

UNIFHY

Unifying policies to support the uptake of green hydrogen to decarbonize Europe.

LSG #5

30. září 2026 | Ostrava



LineUP ;-)

- PROJEKTY INTERREG (*jen chvilku*)
- o PROJEKTU UNIFHY (*2 &3/4 min*)
- DOBRÉ PRAKTIKY: (*5x7 min*)
 - lokální: rekapitulace identifikovaných v ČR (*7 min*)
 - externí: IE#3: Aalborg (*DNK*) (*21 min*)
 - externí: IE#2: Kilkenny (*IRL*) (*7 min*)
- PILOTNÍ PROJEKT
- DISKUSE (*∞ min*)

DOBŘÉ PRAKTIKY:

lokální: identifikované / publikované

Daniel Minařík
odborný pracovník projektu



Low-cost public hydrogen filling station



GP owner / promoter:

Vítkovice, a.s. – local company, producer of large scale hydrogen storage systems & solutions

Brief description:

The first low-cost hydrogen refueling station in the Czech Republic, located in Ostrava, was developed to support the early adoption of hydrogen-powered vehicles. It features advanced energy-efficient technology, reducing operating costs significantly.

In June 2022, Vítkovice, a.s. inaugurated the first public hydrogen refueling station in the Czech Republic. Located in central part of Ostrava, the station covers approximately 90m² and is designed for hydrogen-powered passenger vehicles, offering refueling at 700bar.





Hydrogen safety related risks management system

GP owner / promoter:

Technical University of Ostrava / Moravian-Silesian Region - application guarantor

Brief description:

This practice provides a **comprehensive approach to managing safety risks in the hydrogen economy**, focusing on the integration of safety, security, and sustainability.

It addresses the challenges posed by hydrogen's high energy potential and explosive nature, emphasizing the need for sophisticated risk analysis and preventive measures. **By employing systematic methodologies such as the MOSAR method**, it enables stakeholders to identify, evaluate, and mitigate risks effectively.



Zásobník...



- 1. EDER SERVIS – první certifikované „self made“ servisní zázemí pro H mobilitu v ČR
- 2. APOKS – demonstrační polygon užití vodíku v podmínkách občasné zástavby (RD)
- 3. H2 TRUCK – projekt popularizace a výuky na SŠ
- 4. DEMNOSTRAČNÍ PS – SŠ Chomutov
- 5. H₂ & H₂T KURZY – organizované prostřednictvím DOV



Další dobré praktiky?



Doporučíte nám další dobré praktiky?



DOBŘÉ PRAKTIKY:

Externí z IE#4: Aalborg (DNK)

Daniel Minařík
odborný pracovník projektu



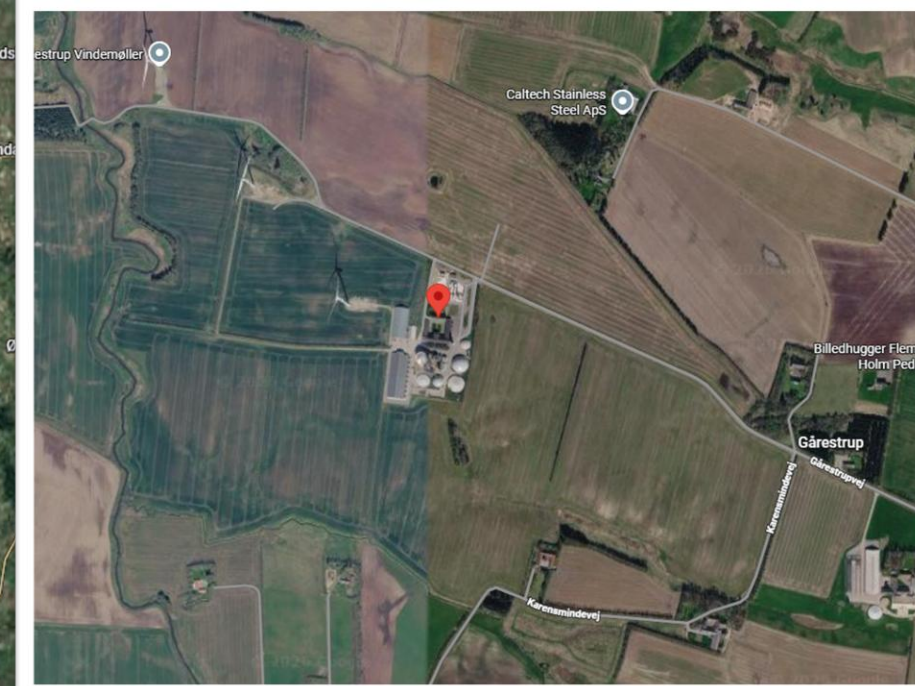
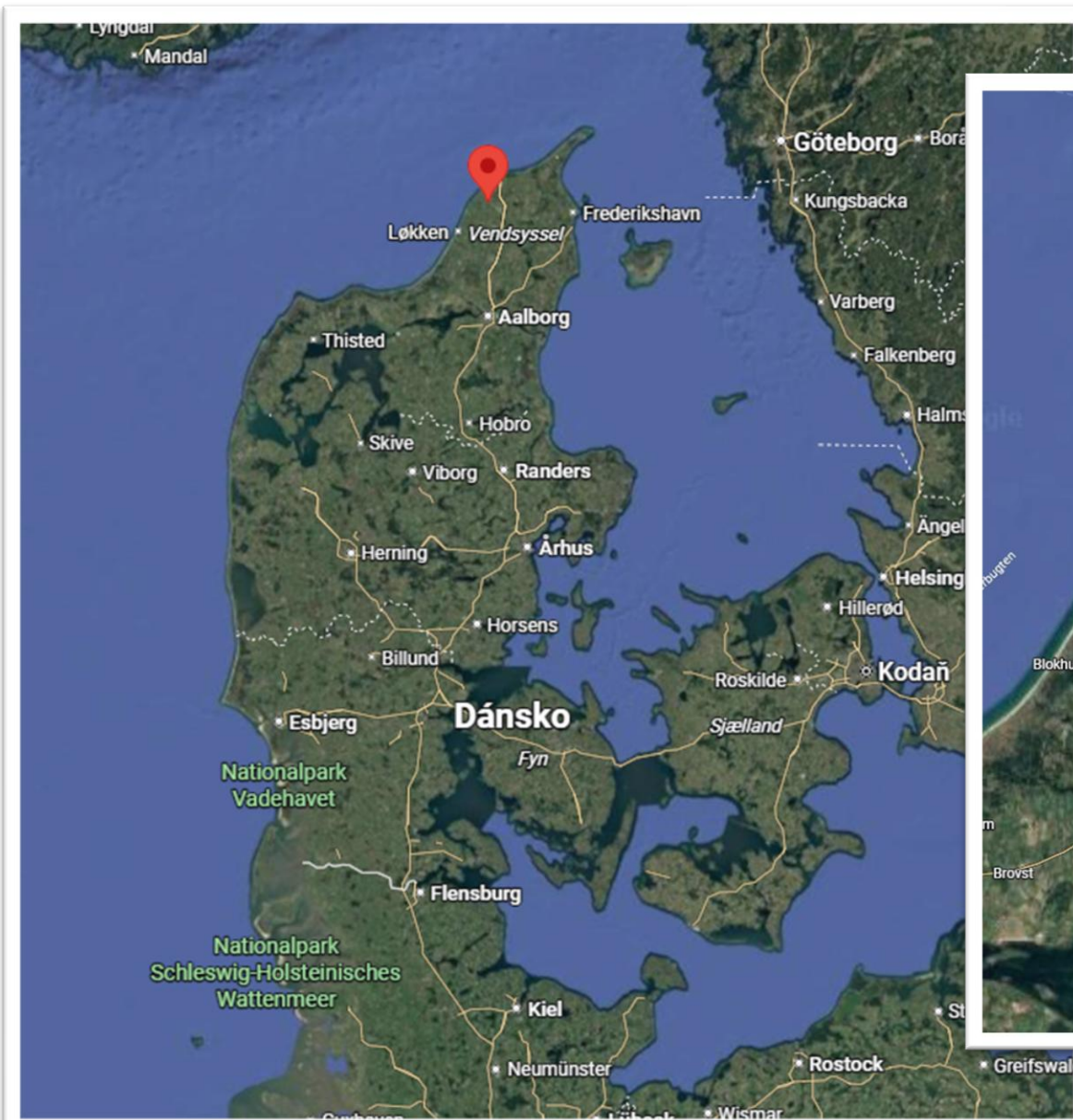
IE#4: Aalborg 4.-7. 5. 2026



IE#4: Aalborg 4.-7. 5. 2026

1. *Aalborg Industrial Park*
2. *Strategies for testing renewable fuels & blends safely in an open combustion system - **Alfa Laval***
3. *Synthetic sustainable aviation fuel (eSAF) project from 2030 in Aalborg - **SynFjord PtX***
4. *Energy effective carbon capture - **Frichs Pyrolysis***
5. *The Hjørring biogas/hydrogen plant – **GrønGas***
6. *Carbon capture and storage – **Aalborg Portland***

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GrønGas



BIOGAS/HYDROGEN STATION GreenGas.dk



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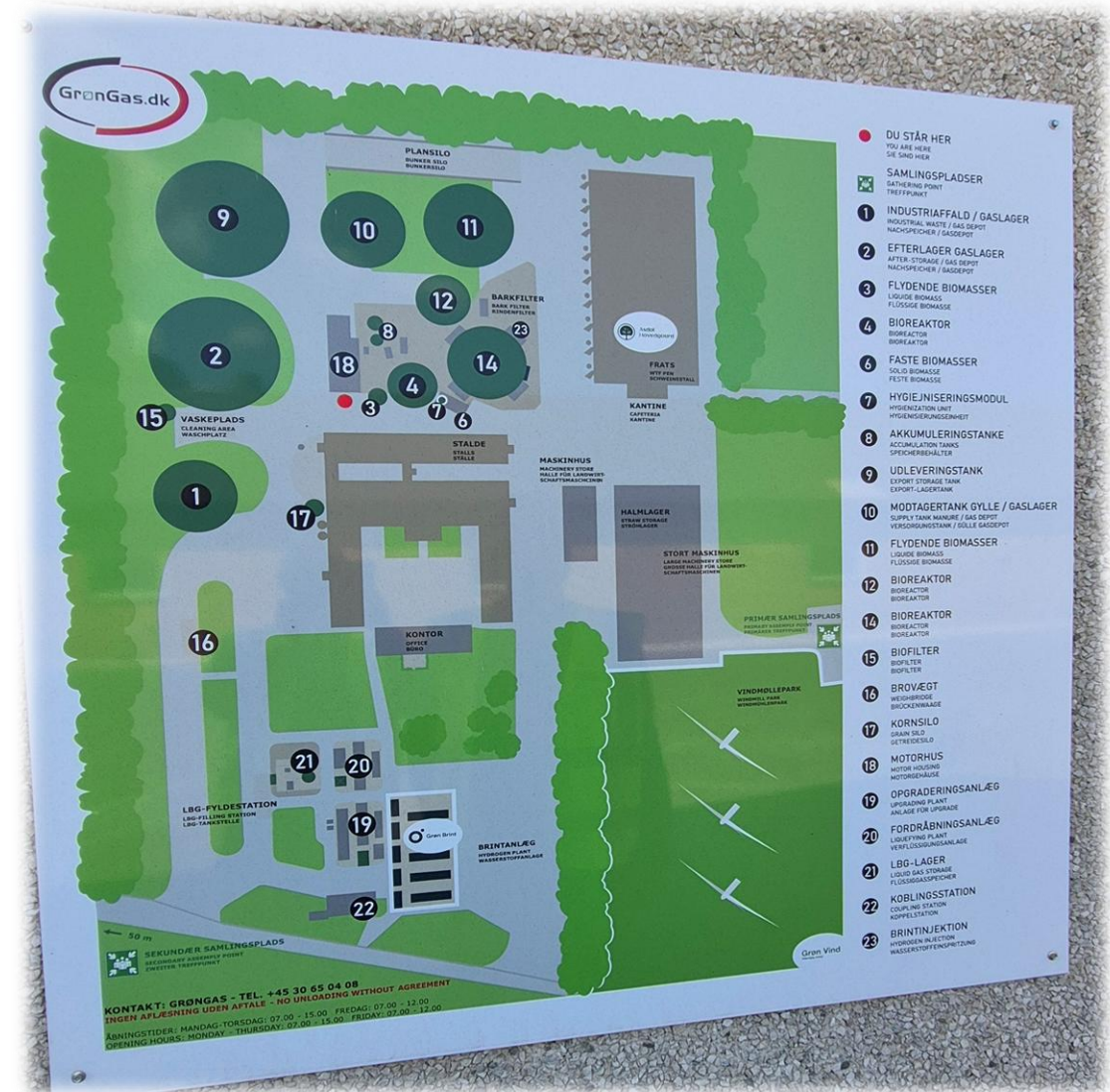
The Hjørring plant was established in 2001 and is **the oldest** in GrønGas' portfolio. The plant where we have most recently expanded and rebuilt.

