



Capturing Carbon. From Waste to Permanent Storage.

Bigadan.com

BECCS Value Chain

Bioenergy with Carbon Capture and Storage

Bigadan operates one of Denmark's most advanced biogas platforms. Our plants convert organic waste into renewable biomethane — and the CO₂ that emerges as a by-product of that process is captured, liquefied and transported to permanent geological storage.

This paper describes Bigadan's role in the BECCS value chain: from biomass sourcing through biogas production, CO₂ capture and liquefaction, to onward transport to Esbjerg Port — where the CO₂ begins its journey to permanent sub-seabed storage.

Bigadan's scope

- Biomass Sourcing
- Biogas Production
- CO₂ Capture & Liquefaction
- Transport to Esbjerg Port

Biomass Sourcing

Where it all begins

Bigadan sources organic waste and residues exclusively from sustainable, non-food-competing feedstocks. All raw materials are carefully selected to maximise gas yield while meeting the strict sustainability criteria of EU RED III.

From organic waste to renewable gas

- **Animal slurry**
Feedstock from Danish livestock farming. Rich in nitrogen — digestate returned to soil as organic fertiliser.
- **Source-separated food waste**
Municipal and industrial organic waste. Processed under strict hygienisation protocols to eliminate pathogens.
- **Industrial organic residues**
By-products from food and pharmaceutical production (e.g. Novo Nordisk and Novonosis insulin and enzyme residues).



Local sourcing priority

Majority of feedstocks sourced within 50 km of each plant, minimising transport emissions and supporting local circular economies.

Biogas Production

From organic waste to renewable gas

Bigadan's co-digestion plants process mixed organic feedstocks in large sealed anaerobic digesters, where microbial communities break down organic matter in the absence of oxygen, releasing biogas — a mixture of methane (CH_4) and carbon dioxide (CO_2).

- **Reception & pre-treatment**

Feedstocks are received, weighed and registered. Solid materials are shredded. All inputs are logged for full traceability.

- **Anaerobic digestion**

Feedstocks are fed continuously into insulated digesters operating at 37–52°C (mesophilic/thermophilic). Retention time: 20–30 days. Microbial consortia convert organic carbon to raw biogas (55–70% CH_4 , 30–45% CO_2).

- **Digestate separation & return**

Residual digestate — rich in nitrogen, phosphorus and potassium — is separated and returned to agricultural land as organic fertiliser.

- **Biogas upgrading**

Raw biogas is cleaned and upgraded using membrane, amin or water scrubbing technology, removing CO_2 , H_2S and trace gases. The result: biomethane at >97% CH_4 purity, meeting grid injection standards.



2 TWh

annual biomethane capacity across
Bigadan's Danish plants

CO₂ Capture & Liquefaction

Partners
in Circular
Energy

Kanadevia
INOVA

Bigadan

Biogenic CO₂ removal is classified as Carbon Dioxide Removal (CDR) — permanently reducing atmospheric CO₂ concentrations.

01 The CO₂ by-product

During biogas upgrading, the CO₂ separated from raw biogas is a pure, biogenic stream. Unlike CO₂ from fossil combustion, this CO₂ was recently captured from the atmosphere by the organic material — making its permanent removal genuinely climate-positive (carbon dioxide removal, CDR).

02 Capture & purification

The biogenic CO₂ stream exiting the upgrading unit is further purified to food-grade or industrial purity standards (>99.9% CO₂). Contaminants including H₂S, siloxanes and moisture are removed using activated carbon filters and molecular sieves, producing a CO₂ stream suitable for liquefaction and long-term storage.

03 Liquefaction

Purified CO₂ gas is compressed and cooled to approximately -20°C / 20 bar, converting it to liquid CO₂ (LCO₂). Liquid CO₂ has a density approximately 800× that of CO₂ gas at atmospheric pressure, making it practical for bulk transport by road tanker to Esbjerg Port for onward offshore injection.

From Plant to Port: Transport to Esbjerg

Biogas-powered road transport

Liquid CO₂ is loaded into cryogenic road tankers at the biogas plant. Bigadan's logistics concept prioritises biogas-fuelled heavy goods vehicles (HGV) — meaning the transport itself is powered by the same renewable gas produced on site, creating a near-zero-emission logistics chain.

- **Cryogenic tankers**
LCO₂ transported at -20°C / 20 bar in cryogenic tankers.
- **Biogas-fuelled vehicles**
HGVs powered by compressed biomethane (CBG), minimising Scope 3 transport emissions.
- **Route to Esbjerg Port**
The LCO₂ is transported 240 km by road from Kalundborg Bioenergi to Esbjerg Port — Denmark's primary offshore energy hub.
- **Full chain-of-custody**
Each tanker load is digitally tracked and linked to the originating biogas plant and feedstock batch for complete traceability.

Esbjerg Port — where our scope ends

At Esbjerg Port, Bigadan's role in the BECCS value chain is complete. The LCO₂ is transferred to our downstream partner Greensand, who handle offshore injection into permanent sub-seabed geological storage formations beneath the North Sea.

- **Port reception & temporary storage**
LCO₂ unloaded into cryogenic storage tanks at Esbjerg Port. Quality and quantity verified on receipt.
- **Offshore vessel loading**
LCO₂ transferred to CO₂ carrier vessels for transport to offshore injection platform.
- **Geological injection**
LCO₂ injected into depleted oil reservoirs below the seabed — permanent, monitored storage.
- **Verification & certification**
Each removal is certified by Isometric and verified by an accredited third-party, producing certified Carbon Dioxide Removal credits traceable to Bigadan's plants through dMRV (Monitoring, Reporting, and Verification) system partners.