European strategy for biomethane innovation and market development

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GreenMeUp Meeting, Leipzig - 25 March 2025

Some new initiatives in the 2025 Commission Work Programme

A new plan for Europe's sustainable prosperity and competitiveness

- **Competitiveness Compass non-legislative, Q1 2025**
- Single Market Strategy non-legislative, Q2 2025
- Digital Package legislative, Q4 2025
- **Clean Industrial Deal non-legislative, Q1 2025**
- **Action plan on affordable energy non-legislative, Q1 2025**
- **Industrial Decarbonization Accelerator Act legislative, Q4 2025**
- **EU Start-up and Scale-up Strategy non-legislative, Q2 2025**
- Communication on a Savings and Investments Union non-legislative, Q1 2025
- Digital Networks Act legislative, Q4 2025
- Bioeconomy Strategy non-legislative or legislative, Q4 2025
- **Roadmap towards ending Russian energy imports non-legislative, Q1 2025**
- Sustainable Transport Investment Plan non-legislative, Q3 2025

Sustaining our quality of life: food security, water and nature

- **European Climate Law amendment, legislative, Q1 2025**
- Vision for Agriculture and Food non-legislative, Q1 2025
- Common Agricultural Policy simplification package legislative, Q2 2025
- Ocean Pact non-legislative, Q2 2025
- European Water Resilience Strategy non-legislative, Q2 2025

A global Europe: Leveraging our power and partnerships

- Pact for the Mediterranean non-legislative, Q3 2025
- EU strategic approach to the Black Sea/ Black Sea Strategy non-legislative, Q2 2025
- Joint Communication on a new Strategic EU-India Agenda non-legislative, Q2 2025

Delivering together and preparing our Union for the future

- **Post-2027 Multiannual Financial Framework proposals legislative, Q3 2025**
- An EU fit for enlargement: policy reviews and reforms non-legislative, tbd

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Clean Industrial Deal COM(2025) 85 final

The EU's business plan to accelerate decarbonization and competitiveness for European industry by boosting innovation and reinforcing EU resilience

Affordable Energy: economy-wide electrification from 21.3% to 32% in 2030 & 100 GW of renewable electricity capacity installed/year until 2030

- Affordable Energy Action Plan to lower energy costs for business and citizens
- Power Purchase Agreements to tackle volatile prices
- Domestically produced clean energy

Lead Markets : 40% of domestically produced key components of clean tech products on the EU market

- Foster demand for clean products made in the EU by sustainability, resilience and European preference criteria in EU public procurement for strategic sectors
- Product label for carbon intensity to allow businesses to reap a "green premium" and inform consumers

Financing: leverage more than € 100 billion investments for the industrial transition

- Empower Innovation Fund by more synergies between existing funding instruments
- Leverage private investment by amending InvestEU
- Simplified State aid rules for more flexibility to MS

Circularity and Access to Materials: Increase circular material use rate from 11.8% today to 24% by 2030

- Lower prices and higher availability for critical raw materials by joint purchases (EU Critical Raw Material Centre)
- Circular Economy Act to reduce dependencies on primary materials imports

Global Markets and International Partnerships: ensure the largest possible share of the global market for clean technologies worth $ 2 trillion in 2035

- European companies better access third markets via trade agreements and Clean Trade and Investment Partnerships
- Intensify international and multilateral cooperation to address global overcapacities redirected to EU market

Skills Enhancement : Reduce occupations number requiring specific skills/knowledge for clean transition

- Union of Skills for strategic industries

Simplification

- Speed up permitting for industrial decarbonization projects
- Simplify State aid rules by 2025 to accelerate clean energy roll-out and support industrial decarbonization
- Enhance coordination between EU and national policies to reduce red tape and leverage the scale of the Single Market

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EU policies

European Climate Law Regulation

&

European Green Deal and Fit for 55

- RED
- REFuelEU aviation
- FuelEU maritime
- ETS
- ESR
- ETD
- CO2 standards

REPowerEU Plan COM(2022) 230 final

- Biomethane Action Plan
- Biomethane Industrial Partnership

Hydrogen and decarbonised gas markets package

- Renewable gases
- Low carbon gases with<=70% GHG emissions on LCA basis

The Green Deal Industrial Plan

EU Net-Zero Industry Act

- Sustainable biogas and biomethane
- Sustainable alternative fuels for aviation and maritime
- RFNBOs

Strategic Technologies for Europe Platform

- Clean technologies
  - Renewable energy
  - RFNBOs
  - SAF (alternative)
- Bio technologies
- Deep and digital technologies

COM(2024) 63 final - Europe's 2040 climate target

reducing EU's net GHG emissions by 90% by 2040

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Funding

EU Multiannual Financial Framework	**€ 320 billion** for climate (2021-2027)
Next Generation EU	**€ 5,4 billion** for Horizon Europe and
	€ 6,1 billion for INVESTEU (2021-2027)
Horizon Europe **€ 95.5 billion** (2021-2027)	Cluster 5 - Climate, Energy and Mobility: € **15.1 billion**
	Innovative Europe (EIC & EIT) **€ 13.6 billion**
Innovation Fund	**€ 47 billion** (2020-2030)
	€1,6 billion for aviation
LIFE Programme	**€ 5.45 billion** (2021-2027)
InvestEU for R & I :	**€ 6,6 billion** (2021-2027) to leverage **€ 90 billion** R&I investments
	Market based finance for the exploitation and scale-up of European R&I
InvestEU / EIB :	**€ 26.2 billion** to leverage **€ 372 billion** (2021-2027)

HORIZON EUROPE

EURATOM

SPECIFIC PROGRAMME: EUROPEAN DEFENCE FUND

Exclusive focus on defence research & development

- Research actions
- Development actions

SPECIFIC PROGRAMME IMPLEMENTING HORIZON EUROPE & EIT*

Exclusive focus on civil applications

Pillar I
EXCELLENT SCIENCE

- European Research Council
- Marie Skłodowska-Curie
- Research Infrastructures

Pillar II
GLOBAL CHALLENGES & EUROPEAN INDUSTRIAL COMPETITIVENESS

Clusters

- Health
- Culture, Creativity & Inclusive Society
- Civil Security for Society
- Digital, Industry & Space
- Climate, Energy & Mobility
- Food, Bioeconomy, Natural Resources, Agriculture & Environment

Joint Research Centre

Pillar III
INNOVATIVE EUROPE

- European Innovation Council
- European Innovation Ecosystems
- European Institute of Innovation & Technology*

WIDENING PARTICIPATION AND STRENGTHENING THE EUROPEAN RESEARCH AREA

- Widening participation & spreading excellence
- Reforming & Enhancing the European R&I system

EURATOM

- Fusion
- Fission
- Joint Research Center

* The European Institute of Innovation & Technology (EIT) is not part of the Specific Programme