Total costs: 140 mil. DKK (19 mil. €)

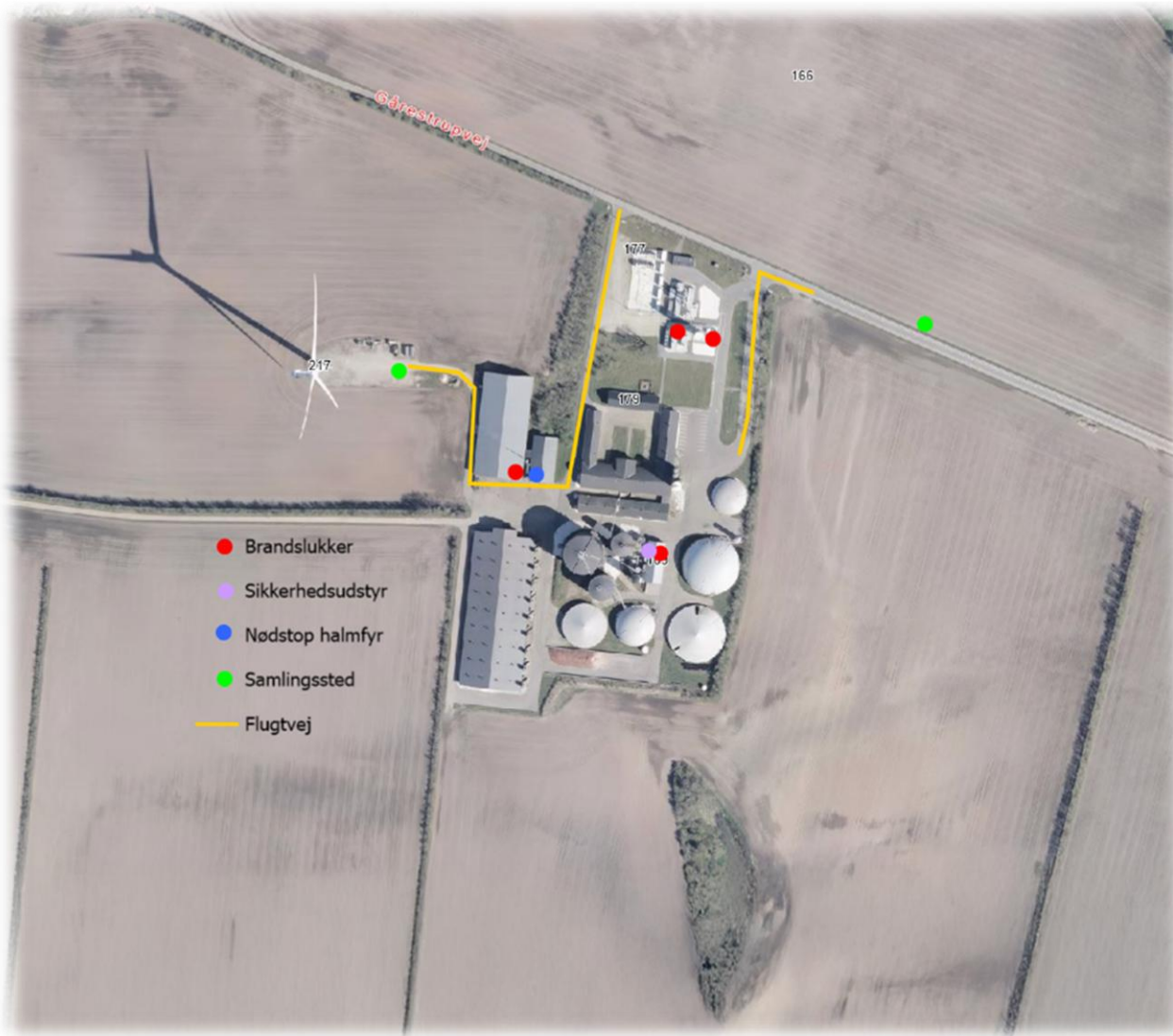
The plant is equipped with the latest technology in biogas production and marketing and is **the only plant in Denmark that produces** and sells the gas **completely without public support.**

Plant produce **liquid biomethane (LBG)**, which is **sold to Germany** and is part of the green transition of German heavy transport.

The biomass intake is **approximately 100,000 tonnes** of biomass annually comes from **30 k pigs** and is optimised to handle a wide range of residues, including **animal manure, organic industrial waste and other biogenic materials.**



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BIOGAS/HYDROGEN STATION GreenGas.dk

The annual production of **liquefied biomethane** corresponds to about **5-6 million litres of diesel per year**.

In collaboration with two other companies **is produce hydrogen from wind turbine power**.

Hydrogen can be used **for the production of e-methane** (e-fuels) and we can thus utilize a large part of the residual stream of CO₂ that is given from the production of biogas at the plant.

The **Hjørring plant** is actually **Denmark's only functioning energy island**, where our electricity consumption at the biogas plant and for hydrogen production comes directly from wind turbines located on the same property.



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Biomass input

Liquid

- pig manure,
- cow manure,
- other certified waste.

Solid

- bleaching earth (*waste from rapeseed oil refining*),
- baker's waste (*purchased bakery waste approximately 4,000 tons purchased in Sweden*)
- oat hull pellets,
- **other certified waste** biomass.

Biomass Preparation

1. homogenized,
2. mixed with slurry,
3. heated to 52 °C,
4. pumped into digesters

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Electrolyzers

Technology:

PEM electrolyzer (Proton Exchange Membrane).
Current installation = 2 containers per 1 MW

Hydrogen Production

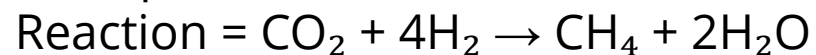
approx. 900 kg H₂/day.

After expansion to 5 MW:
approx. 2,250 kg H₂/day. (calculated using the same ratio)

Efficiency: 75%

Hydrogen-Based Methanation

Principle:



In-situ biological methanation directly in the digester.

Filling Station

Process:

1. weighing the empty vehicle
2. flushing with nitrogen
3. filling with LBM
4. purging the lines with nitrogen
5. departure

Filling time: 1 hr 15 min.

Collection Frequency: 1 a week

The truck hauls: **16–19 tons**

Energy per truck: **50–55 MWh**



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BIOGAS/HYDROGEN STATION GreenGas.dk



AALBORG PORTLAND

1889

FOUNDED

Aalborg Portland was founded in 1889 and is the only cement manufacturer in Denmark.

358

PEOPLE

Aalborg Portland directly employs 358 people in addition to which a substantial number of employees of external contractors and subcontractors work at Aalborg Portland.

3.0

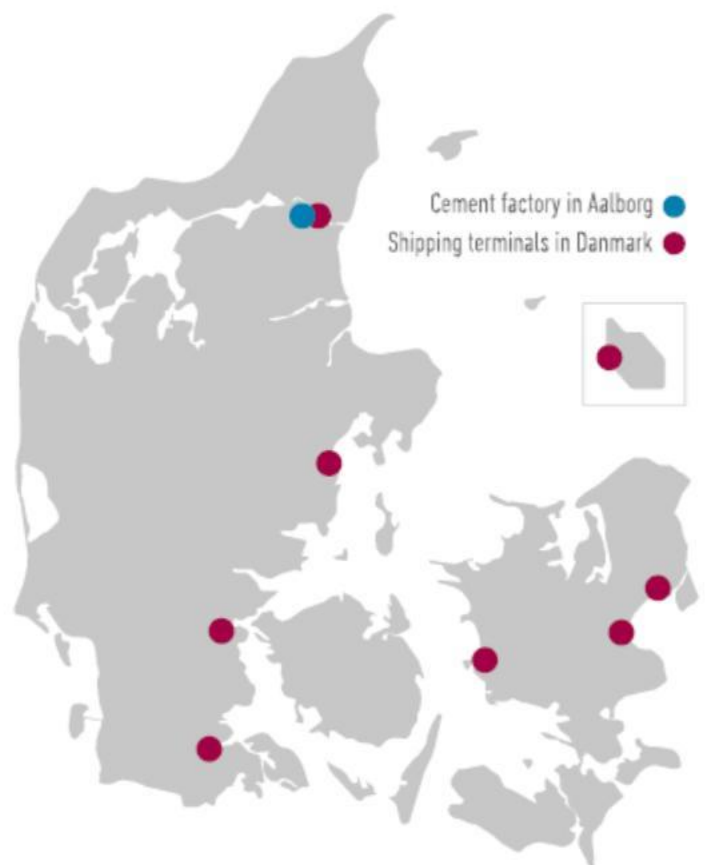
MILLION TONNES CEMENT

Aalborg Portland has an annual production capacity around 3 million tonnes of cement.

18

COUNTRIES

Aalborg Portland has been part of Cementir Group since 2004. Cementir is a multinational Group operating in 18 countries.



Concrete, cement, clinker

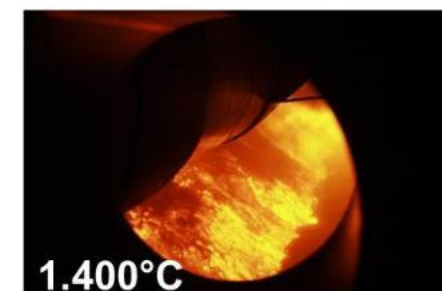
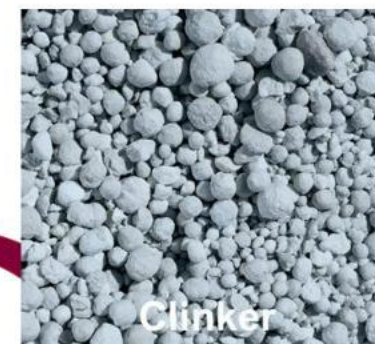
Concrete: cement + water + sand
+ gravel+ aggregates



Cement: clinker +
gypsum



Clinker is the main ingredient in cement
(up to 90%)



Cement production from quarry to customer

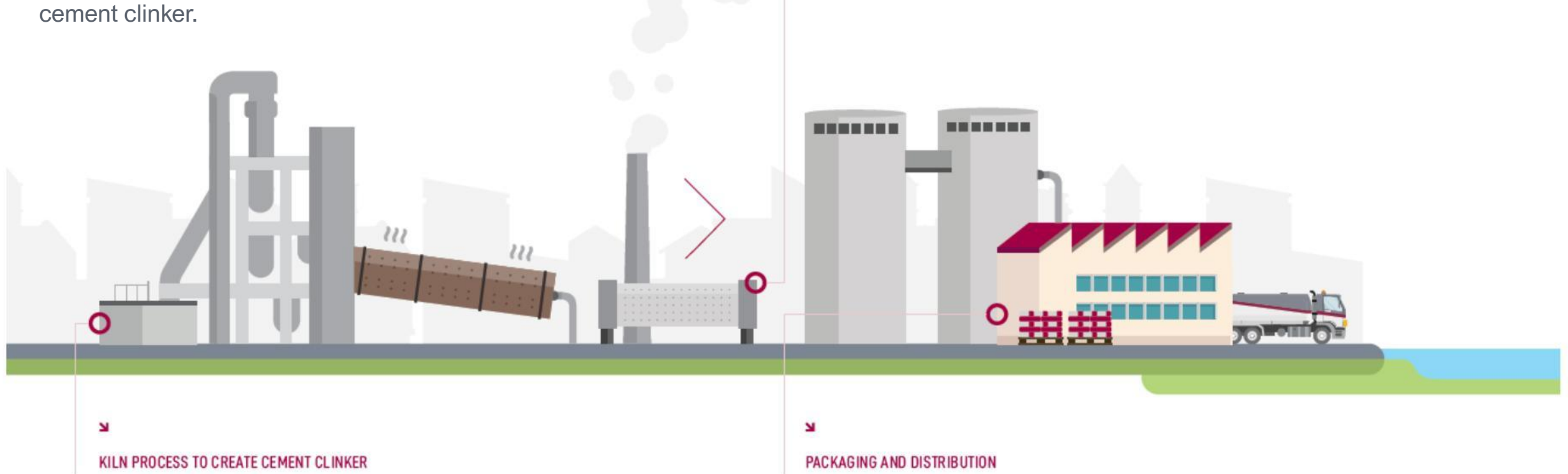
The **slurry** is injected into a dryer crusher, where it is dried and crushed, converting it into a dry powder called **raw meal**.

The **raw meal** moves to calciners, which heat it to **900°C**, then to a **74-metre-long rotary kiln**, heated gradually to **1,500°C** to form cement clinker.



GRINDING OF FINISHED CEMENTS

After stockpiling, the cement mill grinds the cement clinker with other additives such as fly ash, gypsum, chalk, and calcined clay. This combination creates a fine powder known as cement. We then pump the finished cement into storage silos close to our harbour, ready for packaging and distribution.

