

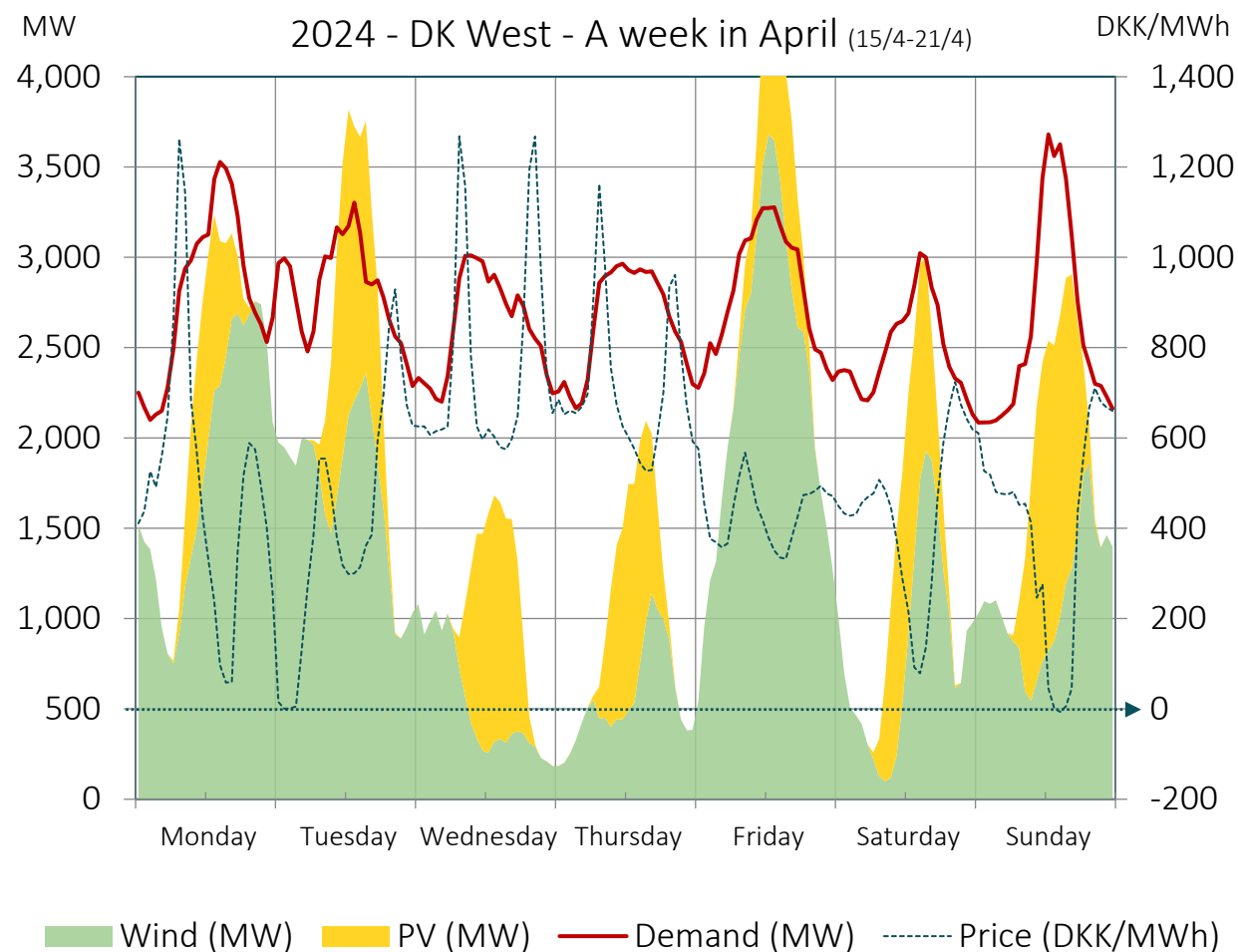
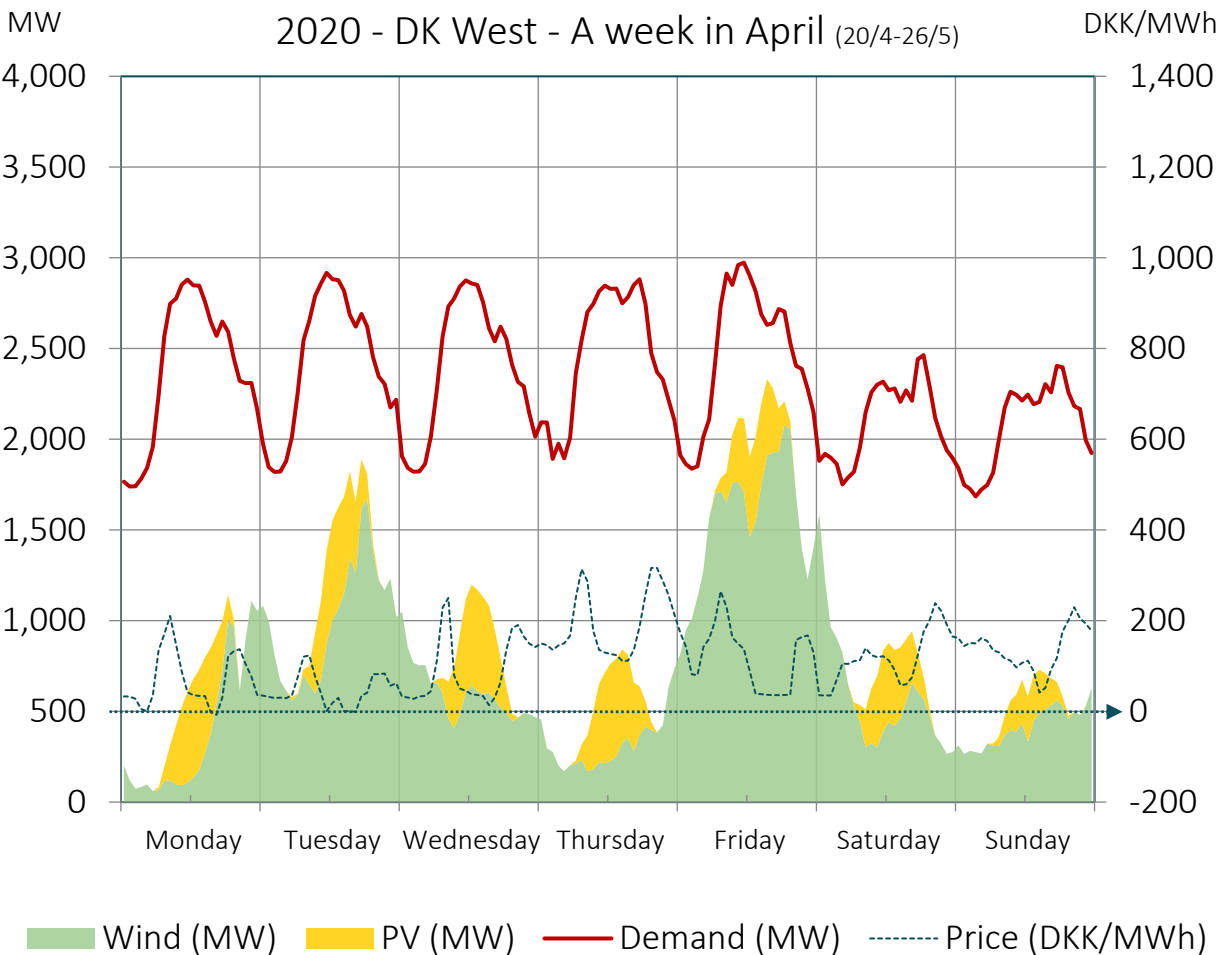
A decorative graphic on the left side of the slide, consisting of a complex network of thin grey lines forming a series of interconnected triangles and polygons, resembling a wireframe or a network diagram.

