Biogas Outlook 2025

Production and use of biogas in Denmark
2024 - 2045

Biogas Danmark

Increased biogas production is a European imperative

Biogas Outlook 2025 outlines how Denmark can achieve a 100 percent green gas supply by 2030 and reinforce its role as a European leader in biogas.

To secure a safe, independent and green energy system, Denmark must deploy all available technologies and solutions, including biogas, wind, solar and green Power-to-X fuels. This is the core message of Biogas Outlook 2025.

Wind and solar play a central role, but do not produce electricity when the wind is calm or the sun is not shining. Biogas, in contrast, can be stored and used to generate electricity and heat when needed. In this way, biogas provides essential flexibility and helps ensure a reliable supply of power and heating.

Biogenic CO_2 from biogas can also be used to produce Power-to-X fuels, while biogas plants contribute to more sustainable food systems by recycling nutrients efficiently.

As shown in this year's Outlook, Denmark and the rest of Europe have access to large volumes of sustainable resources in the form of waste and residues that can be converted into biogas. Making optimal use of these resources is crucial for addressing the challenges related to food and energy production.

On 6 May 2025, the European Commission presented a plan to phase out Russian gas imports and significantly expand biogas production as part of efforts to strengthen European energy security.

A scale-up of biogas production is therefore a necessary task. As a frontrunner in the field, Denmark has a clear responsibility to lead the way.

Biogas Outlook 2025 confirms that the potential is substantial, but also that progress has stalled. The Outlook demonstrates how market demand can be strengthened, allowing Denmark to increase the production of unsubsidized, tax-exempt biogas and reach a fully green gas supply by 2030. Combined with faster and more efficient permitting processes, Denmark can reinforce its position as a European leader in green energy and energy security.

Enjoy the read

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Biogas Danmark

Introduction

Biogas Outlook 2025 presents the impacts of biogas production and use towards 2045 based on three different scenarios

The purpose of Biogas Outlook 2025 is to provide a detailed insight into the development opportunities within biogas production and use, including biogenic CO_2 and fertilizer, based on available bioresources and new technologies such as Power-to-X, CCS and pyrolysis.

Biogas Outlook serves as a reference guide with key facts about biogas. The publication presents three development scenarios and offers data and factual information on biogas-related effects within climate, agriculture, nutrient recycling, the aquatic environment, economy, markets and EU developments.

The KEFM scenario is based on the 2025 climate projection from the Danish Ministry of Climate, Energy and Utilities (KF25). (1)

The Frozen Policy scenario adjusts the KEFM scenario with new framework conditions not included in KF25.

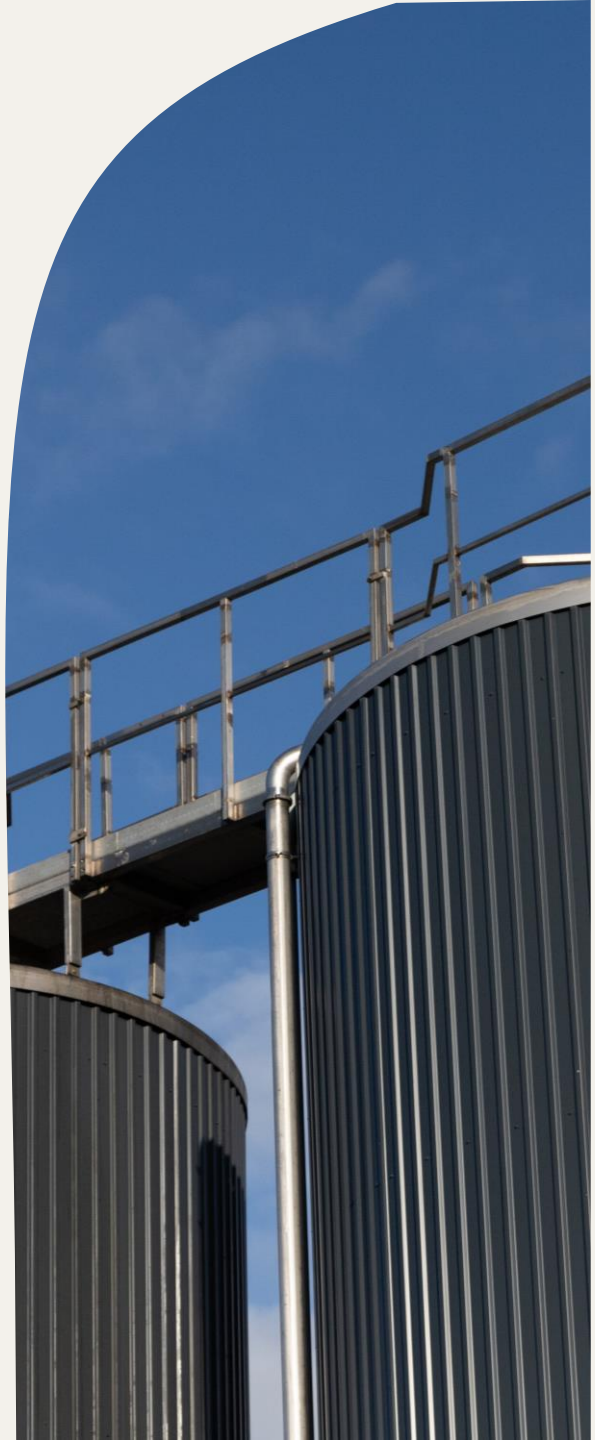
Green Policy scenario builds on the Frozen Policy scenario and adds Biogas Denmark's policy proposals aimed at creating market conditions that support increased production and use of unsubsidized biogas in Denmark.

Biogas Outlook 2025 confirms that the recent rapid growth in production has been replaced by stagnation caused by rigid framework conditions. As expected, this has led to a slowdown in new investments.

In 2024, biogas accounted for around 45 percent of Denmark's total gas consumption, including biogas supplied directly from plants to end users. This is despite the availability of resources sufficient to more than double the current production.

Without new market conditions, no new production will emerge, as shown in the Frozen Policy scenario. The Green Policy scenario demonstrates that Denmark's gas consumption could be covered entirely by biogas from 2030 if Biogas Denmark's proposals are implemented, including tax exemption for unsubsidized biogas.

Biogas Outlook 2025 is available in both Danish and English at www.biogas.dk under the facts section. The website also provides access to Biogas Data Online, where users can find forecasts, historical trends and real-time data on biogas production, gas consumption, storage levels and the current market value of biogas.



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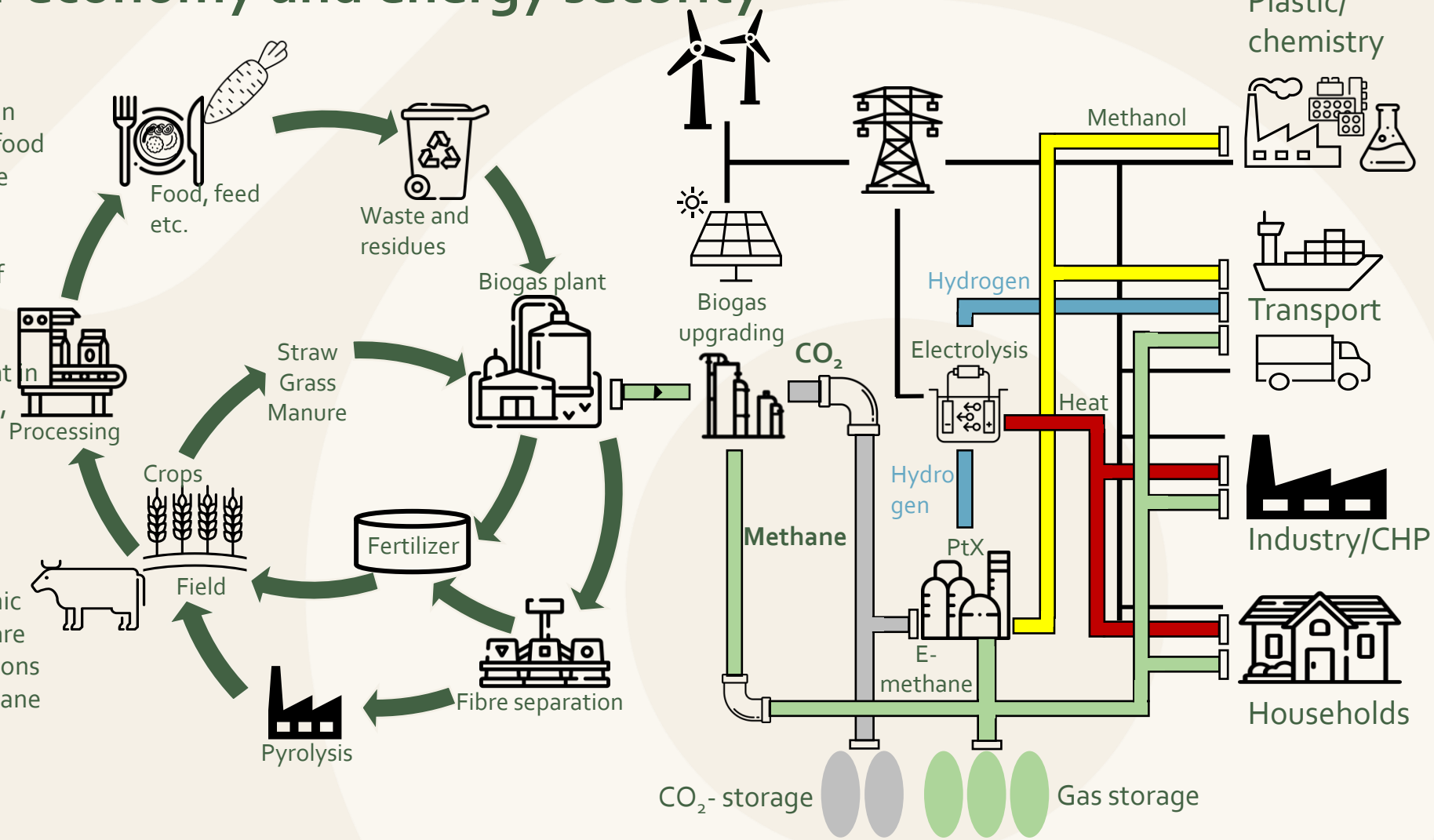
Biogas is circular economy and energy security

Danish biogas plants play a key role in the circular economy by processing food waste and residual products from the food industry and agriculture. This process enables nutrient recycling, supporting a more sustainable use of resources.

At the same time, the energy content in the biomass is converted into biogas, which replaces fossil fuels and strengthens both climate action and energy security.

When the biogas is upgraded and injected into the gas grid, the biogenic CO_2 is separated. Biogas producers are working to use this CO_2 in new solutions such as Power-to-X fuels like e-methane and e-methanol, as well as for CO_2 storage in the underground.



Danish biogas production is a strong example of how the circular economy works in practice.

When raw biogas is upgraded, it delivers not only biomethane but also biogenic CO_2, which can be used to store electricity in Power-to-X fuels.

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Security of supply under pressure

Sharp increase in electricity demand calls for backup capacity from gas turbines running on biogas

Electrification of heating, transport, industry and new data centers is expected to double electricity demand by 2035. Meanwhile, thermal power plants such as coal-fired units are being phased out, and electricity production is increasingly based on wind and solar energy.[2]

Energinet has calculated that during periods with little wind and sun, Denmark will have an electricity self-sufficiency rate of about 30 percent after 2030. [2] This creates a strong dependency on energy imports, which can be reduced by adding backup to the power system.

Large-scale investments in batteries can help balance day-to-day fluctuations, but they cannot cover periods lasting several days. According to the Danish Council on Climate Change [3] and Aalborg University [4], gas turbines powered by biogas from Denmark's large gas storage facilities provide the most cost-effective and efficient backup capacity over longer periods.

The figure illustrates the challenges ahead. Extended periods with little wind and sun will result in a significant need for backup capacity in the power system, especially during cold weather and in a scenario where all remaining gas boilers have been replaced by heat pumps.

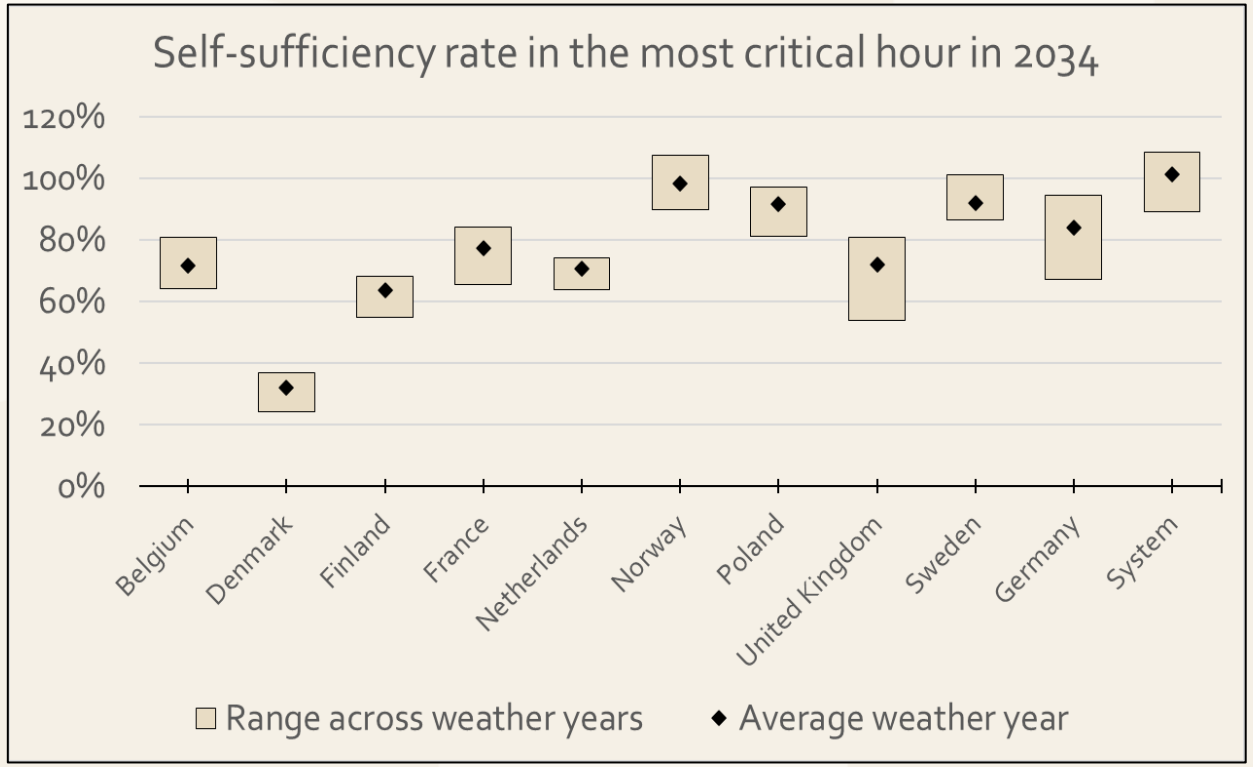

Figure from Energinet showing electricity self-sufficiency including national reserves. The system covers all 10 countries combined, without considering cross-border transmission constraints. It shows that in the most critical situations with low wind and solar production, Denmark can cover only around 30 percent of its electricity demand, while neighboring countries can cover about 70 percent of theirs by 2034. The figure is from Energinet's Redegørelse for elforsyningssikkerhed 2024. [2]

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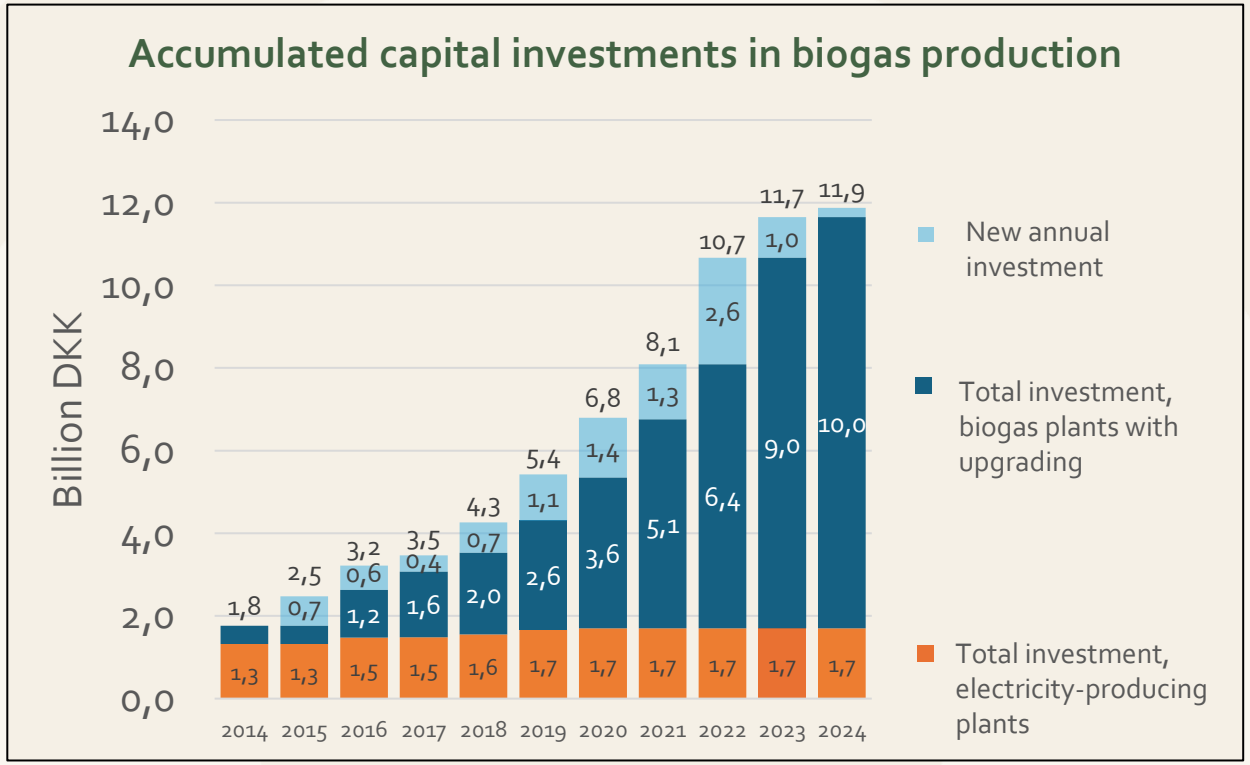
Investments in biogas plants

Trends in investments 2014 - 2023

Since 2014, investments in Danish biogas plants have increased significantly. In particular, the years 2022 and 2023 saw record-high investments, driven by the energy crisis and the urgent need for green gas. The figures shown are estimates based on annual accounts, analysis of investment and production data, and adjusted for price developments.

Most investments have been made in the construction of new biogas plants with upgrading capacity, but many existing plants have also expanded their capacity. In total, investments in the Danish biogas sector are estimated to have reached DKK 12 billion by 2024.

However, under current market conditions, investment activity is expected to decline. Continued investment at a high level requires better framework conditions to support new projects and expand production capacity. High investment levels are crucial for society and a prerequisite for achieving a fully green gas grid and meeting the ambitions of the Green Tripartite Agreement.



Investments in biogas plants grew rapidly from 2019 to 2023 but have now stagnated due to inadequate framework conditions for expanding new biogas production.

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Three scenarios - KEFM, Frozen Policy and Green Policy

Key assumptions and main features of the three scenarios

Shared assumptions across the scenarios
All three scenarios use the projected gas demand from the Climate Status and Projections 2025 (KF25).[1]

KEFM scenario (KF25)
This scenario is based on KF25, which represents the Danish Ministry of Climate, Energy and Utilities' (KEFM) expectations for the development of biogas production.

The scenario uses a biogas production pathway based on KF25, which includes both the current subsidy scheme and the politically agreed biogas tenders.

Since KF25 only specifies the use of livestock manure for biogas production [1], Biogas Denmark has assessed the use of other available biomass resources. This assessment is primarily based on data from the most recent biomass reports submitted to the Danish Energy Agency. [1]

Biogas Denmark has calculated the climate and environmental impacts as well as the potential for CO_2 storage, Power-to-X and pyrolysis in the scenario. This is based on data from research institutions and universities.

Frozen Policy scenario
The Frozen Policy scenario is Biogas Denmark's reassessment of the KEFM scenario for biogas production, including the impact of framework conditions that KEFM has either omitted or assessed differently.

The revised conditions primarily concern the lack of eligibility for guarantees of origin for subsidized biogas under the agreed tenders. Actors in the biogas sector have therefore stated that they do not wish to bid under the new support terms, which means the tenders will not lead to new biogas production.

The reassessment also includes the effects of overcompensation regulations, feed-in tariffs to Evida, a new CO_2 tax on biogas injected into the gas grid, and the ban on maize from 2025.

The current subsidy scheme is expected to peak in 2027 with a supply of about 29 PJ to the gas grid. Due to the weakened new framework conditions, production is only expected to increase marginally from around 27 PJ in 2024 to about 29 PJ in 2027, remaining at that level until the end of the period in 2045.

Green Policy scenario
The Green Policy scenario builds on the Frozen Policy scenario but reflects Biogas Denmark's policy proposal to improve market conditions for unsubsidized biogas, including using the politically allocated tender funds to cover tax exemptions for biogas delivered through the gas grid, as detailed further on page 11.

Comparison of the three scenarios
As Biogas Danmark considers the most realistic future scenarios to be either the Frozen Policy or the Green Policy scenario, these are the two scenarios primarily compared throughout Outlook 2025.

Page 10 highlights the differences between the two in terms of indirect impacts such as climate and environmental effects.

Page 14 shows how the three scenarios meet future gas demand and how the Green Policy proposal can significantly reduce greenhouse gas emissions in the transport sector, construction and other areas after 2030.

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Effects of biogas expansion

Significant climate and environmental benefits from biogas expansion

Compared to the Frozen Policy scenario, the Green Policy scenario offers clear benefits for Denmark in terms of improved energy security, lower climate impact, reduced pressure on the aquatic environment and increased nutrient recycling.

The Green Policy scenario involves a significantly higher level of biogas production than the Frozen Policy scenario. Both scenarios are based on the sharp reductions in gas consumption assumed in the Danish Energy Agency's forecast KF25. (1)

Because biogas production under the Green Policy scenario exceeds current gas demand from 2030 onwards, the available biogas provides a strong buffer in case the projected reductions in gas demand are not achieved. Alternatively, fossil fuels can be replaced in road freight and maritime transport.

Capturing CO_2 from biogas production enables the storage of large volumes of surplus electricity in the form of Power-to-X fuels. Alternatively, the Green Policy scenario can deliver a climate benefit of up to 1.8 million tonnes of CO_2 in 2030 through geological storage of biogenic CO_2 via CCS.

The environmental benefits include a reduction of 1,400 tonnes of nitrogen discharged into water bodies and increased recycling of 7,800 tonnes of phosphorus.

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Effects of biogas expansion	Frozen Policy		Green Policy	
	2025	2030	2030	2035
Biogas production, PJ	**34**	**40**	**51**	**54**
Of which injected into the grid	27	38	49	52
Share of gas grid consumption	46 %	82 %	107 %	155 %
Gas consumption, PJ	**66**	**48**	**51**	**54**
From the gas grid	59	46	46	34
Outside the gas grid	7	2	2	2
Available for ships, aviation, plastic	0	0	3	19
PtX potential, PJ				
E-methane from surplus electricity	18	25	33	35
E-methanol from surplus electricity	10	14	18	19
Net climate effect (mil. tons CO_2e)	**1,9**	**2,4**	**3,4**	**3,6**
Fossil displacement	2,0	2,4	3,2	3,4
Agricultural emission reduction	0,3	0,5	1,0	0,9
Methane loss and own consumption	-0,4	-0,5	-0,7	-0,7
Emission reduction potential (mil. tons CO_2e)				
CCS potential	1,0	1,4	1,8	1,9
Circular economy				
Reduced nitrogen loss, tons N	788	1.062	1.461	1.375
Phosphorus in digested biomass, tons P	22.104	25.311	36.513	34.202
Biogas share of livestock manure	38 %	50 %	85 %	85 %

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Biogas Denmark's Green Policy proposal

A comprehensive package of targeted initiatives

Biogas Denmark recommends the following concrete initiatives to ensure that new, unsubsidized biogas production can cover Denmark's gas consumption from 2030:

1. Implementation of a tax exemption for unsubsidized, sustainability-certified biogas delivered via the gas grid and documented with guarantees of origin

2. A blending requirement for gas suppliers to deliver at least 30 percent green gas for residential heating in 2027, increasing to 100 percent in 2030

3. Implementation of the politically agreed compensation scheme for road tolls on biogas-powered trucks through reimbursement of CO_2 and energy taxes

4. Allocation of existing public funding for new biogas tenders to finance the proposed tax exemption for biogas delivered through the gas grid

Biogas production towards 2035 beyond current subsidy schemes

KEFM, PJ	2024	2025	2026	2027	2028	2029	2030	…	2035
Current subsidy scheme	*33*	*35*	*35*	*37*	*38*	*39*	*39*		*40*
Funds for new tenders	-	-	*2,3*	*3,0*	*3,6*	*4,3*	*5,0*		*8*
Total biogas production	**33**	**35**	**37**	**40**	**42**	**43**	**44**		**48**
Frozen Policy, PJ									
Current subsidy scheme	33	34	36	37	37	37	37		37
Funds for new tenders	-	-	-	-	-	-	-		0
Projects under construction	-	-	0,8	2,0	2,4	2,4	2,4		2
Total biogas production	**33**	**34**	**37**	**39**	**40**	**40**	**40**		**39**
Green Policy, PJ									
Current subsidy scheme	33	34	36	37	37	37	37		38
Funds for new tenders	-	-	-	-	-	-	-		0
Projects under construction	-	-	0,8	2,0	2,4	2,4	2,4		2
Transport	-	0,6	0,8	0,8	0,8	1,1	1,4		6
Blending requirement	-	-	-	0,8	2,2	6,2	10		8
Total biogas production	**33**	**34**	**38**	**41**	**43**	**47**	**51**		**54**

*The **current subsidy scheme** includes all plants approved under the 2012 energy agreement.*
***Projects under construction** refer to biogas projects that have been decided and are currently being implemented*
***Funds for new tenders** indicate the estimated production volumes from the upcoming biogas tenders. KF25 only includes 5 PJ in 2030 and 7.9 PJ from 2034 onwards.*
***Blending requirement and transport** shows the expected effect of new proposed market conditions for unsubsidized, tax-exempt biogas delivered via the gas grid.*

Biogas Danmark

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Green biogas for residential heating

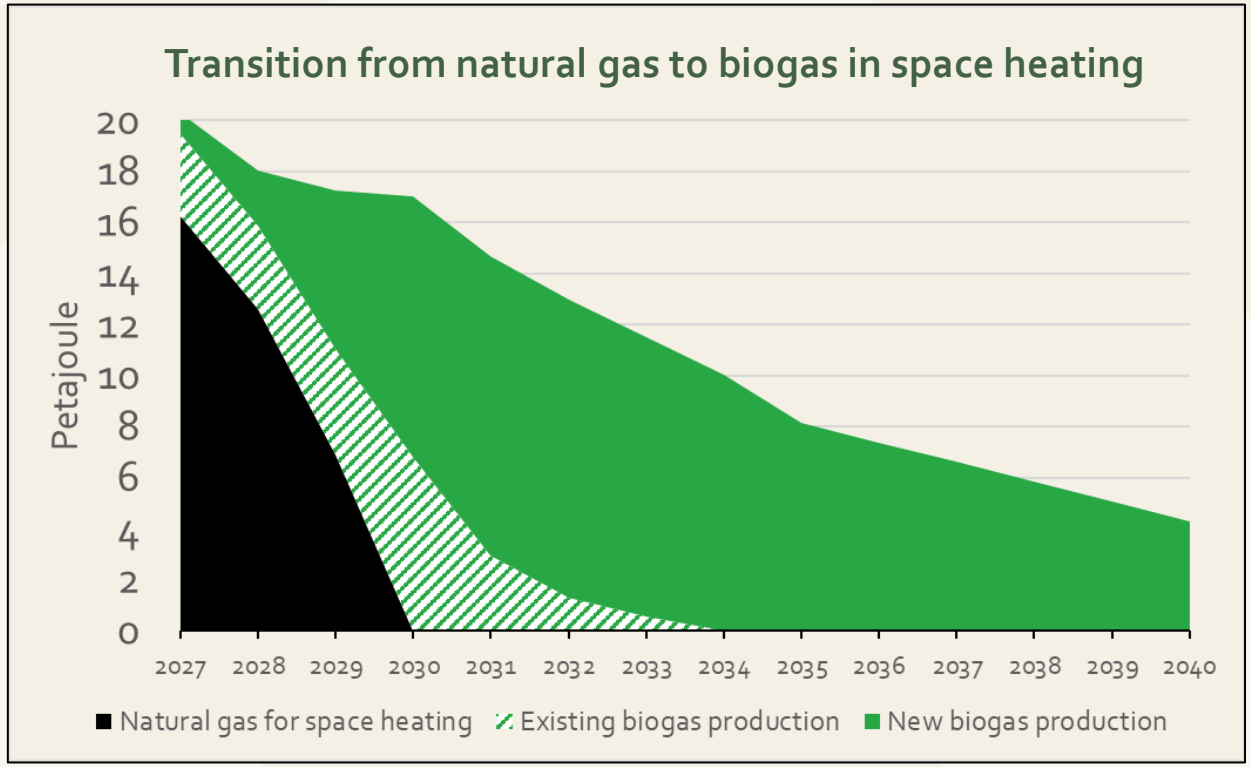
Biogas Denmark's proposal for a blending requirement

Under Biogas Denmark's proposal, gas suppliers must deliver an increasing share of sustainable, tax-exempt and unsubsidized biogas for residential heating from 2027 to 2030. From 2030, the requirement reaches 100 percent and must be met with unsubsidized biogas delivered via the gas grid and documented with guarantees of origin.

