Energistyrelsen

Biogas in Denmark

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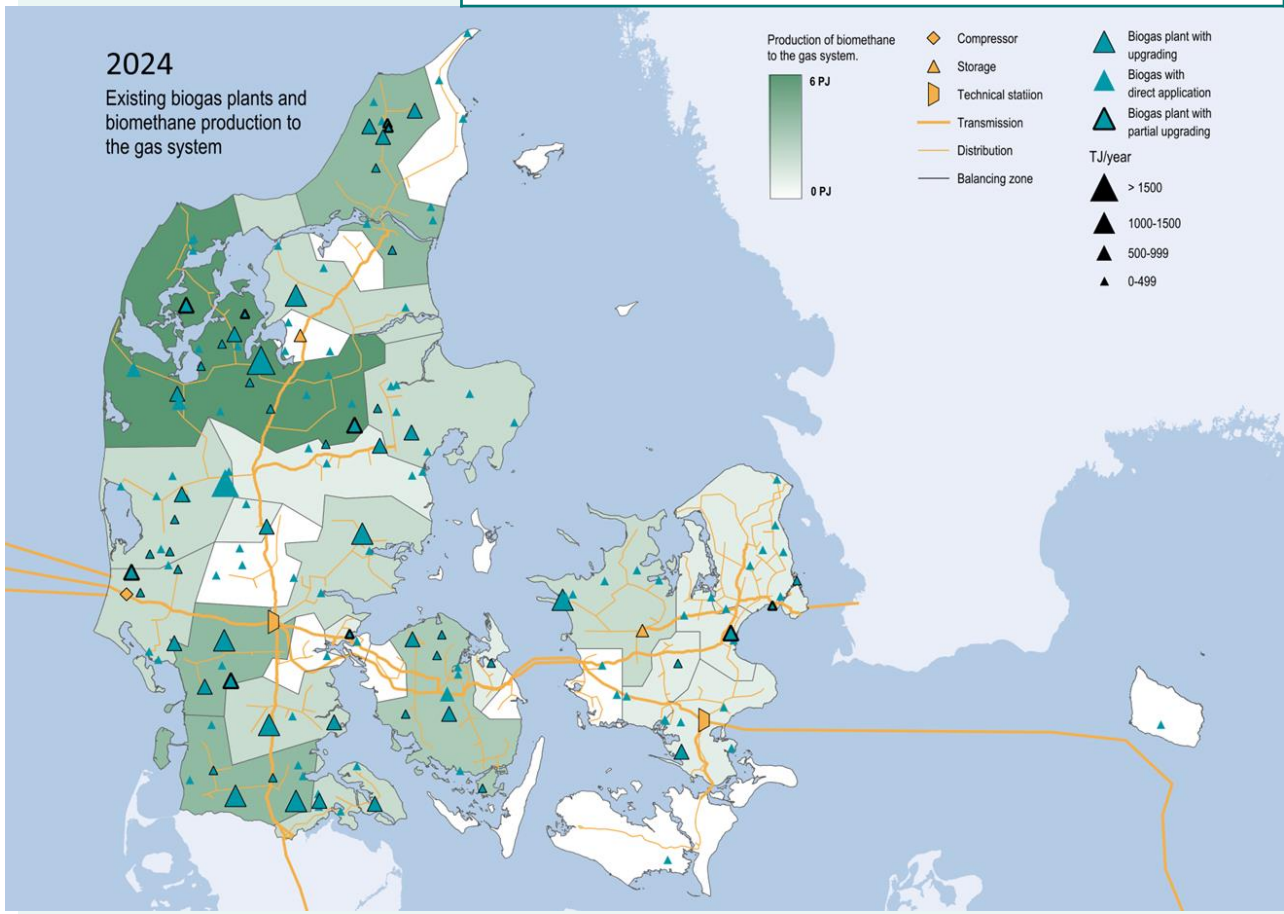
Danish gas system is changing

Danish gas system constructed in 1982-84 supplying gas from the gas fields in the North Sea to most parts of Denmark

From black to green:
Fossil natural gas is being replaced by renewable biogas, e-methane and hydrogen

From many to few:
Many small household consumers change heating sources leaving fewer industrial consumers back

Facts 2025	
Biogas units	150
Upgrading units	60
Biogas production	32,8 PJ
Biomethane	26,8 PJ



Biogas – chain of production

Biomass

Manure and deep litter

Fodder production

Livestock

Industry

Sewage sludge

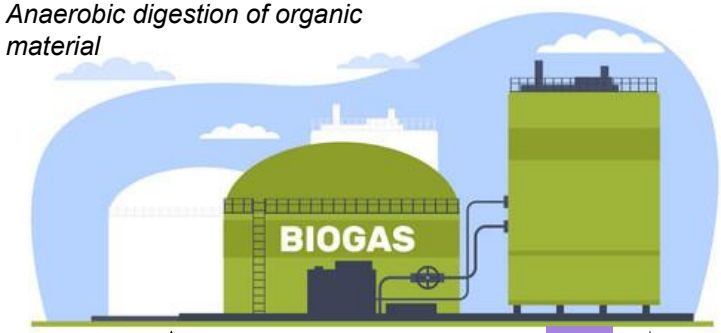
Food waste

Crop biomass

Transport of raw biomass

Biogas production

Anaerobic digestion of organic material



Input

Pre-treatment of biomass

Mechanical
Breaking down the biomass mechanically increases the surface area and makes the substrate more accessible to the microorganisms in the biogas reactor.

Thermal
Heating the biomass to a specific temperature for a period of time can increase the biodegradability of the material.

Chemical
Adding certain acids or bases will dissolve the surface of the biomass and increase the microbiological turnover

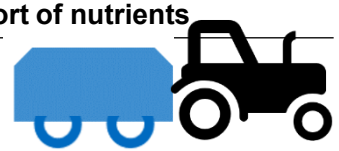
Output

Biogas

Degassed biomass is stored in tanks

Byproducts: Production of heat and recyclable high quality natural fertilizer

Transport of nutrients



Torch

Removal of carbon

Membrane
The biogas is compressed and pushed through a membrane which separates CH_4 and CO_2.

Amine scrubbing
The CO_2 in the biogas is absorbed in amine liquid in an absorber column and thus separated.

Water scrubbing
The biogas is compressed and lead through a scrubber where water absorbs the CO_2.

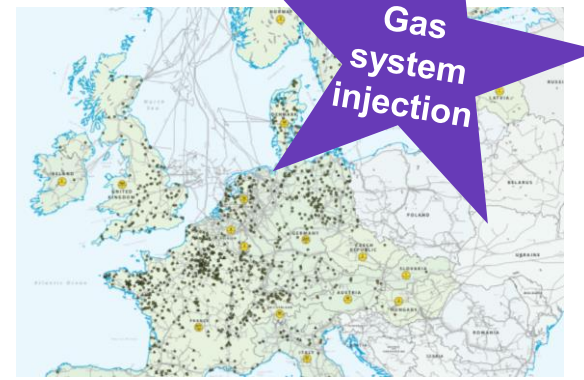
Cleansing of hydrogen sulphide

Coal filter
The biogas is lead through active coal which absorbs the hydrogen sulphide and is then discarded.

Biological filter
The biogas is led in countercurrent with water through a scrubber with bacterial material. The bacteria convert the hydrogen sulphide into free sulphur, which is further converted into sulfuric acid. The sulfuric acid is carried away with the water and excreted.

