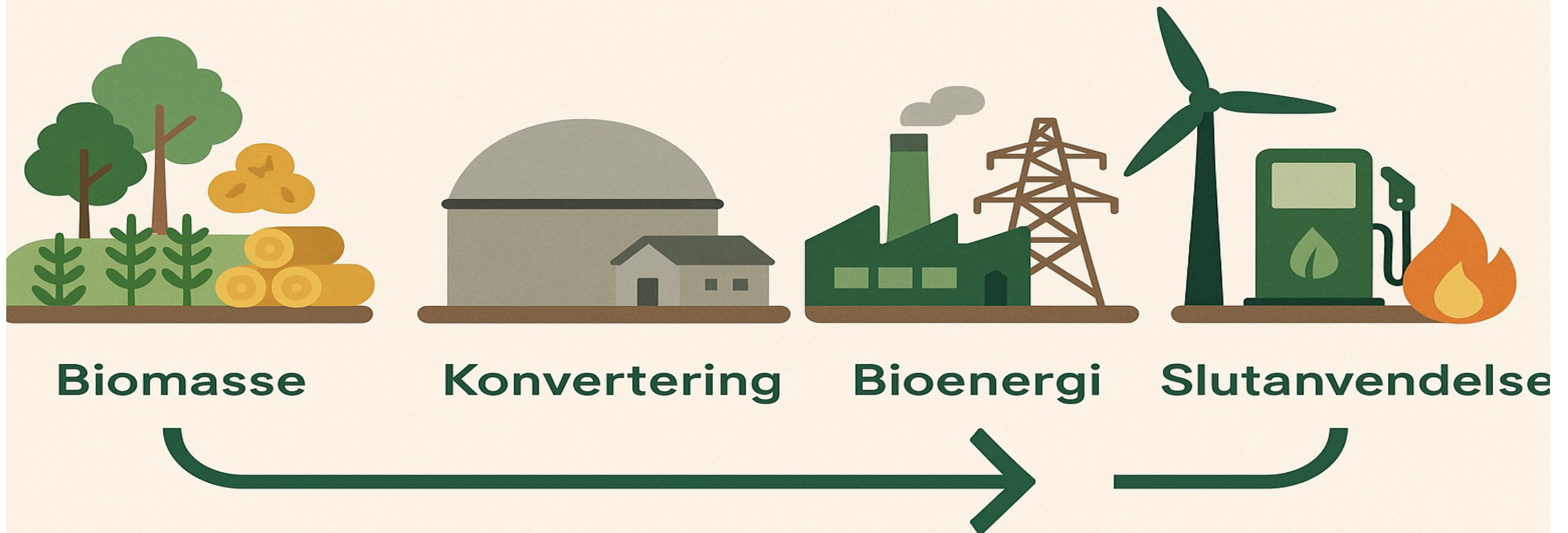


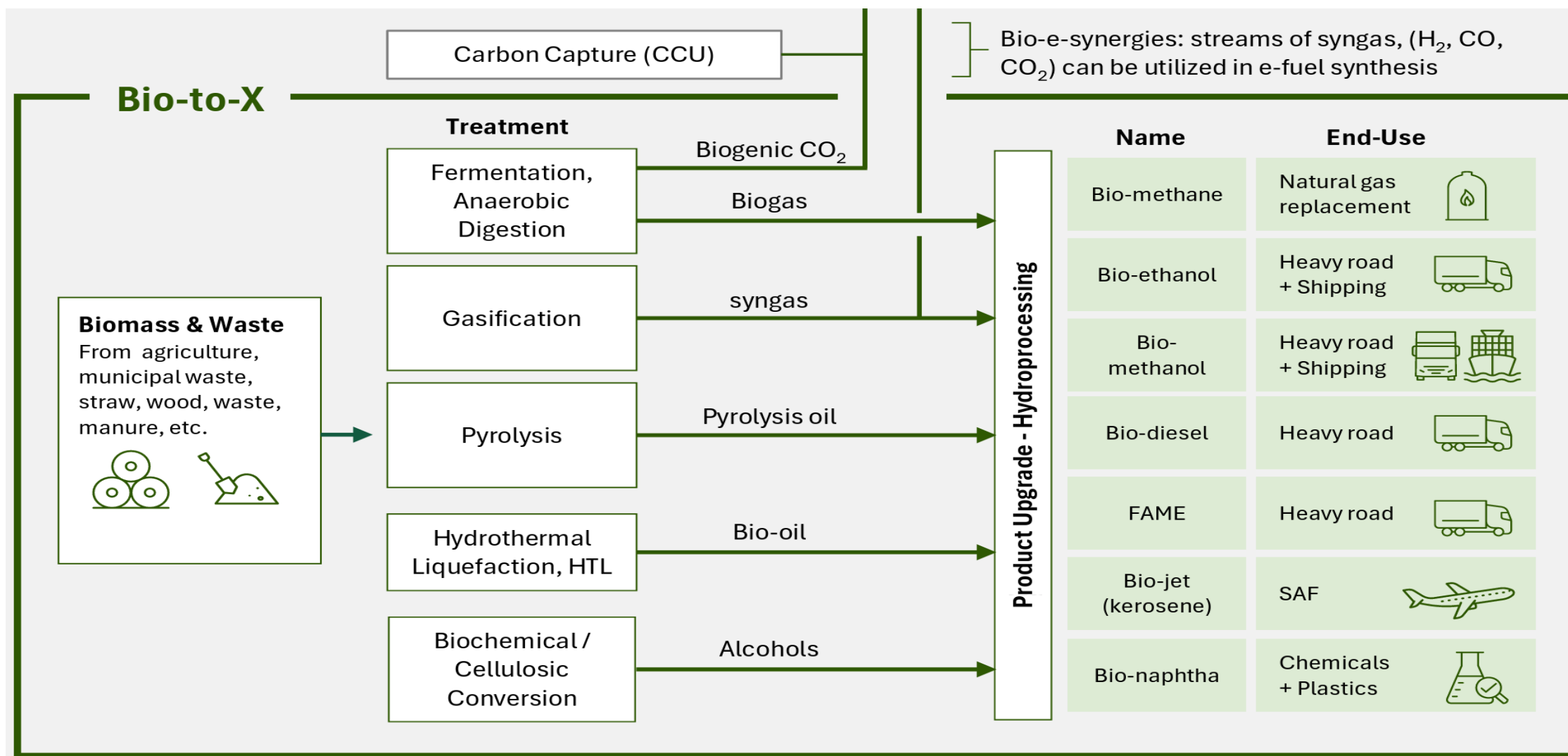
E-Metan i den Grønne Omstilling

Preben Birr-Pedersen,
Direktør i **BiRR**

**LBBL Seminar og
generalforsamling 2025**
d. 10. Oktober

Bioenergiværdikæde

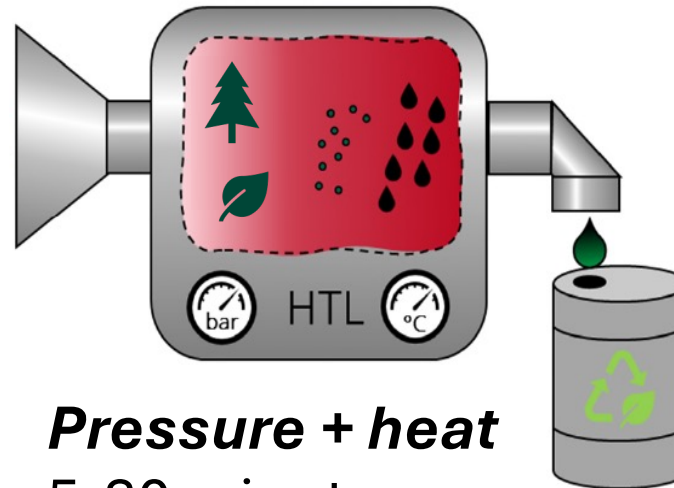




Note: This is a non-exhaustive list and a simplification of often complex multi-step production processes. There are other lower TRL technologies and pathways not shown in the above diagram.

Source: Adaption of Green Power Denmark's "Recommendations for a Danish Power-to-X Strategy"⁴, Ramboll analysis

Hydrothermal liquefaction (HTL): Accelerating natural processes



Pressure + heat
5-30 minutes



Biochar



Biocrude



Gas

HyCarbFuels, en del af Bioenergy Value Chain Programme

Formålet med HyCarbFuels er at afsøge innovative veje til at:

- Lede efter synergier mellem bio- og electrofuels
- Øge forsyningssikkerheden i Norden, og mindske afhængigheden af importeret gas
- Skalere Nordisk bioøkonomi ved at fokusere på anvendelsen af bioaffald i bioenergi værdikæden

Dette gør vi ved at:

- Have dialoger og kontakt med interessenter
- Afdække udfordringer ift. skalering
- Udvikle anbefalinger til nøgle beslutningstagere

Vores policy recommendations bliver præsenteret på Christiansborg d. 11 november

Bliv en del af vores LinkedIn gruppe



HyCarbFuels - Nordic Energy Research
LinkedIn-gruppe



Finansieret af:

Nu strømmer grøn gas ud til danskerne for første gang

Naturgas · 14. september 2011 kl. 14:31 · 12 kommentarer

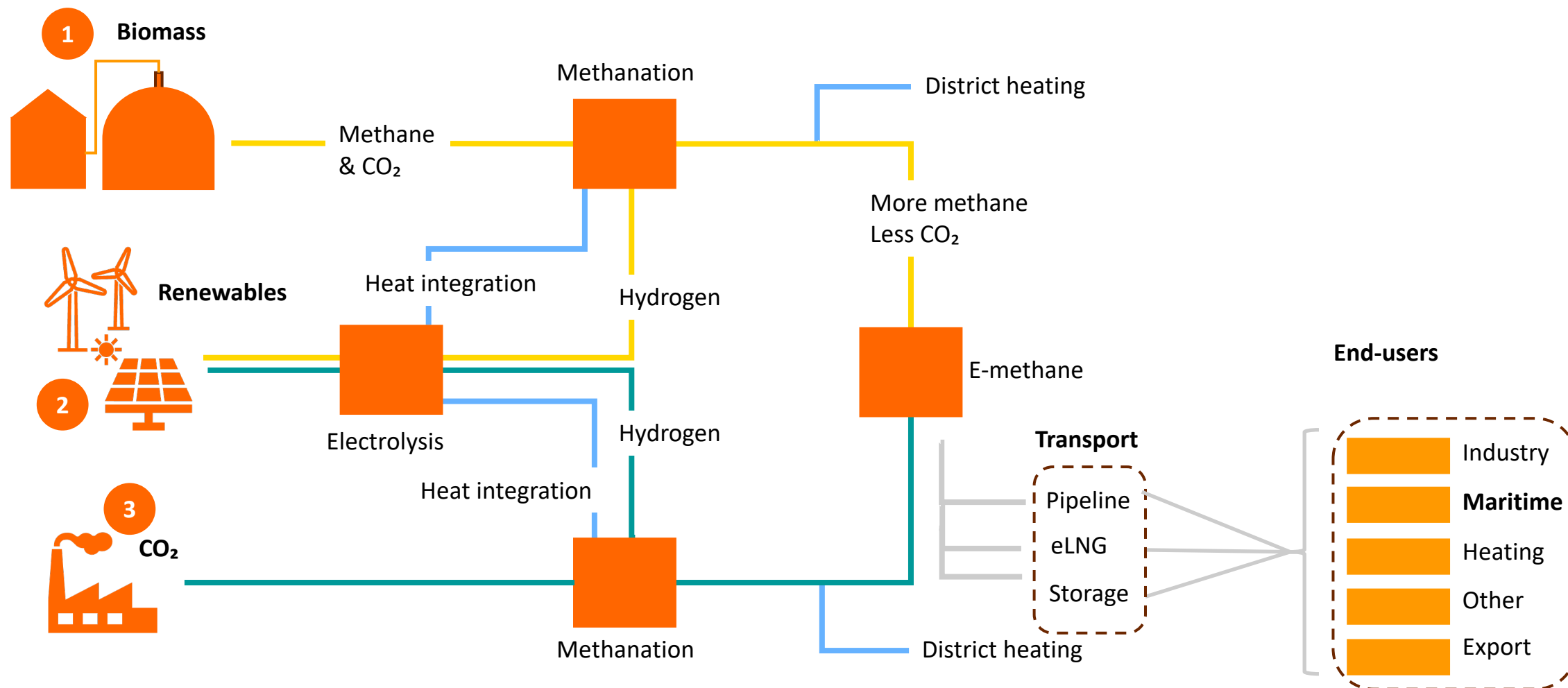
Torsdag modtager naturgasforbrugere i Fredericia-området for første gang en lille smule grøn biogas, der kommer fra Fredericia Spildevandsselskab. Det betyder, at der vil blive sendt en million kubikmeter grøn gas ud til danskerne for første gang.

” SYNSPUNKT

Brintinfrastruktur – er det eksisterende gasnet lige så godt eller bedre?

Brint · 18. februar kl. 14:48 · 33 kommentarer

E-Metan og dens Værdikæde



Brændstoffer Varierer i Modenhed og Udfordringer

The fuel pathways available to maritime will mature and scale at different points in time but while focusing on the short-term potential of certain bio-fuels,

there is a need to look ahead and activate all pathways for us to realise net-zero emission by 2050.

	Feedstock availability	Fuel production	Fuel storage, logistics & bunkering	Onboard energy storage & fuel conversion	Onboard safety & fuel management	Vessel emissions	Regulation and certification
e-methane	●	●	●	●	●	●	●
Bio-methane	●	●	●	●	●	●	●
e-ammonia	●	●	●	●	●	●	●
Blue ammonia	●	●	●	●	●	●	●
e-methanol	●	●	●	●	●	●	●
Bio-methanol	●	●	●	●	●	●	●
Bio-oils	●	●	●	●	●	●	●

● Mature

● Solutions needed

● Significant challenges remaining

Roadmap for Grønne Brændstoffer i Transport og Industri Sektoren 2024

Biofuels production Technologies		Biofuels Technologies	
Technology		TRL	CRI
Biogas/Biomethane	Anaerobic digestion (biomethane)	9	6
	Anaerobic digestion and biological methanation with H2 (biomethane)	7	1
	Anaerobic digestion and catalytic methanation with H2 (biomethane)	8	2
	Biomass gasification - small scale (biomethane) (dry)	9	2
	Biomass gasification - small scale (biomethane) (wet)	4-6	1
	Biomass gasification and catalytic methanation (biomethane)	7	2
	Biomethanisation of syngas	3-5	1
Efuels production technologies		Efuels technologies	
Technology		TRL	CRI
Chemical methanation via catalyst (e-methane)		8-9	2
Methanol synthesis via catalytic hydrogenation		8	2
Fischer-Tropsch using CO2 reduction via reverse water gas shift (RWGS) reaction		6	2
Ammonia synthesis through Haber Bosch process		9	6
CO2 + Hydrogen to CH4 to syngas to Fischer-Tropsch		4-7	1