Natural gas for heating will be gradually phased out and replaced by green gas. Initially, some of this green gas will come from existing biogas plants that opt out of subsidies in favor of delivering tax-exempt biogas. Over time, it will be fully covered by new unsubsidized production.

As gas consumption for heating declines, this does not lead to a reduction in biogas production. Instead, the biogas can be redirected to other sectors in need of green alternatives such as heavy transport, shipping, aviation and plastics production.

The loss of government revenue from natural gas taxes in the heating sector can be financed using the funds already allocated to future biogas tenders.



The figure shows the timeline for a blending requirement for residential heating, ensuring a complete phase-out of fossil natural gas by 2030. It also shows that gas use for heating is expected to decline under KF25 [1], thereby making more biogas available for other sectors.

Biogas Danmark

Resumé

Blending requirement results in a small increase in heating costs

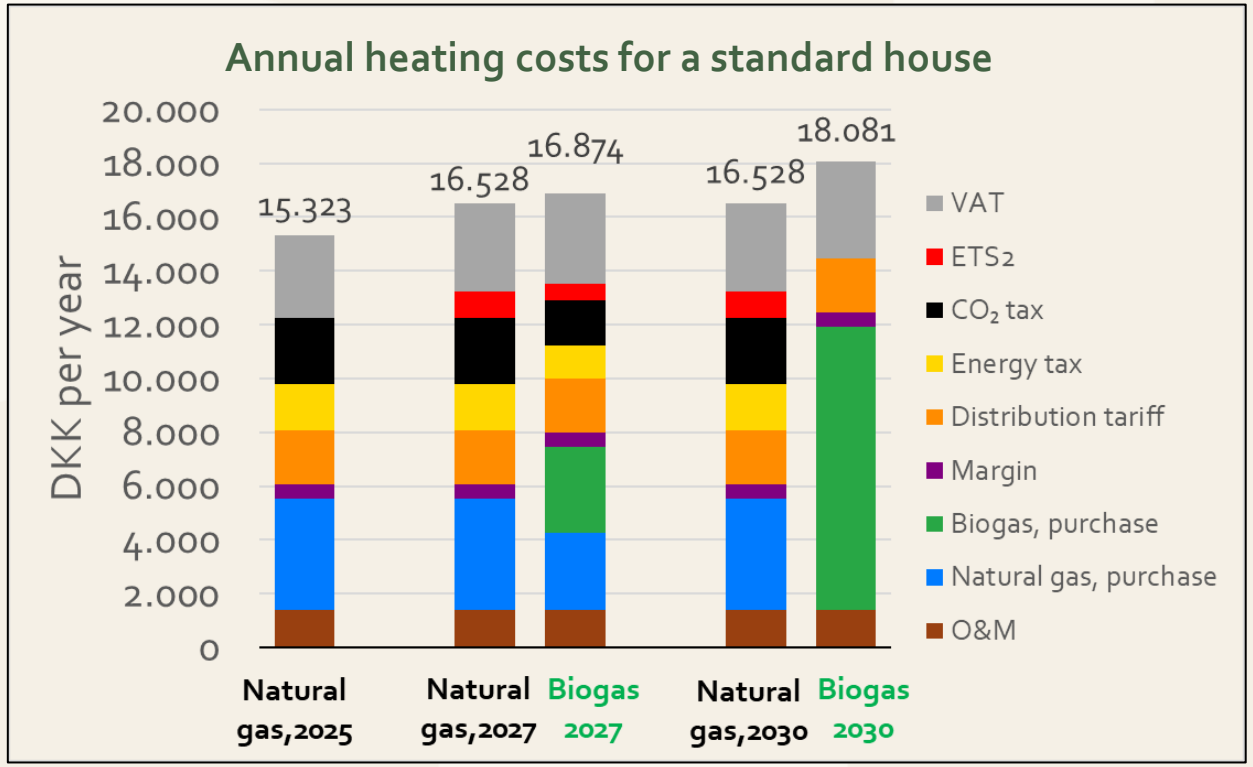
Comparison of future heating prices

Green biogas is more expensive than fossil natural gas. However, since natural gas is subject to CO_2 and energy taxes, and from 2027 also included in the new ETS2 emissions trading system, these price differences are largely balanced out.

The blending requirement is a simple and effective way to reduce households' climate footprint without imposing major investment costs, such as those for air-to-water heat pumps.

The solution uses the existing gas infrastructure and requires no changes to household heating systems. It also enables households that cannot afford to invest in new heating solutions right now to still contribute to the green transition.

This assumes that climate-neutral, unsubsidized biogas delivered through the gas grid is exempt from CO_2 and energy taxes. The calculations are based on a biogas production cost of DKK 7.5 per Nm^3 CH_4 and a market price of DKK 3.2 per Nm^3 for natural gas.



The bars show the annual heating cost for a standard house with a gas consumption of 1,270 m^3.
Bars labelled Natural gas show a household continuing to use 100 percent fossil gas.
Bars labelled Biogas show the cost under a blending requirement for unsubsidized, tax-exempt biogas of 30 percent in 2027 and 100 percent in 2030.

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Resumé

Development in biogas production and gas consumption

Without new framework conditions, Denmark will not achieve a 100 percent green gas supply until after 2033

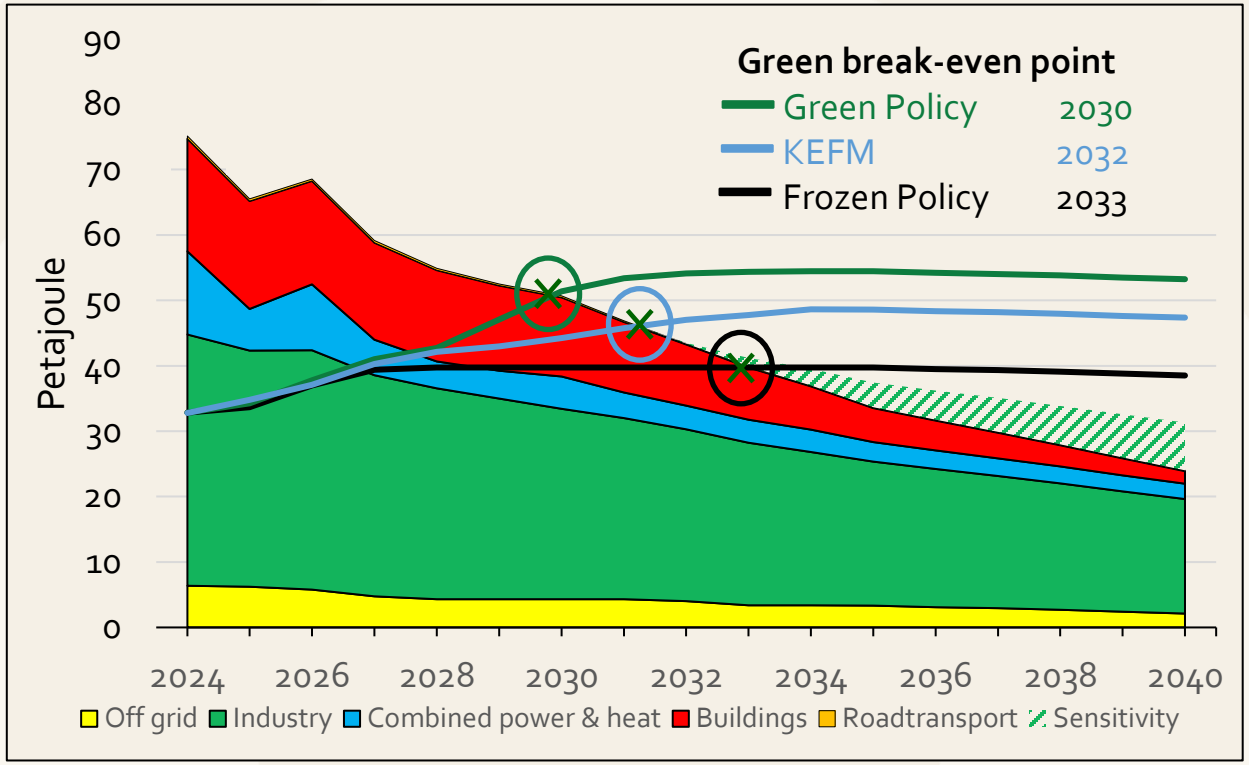
According to the Ministry of Climate, Energy and Utilities' forecast in KF25, gas consumption is expected to decline sharply. Still, household gas use remains at 12.1 PJ in 2030 and 5.2 PJ in 2035. (1)

In the KEFM scenario (blue line), biogas production is expected to match gas consumption by 2032. This projection assumes a significant increase in biogas production through new tender schemes, which Biogas Denmark considers unrealistic under the current conditions.

The consequences of this are shown in the Frozen Policy scenario (black line), where full coverage is not expected until after 2033.

The Green Policy scenario (green line) demonstrates that full coverage can be achieved as early as 2030 if Biogas Denmark's proposals are implemented.

After 2033, when biogas production exceeds domestic gas demand from existing customers, the surplus can be exported or used to replace oil in heavy road transport, shipping, aviation and, eventually, in the production of green plastics.



The figure shows the development in gas consumption according to KF25 and biogas production in the three scenarios. The green shaded area shows a slower phase-out of gas use in industry, aligned with the demand trends in the Danish Energy Agency's 2024 baseline assumptions.

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Resumé

Biogas production by biomass type

More manure and straw to be digested

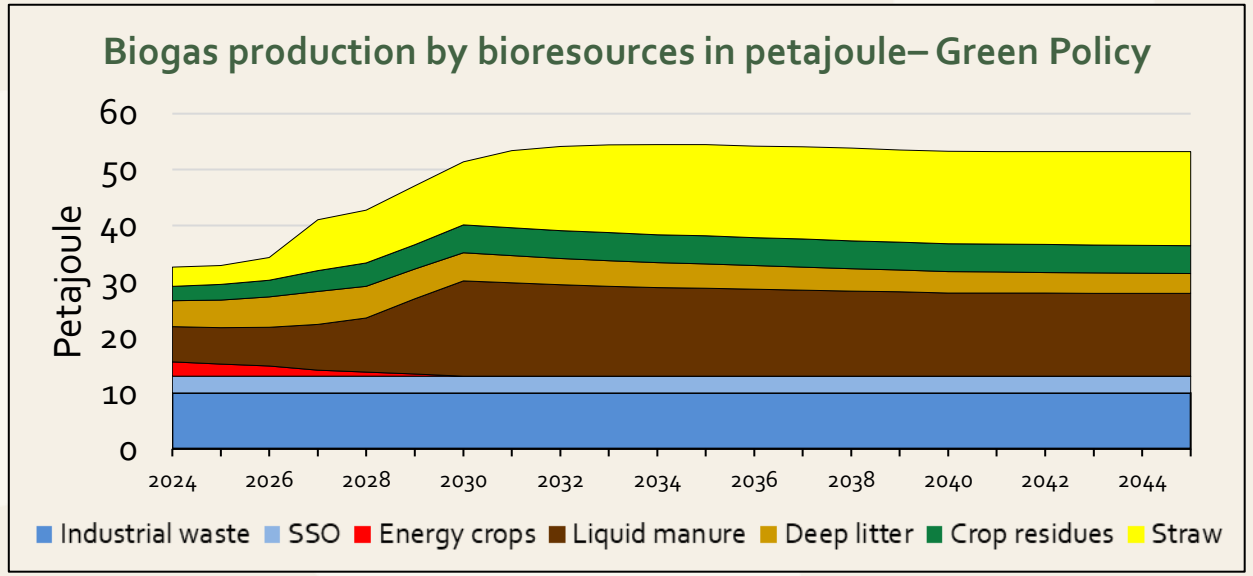
While manure accounts for around 75 percent of the total biomass volume delivered to Danish biogas plants, it generates only about one third of the biogas produced.

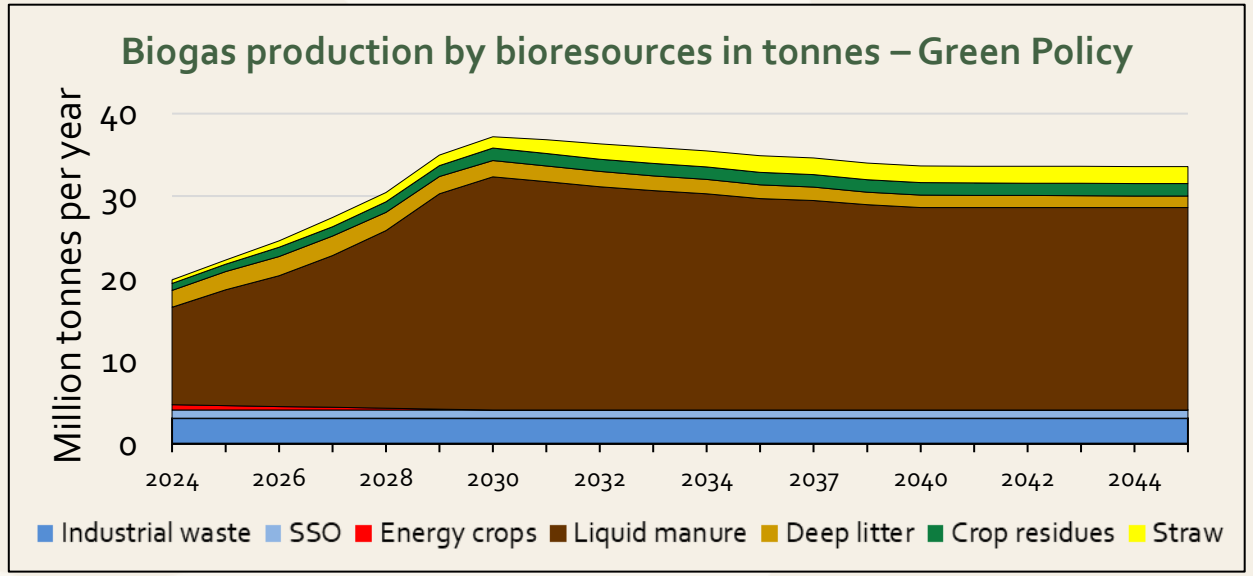
This is because the biogas potential depends on the amount of degradable organic dry matter, meaning that manure yields relatively little biogas compared to drier biomasses such as deep litter, straw, industrial residues and household waste.

In the Green Policy scenario, manure will make up 75 percent of the input in 2035, but only 33 percent of the resulting biogas.

The strong increase in straw and grass digestion aligns with the green tripartite agreement's objective of reducing nitrogen emissions. Over time, this is expected to shift primarily toward grass as the main feedstock. (6)

At the same time, this shift will increase the fibre content in the digestate, which is expected to support the development of technologies for separating the digestate and managing the fibre fraction separately.





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Resumé

Grass is a game changer in future land use conversion

Grass for biogas is a key measure in the green tripartite agreement and helps improve water quality

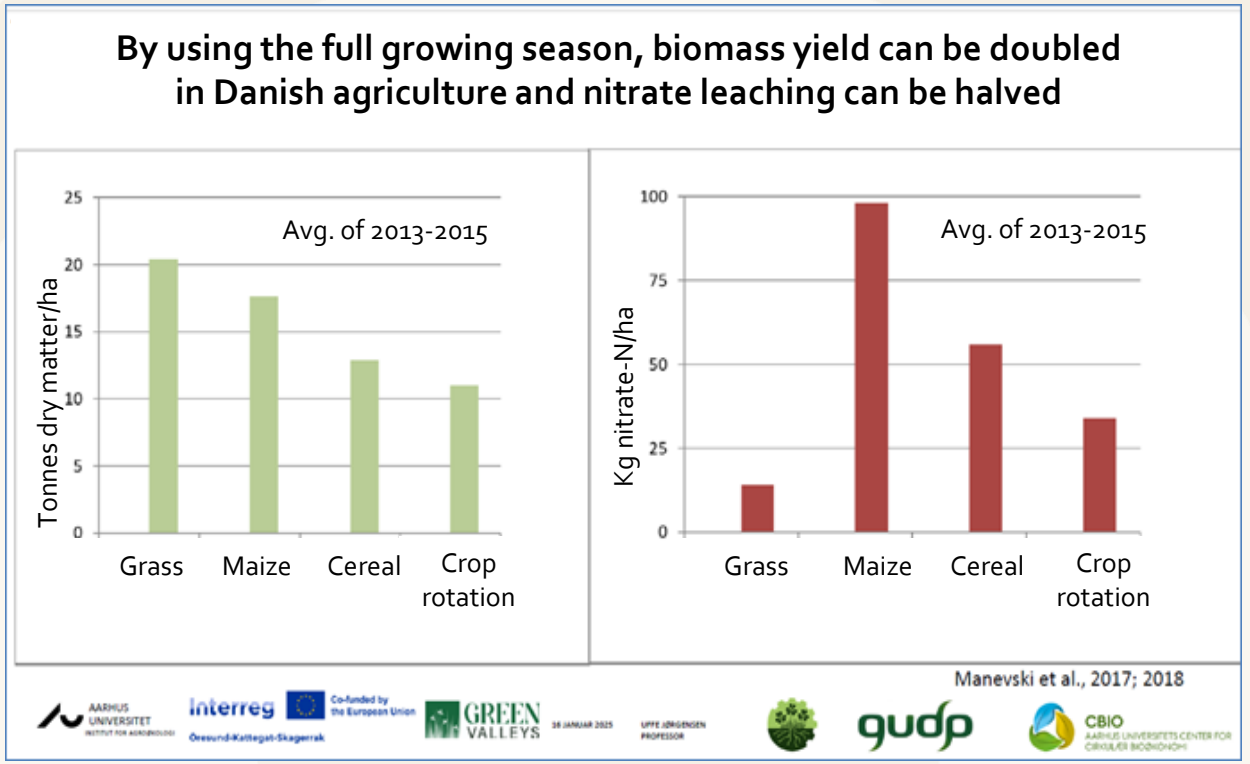
A key focus of the political tripartite agreement is to reduce agricultural emissions of both greenhouse gases and nitrogen to the aquatic environment. (6) Expanding biogas production through improved policy conditions can play a vital role in this effort.

The main approach so far has been to convert farmland to forest and nature. However, while forest takes several years to have an effect, converting land to grass that is harvested and used in biogas production can deliver three major benefits much sooner.

1. Grass captures and binds more CO_2 from the air and produces the highest dry matter yield. The dry matter can then be converted into biogas, which replaces fossil fuels and contributes to both energy security and climate goals.

2. Converting land to grass for biogas use significantly reduces nitrogen leaching, even when the grass is fertilized.

3. Through the biogas plant, nutrients are recycled and returned as fertilizer for new production of grass, feed or food, including on organic farms.



The figures are prepared by Professor Uffe Jørgensen, Aarhus University, based on field analyses documented by Manevski et al. (2017 (7), 2018 (8))

They show a clear effect of converting from annual crops like maize and cereals to perennial grass, both in terms of dry matter production (CO_2 uptake) and nitrogen leaching. All crops shown were fully fertilized.

Biogas Danmark

Resumé

CO_2e taxes on livestock manure

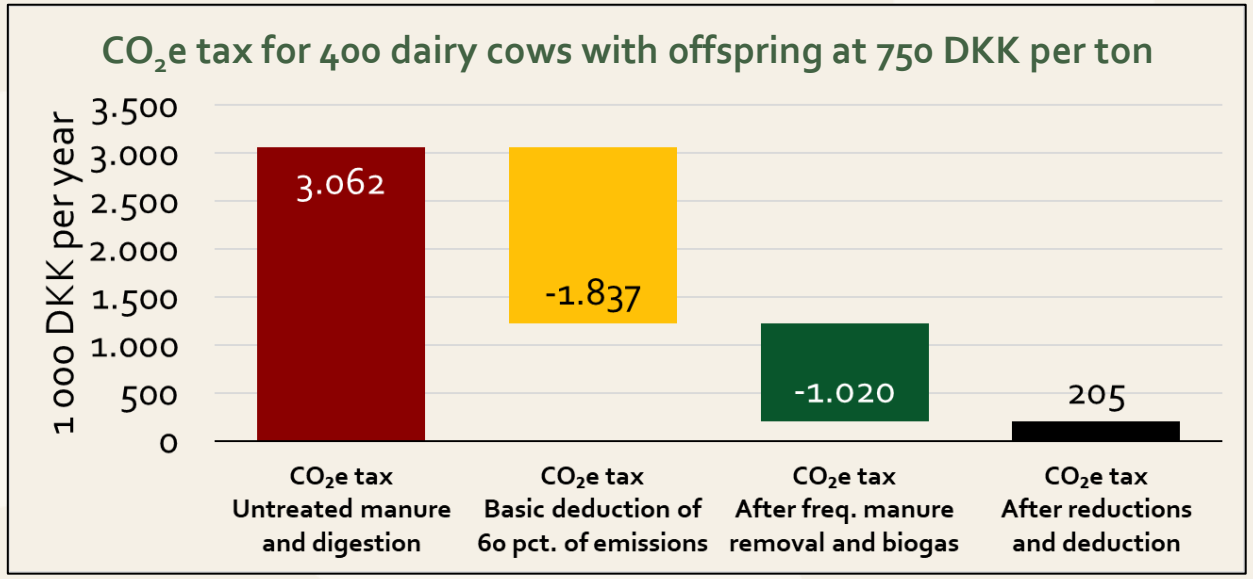
Impact assessment with and without anaerobic digestion

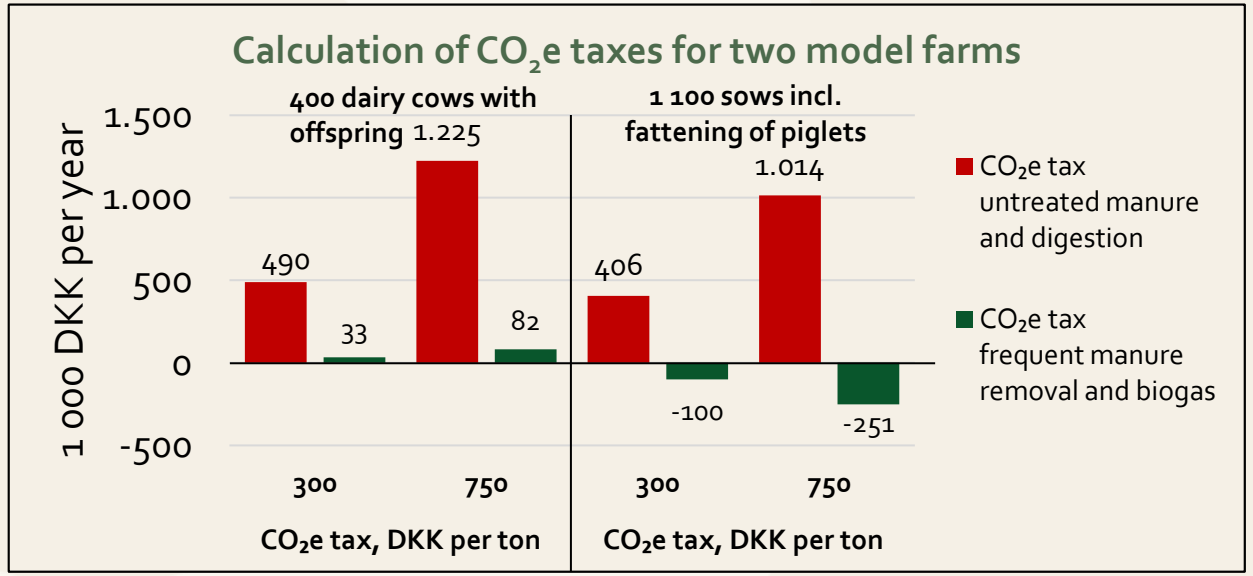
In November 2024, a political agreement was reached on the implementation of a Green Denmark (the Green Tripartite Agreement), which includes the introduction of a CO_2e tax on biological greenhouse gas emissions from agriculture, including methane from livestock manure.(9)

The CO_2e tax is set at DKK 300 per ton of CO_2e in 2030, rising to DKK 750 per ton in 2035. In addition, a basic allowance of 60 percent of the average emission per livestock type is included. This results in an effective tax rate of DKK 120 per ton of CO_2e in 2030, increasing to DKK 300 per ton in 2035.(6)

The figures show calculations of the tax implications for undigested livestock manure, as well as for frequent manure removal and anaerobic digestion. Negative tax values are not reimbursed but serve as a buffer.

It is clear that livestock producers can reduce their CO_2e tax by frequently removing manure from barns and sending it to a biogas plant for digestion. Since final emission factors for livestock manure under the CO_2e tax have not yet been established, current emission values from DCA - Aarhus University have been used.(10)





Biogas Danmark

Resumé

Biogas potential and production in the EU

New EU targets: Biogas to play a key role in European energy security

The European energy supply crisis has brought renewed focus on rapidly increasing biogas production to strengthen energy security and help meet climate targets.

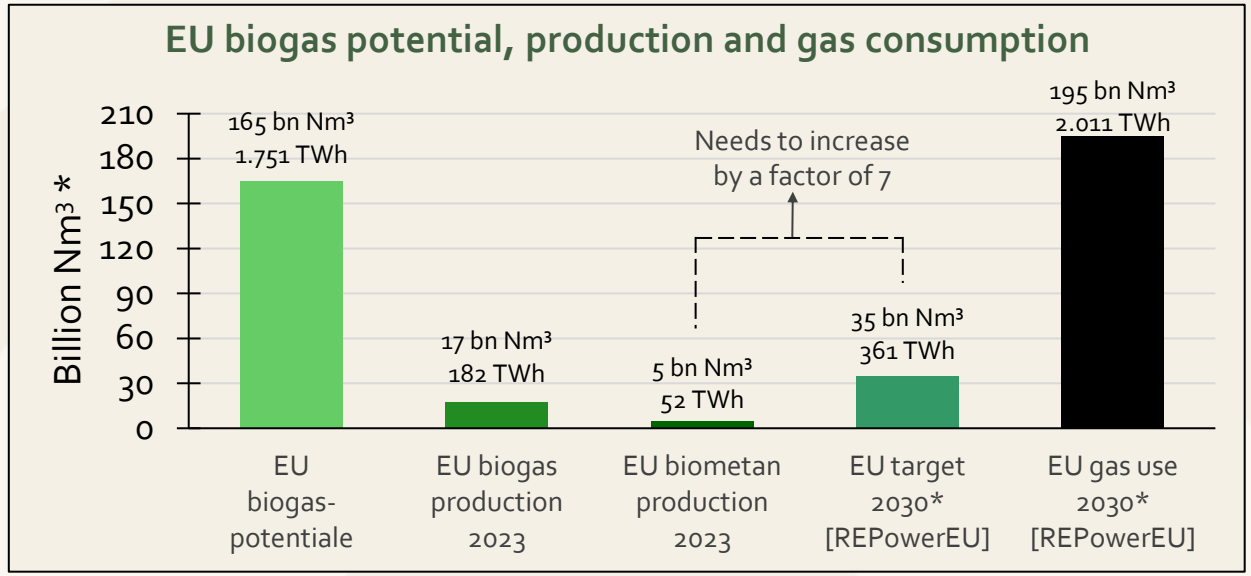
The European Biogas Association has estimated the total biogas potential in Europe at 167 billion cubic meters. (11) According to the EU's REPowerEU plan, gas consumption can be reduced by 52 percent by 2030 to just under 195 billion cubic meters per year. (11) This means the majority of Europe's gas demand could be covered by biogas by 2030.

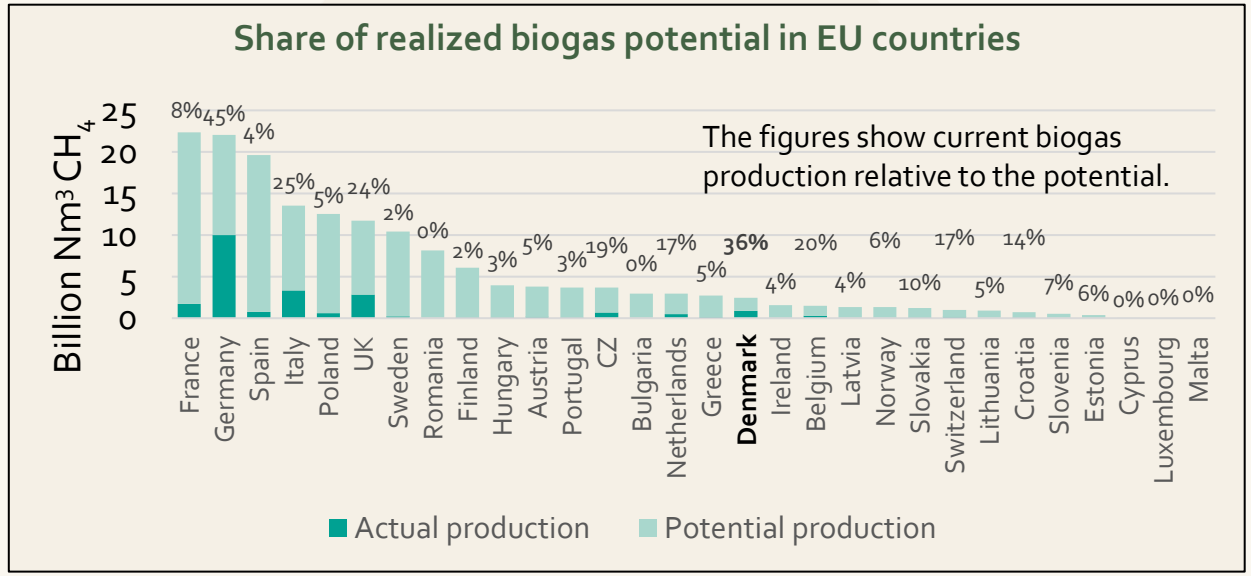
The EU's immediate goal is to increase biogas production to 35 billion cubic meters by 2030. (12)

Denmark is a frontrunner and has already realized the largest share of its national potential. This also supports the case for Denmark using its remaining biogas potential to fully phase out fossil gas, as exporting biogas contributes relatively little at EU level.