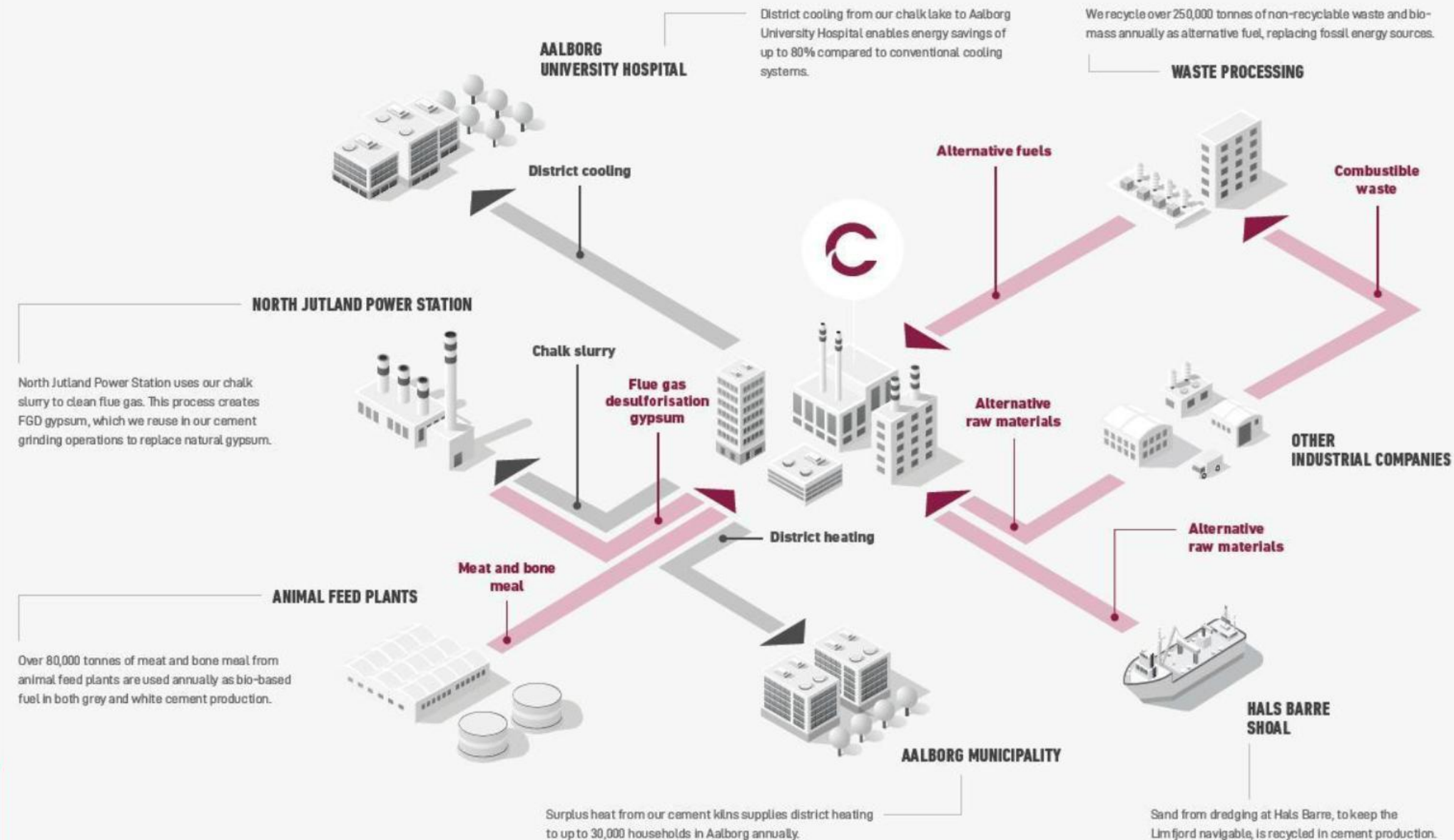


KILN PROCESS TO CREATE CEMENT CLINKER



PACKAGING AND DISTRIBUTION

Resource efficiency and circularity



ALTERNATIVE RAW MATERIALS

FLY ASH

Byproduct from coal-fired power stations.

SAND FROM HALS BARRE

Which is dredged to keep the Limfjord navigable.

IRON OXIDE

Byproduct of the manufacture of sulphuric acid.

OXITON

Byproduct from aluminium oxide filtration.

SEA SHELLS

Byproduct from food processing.

FGD GYPSUM

Byproduct from desulphurisation of flue gases from the North Jutland power station.

ALTERNATIVE FUELS

REFUSE-DERIVED FUEL

Produced from various types of waste such as municipal solid waste, industrial waste and commercial waste.

RECYCLED RUBBER GRANULATES

Recycled rubber from various sources, including tires.

MEAT AND BONE MEAL

Byproduct from the rendering industry.

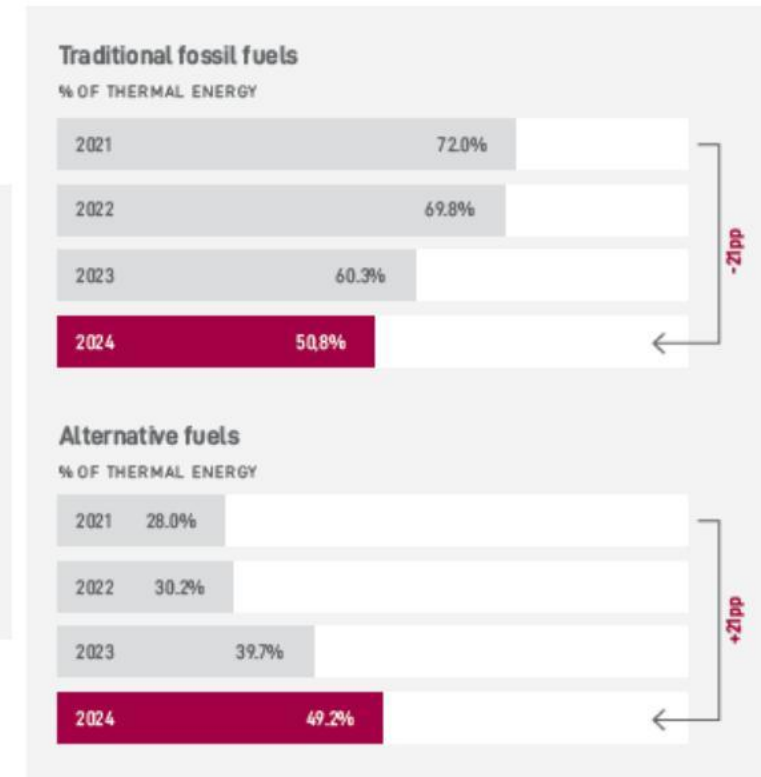
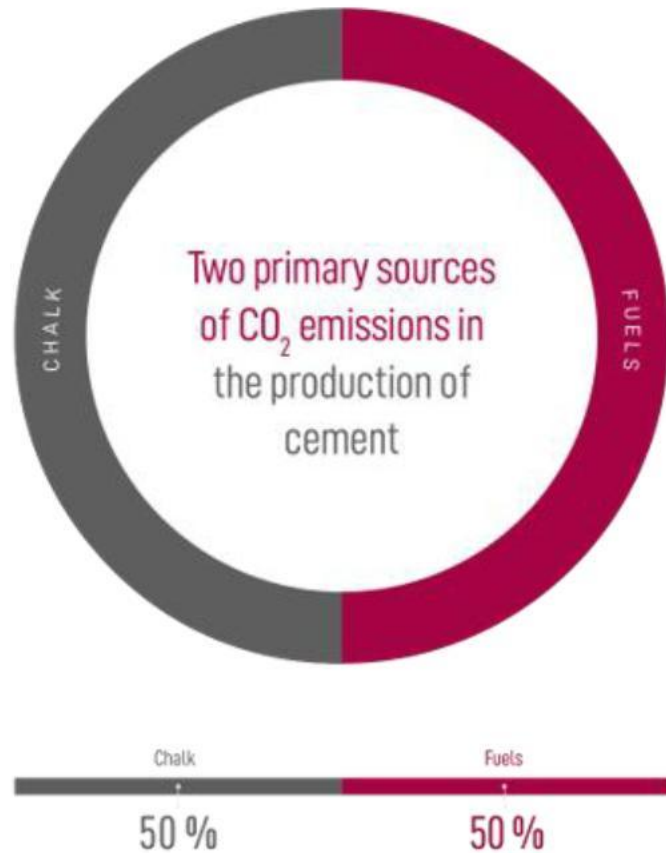
NUT SHELLS

Byproduct from food processing

TROLDTEK PANELS

Pulverised production waste from our customer, Troldtekt.

