

PtX potential for 2050



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Agenda

Why PtX?



Ørsted's PtX ambitions

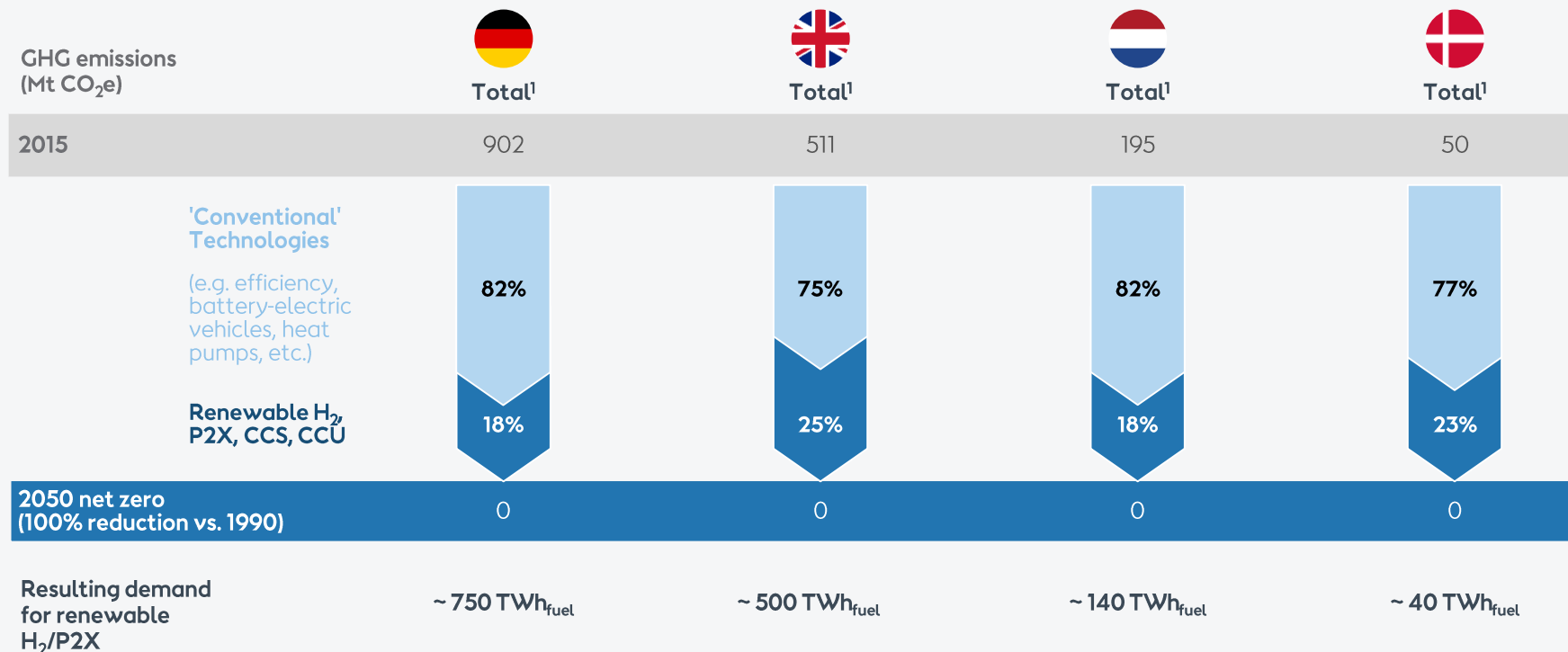


Market Design
(Policy & Regulation)