Biogas Danmark

** All values are based on an energy content of 10.61 kWh/Nm³, equivalent to natural gas..*





Data is sourced from the European Biogas Association, EBA Statistical Report 2024(11)

Gas consumption and biogas production

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Biogas Danmark

Gas consumption and biogas production

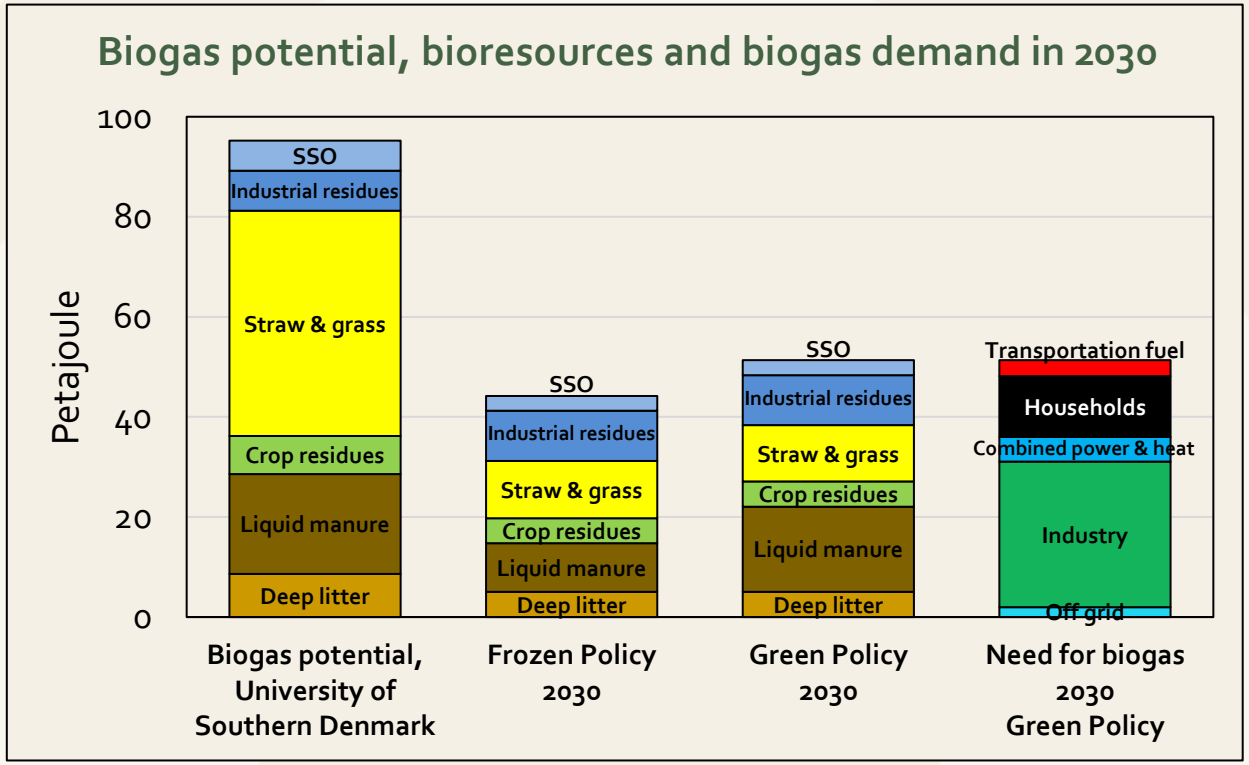
Biogas potential and demand in Denmark

Biomass potential for increased production

The biomass resources available for biogas production include livestock manure as well as organic residues from households, industry and agriculture. An analysis by the University of Southern Denmark, commissioned by the Danish Energy Agency, estimates the total energy potential in these resources to be 94 petajoules (PJ) [13].

This means there are sufficient resources to meet the expected biogas production in both the Frozen Policy scenario, with 40 PJ in 2030, and the Green Policy proposal, with 51 PJ in 2030 and 54 PJ in 2035.

Under the Green Policy scenario, Denmark could allocate 3.2 PJ of biogas to heavy road transport from 2030. Toward 2035, this potential could increase to 5.5 PJ, and up to 13 PJ could be allocated to shipping, aviation and plastic production - provided that proper market conditions are established for unsubsidized biogas.



The left bar shows the biomass potential for biogas production as estimated by the University of Southern Denmark. [13] The two middle bars show the feedstock input in 2030 under the Frozen Policy and Green Policy scenarios, respectively, broken down by type of biomass. The right bar shows how the produced biogas is allocated in the Green Policy scenario.

Biogas Danmark

Gas consumption and biogas production

Trends in gas consumption and biogas production

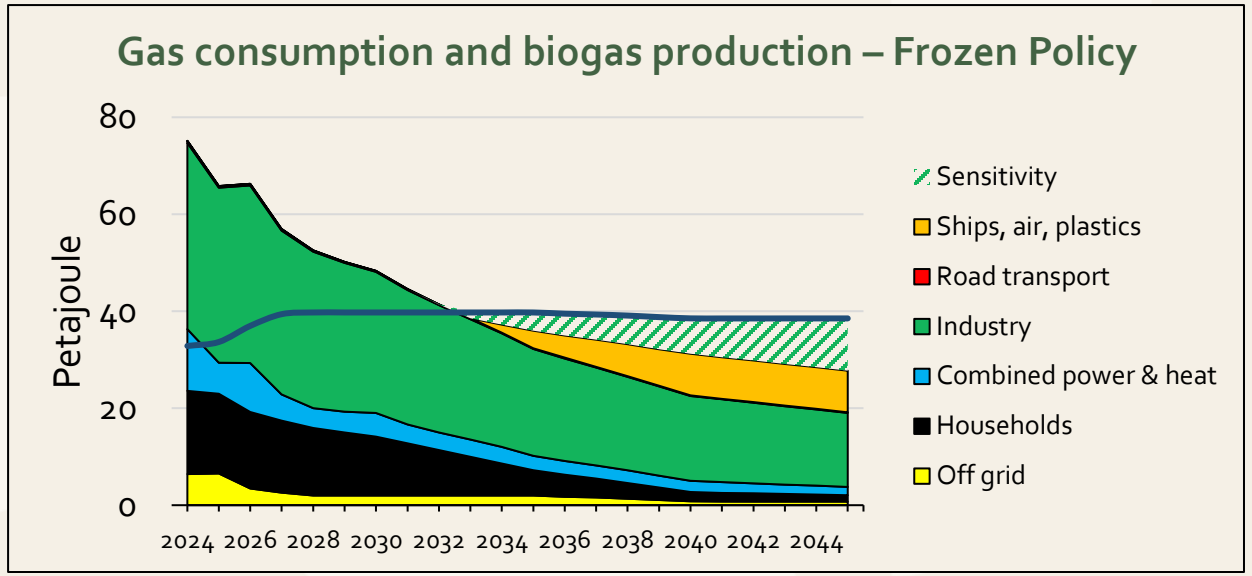
Gas consumption is falling sharply

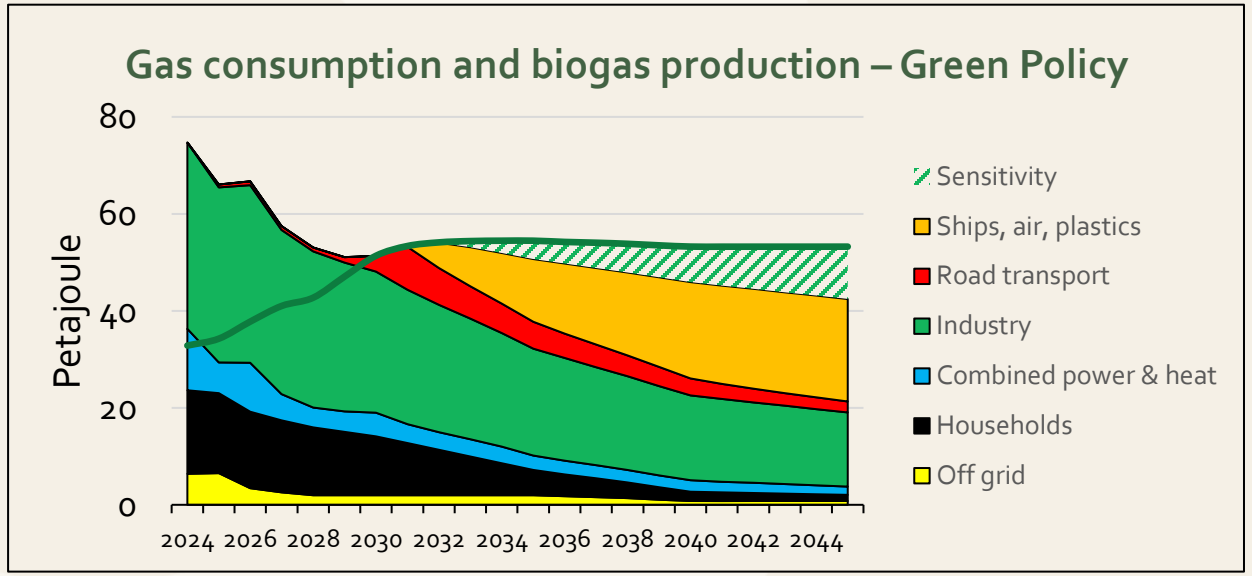
Gas consumption in both scenarios is based on the KEFM forecast in KF25 [1] , which projects a reduction of approximately 25 petajoules by 2030 and a further 17 petajoules by 2035.

The main reasons for this decline are political measures, especially subsidy schemes aimed at phasing out gas in both private homes and district heating. KF25 also assumes a significant drop in industrial gas use after 2035, which Biogas Denmark considers less realistic. The green shaded area in the graphs shows the difference between KF25 and AF24. [14]

Due to expected changes in the framework conditions for new biogas tenders and the use of biogas delivered through the gas grid, the Frozen Policy scenario shows that biogas will not be able to cover gas demand until after 2033.

The Green Policy proposal introduces new incentives to increase demand for unsubsidized biogas delivered via the gas grid. The resulting increase in unsubsidized biogas production also reflects higher demand beyond the levels projected in KF25. This additional consumption is primarily for heavy road transport and, later on, for ships, aircraft and plastic production. This is illustrated by the increase from 2030 in the orange segment of the graphs..





Biogas Danmark

Gas consumption and biogas production

Development in biogas production

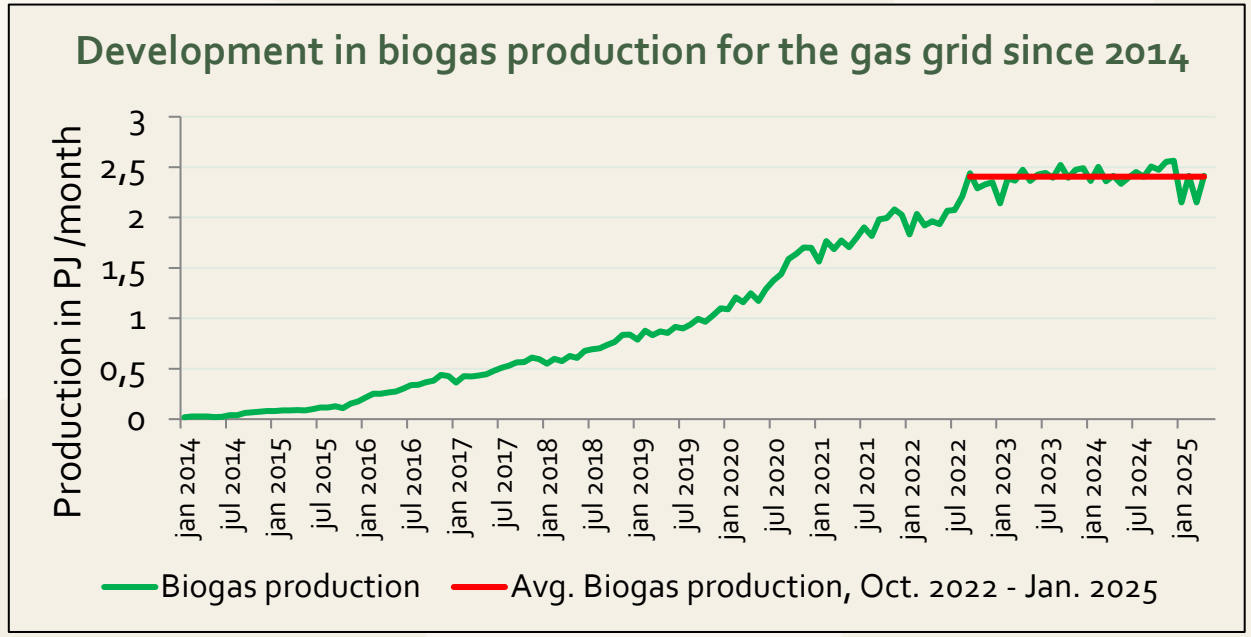
Biogas production stalled in 2022 after strong growth since 2014

After about 10 years of growth under the subsidy scheme, which was closed in 2020, the development in upgraded biogas production for the gas grid has stagnated since October 2022, when the last plants under the scheme were commissioned.

The new politically approved support schemes, intended to boost biogas production from January 2024, have been postponed. At the same time, the terms have been so weakened that it is uncertain whether any significant contribution will follow. In any case, this will not happen before 2027 at the earliest. This forms the basis for the "Frozen Policy" scenario.

A continued increase in biogas production will therefore require improved market conditions for unsubsidized biogas.

In addition to upgraded biogas delivered to the gas grid, around 6.5 PJ has been produced annually for several years for direct delivery from biogas plants to energy production and industrial use outside the grid.



173 biogas plants in Denmark

Plants that do not upgrade biogas to the gas grid typically produce electricity and heat.

- Agricultural biogas plants: 92, of which 55 upgrade and 37 produce electricity
- Wastewater treatment plants: 48, of which 2 upgrade
- Industrial biogas plants: 7, of which 1 upgrades
- Landfill gas recovery plants: 26

Biogas Danmark

Gas consumption and biogas production

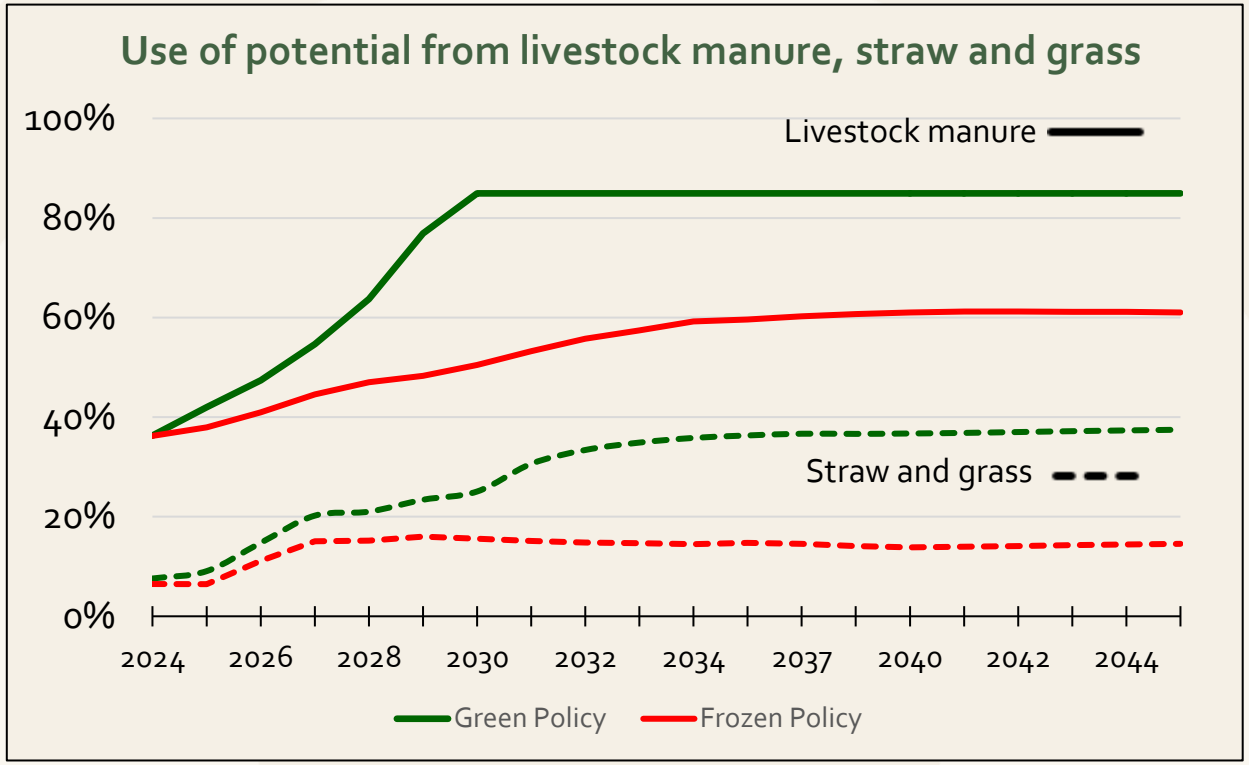
Manure, straw and grass digestion

Significant untapped potential, especially for straw

Although the Green Policy scenario assumes a higher share of manure and straw is digested in biogas plants compared to the Frozen Policy scenario, there is still significant untapped potential, particularly for straw and grass.

The Frozen Policy scenario assumes that 57 percent of livestock manure is digested in biogas plants in 2030, while the Green Policy scenario raises this share to 85 percent, with total biogas production reaching 55 petajoules. The high share in Green Policy is based on the assumption that remaining manure will be managed to reduce CO_2e taxes, and biogas is seen as one of the most cost-effective solutions. KF25 also projects a decline in the available amount of livestock manure, which contributes to the steep increase in the share of digested manure in Green Policy.

For straw and grass, the Frozen Policy scenario requires that just under 20 percent of the resource is used for biogas in 2030, while the Green Policy scenario requires 30 percent in 2030, increasing to around 35 percent in 2035.



The figure shows the share of the total resources of livestock manure, straw and grass that is used for biogas production in the three scenarios.

Research shows that when straw and deep litter are digested in biogas plants, most of the slowly degradable carbon is returned to farmland. This means that over time the same amount of carbon is stored in the soil as if the straw were incorporated directly. (15)

Biogas Danmark

Biogas production and its importance for security of supply

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30: CO_2 from biogas enables large scale PtX fuel production

Biogas Danmark

Security of supply

Need for biogas storage

Temperature fluctuations and stable biogas production require storage in large gas facilities

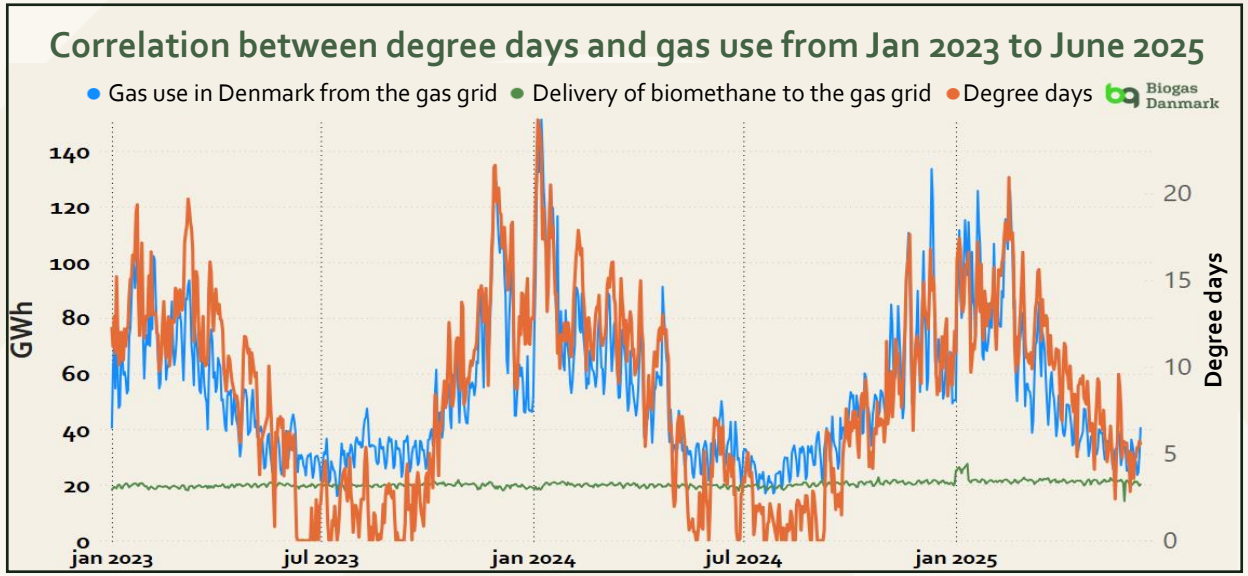
There is a strong correlation between outdoor temperature fluctuations (heating degree days) and gas consumption throughout the year. As shown in the top figure, gas consumption follows temperature closely during the winter season, day by day. The temperature-independent, more constant consumption from industry is reflected in the summer demand.

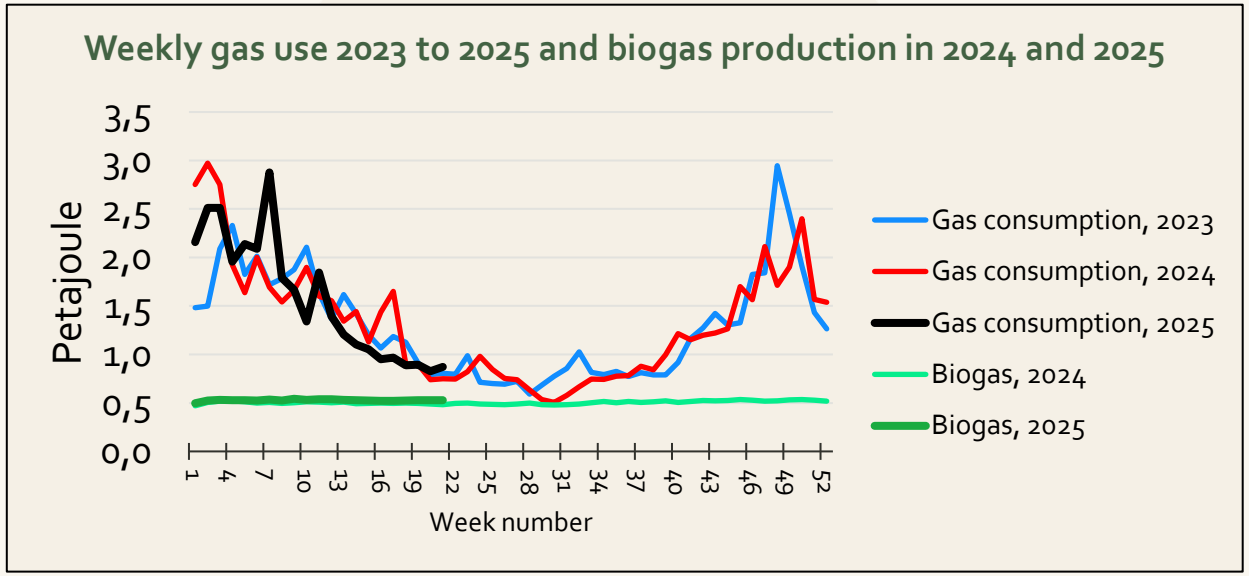
Since biogas is produced steadily throughout the year, this creates a need for storage to align production with consumption.

Energinet and Evida continuously adapt the gas grid to ensure that gas can be distributed from areas with high biogas production to parts of the grid without biogas input. This includes enabling surplus summer production to reach the large gas storage facilities.

Degree days indicate how outdoor temperature impacts energy demand for space heating. A degree day is defined as a 1°C difference between an outdoor temperature of 17°C (which does not require heating) and the measured daily average temperature. Read more on Biogas Data Online – biogas.dk/biogas-data-online

Biogas Danmark





Both figures are from Biogas Data Online.[16]

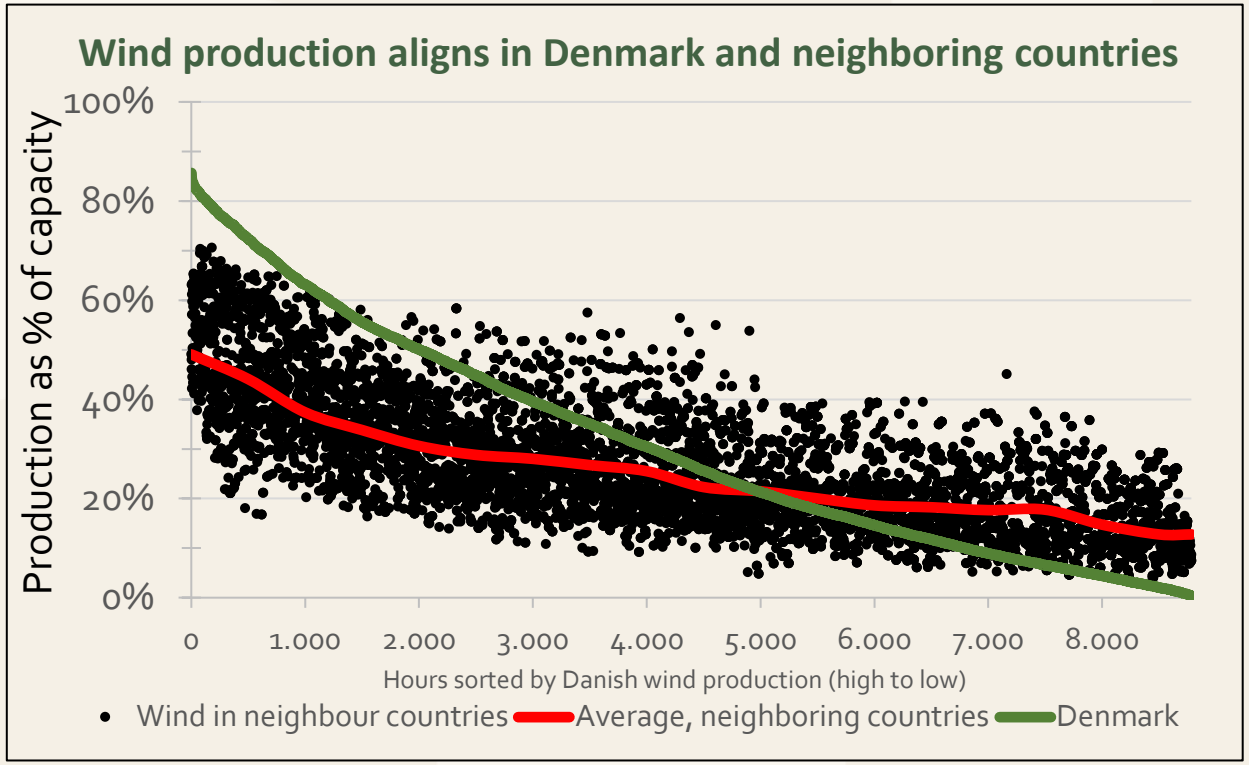
Security of supply

High simultaneity in wind power generation across Northern Europe

Strong need for back-up during periods with low wind

When wind power generation is low in Denmark, the same typically applies to neighboring countries and the rest of the EU. The graph illustrates this correlation, showing that electricity production peaks across Northern Europe at the same time. This means that even a significant expansion of cross-border connections cannot offset these variations sufficiently to make wind a stable energy source capable of serving as baseload in the energy system.

If capacity is expanded to cover electricity demand in the 3,000 hours with the lowest generation, there is a high risk that production will exceed demand during the rest of the year. This is particularly true in the 2,000 hours with the highest output, where there is a clear risk of substantial overproduction. This highlights the need to balance the energy system through a combination of back-up capacity during low-wind periods, such as gas turbines running on green biogas, and new uses for surplus electricity, for example Power-to-X, when wind production is at its peak.



The figure shows hourly wind production as a share of installed capacity delivered in 2024. The green curve shows Danish wind generation ranked from the highest hour on the left to the lowest on the right, where conditions are almost windless across the country. The individual dots show electricity production in Denmark and neighboring countries (SE, NO, DE and NL). The red curve shows the average trend for these countries.
Source: entsoe.eu- Actual Generation per Production Type [17]

Biogas Danmark

Security of supply

Biogas power has high value when wind and sun are scarce

Rising electrification and renewable power are reshaping the market

Rising electricity demand combined with fluctuating supply from wind and solar has led to significant price volatility in the electricity market.