MISSION
GREEN FUELS

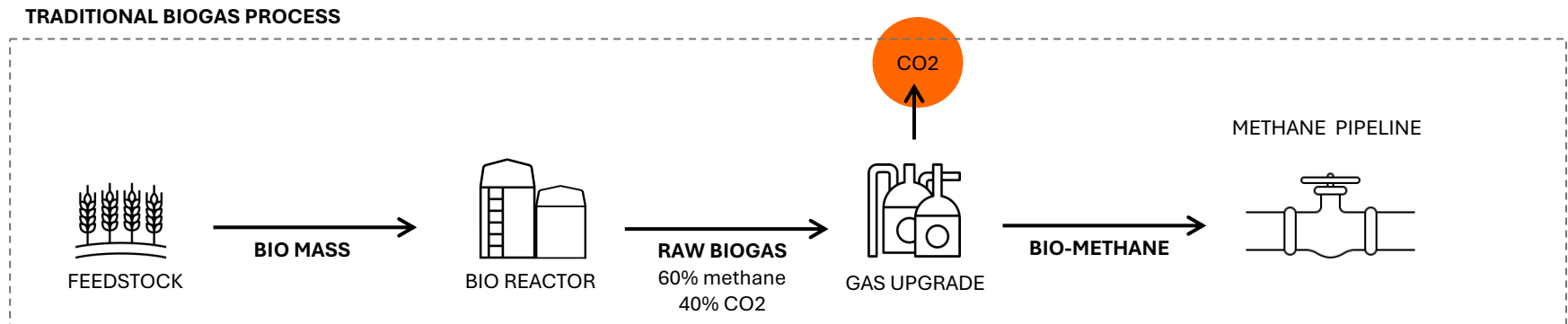
Glansager



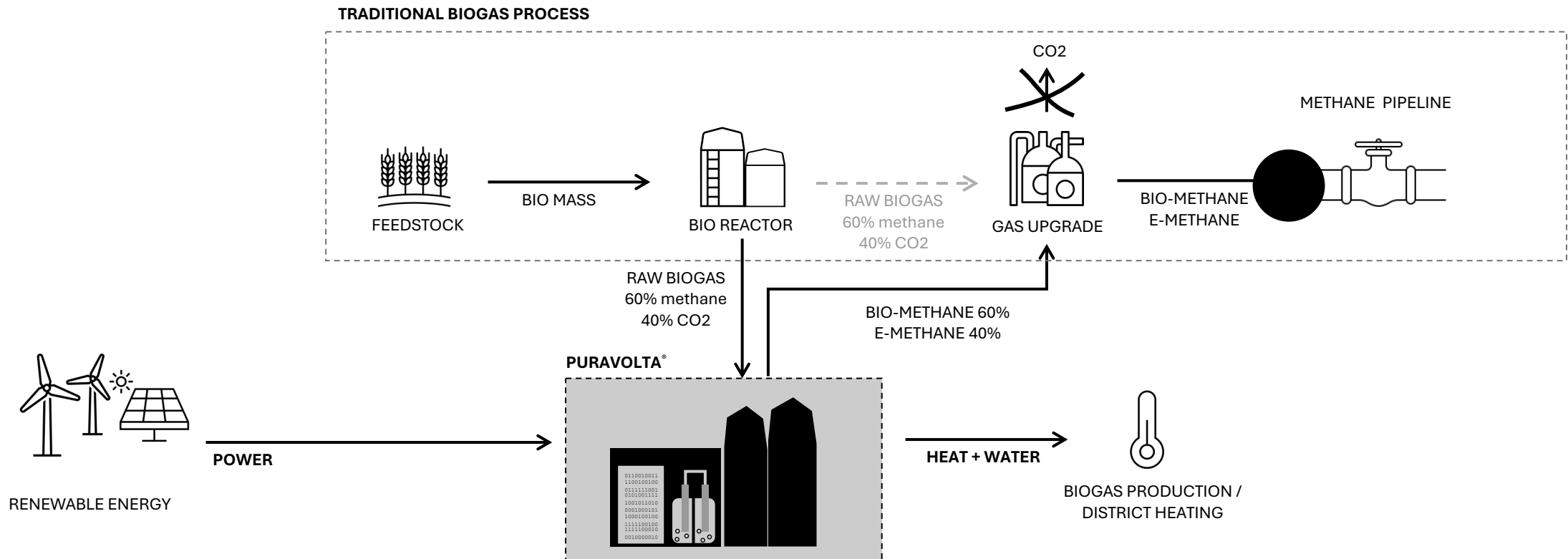
- Fungerer teknisk
- RFNBO ready
- Markedet ikke klart til at betale den ekstra præmium

Omdanner Vedvarende Energi til Konkurrencedygtig E-Brændstof

Plug & Play Løsning (>50% forøgelse af metan output)



Omdanner Vedvarende Energi til Konkurrencedygtig E-Brændstof Plug & Play Løsning (>50% forøgelse af metan output)

