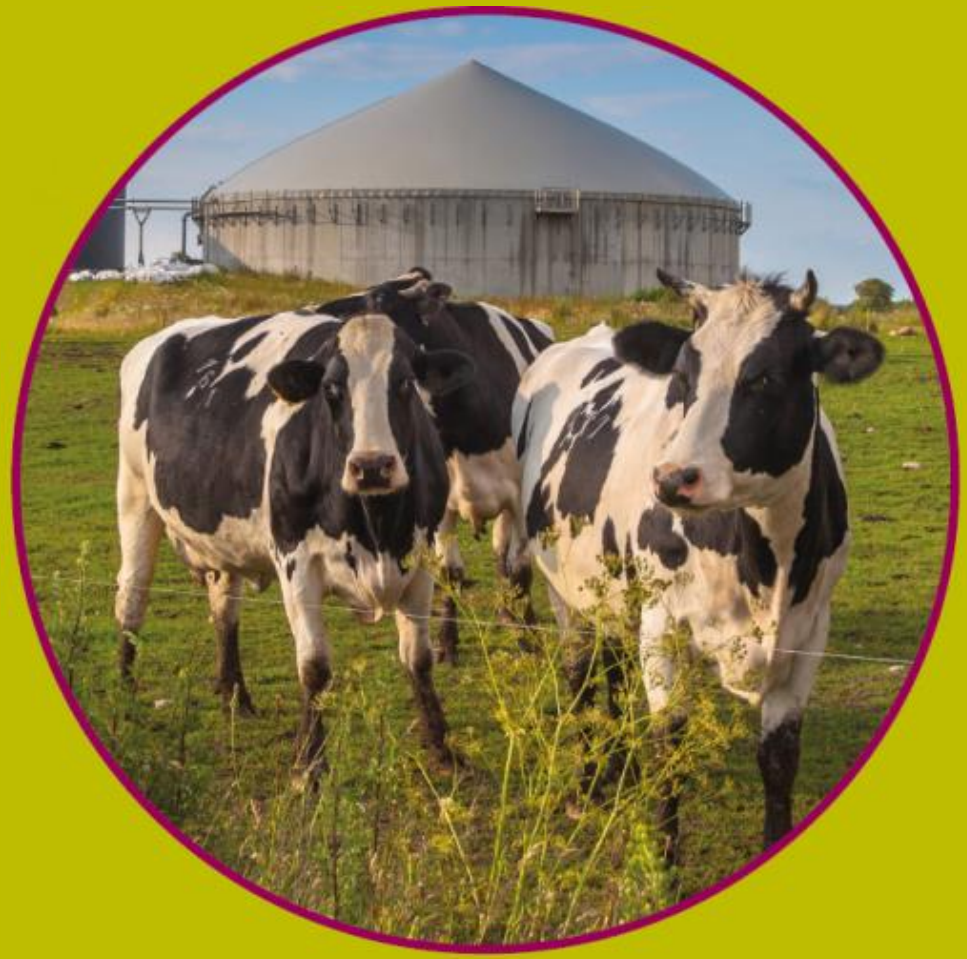
BIOGENIC CO_2 FROM ANAEROBIC DIGESTION

7TH JULY 2002



ADBA

NetZeroWeek™
2nd - 8th July 2022

FOSSIL CARBON VS BIOGENIC CARBON

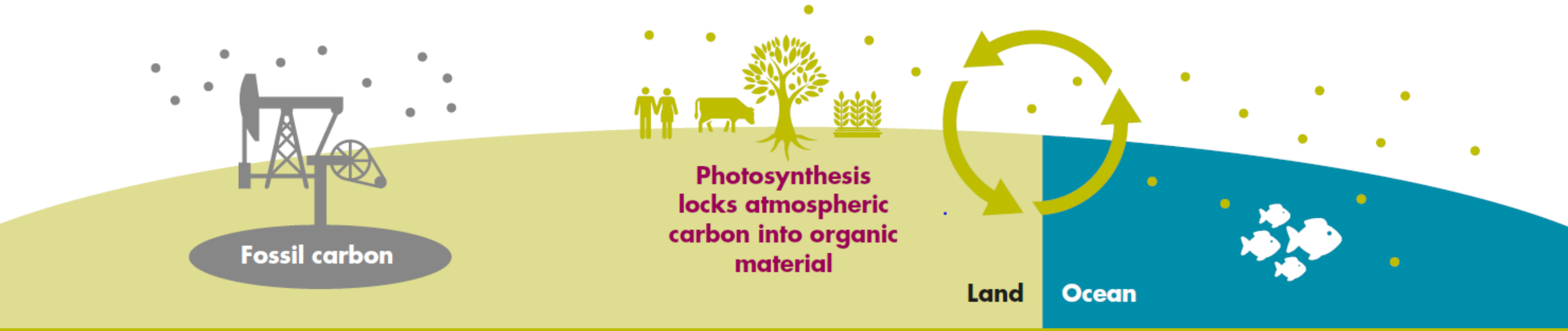
Carbon is a crucial building block to all life on earth.
However, its increasing concentration in the atmosphere is driving climate change.
To tackle climate change, we must consider **where this carbon is coming from** and **what form it is in**.

Fossil carbon

For millions of years carbon has been locked away deep underground. The extraction and use of fossil fuels releases this carbon into the atmosphere.

Natural carbon cycle

Biogenic carbon is derived from living organisms – atmospheric carbon is assimilated into plants and passed on through the food chain. Biogenic carbon is recycled through organic processes.



NOT ALL CARBON IS EQUAL

The emission of carbon dioxide (CO_2) does not always contribute to greenhouse gas (GHG) emissions – it depends on where the carbon originates from…

Carbon dioxide CO_2

Fossil

Originating from fossil resources

Carbon is derived from geological stores, where it has been locked away from the atmosphere for millions of years.

Release of fossil-CO_2 contributes to greenhouse gas emissions

✗ Carbon emissions

Biogenic

Originating from living organisms

Carbon is derived from the atmosphere, where CO_2 is absorbed by plants during photosynthesis.

Release of bio-CO_2 does NOT contribute to greenhouse gas emissions

✓ Carbon neutral

SOURCES OF BIOGENIC CARBON

All organic matter contains biogenic carbon – such as:

All organic matter can be recycled via anaerobic digestion (AD)

AD uses microorganisms to break down organics within sealed tanks (i.e., without oxygen present, or 'anaerobic').

This process concentrates biogenic carbon within the tank.

CAPTURING BIOGENIC CARBON FROM AD

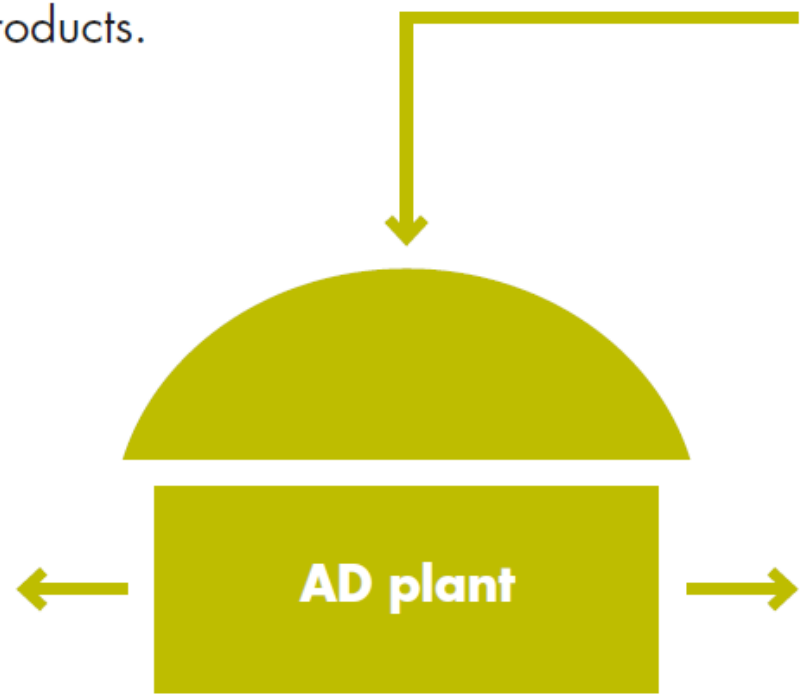
Composed of biogenic carbon, organic feedstocks are brought to AD plants. Here, the AD process converts these feedstocks into two sustainable products.