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Horizon Europe Strategic Plan 2025-2027

Ensuring more efficient, sustainable, secure, and competitive renewable and decarbonized energy supply

R&I activities are needed on renewable energy generation from e.g. solar, wind, geothermal, ocean, hydropower, and sustainable energy vectors like biomethane, advanced biofuels, solar and synthetic renewable fuels, other

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Horizon Europe Work Programme

Cluster 5 Climate Energy and Mobility, Destination Sustainable, secure and competitive energy supply, Renewable Energy

Work Programme 2025

- To be adopted April 2025
- Info day & brokerage event 6 May 2025

  Brussels in physical format, entirely web-streamed, followed by brokerage event (pitching session and B2B), event page available at the beginning of March

Work Programme 2026-2027

- In progress
- To be adopted end 2025
- **Clean Industrial Plan Flagship call under Horizon Europe,** ~ € 600 million, Q4 2025

  Support fit-for-deployment projects

  Promote next generation of clean tech, clean energy and decarbonized manufacturing in the EU

  Synergies of Horizon Europe and Innovation Fund, pipeline of projects from R&I to deployment

R&I days 16-17 September in Brussels (more information to come)

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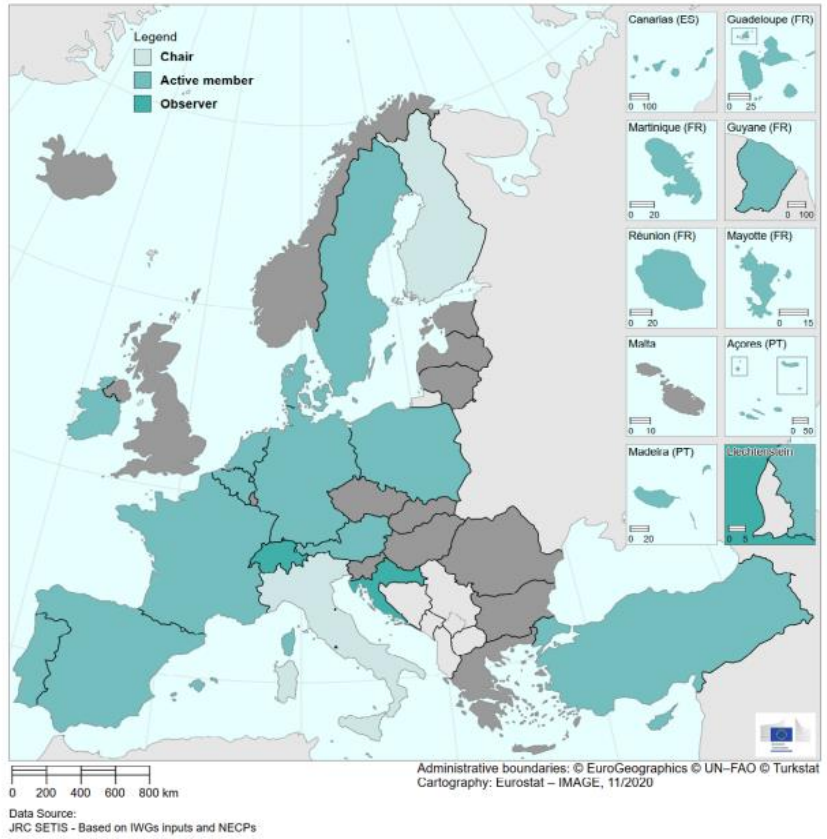
SET PLAN IWG Bioenergy and Renewable Fuels

- *The SET Plan was established in 2007 and since the creation of the Energy Union, it became one of the main instruments of the energy union's 5th pillar on research, innovation and competitiveness*
- *The SET Plan is governed by the SET Plan Steering Group and is Part of NZIA*
- *The IWG of **Bioenergy and Renewable Fuels** issued an Implementation Plan and an R&I actions program aiming at*
  - *Demonstrating advanced liquid and gaseous biofuels, renewable hydrogen and synthetic fuels including for aviation through biochemical /thermochemical / chemical conversion from sustainable biomass and/or from autotrophic microorganisms and renewable energy*
  - *Development of high-efficiency large scale biomass cogeneration of heat and power*

Composition



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Fuelling innovation

Biomethane is a renewable fuel derived from multiple sources and delivered directly to a wide range of consumers. From increasing the supply of feedstocks through improved municipal waste programmes and utilisation of marginal lands, to the development of advanced materials and technologies that can support economical synthesis of sustainable biofuels, each link in this web presents an opportunity for innovative research to increase biomethane production.

Organic matter

Household food and paper waste, farmland residues, and animal manure from meat, egg and dairy production are all waste products high in organic matter, making them an excellent and highly abundant feedstock for biogas production.

Waste waters

During their treatment, industrial and residential waste waters are stored in large ponds that encourage the growth of algae, to remove dissolved nutrients that would otherwise cause harmful pollution. This algae is then harvested and used as a feedstock.

Wood biomass

Bark, sawdust, wood chips, scrap and other residues and wastes from farming, agroforestry and lumber industries are high in cellulose, but also lignin, which makes them difficult to break down in anaerobic digesters.

Anaerobic digestion

Inside large reactors, microbes such as bacteria feed on organic waste, breaking it down and producing high amounts of methane and carbon dioxide in the process, as well as trace gases such as hydrogen sulphide.

Gasification and methanation

Using high temperatures and controlled inputs of oxygen and steam, woody wastes are chemically broken down, releasing nitrogen, carbon monoxide, hydrogen and carbon dioxide. These gases can then be converted into methane. The leftover ash, called biochar, can be used to condition farm soils while sequestrating carbon.

Digestate

The liquid and solid matter remaining after anaerobic digestion is rich in nutrients and helpful microbes, making it highly valued as organic fertiliser.

Upgrading

Here, the gas produced by microbes is treated to separate and concentrate the methane fraction, and remove problem contaminants such as foul-smelling hydrogen sulphide.

Gas network

After upgrading, the biomethane can be injected directly into the existing gas network, displacing natural gas derived from non-renewable sources.

Artificial photosynthesis

Water and atmospheric carbon dioxide represent the most abundant and widely available source of ingredients needed to make methane. By harnessing renewable energy such as solar, the gas can be efficiently synthesised anywhere in the world.

Consumption

To the consumer, biomethane is indistinguishable from fossil fuel gases, supplying the chemical energy needed for transport, industrial applications, heating and cooking.

