



# Biogas in Denmark

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October 2024

# THE DANISH GAS SYSTEM

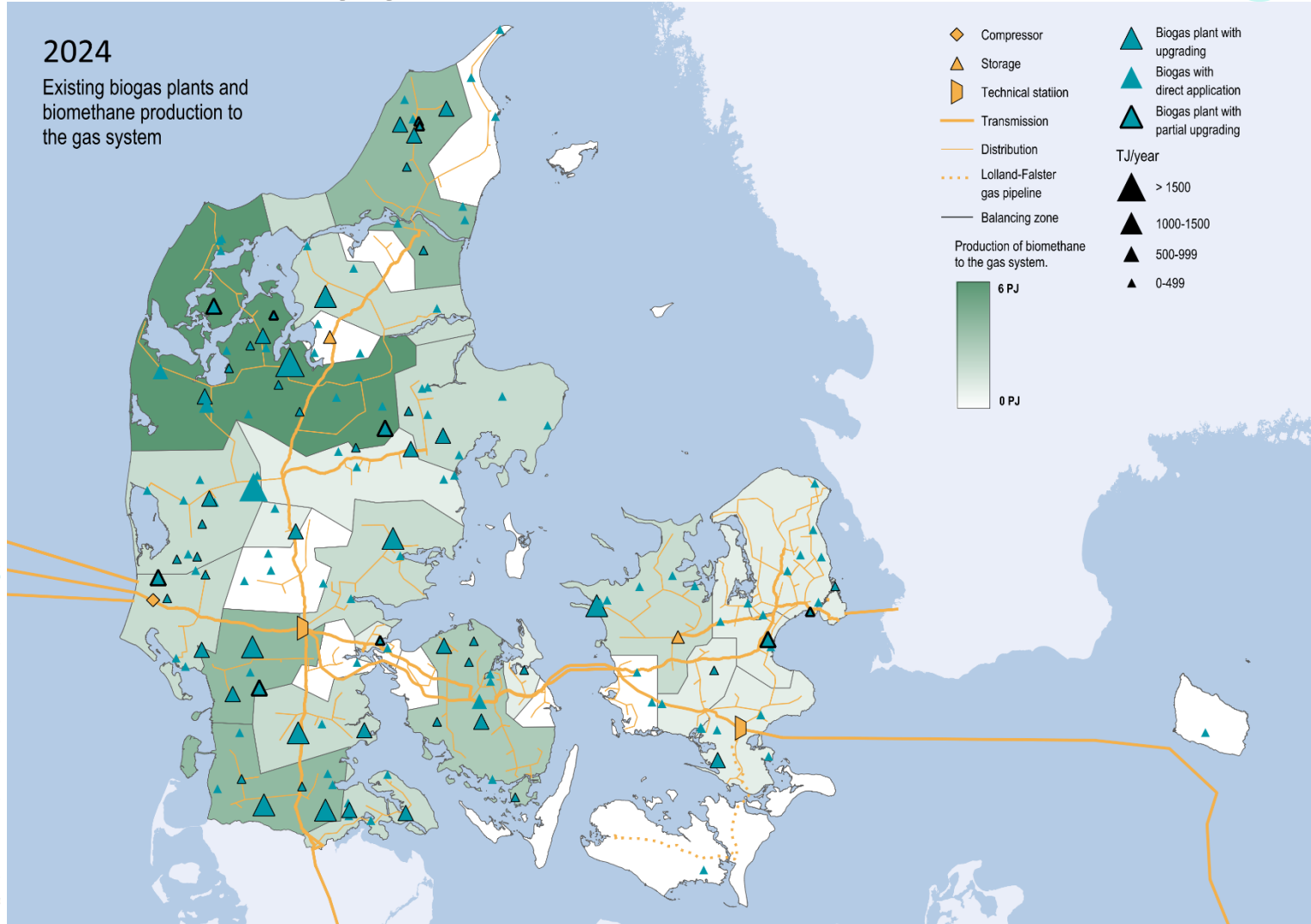
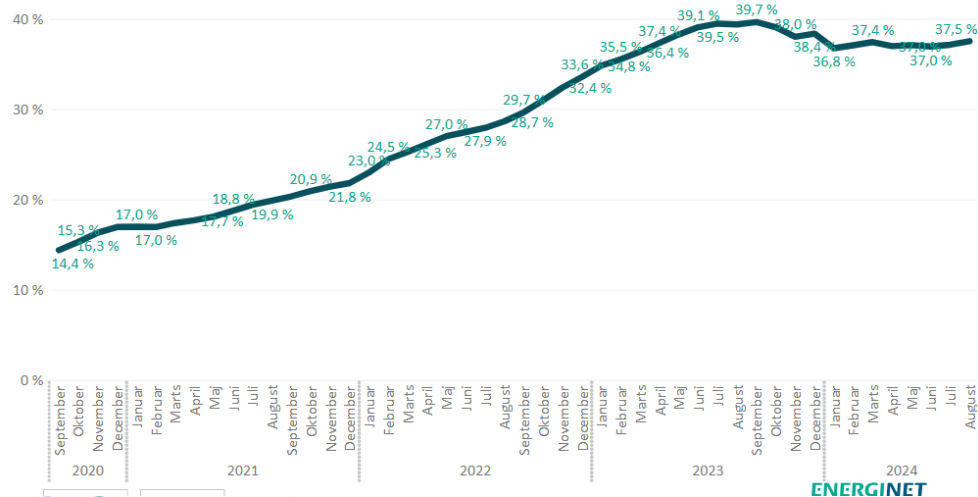
## Increasing production of biogas and decreasing gas consumption

### Increasing production of biogas

Increase since 2014.  
2023 ≈ 38 % of total consumption.

### Decreasing consumption

During the last 15 years gas consumption has decreased by 40% due to diminishing demand in gas for CHP.





# GREEN GAS STRATEGY

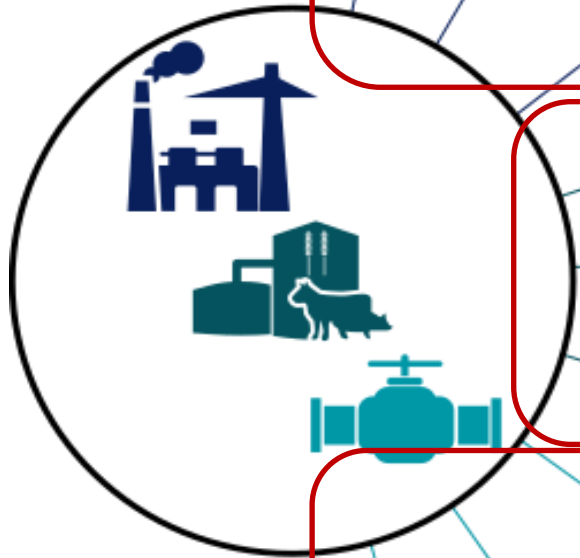
PUBLISHED DECEMBER 2021

- *Energy Agreement 2018*: Agreement of the Danish Parliament to prepare a Danish strategy for the Danish gas infrastructure and regulation in order to secure at continuous commercial utilization of the gas infrastructure within the green transition.
- The strategy is based on continuous work in parallel with the climate agenda
- Simultaneously with the electricity and PtX strategies
- Governmental ambition to have 100 pct. green gas in 2035 – now 2030
- [https://ens.dk/sites/ens.dk/files/Naturgas/groen\\_gasstrategi\\_en.pdf](https://ens.dk/sites/ens.dk/files/Naturgas/groen_gasstrategi_en.pdf)





# NINE FOCUS POINTS



## Gas consumption in the future

- 1) Green gas must supplement the electrification and be used where it has the greatest value
- 2) Green gas in industry must support jobs in Denmark for the benefit of development and employment
- 3) Conversion to green gas must occur with consideration of competitive tariffs and on commercial terms