Organic feedstocks

Product 1 **Biogas**

Biomethane ~55% **Bio-CO_2 ~45%**

Both gases – biomethane (bio-CH_4) and bio-CO_2 - are chemically identical to their fossil equivalents, **biogenic** and **carbon neutral**.



Product 2 **Biofertiliser** (or 'digestate')

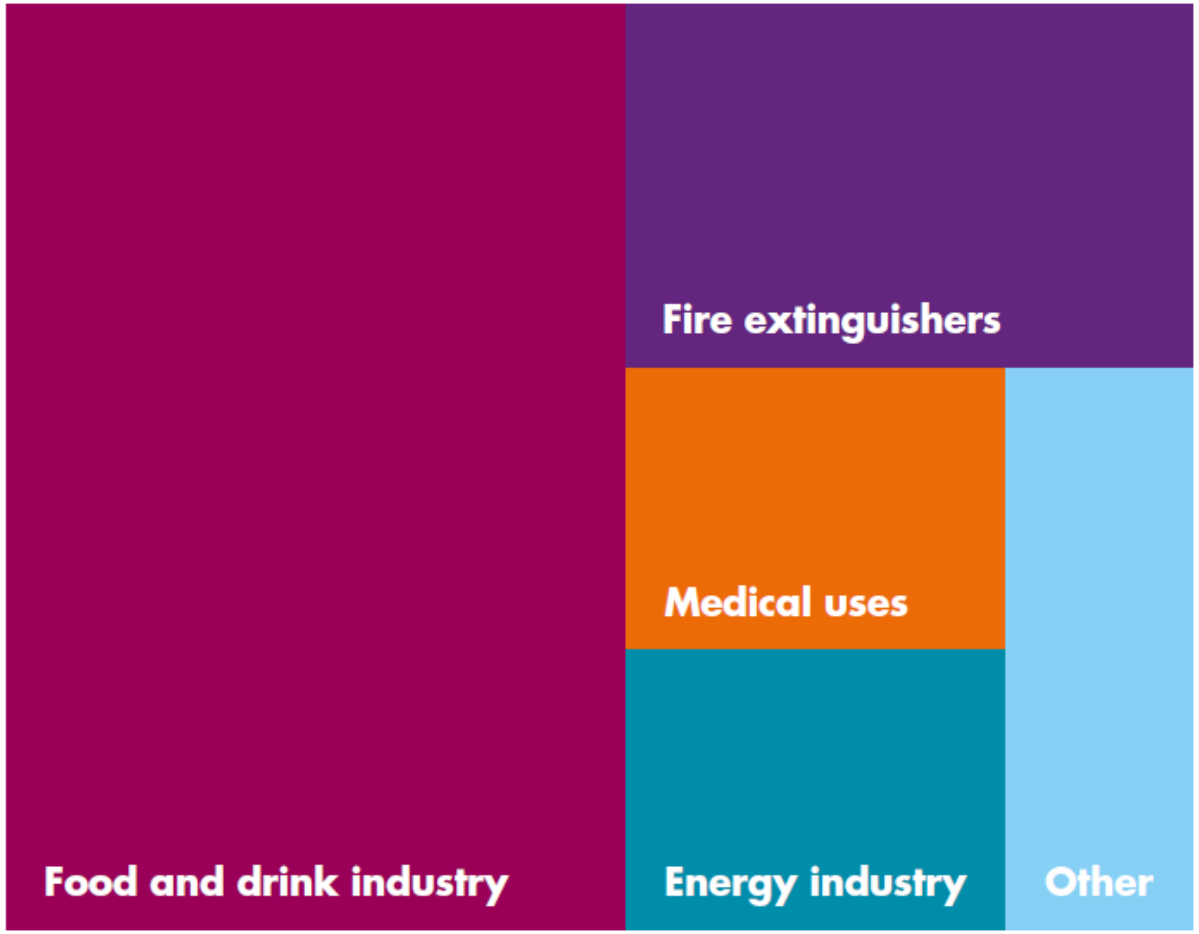
Remaining solid material from the digestion process can be used as an organic fertiliser. Spread to land, it recycles minerals and nutrients from the feedstock and can improve the ability of soil to sequester carbon, away from the atmosphere.

CO_2 GAS DEMAND

UK industries use around **600,000 tonnes CO_2 every year**.

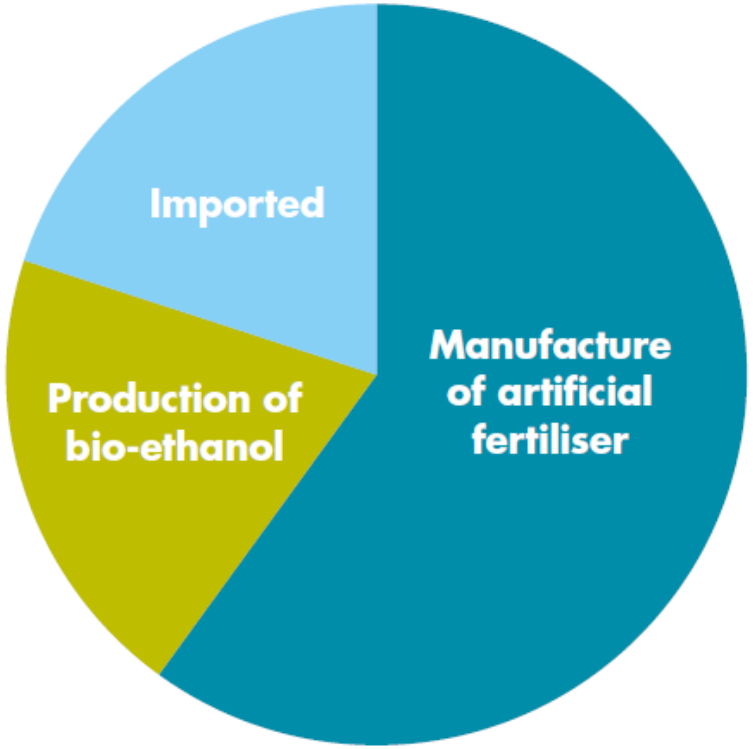
While the majority (50-60%) is used within the production of food and drink, e.g., to carbonate fizzy drinks, CO_2 may be used within multiple different sectors.

The use of CO_2 may increase in the near future, as companies recognise the ability to store carbon within new products – for example, CO_2 can be used to cure concrete, locking away a proportion of carbon within the new material.



Taken from **Food and Drinks Federation (2019)** **https://bit.ly/3yrGaFi**

CURRENT CO_2 SUPPLY



Taken from **Food and Drinks Federation (2019)**
https://bit.ly/3yrGaFi

The majority of the UK's CO_2 gas demand is supplied from the manufacture of artificial fertiliser (~60%).

Here, fossil natural gas is converted into ammonium nitrate, a compound which provides plants with nitrogen (N) necessary for growth.
CO_2 gas is a produced as a by-product of this artificial process.

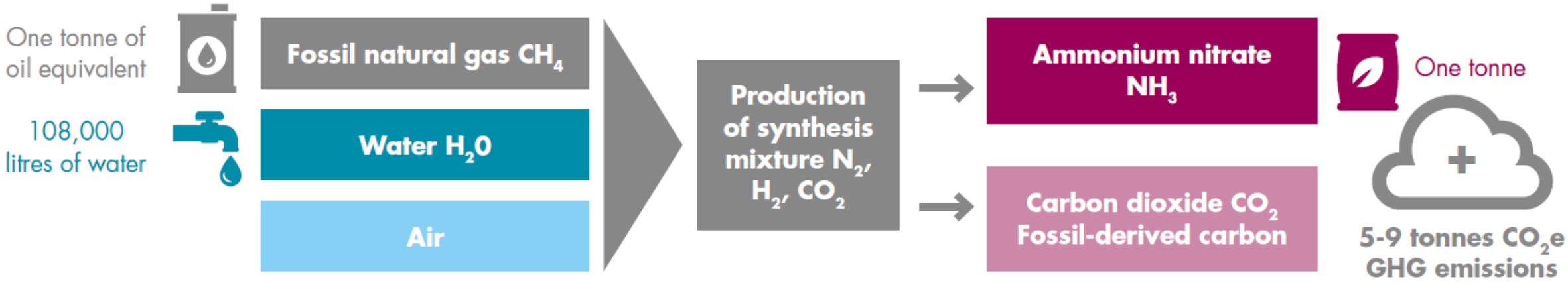
The vast majority of industrial CO_2 gas produced within the UK is from just three plants.