NEW CONSUMPTION, FLEXIBILITY AND CO-LOCATION THROUGH TARIFFS, CONNECTION AND MARKETS

26. June 2024 - Visit from US delegation

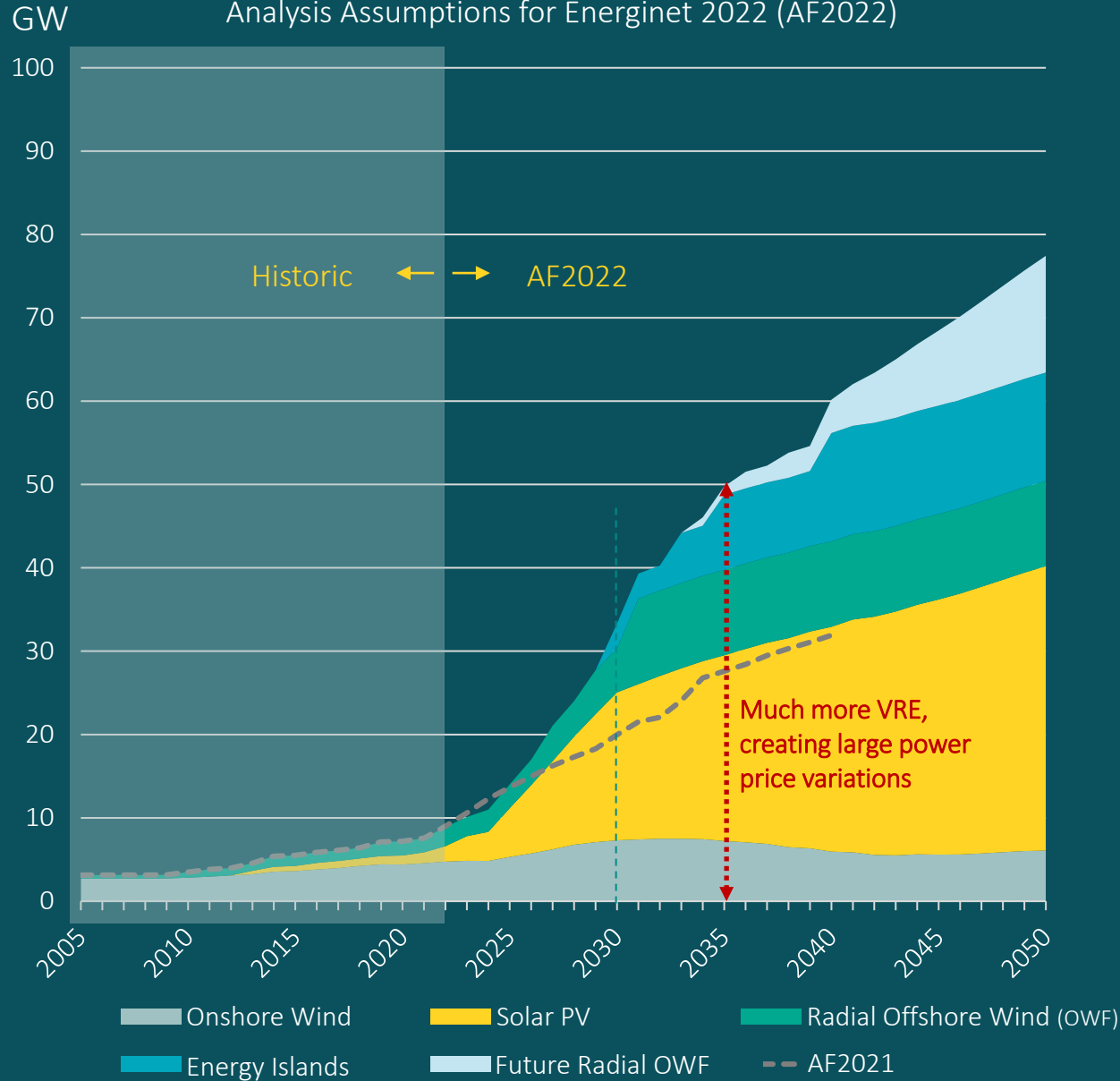
Carsten Vittrup, Energy Strategic Advisor, Energinet

DANISH CONSUMPTION IS BECOMING MORE FLEXIBLE



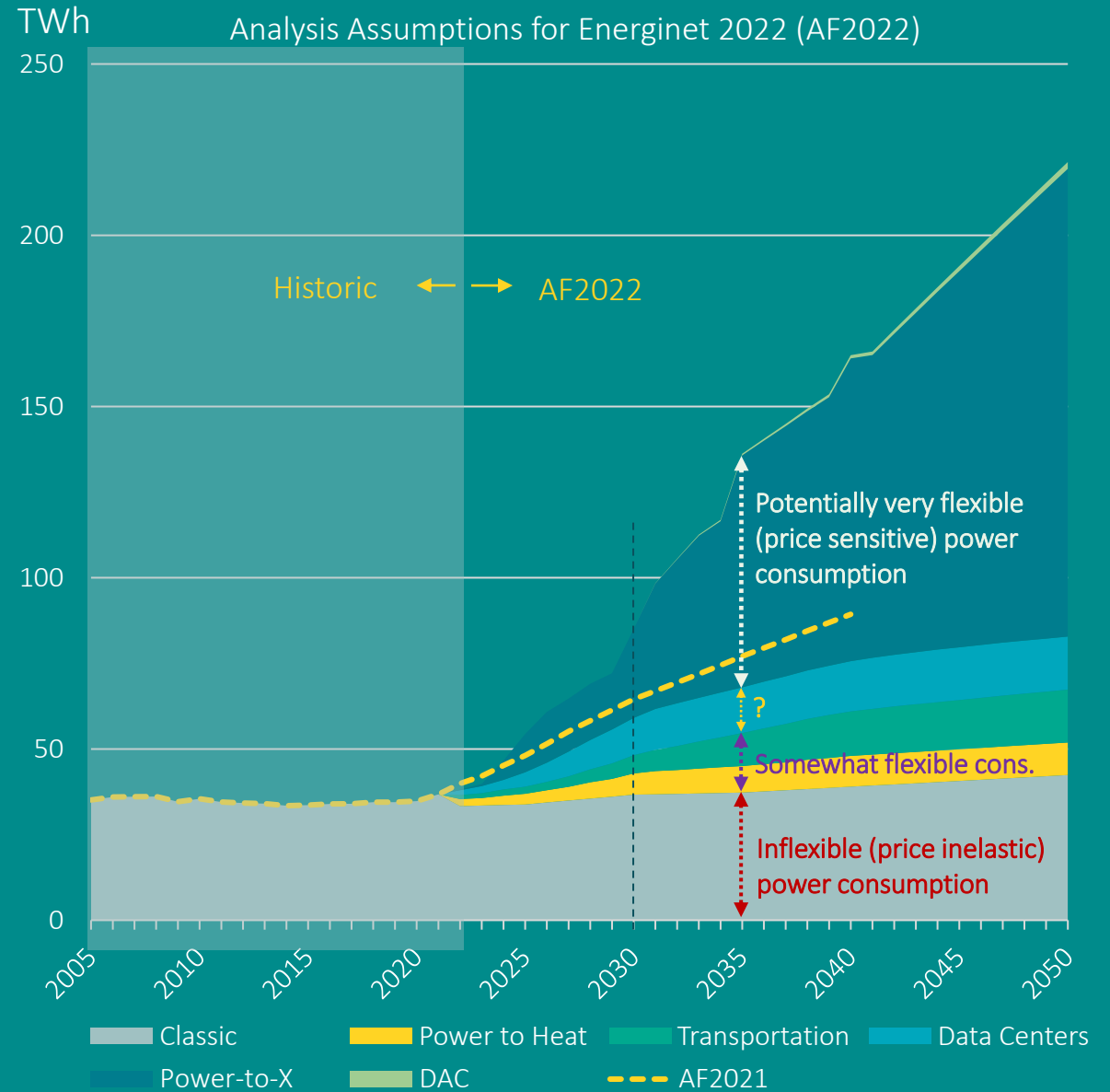
Wind- and solar PV capacities in Denmark