Quality control and odorization

Upgrading biogas to biomethane

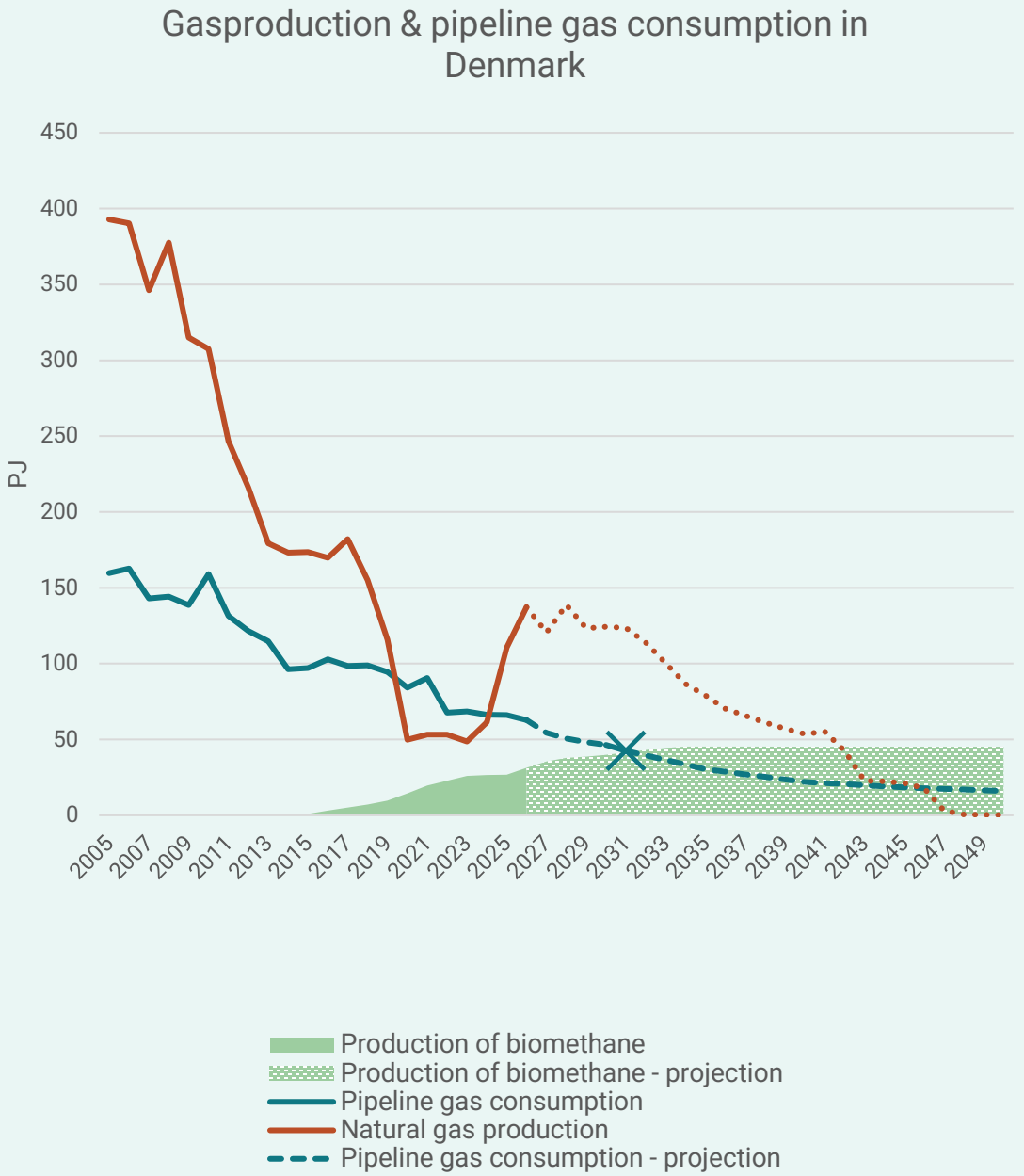


Development in consumption and production

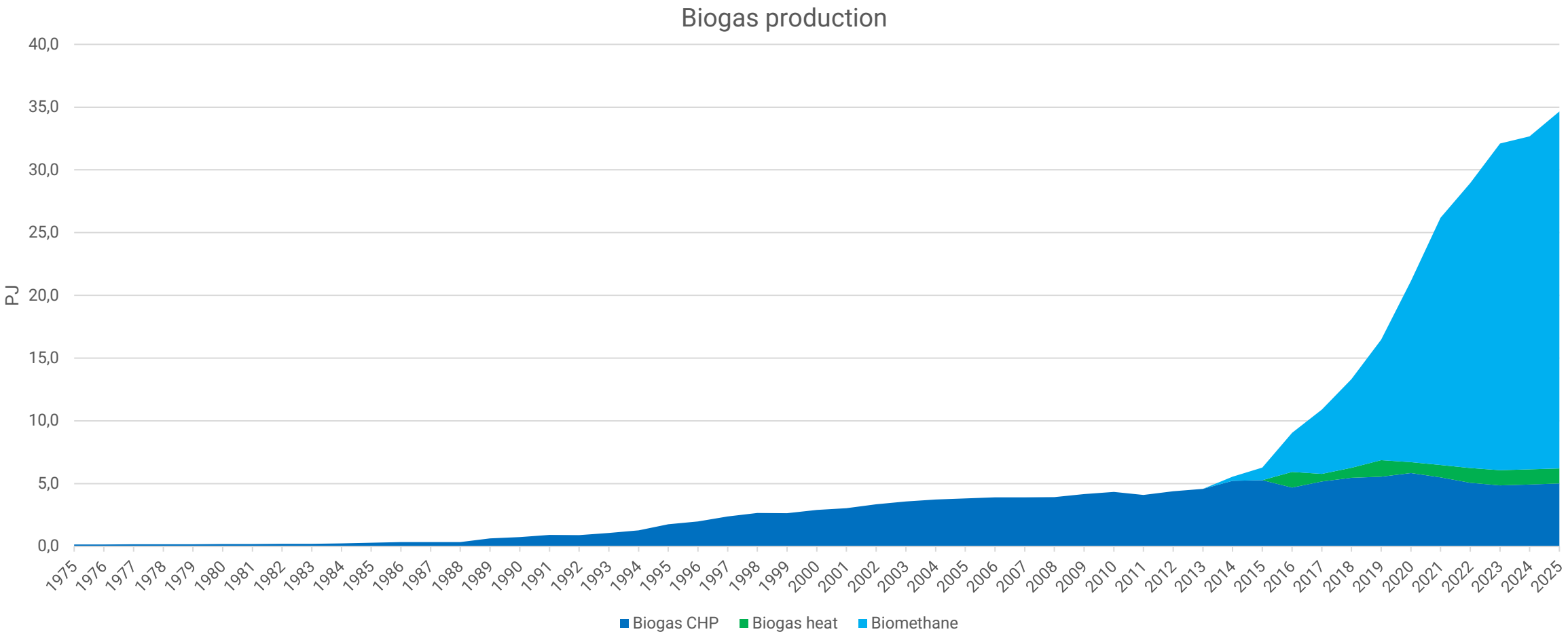
- Reduction in Danish gas consumption:
  - 2010-15 → change in electricity production
  - 2021-25 → change in heating of households