Name	Industry process	CO_2 production capacity
Billingham, Teeside	Artificial fertilisers	400 kt
Ince, Cheshire	Artificial fertilisers	120 kt
Ensus, Teeside	Bio-ethanol production	250 kt*

*Despite a high capacity, relatively low demand for bio-ethanol means the plant has been closed for long periods since opening in 2010

MANUFACTURING ARTIFICIAL FERTILISERS

To create ammonium nitrate, a core ingredient of artificial fertilisers, factories, such as those found in Billingham and Ince, deploy the Haber Bosch process. Manufacturing **one tonne of ammonium nitrate** requires the following:



This process is incredibly energy- and carbon-intensive. In 2019, Chemical and Engineering News reported that in 2010 the world manufactured 157 million metric tonnes of ammonia which used **~1% of the world's total energy supply** and emitted **~1% of global GHG emissions (450 $MtCO_2e$).**

By recycling nutrients found within organic wastes, AD also creates a biofertiliser known as digestate. Spreading digestate can displace the need for artificial fertilisers, helping to decarbonise agriculture and save water.

CO_2 MARKET

Two variables primarily govern the price of industrial CO_2:

1 Proximity to CO_2 production

The price of CO_2 is largely determined by the users' proximity to the three major production plants. Transport by road over distances longer than 150 miles is uneconomic at usual market prices, especially as trucks typically return to base empty to prevent tank contamination from other gases.

2 Cost of natural gas

High levels of natural gas are required to manufacture fertilisers – when its price increases, so does the cost of artificial fertilisers and CO_2 gas

The current gas crisis has suspended fertiliser production, resulting in a CO_2 crisis

CO_2 CRISES

2018

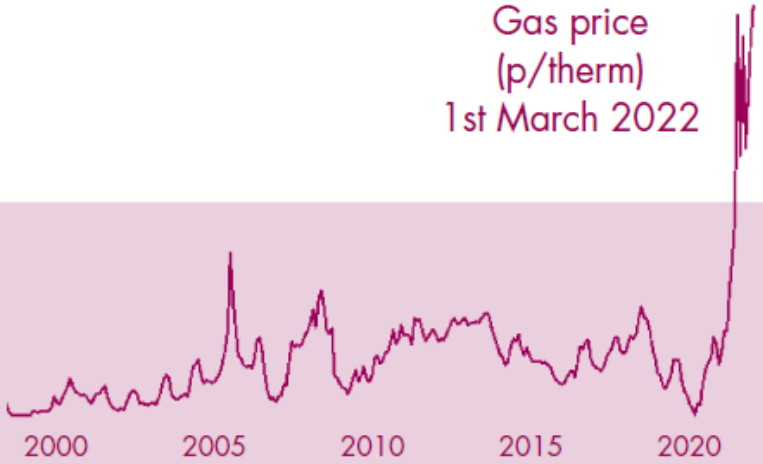
The first major CO_2 crisis was in the summer of 2018 driven by a number of factors:

- **Supply.** Fertiliser plants across Europe, including both Billingham and Ince, went offline as a result of planned maintenance and/or emergency repairs.
- **Demand.** The combination of a major heat wave across the UK and the occurrence of the football World Cup, demand for carbonated fizzy drinks soared.

While the Billingham and Ince plants restarted production after two weeks, it took around **two months** for the market to fully recover.

2021/22

Gas price (p/therm) 1st March 2022



Over the last 15 years, the gas price has averaged around **50p/therm**.

From early 2021, **gas prices began increasing rapidly** as a result of a particularly cold winter in 2020/21 which diminished gas stores, a relatively windless summer which increased gas demand for electricity generation, and increased global gas demand, exacerbated by Russia's invasion of Ukraine.

From September 2021 to present day (March 2022), the gas price remained above 165p/therm. In December, the gas price reached its first record-breaking peak at nearly **450p/therm**. Three months later, this record was beaten again, peaking at **540p/therm**. Today (June 2022), gas price in the UK is 183.6p/therm.

At these prices, it is not economic for artificial fertiliser plants to operate, as they require vast quantities for natural gas. Consequently, both Billingham and Ince plants went offline – **cutting off CO_2 production and supply**.

BIO-CO_2 PRODUCTION

AD plants could supply bio-CO_2 for industrial use, providing a sustainable alternative to fossil-based sources.

As of March 2022, there are **122 biomethane plants** in the UK:

110 plants treat municipal, industrial and/or agricultural feedstocks

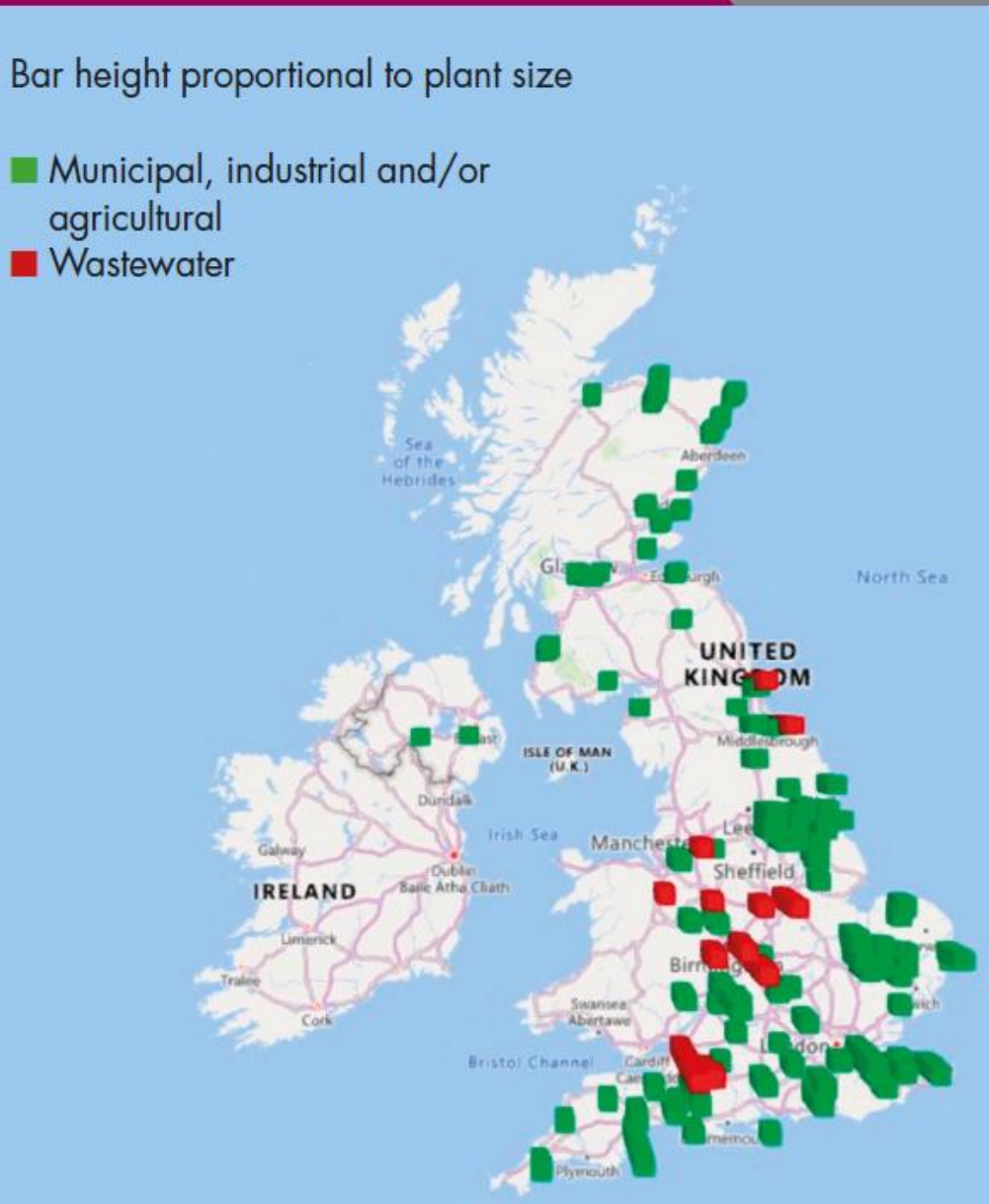
Total bio-CO_2 production = **853,000 tonnes pa**