Analysis Assumptions for Energinet 2022 (AF2022)

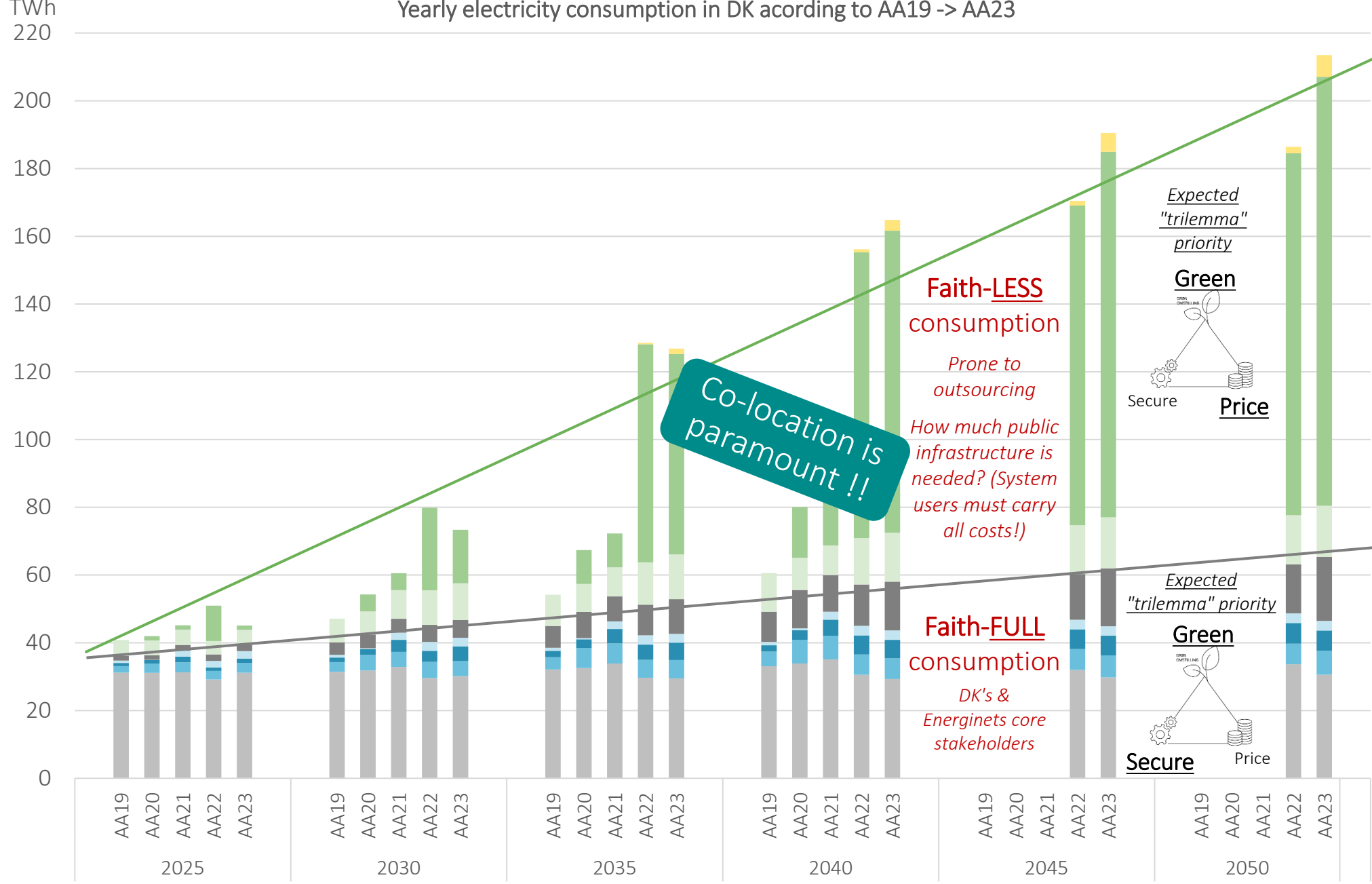


Power Consumption in Denmark

Analysis Assumptions for Energinet 2022 (AF2022)



Yearly electricity consumption in DK according to AA19 -> AA23



Co-location is paramount !!

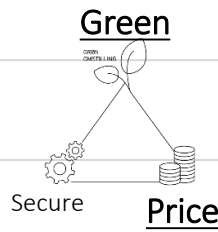
Faith-LESS consumption

Prone to outsourcing
How much public infrastructure is needed? (System users must carry all costs!)

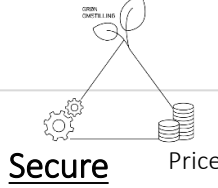
Faith-FULL consumption

DK's & Energinets core stakeholders

Expected "trilemma" priority



Expected "trilemma" priority



"European/ International" place-flexible consumption
Primarily TSO-connected
Development in consumption (and "belonging" production) is VERY unpredictable (and potentially HUGE)

"National" place-bound consumption
Primarily DSO-connected
Development quite predictable! (and manageable in size)

- Classic consumption
- Individual Heat Pumps
- Central Heat Pumps
- Electric Boilers
- Transportation
- Datacenters
- Power-to-X
- Direct Air Capture