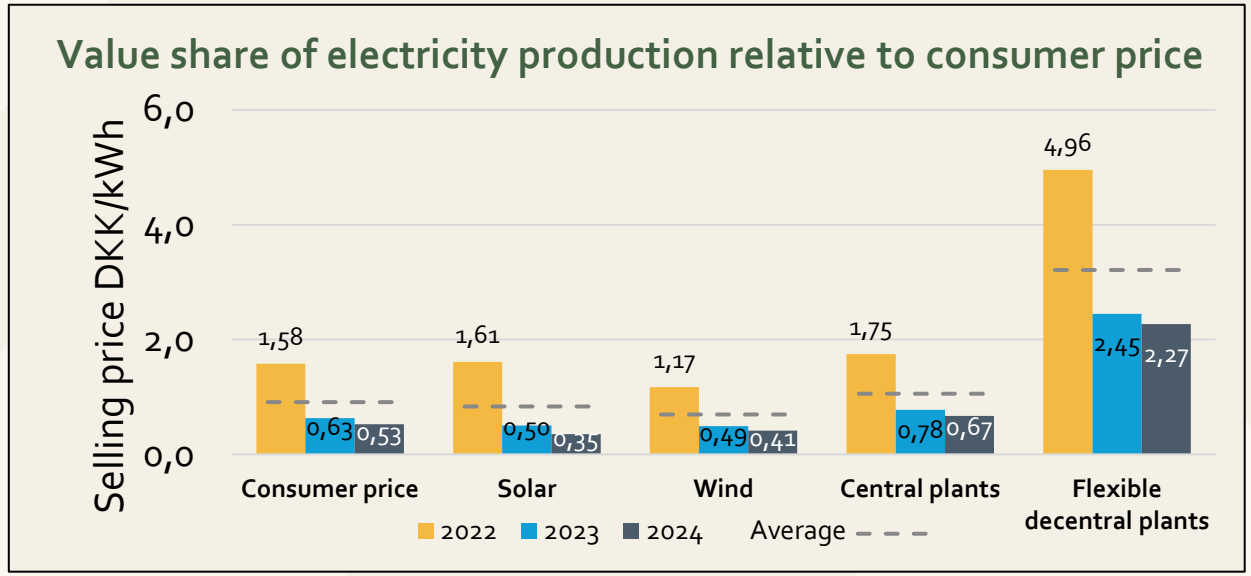
The market value received per kilowatt-hour by wind and solar has dropped significantly compared to the value of electricity from units that provide back-up during periods with low wind and no sunlight. This sends an increasingly clear signal of supply scarcity when variable renewables cannot meet demand.

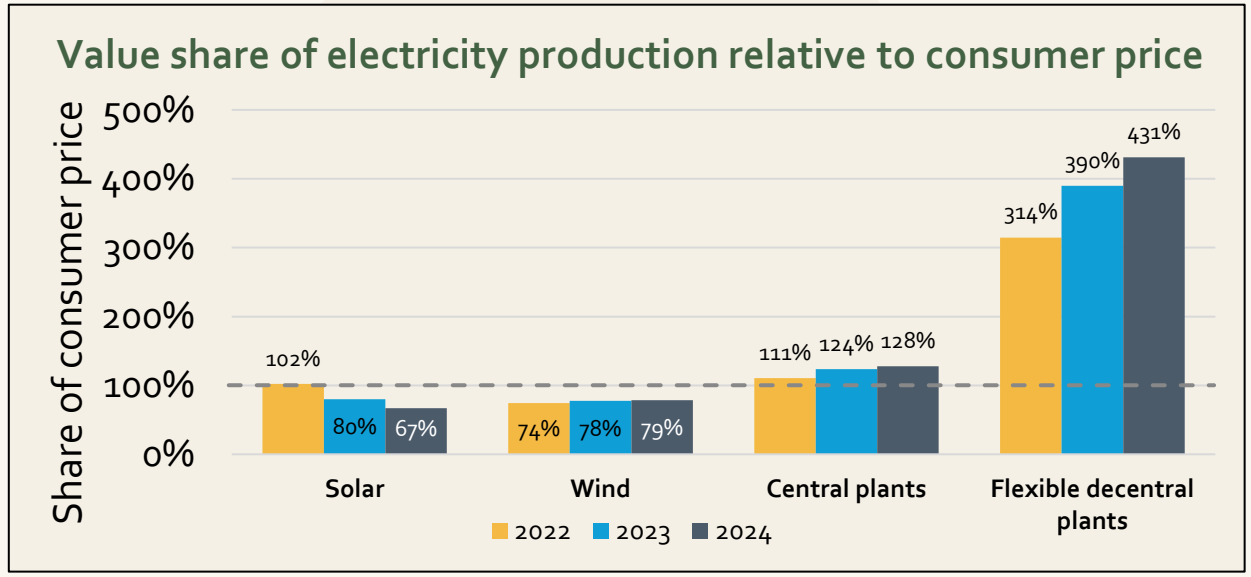
The top figure shows the development in electricity prices per kilowatt-hour by technology, while the lower figure illustrates the relative market value compared to the consumer price in each year.

It is clear that flexible, decentralized gas-fired plants receive the highest price per kilowatt-hour, because they are able to deliver electricity when wind and solar are lacking. This trend will become more pronounced if new capacity is not added in step with growing electricity demand. At the same time, there is increasing potential to take advantage of very low electricity prices during periods of high wind and solar production.

Biogas Danmark

Electricity prices[18] and production[19] are based on data from Energinet's DataService.





Electricity prices[18] and production[19] are based on data from Energinet's DataService.

Security of supply

Key sector integration in onshore energy islands

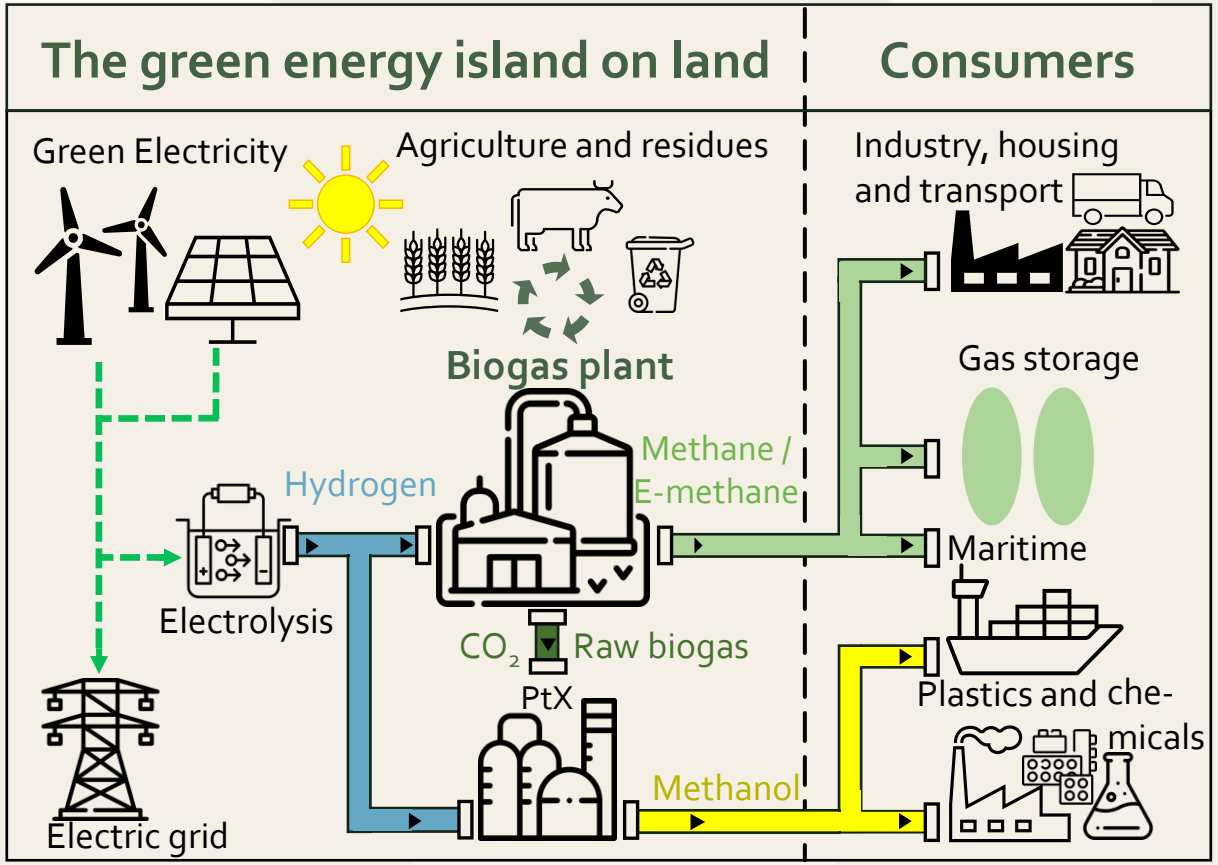
Biogas plants connect sectors and provide flexible and storable green energy

Onshore energy islands are no longer just a vision but already a reality, where biogas production is combined with wind and solar power.

With Power-to-X technology, surplus electricity from wind and solar can be converted into hydrogen, which is then combined with the biogenic CO_2 from biogas to produce e-methane and e-methanol for use in transport, industry and the gas grid.

This creates an integrated system that supports both energy security and the green transition.

At the same time, cascade utilization of CO_2 uptake from agricultural crops is optimized to support energy security, reduce greenhouse gas emissions and promote sustainable food production.



The figure illustrates the concept of the onshore green energy island, where the biogas plant acts as a central hub in the energy system. Biogas production from agricultural waste and manure is combined with surplus electricity from wind and solar via electrolysis, enabling the production of e-methane and e-methanol.

Biogas Danmark

Security of supply

Potential for balancing the power grid with PtX production

Biogenic CO_2 has multiple applications

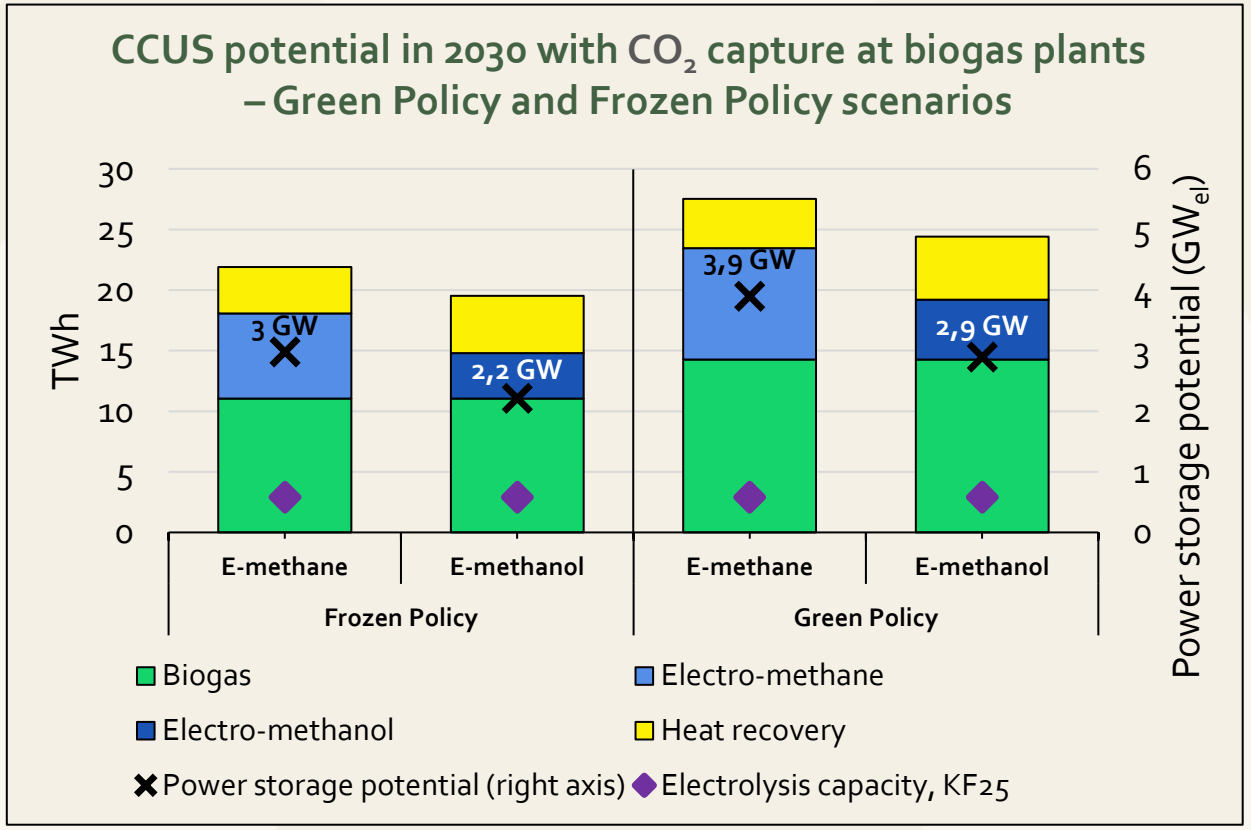
The biogenic CO_2 already captured at the upgrading units of biogas plants can be used in at least five different ways:

1. Replacing industrial CO_2 produced from natural gas
2. Storage via CCS.
3. Using green hydrogen to produce electro-methane [20]
4. Using green hydrogen to produce electro-methanol [20]
5. Replacing fossil oil and natural gas in plastic and textile production

The first four applications are already in use at a few sites. Option five is a long-term solution, as the world will face a shortage of hydrocarbons for many products once the extraction of fossil oil and gas is phased out.

The figures compare PtX solutions with CCS and the ability to continuously balance power from wind and solar.

The most straightforward approach is to alternate between PtX and CCS depending on the real-time need for grid balancing.



The black crosses indicate the power capacity in GW that can be converted into PtX fuels via electrolysis. The blue bars show how much electrofuels the captured CO_2 can lead to. The yellow bars represent the amount of heat that can be delivered from the electrolysis process that supplies the hydrogen. These results require large-scale storage of either CO_2 or hydrogen. 3 GW corresponds to the power production capacity of, for example, the energy island at Bornholm.

Biogas Danmark

Security of supply

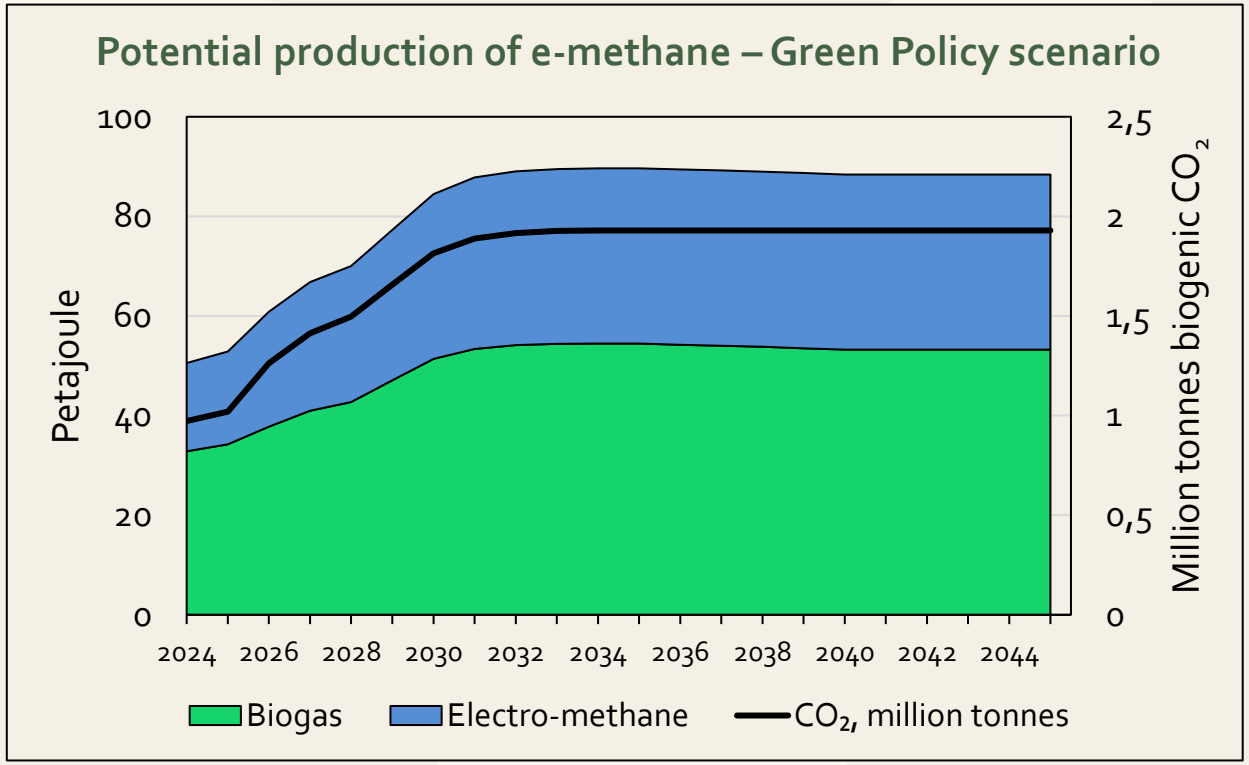
CO_2 from biogas enables large-scale PtX fuel production

Storing surplus electricity from solar and wind

Biogenic CO_2 from biogas is separated during the upgrading process and is therefore readily available for the production of power-to-x fuels. These fuels are produced by using electricity from wind and solar to generate hydrogen via electrolysis. The hydrogen is then combined with CO_2 to produce e-methane or e-methanol.

Electricity from solar and wind can thus be used for power-to-x production when generation capacity exceeds either electricity consumption or the available grid capacity. In such hours, the surplus electricity can be stored in easily usable electrofuels.

The figure shows the full potential if all captured biogenic CO_2 is converted into e-methane. This requires either that CO_2 is stored in hours without surplus electricity from wind and solar, or that hydrogen is stored in hours with major overproduction of renewable electricity compared to demand.



The black line shows the annual amount of CO_2 released when raw biogas is upgraded to concentrated biomethane (the green area) before injection into the gas grid. The blue area shows the potential for e-methane production if the entire volume of captured biogenic CO_2 is converted by combining it with hydrogen.

Biogas Danmark

Climate effect

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Biogas Danmark

Climate effect

Total climate impact of biogas

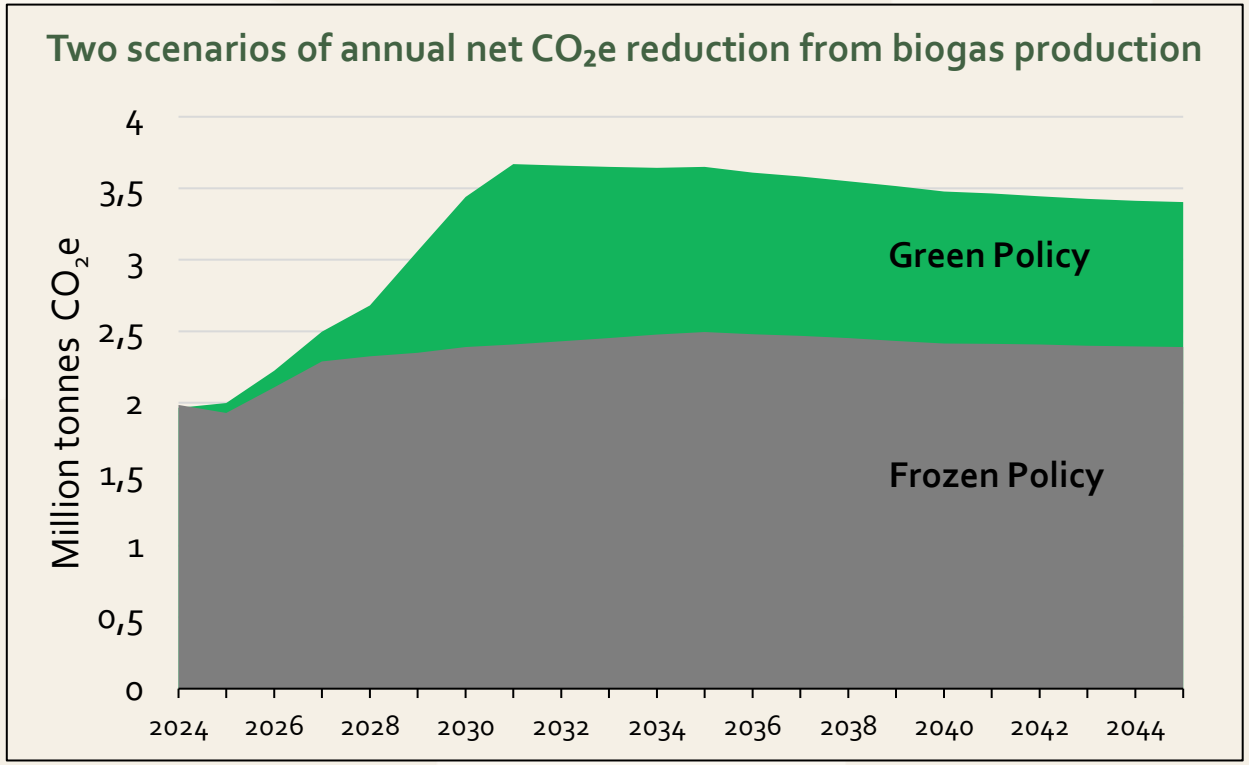
Biogas delivers a significant climate effect

Biogas production has the potential to make a substantial contribution to Denmark's 70 percent emission reduction target for 2030. This is achieved both by displacing fossil fuels across several sectors and by reducing methane emissions from agriculture through increased manure digestion.

The Frozen Policy scenario shows that biogas contributes to a net CO_2 reduction of 1.6 million tonnes in 2025 and 2.0 million tonnes in 2030.

Implementation of Biogas Denmark's Green Policy proposal could increase the greenhouse gas reduction to 3,4 million tonnes in 2030, as higher biogas production both displaces more fossil fuels and increases the reduction of methane emissions from agriculture.

After 2035, the Green Policy scenario is expected to see a slight decline in greenhouse gas reductions, as the Danish Energy Agency estimates that less manure will be available. This will limit methane mitigation in biogas plants and thereby reduce the overall climate effect.



The figure shows the difference in climate impact between the Frozen Policy, which is based on the new deteriorated framework conditions, and the Green Policy, which includes the climate effect of Biogas Denmark's policy proposal.

Biogas Danmark

Climate effect

Climate impact of biogas production and use

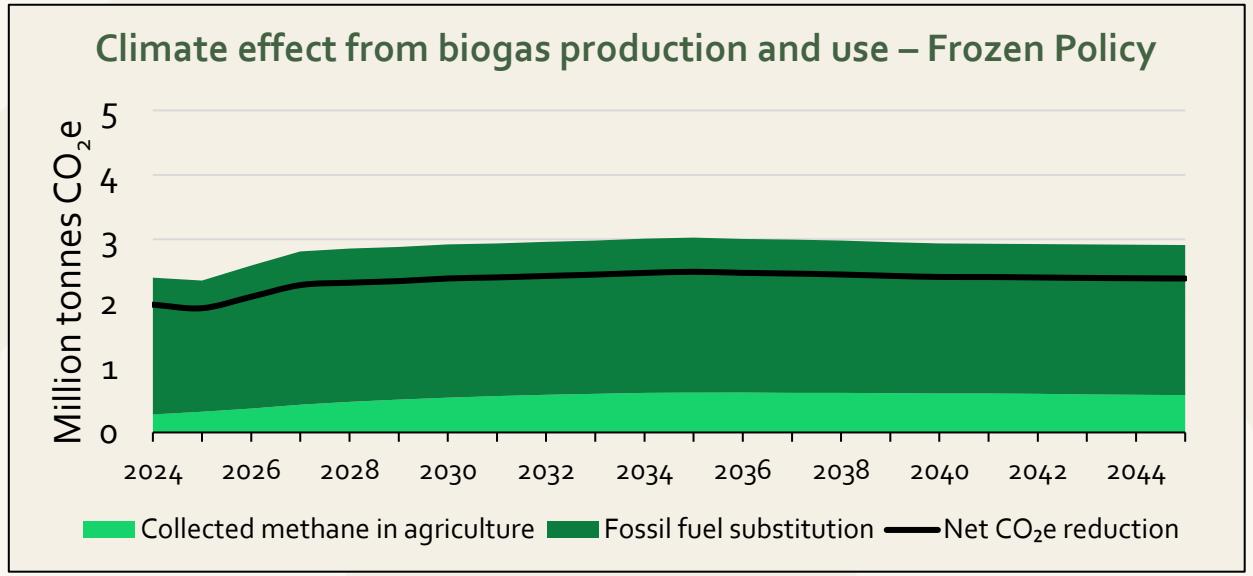
Significant greenhouse gas reduction from biogas

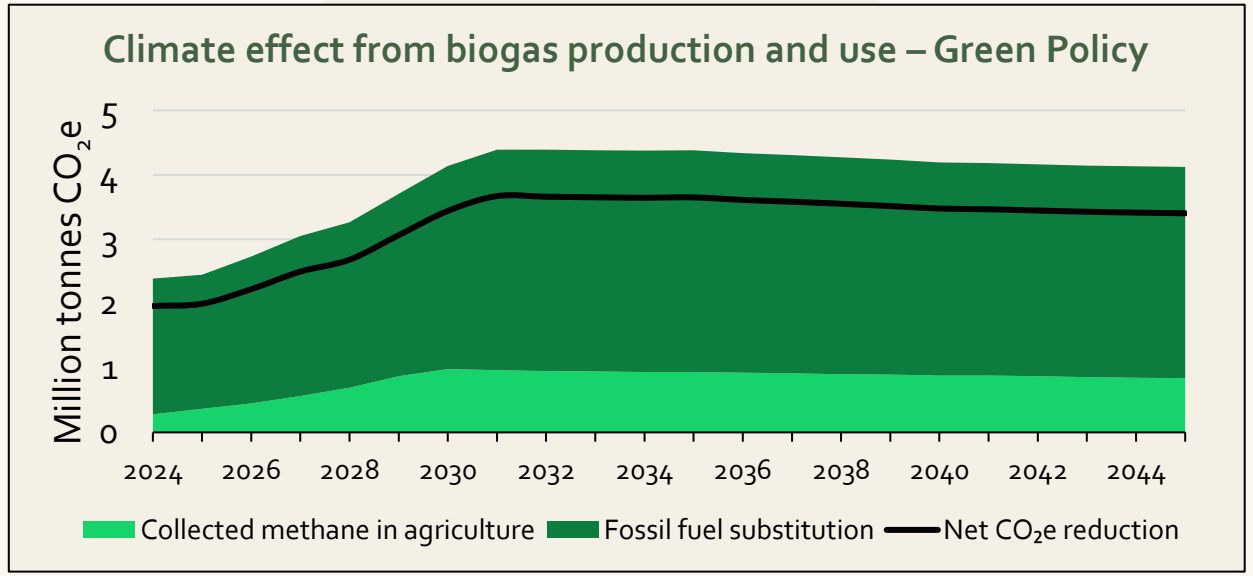
The Frozen Policy scenario results in an annual net CO_2e reduction of around 2.4 million tonnes in the period 2030-2045.

In the Green Policy scenario, a significantly higher reduction is achieved, reaching 3.4 million tonnes of CO_2 equivalents in 2030 and rising to 3.7 million tonnes in 2035.

The net climate effect is calculated based on reduced methane emissions from manure in the agricultural sector and displacement of fossil fuels, with deductions for CO_2 emissions related to biomass and manure transport, energy use at the biogas plants, and methane slip during production.

Since 1 January 2023, a regulation of methane slip has been in place. Based on this, methane slip is assumed to be reduced to 1 percent from 2024.





The net climate effect is calculated after deducting methane slip and energy use at the biogas plants for processing and transport.

Biogas Danmark

Climate effect

Climate impact of biogas

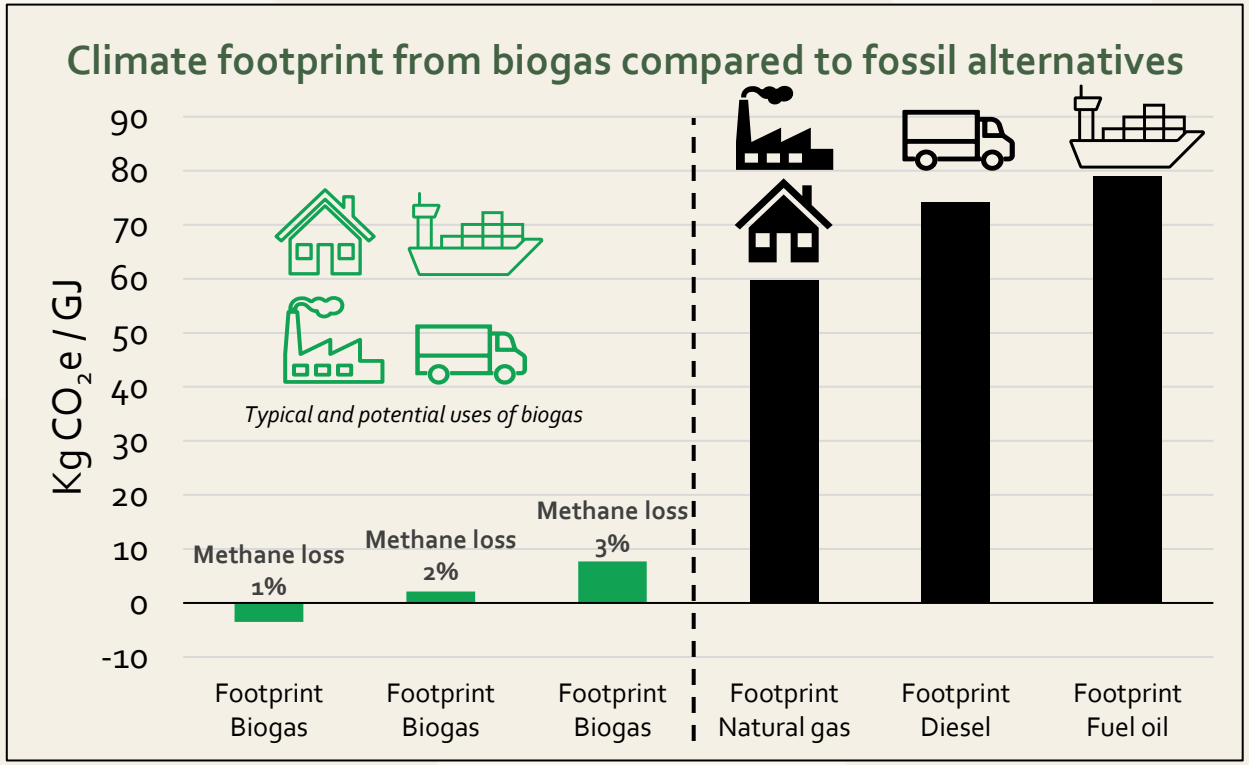
The net climate effect of biogas exceeds the CO_2 reduction from replacing fossil fuels

Biogas not only displaces fossil fuels. When manure is digested in biogas plants, methane emissions are reduced compared to storage in agriculture. However, the production of biogas also creates a climate footprint through methane slip, energy use for operation, and transport of biomass and digestate.