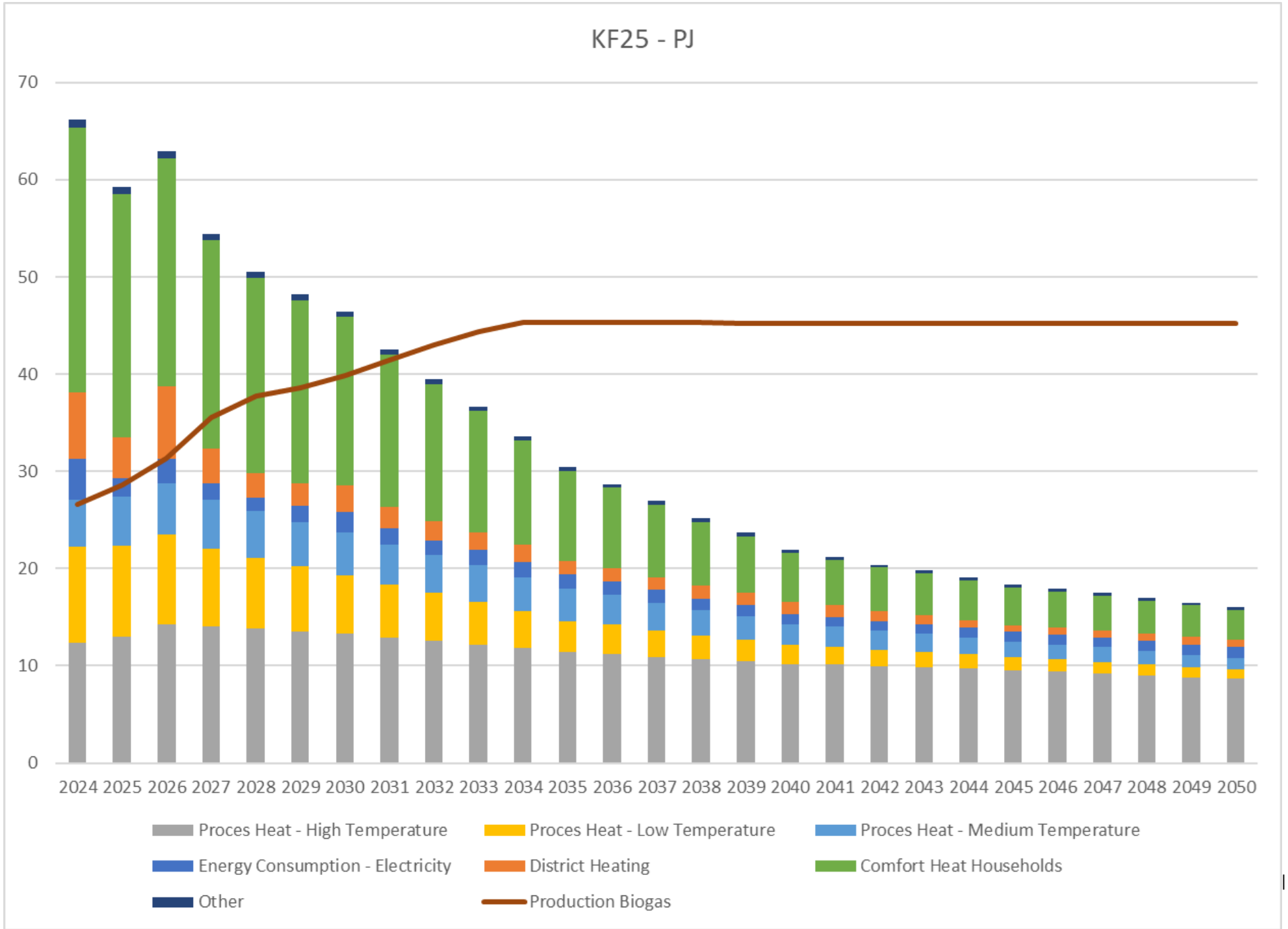
Increase in biomethane production specifically 2015-22

- → 40 pct. green gas in the net Danish consumption
- Ambition of 100 pct. green gas



Biogas 1975-2025




KF25 - PJ
70
60
50
40
30
20
10
0
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050
Proces Heat - High Temperature
Proces Heat - Low Temperature
Proces Heat - Medium Temperature
Energy Consumption - Electricity
District Heating
Comfort Heat Households
Other
Production Biogas

Feedstocks 2024 (Draft)

	Tonnes	%	Gas yield (Nm3 CH4/ton)	Production (mio. Nm^3 CH_4)	Production (%)
Manure	12.627.754	66%	13,3	167,9	21%
Sludge	2.241.813	12%	60,0	134,5	17%
Straw	369.415	2%	210,2	77,6	10%
Energy Crops	695.510	4%	99,1	68,9	8%
House holds organic Waste	585.647	3%	74,4	43,6	5%
Industry waste	2.045.895	11%	91,3	186,7	23%
Glycerine	302.488	2%	352,8	106,7	13%
Other waste	307.496	2%	92,3	28,4	3%
Total	19.176.018	100%		814,4	100%
PJ				**32,2**	

Sustainability Regulation

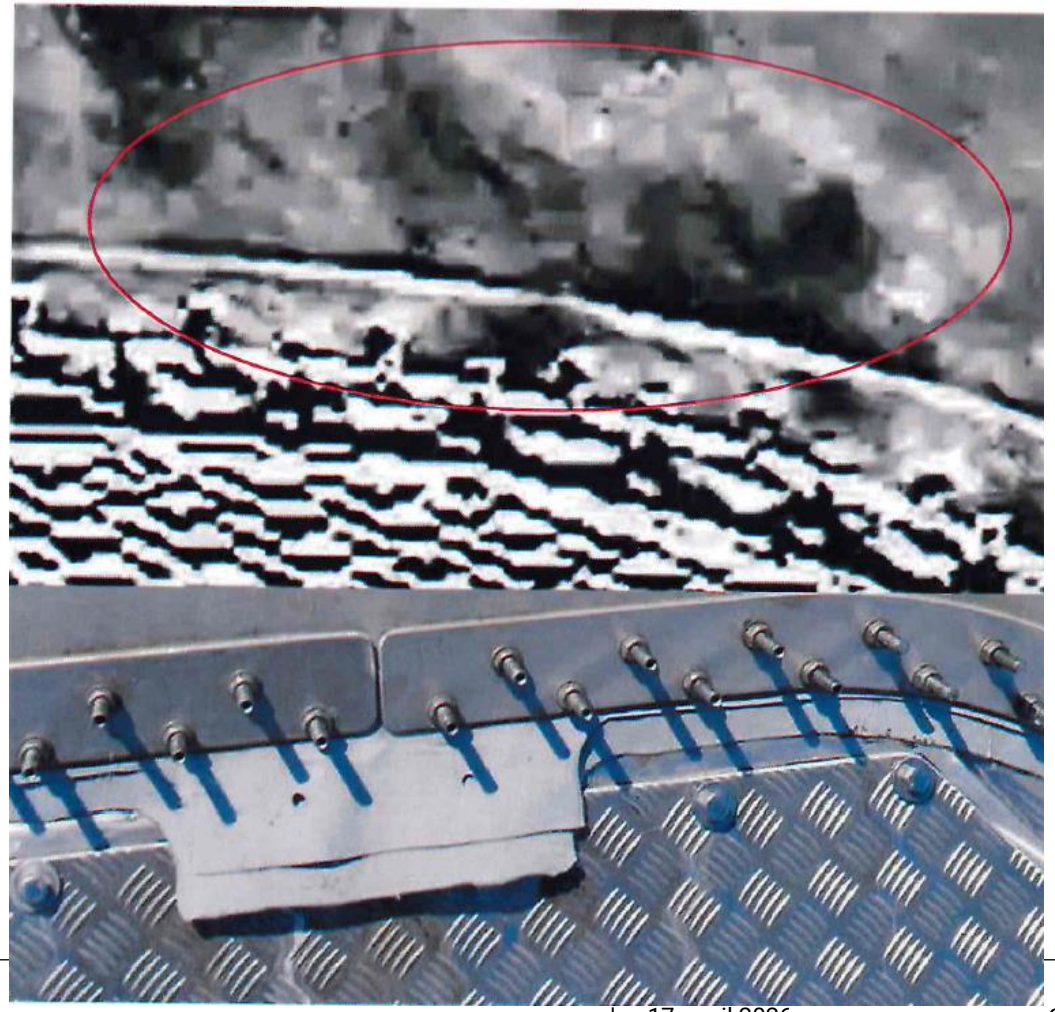
Energy crop-regulation

- Starting 2015 12 %
- Current limit 4 %,
- Ban on use of maize from 2025
- Challenges:
  - Alternatives to maize?
  - Catch crops?