CO₂ emissions



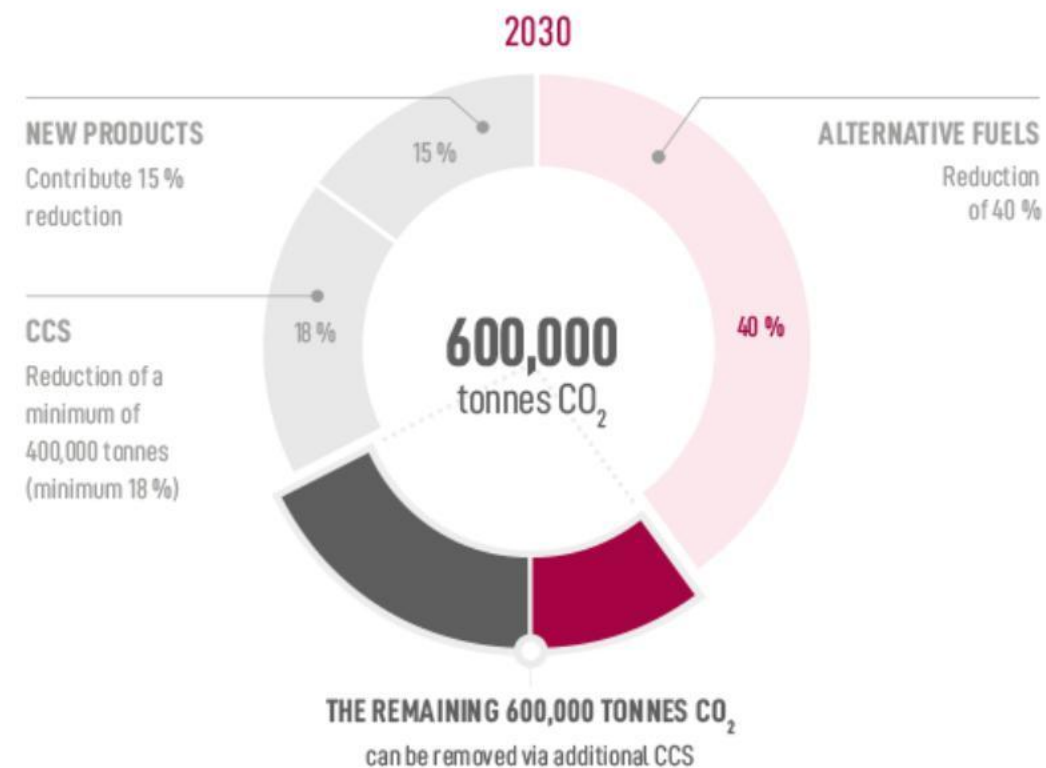
Net zero roadmap

Aalborg Portland's 2020 Roadmap

Goal: cap on emissions 600,000 tonnes of CO₂ in 2030

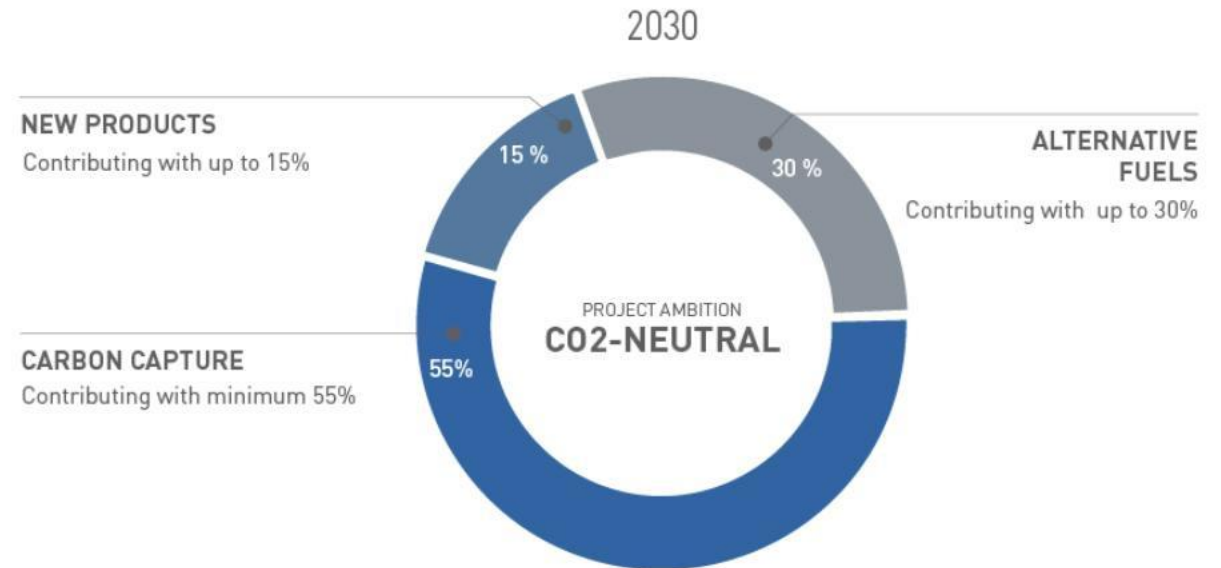
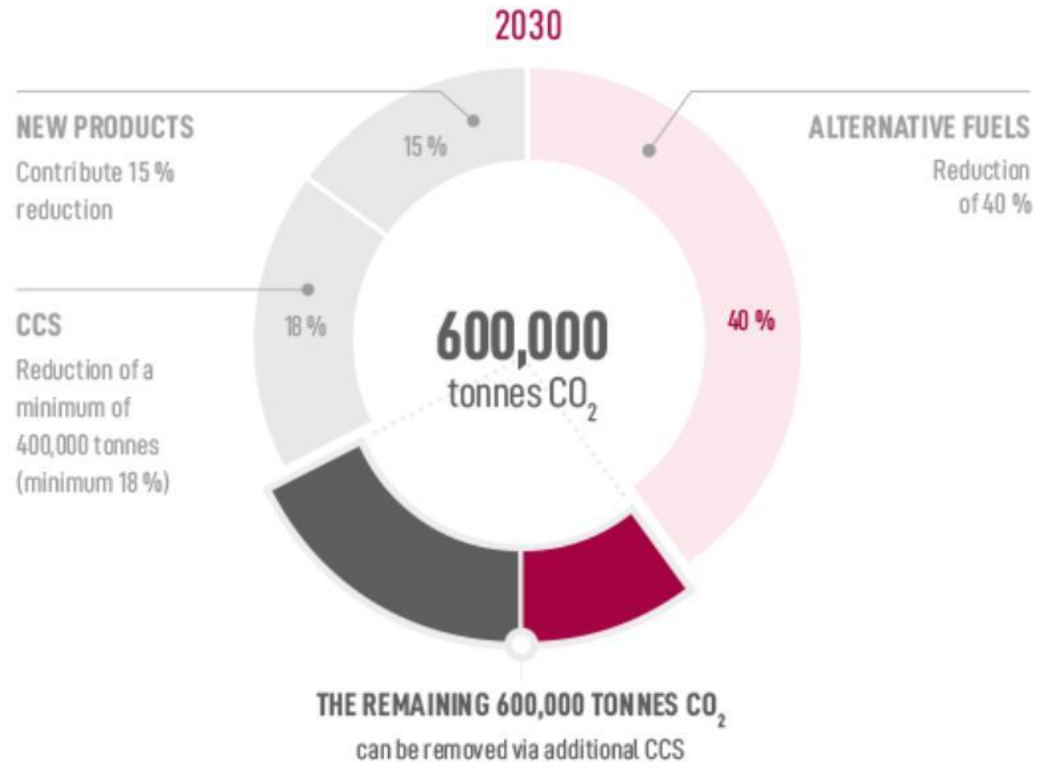
2021 **2200000**

2030

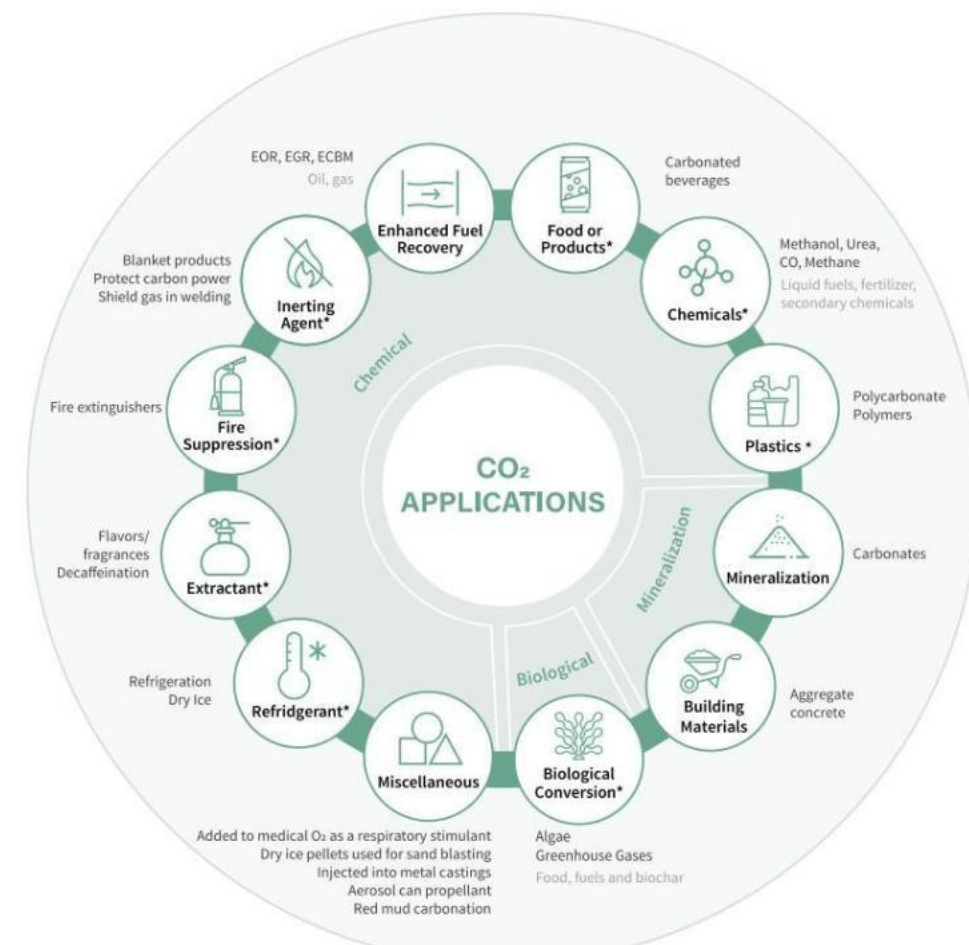
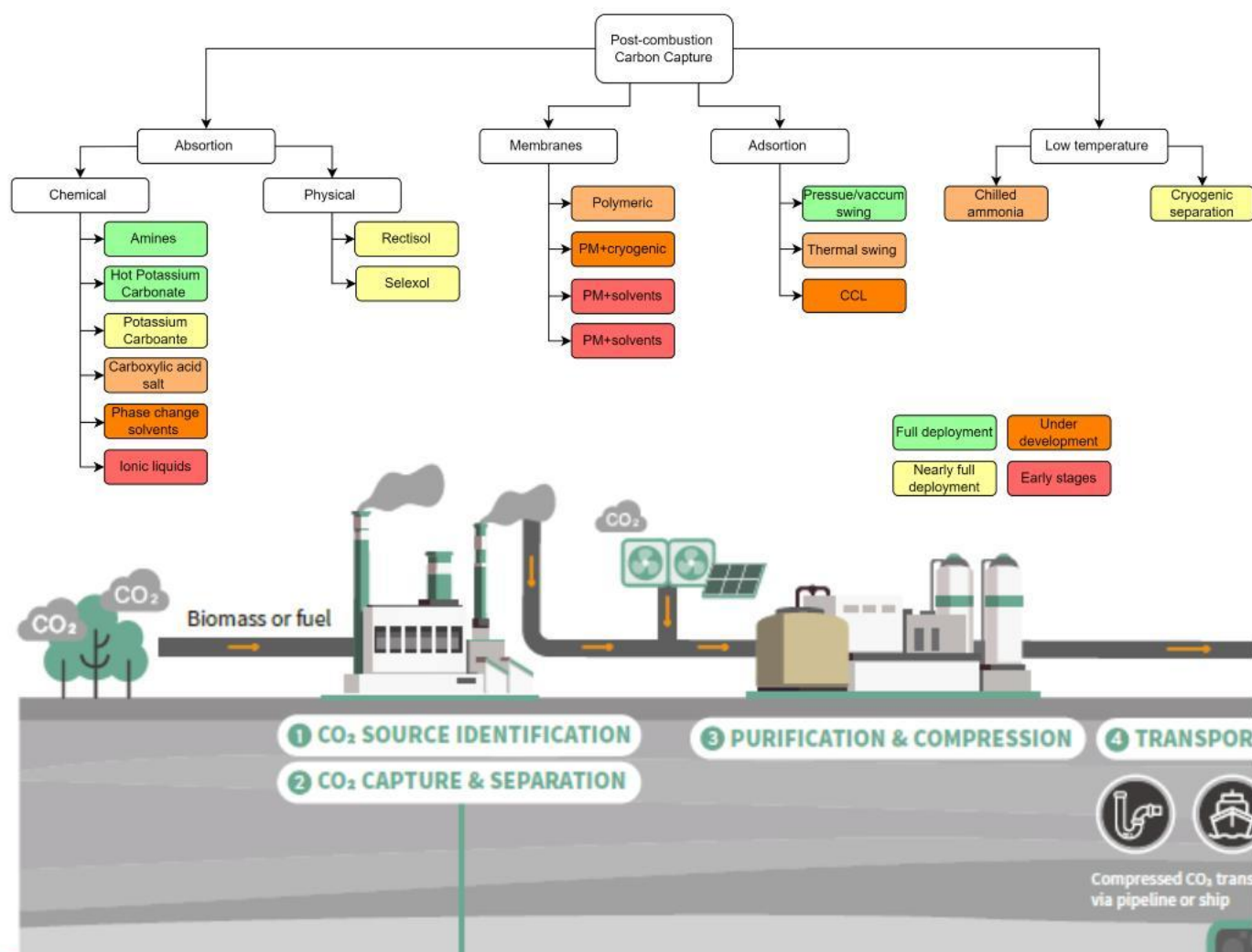


Game changer: ACCSION

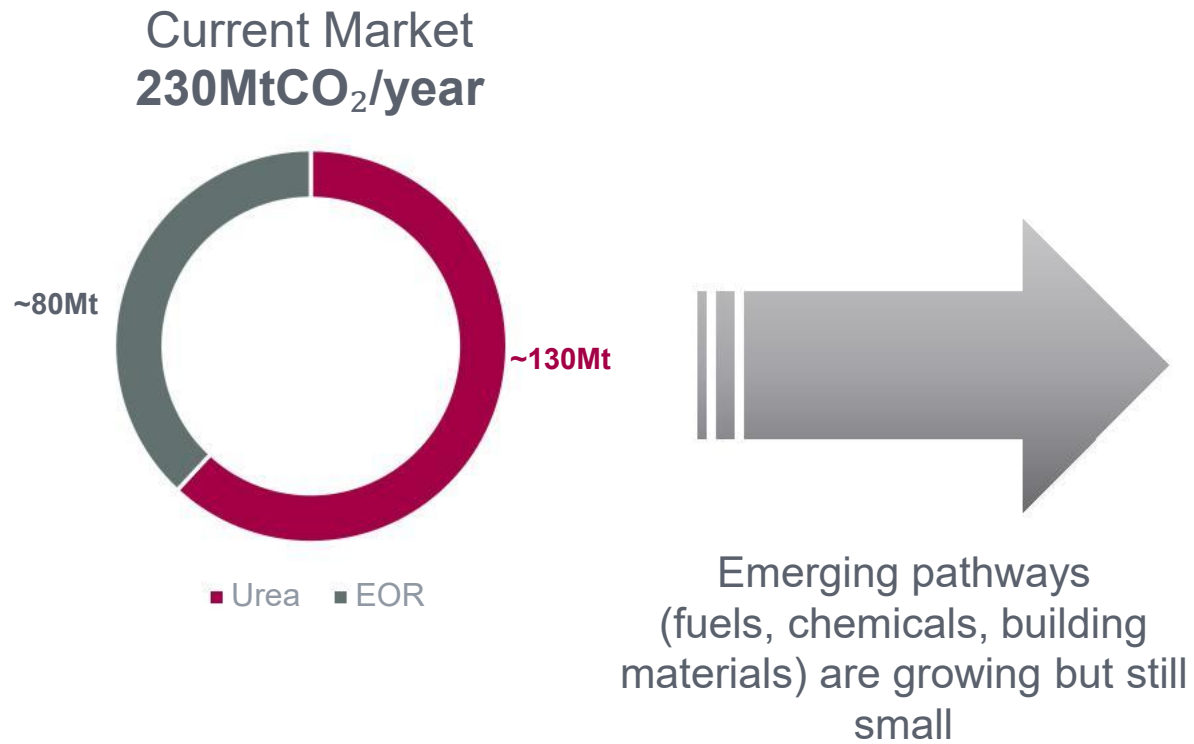
From this.....to this



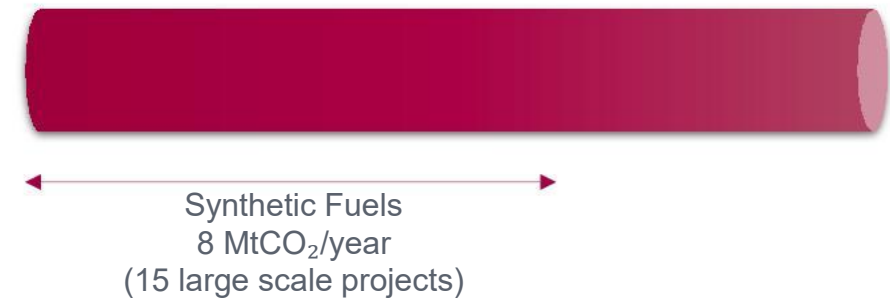
What is Carbon Capture, Storage and Utilization