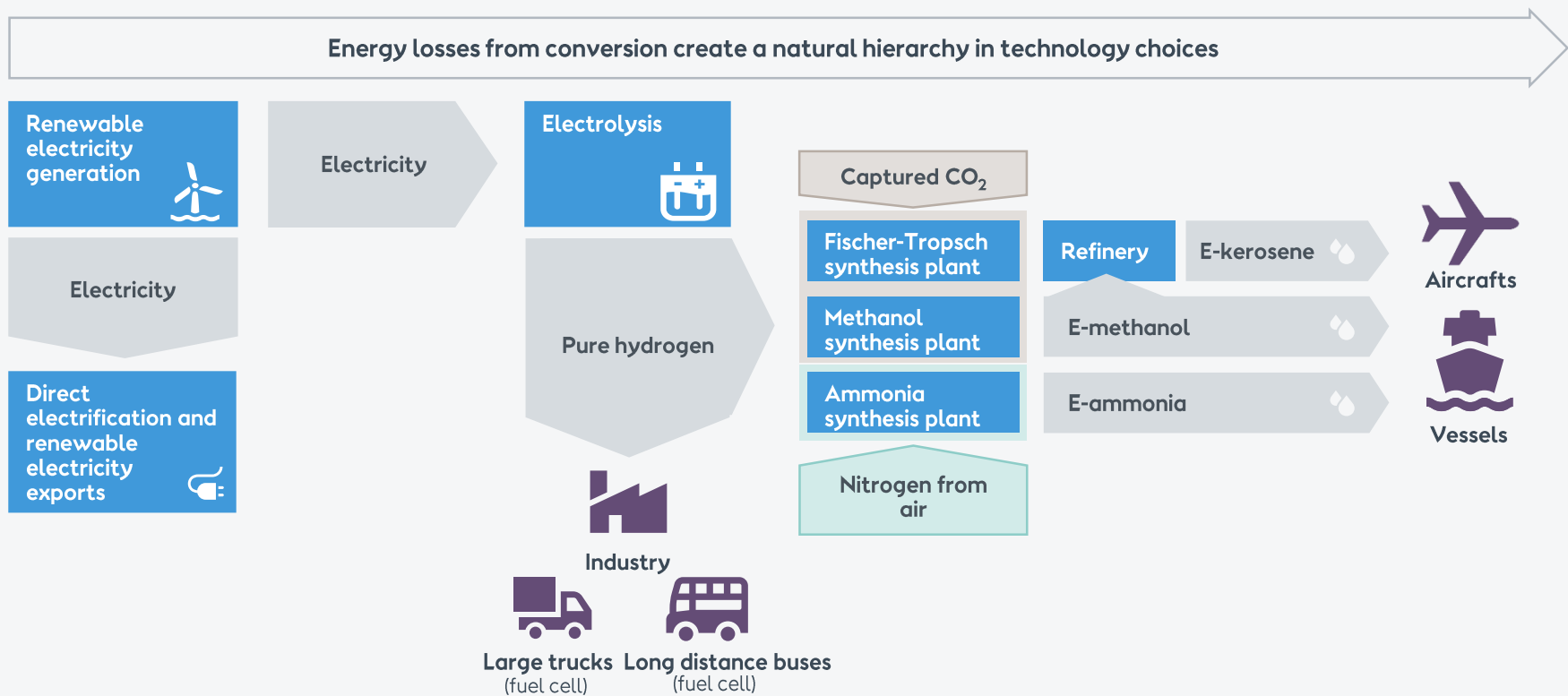


Renewable hydrogen can play a significant role in decarbonisation of society





Renewable hydrogen can decarbonise sectors where direct electrification is not feasible