Wastes / Feedstock
Biomethane
Recycle

Innovative bio-methane production in the EU

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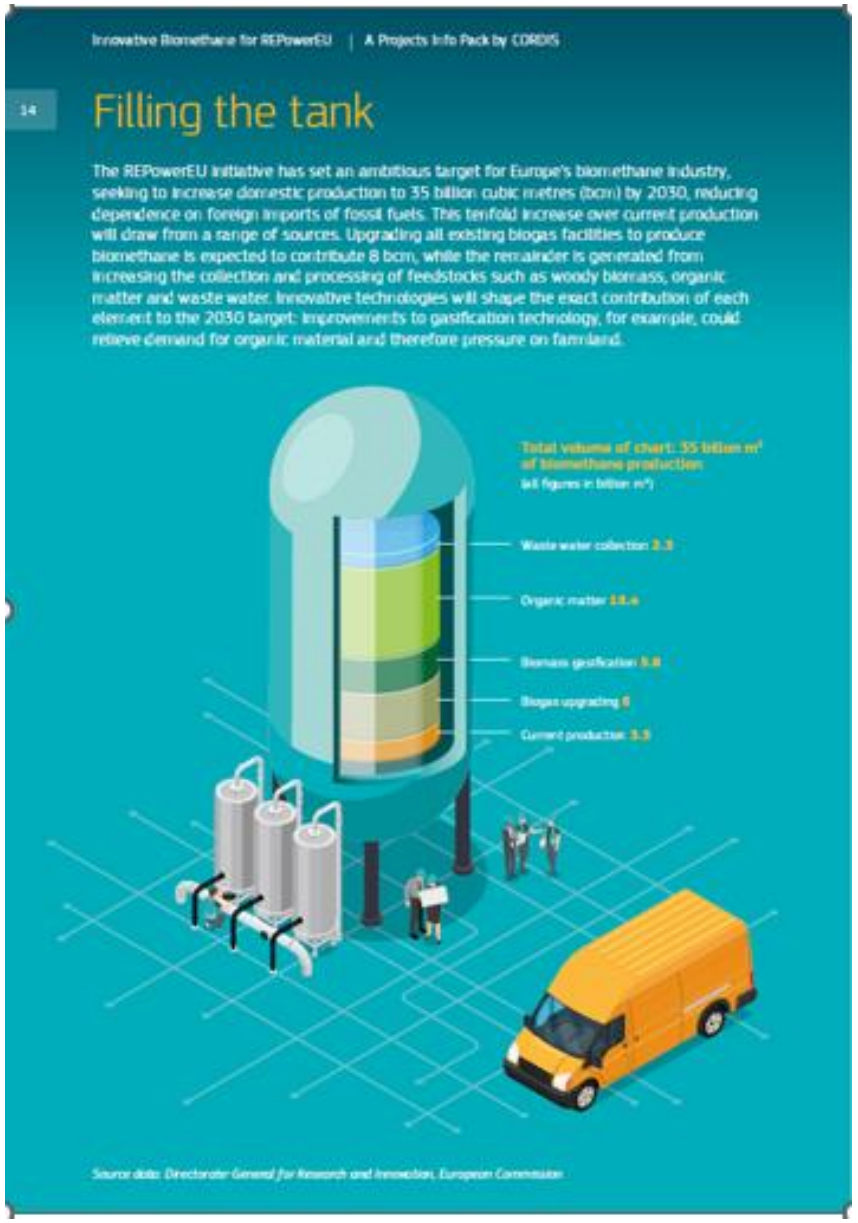
Innovative biomethane production in the EU



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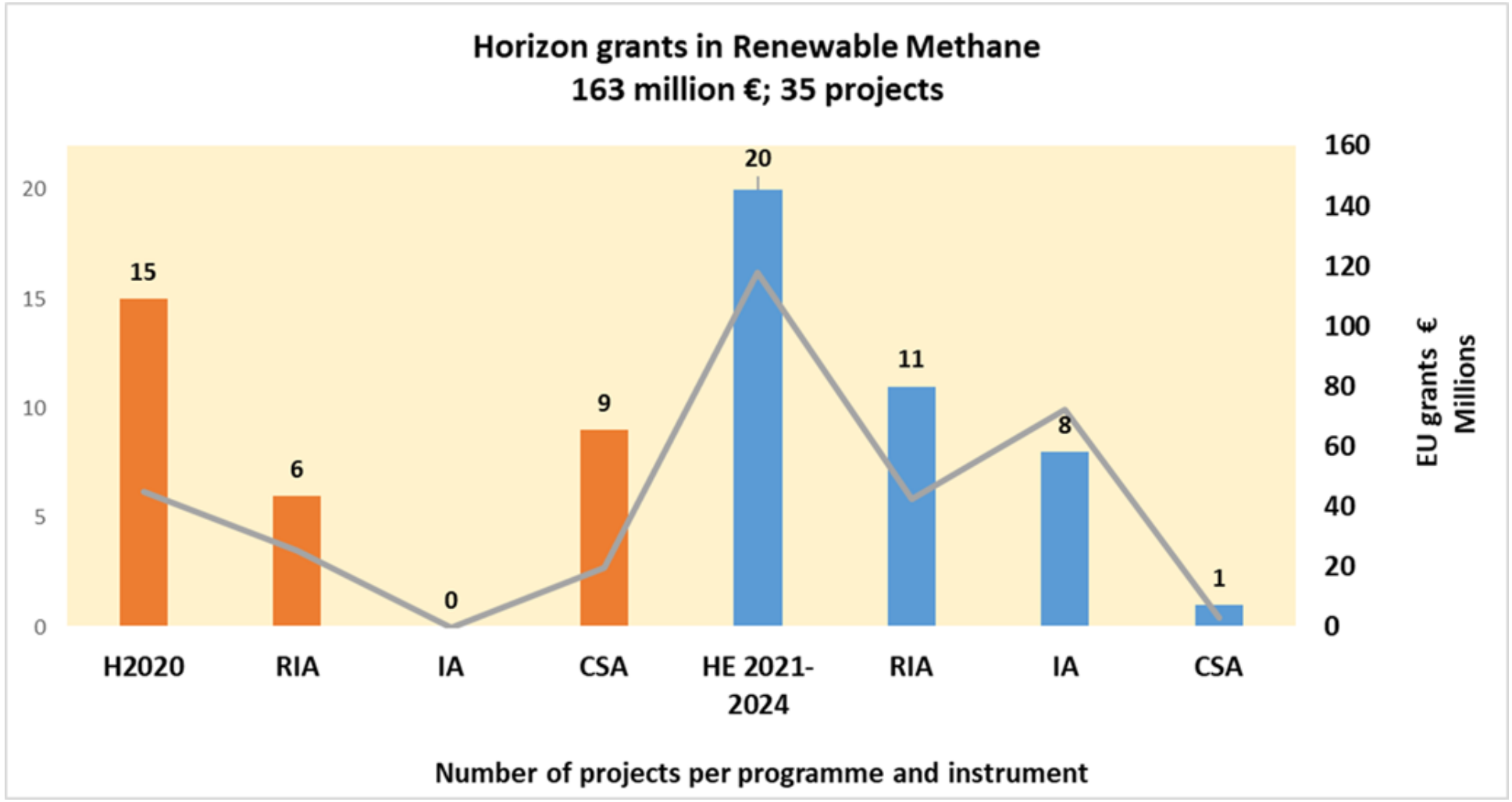