The total climate impact is calculated as the difference between the positive effects and the CO_2 emissions from plant energy consumption and methane slip.

The figure shows the net climate effect per GJ of biogas delivered to the gas grid with methane slip at 1, 2, and 3 percent, including the plant's own energy use.

The results clearly show that biogas has a significantly lower climate footprint than both natural gas and diesel. With methane slip at or below 2 percent, biogas qualifies as CO_2 and a green energy source.



The net greenhouse gas reduction shows that biogas, when replacing fossil fuels, achieves climate neutrality if methane slip is kept at or below 2 percent.

Measurements from 2020–21 at several farm-based biogas plants showed an average methane slip of about 2 percent[21]. In 2022, new regulation was introduced to reduce methane slip, including external leak detection and internal monitoring at biogas plants. This regulation took effect on 1 January 2023. [22]

Biogas Danmark

Climate effect

Biogas in life cycle analysis for heavy transport

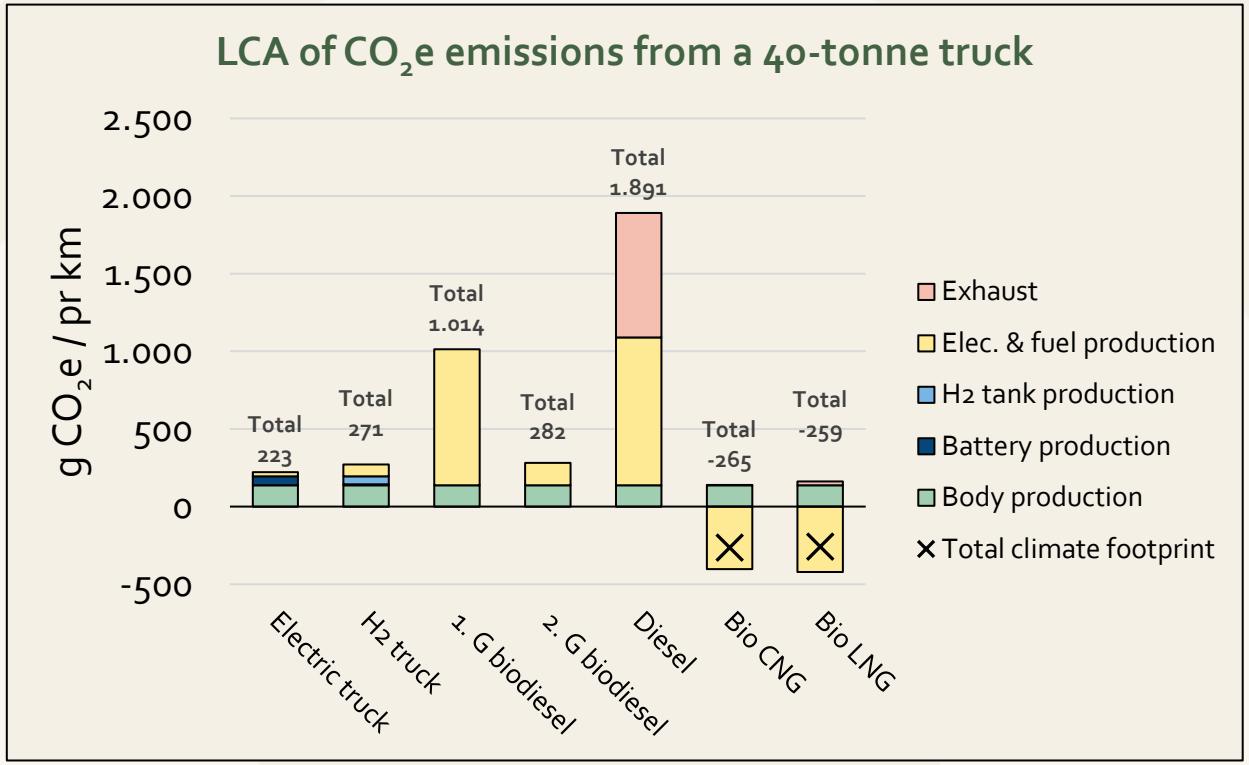
The most CO_2-efficient choice for heavy transport

Results from a 2023 life cycle analysis, prepared in collaboration between Copenhagen Electric and consultancy firm COWI, show that biogas has the greatest potential to drive the green transition in the transport sector.

The report examines the climate footprint per kilometer for various truck types (12 and 40 tonnes) and regional buses using different fuels.

The comparison includes electricity, hydrogen, biogas, biodiesel (1st and 2nd generation), and conventional diesel with 7 percent bio-blend.

The analysis clearly concludes that biogas-based solutions both compressed biogas (Bio CNG) and liquefied biogas (Bio LNG) are significantly more climate-friendly than the alternatives, even when compared to electric solutions in heavy transport.



The 7 bars show results from Copenhagen Electric's life cycle analysis. [23] *The climate effect of biogas is calculated based on the biomass mix used in Danish biogas production, with a methane slip of 2.5 percent.*

Biogas Danmark

Climate effect

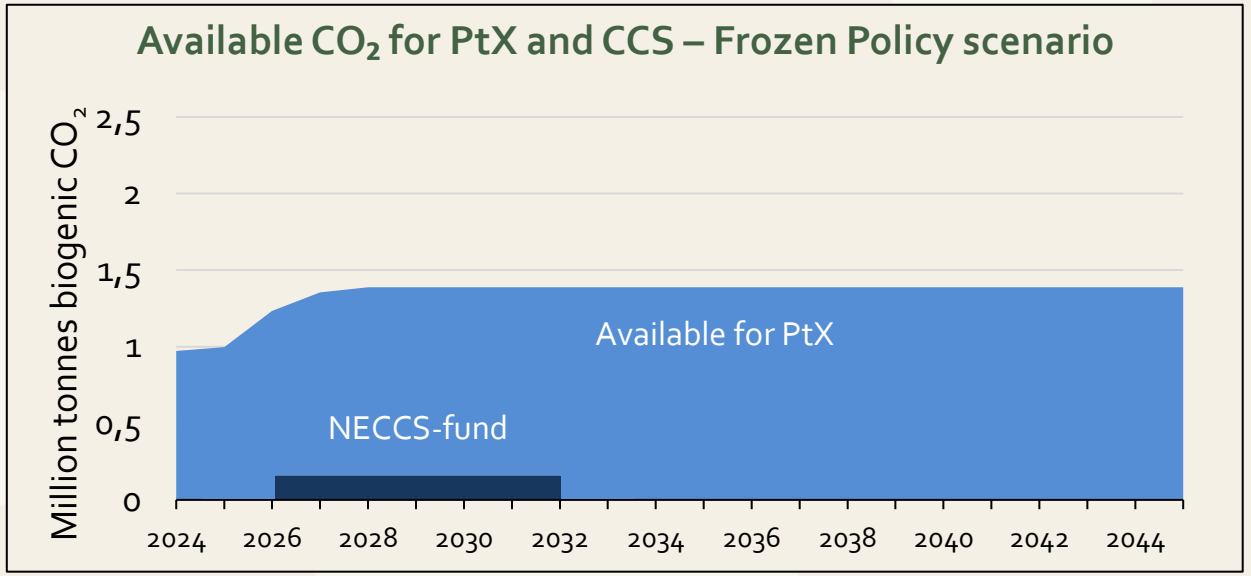
Biogenic CO_2 from biogas

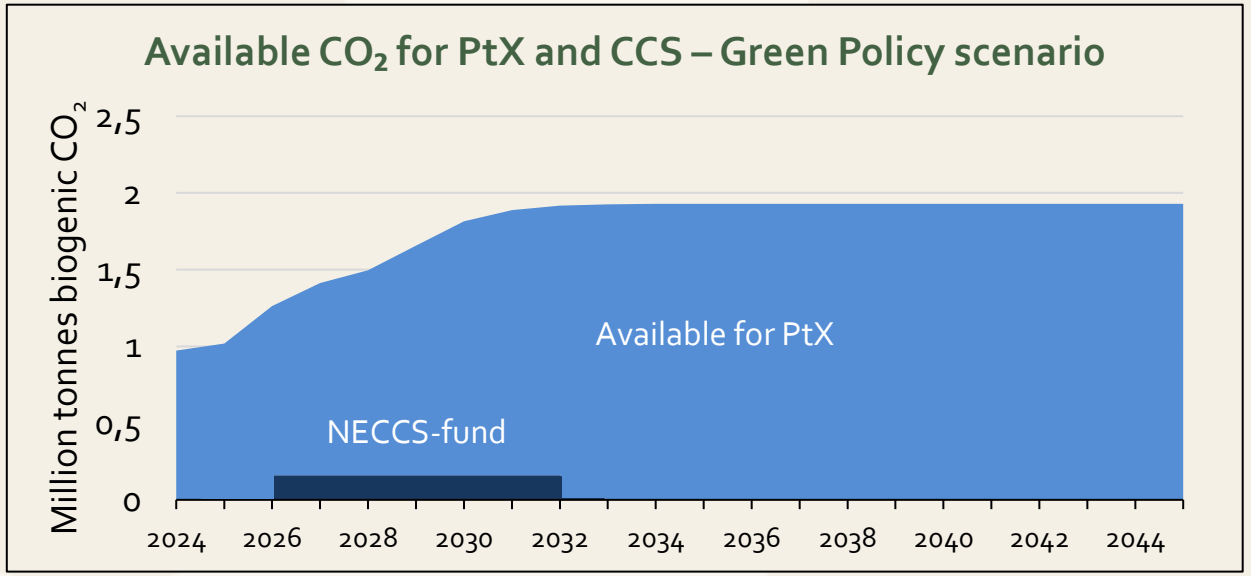
Significant potential in the use of CO_2 from biogas

CO_2 from biogas is referred to as biogenic CO_2 because it originates from plants that have absorbed CO_2 from the atmosphere through photosynthesis. This CO_2 would in any case be released naturally through the decomposition of plant material.

Biogas typically contains 50 to 65 percent biomethane and 35 to 50 percent biogenic CO_2. When the gas is upgraded to grid quality, CO_2 is separated and thereby becomes readily available at the biogas plants. This biogenic CO_2 has considerable potential for use in CO_2 storage (CCS), Power-to-X (PtX), or as a substitute for fossil-based CO_2 in industry. In the Frozen Policy scenario, the available CO_2 potential is estimated at just under 1.4 million tonnes per year, while the Green Policy scenario increases the potential to more than 1.8 million tonnes in 2030.

On 4 December 2021, a support scheme was adopted to enable storage of biogenic CO_2 in the period 2026 to 2032. The winners of the funding tenders were announced on 17 April 2024, and the scheme is expected to store 0.16 million tonnes per year, resulting in total storage of nearly 1 million tonnes of biogenic CO_2.[24]





Biogas Danmark

Climate effect

Highest climate impact from use of captured CO_2

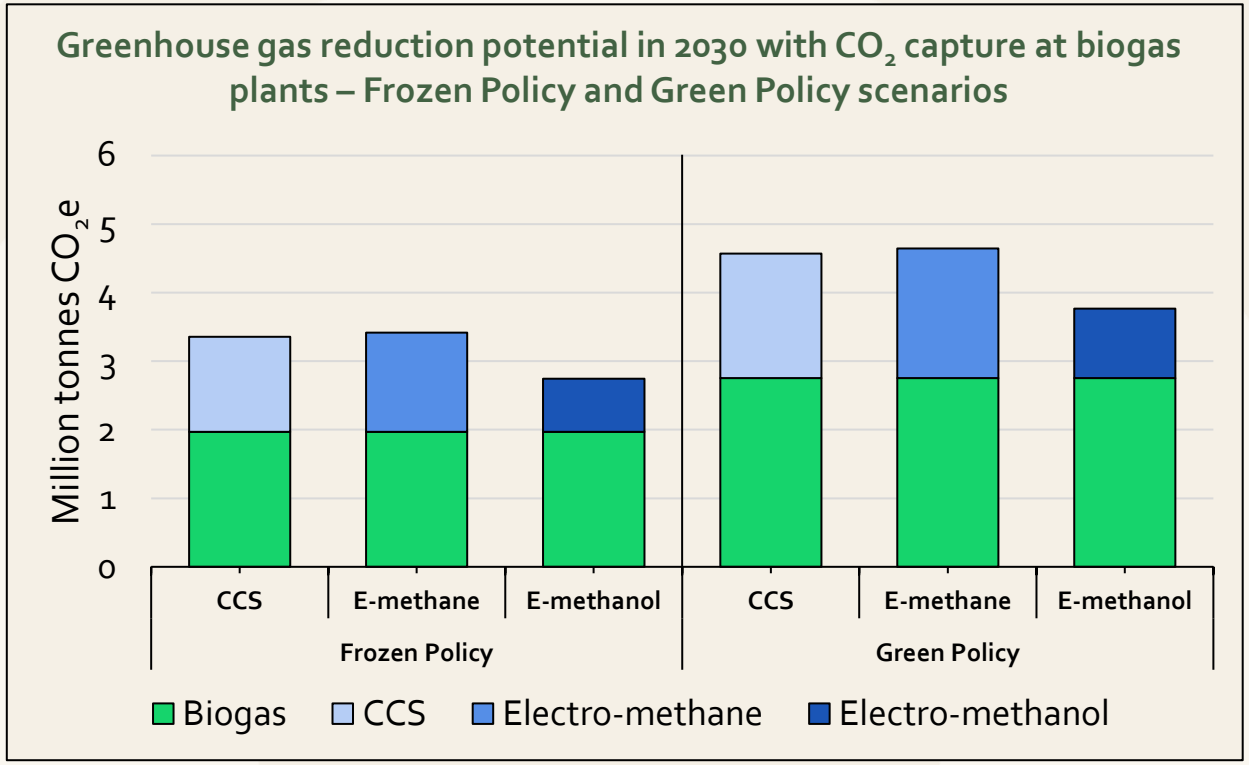
Biogenic CO_2 can make a significant contribution to the green transition

Compared to e-methanol, e-methane can bind a larger amount of renewable electricity when the same volume of biogenic CO_2 is used.

Therefore, e-methane delivers the greatest greenhouse gas reduction, assuming the electricity cannot be used for other purposes.

If there are alternative uses for renewable electricity, CCS may result in a greater overall climate benefit.

The figure to the right compares CCS and two PtX solutions, e-methane and e-methanol, focusing on their climate value.



It is assumed that the electricity used to produce e-methane and e-methanol comes from wind and solar power that would otherwise not be utilized.

Biogas Danmark

Climate effect

Climate impact of manure management

Frequent removal from stables and digestion of livestock manure reduces climate impact

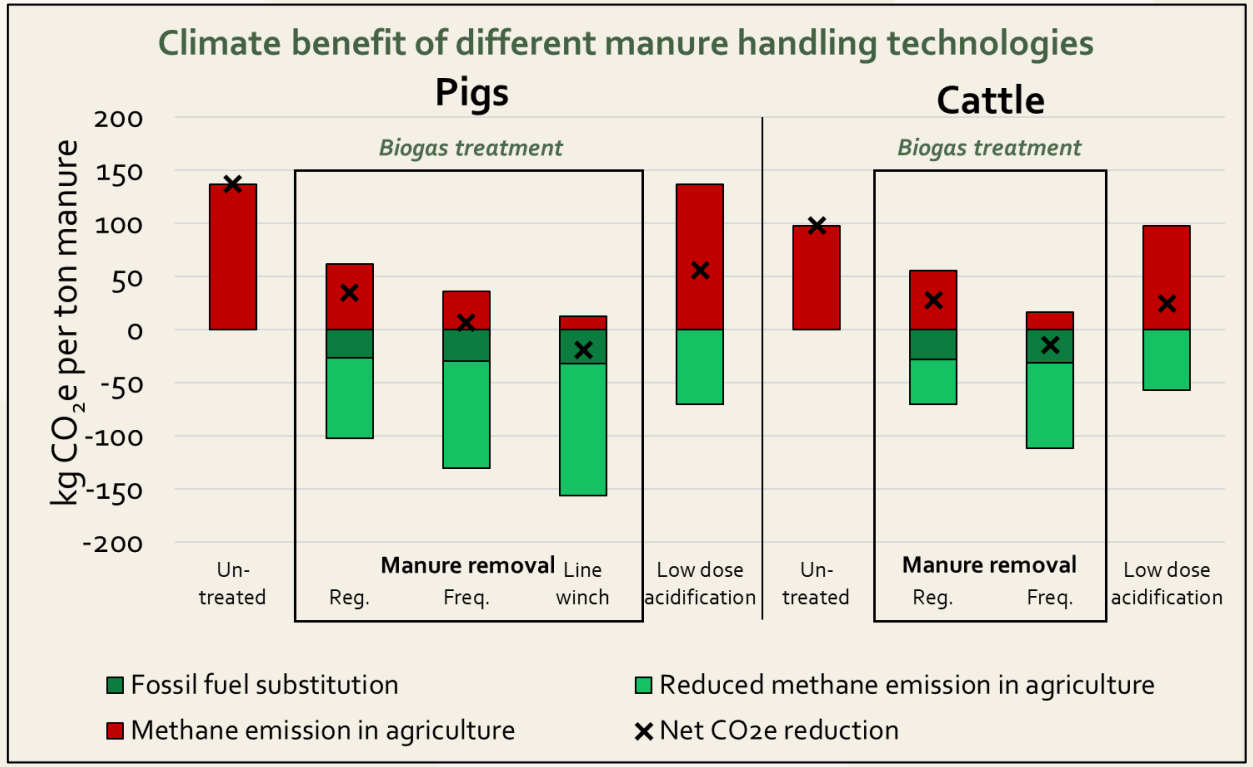
When livestock manure is stored in stables or manure tanks, a biological process leads to the formation and release of methane, which contributes to agricultural greenhouse gas emissions.

By digesting the manure in a biogas plant, the methane is captured, reducing emissions and creating a valuable energy source. The biogas produced can replace fossil fuels and thereby reduce CO_2 emissions in other sectors.

The climate benefit can be increased by transporting the manure more quickly to the biogas plant, either through weekly removal or daily discharge using a cable system. This limits methane formation, as the gas is captured before it escapes into the atmosphere. Optimized manure handling combined with biogas production can therefore almost eliminate the climate impact from livestock manure.

Another method is to add sulfuric acid to the manure, which inhibits methane formation. However, acidified manure is less suitable for biogas production and therefore does not deliver the double climate benefit of reducing methane emissions from agriculture while displacing fossil fuels.
Biogas therefore achieves a greater overall CO_2 reduction than acidification.

Biogas Danmark



The figure shows the climate impact of different manure management technologies per ton of manure. The red bars represent greenhouse gas emissions from agriculture, while the light green areas indicate the reduction in methane emissions. The dark green areas show the climate effect of biogas replacing fossil natural gas and diesel. Net climate effects of the technologies are marked with black crosses. The most effective technology in pig production is the cable system, achieving a net effect of -19 kg CO_2 per ton of manure. For cattle, frequent removal provides the greatest effect with a net impact of around -14 kg CO_2 per ton of manure.
Source: Klimavirkemiddelkatalog 2024 [10]

Climate effect

Climate impact of livestock farming

Biogas reduces greenhouse gases from livestock manure

Digesting livestock manure in biogas plants can almost eliminate methane emissions from both cattle and pig production. The top figure illustrates two typical farms: one with 400 dairy cows including young stock and another with 1,100 sows raising all piglets for slaughter.

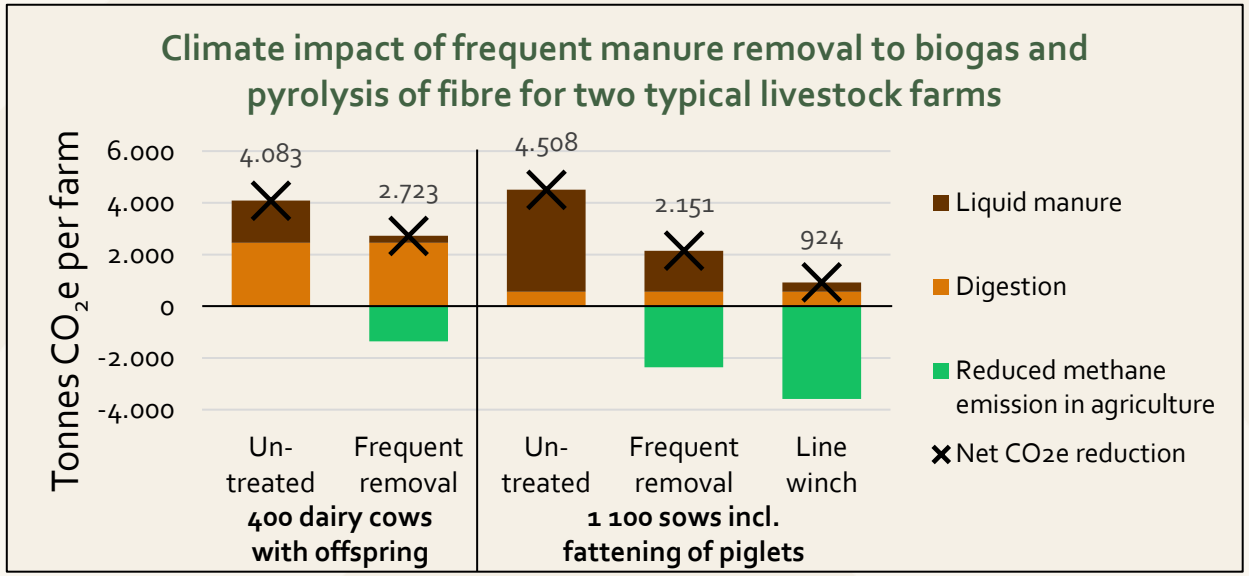
By removing manure quickly from the stables and sending it directly to a biogas plant, methane emissions can be significantly reduced for both cattle and pigs. This markedly lowers the overall climate impact from agriculture.

Additional climate benefits can be achieved by separating the digested biomass and sending the fibre fraction to a pyrolysis plant. Here, the resulting pyrolysis oil and gas can displace fossil fuels, while the CO_2 absorbed from the atmosphere is stored for a longer period as biochar.

The reduced methane emissions from digesting livestock manure make a significant contribution to cutting the overall climate footprint of agriculture.

Biogas Danmark

Emissions from enteric fermentation are based on Climate Status and Projections 2025 (1)
Other emissions and reductions are calculated using Klimavirkemiddelkataloget. (10)



Climate effect of biogas, frequent manure discharge, pyrolysis, and biochar		
Tonnes of CO_2e per typical farm	**Dairy cows with offspring**	**Sows with piglets**
Emissions from stable and storage for liquid manure	4.083	4.508
Emissions after frequent discharge, biogas, and biochar	2.610	853
Total on-farm reduction	**1.473**	**3.656**
Climate effect in agriculture of frequent manure discharge for biogas and pyrolysis of fibre fraction		
kg CO_2e per tonne liquid manure	**Cattle**	**Pigs**
Emissions, liquid manure	98	137
Emissions, digestate	17	13
Effect of biogas	**-81**	**-124**
Biochar from fibres	-8	-3
Reduced emission of greenhouses gases	**-89**	**-127**
Reduced emission of greenhouses gases, percent	**-91%**	**-92%**

The figure and table show the climate impact of frequent manure removal and digestion. A cable system is used for pigs. The table also includes the additional climate effect of biochar.

Climate effect

Climate impact in agriculture

Strong synergy between frequent manure removal and cooling

Like the rest of society, agriculture faces a major climate challenge but is the only sector with a binding climate target. The 2021 climate agreement for agriculture introduced requirements for frequent manure removal from existing finisher pig stables and all new pig facilities as of 1 January 2023.[25]

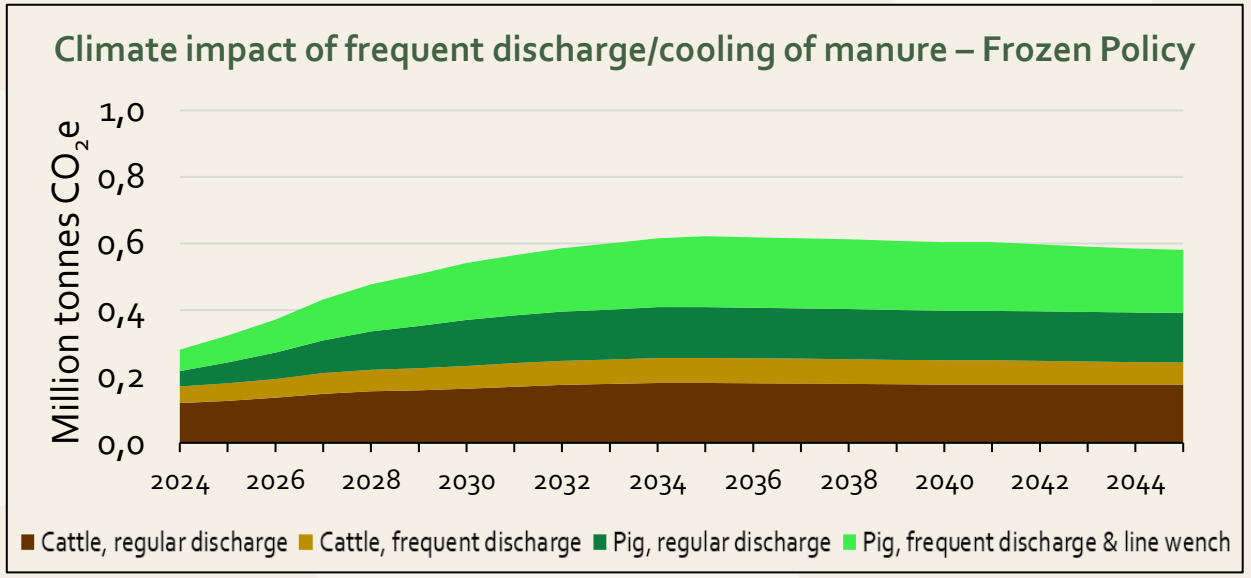
The political agreement on the green tripartite pact from November 2024 also includes incentives for both frequent manure removal and increased delivery of livestock manure to biogas plants.

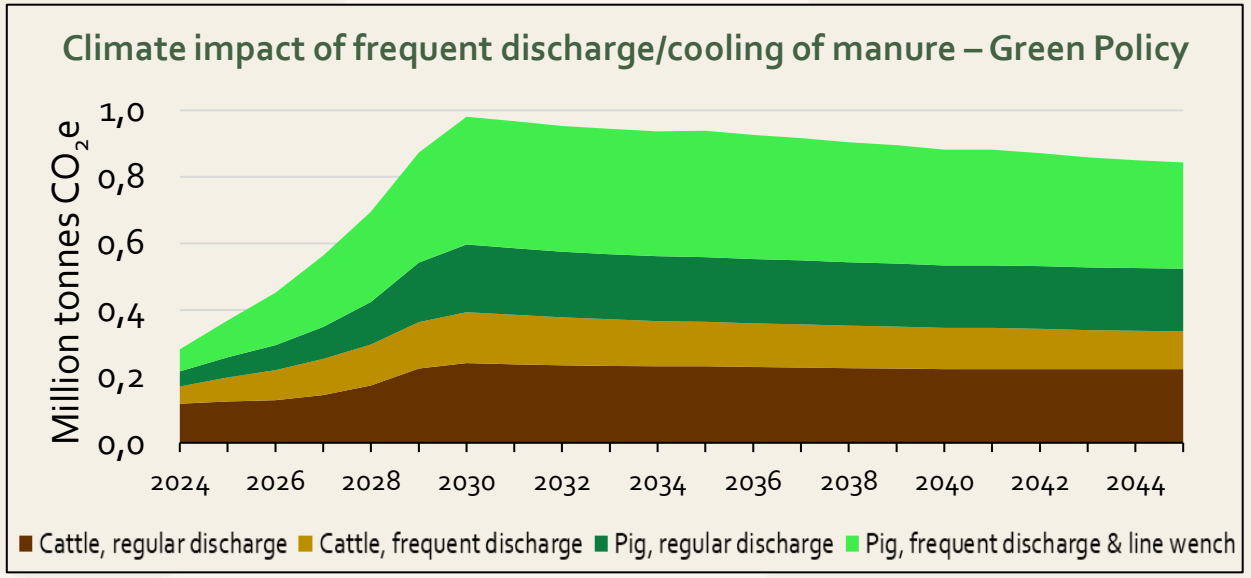
The effect of frequent manure removal in existing stables is well documented [10], and the impact is even greater in new facilities with systems for either weekly pumping or daily removal using cable-driven systems.

