Support to the coordination of national research and innovation programmes in areas of activity of the European Energy Research Alliance

SUPEERA workshop

Bringing research and industry closer: accelerating innovation and uptake of biomethane

- → *The workshop is in hybrid mode (**recorded**)*
- → ***Do not turn on your microphone and camera during the event;** you **only** might be requested to do so during the Q&A session*
- → *Please **send your questions via chat** to all organisers*
- → *The **recording** of the webinar and the **PPT** will be **circulated shortly after***

Bologna, Italy , 07.06.2023

AGENDA (speakers) 1/2

09:00	**Welcome and objective of the workshop -** Ivan Matejak, Coordinator of SUPEERA, European Energy Research Alliance (EERA)
09:15	**Keynote presentation -** Maria Georgiadou, European Commission, Directorate-General for Research and Innovation, and Biomethane Industrial Partnership Task Force 5.
Collaboration between Research and Industry for identifying R&I needs to accelerate biomethane production	
09:35	**R&I to accelerate biomethane production through gasification from the industry perspective** - Marion Maheut, Engie
09:50	**R&I to accelerate biomethane production through upgrading of anaerobic digestion biogas from the industry perspective** – Luisa Brega, Prodeval
10:05	**R&I for efficient and cost-effective production of biomethane through thermochemical technologies** - Francisco Girio, The National Laboratory of Energy and Geology (LNEG)
10:20	**R&I to unlock feedstock potential for biomethane production** - Myrsini Christou, Centre for Renewable Energy Sources and Saving (CRES) and EERA Bioenergy
10:35	**Panel discussion and Q&A -** Berta Matas Güell, SINTEF
11:05	**Coffee Break**

AGENDA (speakers) 2/2

Cross-sectorial dialogue to facilitate the biomethane market deployment	
11:30	**Removing Technical Barriers to Biomethane Standardisation** - Erik Büthker, TotalEnergies and European standardisation committee for biomethane, CEN PC 408
11:45	**Sustainability in technical, economic, and environmental terms** - Marlies Hrad, University of Natural Resources and Life Sciences Vienna (BOKU)
12:00	**Policy framework to facilitate biomethane market development** - Giulia Cancian, European Biogas Association (EBA)
12: 15	**Social acceptance in socio-political and community dimensions -** Myriam Röder, Aston University
12: 30	**Panel discussion and Q&A –** Moderator, Myrsini Christou**,** Centre for Renewable Energy Sources and Saving (CRES) and EERA Bioenergy
13:00	**Light lunch**

Welcome and objective of the workshop

Ivan Matejak, EERA,
Project Coordinator

SUPEERA supports the SET-Plan and the Clean Energy Transition

We...

- → Facilitate the coordination of the research community
- → Accelerate innovation and uptake by industry
- → Provide recommendations on policy
- → Promote the SET-Plan and the Clean Energy Transition

We connect the dots.

EERA
European Energy Research Alliance

cea

DTU

KIT
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SINTEF

VTT

OBJECTIVES of the:

PROJECT ACTIVITY:

- Promoting and establishing a **dialogue between industry and energy experts** (including SET Plan IWGs, European industrial organisations & related platforms);
- **Analysing** the proposed energy measures in the **NECPs** and LTSs;
- **Defining pathways** covering different realities in terms of maturity & regional coverage;
- Delivering sectorial, cross-sectorial and systemic **recommendations on R&I priorities**; supporting uptake of new technologies by the industry

WORKSHOP:

- Update on selected **Bioenergy** pathway
- Present and **discuss key findings** of initial analysis of NECPs and national & EU initiatives;
- Focus on **relevant cooperation practices/experiences** (esp. research-industry) to facilitate innovation & market uptake;
- Consider **preliminary recommendations** & their possible replicability in other countries;
- Follow up on **series of workshops**

The SET Plan & NECPs as tools for EU-wide collaboration on R&I (*new priorities of low carbon technologies)*