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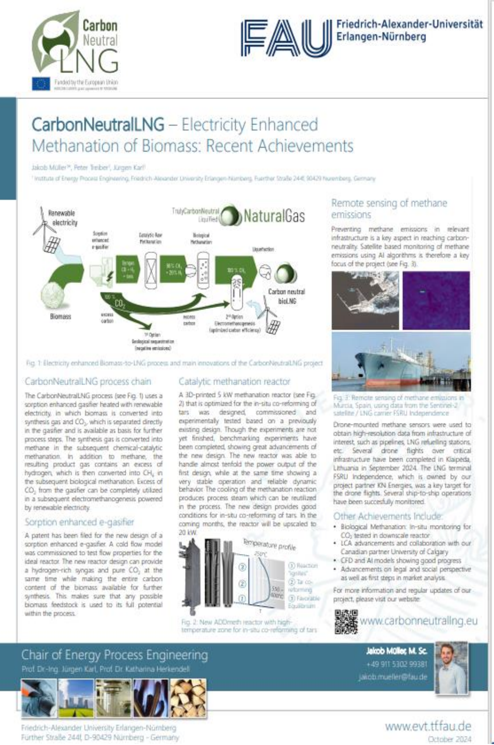
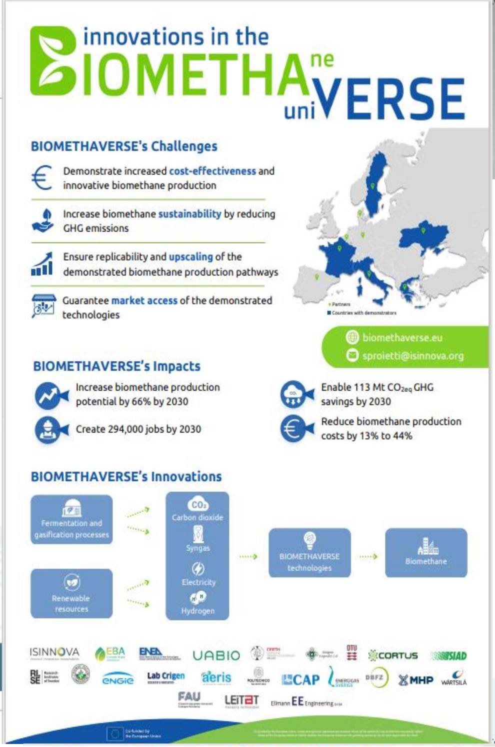
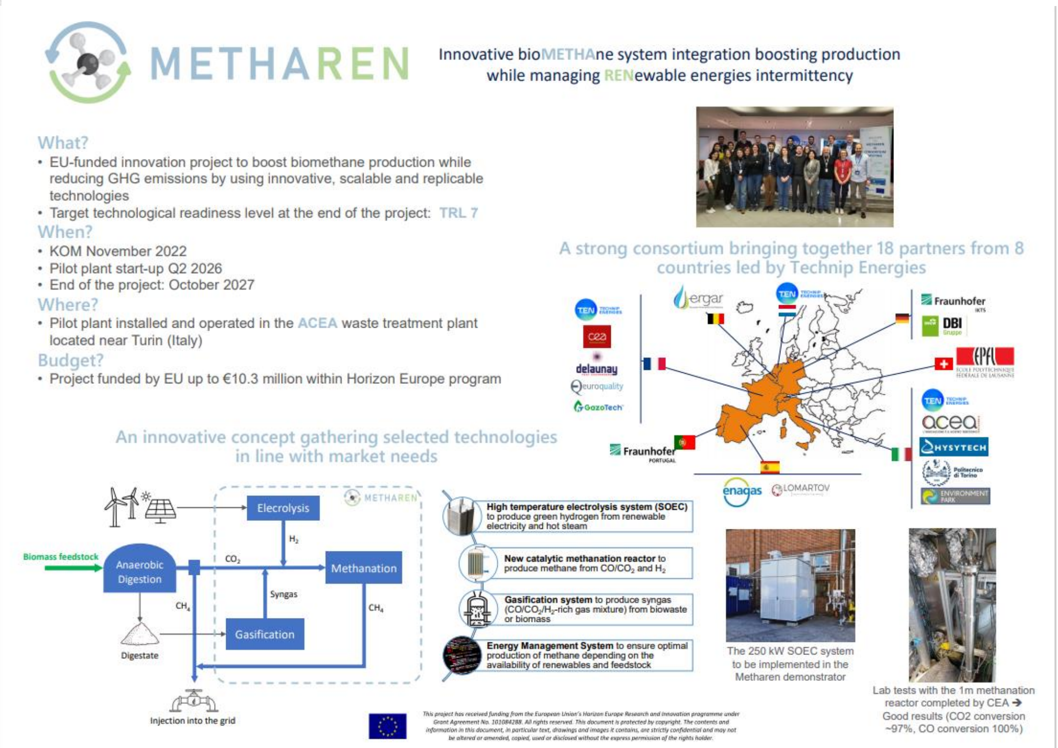
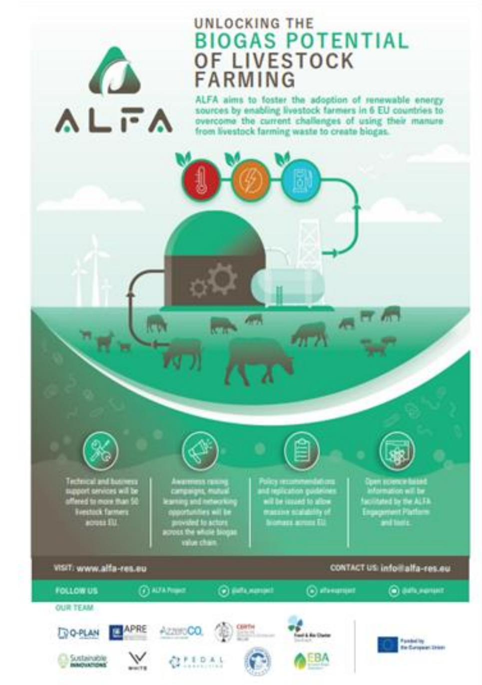
Biomethane HE Projects