Digesting livestock manure provides an additional climate effect, as it reduces methane emissions from stables and manure storage, while the biogas produced replaces fossil gas and thereby reduces CO_2 emissions.

In the Frozen Policy scenario, total greenhouse gas reductions are around 2.8 million tonnes CO_2e in 2030, of which approximately 0.7 million tonnes come from agriculture. In the Green Policy scenario, total reductions increase to 3.4 million tonnes CO_2e, including 1.0 million tonnes from agriculture.

Biogas Danmark





Climate effect

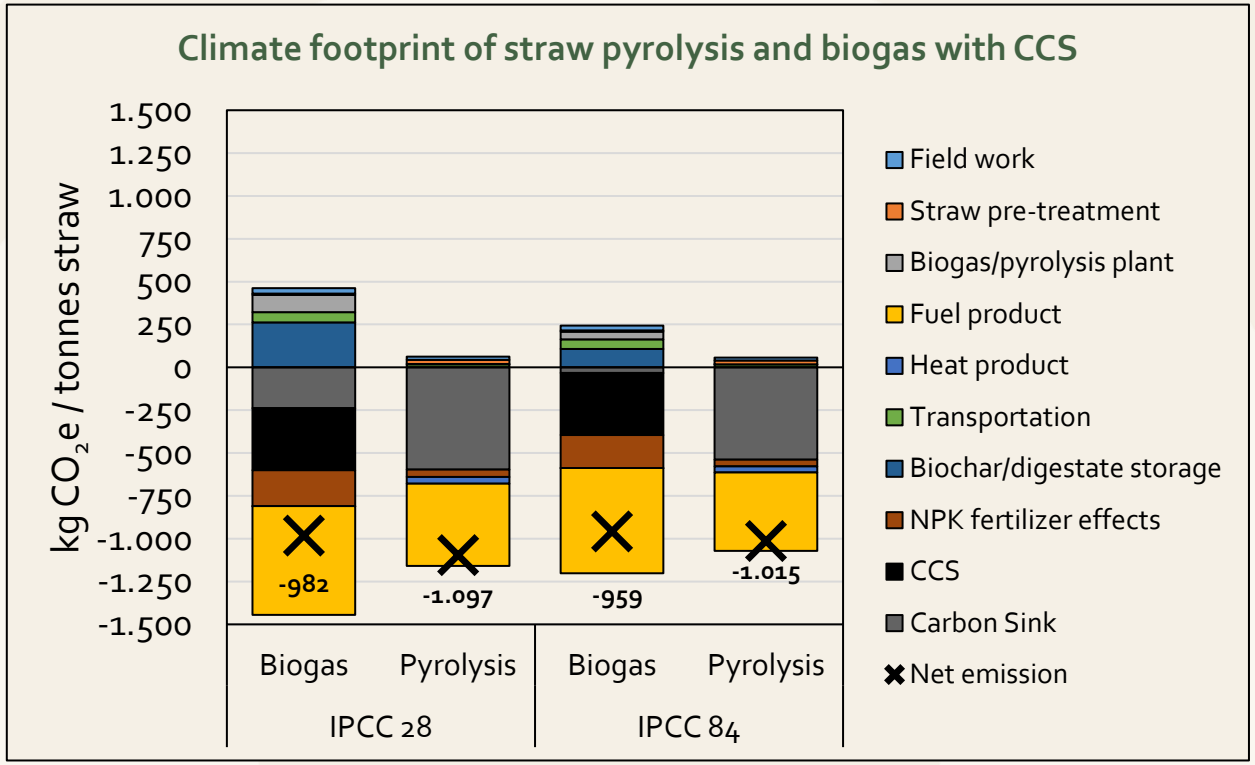
Life cycle analysis of climate impact from pyrolysis and biogas

Significant CO_2 reduction from pyrolysis and biogas

A certified life cycle analysis from Roskilde University (RUC) in 2021 examined the climate potential of using straw for pyrolysis and biogas production. The analysis shows that combining straw with manure for biogas production is a climate-effective solution [26]

In pyrolysis, straw is converted into fuel and biochar, which can be stored in agricultural soil. In biogas plants, straw and manure are converted into upgraded biogas, while the biogenic CO_2 can be captured and stored. The calculations include energy consumption, biomass transport, and other related factors.

The analysis concludes that both technologies offer significant climate benefits and are comparable in terms of total greenhouse gas reductions. The results suggest that the most optimal solution may be a combination where straw is first digested in a biogas plant, and the separated fiber fraction is then sent to pyrolysis.



Life cycle analysis comparing the use of straw for biogas with manure (including CO_2 storage) and straw pyrolysis. The black markers show the total greenhouse gas reduction in kg CO_2 equivalents per ton of straw at methane emission factors of 28 (100-year perspective) and 84 (20-year perspective)[26]

Biogas Danmark

Climate effect

National climate impact in agriculture

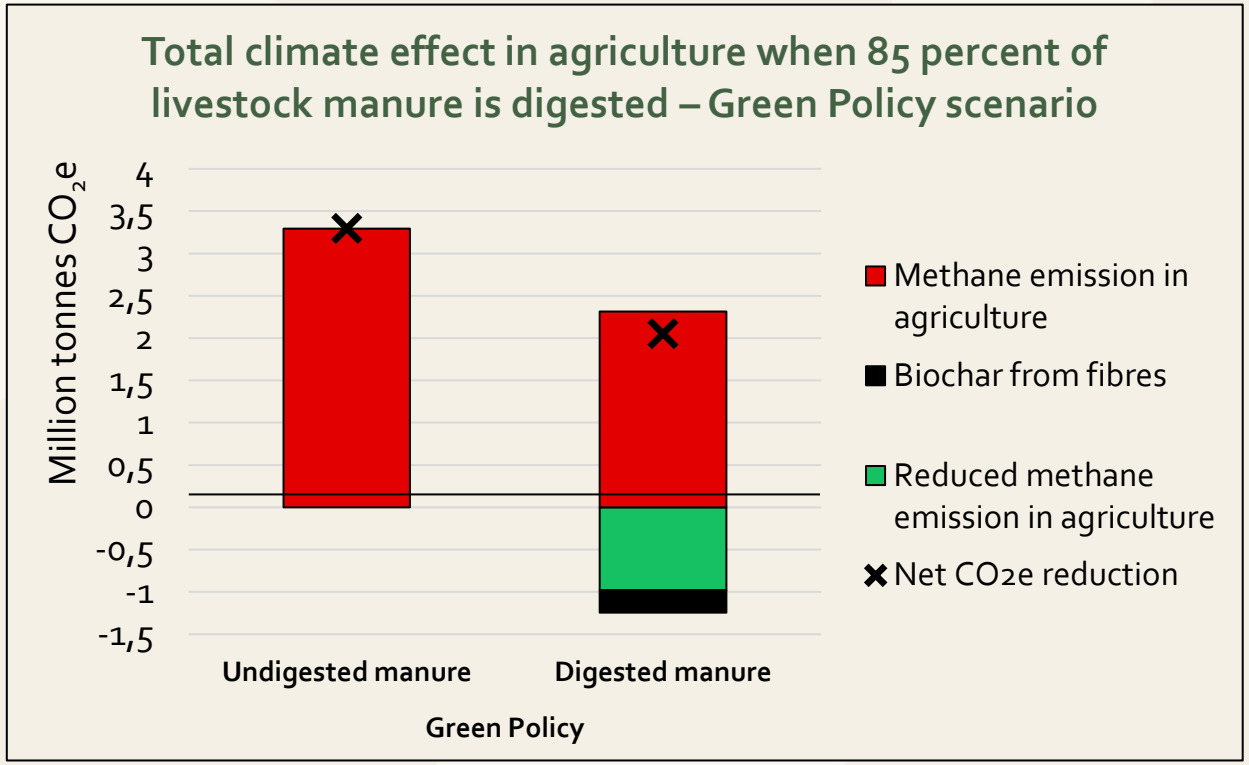
Significant reduction in greenhouse gases from frequent manure removal to biogas and pyrolysis plants

If 85 percent of livestock manure in 2030 is removed from barns through frequent discharge or via vacuum systems and sent to biogas plants, where the remaining fiber fraction is later used for pyrolysis, methane emissions from manure can be reduced by approximately 1.3 million tonnes of CO_2e.

Frequent removal lowers methane formation in barns and storage tanks, while biogas production captures and utilizes methane that would otherwise have been emitted. After digestion, the fiber fraction can be separated and used for pyrolysis, where the resulting biochar stores carbon and provides an additional climate effect.

The 85 percent corresponds to the share of the manure fraction where methane emissions are reduced in the Green Policy scenario. If all livestock manure is treated in the same way, the greenhouse gas reduction can be increased significantly.

The figure shows the effects of each individual measure. The pyrolysis effect results from depositing biochar made from the fiber fraction left after digestion. This further reduces CO_2 emissions by binding carbon over a longer period.



The figure shows the nationwide climate impact for approximately 85 percent of livestock manure reduce methane emissions in the Green Policy scenario. The left-hand column shows emissions from manure without any treatment, such as frequent removal or biogas production. The right-hand column illustrates how the climate footprint can be reduced through various measures, including rapid removal, biogas production, and pyrolysis of the fiber fraction. The black crosses indicate net emissions for untreated and treated livestock manure, clearly showing the difference in climate impact.

Biogas Danmark

Climate effect

Potential climate impact from pyrolysis gas and biochar

Strong synergies between biogas and pyrolysis

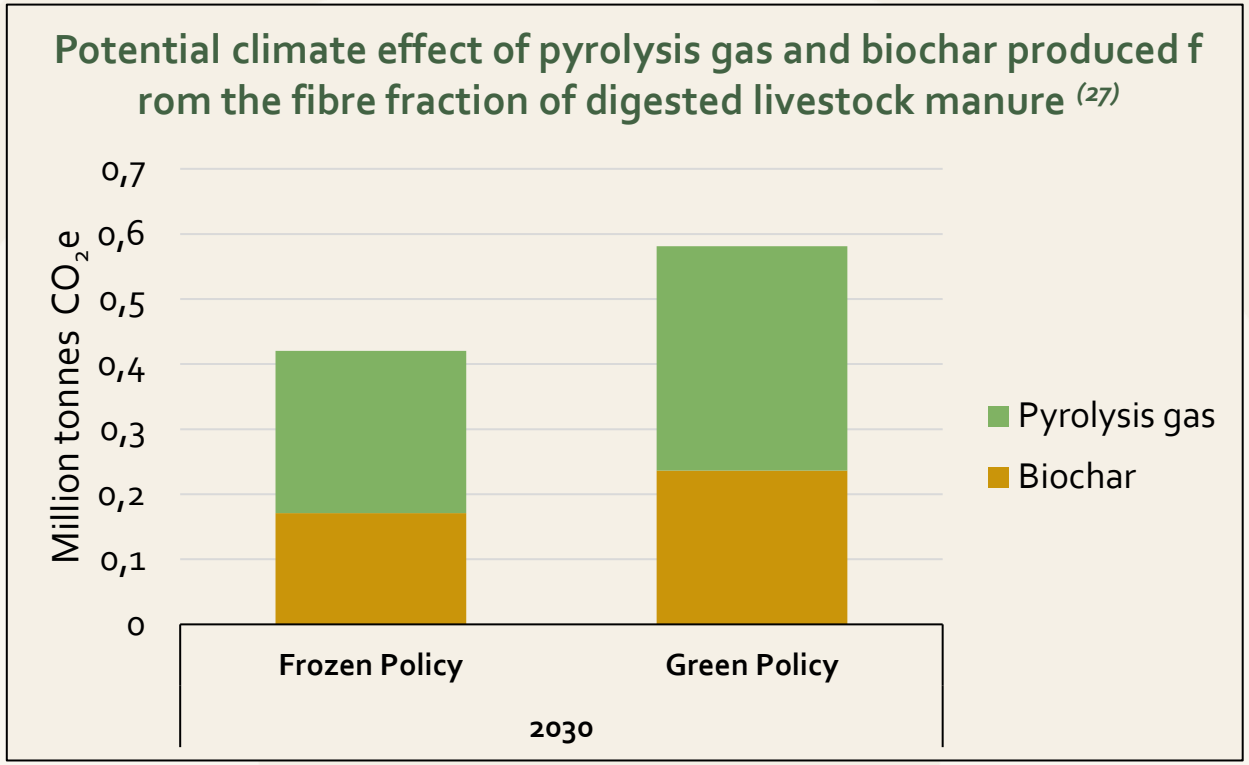
There is significant potential to improve agriculture's climate balance by leveraging synergies between biogas production and pyrolysis.

By separating the digested biomass from biogas plants, it can be split into a liquid fraction and a fiber fraction.

The liquid contains most of the plant-available nitrogen and is therefore a valuable fertilizer. The fiber can either be used directly as a soil amendment or processed in a pyrolysis plant.

In pyrolysis, the fiber is heated to produce pyrolysis gas and biochar. The pyrolysis gas is used to dry the fiber before it enters the pyrolysis process. Excess heat from the process can be reused in the upgrading unit of the biogas plant, increasing overall energy efficiency.

The carbon-rich biochar can be applied to agricultural soils, where it stores carbon for long periods and thereby helps reduce CO_2 emissions from agriculture.



In the Frozen Policy scenario, the climate potential from pyrolysis gas and biochar is approximately 0.4 million tonnes of CO_2e, while the Green Policy scenario shows a potential of around 0.6 million tonnes. The climate effect of pyrolysis gas is calculated based on its ability to reduce internal gas use at the biogas plant, allowing more natural gas to be displaced. For biochar, a 100 percent long-term effect is assumed.

Biogas Danmark

Climate effect

Total climate potential from biogas, CCS and pyrolysis

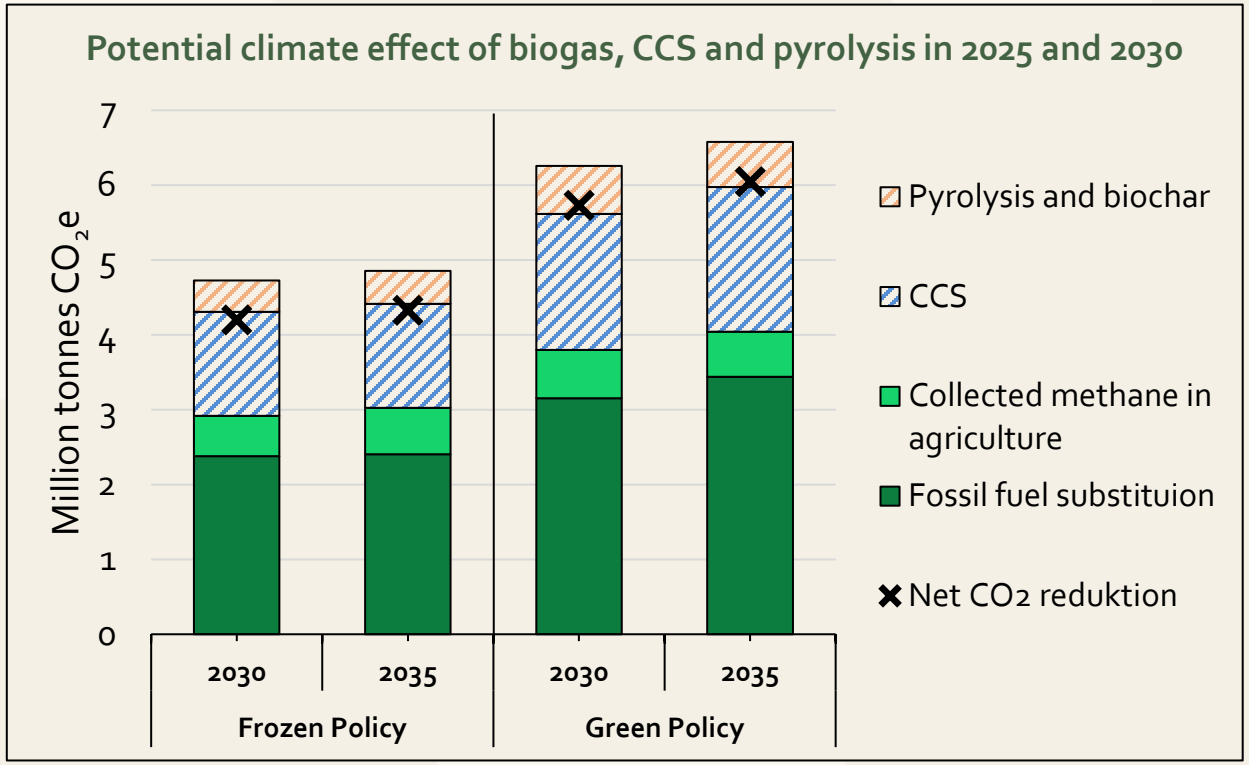
Full utilization of CCS and pyrolysis significantly increases the climate effect of biogas

Biogas plants reduce methane emissions from livestock manure in agriculture while the produced biogas displaces fossil fuels in the energy sector, industry and heavy transport.

The climate effect can be significantly increased if the biogenic CO_2 from biogas is stored and the residual fibre from biogas production is processed in a pyrolysis plant. The pyrolysis process converts part of the fibre into pyrolysis gas, which can be used for energy production, for example as process heat at the biogas plant. In addition, biochar is produced, which can be applied to farmland and contribute to long-term carbon storage.

In the Frozen Policy scenario, full utilization of the potential in CCS and pyrolysis will increase the climate effect from 2.9 million tonnes to 4.2 million tonnes CO_2e in 2030.

In the Green Policy scenario, full utilization of the potential in CCS and pyrolysis will increase the climate effect to 5.7 million tonnes CO_2e in 2030.



The figure shows the total potential climate effect of biogas, CO_2 storage (CCS) and pyrolysis. The dark green color shows the climate effect of biogas displacing natural gas and diesel. The light green color shows methane reduction from manure digestion in agriculture. The hatched areas show the potential climate effect of CCS and of pyrolysis gas and biochar.
Net CO_2 reduction, marked with black crosses, shows the total climate effect after deducting 1 percent methane loss and the biogas plants' energy consumption for process and transport.

Biogas Danmark

Circular economy and agricultural effects

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47: Reduced nitrogen losses to the aquatic environment

48: Synergy between biogas and organic farming

49: Biogas and biorefining

Biogas Danmark

Circular economy and agricultural effects

Phosphorus recycling

Biogas plants recycle scarce resources

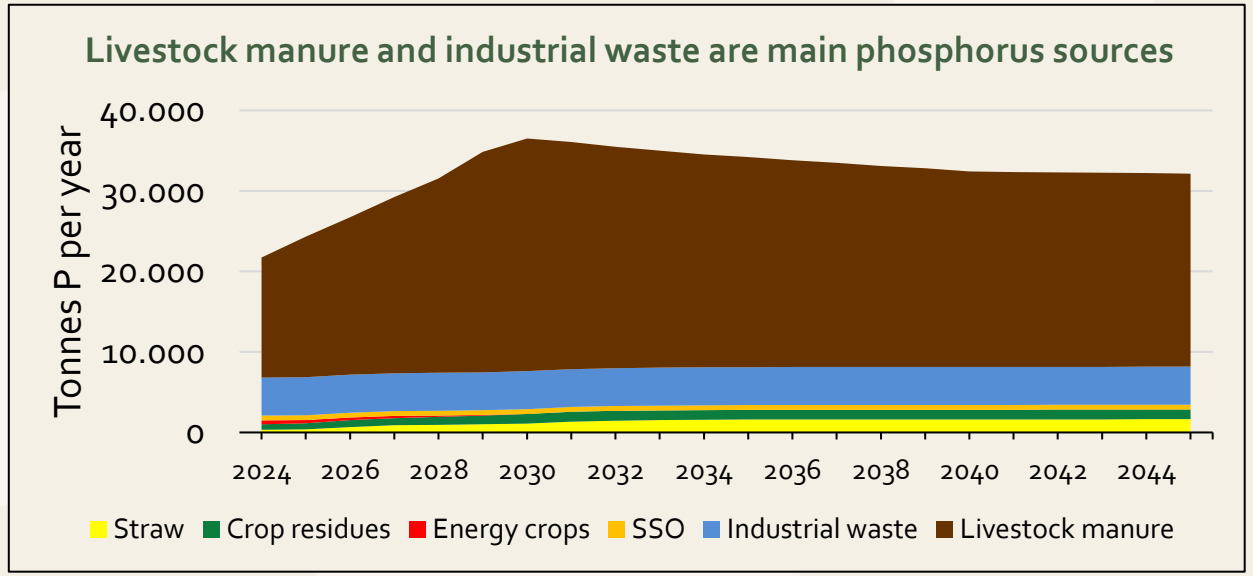
Biogas plants play a key role in utilizing large volumes of residues from agriculture, households and industry while ensuring the recycling and reuse of nutrients as fertilizer.

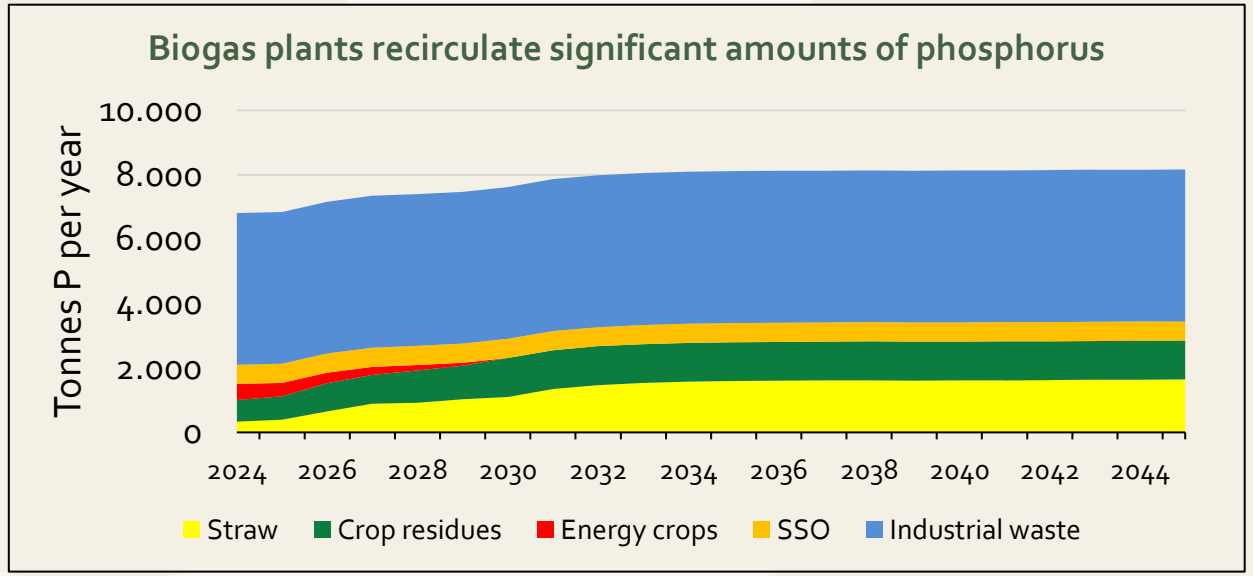
The largest amounts of phosphorus are found in livestock manure, but significant volumes are also recycled through industrial residues and food waste from households.[28]

In the Green Policy scenario, biogas plants are expected to recycle around 34,000 tonnes of phosphorus in 2030. Of this, nearly 5,300 tonnes come from industrial and food waste and 1,950 tonnes from straw and crop residues from agriculture.

For comparison, Danish crops receive about 13,500 tonnes of phosphorus from mineral fertilizers. [29]

Biogas plants not only contribute to sustainable energy but also play an important role in reducing the need for newly added phosphorus in agriculture, which are a resource that is in limited supply.





Both figures refer to the Green Policy scenario.

Biogas Danmark

Circular economy and agricultural effects

Reduced nitrogen losses to the aquatic environment

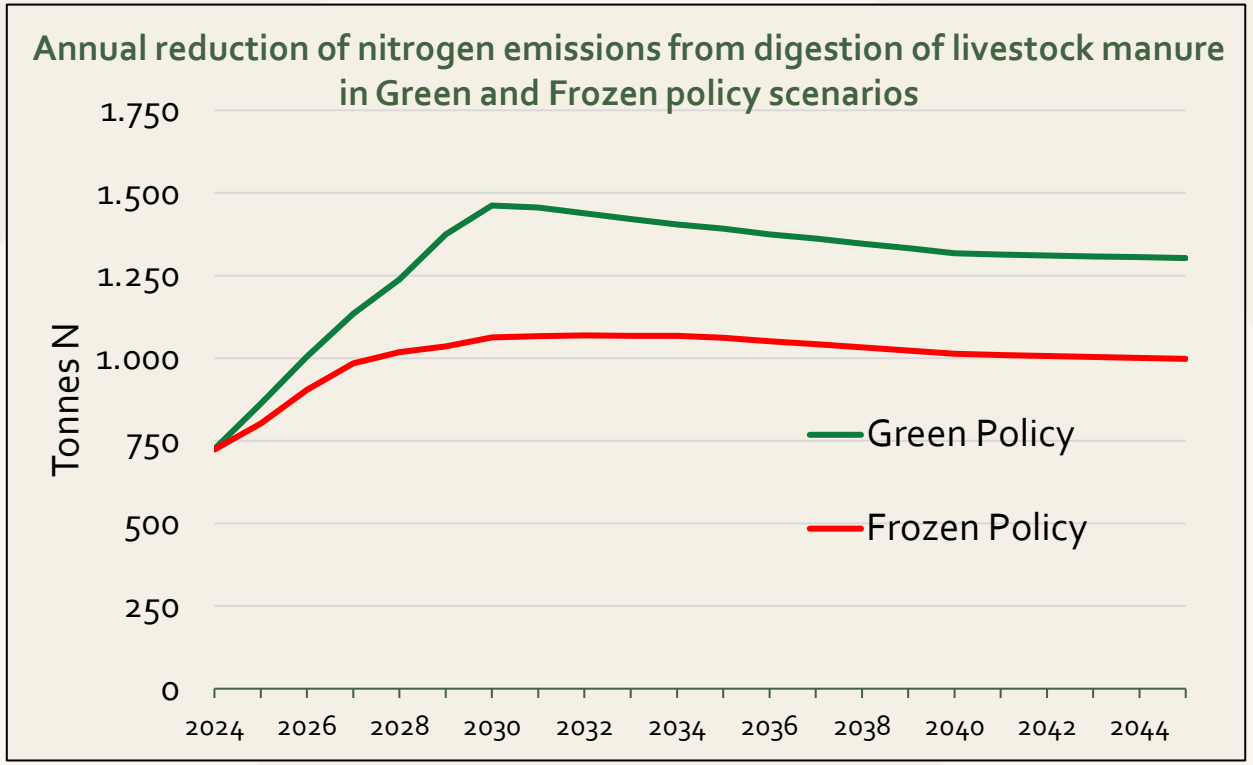
Biogas plants can support the agricultural agreement's targets for lower nitrogen emissions

When livestock manure is digested in biogas plants, part of the nitrogen is converted into a more plant-available form, which improves crop uptake (mineralization)[30]. Applying the digested biomass as fertilizer enhances plant growth, increases yield and reduces the risk of nitrogen leaching into the aquatic environment.

Under the 2021 agricultural agreement, Denmark has committed to reducing nitrogen emissions by 10,400 tonnes by 2027,[25] in order to meet the EU's target for good ecological status in the aquatic environment.

In the Frozen Policy scenario, biogas production of 39 petajoules enables the digestion of 51 percent of livestock manure, which could reduce nitrogen emissions to the aquatic environment by approximately 1,000 tonnes annually by 2027.

If the Green Policy scenario is implemented, earlier and more widespread manure digestion could increase the annual reduction to 1,100 tonnes by 2027.



Digestion of 51 percent of livestock manure in the Frozen Policy scenario could reduce nitrogen emissions by nearly 1,000 tonnes in 2027. An increase in biogas production in line with the Green Policy scenario could raise the annual reduction to around 1,400 tonnes from 2030.[30]
According to Climate Status and Projection 2025 (KF25), declining amounts of livestock manure are expected in the coming years, which will also affect the volumes available for biogas production. As manure volumes gradually decline during the 2030, a corresponding decrease in nitrogen leaching reductions is expected.