Ivan Matejak,
SUPEERA Coordinator

Dynamism of R&I in the EU energy transition

Need for R&I coordination → Integrated SET Plan (2008; 2015; *2023*)

Climate emergency → European Green Deal (2019)

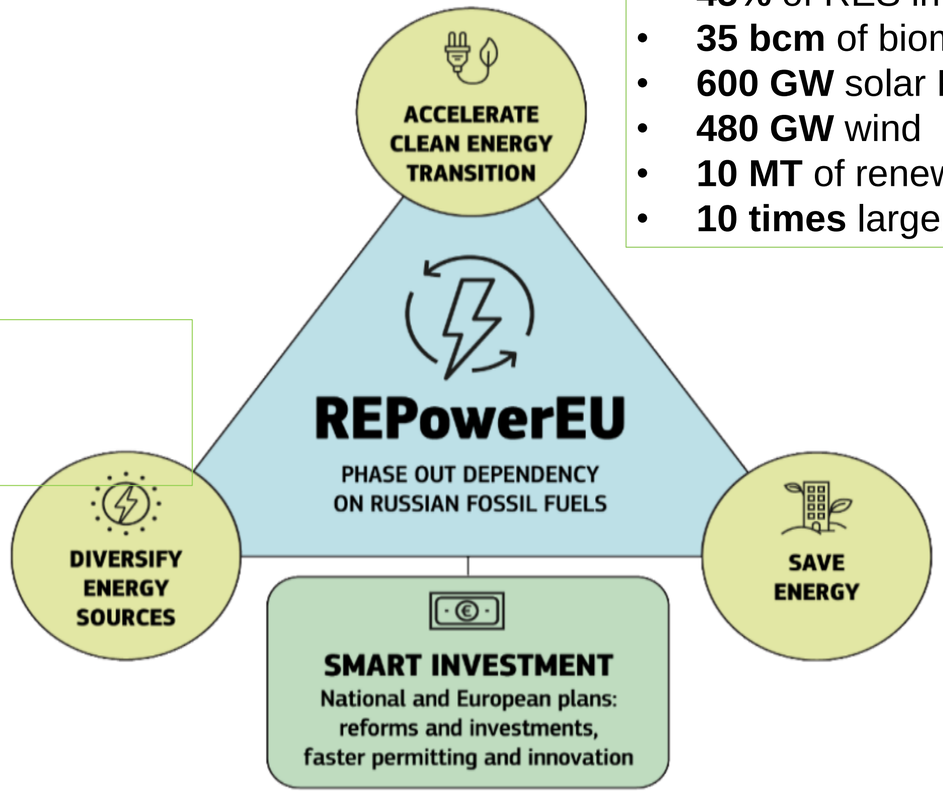
COVID emergency →Recovery Plans (2021)

Energy emergency → REPowerEU (2022)

Competitiveness emergency → Green Deal Industrial Plan + ? (2023, 2024…)

REPowerEU

- **45%** of RES in the mix
- **35 bcm** of biomethane
- **600 GW** solar PV
- **480 GW** wind
- **10 MT** of renewable H2 produced in the EU
- **10 times** larger electrolyser manufacturing