## Production of green gases

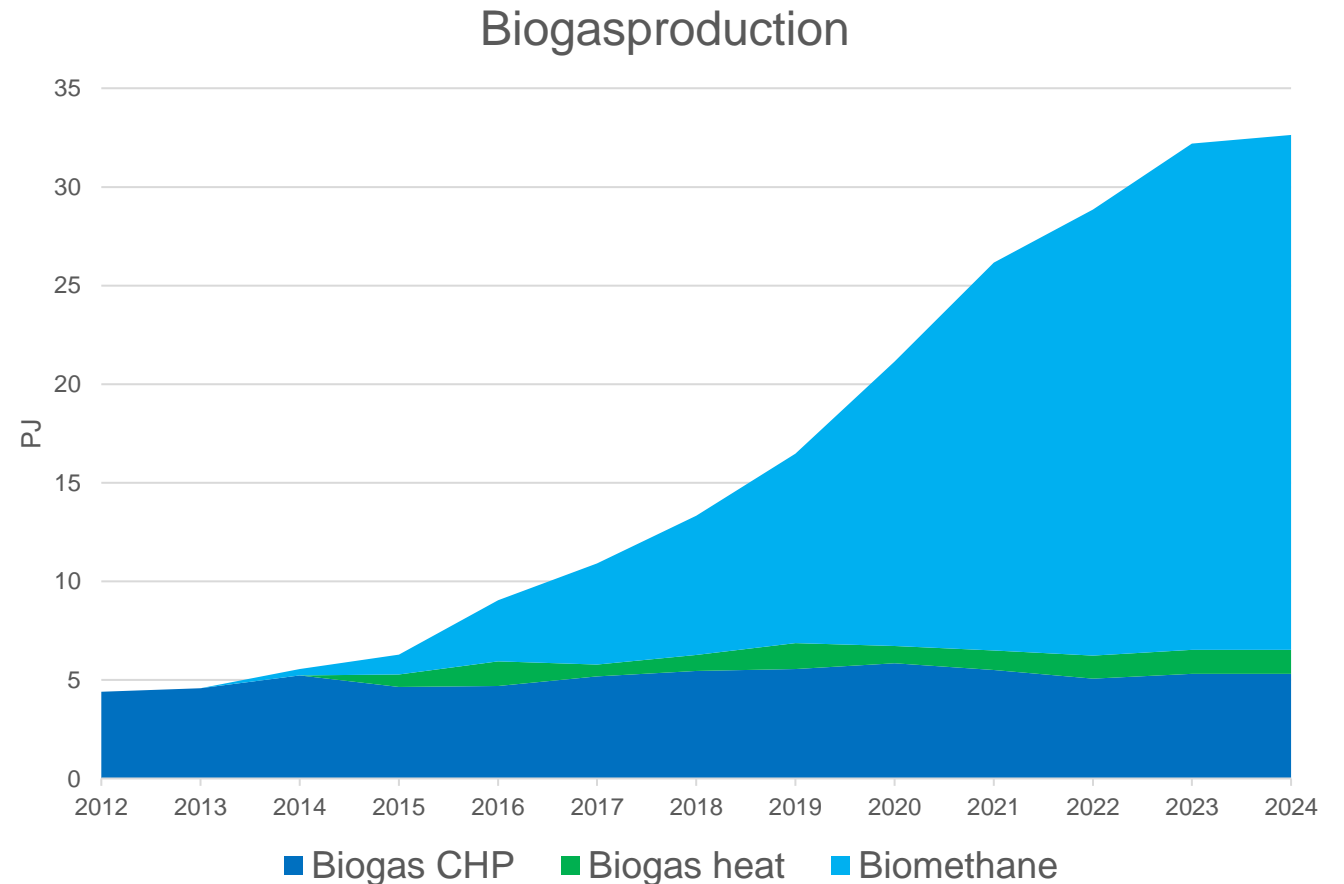
- 4) Over time, green gas must cope with market conditions
- 5) Green gases must be produced sustainably
- 6) The development of green gas production and gas infrastructure must take place with the close involvement of the citizens concerned and take into account biodiversity and the environment

## Gas infrastructure in the future

- 7) The gas system must support and be used for the green gases of the future
- 8) The gas system must be adapted and effectively support the energy system of the future and contribute with flexibility and security of supply
- 9) Denmark must work for the development of a well-functioning European market for green gases

# Development in Denmark

- Increase in biogas production up to 2022
- Pipeline:
  - Mature projects app. 18 PJ
  - Immature projects app. 30 PJ
- New incentives:
- Tenders?
- Blending obligation?
- Tax exemption?





# TECHNOLOGY AND PRODUCTION APPROACH

- Plant capacities (biomass input): 10,000-1,000,000 ton/year (existing plants); 0.8-2 mill. ton/year (future plants)
- Plant capacities (output, CH<sub>4</sub>): 2,5-40 Nm<sup>3</sup>/year (existing); 25-50 mill. Nm<sup>3</sup>/year (future plants)
- Co-digestion of biomasses
- HRT: 47 days (average existing plants); 60-100 days (new plants)
- Digestate used directly on fields as fertilizer
- Amine technology used for upgrading
- Average yield per ton input biomass: 44,7 Nm<sup>3</sup> CH<sub>4</sub>/ton (equivalent to 1,6 GJ/ton)

# Biomasses

Biogas			Gas produced	
2021-2022	Tonnes		mio. Nm3	
Manure	11.701.000	74%	335	31%
Energy Crops	833.000	5%	127	12%
Crop residues	184.000	1%	26	2%
Straw	193.000	1%	60	6%
Husk	121.000	1%	41	4%
Olive residues	36.000	0%	11	1%
Potato/beet pulp	306.000	2%	22	2%
Fisheries residues	212.000	1%	31	3%
Slaughterhouse waste	514.000	3%	75	7%
Soapstock	110.000	1%	49	4%
Melasse	247.000	2%	75	7%
Glycerine	240.000	2%	130	12%
Industrial waste	576.000	4%	41	4%
Household pulp	544.000	3%	62	6%
Grand Total	15.817.000		1.087	
Energy content PJ			25	
Methane yield, Nm3 pr. tonnes biomass			45	



# SUSTAINABILITY REGULATION

## Energy crop-regulation

- Starting 2015 12 %
- Current limit 9 %,
- Decrease to 4 % 2025
- Ban on use of maize from 2025

### Challenges:

- Alternatives to energy crops?
- Catch crops?

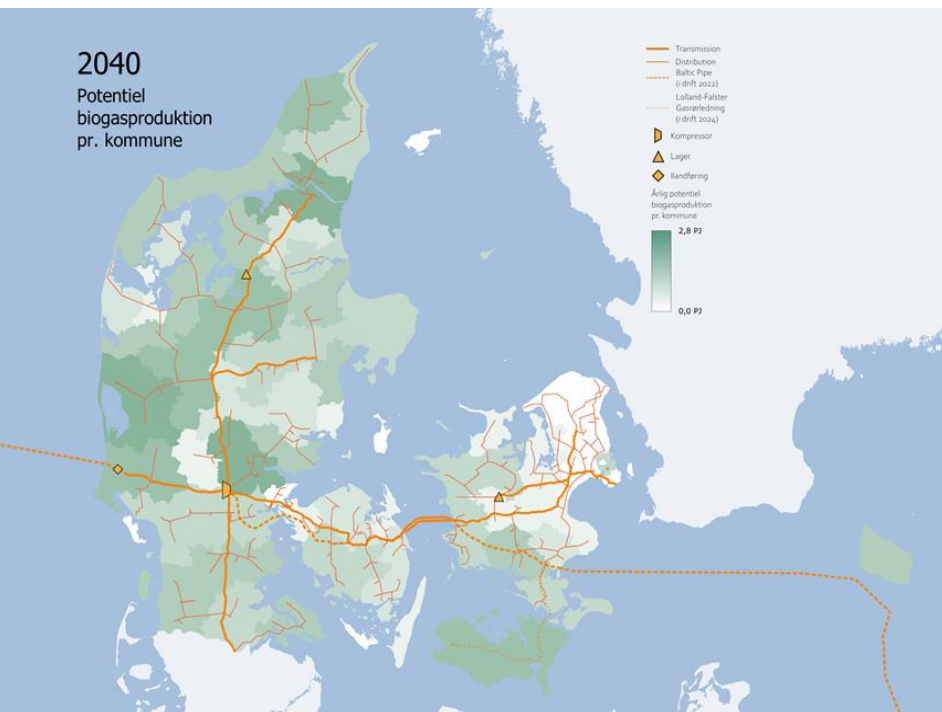
## Methane loss

- Report from 2021 shows average loss of 2.5 pct.
- New regulation (implemented 2023):
  - Sources of leak must be identified and improved
  - Annual examination of the plant from 3<sup>rd</sup> party
  - Point source loss from upgrading plant max 1 pct.