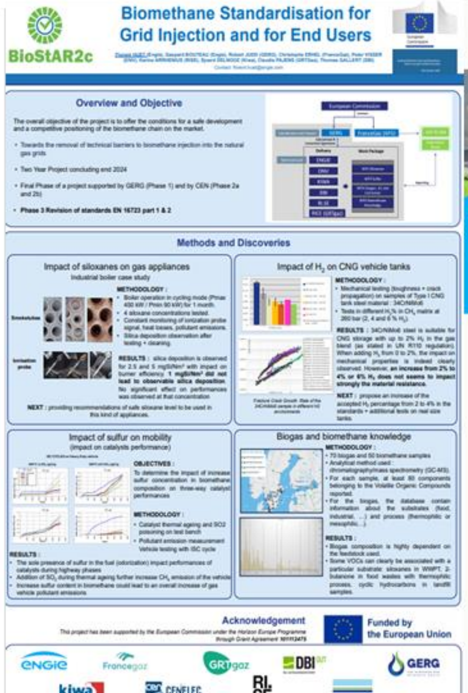
Project acronym	Project name	Brief Abstract	End product	Technology	Feedstock
ALFA	Scaling up the market uptake of renewable energy systems by unlocking the biogas potential of agriculture and livestock farming	ALFA supports 50 livestock farmers in six EU countries in installing biogas systems by analysing local livestock value chains and providing them with a series of demand-driven financial, business and technical support services	Biogas	Anaerobic digestion	Residues from agricultural and feedstock farming
BIOMETHAVERSE	Demonstrating and Connecting Production Innovations in the BIOMETHAne uniVERSE	In the BIOMETHAVERSE demonstrators, CO2 effluents from anaerobic digestion or gasification and other intermediate products will be combined with renewable hydrogen or renewable electricity to increase the overall biomethane yield. All demonstrated production routes consider a circular approach for energy and material use.	Biomethane	5 pathways investigated: 1. In-situ and Ex-Situ ElectroMethanoGenesis 2. Ex-situ Thermochemical/catalytic Methanation 3. Ex-Situ Biological Methanation 4. Ex-Situ Syngas Biological methanation 5. In-situ Biological Methanation	All types of feedstocks
BIOSTAR2C	Removing Technical Barriers to Biomethane STAndaRdisation Phase 2C	BIOSTAR2C aims to remove the barriers that impede biomethane introduction into gas networks and vehicles. Project work will help ensure that biomethane injection costs are optimised and will increase confidence in investing in biomethane production and injection.	Biomethane	Technical barriers identified by CEN/TC 408	Biogas & biomethane
CarbonNeutralLNG	Truly carbon neutral electricity enhanced synthesis of liquefied natural gas (LNG) from biomass	CarbonNeutralLNG delivers truly carbon-neutral bioLNG by harnessing low-cost renewable electricity in a proposed hybrid process that combines chemical catalytic with biological methanation and electromethanogenesis to directly convert the electrical current to methane via anaerobic respiration in microbes	Liquefied Natural Gas (LNG) from biomass	Sorption enhanced e-gasification, additively manufactured "Chemical Catalytic Raw Methanation" and a "Biological Methane conditioning" by means of biological methanation and electro-methanogensis	Biomass residues (not further specified)
GrenMeUp	Green biomethane market uptake	GreenMeUp facilitates the wider market uptake of biomethane in the European energy and transport sectors by strengthening the market in countries with slow development rates.	Biomethane	Anaerobic digestion + upgrading & thermal and hydrothermal gasification	All types of feedstocks (depending on the target country)
HYFUELUP	Hybrid biomethane production from integrated biomass conversion	HYFUELUP demonstrates a flexible pathway for efficient and cost-effective biomethane production through thermochemical technologies combined with renewable hydrogen	Biomethane	Innovative thermochemical processes to be demonstrated: 1. sorption-enhanced gasification coupled with syngas or flue gas clean-up 2. fluidised-bed methanation of either syngas or flue gas with the dynamic addition of hydrogen	Dried digestate sludge with lignocellulosic materials (woody biomass, namely wood and forestry waste)
Metharen	Innovative biomethane system integration boosting production while managing renewable energies intermittency	METHAREN aims to demonstrate a cost-effective, innovative, more sustainable and circular biomethane production system enabling renewable energy sources intermittency management by improving: i) the biogas plant efficiency; ii) flexibility and energy management for RES integration; iii) the circularity approach for sustainable production and iv) innovative business models and adapted policies	Biomethane	Combination of gasification, methanation and a reversible combination of gasification, methanation and a reversible SOEC system (SOEC) system	Biowaste
SEMPRE-BIO	Securing domestic production of cost-effective biomethane	SEMPRE-BIO project develops novel and cost-effective biomethane production solutions and pathways, setting up three European biomethane innovation ecosystems (Belgium, Spain and France).	Biomethane	Different technologies are addressed: pyro-biomethanation (syngas biomethanisation), proton exchange membrane electrolysis (PEMEL), biomethane upgrading by solid cryogenic, etc.	Novel feedstock for biomethane (non-digestible biomass, e.g. woody biomass)
VALUE4FARM	Sustainable renewable energy VALUE chains for answering FARMers' needs	VALUE4FARM aims to revolutionise farming practices and drive the defossilisation of agriculture by matching the energy needs of local farmers with three renewable-based local value chains centred around biogas	Biomethane, REN	Intercooled regenerative reheat gas turbine cycle, flameless combustion, oil-free Organic Rankin Cycle loop with a microturbine expander	Residual streams