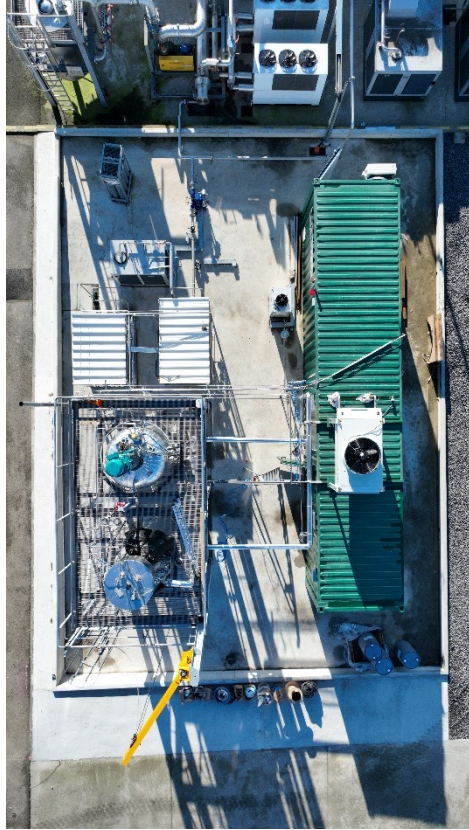


enos

Denobio®

BiRR

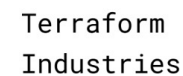
An industrial demonstration plant



- **Plant commissioning:** March 2025
- **CO₂ / biogas processing:** Achieved at nominal rate (CO₂ conversion > 99%)
- **Compliance with gas network requirements:** Achieved (H₂ slip < 0.2%)
- **Injecting into the natural gas grid:** Since July 2025
- **Intermittent operations:** Planned in 2025 / 2026
- **RFNBO certification:** Process on-going (ISCC)



Photo credits: Energia Thiérache, Enosis 2025

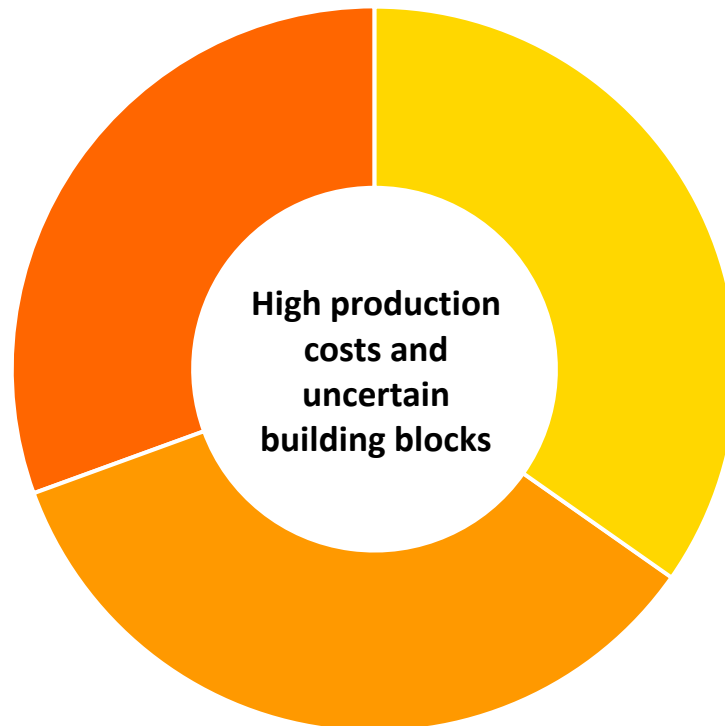


The e-NG Coalition is a collaborative alliance of pioneering companies that believe electric Natural Gas (e-NG) has a role to play to accelerate the energy transition towards a net-zero carbon future.

Økonomien for E-Metan er skrøbelig, men kan forbedres

Electricity

- Competing priorities increase uncertainty for producers.
- Secondary use of electricity (e.g., auxiliary services) can have higher value, which creates uncertainty for e-methane producers.
- Value capture often favors traders over producers.



Hydrogen

- E-methane costs exceed other fuels because green/low-carbon hydrogen is required.
- Green hydrogen costs 4-8 EUR/kg, dominating e-methane costs.
- Blue hydrogen offers a cheaper option but relies on CCS and natural gas prices.
- White hydrogen (1-2 EUR/kg) has potential but remains undeveloped and faces extraction challenges.
- EU regulation (RFNBO) pushes green hydrogen despite cost challenges.
- EU Innovation Fund Hydrogen Auction driving down production cost.

CO₂

- Availability depends on capture costs or imports.
- Logistics and regulation shape CO₂ supply reliability.
- Competition from CCS.

Expected cost reductions within the next five years will make e-methane increasingly competitive in near future.

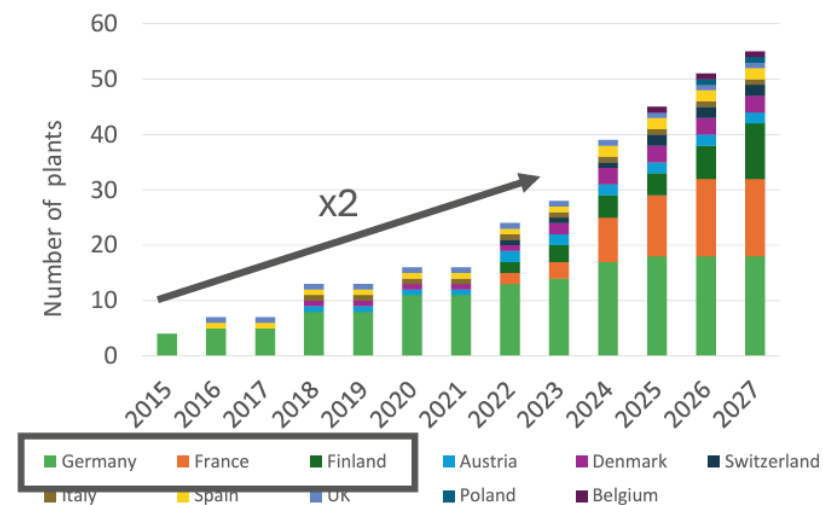
EU Scenarier: ENTSOG Ten Year Network Development Plan (TYNDP)