CCU at glance



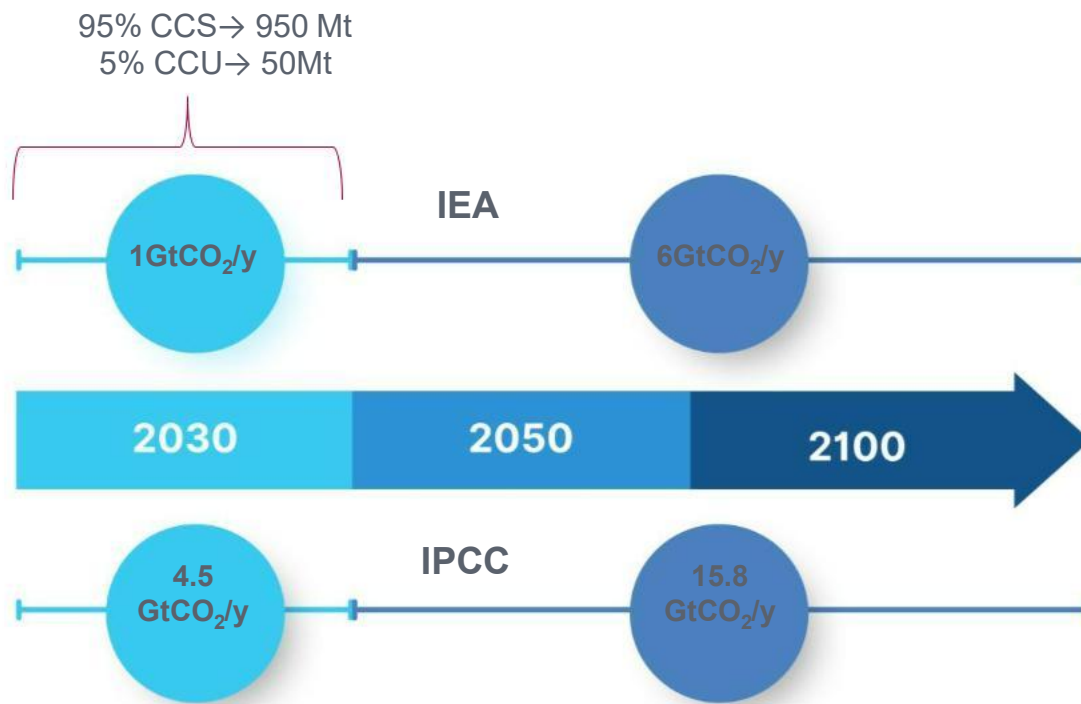
CCU Projects pipeline
15MtCO₂/year by 2030



- Only $\frac{2}{3}$ of required levels for e-fuels by NZE 2050 (target 12Mt)
- Only ~4 Mt comes from sustainable sources (biogenic/DAC)

CCU and CCS

CCU can play a role, **but does not replace geological storage**



Challenges:

Limited climate benefits: Emissions reduction depends on:

- CO₂ source (fossil, biogenic, DAC)
- Product displaced
- Energy carbon intensity
- Retention time in the product

High dependence on low-carbon energy:

- CCU pathways (especially fuels and chemicals) are **highly energy-intensive**
- Climate benefits require **access to renewable or low-carbon energy**

Short carbon retention in most applications

- Fuels: CO₂ released within ~1 year
- Chemicals: CO₂ released within ~10 years

Very limited market size:

- Demand for CO₂-based products is **too small to absorb large volumes**

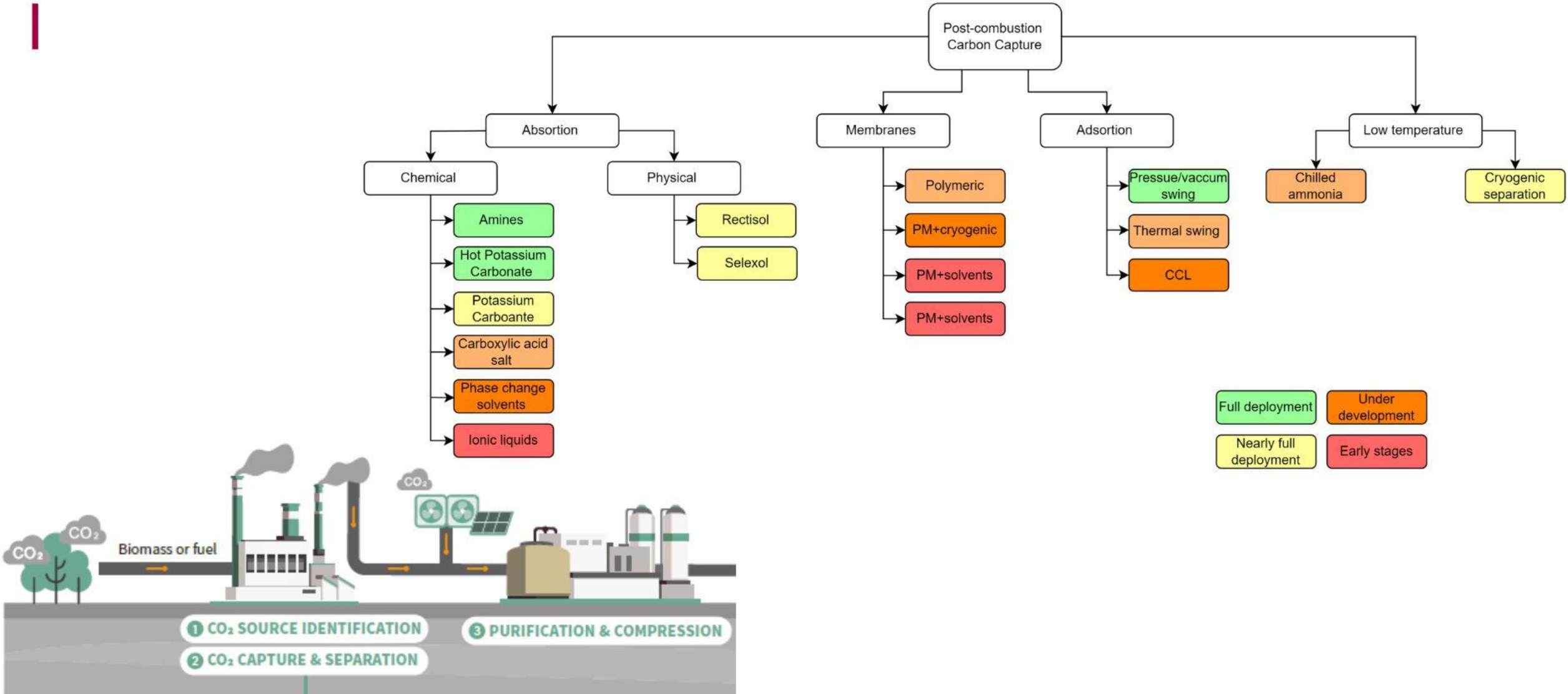
Dependence on sustainable CO₂ sources in the future

- CO₂ must increasingly come from **biogenic sources or air (DAC)**

Declining value of CO₂ displacement over time

- The benefit of replacing fossil-based products with CO₂-based ones **decreases** (fuels are phased out)

CCS



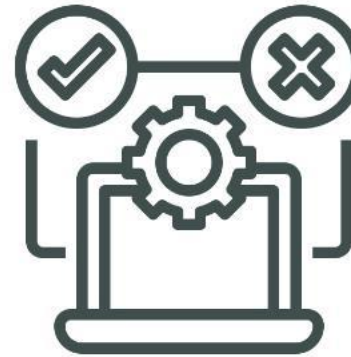
Type of projects from 2020

Desk studies



2020-2022

Pilot plants



CORT
2022-2023



CASPER
2024-2025

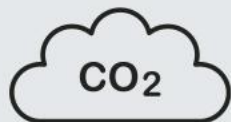


Full scale



Technology selection:
 ? Amine-based
 ? Hot Potassium carbonate
 ? Cryogenic
 ? Chilled ammonia
 ? Potassium + enzymes
 9 vendors!

KEY NUMBERS:



01

1.4 million tonnes CO₂
Captured - both White
and Grey kilns



02

Recover **1250 TJ** of waste
heat for district heating to
Aalborg Municipality



03

Power consumption 649 GWh
in capture plant and **850TJ**
Biogas used in fuel mix



04

Funding of 1,6 billion
DKK by the EUIF

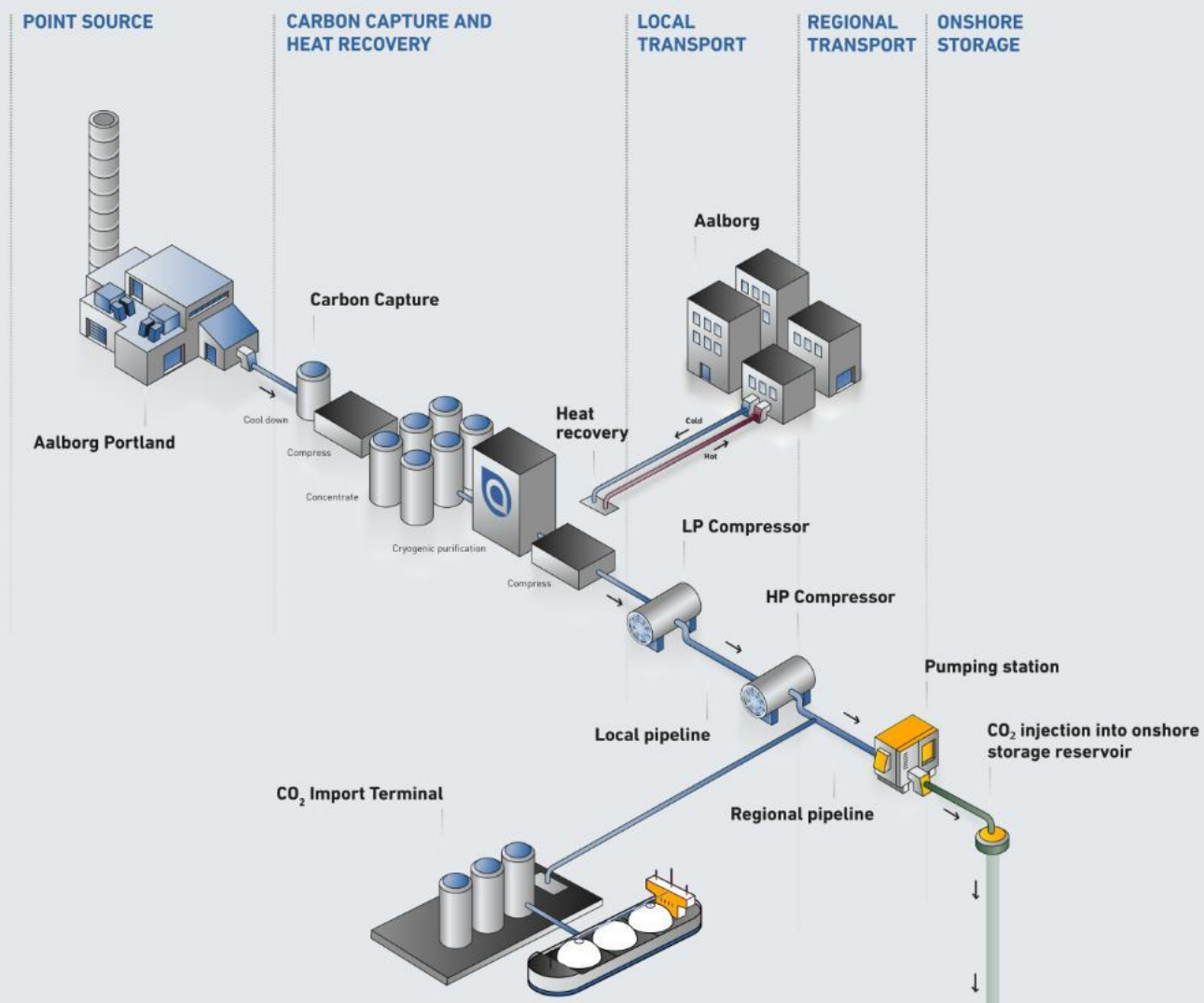


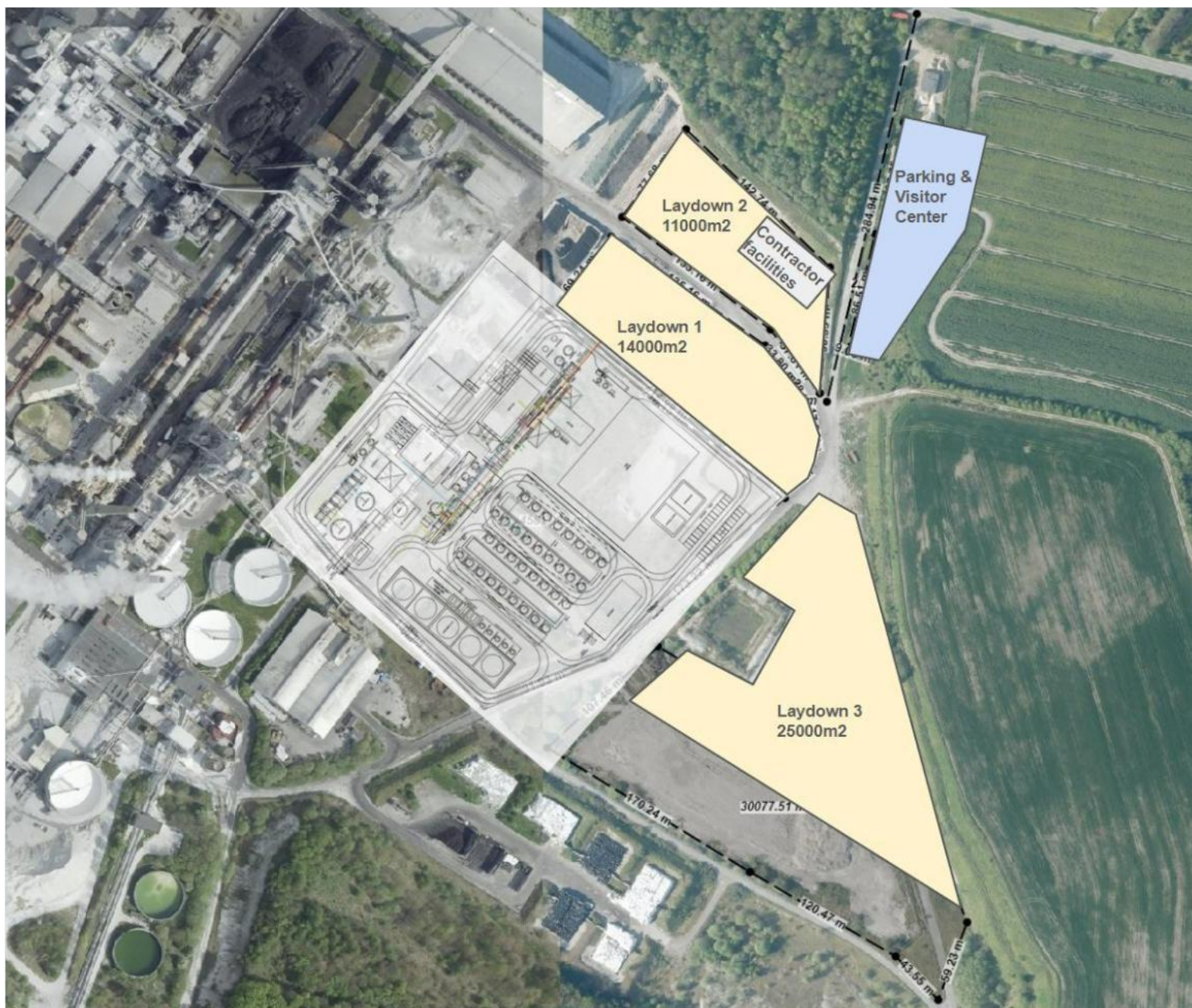
05

Entry into operation by
2030



THE VALUE CHAIN





THE CAPTURE SITE

- 40,000 m² site area
- 50,000 m² laydown area during construction
- Parking for 200 vehicles during construction

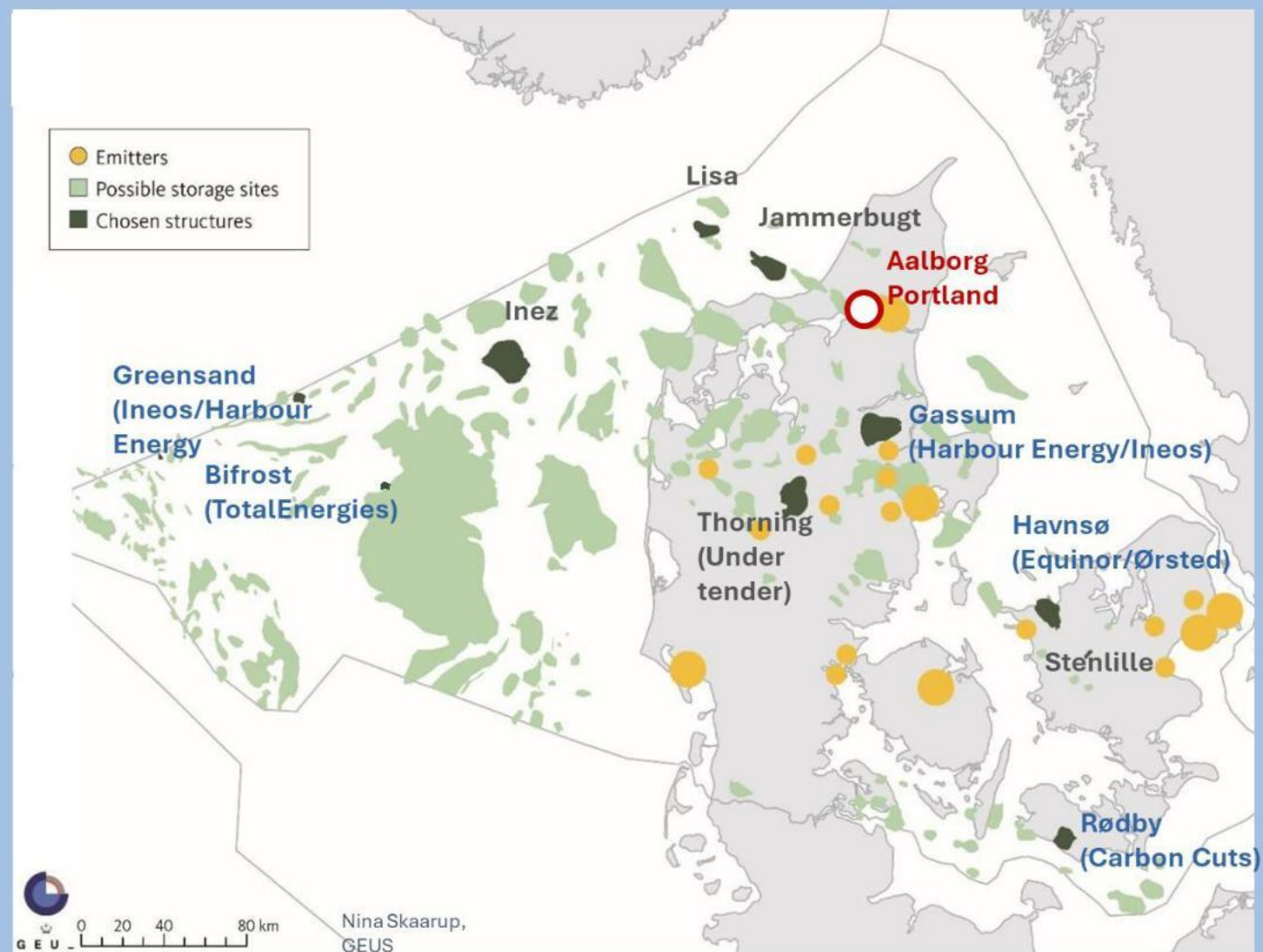


PERMANENT STORAGE

The storage operator is responsible for building, operating and maintaining this building block.

Our primary target is to connect Aalborg Portland with onshore storage through a CO₂ pipeline.

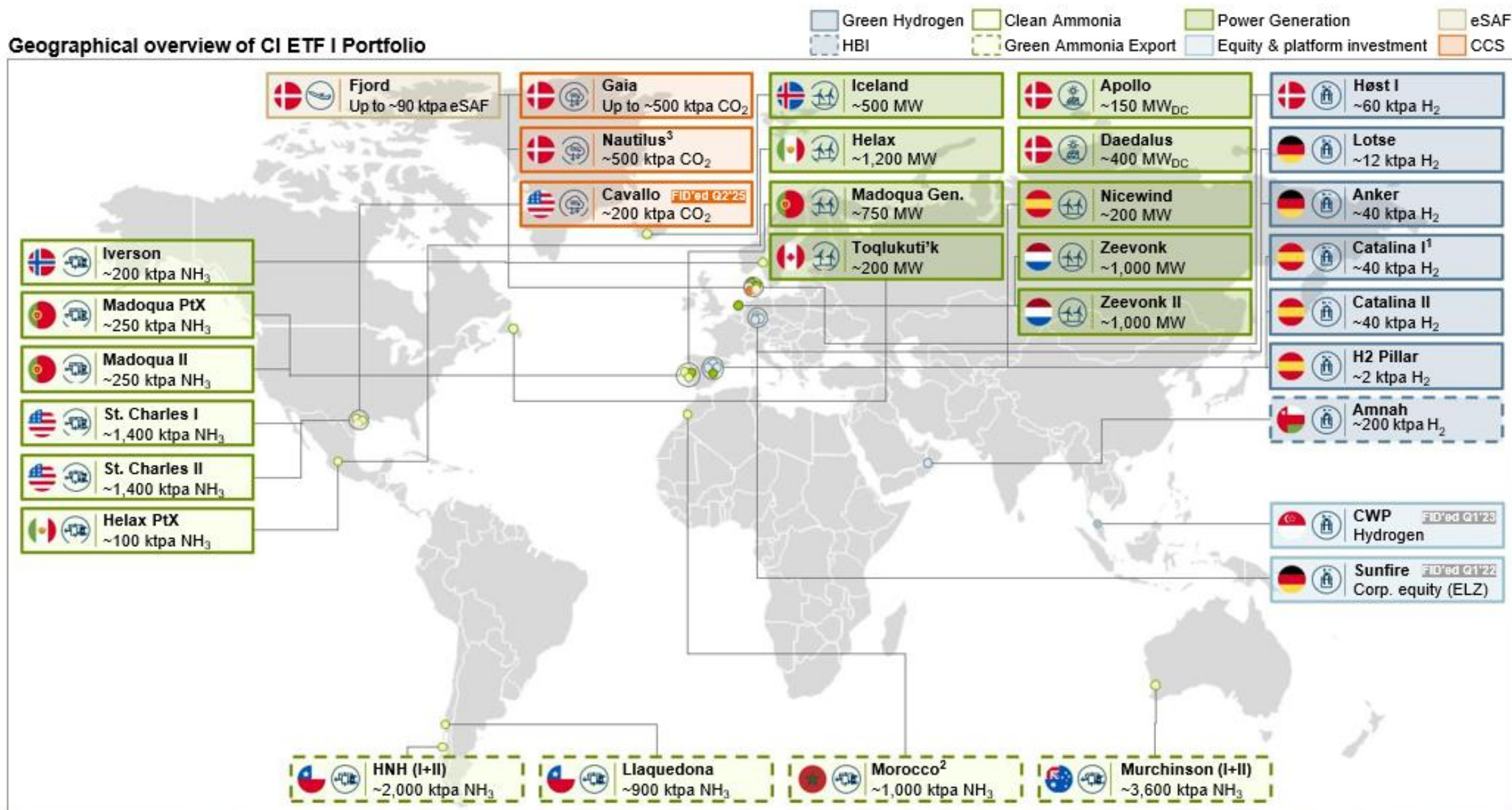
Denmark's CO₂ storage sites are few and mostly in exploration until 2026-2028, posing a risk that storage may be delayed