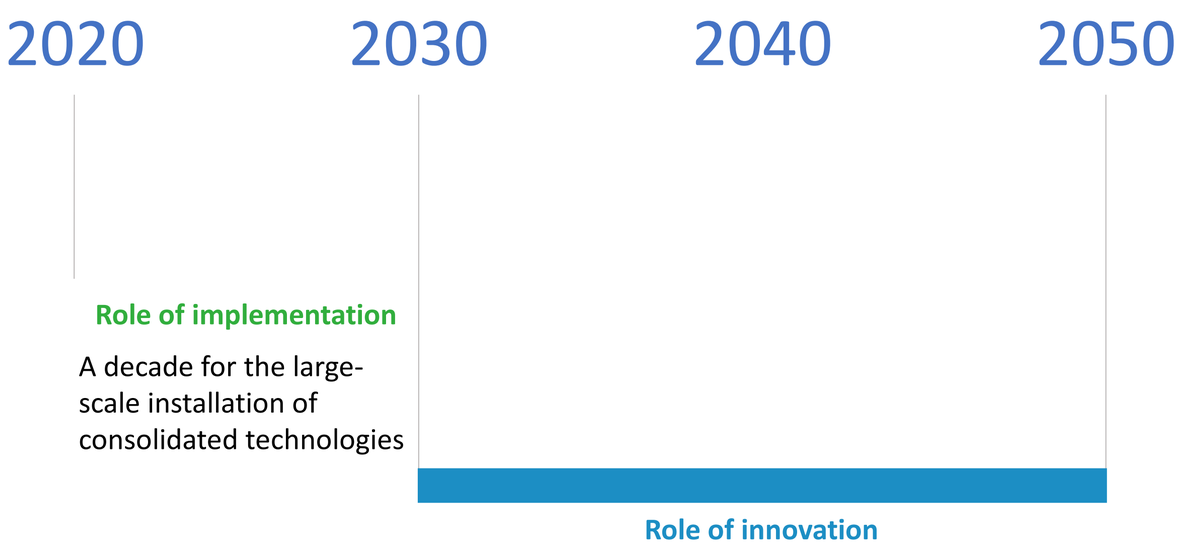


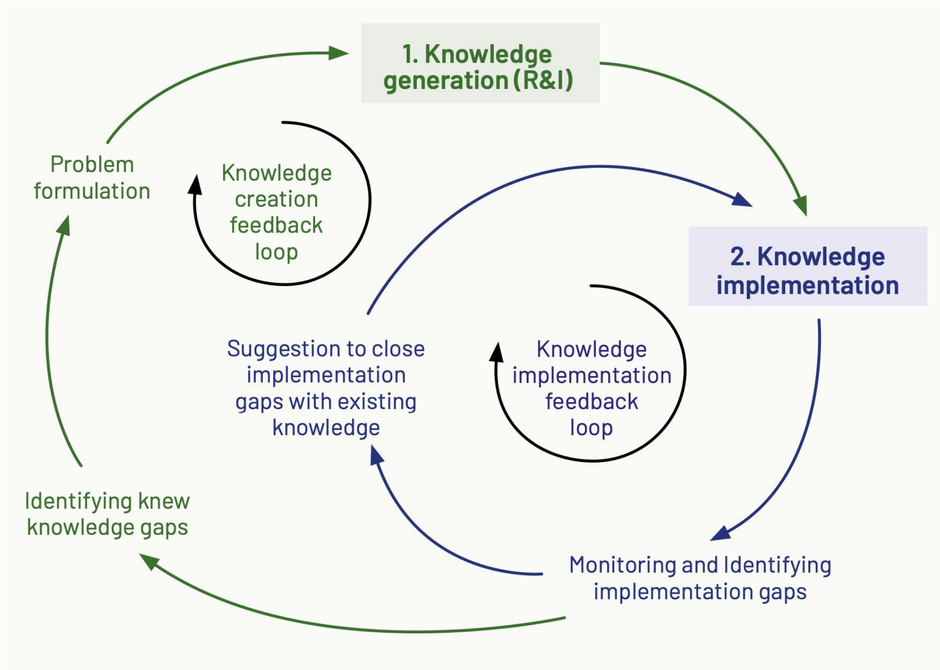
- Joint **gas** and **H2** purchases
- **LNG** investment

- **15%** reduction in gas demand
- **35 bcm** gas saving in industry

- **200 bln €** in diverse CET infrastructure
- **200 bln €** in green H2
- **10 bln €** in LNG

A new role for research: facilitating REPowerEU implementation





Link: EERA REPowerEU Manifesto

The political reaction beyond REPowerEU: EC's Green Deal Industrial Plan

- Launched on **1st Feb 23**

Largely a reaction to the **US I.R.A** (package of $**369** bn for climate measures)