Ørsted has a strong starting point

Our vision

Lets create a world that runs entirely on green energy



Extensive experience in scale up and cost out of new technologies



Synergies with global renewable generation portfolio



Proven partnership approach

Our leading sustainability ambition

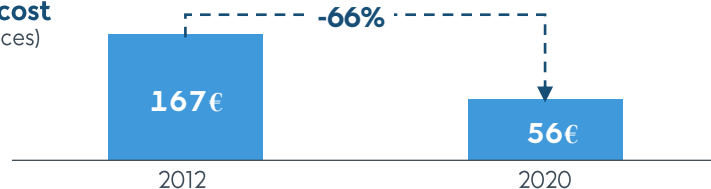
No landfills today

Coal free in 2023

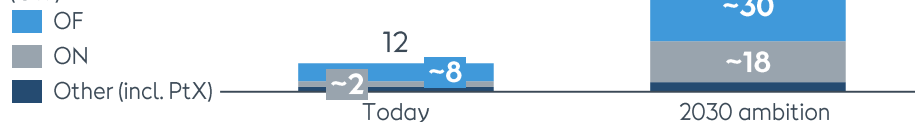
Net zero in 2025

Biodiversity positive in 2030

Offshore wind cost EUR/MWh (2021 prices)



50 GW installed capacity ambition by 2030 (GW)



Financial partners



Offshore wind co-development partners



Energy transition co-development partnerships



In NW Europe offshore wind electricity generation is well suited for electrolysis

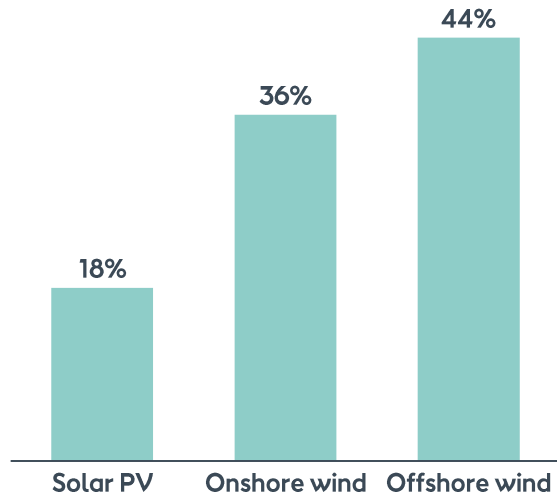
Scale

Offshore wind capacity of
>25GW now installed in Europe



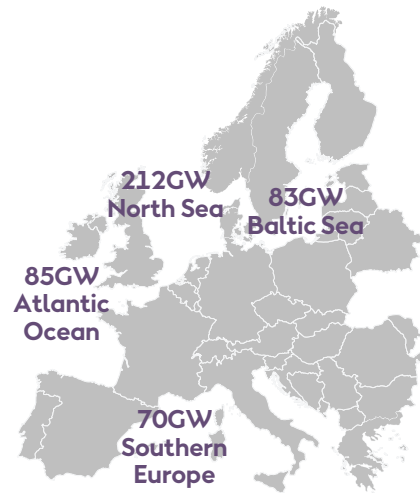
Capacity factor

Highest capacity factor of
variable renewable generation¹



Resource availability

450GW realizable OFW
potential identified in Europe²



Sources: IRENA Renewable Power Generation Costs in 2019; 1. 2019 average global capacity factors 2. Potential towards 2050 identified by the interest organisation Wind Europe. European Commission expect 230-450GW (depending on scenario) offshore wind in 2050



Strong concrete project pipeline across sectors and markets

Project	Main partners	Offtake	Current potential (MW) ¹
 Green Fuels for Denmark	▪ Maersk, SAS, CPH Airport, DFDS, DSV, Haldor Topsøe ⁴		 1,300
 SeaH2Land	▪ Yara, ArcelorMittal, Dow, Zeeland Refinery, North Sea Port ⁵		 1,000
 Westküste 100 ¹ / HySCALE100	▪ Raffinerie Heide, Hynamics, Holcim ⁶		 700 – 2,100
 Lingen Green Hydrogen	▪ bp		 550
 Haddock	▪ Yara		 100
 Gigastack	▪ Philips 66, ITM Power ⁷		 100
 H2RES	▪ Everfuel, DSV, GHS ⁸		 2
 Oyster	▪ ITM Power, Siemens Gamesa, Element Energy	Offshore H ₂	 1
 DFDS Europe Seaways ³	▪ DFDS, Ballard, Lloyd's Register ⁹		TBD