# BIOGAS POTENTIAL

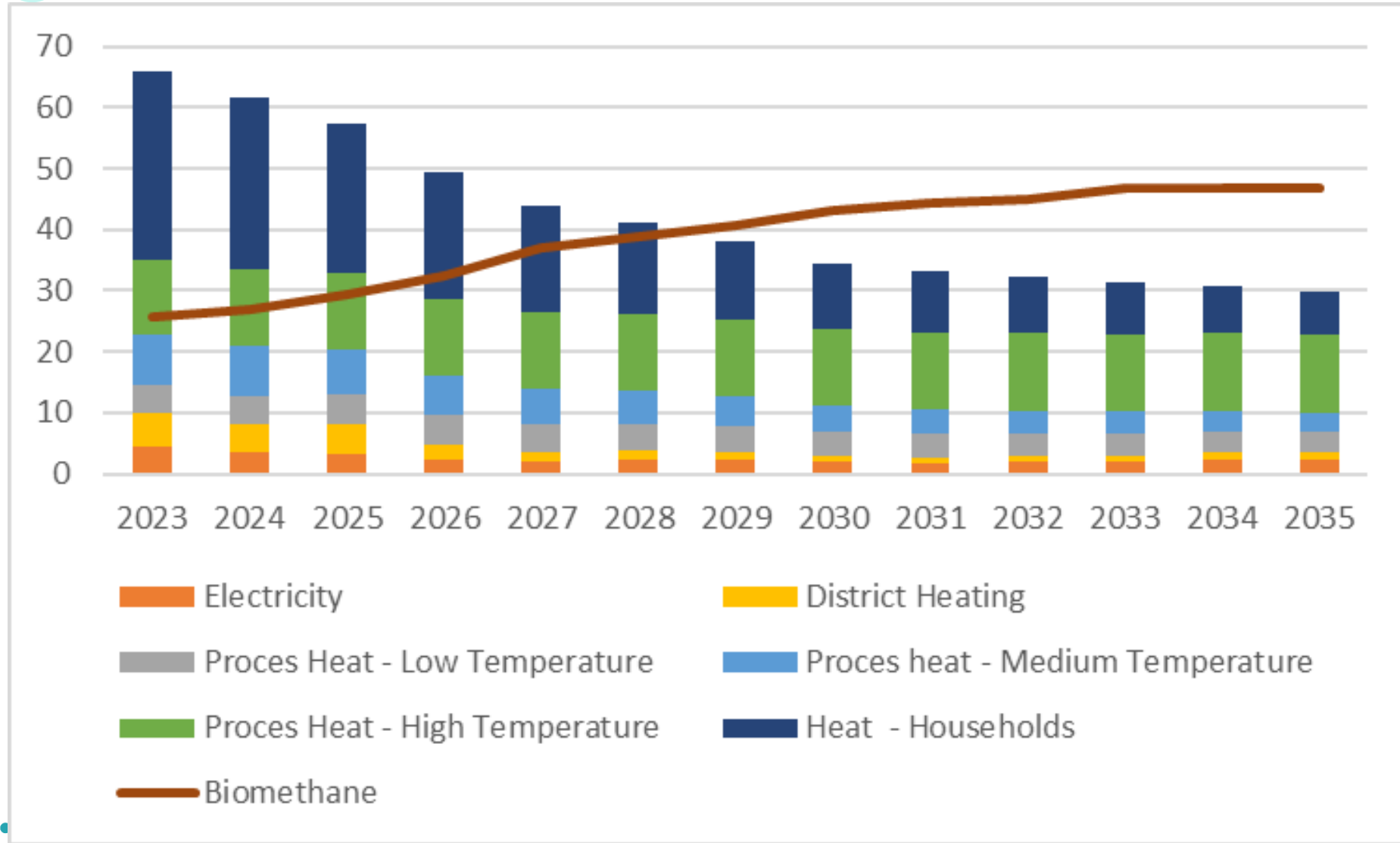


	Potential (PJ/Year)			
	2020	2025	2030	2040
<b>Manure/ Slurry</b>	5	6	12	20 <sup>6</sup>
<b>Straw</b>	1	5	15 <sup>5</sup>	45 <sup>5</sup>
<b>Deep Litter</b>	0,7	3	6	7
<b>Waste Food Industry</b>	8	8	8	8
<b>Discarded Crops</b>	0,3	0,4	0,6	0,9
<b>Household organic waste</b>	2	6	6	6
- heraf KOD	2	5	5	5
- have/park affald	0	1	1	1
<b>Residuals from vegetal crops</b>	1	2	7	7
- heraf roetoppe og andre toppe	0	1	3	3
- græs fra naturarealer <sup>7</sup>	1	2	3	3
- randzoner og grøftekanter	0	0	1	1
<b>I alt</b>	<b>16</b>	<b>30</b>	<b>55</b>	<b>94</b>



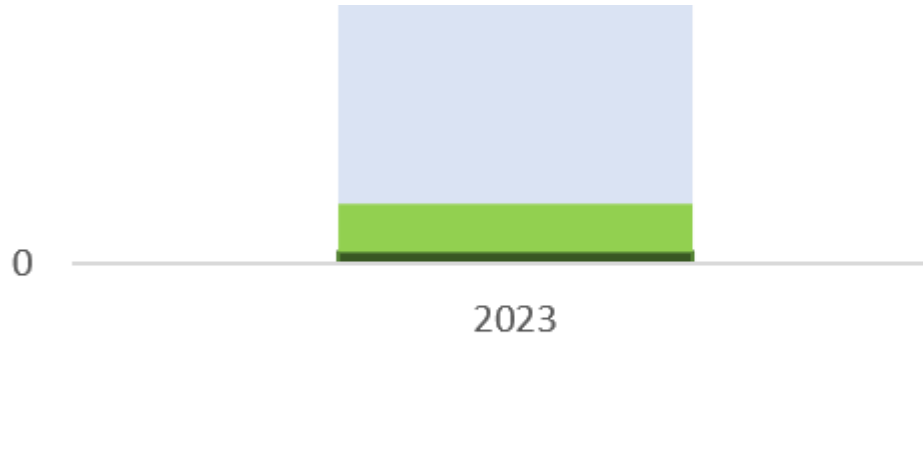
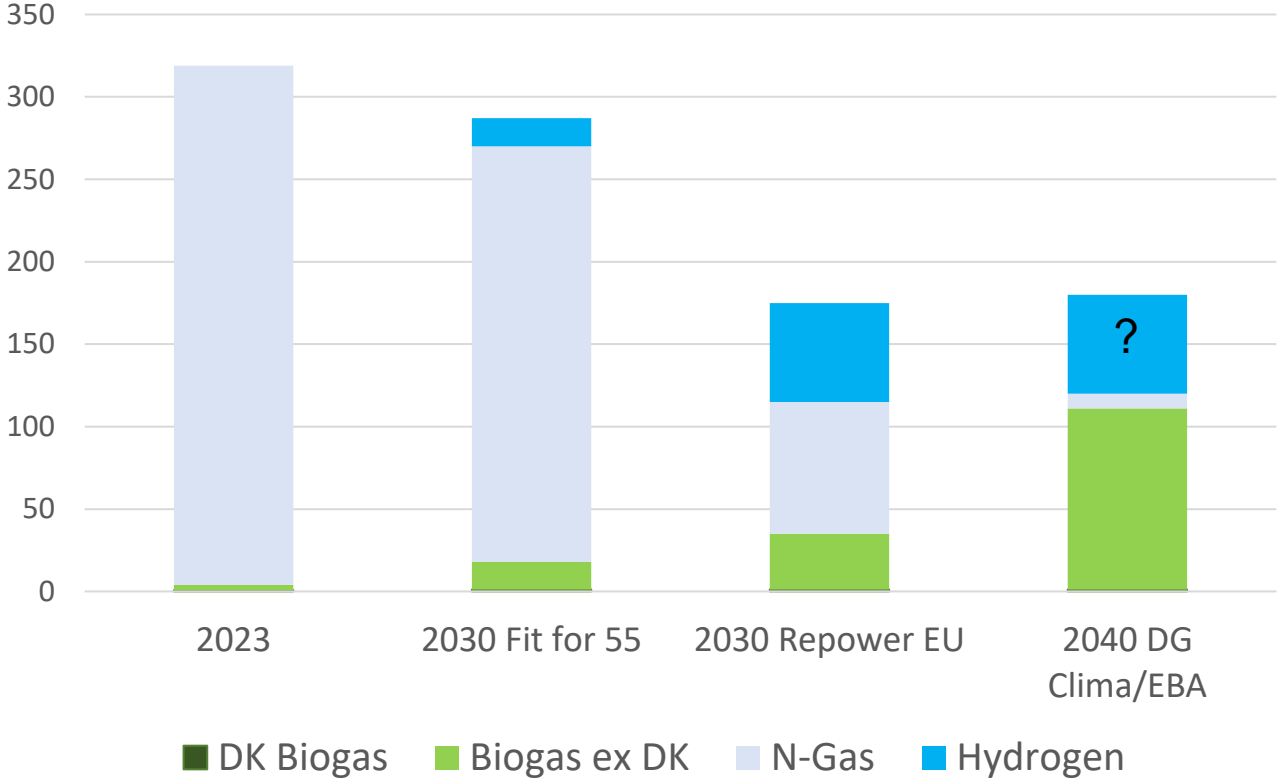
# DEVELOPMENT IN BIOGAS PRODUCTION AND CONSUMPTION