Biogas Danmark

Circular economy and agricultural effects

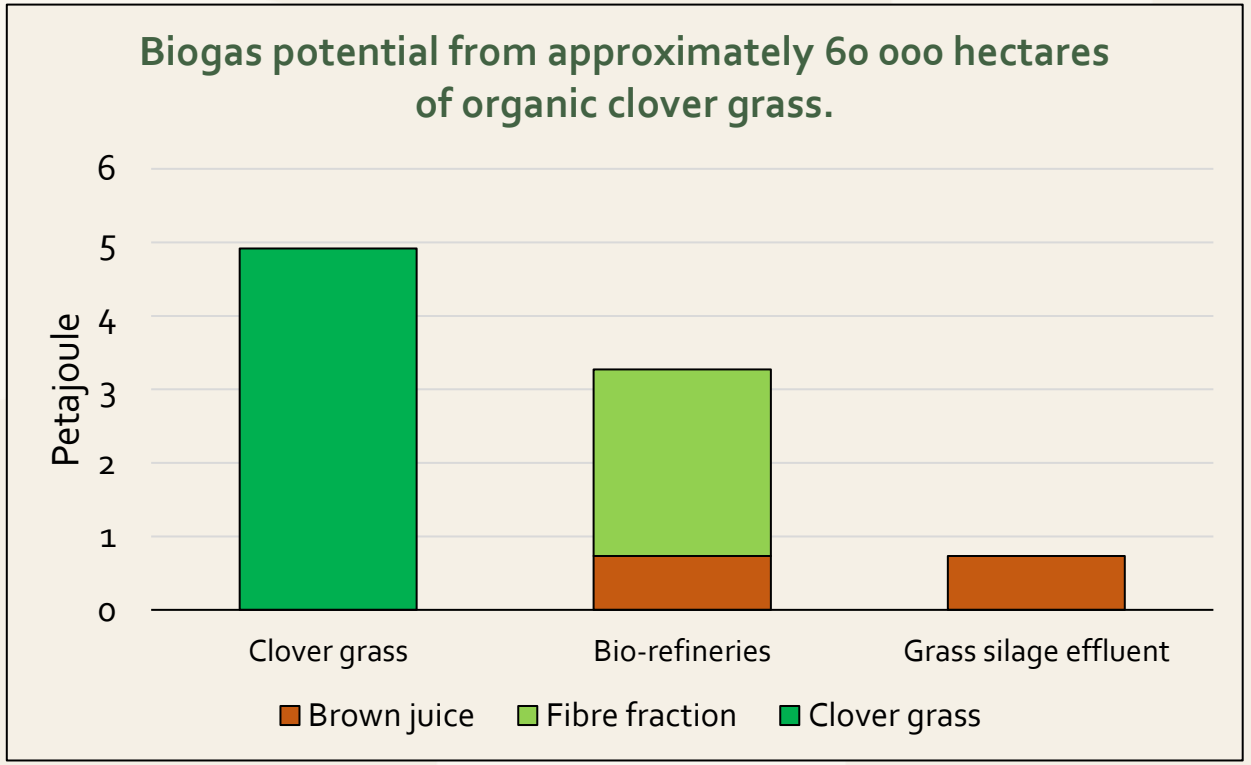
Synergy between biogas and organic farming

Biogas plants can support the expansion of organic agriculture

There is a political ambition to double the organic farming area in Denmark, and biogas plants can support this development by recycling nutrients from household and industrial waste as well as clover grass from organic farms.

Seges Innovation has estimated that expanding the organic area by 300,000 hectares will require 60,000 hectares of clover grass, which captures nitrogen from the atmosphere[31]. If there is no demand for the clover grass as animal feed, it can instead be utilized in biogas plants for energy and fertilizer production. Digesting clover grass in a biogas plant instead of ploughing it directly into the soil reduces the risk of both nitrogen leaching and greenhouse gas emissions.

Clover grass from 60,000 hectares yields approximately 1.4 million tonnes with a biogas potential of nearly 5 PJ. As biorefinery capacity increases, protein can be extracted from the clover grass for feed and food production, while the remaining fibre and brown juice can be used for biogas. If the fibre is used as cattle feed, the remaining brown juice still holds a biogas potential of about 0.9 PJ. If both fibre and brown juice are used in biogas plants, production could reach up to 3.8 PJ.



Clover grass plays a key role in organic farming by adding nitrogen to the soil. If it is not used as feed for ruminants, it can be advantageously digested in biogas plants. In the future, clover grass may also be processed in biorefineries, where protein is extracted and the remaining fibre and brown juice are used for biogas or feed. Source: Seges Innovation. [31]

Biogas Danmark

Circular economy and agricultural effects

Biogas and biorefining

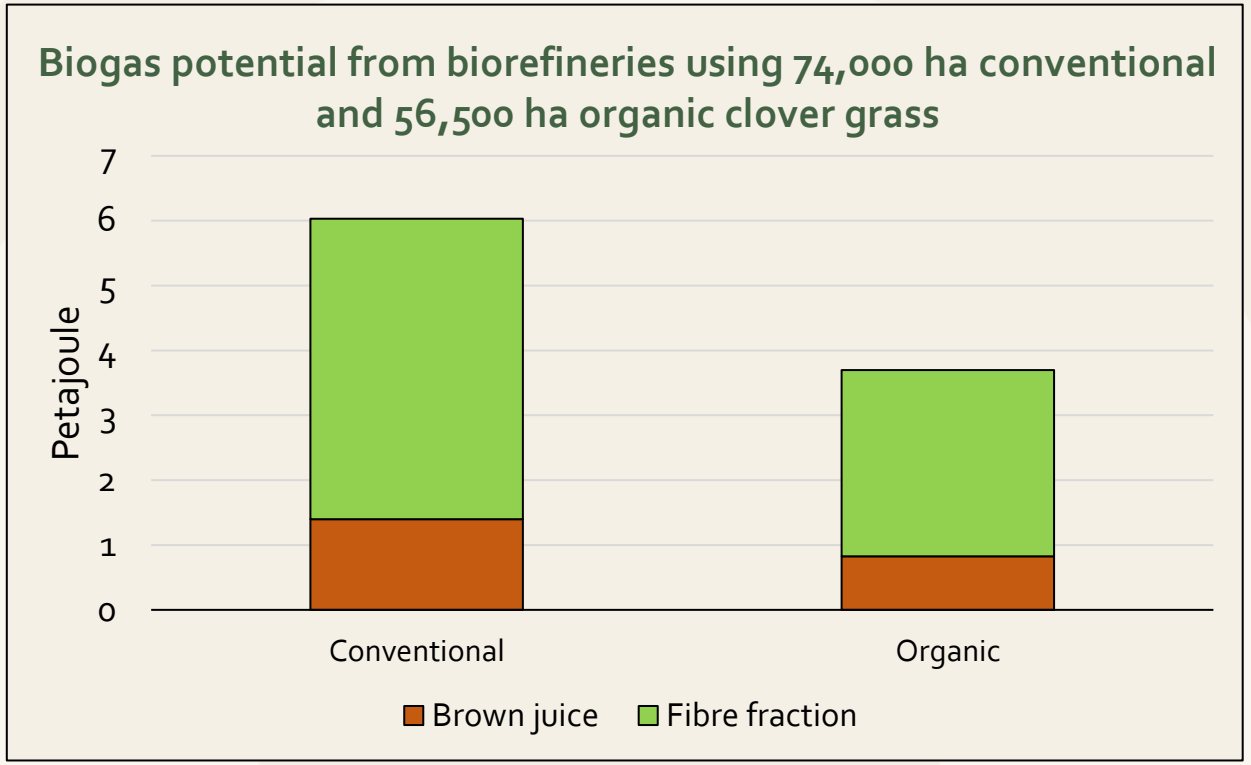
Biogas supports green biorefining

There is increasing focus on replacing imported protein by establishing biorefineries that can extract protein from green crops and reduce reliance on soy-based feed. Funding is available for feasibility studies and the establishment of new biorefineries.

Biorefining produces valuable protein for animal feed, and biogas plants play a key role in utilizing the residues from this process. Fibre residues can be used as cattle feed, while the brown juice and, if applicable, the fibre can be converted into biogas. This ensures both energy production and nutrient recycling.

Seges Innovation has assessed the biogas potential of residues from biorefineries producing 50,000 tonnes of conventional and 30,000 tonnes of organic protein. This requires the cultivation of 74,000 hectares of conventional grass and 56,500 hectares of organic clover grass.

If both the brown juice and fibre residue are used in biogas plants, the total biogas potential is 9.7 PJ. If only the brown juice is utilized, the potential is 2.2 PJ. These perspectives have been explored by both the Bioeconomy Panel and the Expert Committee on cascade use.



Source: Seges Innovation. [31]

Total Danish protein imports amount to approximately 700,000 tonnes of raw protein per year. Around 30,000 tonnes of protein are imported annually for organic feed, which can be replaced with Danish grass protein.[32]

Biogas Danmark

Economy and market

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Biogas Danmark

Economy and market

Guarantees of origin

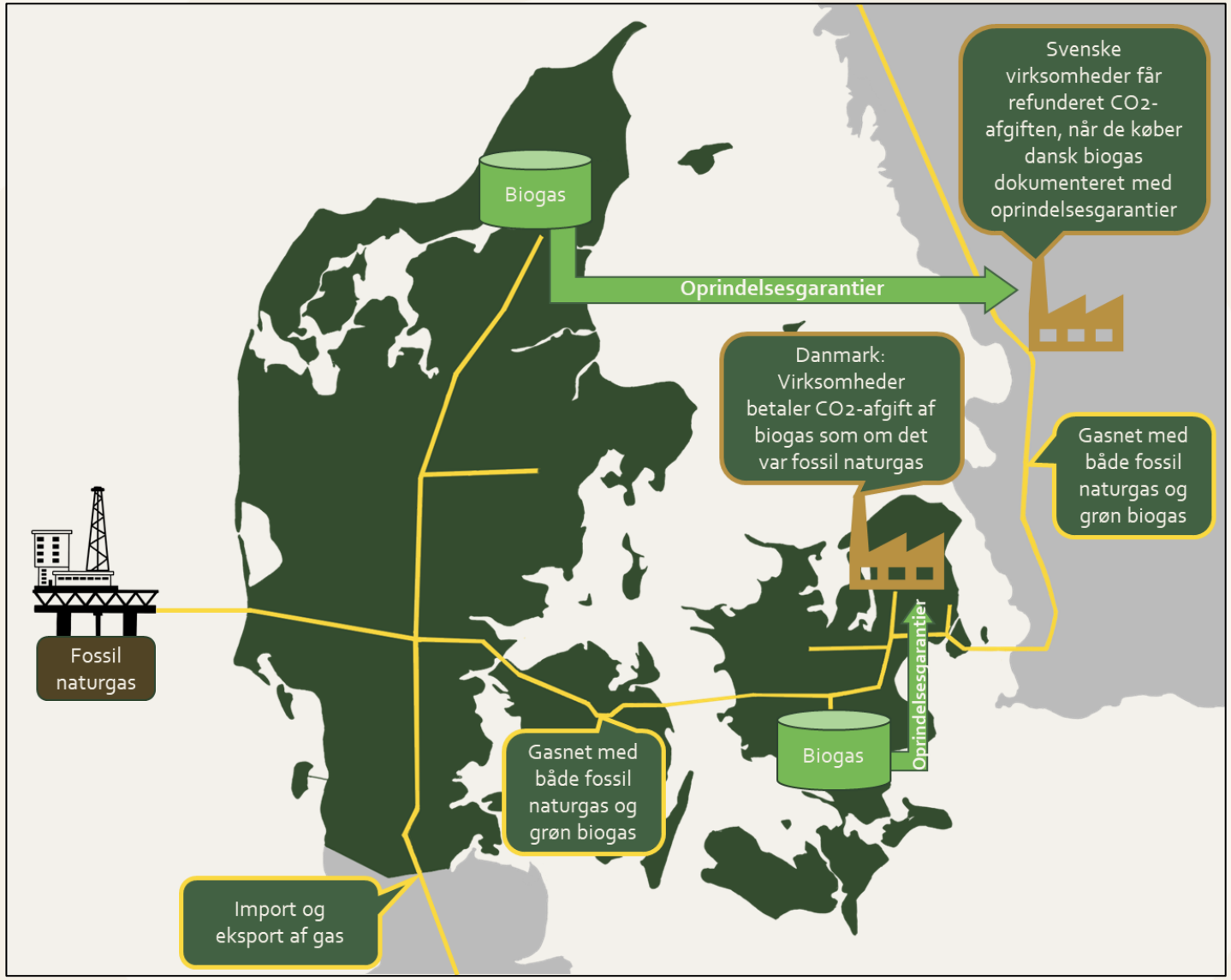
Guarantees of origin document delivery of biogas through the gas grid

Biogas producers sell biogas delivered through the gas grid to gas customers in both Denmark and abroad. The state-owned Energinet issues guarantees of origin that document the name of the biogas plant and the amount of biogas injected into the grid.

Gas customers can purchase biogas by paying for both the gas and the guarantee of origin. When the guarantee is cancelled in Energinet's registry, it confirms that the gas has been consumed and cannot be resold.

In Germany and several other countries, tax authorities recognize guarantees of origin as documentation for CO_2 tax refunds for unsubsidized biogas. This is not yet the case in Denmark, where guarantees of origin can only be used to substitute for purchasing EU ETS allowances.

Biogas flow, guarantees of origin, and national CO_2 tax refund differences



Biogas Danmark

Economy and market

Guarantees of origin and sustainability certificates

Guarantees of origin document origin – sustainability certificates declare sustainability

The market uses guarantees of origin to document the source of the biogas, whether it has received subsidy, and that it has only been used once.

The sustainability of the biogas is certified by an EU-accredited organization such as ISCC or REDCert, which assesses both the climate impact and the bioresources used.

The market price of guarantees of origin depends on the specifications of the sustainability certificates.
Biogas customers receive:

1. A receipt from Energinet confirming the transfer and cancellation of guarantees of origin from a specific producer, including information on any subsidy.

2. A sustainability declaration for the supplied biogas, where the climate impact is typically determined according to the Renewable Energy Directive III using standard values based on a cradle-to-grave approach

Sustainability Statement - Biomethane

Company Name	
Contact Name and telephone number	
Customer	
Production site	
Item Short Name and name	
Batch number	

The product that was delivered to the costumer complies with requirements in EU Renewable Energy Directive 2009/28/EC "RED"

GHG Emission CO2eq/MJ – values and savings have been calculated according to the methodology in Directive 2009/28/EC.

The reference GHG value in RED/Directive 2009/28/EC for fossil transport fuel is equal to 83,8 g CO2eq/MJ.

Example of part of a sustainability certificate, where the climate impact is certified according to EU-approved certification schemes and by authorized auditors.

Biogas Danmark

Economy and market

Market value of biogas delivered via the gas grid

Development in market value and support costs

Following Russia's reduction of gas supplies to Europe in 2022, European gas exchanges experienced a significant price increase. As a result, Danish biogas delivered via the gas grid displaced fossil natural gas with a market value of DKK 6.5 billion in 2022. Including off-grid biogas, this value exceeds DKK 8 billion.

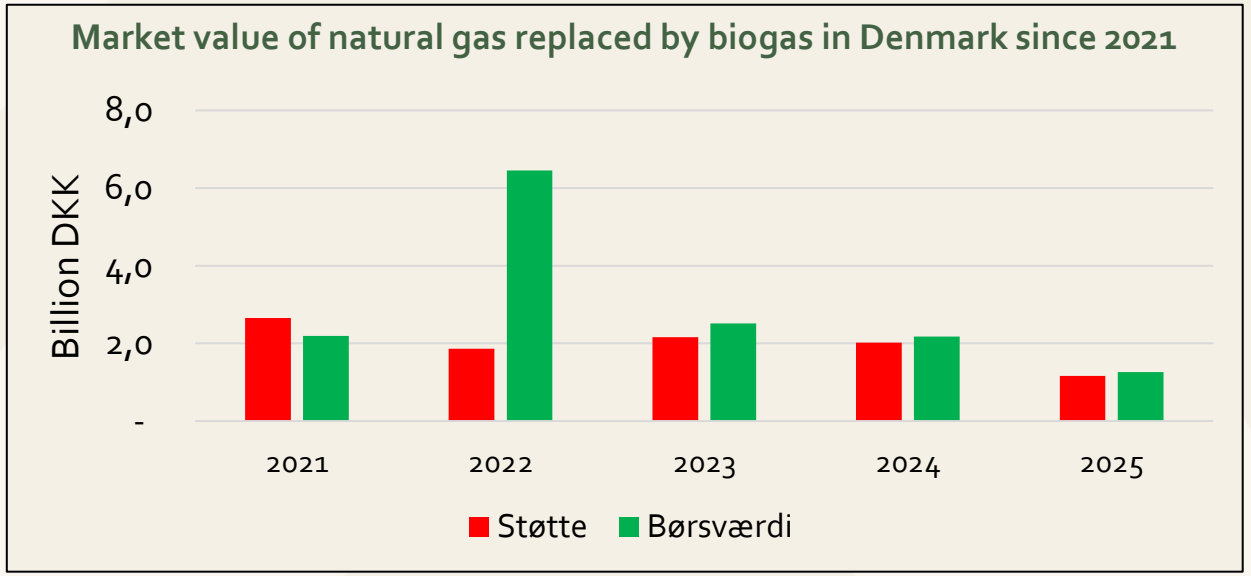
The market value of biogas is shaped by a volatile market, but gas exchange prices remain significantly higher than in previous years, and forward prices indicate a continued high level in the coming years.

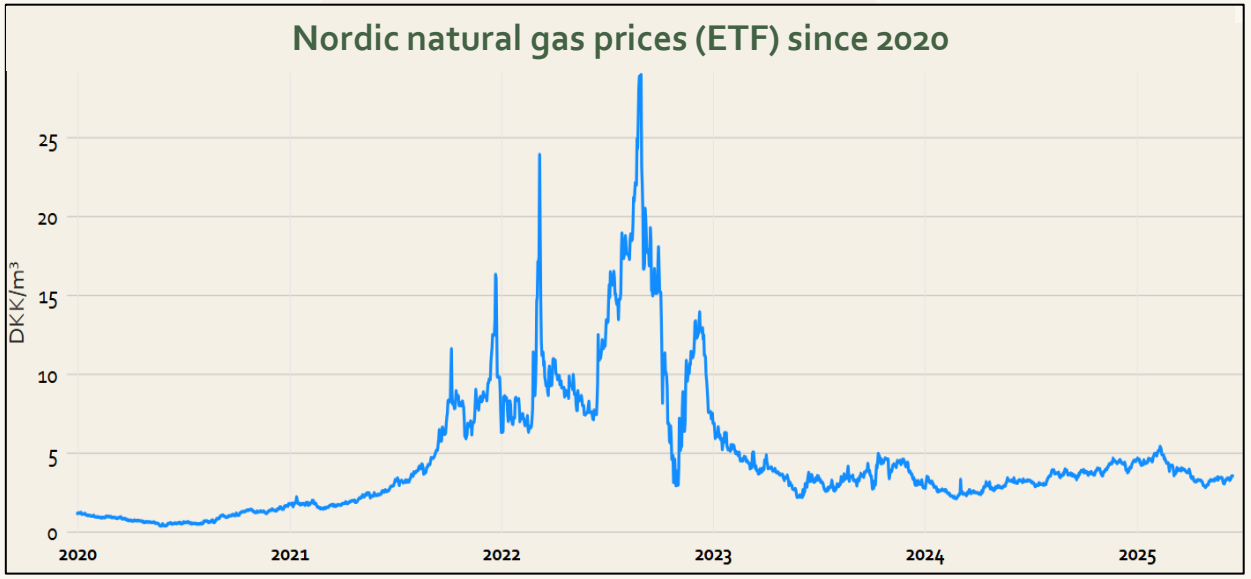
When gas prices rise, the subsidy level is reduced accordingly, and subsidy is expected to remain low for an extended period.

Since the displaced gas would otherwise have been imported from Russia, these funds now remain within Denmark and the EU, creating value for biogas producers and especially for the many customers who have agreed on fixed-price contracts with biogas producers.

Biogas Danmark

Subsidy for biogas compared to the market value of the natural gas displaced by biogas. Sources: Energinet (biogas delivered to the gas grid) (33), Danish Energy Agency (subsidy) (34), and EEX Gas Market Data (market value) (35).





The development in gas prices has led to a situation where the market value of the displaced natural gas has, for a period, exceeded the state's support costs for biogas. (16)

Economy and market

Distribution of costs and revenues for biogas

Economy of biogas tenders challenged by lack of access to guarantee of origin revenues

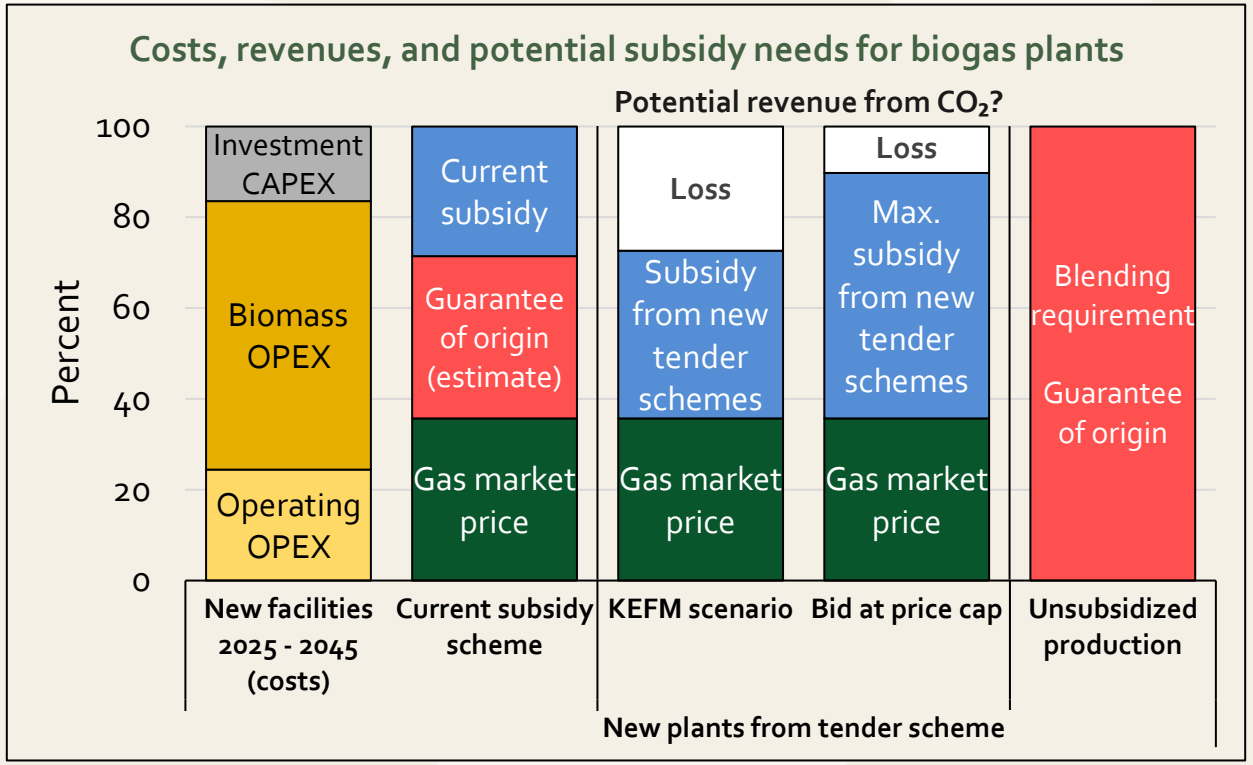
The cost structure of biogas plants differs from that of wind and solar power, where investment costs dominate. For biogas plants, operating costs, particularly the procurement and handling of biomass, account for the largest share.

Larger biogas plants have already achieved significant economies of scale, reducing both investment and operating costs.

It has been decided that support under the tender schemes cannot be combined with the sale of guarantees of origin, which means the economics of the tenders do not add up for biogas producers. This is illustrated in the figure, which clearly shows the imbalance between costs and revenues.

As a result, the expansion of biogas production remains dependent on CO_2 obligations and tax exemptions in other European countries, since Denmark has not created similar market conditions for unsubsidized biogas with guarantees of origin.

This means that Denmark loses shares of renewable energy to the purchasing countries, along with associated revenue.



The figure illustrates the general relationship between production costs [36], market revenues and any subsidy requirements for biogas delivered via the gas grid. The two columns for upcoming tenders show that the sector faces a significant financial gap. Even with full use of the subsidy ceiling, which results in lower production, the tenders remain economically unviable. With a blending requirement based on the sale of guarantees of origin, it would be possible for producers to make unsubsidized biogas production financially viable.

Biogas Danmark

Economy and market

Biogas for heavy transport

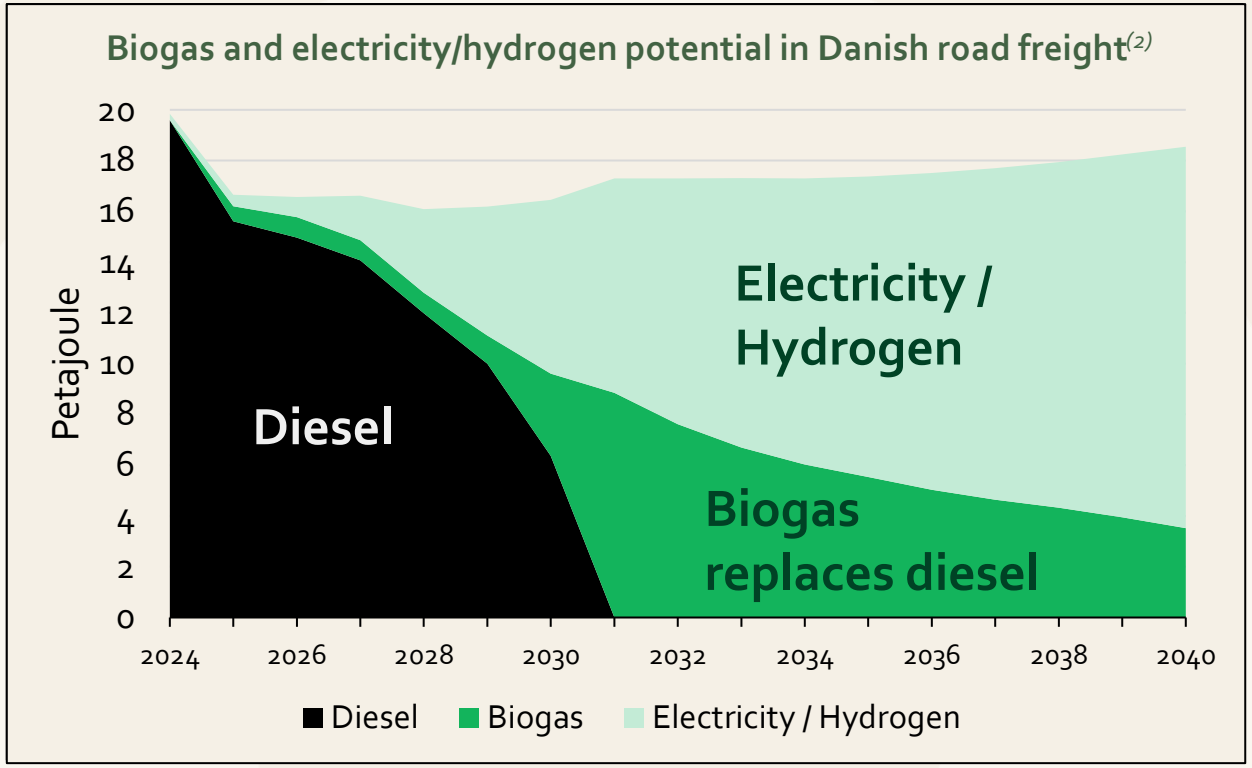
Biogas can accelerate the green transition

Today, road freight transport runs almost exclusively on fossil diesel blended with food-based biodiesel. In the future, the transport sector is expected to become more diverse, with a broader mix of technologies and fuels, including electricity, hydrogen, biogas and other green alternatives.

In recent years, there has been growing interest in converting trucks to biogas in Denmark. Since mid-2022, this biogas has been delivered without public support, as the EU's CO_2 displacement rules do not allow the use of subsidized fuels.

According to Biogas Denmark's Green Policy proposal, Danish biogas plants have the potential to deliver around 3.2 PJ of unsubsidized biogas to the transport sector from 2030. Over time, biogas could fully displace diesel in heavy transport. If the development of electric trucks progresses more slowly than expected, the biogas sector could contribute with more than 10 PJ.

The figure shows the Danish Energy Agency's projection of how electricity and hydrogen are expected to gradually displace diesel in heavy transport, compared to Biogas Denmark's estimate of biogas' potential contribution.



According to KF25, significant amounts of diesel will still be used in heavy road freight transport through to 2040. The figure shows how biogas can enable a much faster transition in Danish freight transport and ensure that diesel is phased out completely after 2030. Since trucks in Denmark typically have a lifespan of six years, and even shorter for those used in shift operations, operators can choose to run on biogas for a few years and then switch to electricity when the technology meets their operational needs.

Biogas Danmark

Economy and market

Climate impact of biofuels under the Renewable Energy Directive

Used in the market to meet CO_2 displacement targets

To provide a consistent framework for assessing the sustainability of fuels in the transport sector, the EU's Renewable Energy Directive includes a comprehensive list of standard values that can be used without additional documentation.

These values cover the full life cycle from cradle to grave. For example, the emissions value for diesel is 94 kg CO_2 per GJ instead of just the fuel's CO_2 content of 74 kg CO_2 per GJ, as upstream emissions are also included. Similarly, biogas produced from manure is assigned a negative value because biogas plants reduce methane emissions from agriculture. (37)

These standard values are particularly important in countries with CO_2 displacement requirements. As the table illustrates, manure-based biogas can displace nearly five times as much CO_2 per GJ as biodiesel.

If an operator exceeds the displacement requirement, they receive a CO_2 ticket that can be sold to others who fall short. This provides strong financial incentives to choose sustainable fuels.

Climate effects according to the RED and the Sustainability Order

RES II Directive [kg CO2eq/GJ]	GHG emissions [Diesel]	GHG emissions [Default value]	GHG emissions [CCS]	Emission savings compared to diesel	Emission savings in percent
Biogas:					
Manure	94	-100	-31	**225**	**239%**
Organic waste	94	14	-31	**111**	**118%**
Maize	94	30	-31	**95**	**101%**
Biogas, 2025	94	-26	-31	**151**	**161%**
Biodiesel:					
Waste oil (HVO)	94	15		**79**	**84%**
Rendered animal fat	94	20		**74**	**79%**
Rapeseed (1.gen.)	94	50		**44**	**47%**
Emmelev (1.gen.)	94	20		**74**	**79%**

The table shows selected standard values for climate impact and reductions that are approved in the Renewable Energy Directive for calculating CO_2 displacement in the transport sector.(37) It is also possible to use individual values, provided they are certified in accordance with the directive's requirements. The climate impact of CCS is estimated by Biogas Denmark and includes energy use for transport and storage, which is assumed to be around 7 kg CO_2e per GJ.