Methane loss

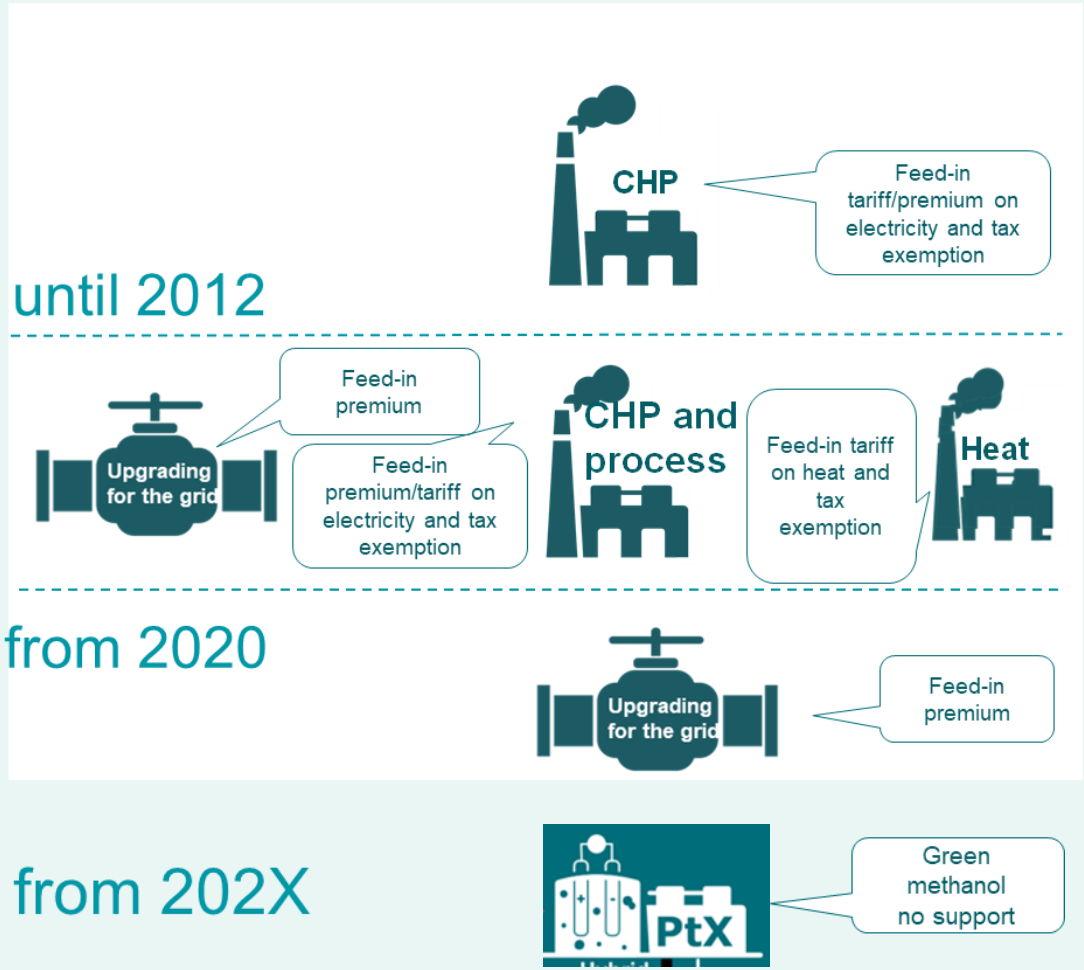
- Report from 2021 – 2.5 pct.
- Most recent report 2025 – 2.8 pct.
- New regulation (implemented 2023):
  - Sources of leak must be identified and improved
  - Annual examination of the plant from 3rd party
  - Point source loss from upgrading plant max 1 pct.
- Moving forward – what now?

Methane loss regulation
Flir-Camera



Support schemes – expanding first – then downgrading

- Support schemes (lasting 20 years)
  - Until 2012: support for CHP using biogas
  - 2012-2019: support in 20 years for upgraded biogas (biomethane) and direct applications (about 2 billion DKK in support pr. year)
  - Planned from 2020: Tenders for biomethane (12,96 billion DKK ≈ 1,7 billion Euro) over 20 years for biomethane – but not implemented
  - From 2026: Incentives in relation to consumption – to be decided



Incentive schemes

Production support

- Taxpayers pay
- Long support period
- High investor certainty
- Necessity to start a new biogas sector
- Safety net for investors
- Best in an immature biogas sector
- CO2-effect in production country (IPCC)

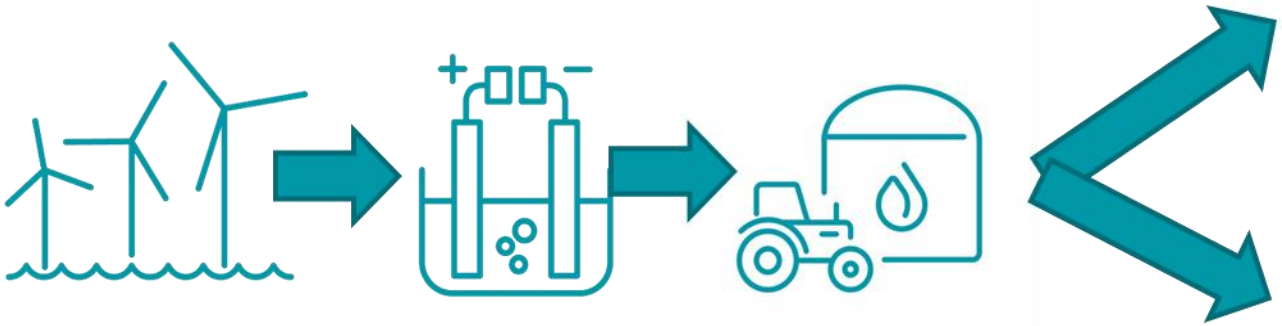
Blending obligation

- Consumers pay
- Tax exemptions
- Short contracts
- Low investor certainty
- Large flexibility at improved market conditions
- Best in a mature biogas sector
- RE-Share in country of consumption (REDIII)

PtX – the next chapter

E-methane (Sabatier)