- The European organisation for National Transmission System Operators for Gas (ENTSOG) is obliged by EU Regulation to bi-annually analyse the infrastructure needed for molecules/gasses in 2030, 2040 and 2050. Scenarios is made jointly with ENTSO-E.
- Overall molecule/gas is expected to decline a little in all scenarios from today 4000 TWh (400 BCM) to 3000-4000 TWh accross the scenarios; with smallest demand in Distributed Energy scenario. Methane drop from 4000 TWh down to 1-2000 TWh, with hydrogen increasing from 0 to 1500-3000 TWh and biomethane equal.
- TYNDP'2024 include little detail on "e-methane". The future will be a blend of different types (natural gas = methane, biomethane and synthetic methane, with e-methane) – their mix is uncertain and will rely on future costs.

	National Trends		Distributed Energy		Global Ambition	
	2030	2040	2040	2050	2040	2050
Methane	90%	76%	68%	21%	61%	5%
Biomethane	9%	20%	29%	63%	34%	76%
E-methane	0%	4%	3%	17%	5%	20%
E-methane (BCM)	0	14	11	60	18	70

E-Metan Efterspørgsel Stiger: Produktion skal Skaleres mere end Nuværende Planer

- From the basis of the methane (Natural Gas, NG) market, lowcarbon and renewable gasses are maturing fast.
- EU currently have a 35 BCM target in 2030 for **biomethane**, whereas the countries only have forecasts aggregating to 32 BCM.
 - There is no EU target for **e-methane**.
- No countries have in the national energy and climate plans (NECPs) included **e-methane** for 2030, but some of them have included it for 2040; adding up to some BCM (dependent on calorific value).
 - TSO's expect 14 BCM by 2040 (previous page).
- ENTSOG in their TYNDP (from previous page) see a growth for **e-methane**:
 - 2040 between 11-18 BCM
 - 2050 between 60-70 BCM
- The latest status for EU conclude there is 35 **operational e-methane plants** in EU, of which 14 are in Germany. More than 20 new plants are planned or under construction, most in France and Finland (see below).
- In 2016, EU produced 20 GWh e-methane, increased to 449 GWh this year. **Projections for 2027** are 3000 (equal to 0,27 BCM). The sector organisations do not have forecasts for 2030.

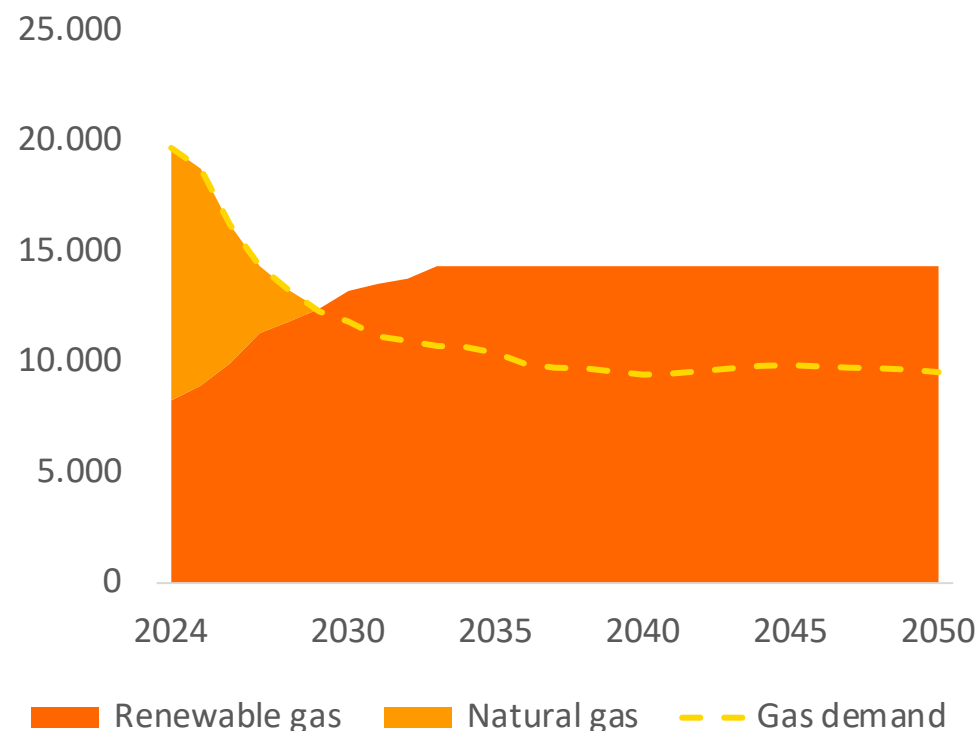


E-Metans Rolle i Prognoser: Indsigter fra Dialog med Førende EU Energi Organisationer