Synthetic sustainable aviation fuel (eSAF) project



Geographical overview of CI ETF I Portfolio



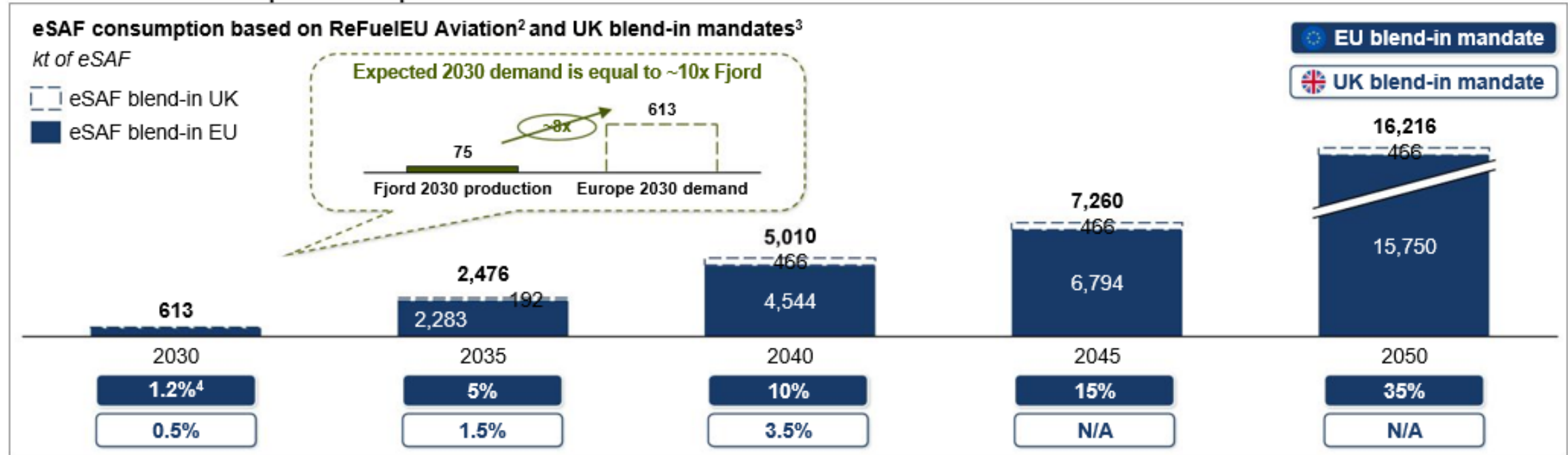
Portfolio comprises projects across key PtX technologies and offers attractive flexibility to cater for short and long term expected market development

Ambitious requirements in ReFuelEU Aviation will accelerate eSAF demand

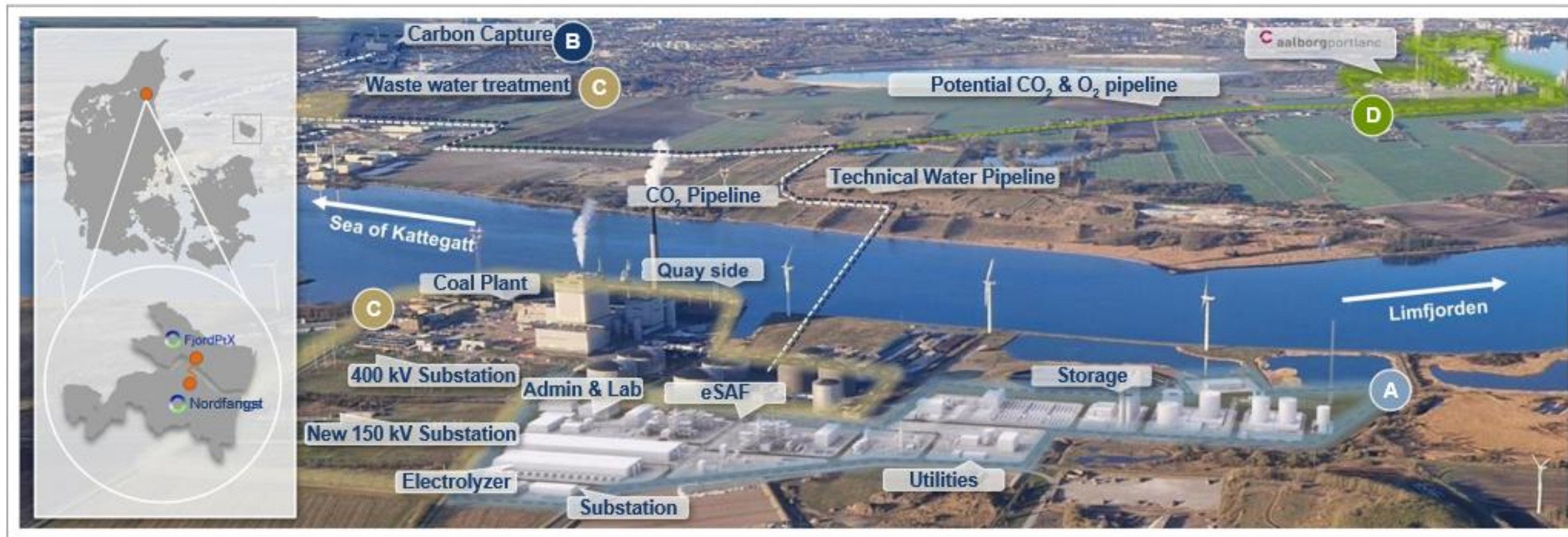
Overview of ReFuelEU Aviation

1  Blend-in requirements ReFuelEU	2  Penalties	3  Refuelling obligations and anti-tankering
- Fuel suppliers will have to blend increasing amounts of sustainable aviation fuels (SAF) with kerosene, starting with a 2% minimum blend-in 2025, and rising to 70% in 2050 - From 2030, 1,2% of jet fuel is mandated to be blended with eSAF, increasing to 35% in 2050 The UK has implemented a similar blend-in mandate, increasing the overall expected demand in Europe	- Non-compliance with blend-in requirements will result in a penalty for fuel suppliers of a minimum of 2x the yearly average price spread of eSAF and conventional aviation fuel expected at EUR ~+8,000 EUR/t eSAF - Penalties are not remedial, meaning that fuel suppliers failing to comply with the share targets will – in addition to paying a penalty – have to supply the shortfall in the next reporting period	To discourage tankering practices that lead to additional emissions, aircraft operators are required to uplift at least 90% of their yearly aviation fuel requirements at a given EU airport

Forecasted eSAF consumption in Europe¹



Attractive industrial site close to existing infrastructure and project partners



A Fjord project site

- Land lease of ~23ha secured with Aalborg Forsyning
- Ease of permitting due to the surrounding site currently being used for a coal fired power plant, expect to receive all permit (EIA, Local Plan) in 2Q26
- Existing quay side enabling modularisation during construction and easy distribution of eSAF (up to 25.000mt) and CO2 during production
- 64.000mt eSAF storage terminal including potential blending hub part of project scope

B Nordfangst project site

- Land lease of ~1ha under finalised with Nordværk (JV partner)
- The site is located next to the existing waste-to-energy plant and will utilize the existing utilities.
- ~9km of pipeline is planned from Nordfangst to Fjord site. Crossing ~8 (mixed of private and industrial landowners).

C Existing infrastructure

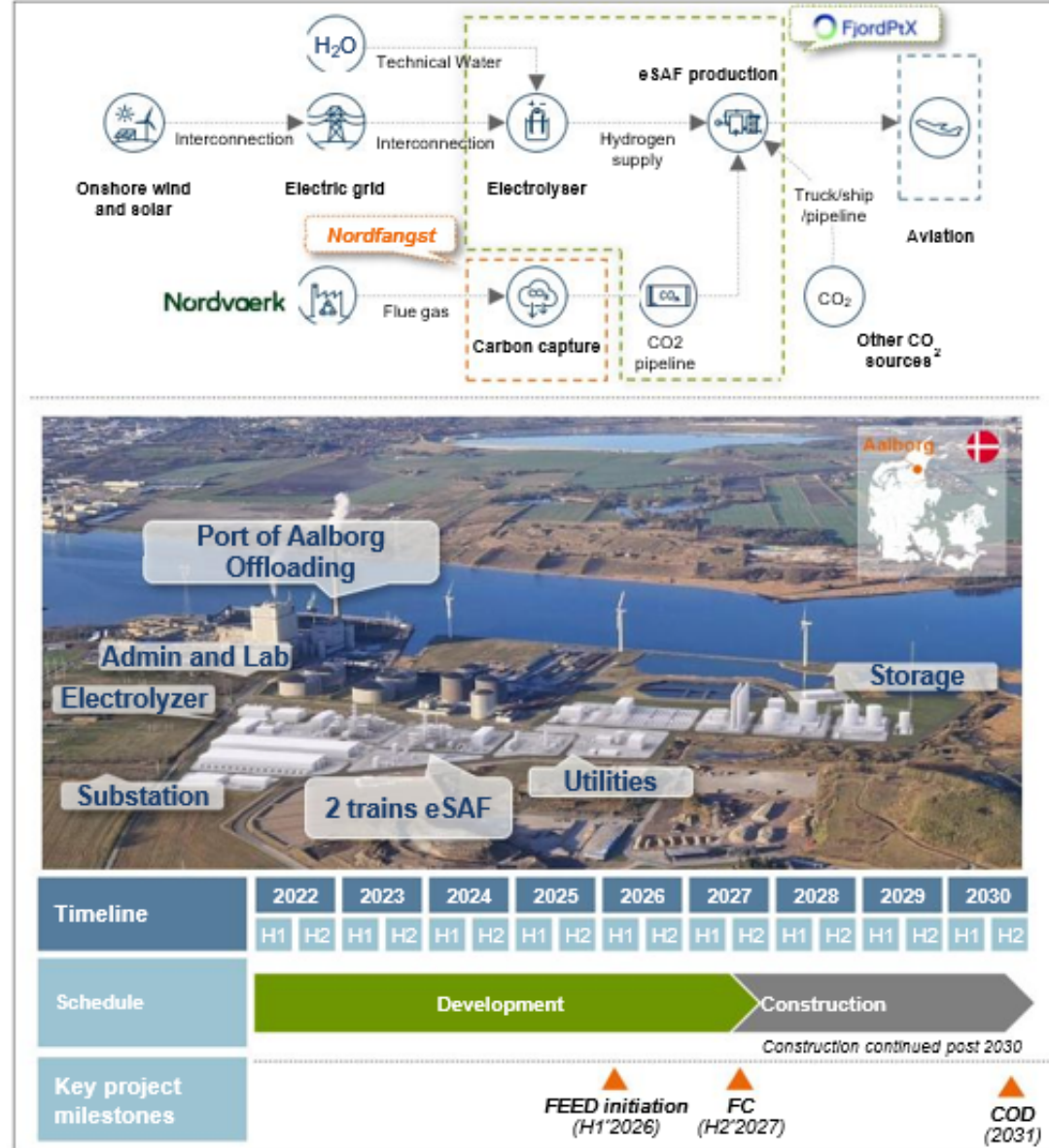
- Site already contains a large part of the necessary infrastructure to facilitate the project such as district heating network, cooling duct, water and sewage system
- As the coal fired power plant is decommissioned in 2028, the quay area is available during construction and to import and export products
- Next to Fjord site is an existing 400 kV and upcoming 150 kV Substation, Grid connection under negotiation with Energinet

D Potential CO2 infrastructure

- Fjord is well positioned to receive CO2 from nearby point emitters such as Aalborg Portland.
- Aalborg Portland intent, with their Accsion project, to annually capture ~1.5m tons of CO2 for storage by 2030. Discussions of common infrastructure and utilization of biogenic CO2 from them instead of storing is ongoing.
- Aalborg Portland could also be an offtaker of surplus oxygen from the hydrogen production

Introduction to Project FjordPtX

Overview of infrastructure assets and project location



Key project facts

Project overview

- Project Fjord is a Sustainable Aviation Fuel (eSAF) project utilizing renewable generation capacity for hydrogen production via electrolysis. Hydrogen is combined with carbon in a synthesis to produce eSAF
- The PtX plant is to be located within Norbis industrial park. The existing coal fired plant will be dismantled in 2028 allowing full access to the Port facilities
- Grid connection is available at Norbis industrial park
- ~350 MW electrolyser capacity¹ to produce up to ~90 ktpa of eSAF based on up to ~330 ktpa CO₂
- Two x 45 ktpa eSAF train configuration allowing ramp-up and production flexibility

Site location

- 30-year land lease secured from Aalborg Forsyning, owner and operator of the Norbis industrial park

CO₂

- Fluegas put or pay agreement, CO₂ take or pay agreement and JV agreement signed January 2026
- Carbon capture facility is jointly owned by CIP and Nordværk (waste incineration) in 51%/49% JV and located at the WtE plant enabling control of feedstock intake for the project

Power sourcing

- Base configuration includes renewable PPAs, baseload & spot power, 585 MW grid connection secured
- Potential to source offshore wind power from upcoming North Sea Danish tenders as well as the CI ETF solar portfolio

EPC

- Technologies chosen include RWGS² and Fischer-Tropsch
- Dual Competitive pre-FEED to be completed November 2025, with Saipem (using Topsoe/Sasol eSAF technology), and Tecnicas Reunidas (using JM/BP eSAF technology)

Project partners

- Local utility in Aalborg (Aalborg Forsyning) and local waste incineration providing CO₂ (Nordværk)

Fjord project assets
CaptureCo assets

Potential offtake markets

DOBŘÉ PRAKTIKY:

externí: IA#2: Kilkenny (IRL)

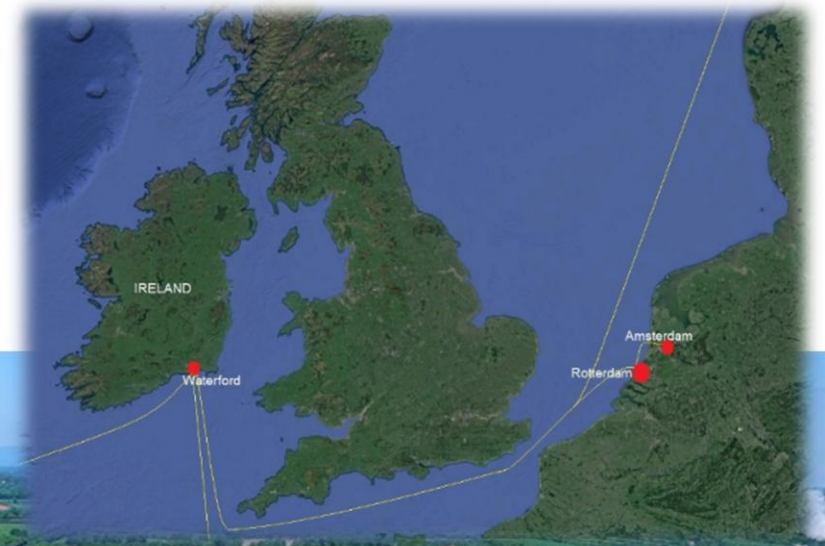


GP#1 Local case Waterford „Belview Port“ - potential Growth in demand to meet Supply

The Belview Port Zone consists of **265 ha** of development land zoned for port related development.