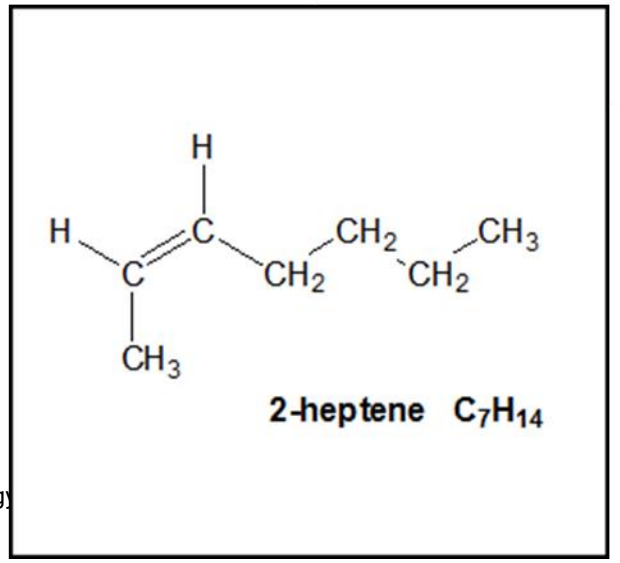
$4H_2 + CO_2 \rightarrow CH_4 + 2H_2O$

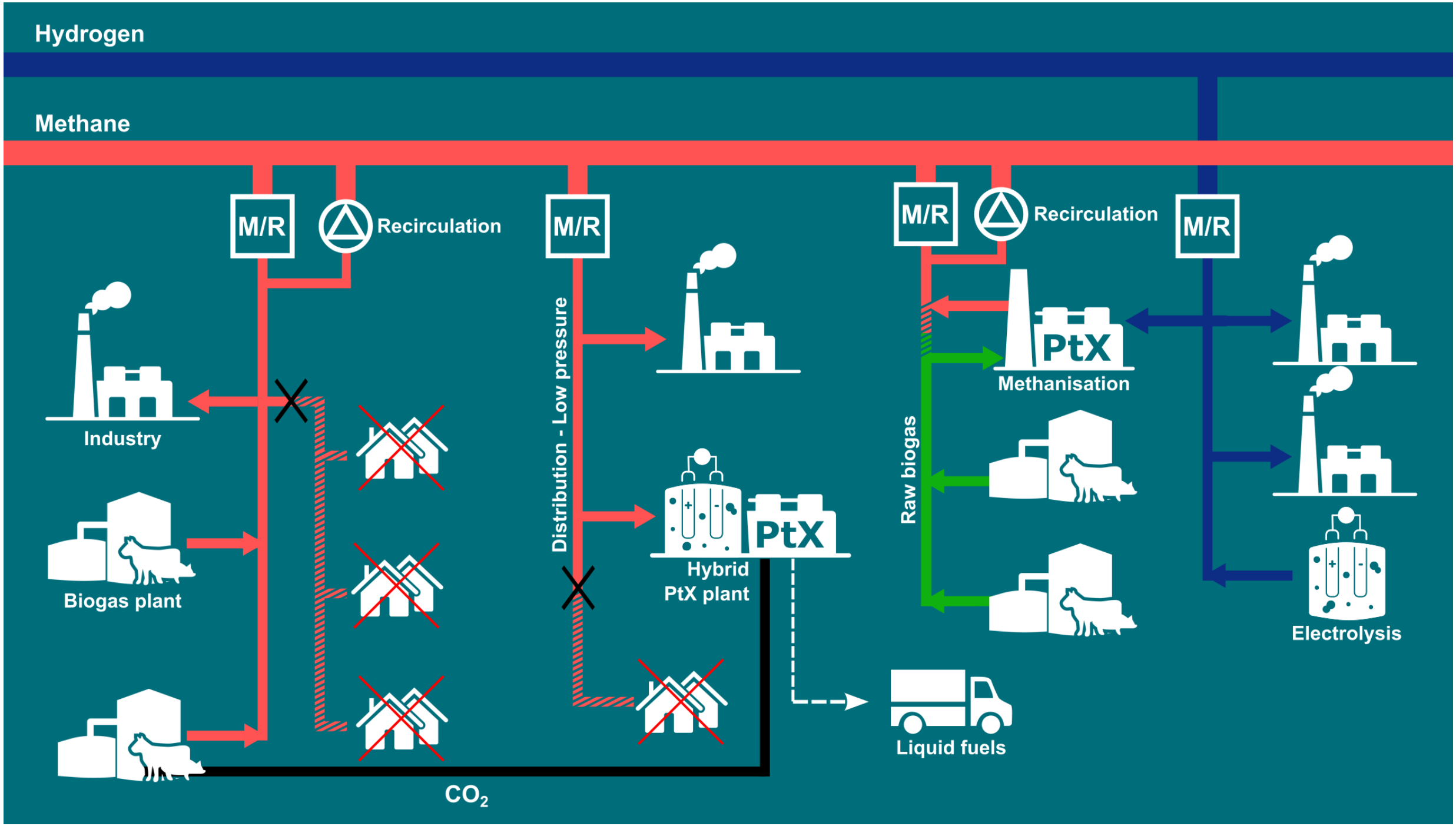


Methanol (Catalytic)