Place-bound

Place-flexible

THE ABUNDANT OFFSHORE WIND (AND SOLAR PV) RESOURCE

... and the less abundant electricity grid



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



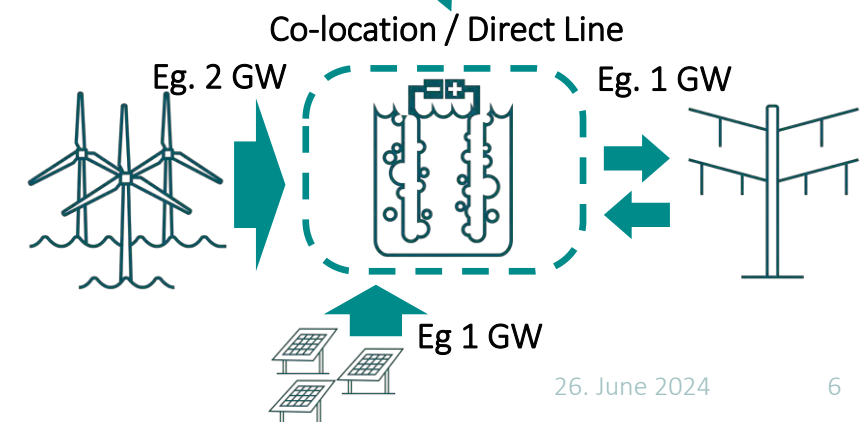
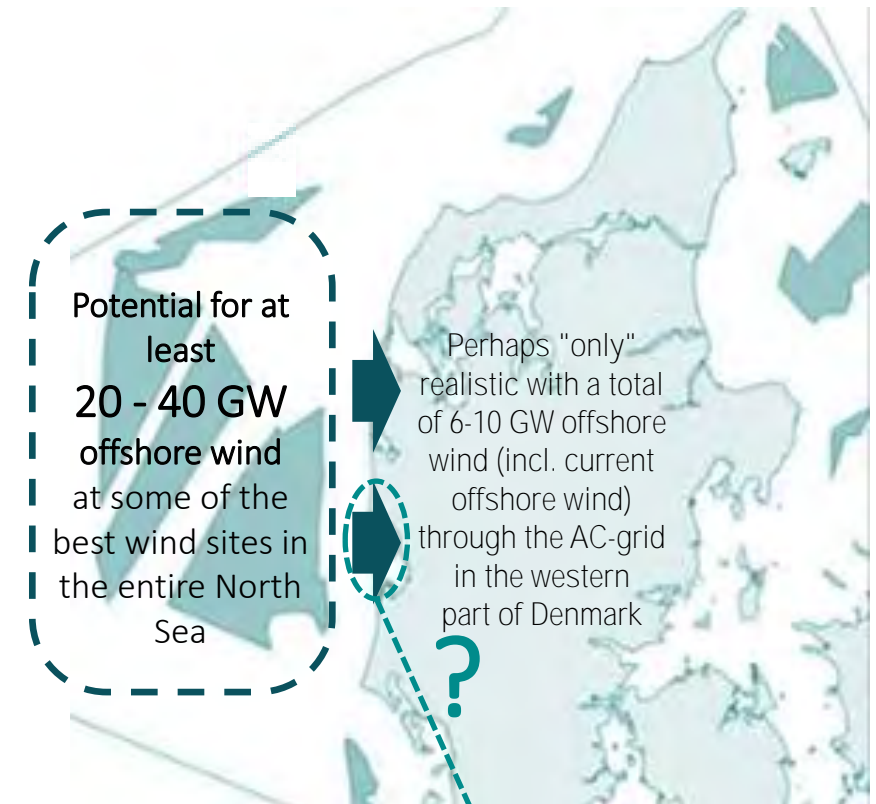
Perhaps "only" realistic with a total of 6-10 GW offshore wind (incl. current offshore wind) through the AC-grid in the western part of Denmark

REASONING FOR CO-LOCATION

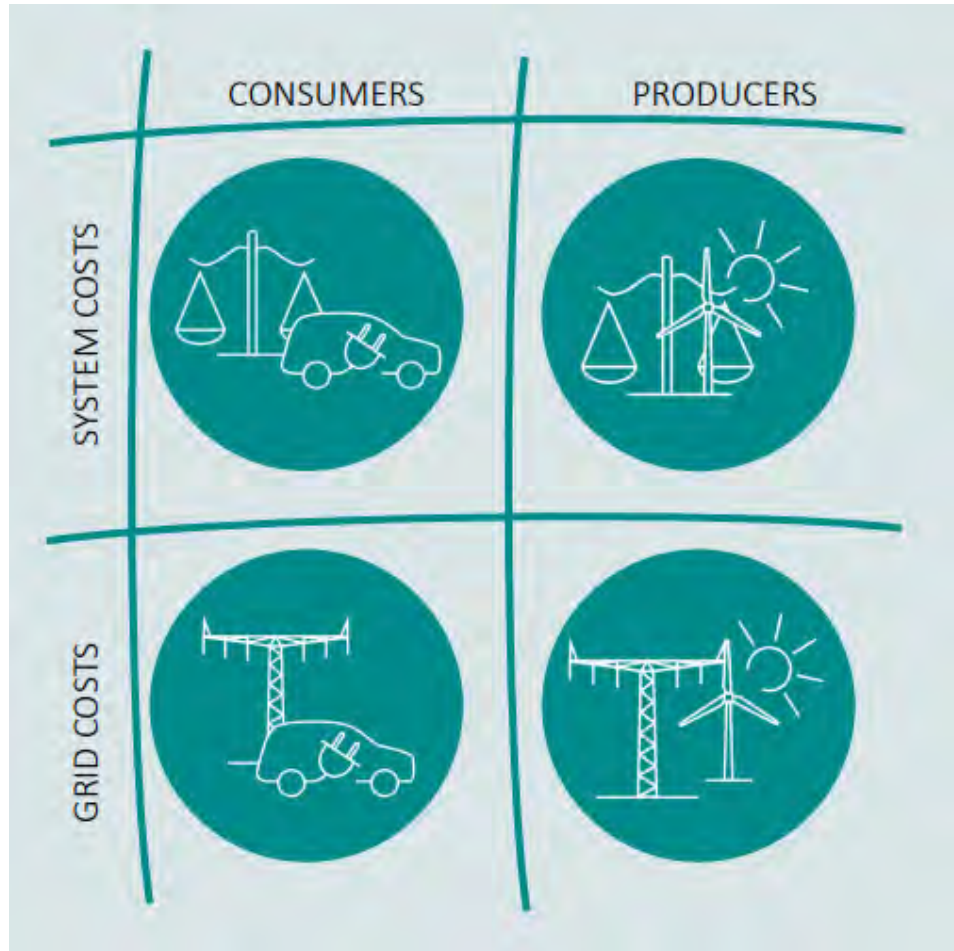
Incorporate more fluctuating wind and solar in a given electricity infrastructure than otherwise possible - through co-located and simultaneous production / consumption (large prosumer) on the "edge" of the collective electricity transmission grid

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

Without price flexible electrolysis/PtX it will be difficult and less attractive to install many GW new wind (and PV) in Denmark. Due to power price "cannibalism"; limited grid capacity towards central Europe and public challenges with expanding electrical infrastructure.



GENERAL APPROACH TO TARIFF DESIGN



- What are the cost drivers?
- Where can we give relevant forward looking price signals/incentives?
- How can we ensure we are not hindering the green transition?

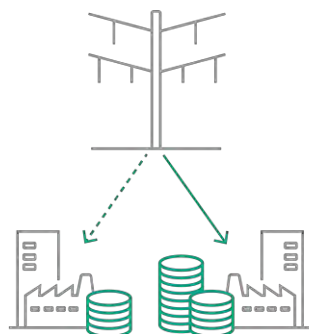
TARIFF CHANGES (MAIN ELEMENTS)

Tariffs must be more cost-reflective and better incentivize the utilization of the grid



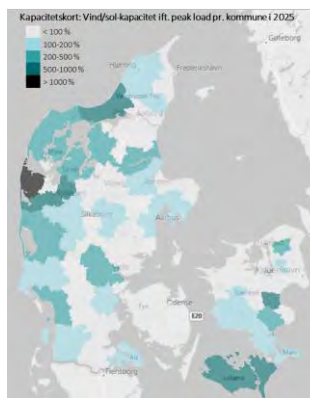
CAPACITY PAYMENT

Fixed element to reflect capacity (energy component probably only Grid Loss). A key cost-reflective change!



LIMITED GRID ACCESS

Lower (capacity) tariff for consumers, who choose being interruptible in case of local capacity constraints.