Average plant production = **9,490 tonnes pa**

12 plants treat wastewater

Total bio-CO_2 production = **111,000 tonnes pa**

Average plant production = **11,315 tonnes pa**



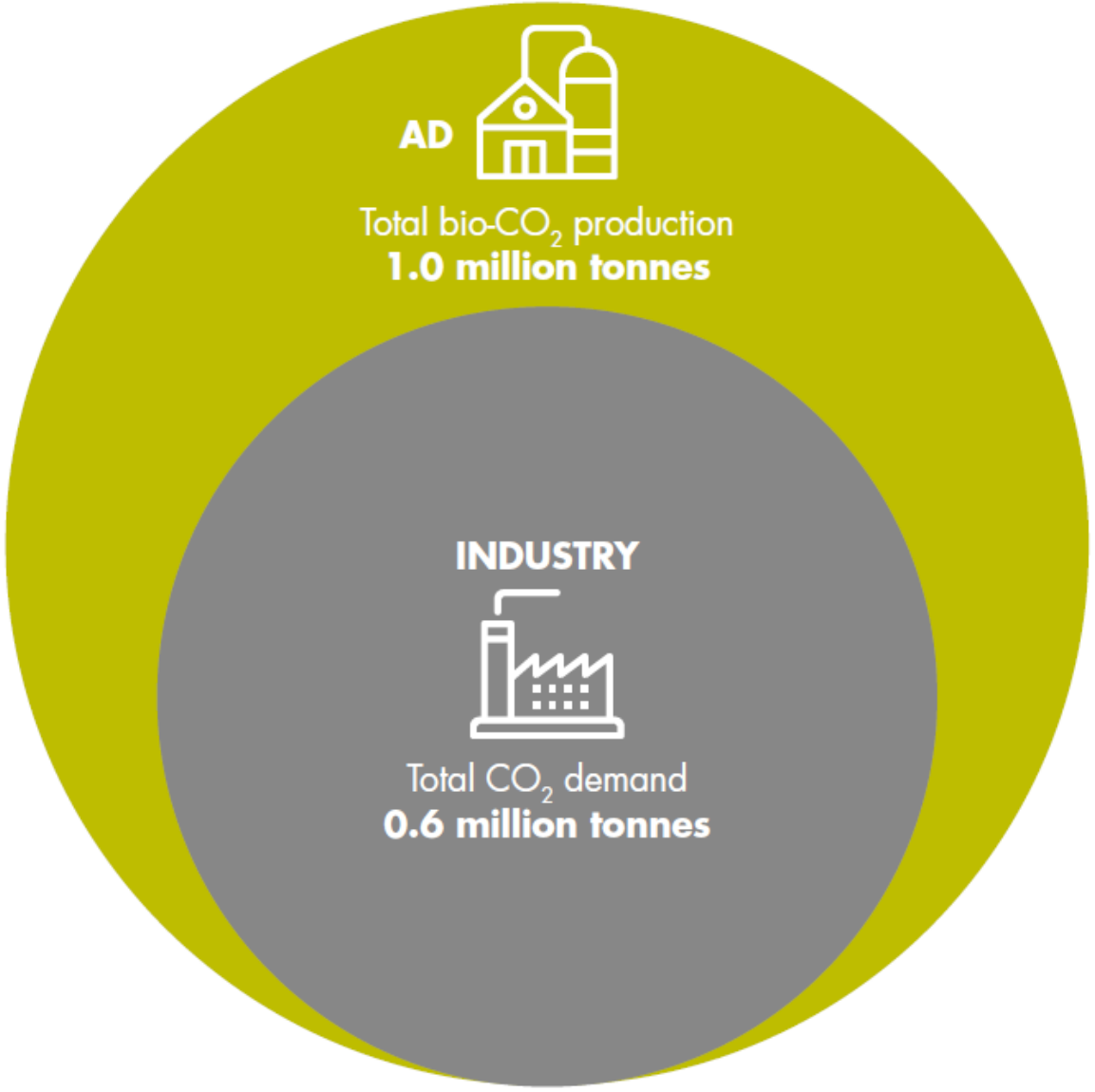
BIO-CO_2 PRODUCTION

In total, the UK's biomethane plants currently produce almost double the CO_2 demand from industry.

The supply of bio-CO_2 from biomethane plants can reduce industries' dependence on the 2-3 major production sites – mitigating the risk of future CO_2 crises.

As of March 2022, just **11 biomethane plants** currently capture bio-CO_2 from the biogas upgrading process.

These plants supply around **80-90,000 tonnes bio-CO_2** to industry per year (~15% demand).



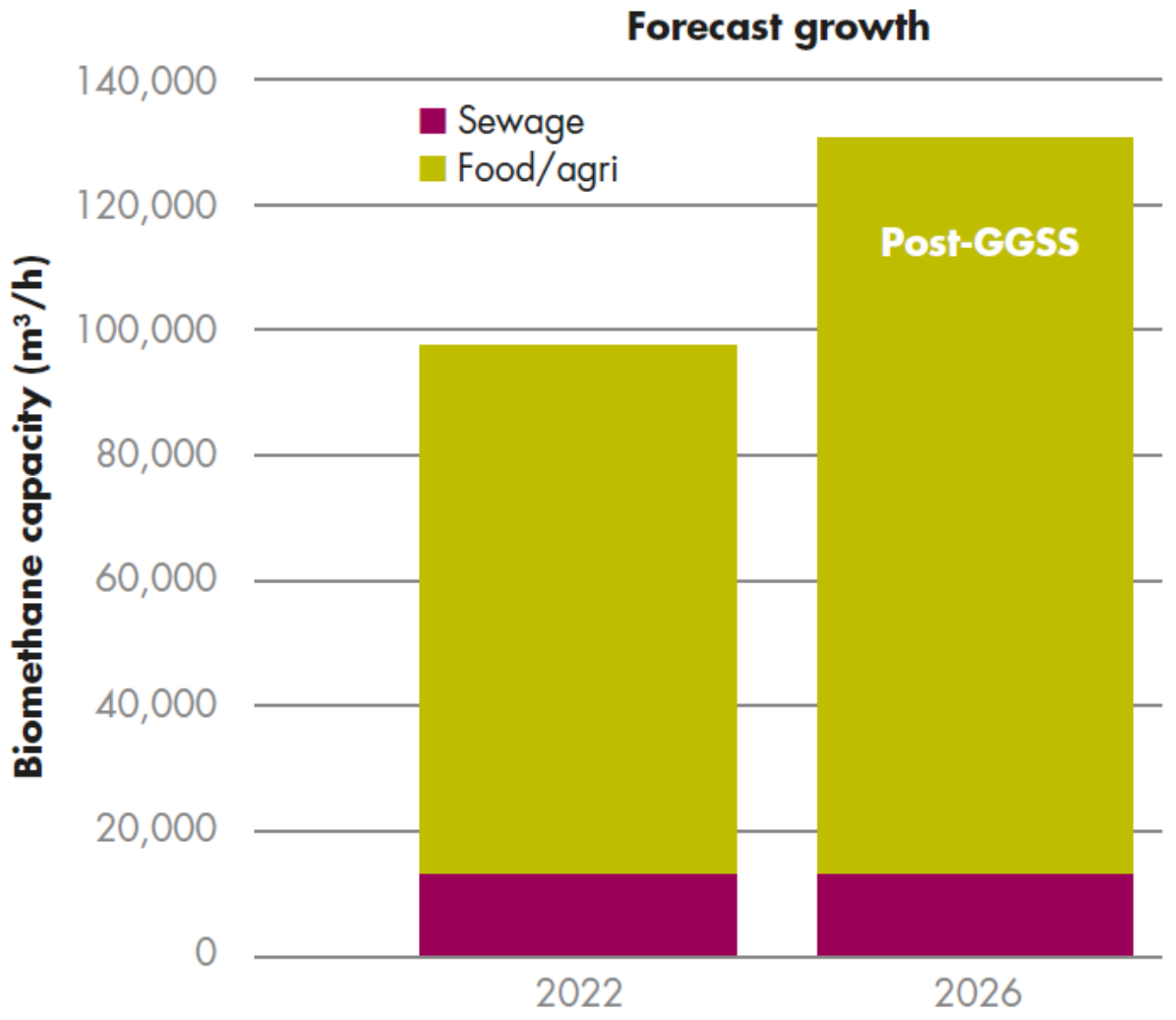
GROWING BIOMETHANE (AND BIO-CO_2) CAPACITY

In November 2021, BEIS launched the Green **Gas Support Scheme (GGSS)**. This scheme rewards the production of biomethane from AD plants through a fixed tariff rate (p/kWh), secured for 15 years.