$2H_2 + CO_2 + CH_4 \rightarrow 2CH_3OH$

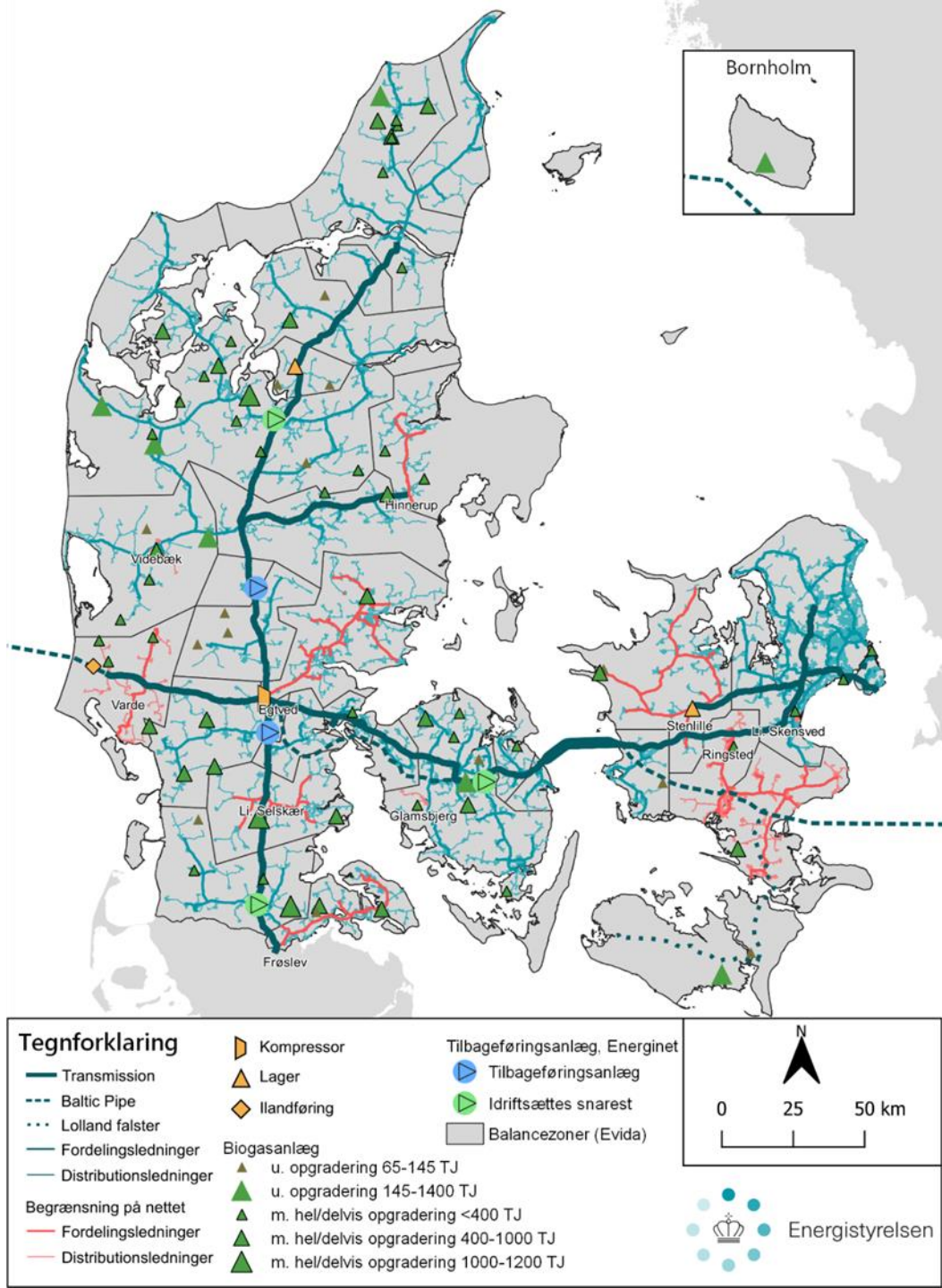
Fischer-Tropsch



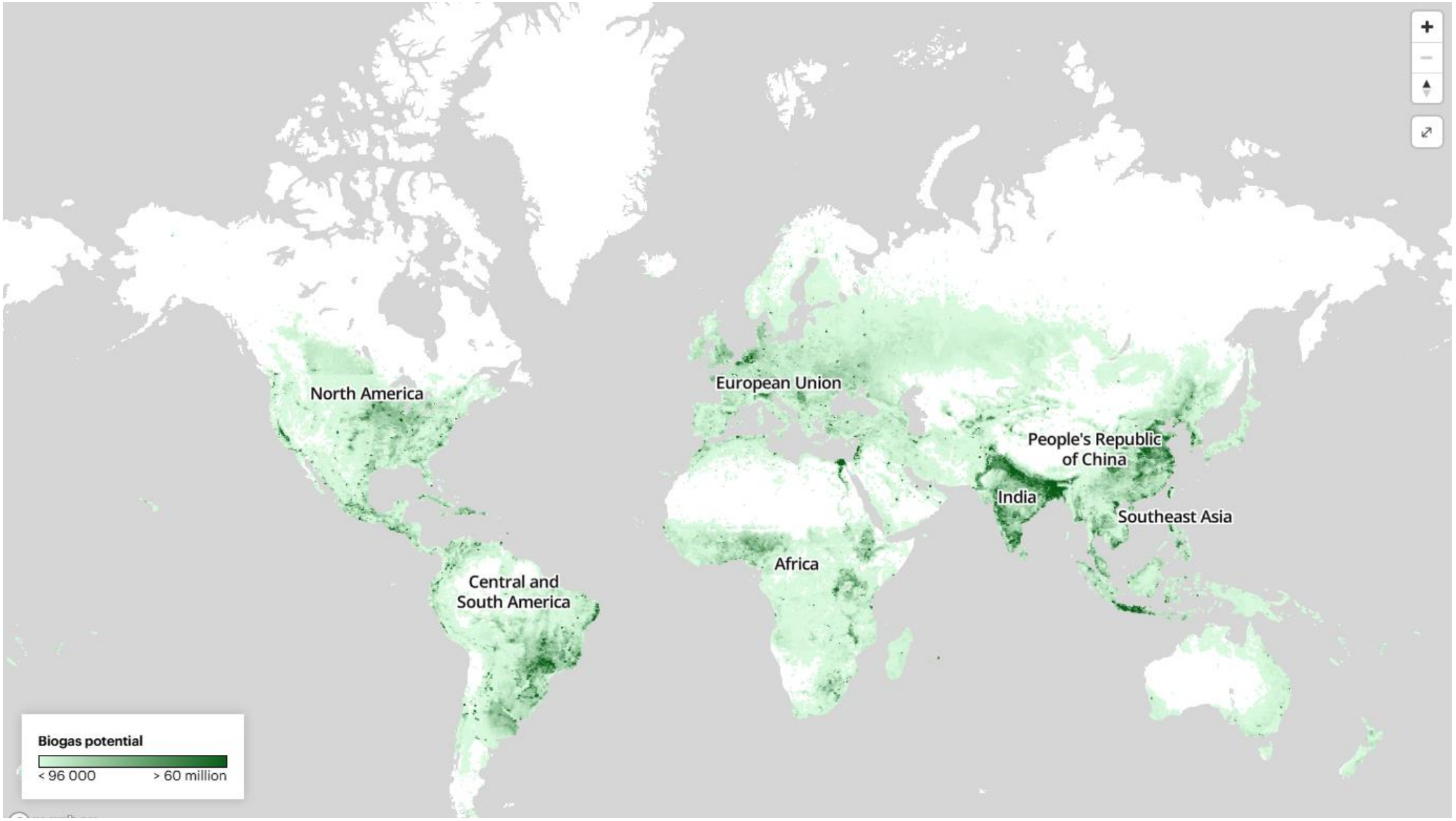

Hydrogen
Methane
M/R
Recirculation
M/R
M/R
Recirculation
M/R
Industry
Biogas plant
Distribution - Low pressure
PtX
Hybrid
PtX plant
PtX
Methanisation
Raw biogas
Electrolysis
Liquid fuels
CO_2

Challenges and options

- Adjusting the system to new flow patterns with decentral renewable energy gas production
- Modify the system for new gasses to transport (hydrogen, CO_2; raw biogas)
- Modify the support scheme
- Blending obligations /Tax exemptions
- Strengthen sustainability
- Security of supply/Storage
- PtX/e-methane/methanol



Potential for Global Biogas Production



Q/A

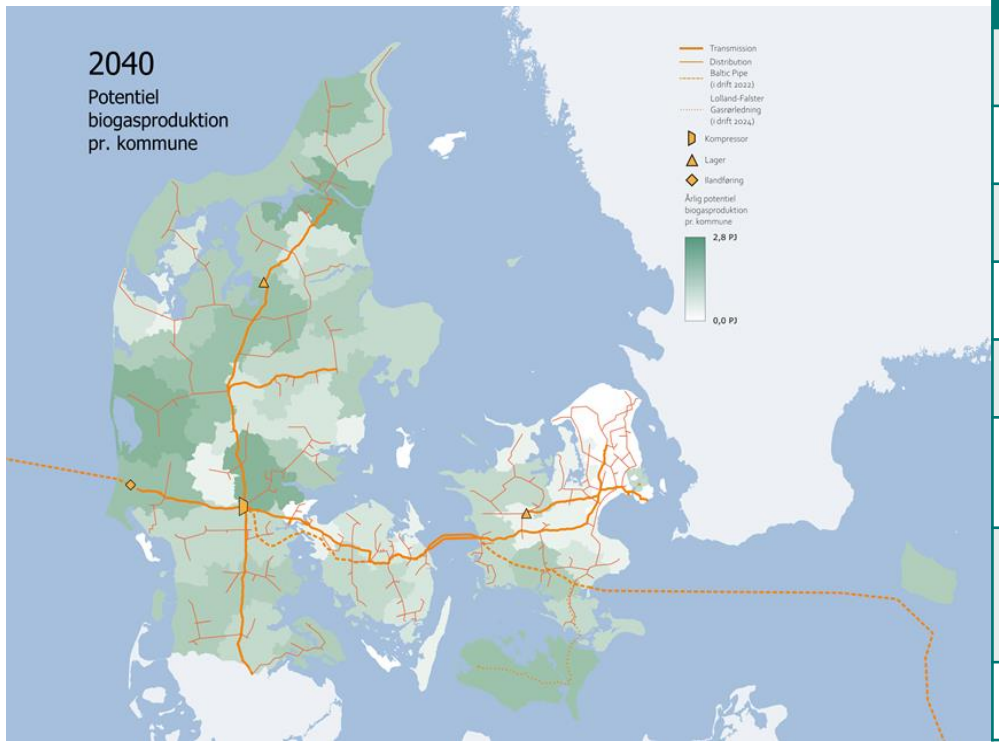
Extras

Blending obligations (partly from Veyt)

	France	Germany	Austria	Portugal	Netherlands
Gas type	Biomethane	Biomethane and Hydrogen	All renewable and recycled gases	Renewable hydrogen and biomethane	Renewable gases
Certification	Biomethane Production Certificates (BPCs)	TBD	GOs + green gas seal	GOs	GOs + Green Gas Units (GGEs)
Unit	TWh	TWH	TWh	TWh	GHG reduction
Timeline	From 2026 onwards	2029	From 2024 onwards	From 2023 onwards	From 2026 onwards
Status	Draft	Political negotiations	Fail	In force	Political negotiations
Qualified production	Domestic only		Domestic only	EU production	Domestic only
Buy-out price	100 EUR/MWh	TBD	2024: 180 EUR/MWh 2027: 200 EUR/MWh	max. 62 EUR/MWh	500 EUR/MWh
Targets	2026: 0.63% 2027: 2.91% 2028: 6.59%	2029: 1% Households 10 % New installations	2024: 0.7% 2025: 1.05% 2026: 1.75% 2027: 2.8% 2028: 4.2%	2025: 1% of in end-user portfolio 150 GWh/year	2026: 0.15 bcm 2030: 1.6 bcm/2.9 Mton chain emission reduction