## CLIMATE PROJECTION (KF24)



# Gas Consumption & Biogas Production

Gas Consumption EU-27 Bcm



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>

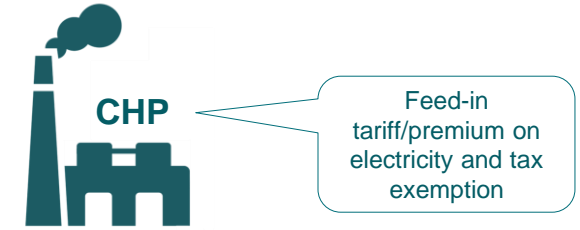
# SUPPORT SCHEMES

EXPANDING FIRST, THEN DRIVING DOWN SUBSIDY COST

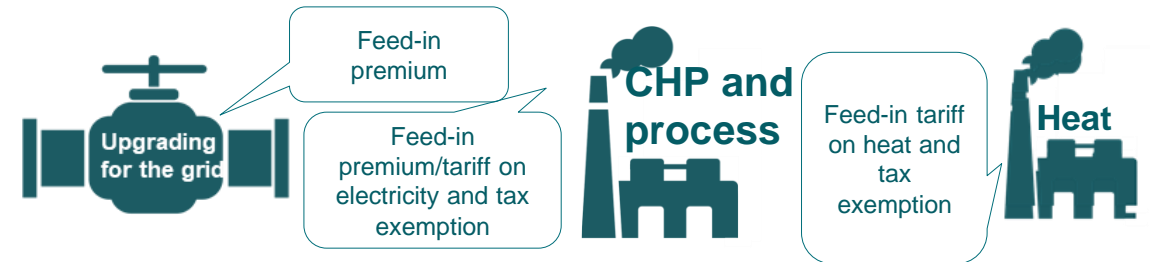
Support schemes (lasting 20 years)

- Until 2012: support for CHP using biogas
- 2012-2019: support in 20 years for upgraded biogas (biomethane) and direct applications
- From 2020: Tenders for biomethane (12,96 billion DKK  $\approx$  1,7 billion Euro) over 20 years for biomethane

until 2012



from 2020



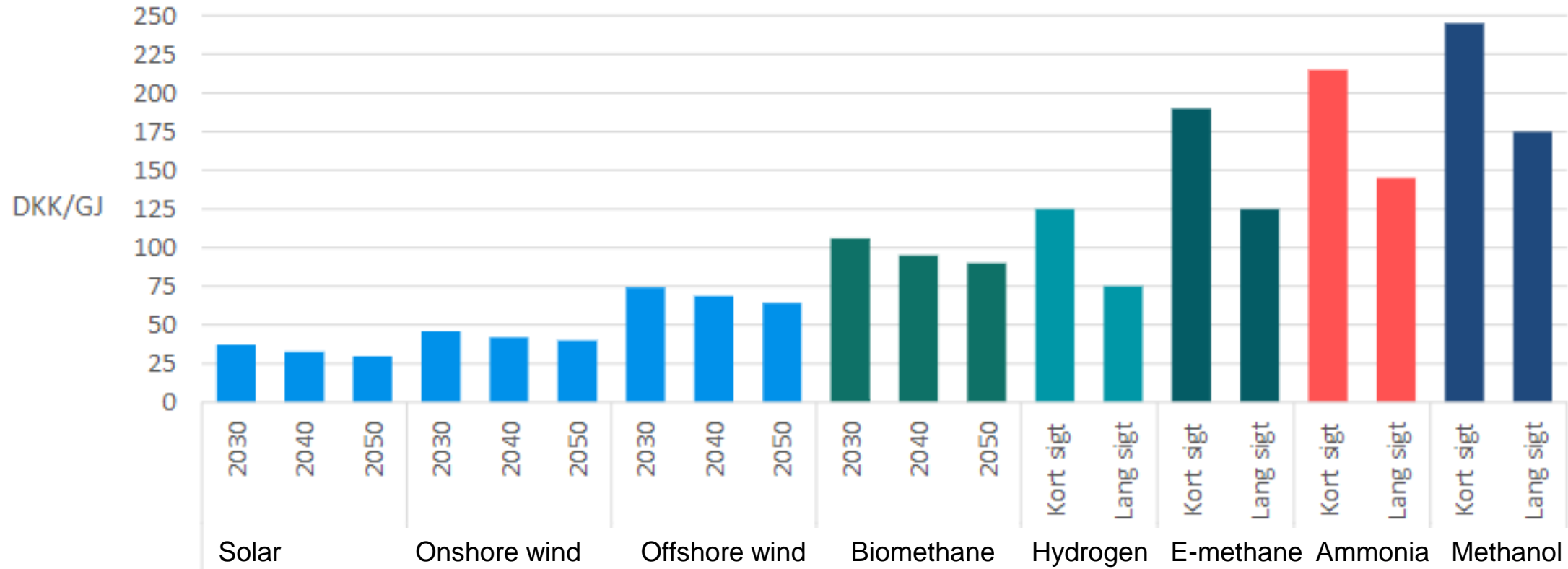
from 202X



# NEW TENDER SCHEME

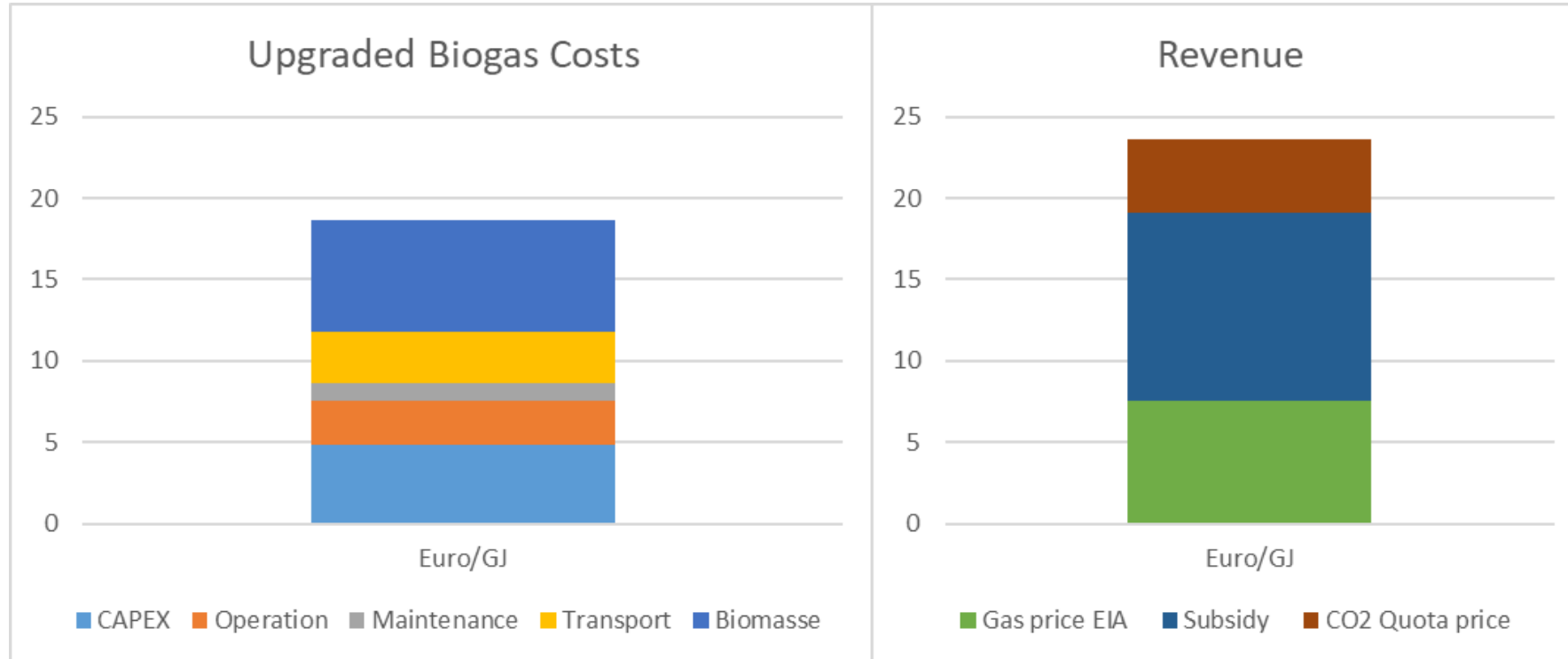
- June 2020 - Political agreement
- Winter 2020-21 Internal discussions in government CfD vs Feed in Premium
- December 2022 - Political negotiations design (CfD vs FiP) - Mandate Prenotification March 2022
- December 2022 Court ruling Swedish tax exemption and Landvärme complaint
- Autumn 2023 proposal No GO's to supported biomethane / new political mandate
- Spring 2024 Final issues Claw back on opt-out opt-in feature
- September 2024 Notification
- Awaits state aid approval – expected in November 2024
- Summer 2024 Biogas Association prefer blending obligation.....
- New Government decision in progress.....

