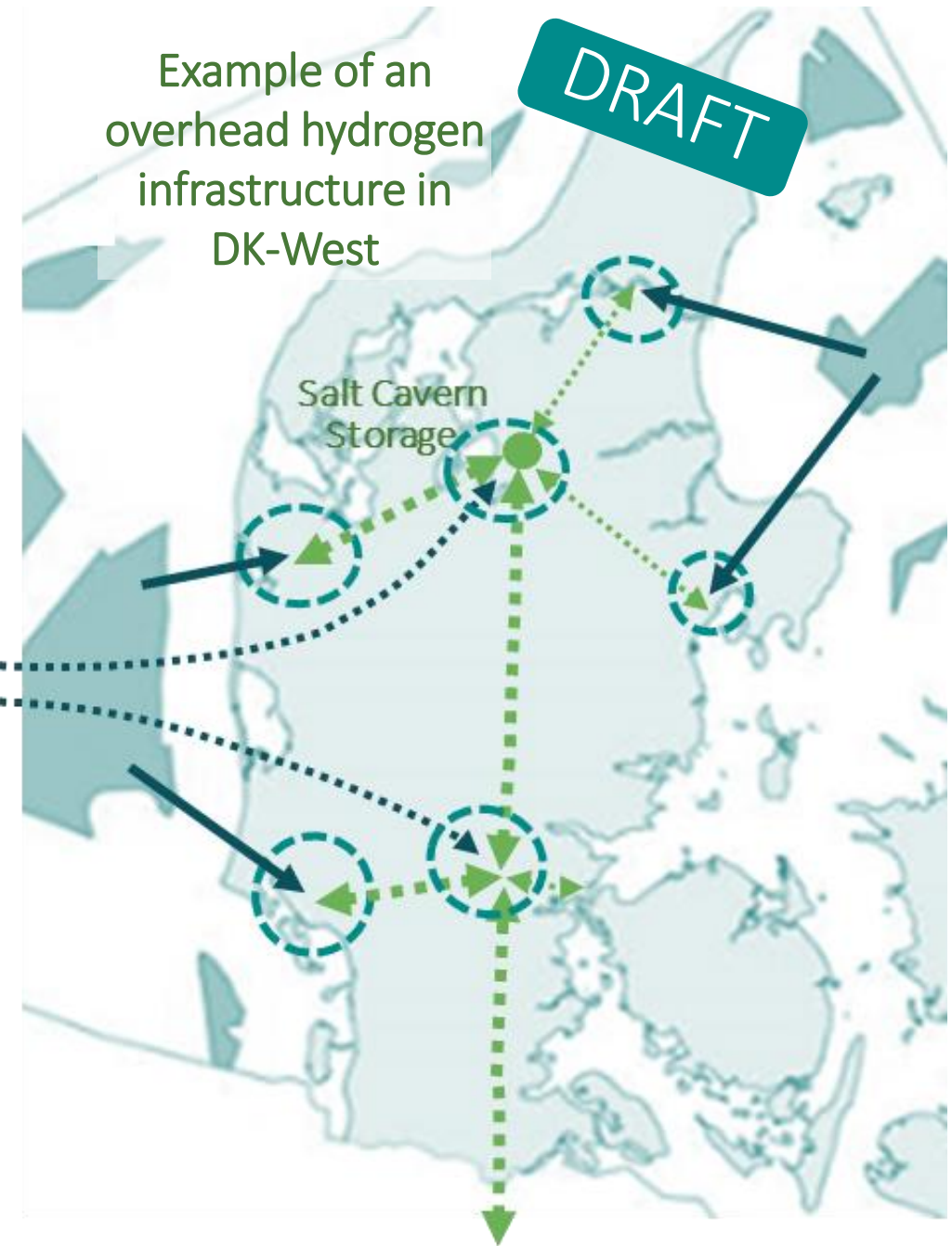
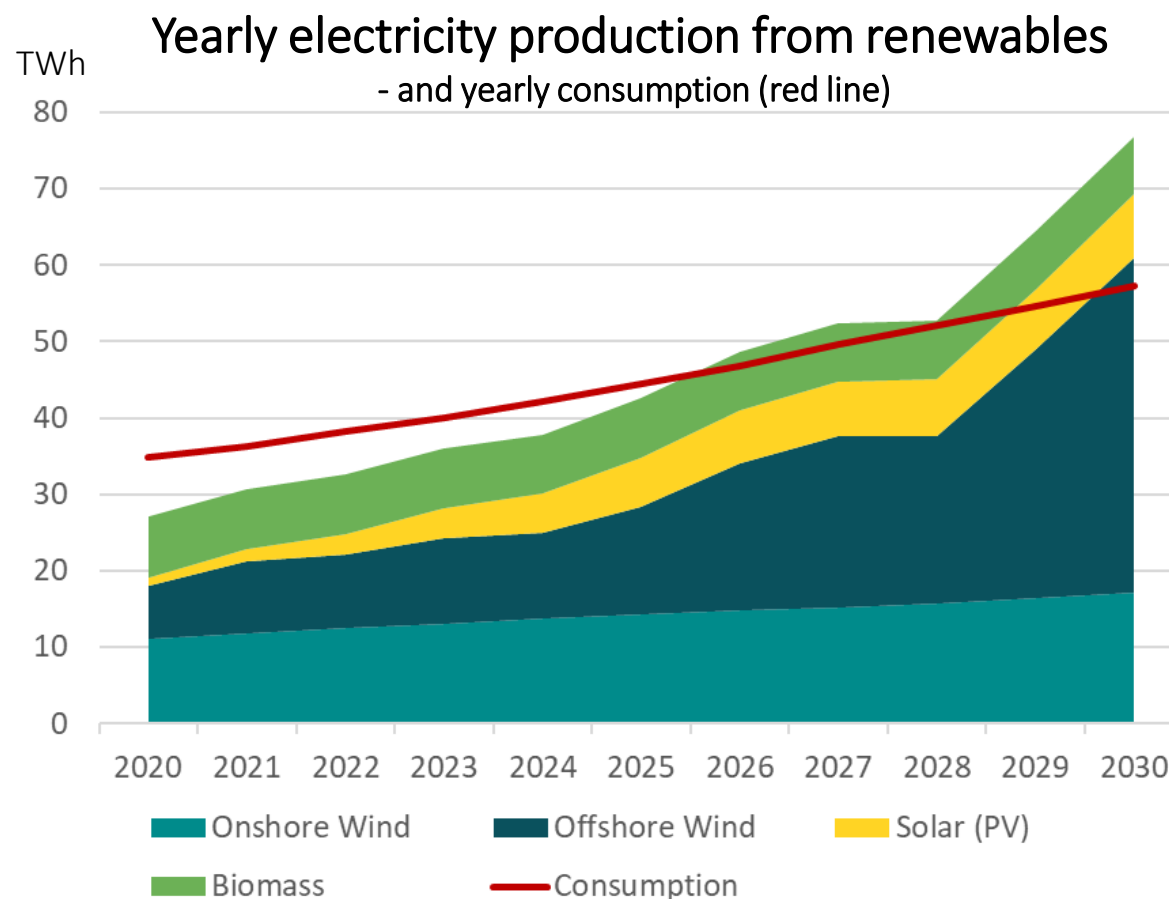# CO-LOCATION AND FLEXIBILITY HAS VALUE FOR THE GRID

Work in progress on a new tariff-model which might include incentives for co-location and flexibility/interruptability

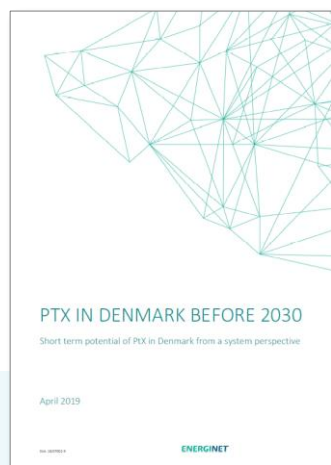Total Wind & PV capacity compared to peak load pr. municipality

- < 100 %
- 100-200 %
- 200-500 %
- 500-1000 %
- > 1000 %