https://www.veyt.com/articles/review-of-blending-obligations-across-europe

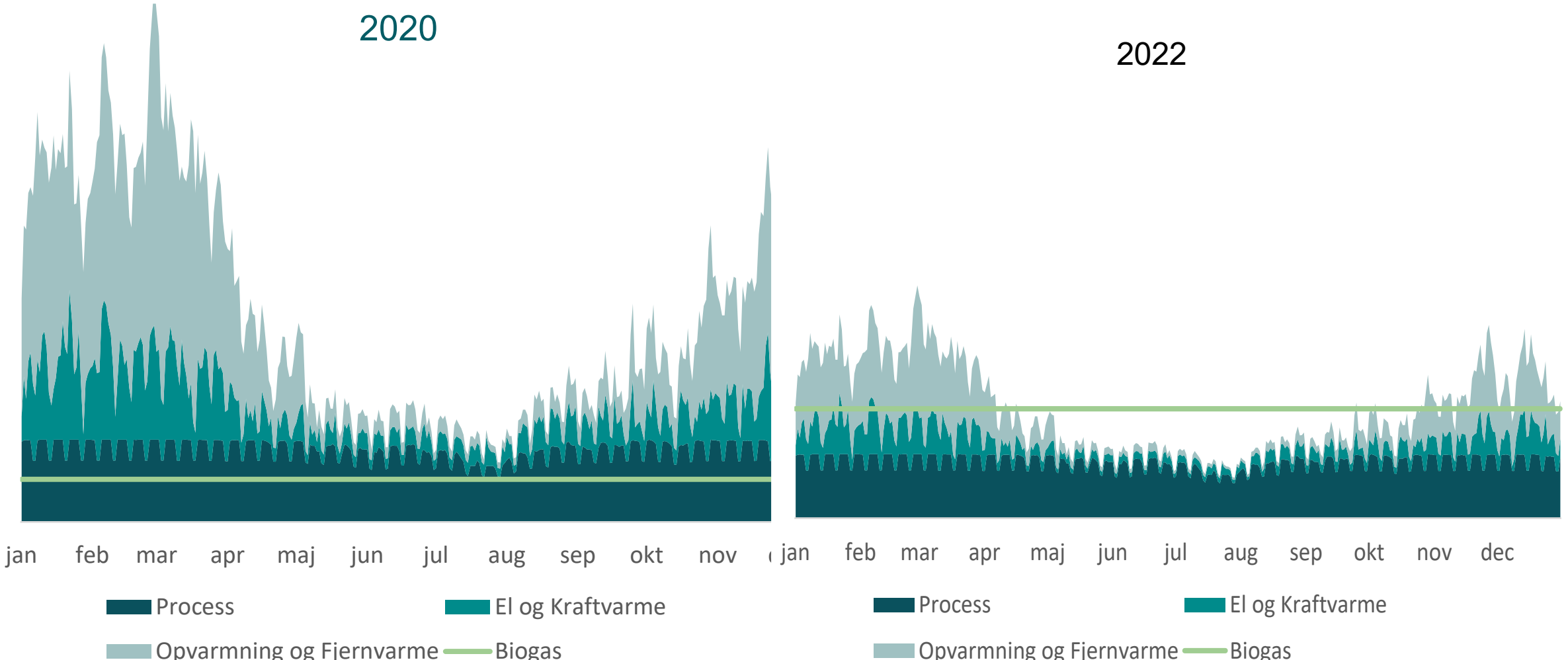
Biogas potential



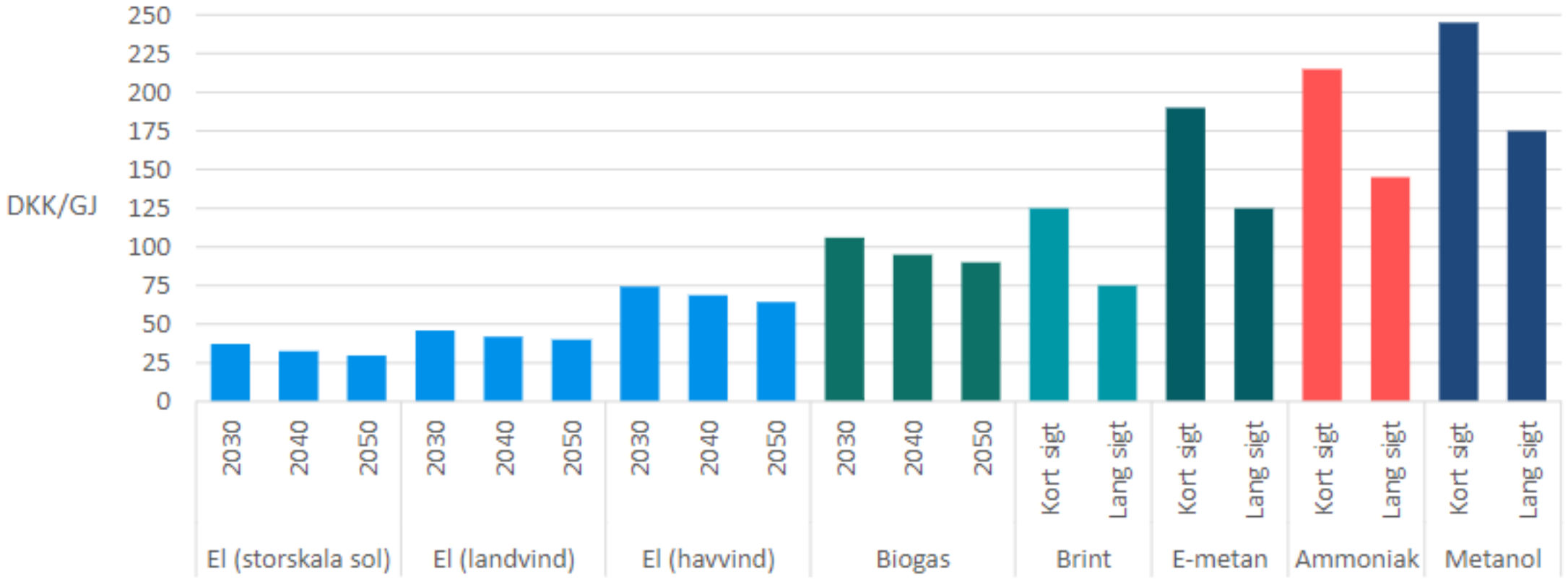
PJ	2024	2030*	2040*
Manure	6,4	12	20
Straw	3,1	15	45
Sludge	5,3	6	7
Industrial waste	7,4	8	8
Household waste	1,7	6	6
Other waste Agriculture, Vegetation management	1,3	7	7
Energy crops, Glycerine	7,0		
Total	32,2	55	94