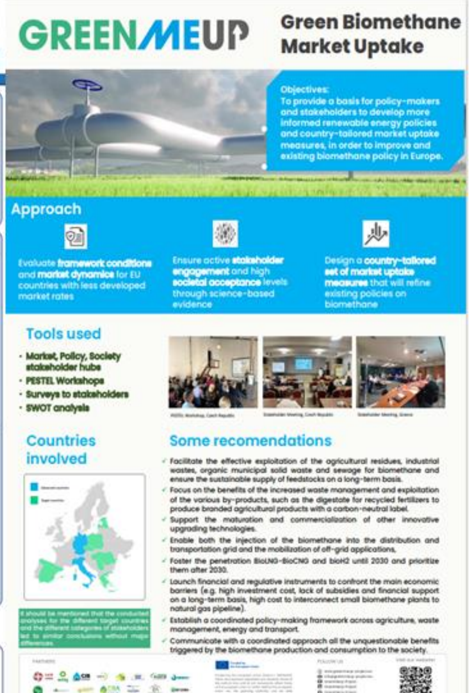


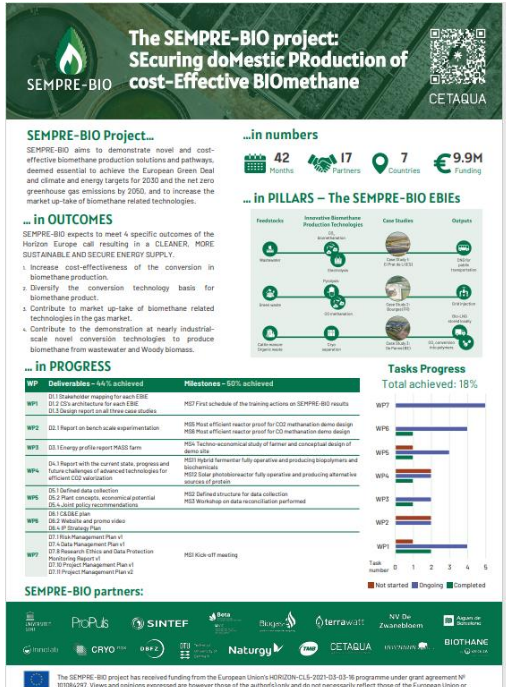




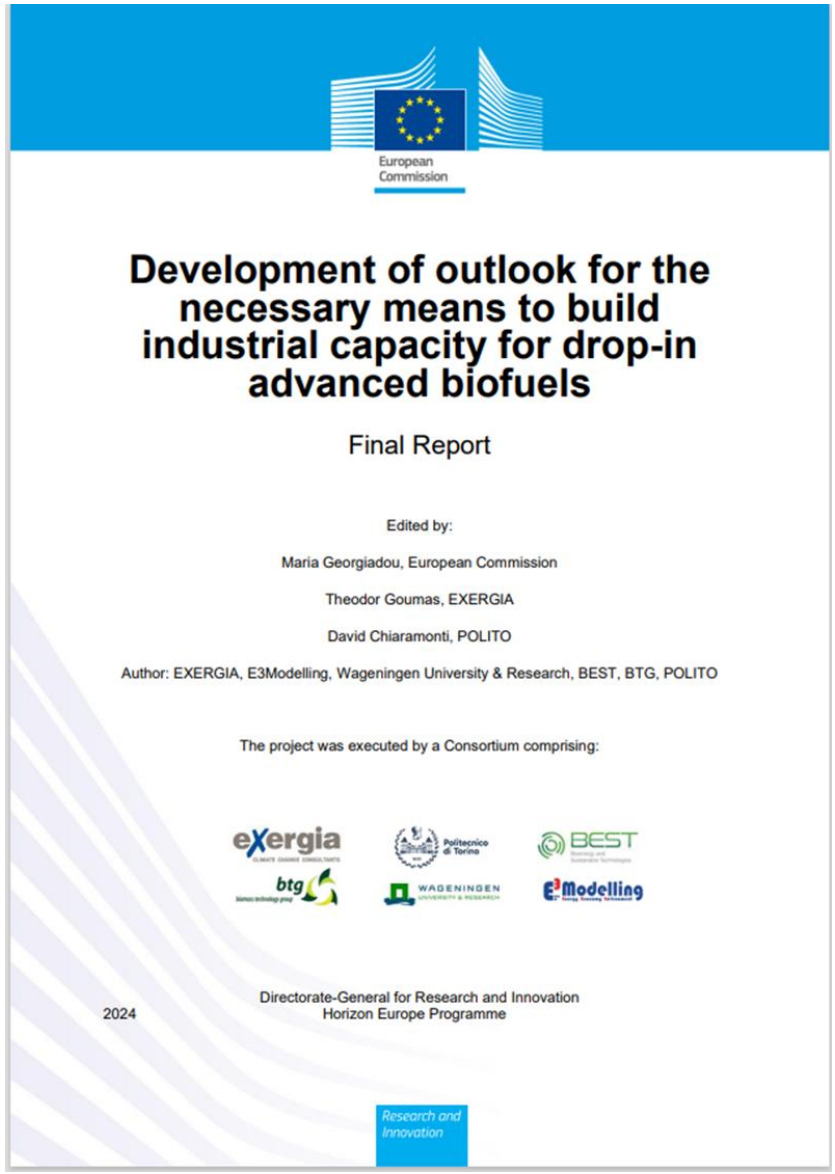








Development of Outlook for the Necessary Means to Build Industrial Capacity for Drop-in Advanced Biofuels (2024) *EC RTD study*



Objective

Identification of the factors for industrial growth of advanced and sustainable biofuels production in EU under the pertinent EU policy & respective regulatory framework

Key Messages

- *Biofuels have a vital role to play in helping reduce emissions in the transport sector as part of the Ff55 and the climate neutrality goals, while contributing to increasing the EU's industrial competitiveness, gross domestic product, and net employment*

- *Such role is expected to further increase in the future, when advanced biofuels will become more and more available because of scale-up to full commercial technologies, processes, and value chains, driven by ambitious policies and sectorial targets and fostered by an EU strategy and R&I support*