Before the end of 2025, the GGSS is forecast to:

- Support the construction of **~45 new plants** with an average biomethane capacity of >750 m^3/h
- At this size, each plant would produce around **9,200 tonnes bio-CO_2 per year** (25 tonnes per day).

It is expected most of these plants will deploy CCUS technology with an upgrading system capable of producing **food-grade CO_2**



CONCLUSION

1. Demand

Around 600,000 tonnes of CO_2 gas is **utilised** within industrial processes each year (e.g. the manufacture of food and drinks).

Greenhouse gas removals (GGR) via bioenergy with carbon capture and **storage** (BECCS) will be essential in the delivery of Net Zero by 2050.

2. Capturing biogenic carbon

By treating organic feedstocks, anaerobic digestion (AD) captures biogenic carbon – i.e., carbon originating from the atmosphere.

Bio-CO_2 can be captured during the production of biomethane.

3. Current production

At present, the UK's 122 biomethane plants produce around **1 million tonnes of bio-CO_2 per year**. However, less than 10% is being utilised or stored, due to two key barriers: cost and perception.

4. Valorising bio-CO_2

The value of bio-CO_2's ability to displace the use of fossil-CO_2 or deliver GHG removals must be accounted for by markets. **Bio-CO_2 certificates** could help accelerate CCUS deployment.

5. Full potential

At full potential, where all unavoidable organic wastes are recycled, the UK's AD industry could capture over **8.3 million tonnes of bio-CO_2 per year**.

BIOGAS INSIGHTS 4

BIOGAS INSIGHTS 1

TRANSPORT

BIOMETHANE FUELLING
A TRANSPORT REVOLUTION

Save money while saving the planet

ADBA **Dr Nick Primmer** | Policy Analyst

BIOGAS INSIGHTS 2

HYDROGEN

BIOMETHANE & HYDROGEN
TWO GREEN GASES,
ONE FUTURE

ADBA **Dr Nick Primmer** | Policy Analyst
Emily Tradd | Manager, Biomethane Certification Scheme