# Technology Projections



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](https://dgc.dk/media/fnpmk50w/prod_upgraded_biogas_optimization_uk_summary.pdf)

# Blending obligations (Veyt)

	France	Germany	Austria	Portugal	Netherlands
<b>Gas type</b>	Biomethane	All renewable gases	All renewable and recycled gases	Renewable hydrogen and biomethane	Renewable gases
<b>Certification</b>	Biomethane Production Certificates (BPCs)	TBD	GOs + green gas seal	GOs	GOs + Green Gas Units (GGEs)
<b>Unit</b>	TWh	GHG reduction	TWh	TWh	GHG reduction
<b>Timeline</b>	From 2026 onwards	NA	From 2024 onwards	From 2023 onwards	From 2026 onwards
<b>Status</b>	Draft	Concept	Fail	In force	Draft
<b>Qualified production</b>	Domestic only	EU production	Domestic only	EU production	Domestic only
<b>Buy-out price</b>	100 EUR/MWh	TBD	2024: 180 EUR/MWh 2027: 200 EUR/MWh	max. 62 EUR/MWh	500 EUR/MWh
<b>Targets</b>	2026: 0.63% 2027: 2.91% 2028: 6.59%	2025: 0.67% 2030: 7.5%	2024: 0.7% 2025: 1.05% 2026: 1.75% 2027: 2.8% 2028: 4.2% 2029: 5.95%	2025: 1% of in end-user portfolio 150 GWh/year	2026: 0.15 bcm 2030: 1.6 bcm/2.9 Mton chain emission reduction



# Incentive schemes

## Production support

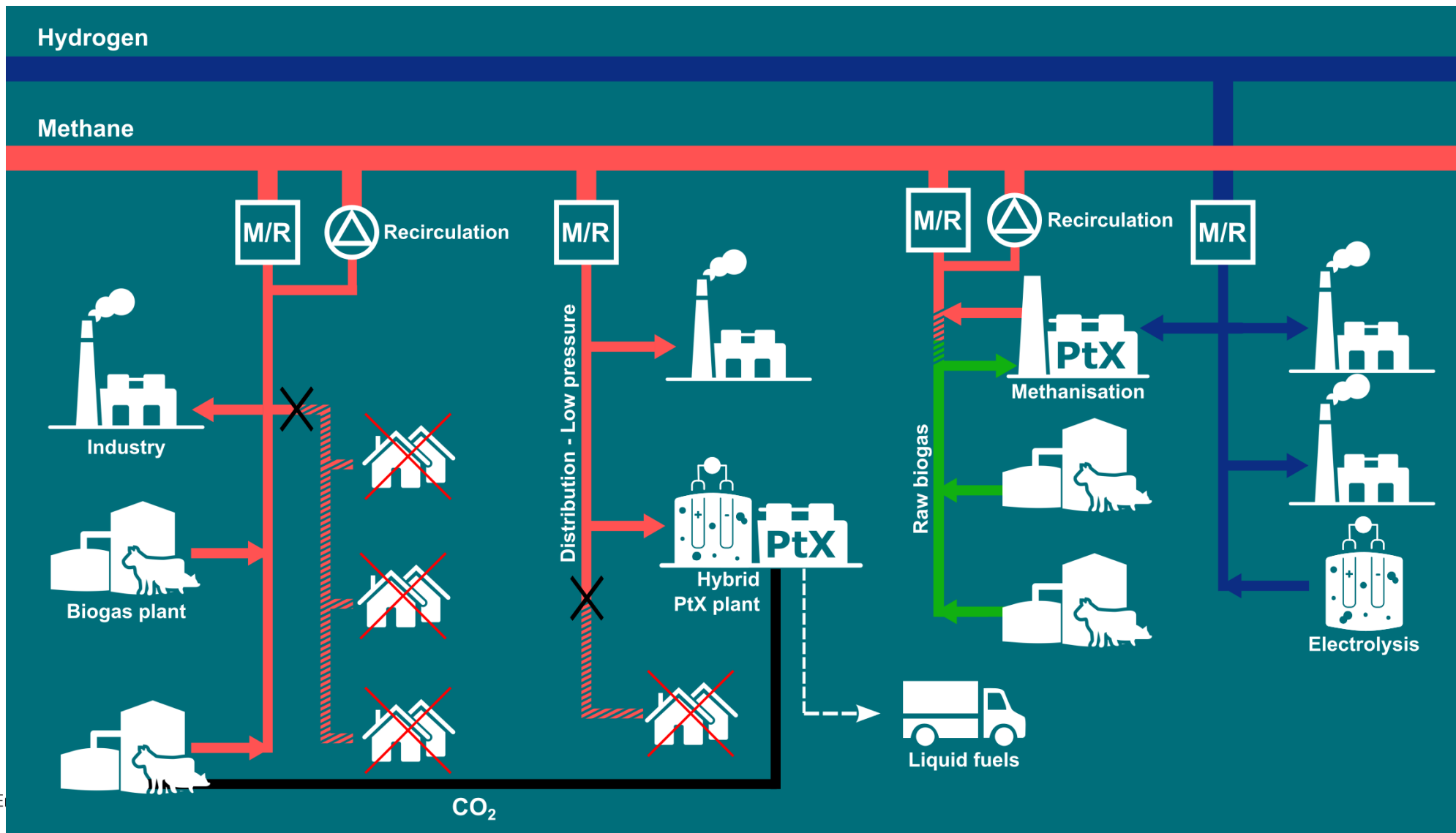
- Taxpayers pay
- RE-Share in country of consumption (REDII)
- Clima effect in production country (IPCC)
- Long support period
- High investor certainty
- Necessity for start a new biogas sector
- Safety net for investors
- Immature biogas sector

## Blending obligation

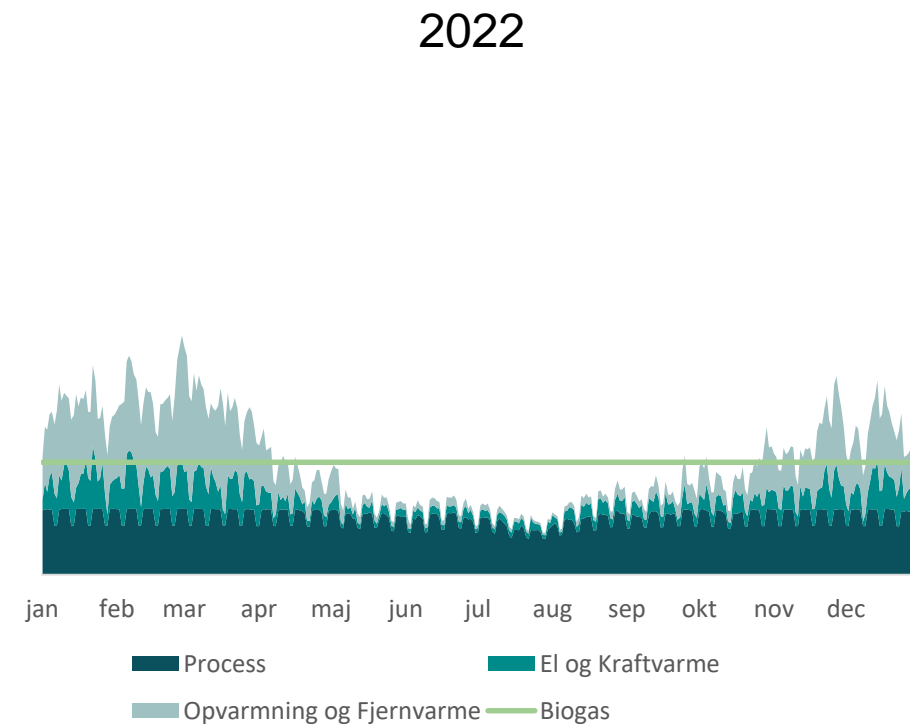
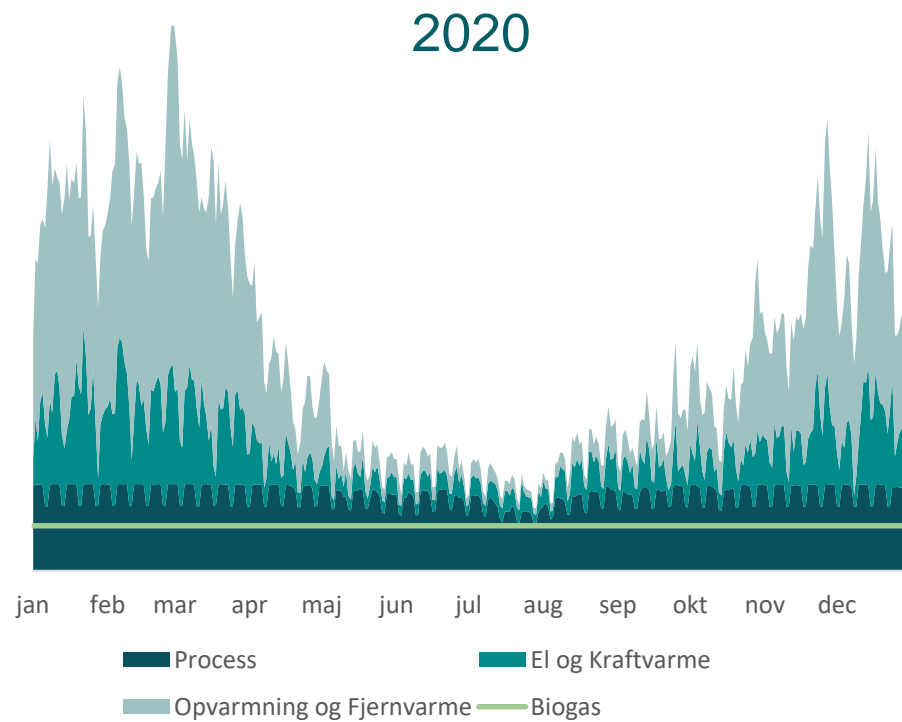
- Consumers pay
- RE-Share in country of consumption (REDII)
- Clima effect in production country (IPCC)
- Short contracts
- Low investor certainty
- Large flexibility at improved market conditions
- Mature biogas sector

# MODIFY THE GAS SYSTEM

HYDROGEN, BIOMETHANE, CO2 AND BIOGAS?