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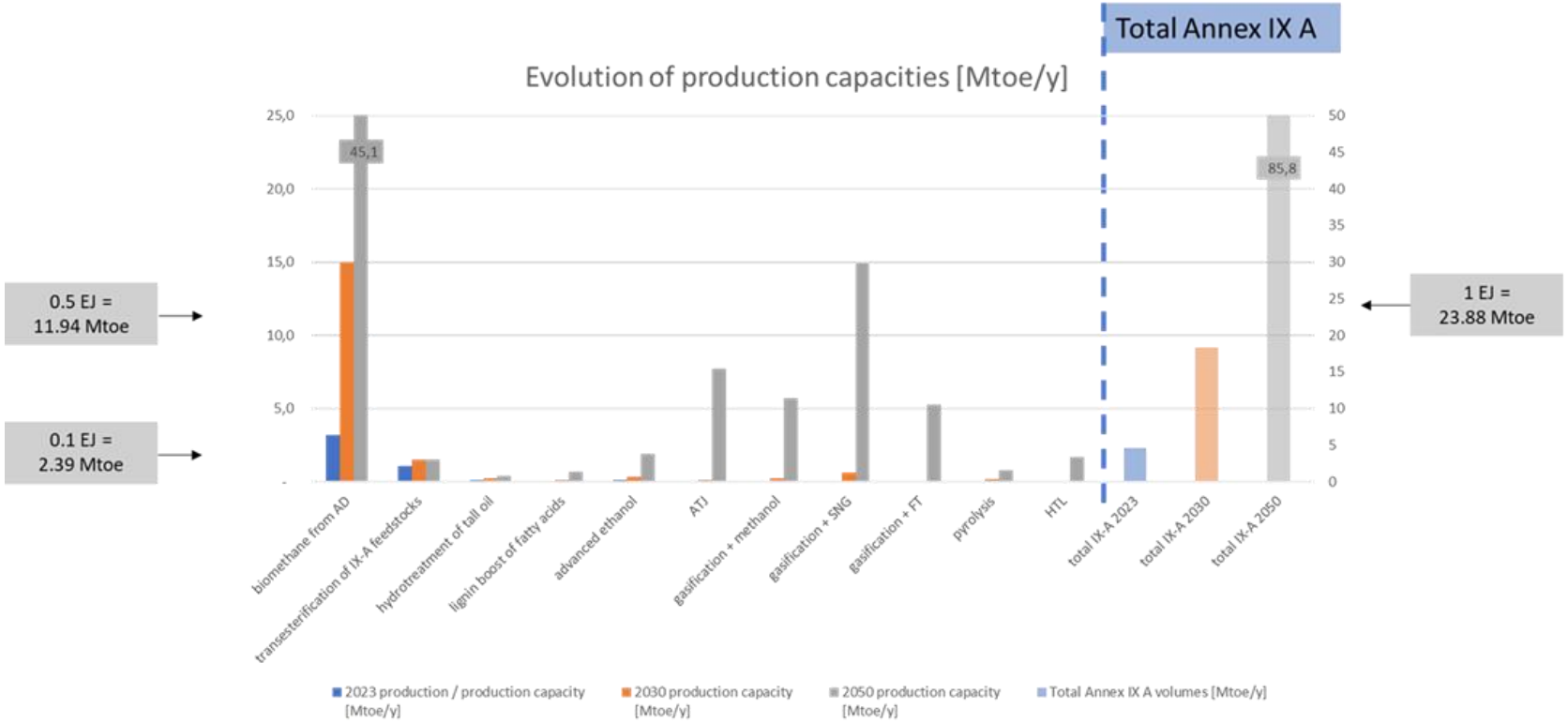
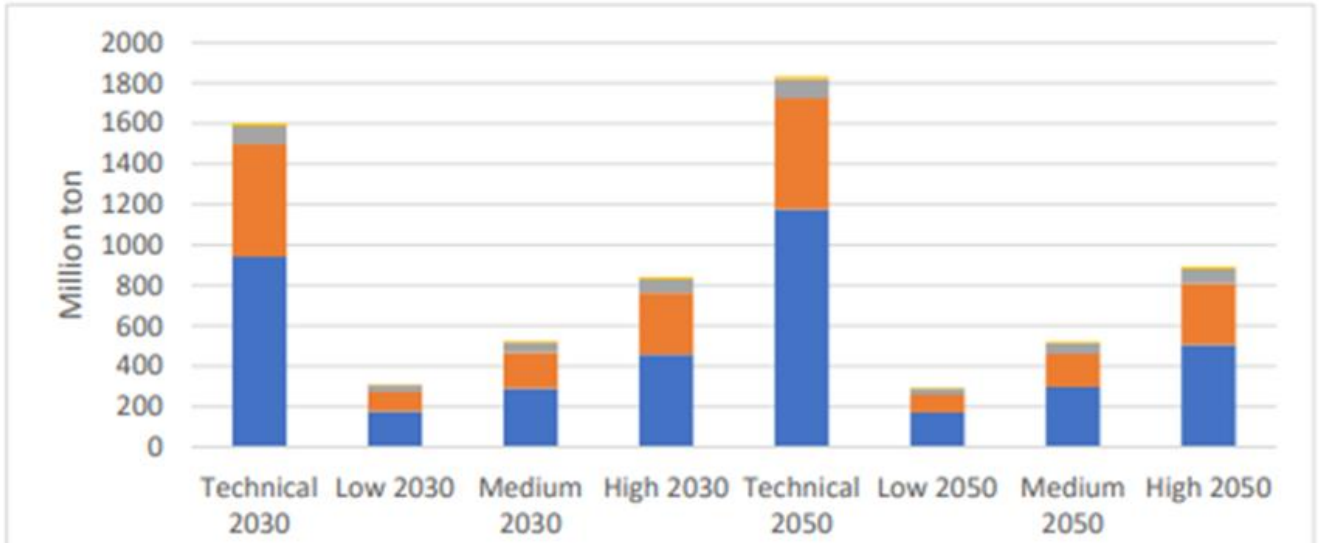


- *Capacity expansion for advanced biofuels and biomethane **18.4 Mtoe/y in 2030**. Biomethane from AD 15.0 Mtoe/y,*
- *From a technical point of view, capacity expansion could be almost **3 times larger and reach 57.7 Mtoe/y in 2030***

Biomass (Annex IX Part A & B) Potential per type
Technical, low, medium, and high potentials in 2030 and 2050 and distribution



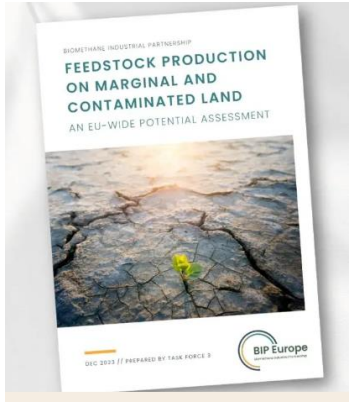
Biomethane Industrial Partnership

Partnership between the European Commission and the European Biogas Association established in the Biomethane Action Plan of REPowerEU in Sept 2022

Stimulates production of EU renewable gases to reach sustainable biomethane annual production of **35 bcm** by 2030

Engages European Commission, EU countries, industry representatives, feedstock producers, academia and NGOs

Address main barriers to sustainable biomethane production, use and integration into the EU internal gas market by Six Task Forces



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Innovative technologies for biomethane production

Under the Biomethane Industrial Partnership Task Force 5

The goal of Task Force 5 is to provide insights on the **Research, Development and Innovation needs for Biomethane production**

5.1

Review of the current state of the art in innovative technologies for biomethane production

5.2

Improving and enabling enhanced digestate valorization to reduce costs

5.3

Innovative technologies for the valorization of biogenic CO2

Biomethane Action Plan & Industrial Partnership Task Force R&I Report

https://bip-europe.eu/downloads/

- Many promising technologies that can contribute towards 35 bcm
- Some close to commercialization - others require more work to go from pilot to full scale
- Research, innovation and economic support needed
- Regulatory gaps on e.g. aquatic feedstock
- Integration and synergies with other systems
- Diversity of technologies → reduced risk

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TF5.1 Report – Methodology

- Thermochemical, biochemical and biological technologies
- Innovative: TRL < 9
- Current state of the art, Technological gaps, Recommendations for further R&Iation

Pretreatment	Conversion	Post-conversion
• Enzymatic hydrolysis • Acid hydrolysis • Lignocellulose steam explosion	• Biomass gasification • Hydrothermal processes • Thermo-catalytic reforming • Microbial electrolysis cell • Macroalgae fermentation	• Biological methanation • Catalytic methanation • Photosynthetic upgrading • Cryogenic upgrading

Pretreatment Technologies

Innovative Technologies for biomethane production

Technology	TRL	Strengths	Challenges/recommendations
Enzymatic hydrolysis	6 – 9	No inorganic chemicals used, operates at mild conditions	More efficient process, reducing investment and operational costs
Acid hydrolysis	6 – 9	Relatively fast and efficient process	Chemical recovery, inhibiting byproducts, corrosion
Lignocellulose steam explosion	6 – 9	Low CAPEX, low energy use	Process efficiency, inhibiting byproducts