BIOGAS INSIGHTS 3

FOOD WASTE RECYCLING

ANAEROBIC DIGESTION
THE NET ZERO LEVER FOR
LOCAL AUTHORITIES

BIO CAPITAL

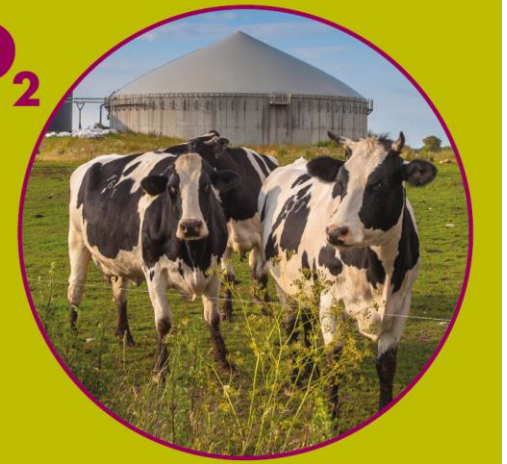
ashfords

ADBA **Leanne Williams** | Lead Analyst: Environment and Agriculture

BIOGAS INSIGHTS 4

BIOGENIC CO_2 FROM AD

SECURE SUPPLIES,
CARBON NEUTRAL,
MARKET READY



ADBA **Nick Primmer** | xxxxx

THANK YOU

futurebiogas

Green Gas & Carbon Capture

Dr Nick Primmer

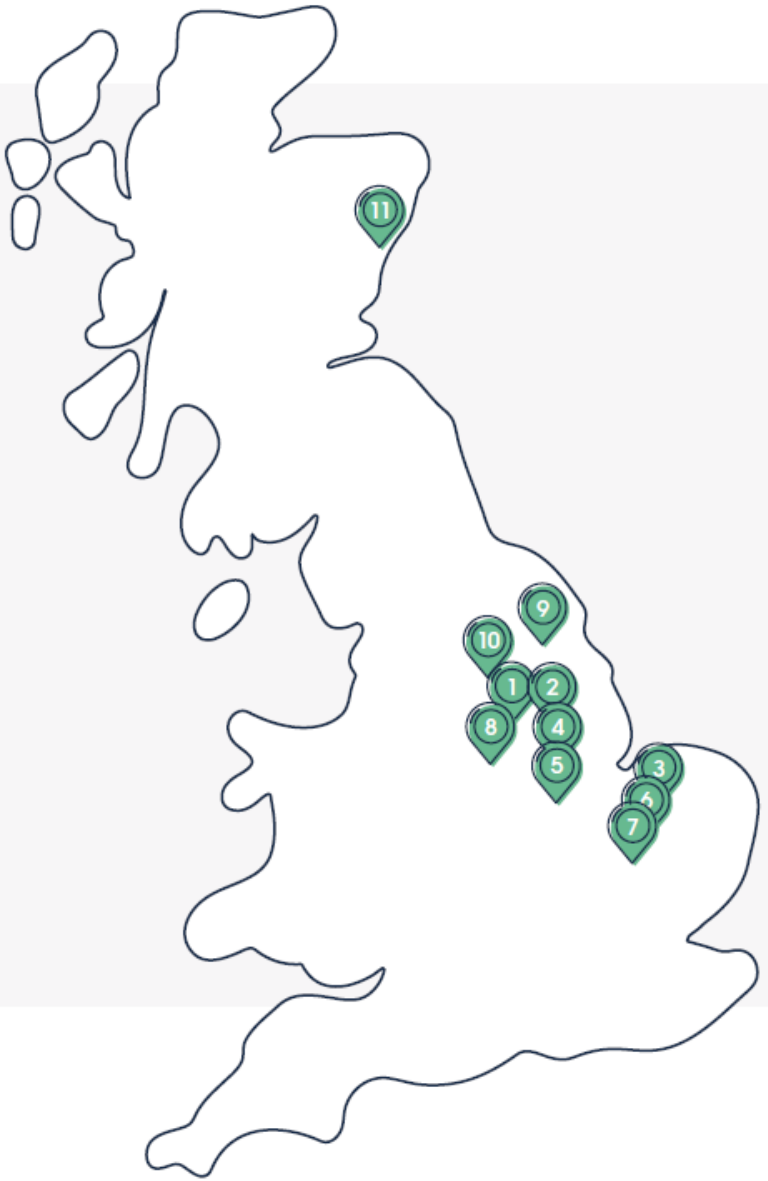
Policy advisor

June 2022

Largest Biomethane Producer in the UK

11

AD Plants



Green Gas

489 **GWh/per year capacity**

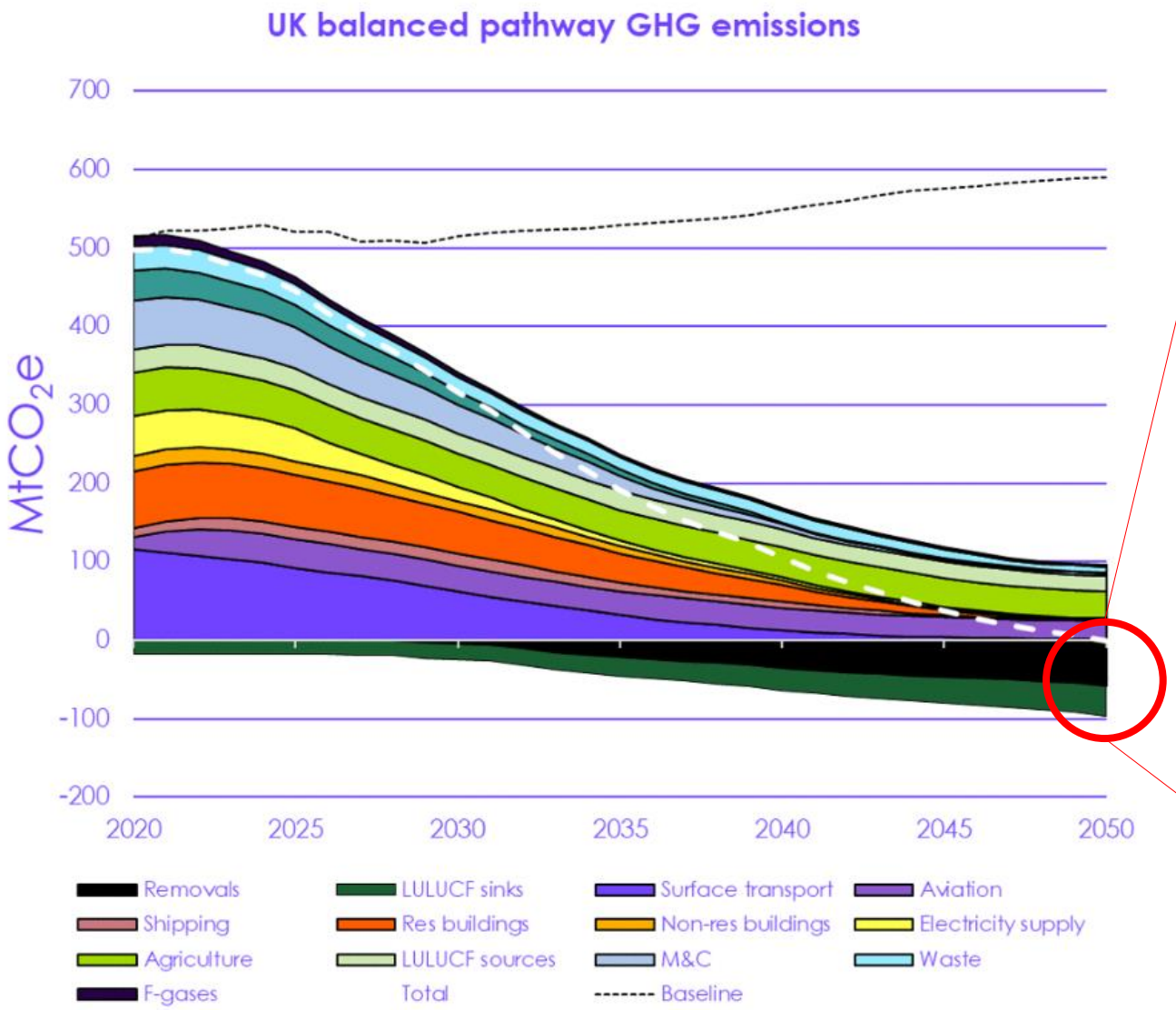
Clean Electricity

73 **GWh/per year capacity**

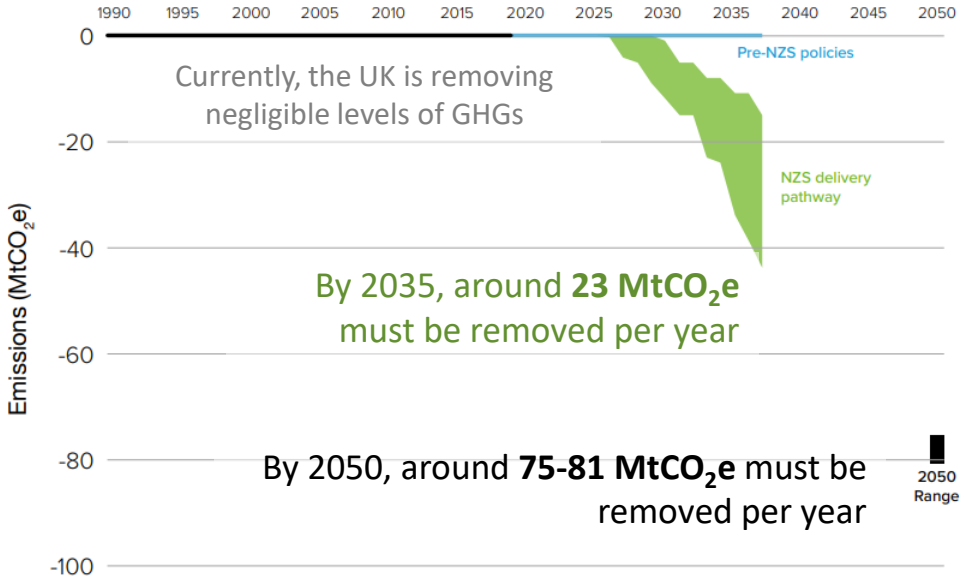
Working with over

400 **farmers**

GHG removal and Net Zero



Taken from the CCC's sixth carbon budget



Taken from the government's Net Zero Strategy (2021)

GHG removals

Engineered removals

+ Permanent removal
+ Low risk of re-release
+ High integrity
- Expense (at present)

Nature-based removals

+ Cheaper
+ Positive externalities
- Not permanent
- Difficult to quantify

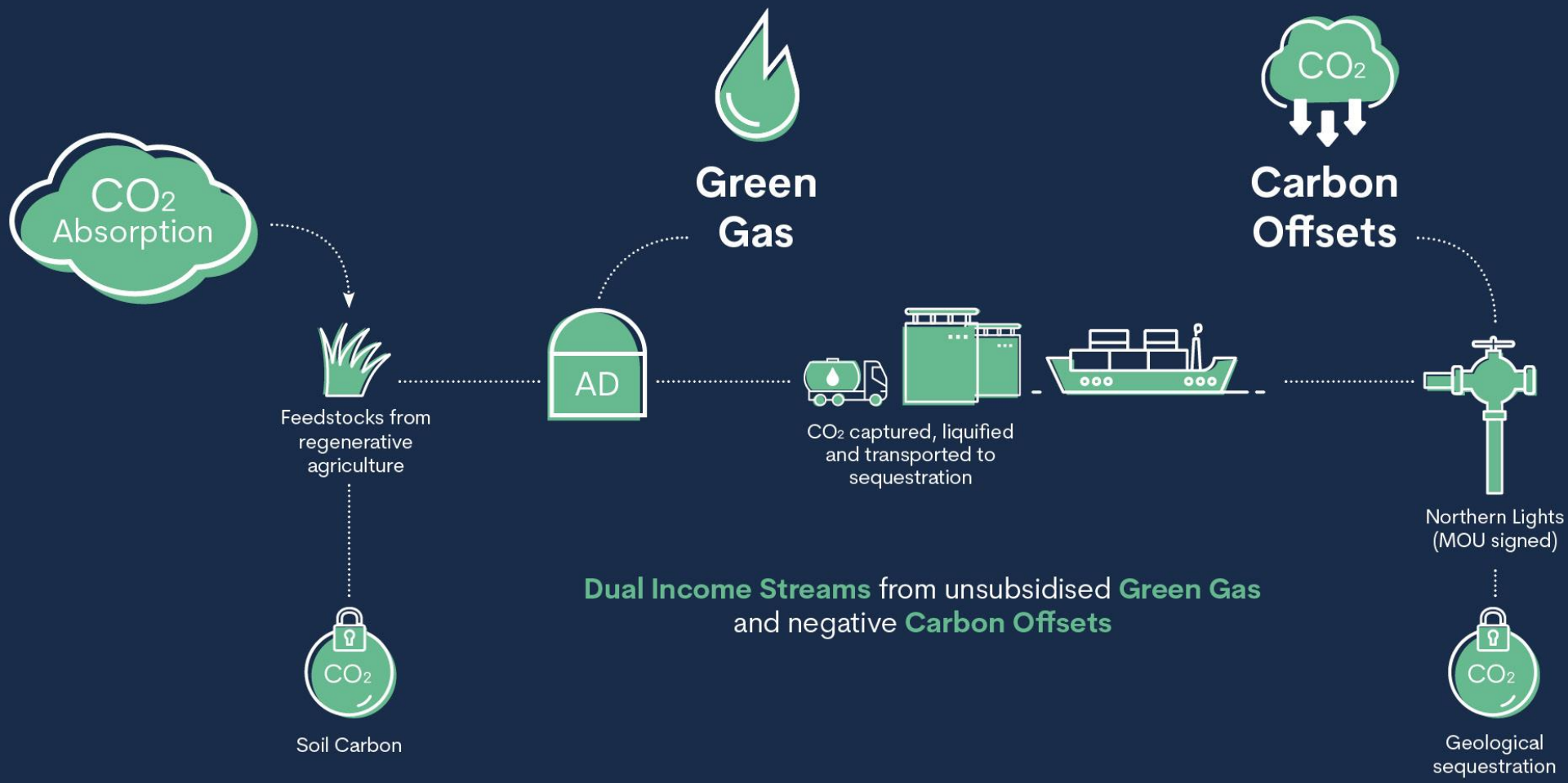
Carbon is derived from the atmosphere and captured within an AD tank.
Bio-CO2 can be liquefied and stored within geological storage.