# DSO bottlenecks biomethane



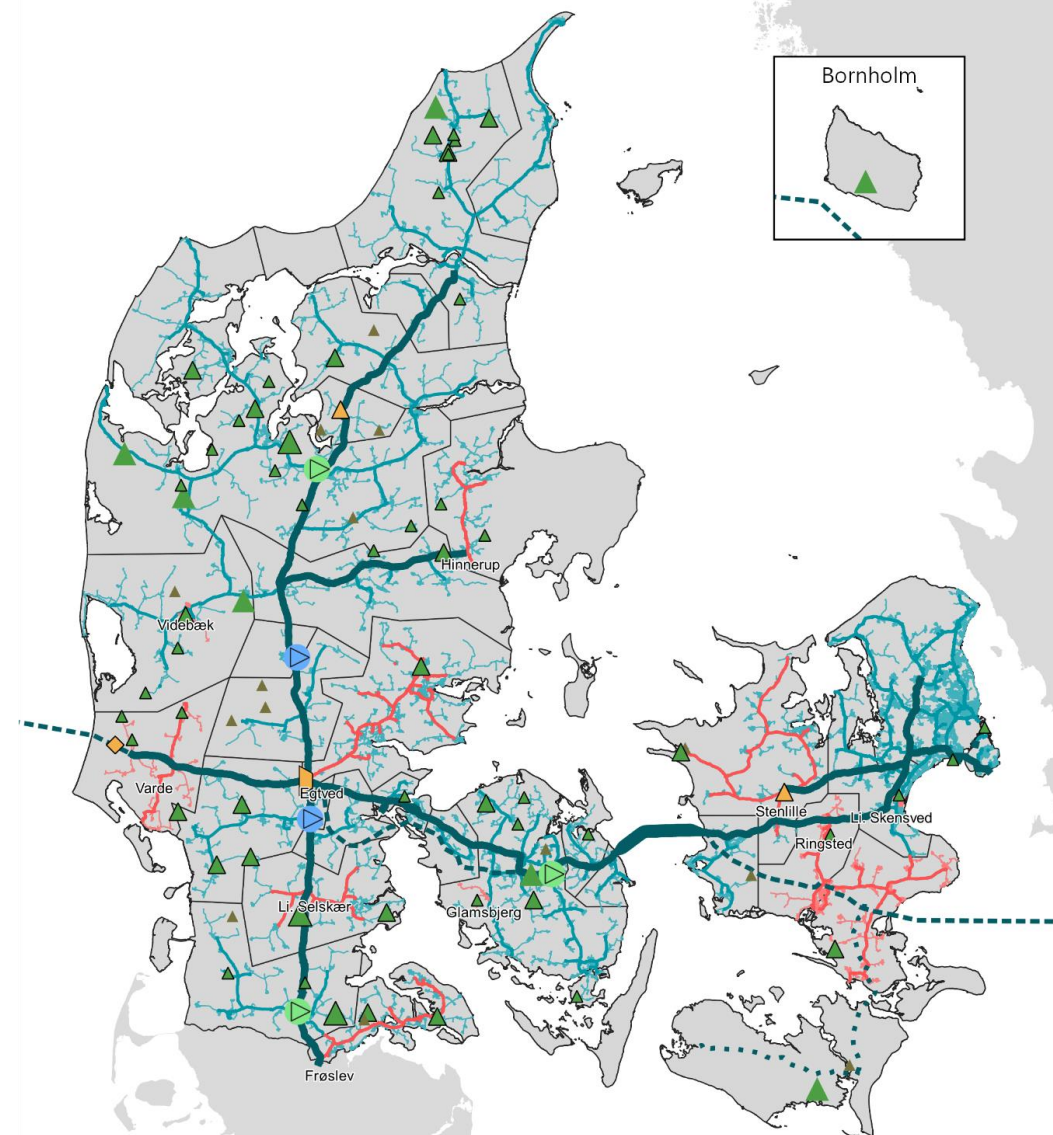


# CHALLENGES AND OPTIONS

## ADAPTING THE GAS-GRID(S)



- Adjusting the system to new flow patterns with decentral RE-gas production
- Modify the system for new gasses to transport
- Modify the support scheme
- Blending obligations
- Tax exemptions
- Sustainability



<b>Tegnforklaring</b>	Kompressor	Tilbageføringsanlæg, Energinet
Transmission	Lager	Tilbageføringsanlæg
Baltic Pipe	Ilandføring	Idriftsættes snarest
Lolland falster	<b>Biogasanlæg</b>	Balancezoner (Evida)
Fordelingsledninger	u. opgradering 65-145 TJ	
Distributionsledninger	u. opgradering 145-1400 TJ	
<b>Begrænsning på nettet</b>	m. hel/delvis opgradering <400 TJ	
Fordelingsledninger	m. hel/delvis opgradering 400-1000 TJ	
Distributionsledninger	m. hel/delvis opgradering 1000-1200 TJ	