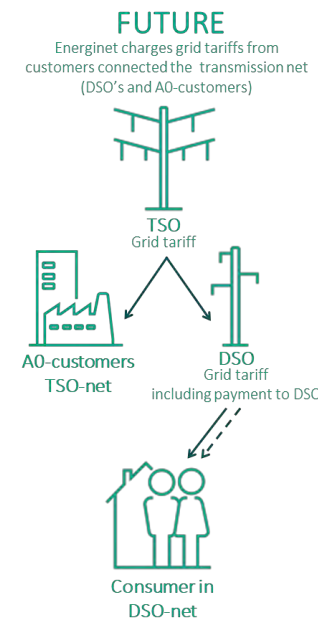
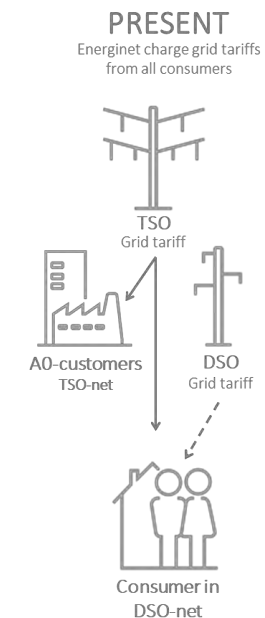
GEO.DIFF. PRODUCTION TARIFF

Geographical differentiated energy-based tariff and connection payment (capacity) for production.



SYSTEM TARIFF

Fixed element (25%) and (much) lower energy based tariff for yearly consumption >100 GWh



TSO-DSO-MODEL

Instead of charging all consumers we are looking at a model where we only charge those that are directly connected to the transmission grid.

NEW CAPACITY-BASED TARIFFS ARE CENTRAL

From fully energy based tariffs to capacity centric infrastructure payments

CAPACITY CENTRIC INFRASTRUCTURE TARIFFS



Consumption

- Yearly payment per agreed upon MW import capacity at PoC
- Gridloss is the only energy based part of the infrastructure tariff (day ahead price dynamic)

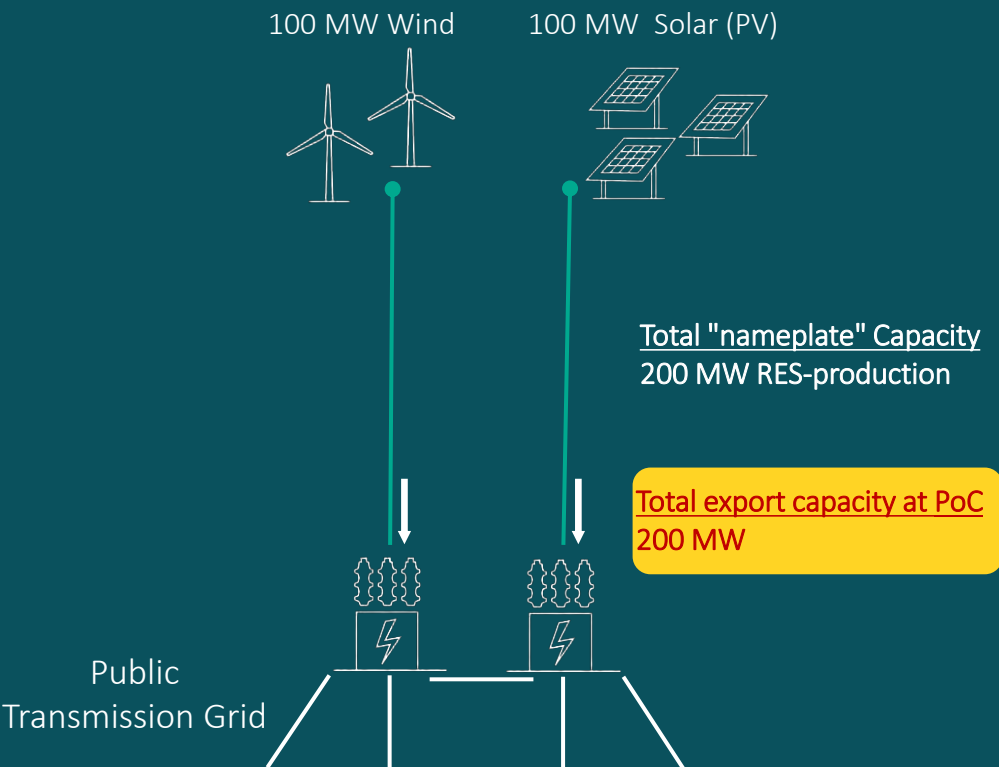
Production

- A new capacity based, geographically differentiated, connection payment (standardized and "deep") dominates the total tariff payments from producers

EXAMPLE: PRODUCER CONNECTION PAYMENT INCENTIVIZE CO-LOCATION OF WIND AND SOLAR (PV) – AND OPTIMIZATION OF NEEDED EXPORT CAPACITY

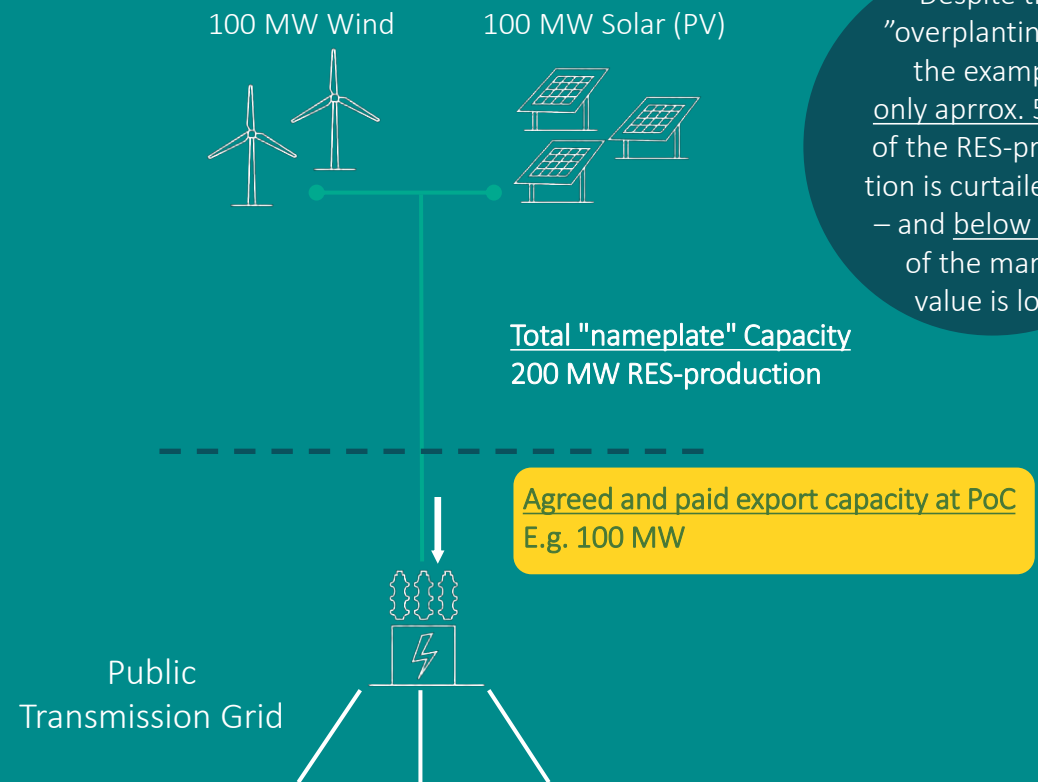
CONNECTION OF WIND AND SOLAR (PV) BEFORE "NEW PRODUCER PAYMENT"