* Syddansk Universitet og SEGES 2020: Energiafgrødeanalysen

DSO bottlenecks biomethane

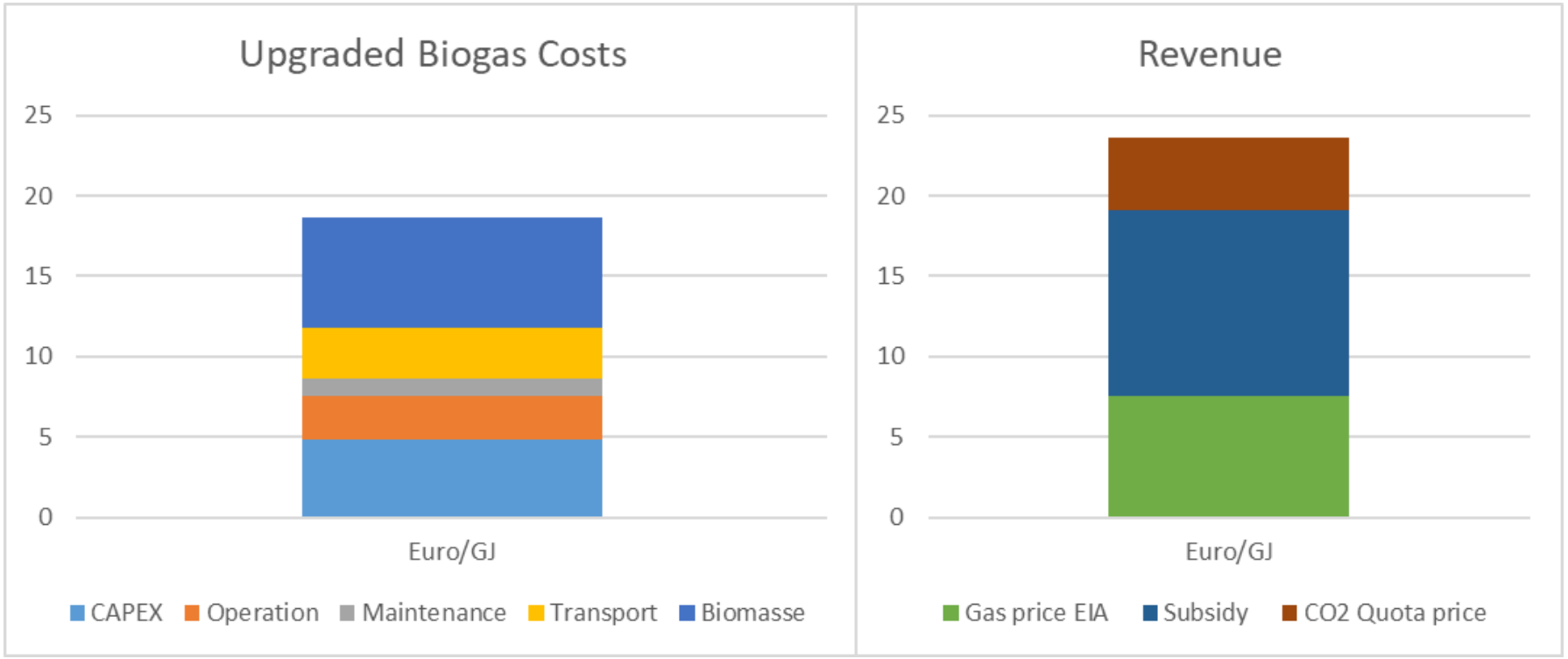


LCOE Gas strategy 2021



Levelised Cost of Energy (LCOE)

Costs and revenues of upgraded biogas - LCOE

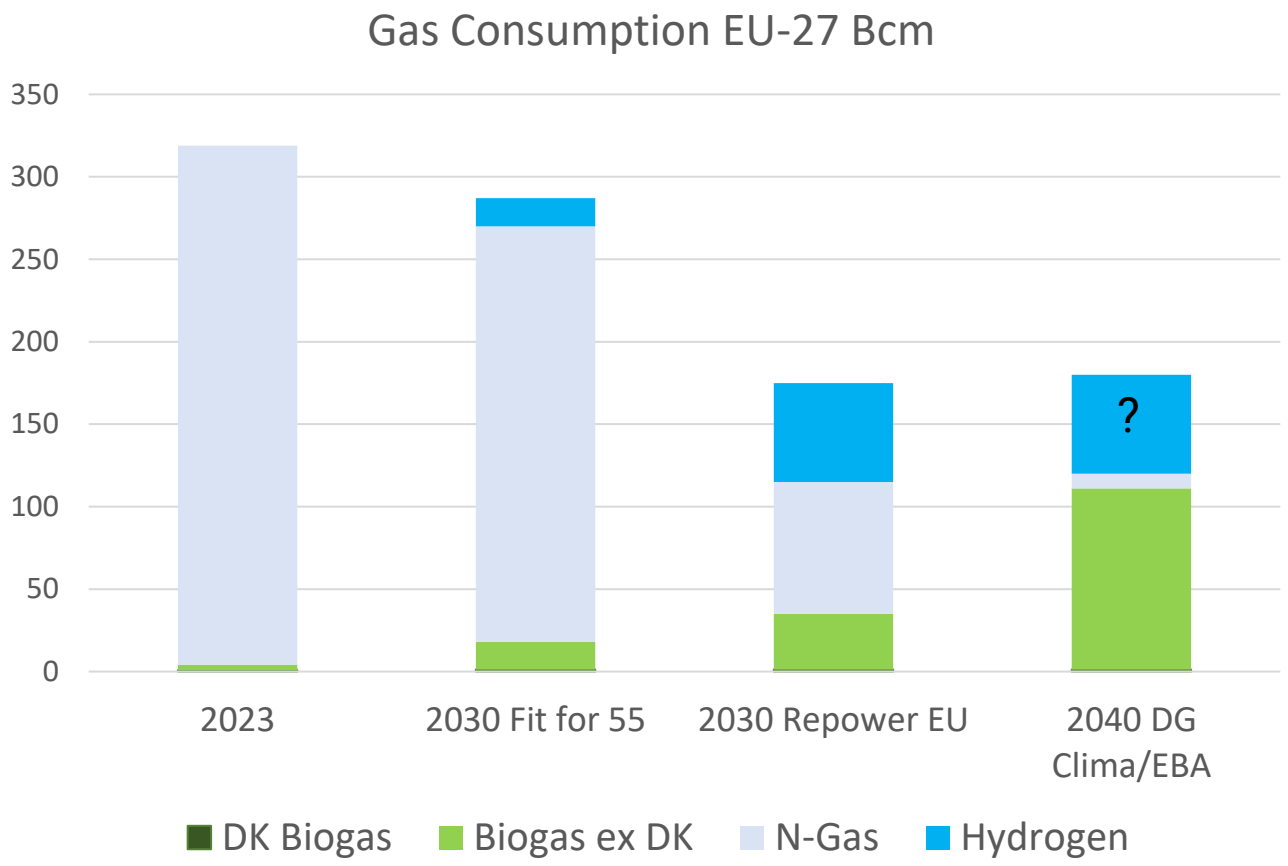


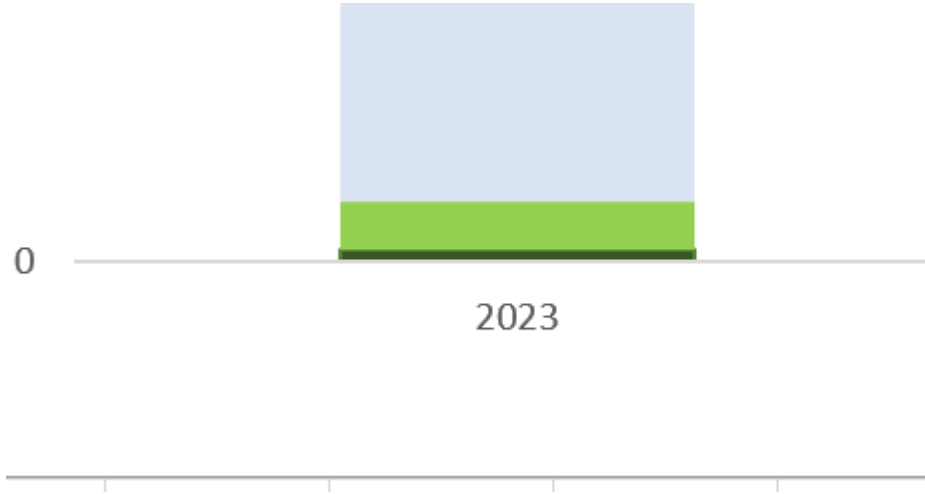
Guaranties of origin – No public available price – EU quota price

2020 study on costs for producing biogas (2024 prices)

https://dgc.dk/media/fnpmk50w/prod_upgraded_biogas_optimization_uk_summary.pdf

Gas Consumption & Biogas Production





Source:
EU Fit for 55
Repower EU
DG Clima: Securing our future Europe's 2040 climate target and path to climate neutrality by 2050 building a sustainable, just and prosperous society
EBA: Biomasses toward 2040 and beyond
https://zerocarbon-analytics.org/archives/energy/existing-gas-supplies-to-meet-eu-demand-under-2040-emissions-target