0 25 50 km

Energistyrelsen

# Questions?

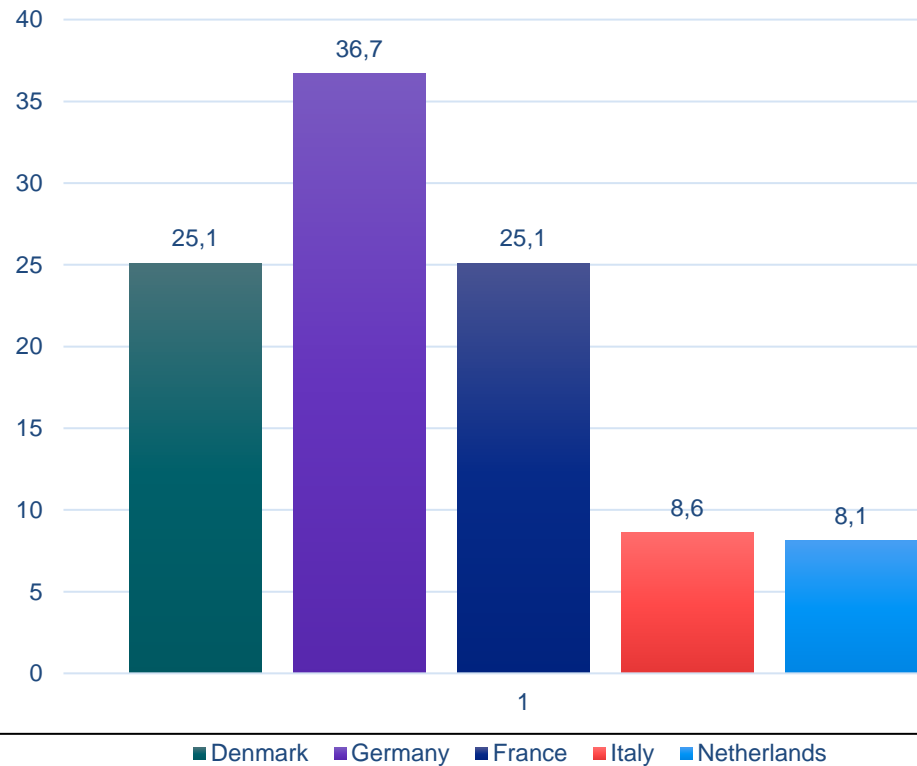


Energistyrelsen

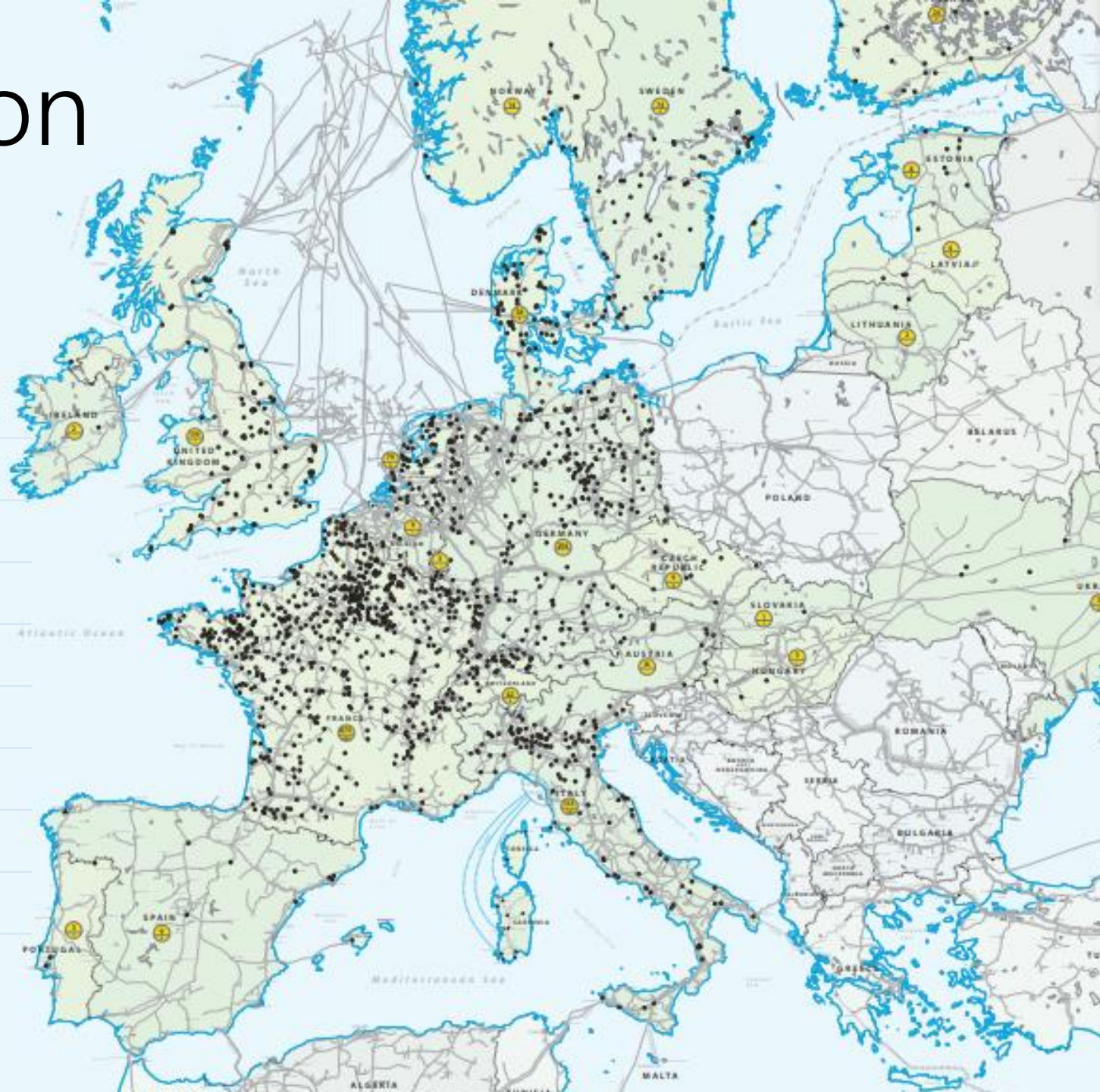


# Biogas Production i Europa

Biogas & biomethane 2022  
(PJ)