All RES is connected at PoC with full "nameplate" capacity



OVERPLANTING WITH "NEW PRODUCER PAYMENT"

Different co-located RES-sources share connection capacity

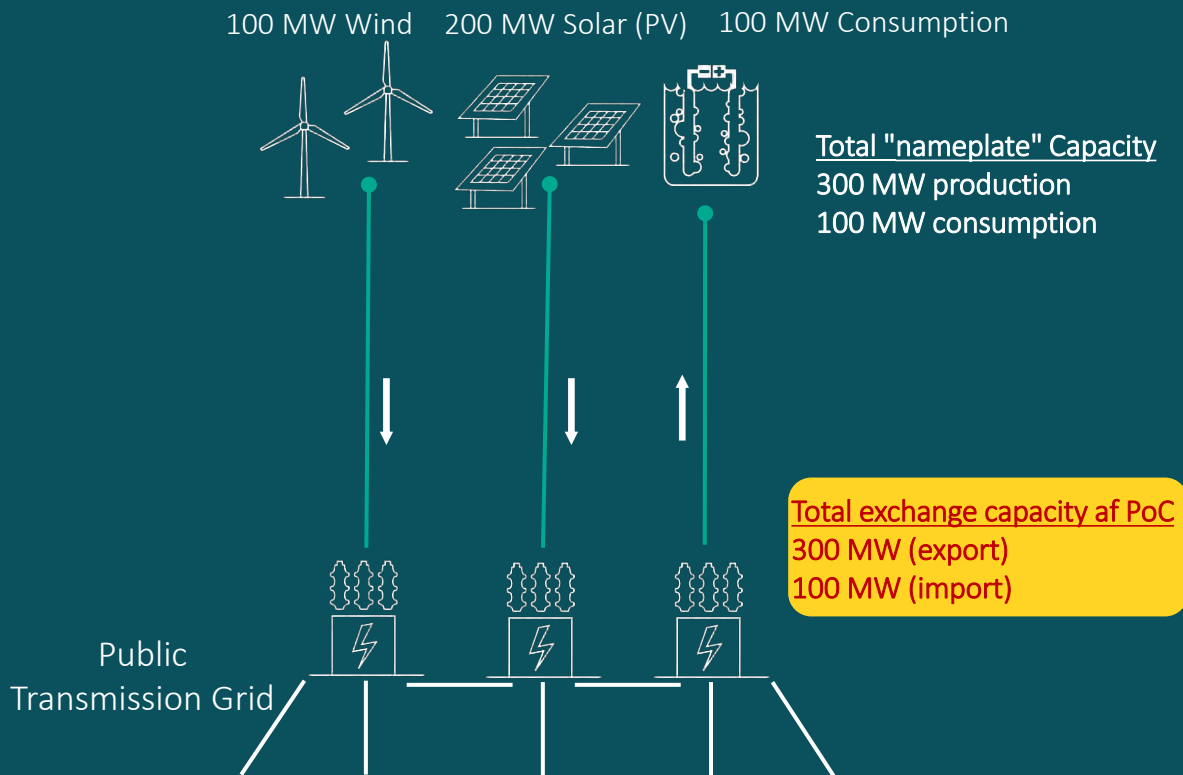


Despite the "overplanting" in the example only approx. 5 pct. of the RES-production is curtailed/lost – and below 1 pct. of the market value is lost.

EXAMPLE: DIRECT LINES INCENTIVIZE CO-LOCATION OF WIND, SOLAR (PV) AND FLEXIBLE CONSUMPTION - AND OPTIMIZATION OF NEEDED EXPORT AND IMPORT CAPACITY AT POC

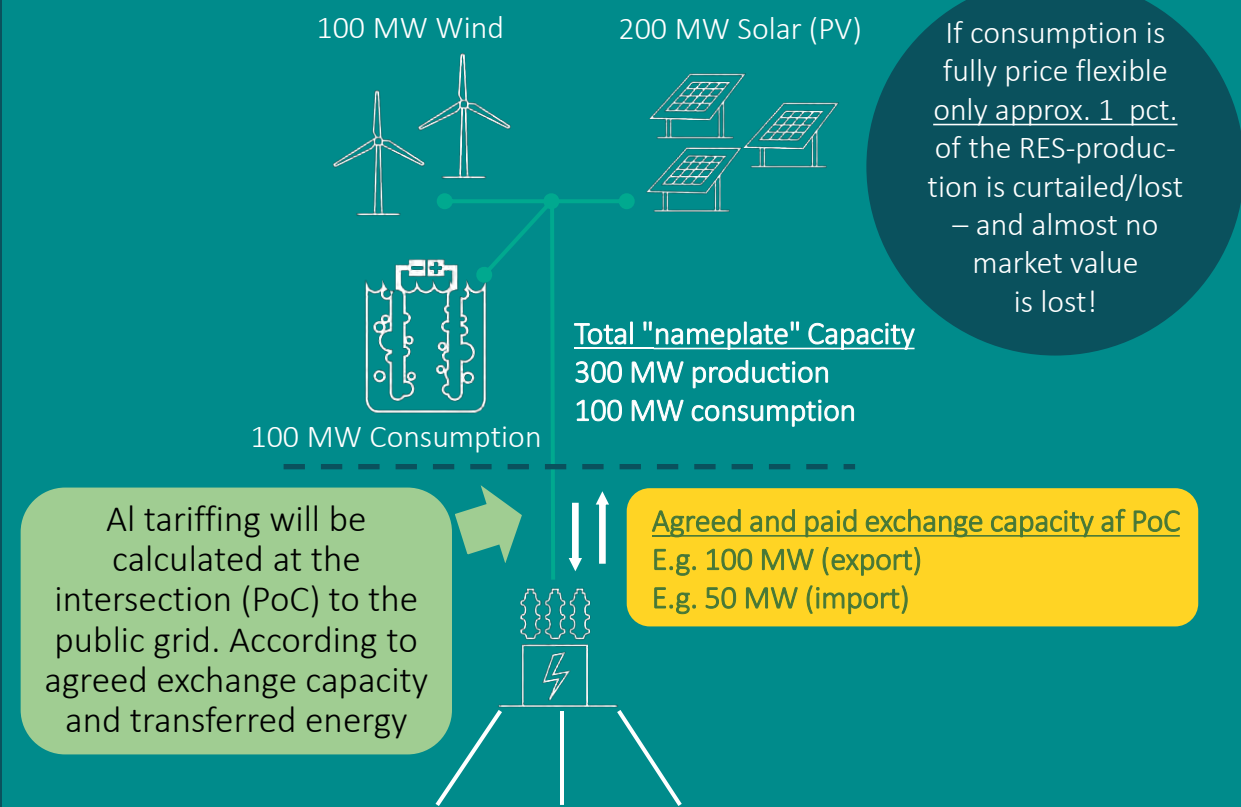
INDIVIDUAL CONNECTION OF WIND, SOLAR (PV) & CONSUMPTION

At full nameplate capacity



DIRECT LINES (PROSUMER)