A number of parcels are available for immediate development.

Port of Waterford is ready to work with local and national development agencies to promote industrial and commercial projects.



GP#1 Local case Waterford „Belview Port“ - potential Growth in demand to meet Supply

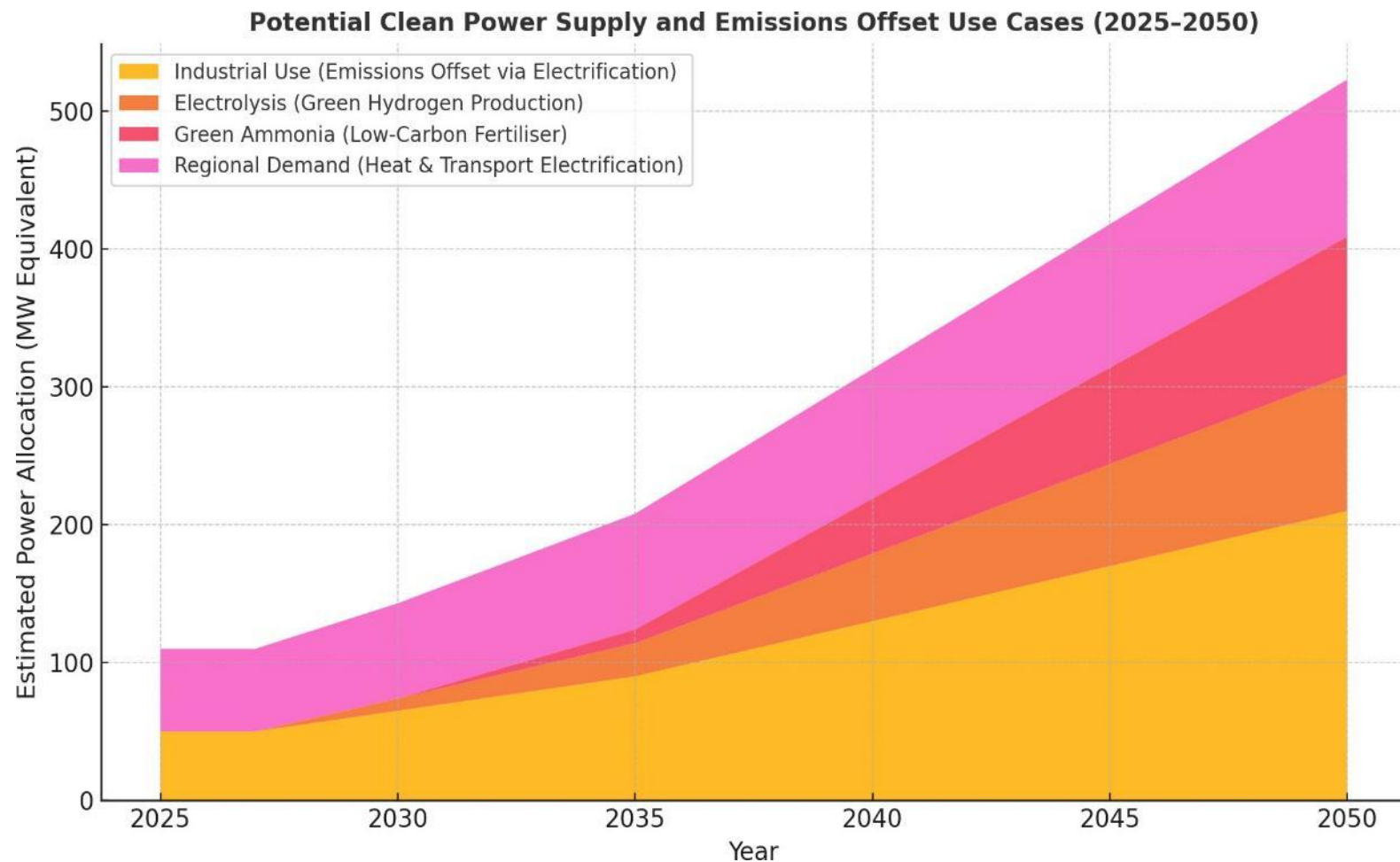
This graphic shows the projected increase in electricity demand at **Bellview Port** and the surrounding region from 2025 to 2050:

Industrial Use grows steadily with the development of the hub.

Electrolysis ramps up from 2027 onwards, enabling green hydrogen production.

Green Ammonia for fertiliser begins post-2030 and scales significantly after 2035.

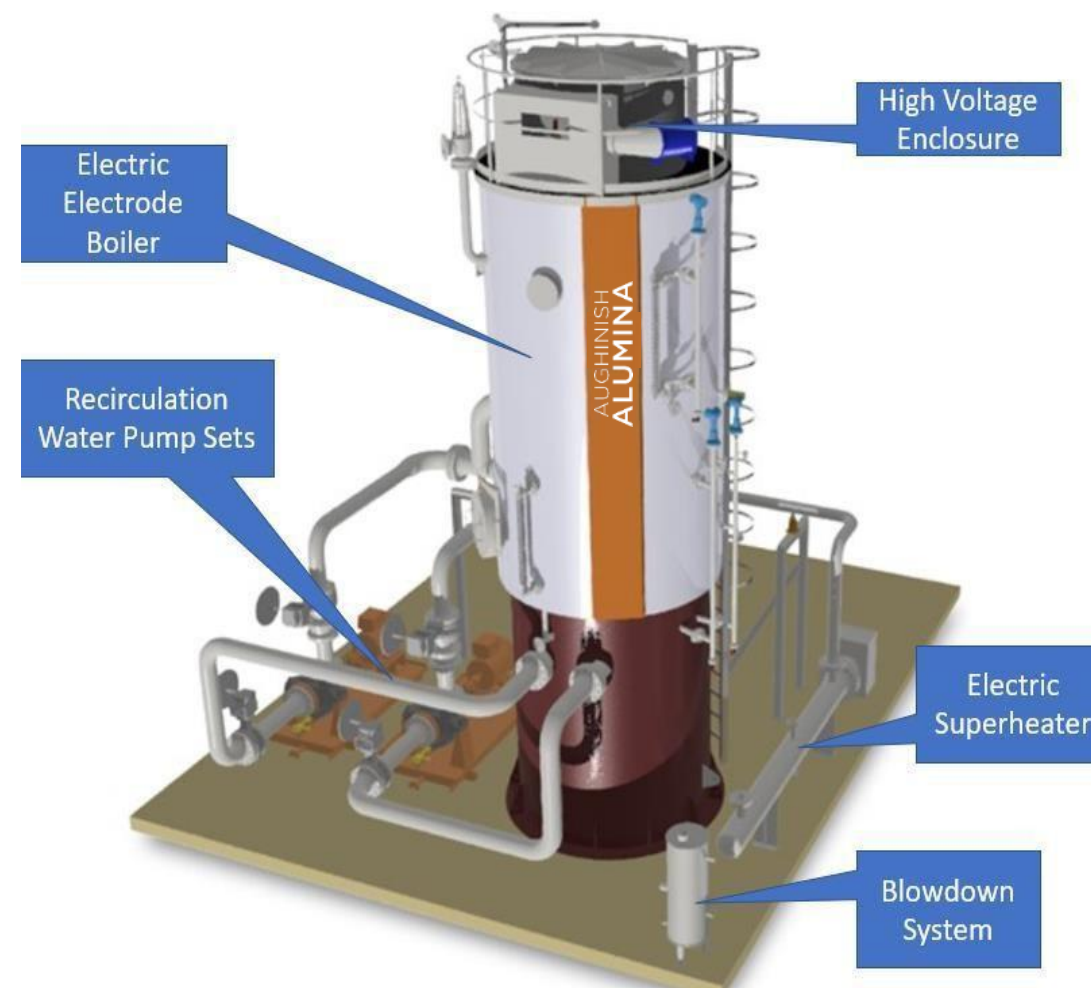
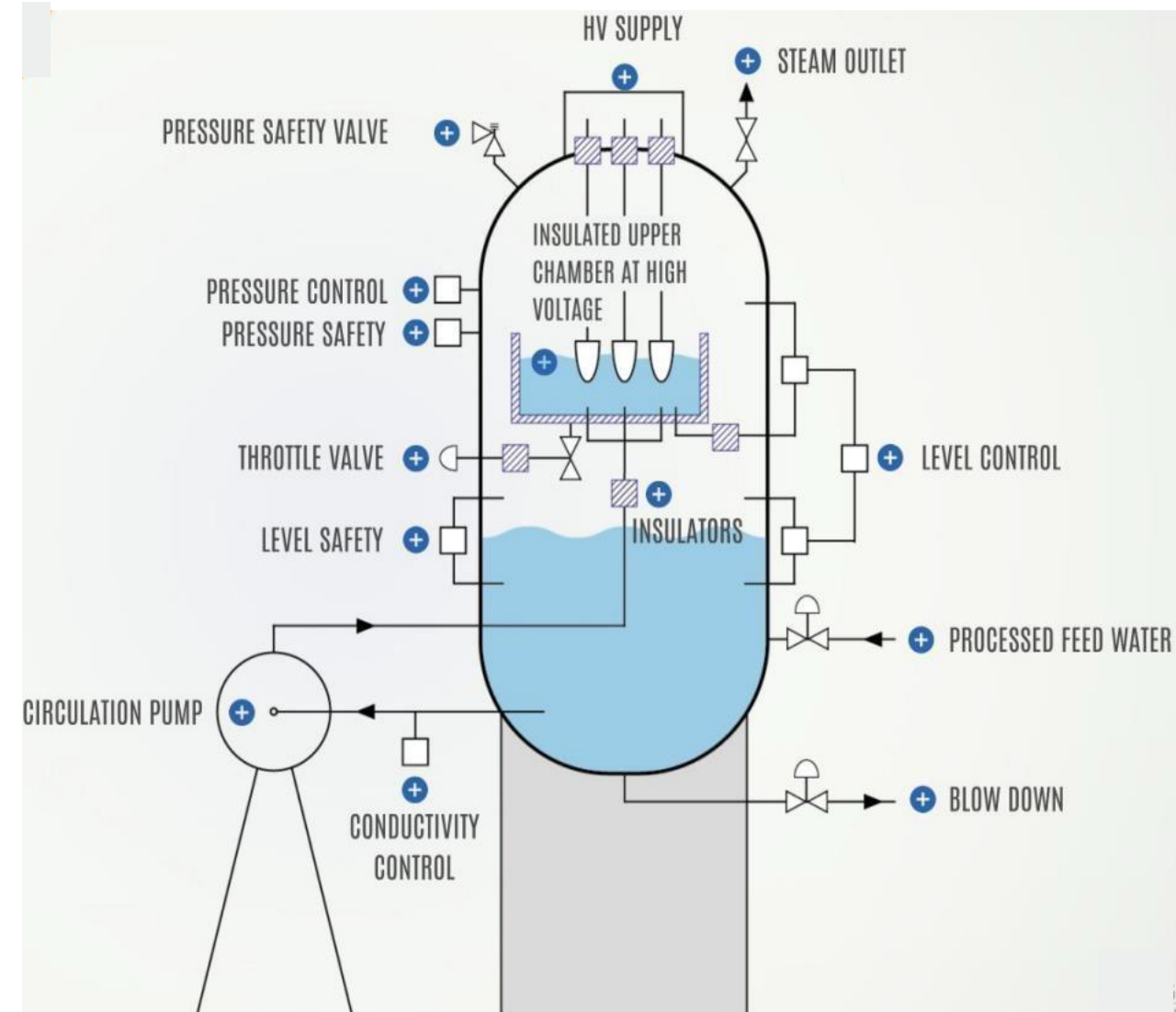
Regional Demand rises due to electrification of heat and transport, aligned with national policy.



GP#2 Limerick - Aughinish Alumina; ELECTRIC BOILER 25MW



GP#2 Limerick - Aughinish Alumina; *ELECTRIC BOILER 25MW*



GP#3 Dalton ATHY - grain drying



H2 Blending up to 100% to feeding gas



GP#3 Dalton ATHY - grain drying



DĚKUJEME ZA VAŠI ÚČAST!



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