Example of funding paths



- **IPCEI**¹⁰ status targeted for major projects unlocking EU and national funding pools
- **EU Innovation Fund** of DKK 7.5 bn² targeted by selected large-scale projects including Lingen Green Hydrogen project
- **Local funding pools** targeted by applicable projects – e.g., H2RES which received funding from Danish EUDP (DKK ~35 m)

Regulatory mandates or incentives for green fuels will be **key to unlock** renewable hydrogen and green fuels

1. Intended as full electrolyser capacity currently identified 2. Budget total depends on CO2 allowances - annual monetization for funding call realized (allowances sold) last year 3. DFDS is project lead, Ørsted project partner 4. Includes COWI and BCG (knowledge partners) 5. Other partners include Smart Delta Resources, Province of Zeeland, Province of Oost-Vlaanderen 6. Other partners include EDF Germany, OGE, Stadtwerke Heide, Thyssenkrupp Industrial Solutions, Heide region development agency, Westküste University of Applied Sciences 7. Partnership also includes Element Energy 8. Other partners include Green Hydrogen Systems, NEL Hydrogen, Hydrogen Denmark Energinet Elsystemansvar 9. Other partners include ABB, Hexagon Porus, KNUD E. HANSEN, Danish Ship Finance 10. Communication on Important Projects of Common European Interest

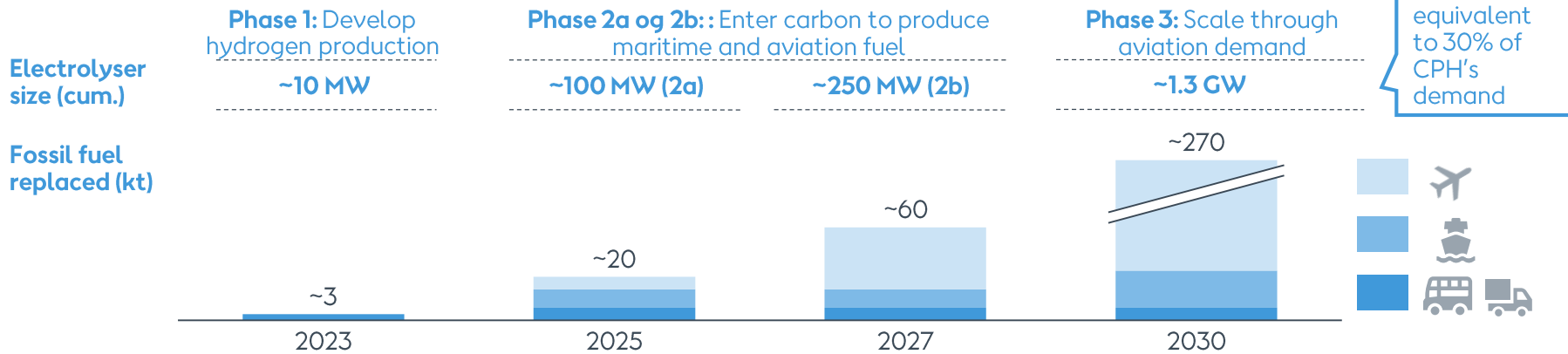


Green Fuels for Denmark | Leading Danish companies join forces on an ambitious sustainable fuel project in the Copenhagen area



Supported by
COWI
BCG

Associated partners
nel • **Everfuel** • **MOLSLINJEN** • **REGION** • **HALDOR TOPSØE** • **DTU**





Market design | Several key success factors exist for renewable hydrogen and PtX to reach the political targets and forecasts