Biogas Danmark

Economy and market

Export of guarantees of origin

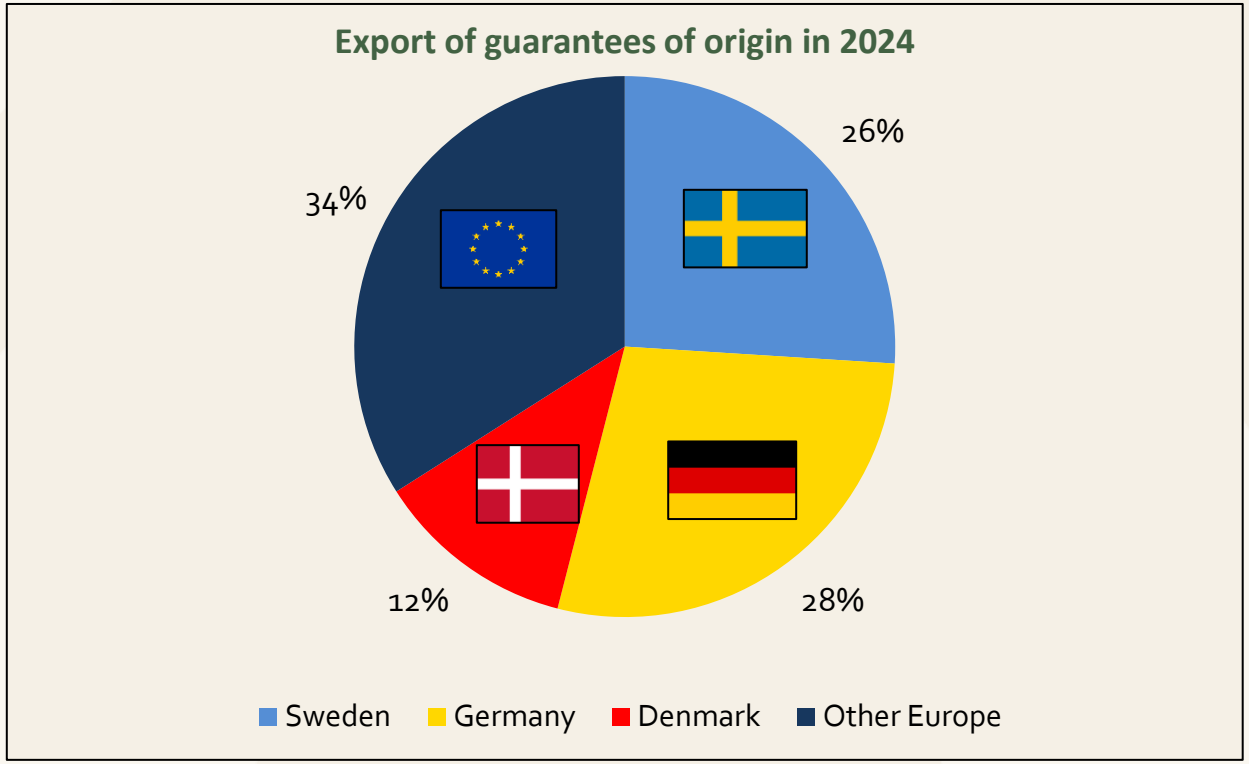
Over 85 percent of biogas exported in 2024

For several years, the majority of Danish guarantees of origin for biogas delivered to the gas grid have been purchased by foreign companies, particularly in Sweden and Germany. A 2024 overview shows that 88 percent of the biogas was sold to foreign buyers. (38)

The main reason for the high export of Danish guarantees of origin is that tax authorities in Sweden and Germany have accepted EU guarantees of origin as the basis for CO_2 tax refunds.

Since Denmark has not had a scheme for refunding either CO_2 or energy taxes, Danish companies have lacked a financial incentive to buy biogas via the gas grid instead of fossil natural gas.

Biogas Denmark's Green Policy proposal includes the establishment of improved market conditions and tax incentives in Denmark for the purchase of unsubsidized biogas documented with guarantees of origin. This would increase domestic demand for biogas, support the production of unsubsidized biogas, and ensure that a larger share of the EU-mandated renewable energy share benefits Danish gas customers.



The figure shows the distribution of guarantees of origin from Danish biogas production by buyer country in 2024 (38)

The climate effect remains in Denmark – renewable shares are exported

The climate effect remains in Denmark – but renewable shares are exported Guarantees of origin give foreign companies access to tax refunds and the ability to market themselves with green energy use. Although the guarantees are exported, the climate benefit from biogas production still counts in the Danish national climate accounts. However, the upcoming implementation of the Renewable Energy Directive III means that the renewable share will follow the export of guarantees of origin. For biogas, this will remove around 10 percentage points from Denmark's current renewable share obligation of approximately 60 percent (39).

Biogas Danmark

Biogas in the EU

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62: Large gap between EU targets and national ambitions for biogas

Biogas Danmark

Biogas in the EU

Biogas potential in the EU

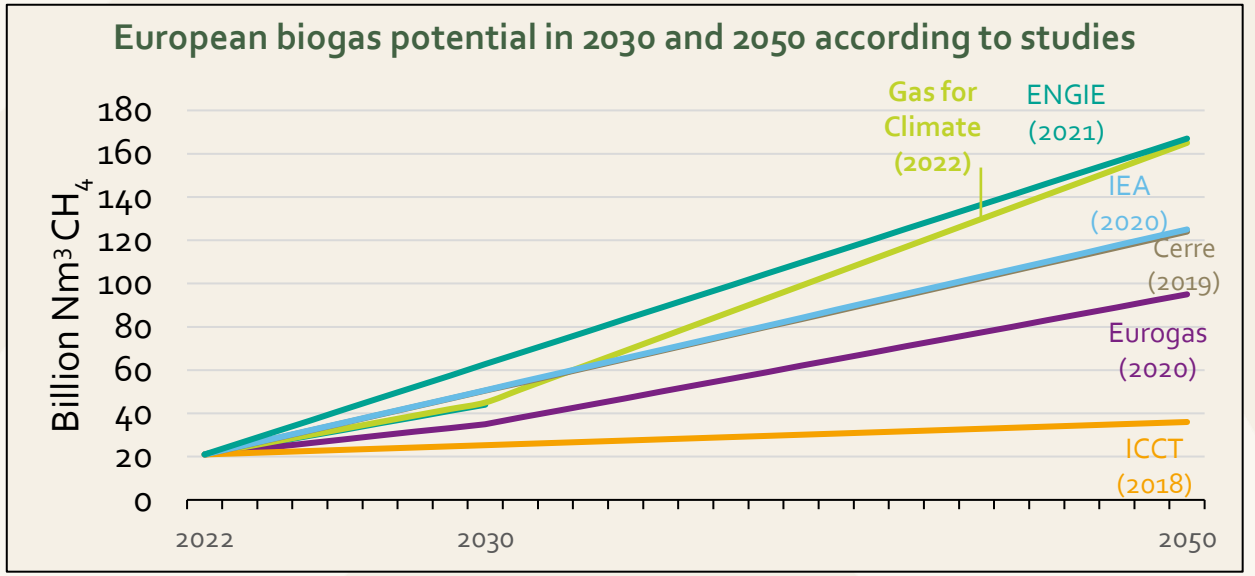
Denmark as a frontrunner in the EU

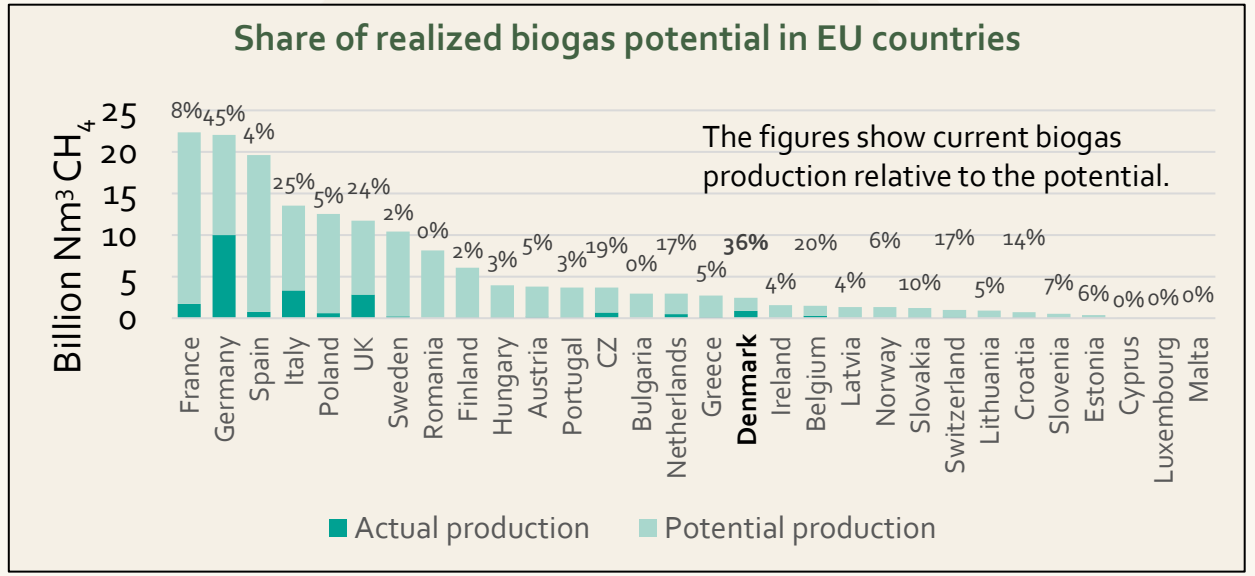
The production potential for upgraded biogas in the EU countries, as well as Norway, Switzerland and the United Kingdom, is estimated to range from 95 to 167 billion cubic meters by 2050. (11) This means that upgraded biogas in the European gas grids could potentially cover up to 85 percent of expected gas demand in 2050.

At the national level, France, Germany, Spain and Italy have the highest production potentials for upgraded biogas. At the same time, several countries, including Germany, Denmark and the United Kingdom, have already utilized a significant share of their biogas potential.

In the Danish debate, it is often pointed out that Europe's demand for gas is so high that Denmark should export its biogas to the European market. However, Danish production remains small in a European context. Denmark's most important contribution is therefore to demonstrate how high biogas production and capture of biogenic CO_2 can strengthen energy security, reduce the climate footprint and support a circular economy through nutrient recycling.

Data in the figure is from the European Biogas Association, EBA Statistical Report 2023(40)





Data in the figure is from the European Biogas Association, EBA Statistical Report 2024 (11)

Biogas Danmark

Biogas in the EU

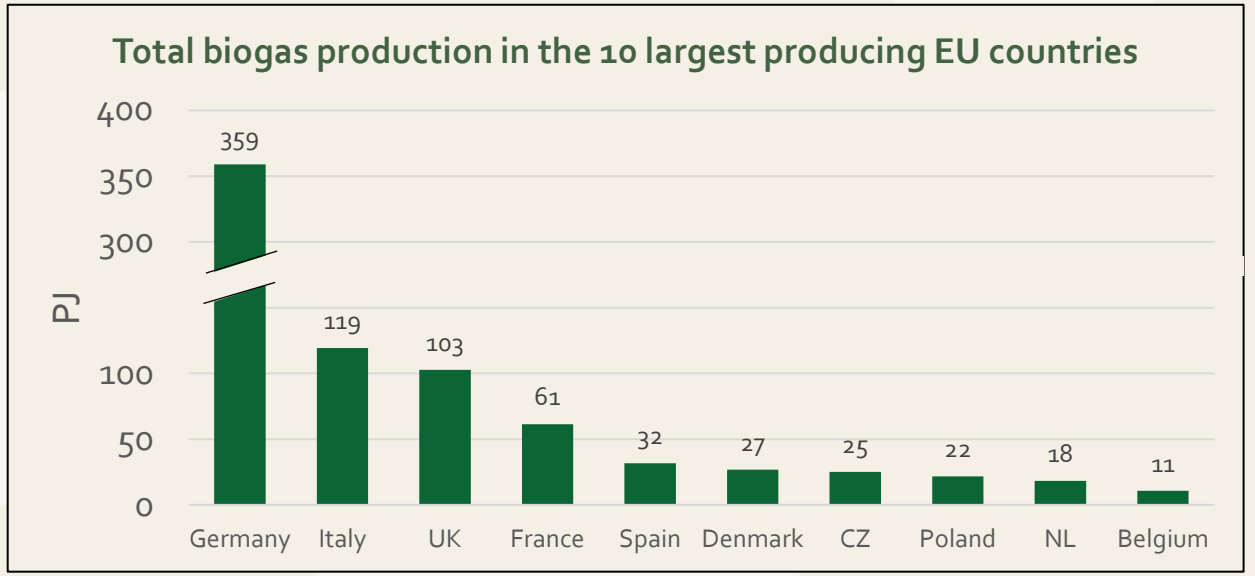
Biogas production in EU countries

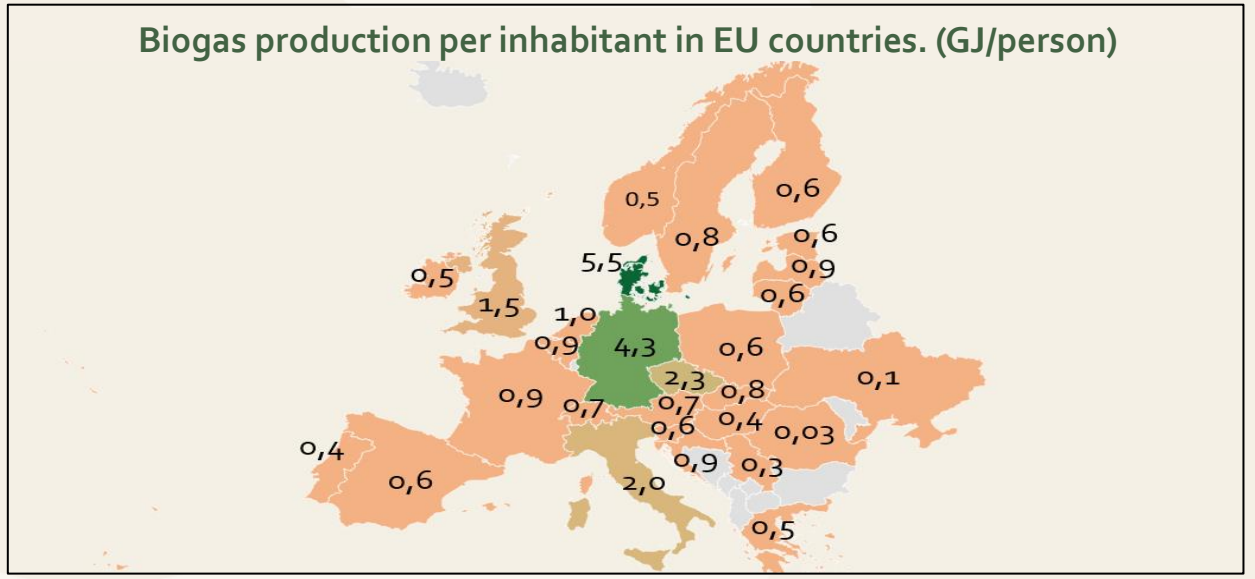
High biogas production in Denmark attracts interest across Europe

In 2023, the total production of biogas and upgraded biogas in the EU reached 234 TWh, equivalent to 22 billion cubic meters. This exceeds the combined domestic gas consumption of Belgium, Denmark and Ireland, and covered 7 percent of the EU's total gas demand that year. (11)

Despite its small geographical size, Denmark has achieved one of the highest per capita biogas production levels in the world. Only Germany comes close, but Denmark still produces 28 percent more per capita, as shown in the figure at the bottom right. Compared to most other countries, Denmark produces three to five times more biogas per capita, making Danish biogas production and technology internationally sought after.

This high production level and technological leadership attract significant international attention, reflected in the many foreign delegations that visit Danish biogas plants to gain knowledge and inspiration.





Data in the figures is from the European Biogas Association, EBA Statistical Report 2024(11)

Biogas Danmark

Biogas in the EU

Production of upgraded biogas in the EU

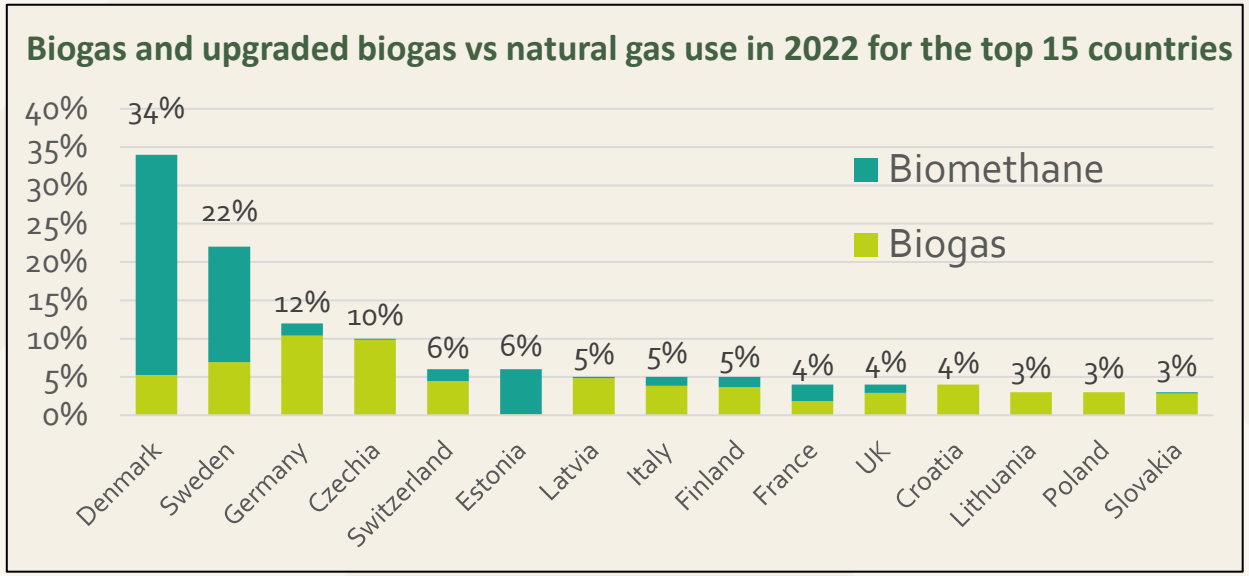
European countries are catching up with Denmark

At the European level, Denmark is the fourth-largest producer of upgraded biogas, surpassed only by Germany, France and the United Kingdom.

In 2023, several European countries experienced significant growth in the production of upgraded biogas, particularly France (3,392 GWh), Denmark (926 GWh), the United Kingdom (634 GWh) and the Netherlands (511 GWh).

The figure below shows the countries with the highest production of upgraded biogas. In 2022, Germany produced approximately 6,000 GWh more than France, but the gap has now narrowed to 4,000 GWh.

In 2024, upgraded biogas injected into the gas grid accounted for about 38 percent of Denmark's gas consumption. Including biogas that displaced fossil gas outside the grid, the share reached approximately 45 percent.



Data in the figures is from the European Biogas Association, EBA Statistical Report 2024[11]

Biogas Danmark

Biogas in the EU

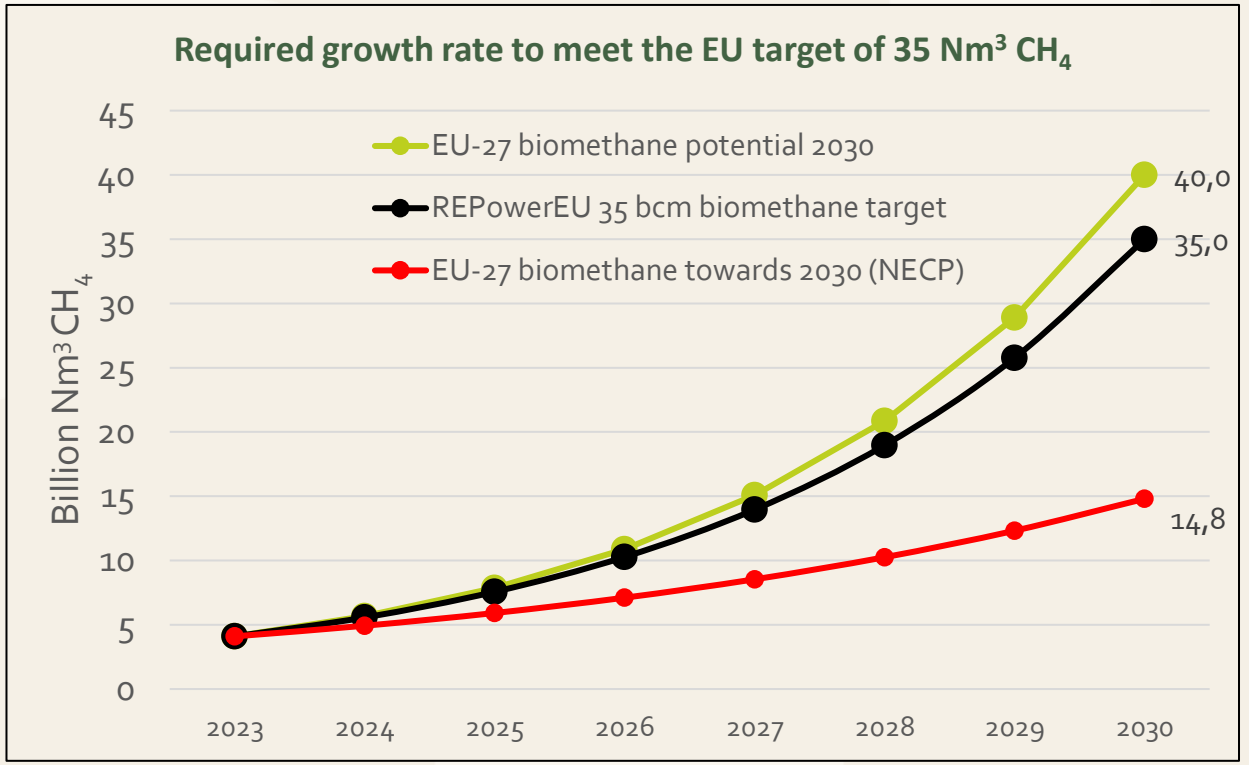
Large gap between EU targets and national ambitions for biogas

European biogas production must grow faster to meet the EU target

As part of the effort to secure greener and more independent energy production in Europe, the EU has set an ambitious target to increase the production of upgraded biogas (biomethane) to 35 billion cubic meters annually by 2030. In May 2025, the European Commission presented a plan that includes a ban on the purchase of Russian energy, along with initiatives to support the EU biomethane target.

Achieving this target requires an annual growth rate of approximately 36 percent in the capacity for upgraded biogas production. By comparison, the targets set in the national energy and climate plans (NECPs) only require a growth rate of 20 percent. This reveals a significant gap between the EU's objective and the national ambitions.

There is therefore a need to highlight that national efforts must accelerate significantly if the REPowerEU target is to be achieved. This also means that Europe may increasingly become an attractive market for Danish biogas solutions, as Denmark currently holds a lead over many other European countries.



The graph shows the required growth rate to meet the EU target of 35 billion cubic meters of biomethane by 2030. It compares the national energy and climate plans (NECPs) at 20 percent with the REPowerEU target, which requires a significantly higher growth rate of 35.8 percent. Data source: European Biogas Association, EBA Statistical Report 2024 [11]

Biogas Danmark

Methodology

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65: Key figures and standard values

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Biogas Danmark

Methodology

Data basis and assumptions

Biogas Outlook 2025 is based on the Climate Status and Projection 2025 (KF25) for biogas production and gas consumption [1]. In KF25, the Danish Energy Agency outlines the development of manure volumes [1] sent to biogas plants but provides no further details on which biomass types are expected to be used. Therefore, Biogas Danmark has assumed the biomass distribution based on the annual biomass reports submitted to the Danish Energy Agency [5] and the biomass potential assessment from the University of Southern Denmark [13]. KF23 includes an expected distribution of cattle and pig manure [1].

KF25 also does not provide a detailed forecast of the implementation of frequent manure removal from livestock housing to biogas plants. For the period up to 2045, Biogas Danmark has made its own assumptions, based on data from Aarhus University on frequent manure removal. [10]

It is further assumed that methane losses will decrease from the measured level of about 2 percent to 1 percent from 2024, based on the Climate Agreement on green electricity and heating from June 2022[21], which decided to introduce methane loss regulation as of 1 January 2023.

While the Energy Agency scenario follows the biogas projection in KF25, the Frozen Policy scenario is based on Biogas Danmark's assessment of the implications of the existing policy framework for biogas production.

The Green Policy scenario illustrates how biogas production could develop if the recommended measures are implemented, including tax exemption for certified biogas, blending requirements for heating, and compensation for biogas-powered trucks. Based on this, Biogas Danmark has prepared assumptions for biomass distribution at higher levels of biogas production.

This results in both higher production and greater methane reductions in agriculture.

Reductions in nitrogen leaching are calculated based on research from Aarhus University [30]. Phosphorus recycling is based on standard values from Seges. [28]

Market value of biogas is calculated using data from Energinet[33], EEX Gas Market Data [35] and the Danish Energy Agency [34].

Calculations for CO_2 storage and Power-to-X are primarily based on the Danish Energy Agency's technology catalogues [20] CO_2 content is calculated based on the distribution of CO_2 and methane in biogas.

Methodology

Key figures and standard values

The tables on this page show the key values for gas yield from different biomass types [1, 41] as well as the values used for energy content, density, climate effects, methane losses, projected implementation of frequent manure removal, and more.

Biomass	Dry matter [%]	Volatile soil VS [%]	Gas yield Nm^3 CH_4/ kg VS	Gas yield Nm^3 CH_4/ tonne biomass
Cattle manure	8	6	0,25	15
Pig manure	5	4	0,35	15
Deep litter	30	24	0,27	65
Energy crops	31	29	0,33	96
Crop residues	30	29	0,32	92
Straw	84	80	0,29	228
Industrial waste	22	20	0,45	90
SSO	23	20	0,43	84

Overview of Parameters		
Calorific value and density		
Methane, lower calorific value	35,9	MJ/Nm^3
Natural gas, lower calorific value	39,6	MJ/Nm^3
Density, methane	0,72	MJ/Nm^3
Density, carbon dioxide	1,98	MJ/Nm^3
CO_2e emissions		
CO_2 emission, natural gas	57,1	kg CO_2/GJ
CO_2 emission, diesel	74,1	kg CO_2/GJ
CO_2 emission, diesel RED II	94,1	kg CO_2/GJ
CO_2 emission, electricity production	Energinet projection	
Own consumption		
Pretreatment and biogas production	26 - 36	kWh/ton biomass
Upgrading	0,1 - 0,6	kWh/Nm_3 CH_4
CO_2 transport of biomass	1.080	tons CO_2 / PJ biogas
Upstream emission, natural gas	7.000 → 3.000	tons CO_2 / PJ biogas
Fugitive methane emission	2,1 → 1	%
Projection of frequent discharge	7 9	%, new stables %, old stables
PtX		
CH_4/CO_2 ration in biogas	60 / 40	%
PtX, elektromethane	35	%, Efficiency
PtX, methanol	48	%, Efficiency

Biogas Danmark

References

Note nr.	Reference/Link
1	Climate status and projection, 2025
2	Security of energy supply 2024
3	Danish Council on Climate Change
4	Aalborg University, Climate projections 2045
5	Biomass reporting
6	Expert committee on cascade utilization
7	Manevski et al. 2017
8	Manevski et al. 2018
9	Agreement on implementing a Green Denmark
10	Measures to reduce agricultural greenhouse gas emissions
11	EBA Statistical Report 2024
12	Biomethane Industrial Partnership (EU)
13	Energy crop analysis - Biogas potential
14	Energinet, Assumption basis, 2024
15	Digestate helps preserve soil carbon
16	Biogas Data Online - Biogas Danmark
17	Electricity production by type
18	Energi Data Service | Datasets | Elspot Prices
19	Energi Data Service | Datasets | Production and Consumption
20	Technology catalogue for renewable fuels
21	Targeted efforts to reduce methane loss from Danish biogas plants
22	Climate agreement on green electricity and heating 2022
23	Transition to heavy transport
24	Agreement on a continued greener Denmark – regeringen.dk
25	Agreement on green transition of Danish agriculture
26	Carbon Footprint of Danish straw pyrolysis and straw biogas
27	Knowledge synthesis of biochar in Danish agriculture
28	Phosphorus regulation
29	Phosphorus in Danish agriculture
30	Climate and environmental effects and nitrogen leaching
31	Seges Innovation, notes
32	Aarhus University on protein
33	Energi Data Service | Datasets | Commercial Gas Amounts
34	Danish Energy Agency, subsidy rates 2025
35	Spot market natural gas
36	Production prices and consumption
37	Renewable Energy Directive, 2018
38	Certificates in figures
39	National Energy and Climate Plan for the EU
40	EBA Statistical Report 2023 | European Biogas Association
41	Article on gas yield from biomass

Biogas Danmark

Biogas Outlook 2025

Produced and published by Biogas Denmark, June 2025.

Cover photo: Grøngas Hjørring, Denmark's first "energy on land" project integrating biogas, electricity from wind and Power-to-X fuel production. Photo: Grøngas Hjørring.

Biogas Outlook 2025 is available at https://www.biogas.dk/biogas-outlook-2025

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Subject to errors and omissions

Biogas Danmark

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Fremtiden er cirkulær