Focus	Short term	Longer term
Opportunities	• ENTSOG see huge potential for e-methane. • Half of gas TSOs (around 20) have e-methane as part of their network planning for 2040. • IEA and EBA sees strong e-methane development in selected EU-countries Finland and France (with global interest from EU commercial companies and Japan). • EBA will in 2025 reassess "potential for e-methane in EU" including "potential projects" (2024 analysis included only FID projects) and "biogene CO₂ opportunities." • GIE see first potential in Maritime and Transport in connection with existing LNG terminals.	• With a declining natural gas demand, the need for biomethane and synthetic methane increases. • Understanding of the energy system and energy transition evolves slowly, but the role for e-methane is expected to be improved. • GIE expect some EU Member States to focus on hydrogen and derivatives, while others on methane (with CCUS).
Challenges	• None/few EU Member States have e-methane in NECPs. • Most EU Members States have more policies and funding on CCS, incl. storing of biogen CO₂ (from biogas). • IEA have reduced global focus on e-methane during 2021-2024 (but increased focus on CO₂ and biomethane). IEA do not see global trend for e-methane.	• ENTSOG will (most likely) reduce forecasts / potentials for e-methane, as their analyses become more controlled (by ACER and Commission) [More politically oriented]. • IEA expect gas demand in EU to decline; probably more than EU and ENTSOG.

Grøn Gas for at Imødekomme Efterspørgsel

Gas market (GWh)



E-Methane: beyond biomass and biogas

- Biomass potential is estimated at 26,000 GWh annually, which is sufficient to fully cover national gas demand even under high-demand scenarios.
- Biogas will fully replace natural gas before 2030, with e-methane as a future complement.
- Biogenic CO₂ from biogas is available for e-methane production, which can turn excess wind and solar power into a scalable renewable fuel.
- E-methane enables seasonal energy storage and can integrate up to 2.5 GW of surplus renewable electricity into gas grid.

Nøgle Projekter blandt Power-to-X Udfordringer

- Denmark aims to leverage its renewable energy surplus to become a leading exporter of green hydrogen and e-fuels.
- Over 50 projects focused on green hydrogen, e-methanol, e-ammonia, and e-methane.
- Uncertainties around energy islands and broader hydrogen and PtX markets, highlighted by Ørsted's decision to withdraw from selected projects.

E-methane projects

Project	Capacity	Location	Commissioning	Remarks
Nature Energy Glansager	12,000 m ³ e-methane/day	Glansager, Sønderborg	Operational (2023)	Heavy transport and industry.
Grøn Brint	2 MW	Hjørring, Nordjylland	Operational (2023)	Supported by REACT-EU; focus on integration into gas grid.
Biocat Roslev	9,600 m ³ e-methane/day	Roslev, Midtjylland	Planned (2026)	Industry and heavy transport; received DKK 71m in PtX funding.



Nøgle E-Metan Projekter

Project Name	Location	Methanation type	Start Year	Status	End use	CO ₂ Source	CO ₂ (t/year)	Energy (GWh/year)	Electrolysis Tech	Electrolyser Power (MW)	H ₂ Production (Nm ³ H ₂ /hr)	Type
Keravan Energia Bio-CHP (link2)	Kerava	ex-situ biological	2027	under construction	transport + heating	Other	37000	180.0	na	34	7621	industrial
e-methane project	Tampere	ex situ catalytic	2023	under construction	mobility / transport	Other	39885	201.0	Alkaline	45	23099	industrial
Lahti	Lahti	na	2027	under construction	heating	Other	70000	360.0	na	68	15241	industrial
Kotka (link2)	Kotka	na	2026	under review/feasibility study	heating	Other	110000	200.0	na	104	23099	industrial
Mikkeli (link2)	Mikkeli	na	2027	under construction	heating	Other	37000	200.0	na	34	7621	industrial
Pori (link2)	Pori	na	2027	under construction	Mobility / transport	Other	100000	382.0	na	68	15241	industrial



Nøgle E-Metan Projekter

Project Name	Location	Methanation type	Start Year	Status	End use	CO ₂ Source	CO ₂ (t/year)	Energy (GWh/year)	Electrolysis Tech	Electrolyser Power (MW)	H ₂ Production (Nm ³ H ₂ /hr)	Type
Power-to-X plant (link2)	Kristinestad	ex situ catalytic	2026	under review/feasibility study	transport + power	Other	181332	949.0	Alkaline	200	41419	industrial
Carbon2x	Riihimäki	ex situ catalytic	2022	planned	na	Other	14	55	na	na	na	industrial
Vantaa Energia renewable methane	Vantaa	na	2022	planned	mobility / transport	Other	13992	81.0	na	20	4450	industrial



Nøgle E-Metan Projekter

Project name	Location	Methanation type	Start year	Status	End use	CO ₂ source	CO ₂ (t/ year)	Energy (GWh/ year)	Electrolysis tech	Electrolyser power (MW)	H ₂ production (Nm ³ H ₂ /hr)	Type
STORE&GO Windgas/Demonstration Falkenhagen	Falkenhagenn	ex situ catalytic	2018	active	grid injection	Other	906	5.2	PEM	1.0	180	demo
BioFARM/MicroPyros	Straubing	ex situ biological	2024	constructed	power	Gasification	32	0.2	AEM	0.04	8	demo
PFI - Pirmasens-Winzeln (link2)	Pirmasens-Winzeln	ex situ biological	2015	active	grid injection	biogas (AD)	874	5.0	na	2.5	556	pilot
Eucolino	Schwandorf	in-situ biological	2012	constructed	power	biogas (AD)	84	0.5	na	0.1	21	pilot
WeMetBio2 / consortium	Flensburg	ex situ biological	2025	planned	transport + heating	biogas (AD)	318	1.8	na	na	na	demo
Audi e-gas ATLANTIS (link2)	Wertle	ex situ catalytic	2013	active	Mobility/ transport	biogas (AD)	2800	15	Alkaline	6.3	1402	industrial
BioPower2Gas (link2, link3)	Allendorf, Giessen	ex situ biological	2016	constructed	grid injection	biogas (AD)	na	2.8	PEM	0.3	67	demo
Power-to-Gas-Anlage, Sektorenkopplung (link2, link3)	Mainz	na	2018	active	grid injection	biogas (AD)	5509	32	PEM	6.3	1402	industrial