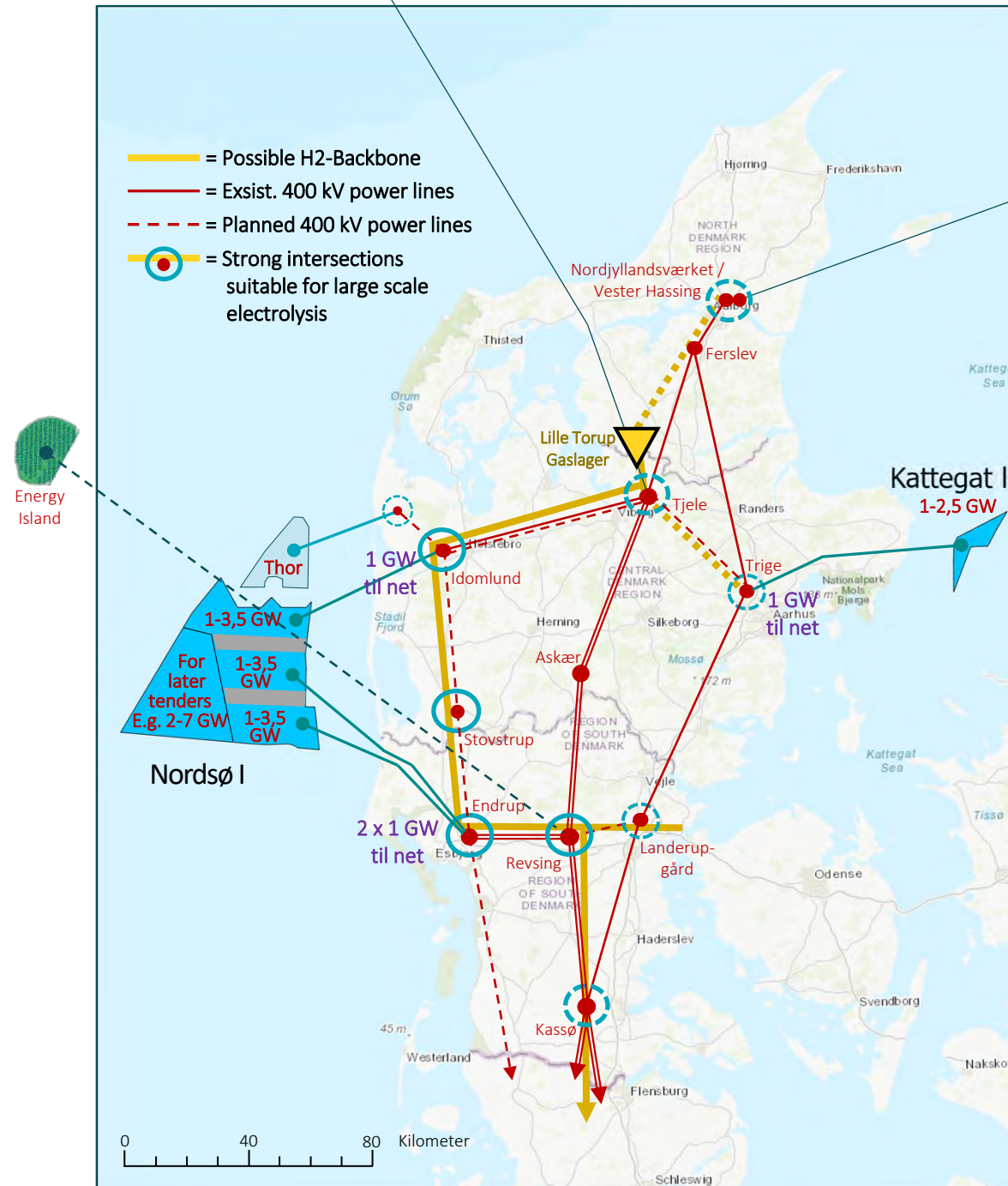
Incentivized by capacity centric tariffs





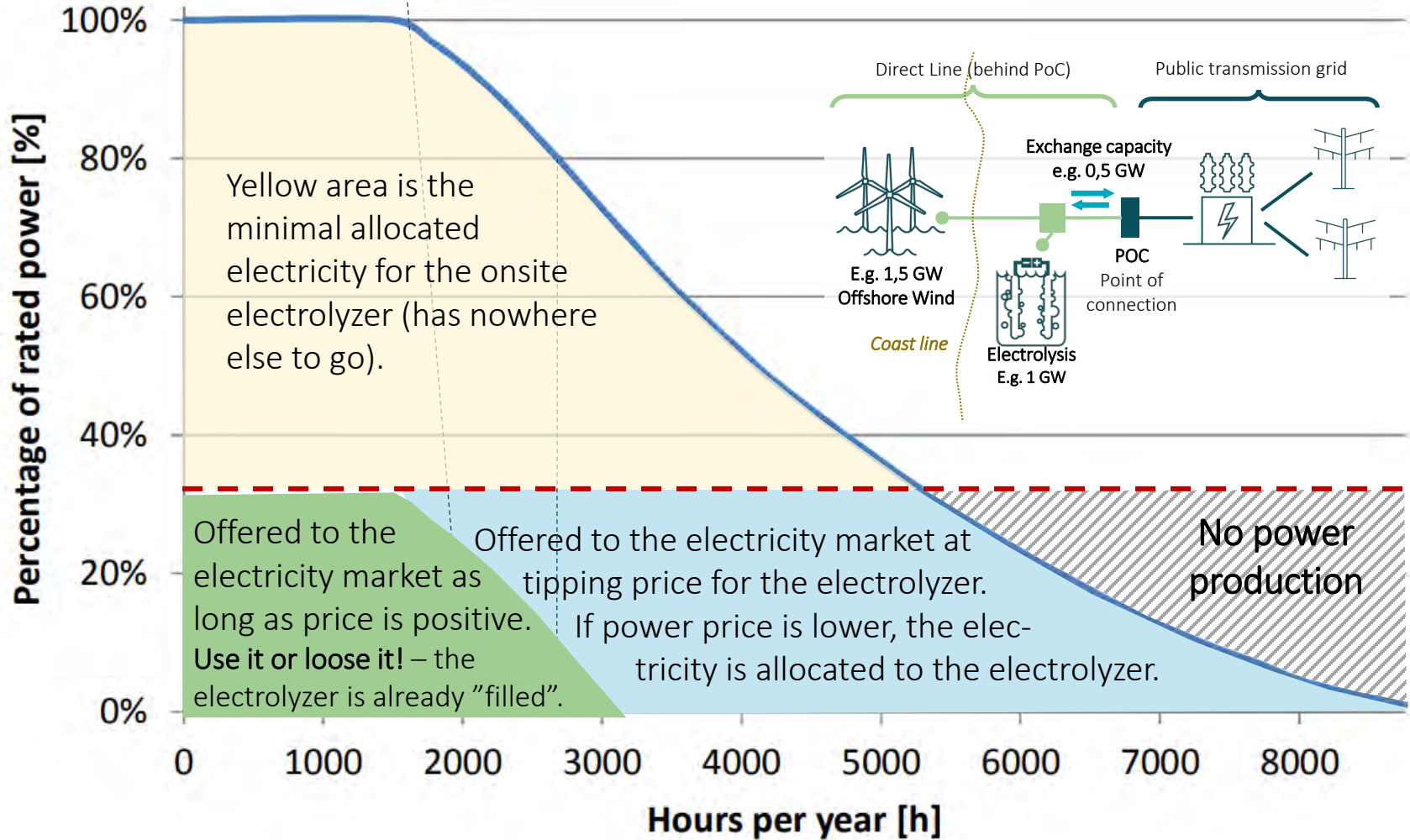
Potential synergies between upcoming GW-offshore tenders, large scale electrolysis and H2-infrastructure.