Carbon-rich digestate spread back to land, sequestering biogenic carbon in soils

Sustainable agricultural practices reduce maintain higher levels of soil carbon

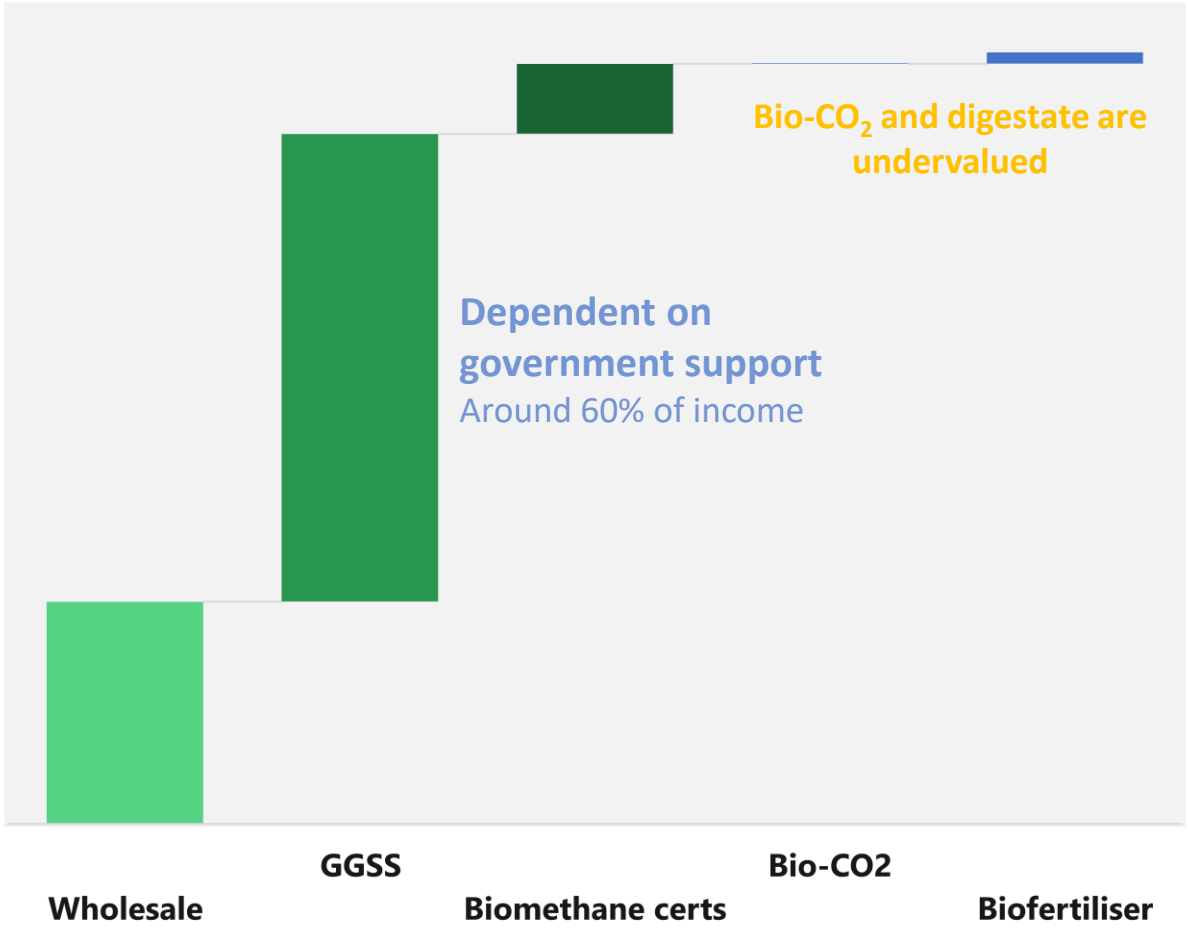
Bio-CO_2: the key to AD's future

futurebiogas

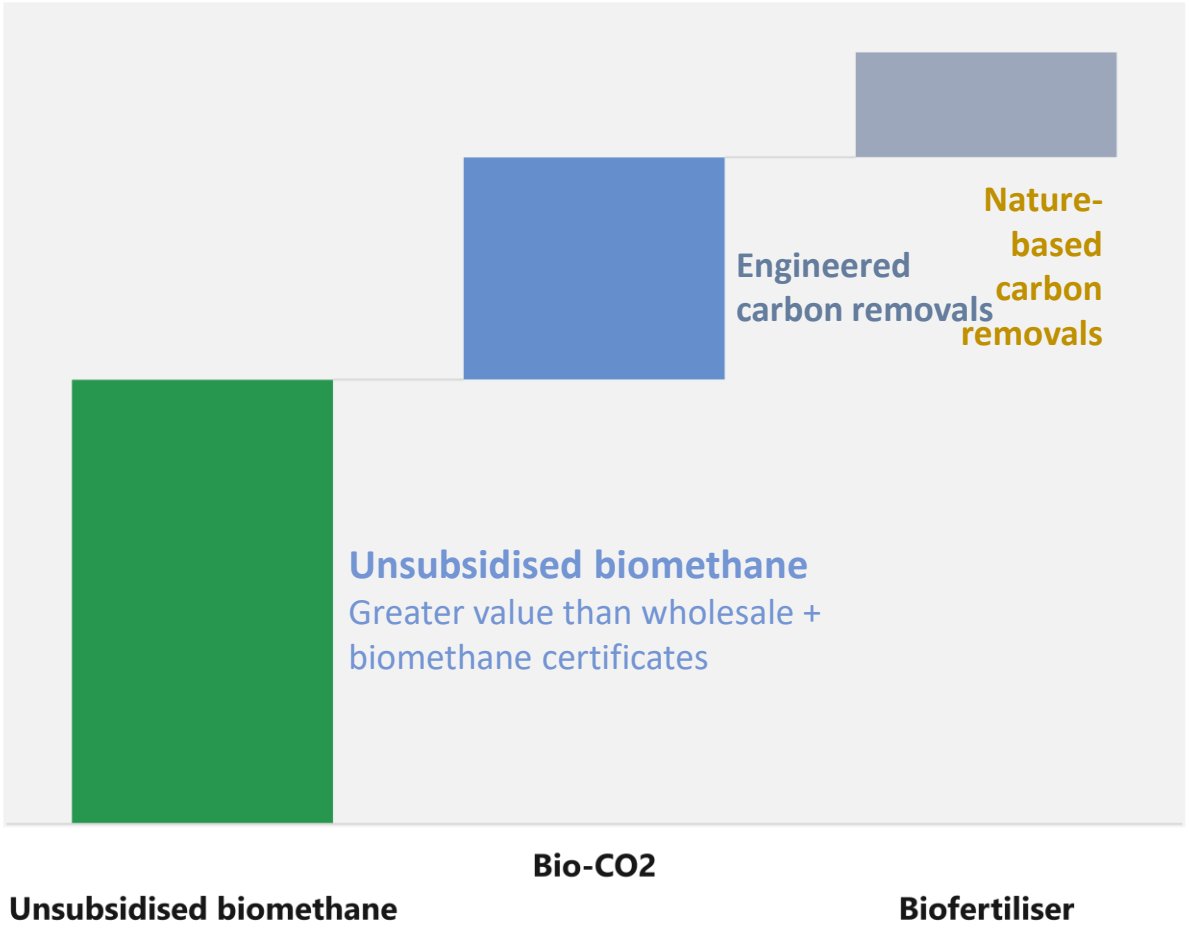


Shifting focus to Net Zero targets

Conventional AD income revenue streams

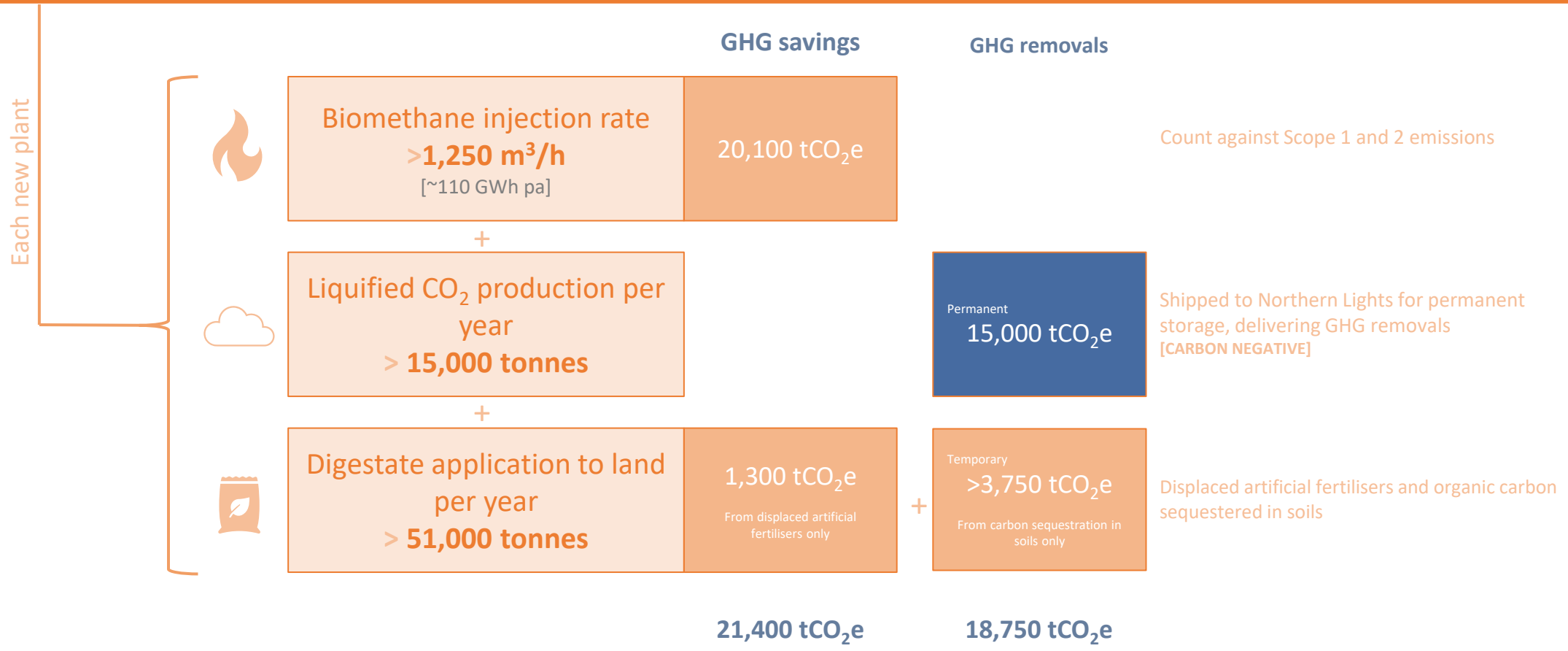


BECCS plant revenue streams



Project Carbon Harvest

25 new BECCS plants…



… each fed by **zero-carbon crops** grown under long-term contracts with sustainable farmers.

Placing farms at the heart of GGR

Much of the current agricultural system is **NOT** sustainable
- High use of carbon-intensity, artificial fertilisers
- High use of pesticides and herbicides
- High rates of soil degradation
- Low levels of biodiversity

AD can be integrated into sustainable agriculture

+ Recycling nutrients
+ Restoring soil health
+ Returning carbon to soils
+ Enhancing biodiversity