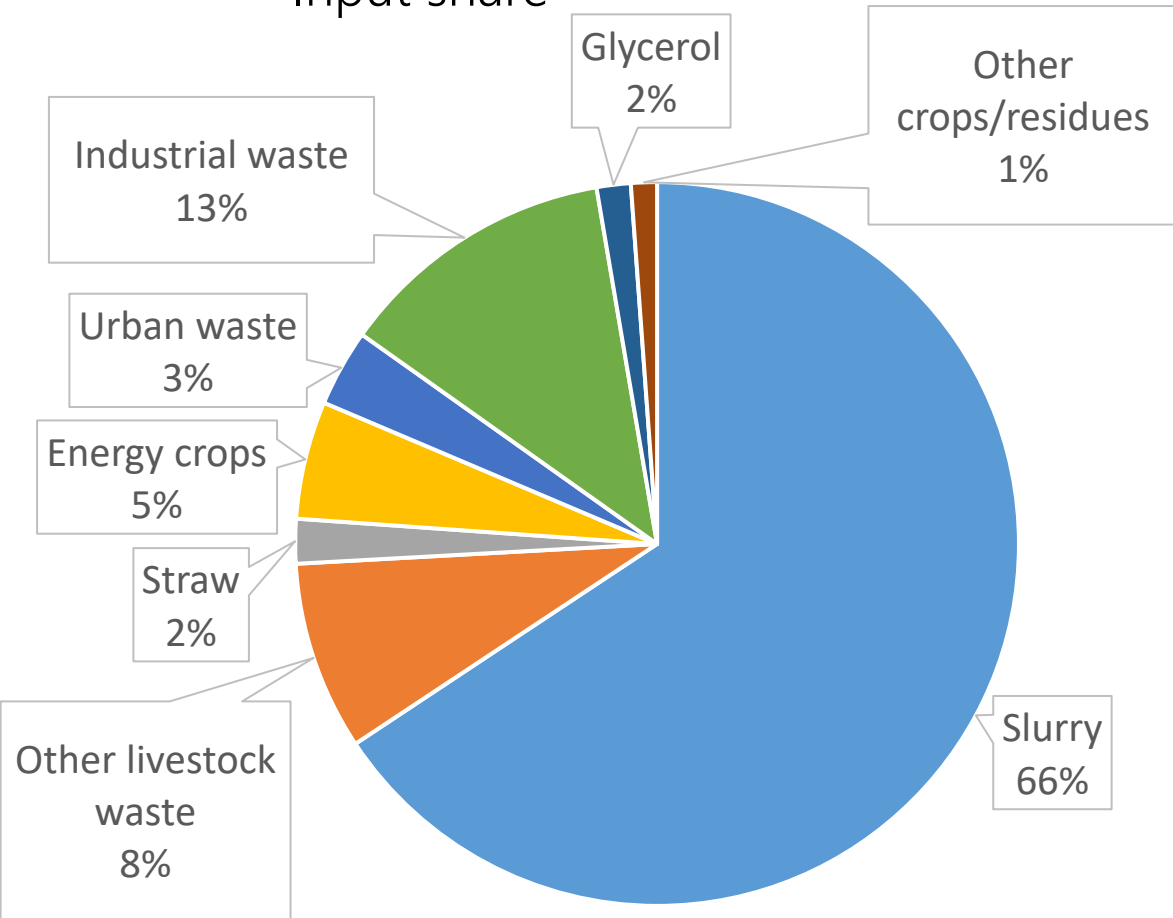
Energistyrelsen



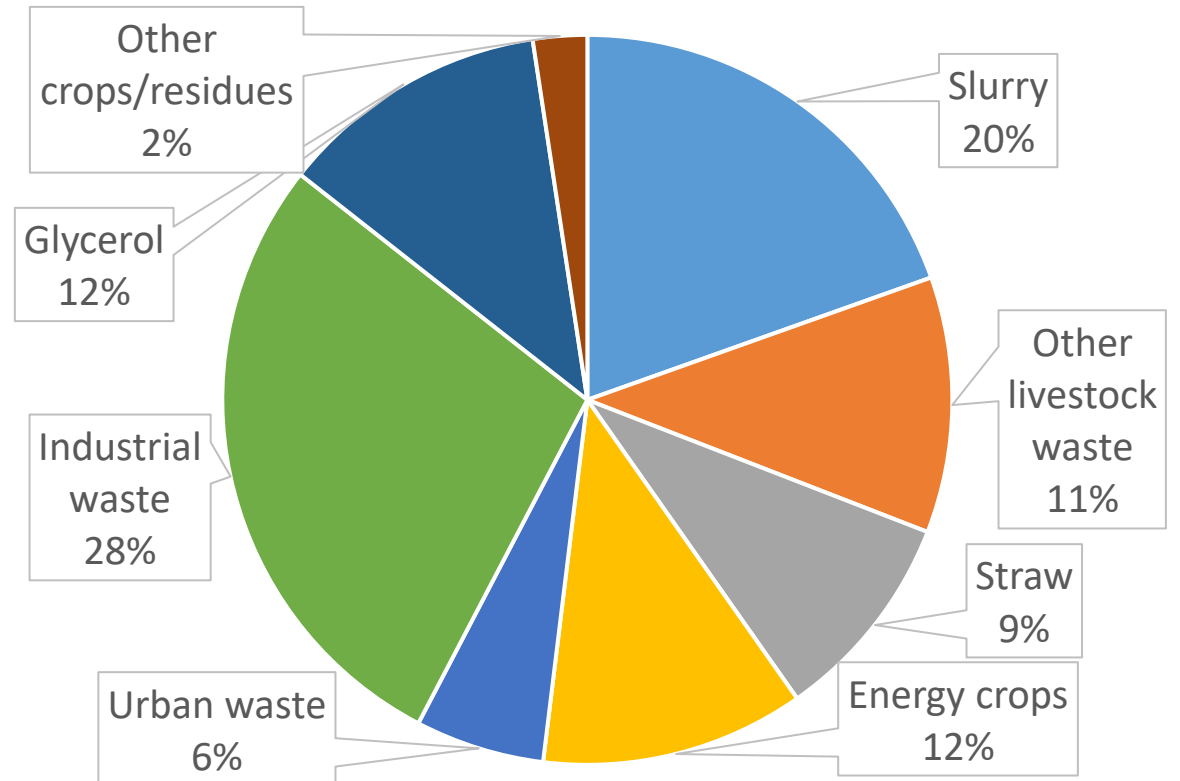


# BIOMASS

Input share

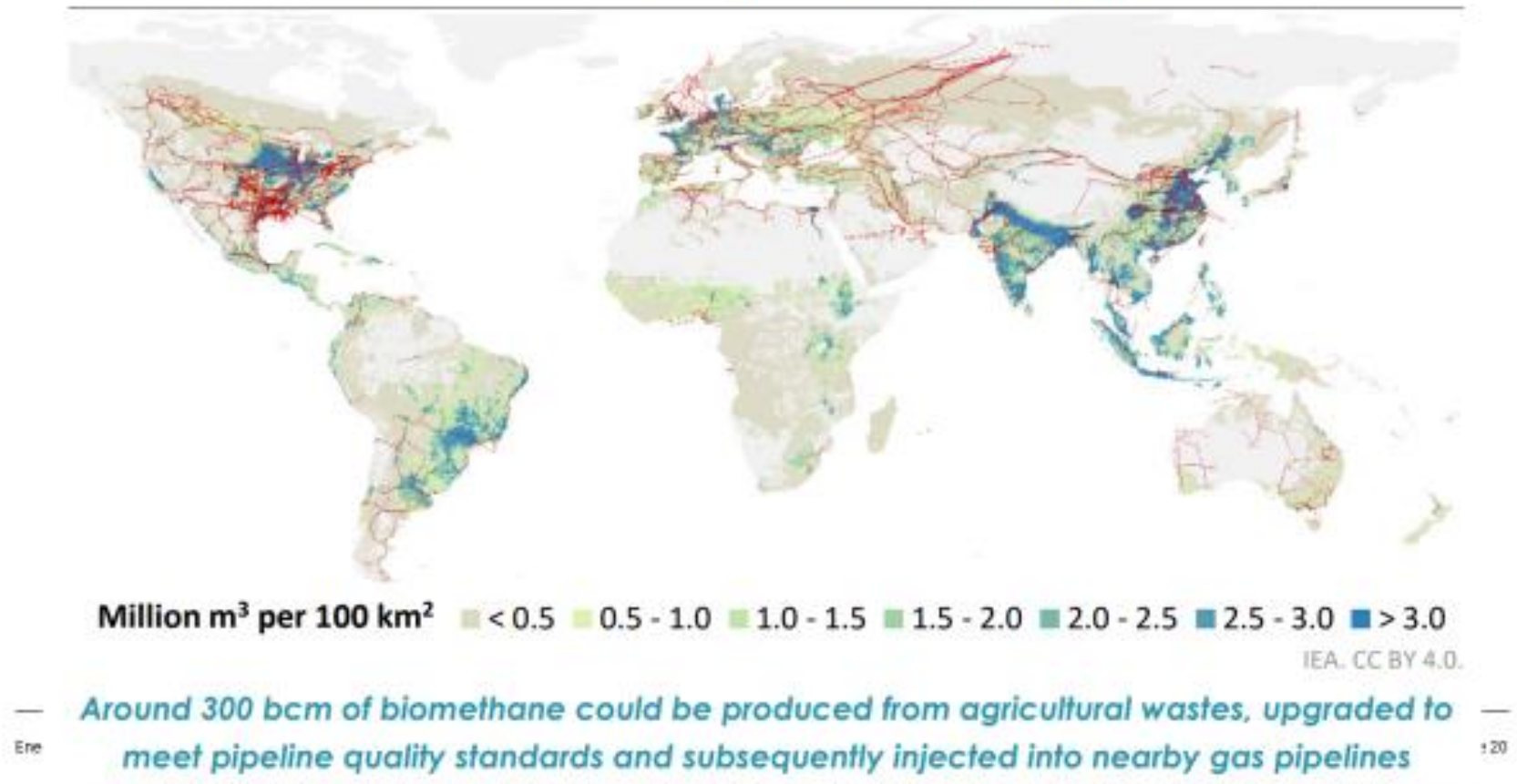


Output share



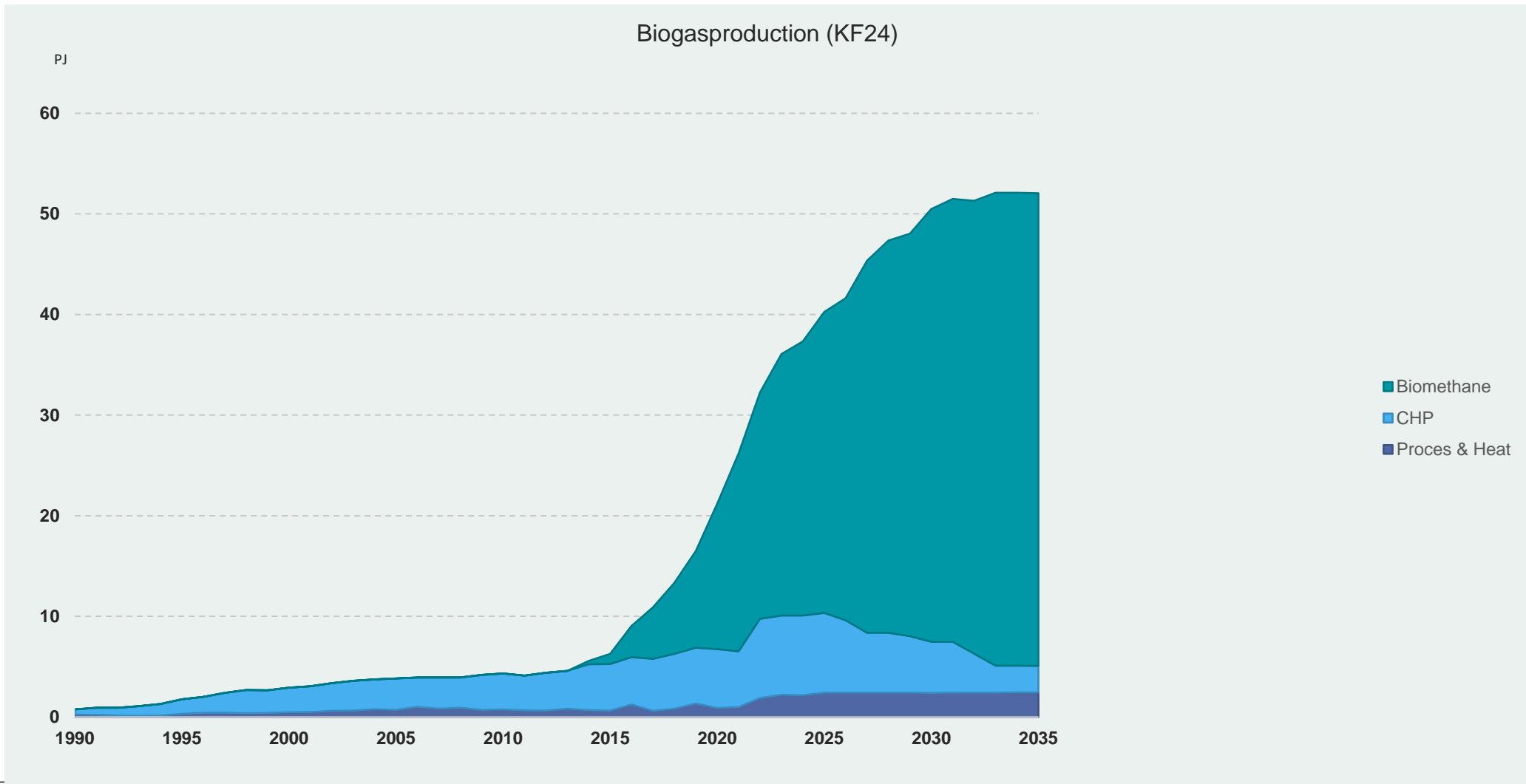
# Potential for Global Biogasproduction

**Figure 3.32** ▶ Assessed yearly biomethane potential from agricultural wastes and residues, and location of natural gas transmission pipelines





# Biogasproduction



# 2012 SUPPORT SCHEME UPGRADING/BIOMETHANE



## Subsidy structure:

- Base premium
- Natural gas price adjusted premium  
(Low gas price -> high premium,  
High gas price -> low premium)
- Early starter premium (phased out in 2019)

## Characteristics of scheme:

- 20 year subsidy period
- Possible to opt in and out
- Check for over-compensation

	2020	2021	2022	2023	2024
Base premium USD/GJ	12,0	12,0	12,1	12,7	13,0
Natural gas price adjusted premium USD/GJ	6,3	7,5	0,0	0,0	0,0
Total	18,3	19,5	12,1	12,7	13,0

# Greening the Gas Consumption - Scenarios