Massive **renewable energy build-out**



Cost reductions through technological innovation and scale



Financial support bringing hydrogen from pilot to scale

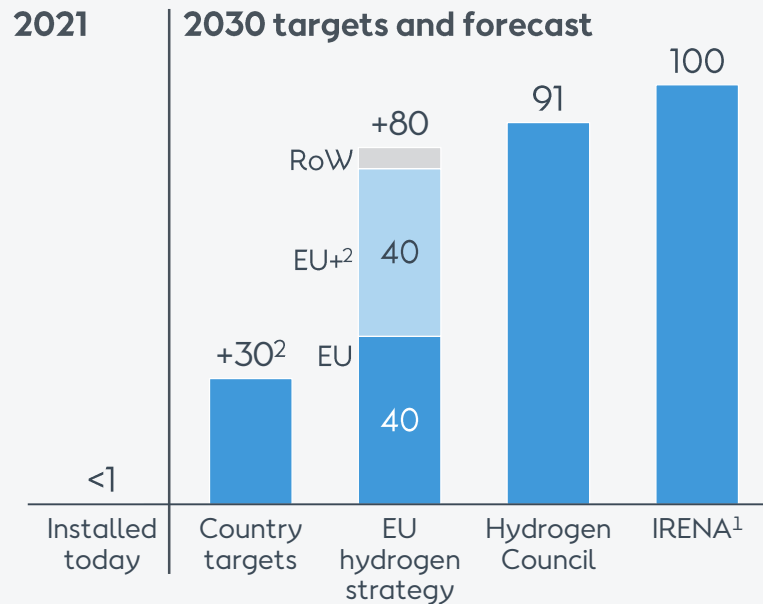


Coherent regulatory framework for PtX setting **definitions** and stimulating both **supply and demand**:

Examples

- Guarantees of Origin, def. of green
- Requirements of additionality
- Clarity on taxes, levies and tariffs
- Blending mandates etc.

2030 renewable hydrogen electrolyser capacity (GW)



Annex



21-10-05

 Orsted



2030 aspiration: Become the world's leading green energy major

Become the
world's leading
green energy
major



One of the world's largest **green electricity producers**

Global no. 1
in offshore



Global top 10 in
onshore



A global leader in renew-
able H₂ & green fuels



One of the world's largest and most value creating **deployers of capital** into the green transformation



The world's **leading talent platform** in renewable energy



A **globally recognised sustainability leader**



A core contributor and **catalyst for change** towards a world running entirely on green energy



Ørsted has a strong starting point



Extensive experience in scaling up new technologies

- Proven track record of scaling new renewable technologies
- Vast experience in working with decision-makers to shape regulatory conditions for adoption and scale-up



Synergies with global renewable generation portfolio

- Global renewable portfolio with large potential for synergies with renewable hydrogen and green fuels business
- Proximity of generation assets to large renewable hydrogen and green fuels offtakers e.g., industrial clusters in Europe



Proven partnership approach

- Proven ability to work with partners across the renewable hydrogen and green fuels value chain
- Attractive and credible partner for companies seeking to embark on a decarbonisation journey
- Established partnerships with key offtakers in target sectors



H2RES

Offtake sector: Heavy transport

FID: December 2020, COD expected end 2021

Project description

- Project serves as a demonstration plant of a **2 MW electrolyser** at Avedøre Power Station, powered by two 3.6MW turbines to produce hydrogen for **bus offtake in Zealand**
- Ørsted's scope is production of hydrogen and **full asset ownership**, while Everfuel is the offtaker and responsible for fuelling and distribution
- Project is funded by **Energy Technology Development and Demonstration Programme (EUDP)**

Partners

Everfuel

DSV

GREEN
HYDROGEN
SYSTEMS

ENERGINET

Brintbranchen
Hydrogen Denmark

Current project status

- The H2RES demonstration project is progressing as planned with renewable hydrogen production expected to **commence by the end of 2021**
- On 17 June 2021, Ursula von Leyen and Mette Frederiksen visited Avedøre Power Station and was shown the H2RES construction site and the envisaged co-located site of Green Fuels For Denmark