Conversion technologies

Technology	TRL	Strengths	Challenges/recommendations
Biomass gasification	6 – 8	Possible to produce a variety of fuels at large scale and with high efficiency	Cleaning of tars, fuel feeding, access to large amounts of feedstock
Hydrothermal processes	5	High efficiency for wet biomass	Reactor design, process development, corrosion of materials
Thermo-catalytic reforming	6 – 7	Relatively competitive costs, valuable byproducts	Upgrading off-gas to biomethane
Microbial electrolysis cell	4 – 5	Can convert renewable electricity into biomethane	Reactor design, process optimization, energy efficiency
Macroalgae fermentation	3 – 7	Sustainable feedstock, enables marine nutrient recycling	Developing efficient harvesting methods, optimizing AD process

Post- Conversion technologies

Technology	TRL	Strengths	Challenges/recommendations
Biological methanation	6 – 7	Can be integrated with AD (in-situ), tolerates impurities	Access to and solubility of hydrogen, low cell growth rate of microorganisms
Catalytic methanation	7 – 8	Relatively low CAPEX	Access to hydrogen, tolerance to impurities, use of excess heat
Photosynthetic upgrading	4 – 9	Valuable byproducts	Large land area needed, more effective methods for CO_2 absorption
Cryogenic upgrading	6 – 8	High purity, integrates upgrading and liquefaction, produces L-CO_2	Integrating upgrading and liquefaction, CO_2 utilization, energy efficiency

Improving digestate valorisation: novel technologies and research needs Task Force R&I Report

https://bip-europe.eu/downloads/

Further R&I needs

- Agronomic use of digestate
- Mineral nutrient extraction and valorisation
- Extraction of other valuable compounds
- Microbial valorisation of digestate
- Trans-sectoral use of digestate
- Economic optimisation and social acceptance
- Environmental impact

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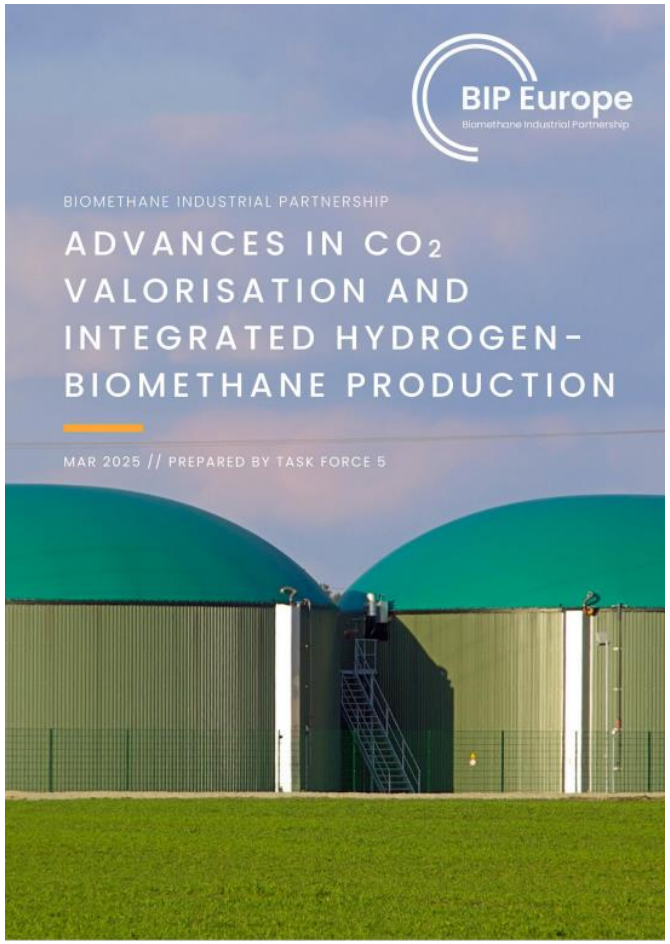
Advances in CO_2 valorisation and integrated hydrogen-biomethane productionTask Force R&I Report

TABLE 3 R&D&I IDENTIFIED GAPS AND RECOMMENDATIONS FOR TECHNOLOGIES TO ENABLE INTEGRATION OF HYDROGEN PRODUCTION INTO BIOGAS AND BIOMETHANE STREAMS

Category	Description
Biomethane purification	The purification of biomethane derived from organic waste sources presents a significant challenge due to the presence of impurities. Invest in R&I to improve biomethane purification techniques, focusing on cost-effective and energy-efficient methods.
Biomethane reforming	Conventional reforming technologies require adaptations to accommodate the unique characteristics of biomethane. Advance the development of catalysts and reactor designs specifically tailored for biomethane reforming.
Hydrogen separation	Traditional separation techniques may not be optimised for the diverse gas compositions encountered in integrated hydrogen and biomethane production. Explore novel hydrogen separation technologies that can handle the complex gas compositions encountered in integrated production.
Process integration and optimisation	Achieving an efficient and cost-effective integrated production process requires optimal process integration and operation. Invest in the development of comprehensive process modelling, simulation, and optimisation tools specifically tailored to integrated hydrogen and biomethane production.
Scale-up and commercialisation	There is a need to scale up these technologies to commercial levels. Promote collaborative demonstration projects that showcase the feasibility and performance of integrated hydrogen and biomethane production at larger scales.



https://bip-europe.eu/downloads/

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Useful links

- **Horizon Europe Info Days – Cluster 5**

  Destination 3: Renewable solutions, Ocean energy, Carbon Capture and Utilisation (CCU)

  https://research-innovation-community.ec.europa.eu/events/4MjD45QEP6eLsP9j3MCEOc/programme

- **Horizon Europe Work Programme 2023-2024**

  8. Climate, Energy and Mobility

  https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/wp-call/2023-2024/wp-8-climate-energy-and-mobility_horizon-2023-2024_en.pdf

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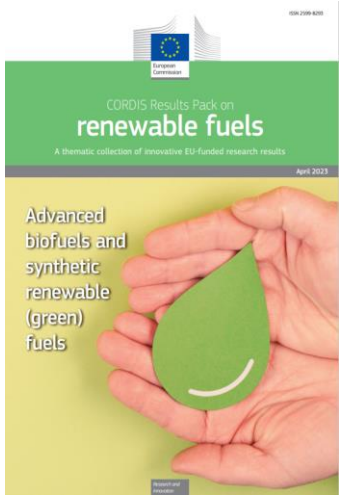

[CORDIS results pack on renewable fuels]

Thank you!

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http://ec.europa.eu/horizon-europe

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https://www.facebook.com/EUScienceInnov/

[Innovative biomethane for REPowerEU]