Nøgle E-Metan Projekter

Project name	Location	Methanation type	Start year	Status	End use	CO ₂ source	CO ₂ (t/ year)	Energy (GWh/ year)	Electrolysis tech	Electrolyser power (MW)	H ₂ production (Nm ³ H ₂ /hr)	Type
Energy Lab 2.0 am KIT (link2)	Eggenstein-Leopoldshafen	ex situ catalytic	na	constructed	grid injection	biogas (AD)	159	0.9	PEM	0.1	22	pilot
Nachhaltige Energieversorgung Bernsteinsee	Sassenburg	ex situ catalytic	2020	constructed	grid injection	Gasification	130	na	na	na	na	na
BiRG (BioReststoffGas) (link2, link3)	Goldenstedt	ex situ biological	2023	constructed	other	Gasification	na	0.2	na	0.1	24	demo
Forschungsprojekt - KraftwerkLand project (link2)	Dörrentup	ex situ catalytic	2018	active	na	other	na	na	PEM	na	na	pilot
Turn2X	Brandenburg	na	2024	under construction	grid injection	na	na	na	na	na	na	industrial
Infinity 1	Pfaffenhofen an der Ilm	ex situ biological	2020	active	grid injection	biogas (AD)	na	7.52	na	1	223	industrial
RB-HTWP / GICON GmbH	Cottbus	ex situ biological	2022	constructed	grid injection	biogas (AD)	8	0.05	na	na	na	demo



Nøgle E-Metan Projekter

Project name	Location	Methanation type	Start year	Status	End use	CO ₂ source	CO ₂ (t/ year)	Energy (GWh/ year)	Electrolysis tech	Electrolyser power (MW)	H ₂ production (Nm ³ H ₂ /hr)	Type
CUMA des éleveurs du Bergeracois	Saint-Pierre-d'Eyraud	Biological	2026	Under review/feasibility study	Grid injection	Biogas (AD)	2,067	11.92	N/A	2.3	520	Industrial
MarHySol	Marmagne, Cher	Catalytic	2026	Under review/feasibility study	Grid injection	Biogas (AD)	2,385	13.75	N/A	2.7	600	Industrial
Occi-Biorne	Ludiès	Biological	2025	Under review/feasibility study	Grid injection	Biogas (AD)	1,161	6.7	PEM	1.4	312	Industrial
STEP de Bonneuil	Bonneuil-en-France	N/A	2025	Under review/feasibility study	Grid injection	Biogas (AD)	636	3.67	N/A	0.7	160	Industrial
Méthy-Centre (Storengy)	Angé	Biological	2024	Under construction	Grid injection	Biogas (AD)	199	1.15	PEM	0.25	56	Pilot
Biofactory Pau	Lescar	Catalytic	2024	Under construction	Grid injection	Biogas (AD)	3,143	6.23	PEM	1.3	289	Industrial
COMETHA / GICON GmbH	Paris	Biological	2024	Active	N/A	Biogas (AD)	1,6	0.01	N/A	N/A	N/A	Demo
Denobio-Enosis	Lesquielles-Saint-Germain	Biological	2024	Under construction	Grid injection	Biogenic CO ₂ from AD	318	1.83	N/A	0.4	80	Pilot

Nøgle E-Metan Projekter

Project name	Location	Methanation type	Start year	Status	End use	CO ₂ source	CO ₂ (t/year)	Energy (GWh/year)	Electrolysis tech	Electrolyser power (MW)	H ₂ production (Nm ³ H ₂ /hr)	Type
Methan'Up	Le Havre	Catalytic	2024	Under review/feasibility study	Grid injection	Biogenic CO ₂ from AD	1,749	10.09	N/A	N/A	N/A	Pilot
STEP Perpignan	Perpignan	Biological	2023	Under review/feasibility study	Grid injection	Biogas (AD)	795	5	Electrolysis	1	200	Industrial
METHA2	Audun-le-Tiche	Catalytic	2022	Under construction	Mobility/transport	Biogas (AD)	41	0.24	Electrolysis	N/A	N/A	Pilot
ENERGO	Sempigny	Other (plasma-catalysis)	2022	Active	N/A	Biogas (AD)	N/A	0.28	Electrolysis	0.1	12	Industrial
BIMOTEP - Enosis	Épinal	Biological	2022	Active	N/A	Biogenic CO ₂ from gasification	N/A	N/A	N/A	N/A	N/A	Demo
SOLIDIA - Enosis	Toulouse	Biological	2018	Active	N/A	Biogenic CO ₂ from AD	N/A	N/A	Electrolysis	0.05	N/A	Demo