Overplanting / Direct Lines is part of the upcoming offshore tenders



Allocation of wind-production between fully flexible electrolyzer and the power grid

DRAFT example of overplanting where only 1/3 of the (offshore) wind capacity has access to the common power grid

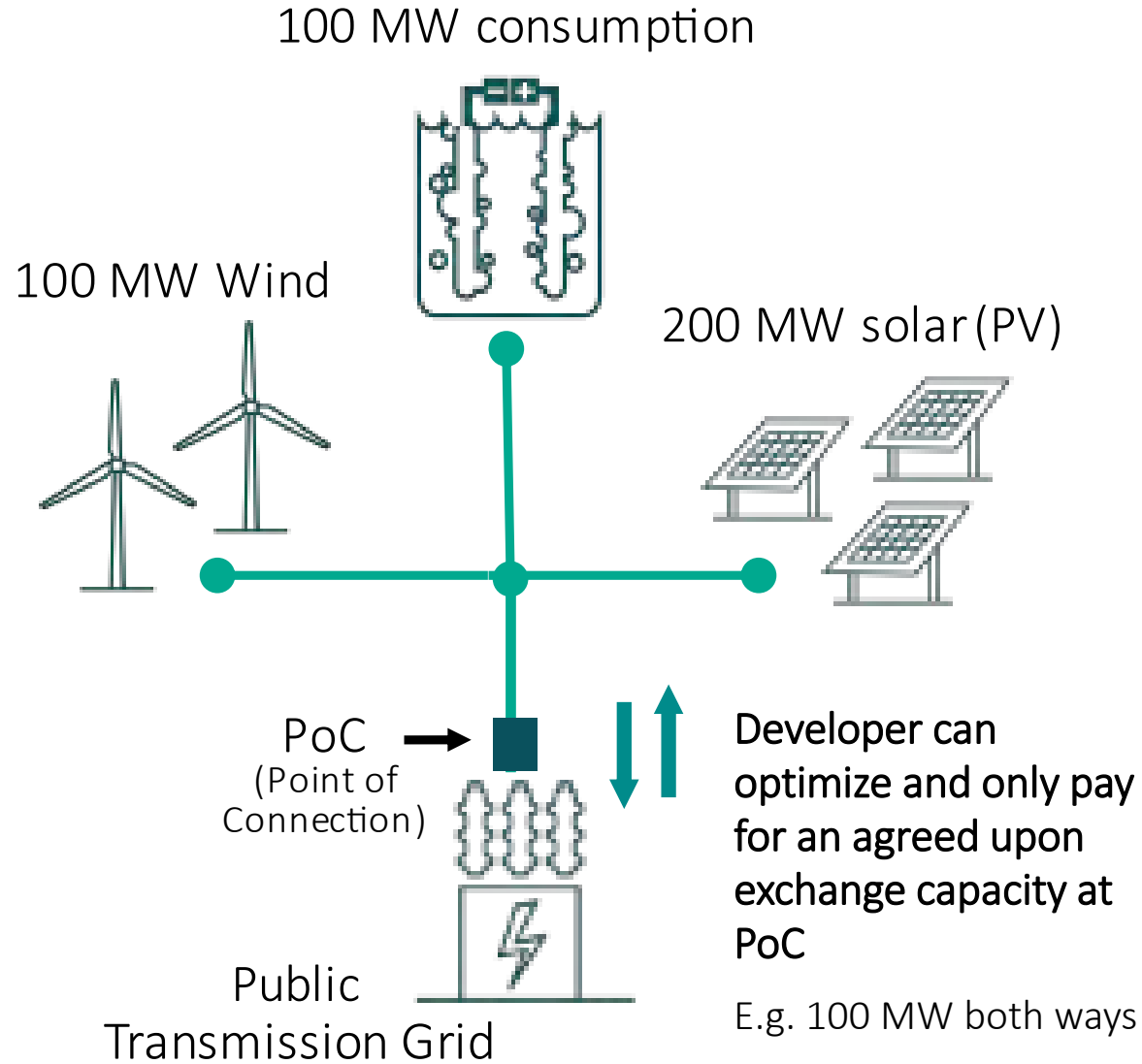


Electrolyzer capacity in example is 2/3 of wind capacity
Result ≈ the electrolysis gets between 3,500 and 5,000 Full Load Hours a year (FLH)
 Depend on which share of the blue area is allocated to electrolysis.

Capacity of the offshore wind "seen" from the market (1/3 of total wind capacity).

Result: Available offshore wind to the power market ≈ 6,500 FLH.
 Almost full dispatchable wind!

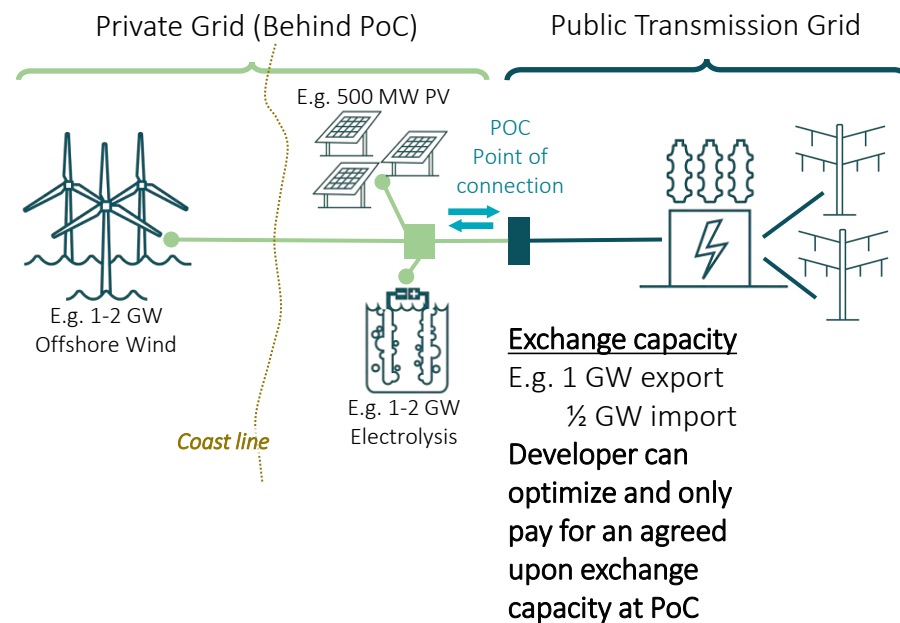
Note: The underlying generic offshore duration curve is taken from DEA Technology Data



WHAT IS A DIRECT LINE ?

- Direct lines are an exception to the main principle, that all transportation of electricity in Denmark is done through the public grid.
- The framework is meant to support co-location of production and consumption
- The criterias for direct lines must be objective and non-discriminating.

DIRECT LINES – CENTRAL CRITERIAS



The Direct Line concept with extended possibility for RES-production and consumption "behind PoC" was politically agreed upon in the PtX-agreement in Marts 2022 and implemented through law by 1. May 2023

Central Criterias

- Distance-criteria to avoid parallel electrical infrastructure (no more private grid behind PoC, than if all facilities were individually connected to the public grid)
- Both onshore wind, solar (PV) and offshore wind are expected to be possible candidates for this concept.
- Either consumption or production (or both) must be new plants/facilities
- The Danish Energy Agency gives permission to Direct Lines
- Only one connection-point to the public grid – and all facilities/entities "behind the meter" must act as one towards the public grid and the electricity markets (e.g. only one BRP!).
- Net-exchange and reserved exchange capacity in PoC determines tariffs/connection fees. The same tariffs/fees in PoC as with individual connection.