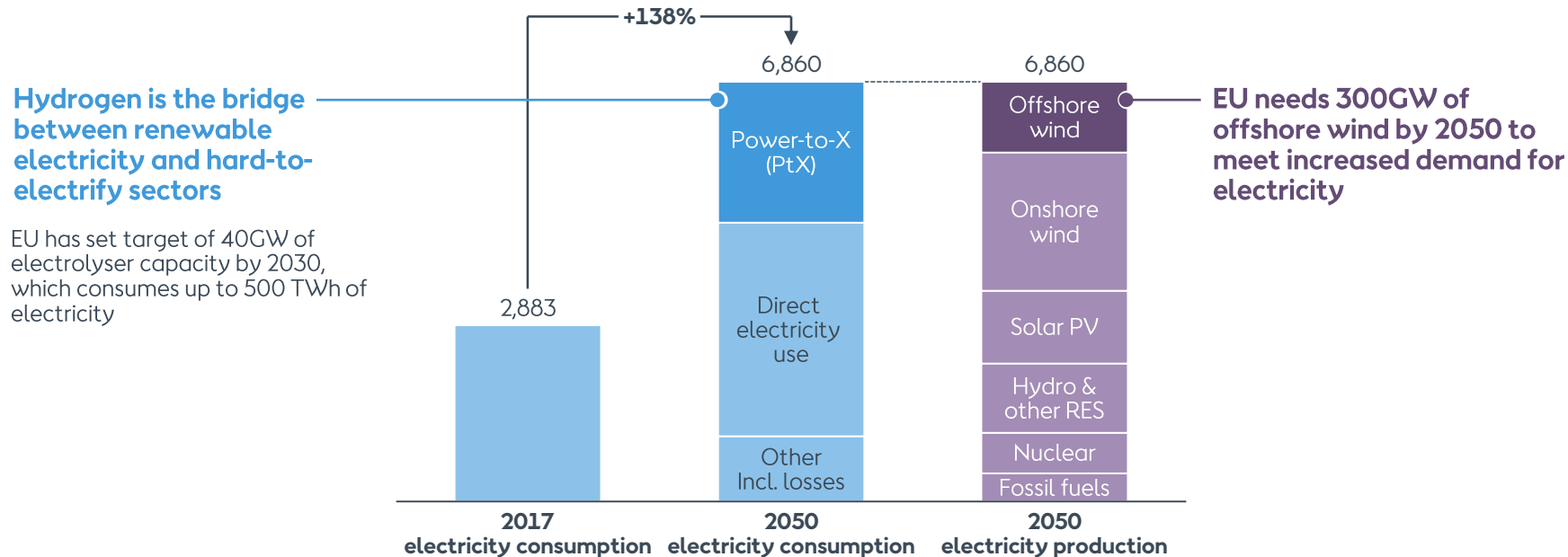
High level timeline

Main Activities	2020	2021												
	Dec	jan	feb	mar	apr	maj	jun	jul	aug	sep	okt	nov	dec	
Key milestones	▲ FID												▲ COD	
Contract Tender	←													
Site works							→							
Operation period													→	



Market design | Europe needs to build large amounts of new renewable electricity capacity to reach net-zero by 2050

Full decarbonisation requires strong direct and indirect electrification which will increase electricity demand by ~135%
EU electricity production and consumption by source¹, TWh



¹. Numbers are based on EC offshore strategy and the EC 2030 CTP Figure 37 (electricity consumption) and 46 (2050 electricity production) PtX share based on conversion rates used in E3M PRIMES (2019). Efficiencies will likely increase towards 2050, likely leading to a reduction on electricity demand for PtX. The value of the category "Other Incl. losses" is obtained by subtracting "Direct electricity use" and "Power-to-X" from the total electricity production. Losses related to PtX in 2050 amount to 975 TWh (this includes further conversion into synthetic fuels such as CH₄).