Focusing on sustainably agriculture is key to unlocking full potential of AD – benefiting all parties:

Farmer

Diversify income
Improve soil structure
Reduce demand for fertilisers

AD plant

Rewards for environmental services
Improves feedstock security
Removes dependence on subsidies

UK

Supports delivery of Net Zero
Enhance **food security** and **energy security**
Creates jobs in the rural and green economy

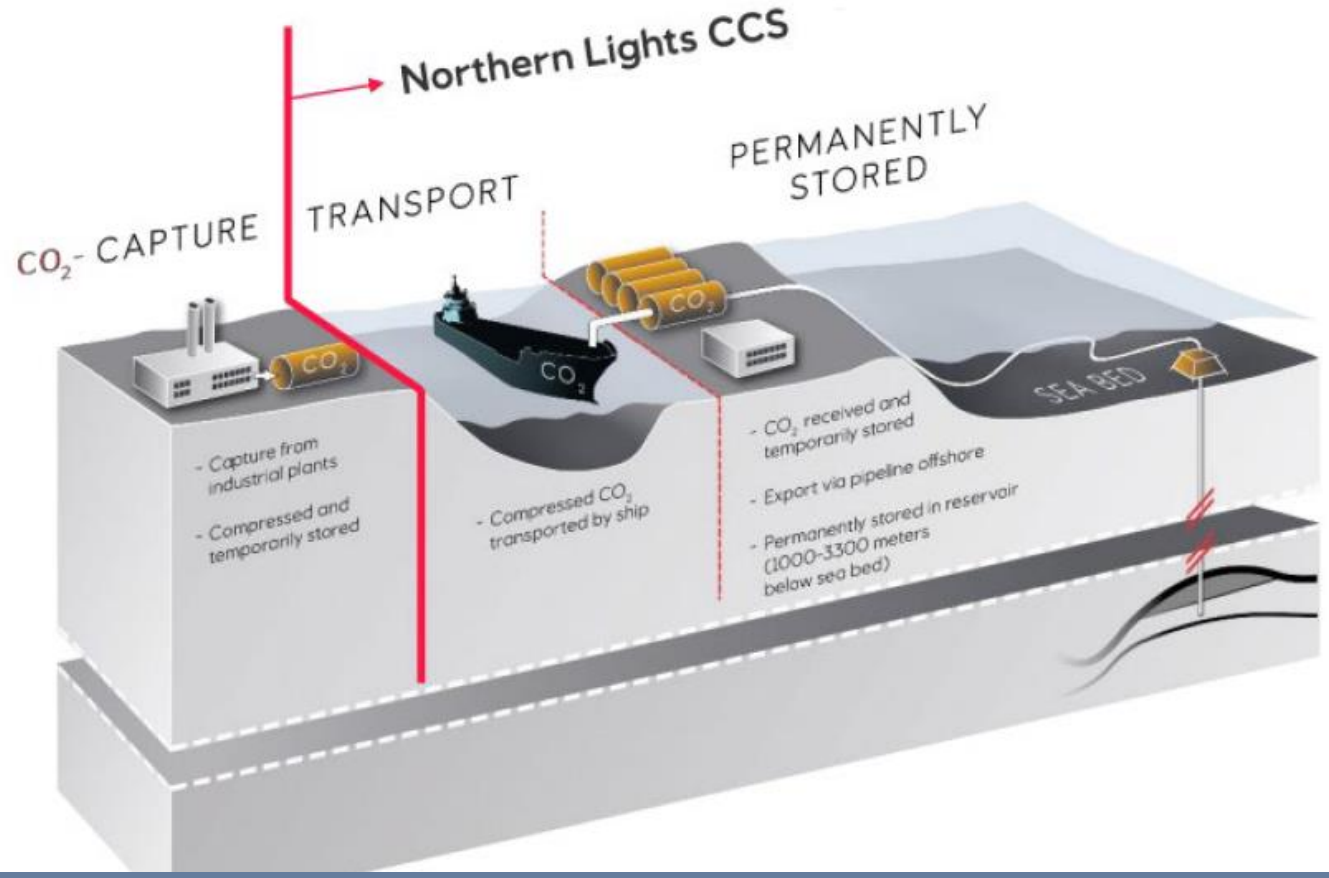
Northern Lights Project

CO_2 Sequestration

- In construction
- Permanent geological storage
- On schedule for 2024 operations

Northern Lights JV

- JV between Equinor, Shell and Total
- 16.8bn NOK (£1.4bn) funding from Norwegian State



Project Carbon Harvest aims to:

- **Remove 375,000 tonnes bio-CO_2** per year
- Generate 2.75 TWh unsubsidised biomethane per year

Thank you

Dr Nick Primmer
Policy advisor

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futurebiogas

Thank you

www.futurebiogas.com