PREDICTABLE AND SIMPLIFIED REGULATORY ENVIRONMENT

- **Net Zero Industry Act** → simplified regulatory framework for production of "net-zero" products; criteria for net-zero supply chain projects of "strategic interest"
- **Critical Raw Materials Act** → EU's access to minerals, metals critical for net-zero technologies
- **Electricity Market Design Reform** → shield households and businesses from high energy prices, increase resilience, accelerate the clean energy transition

FASTER ACCESS TO SUFFICIENT FUNDING

- Changes to the **EU state aid rules** to unlock public national financing and increase the volume of EU funding for net-zero technologies

ENHANCING SKILLS

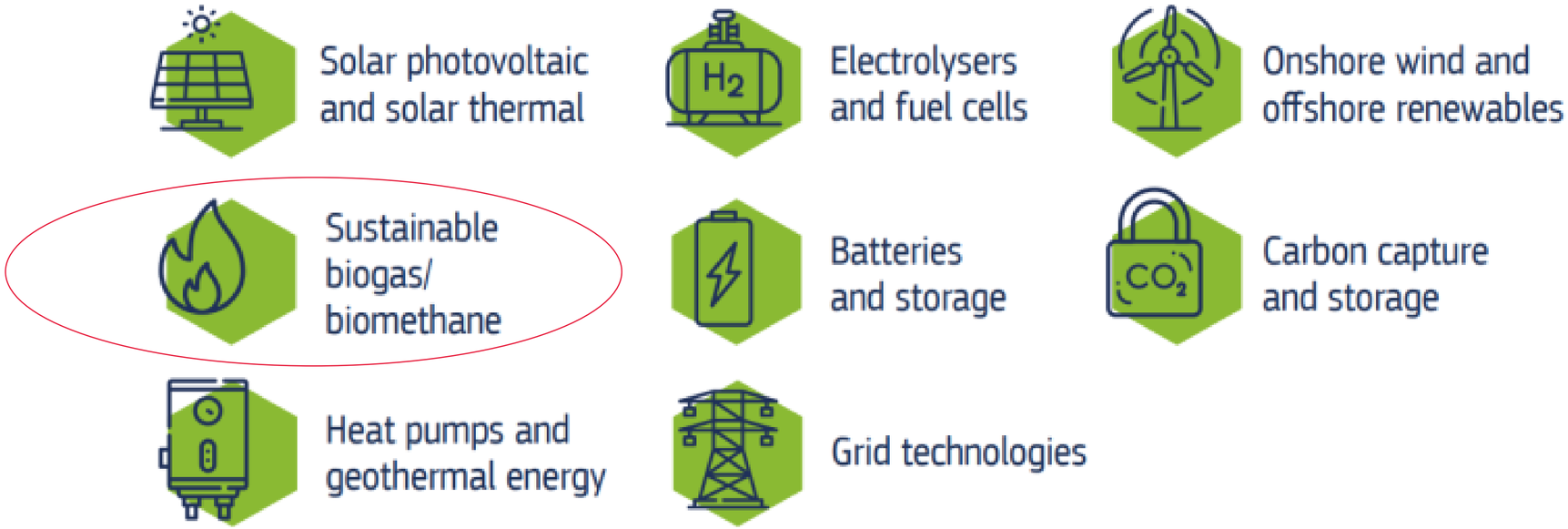
- **Net-Zero Industry Academies** to upskill, re-skill the workforce and facilitate the access of third-country nationals to EU labour markets in priority sectors

OPEN TRADE FOR RESILIENT SUPPLY CHAINS

- Development of **EU's Free Trade Agreements**, protection of the EU market from unfair trade, creation of **Clean Tech/Net-Zero Industrial Partnerships** and a "**Critical Raw Materials Club**"

Net-Zero Industry Act (NZIA) – Technologies concerned

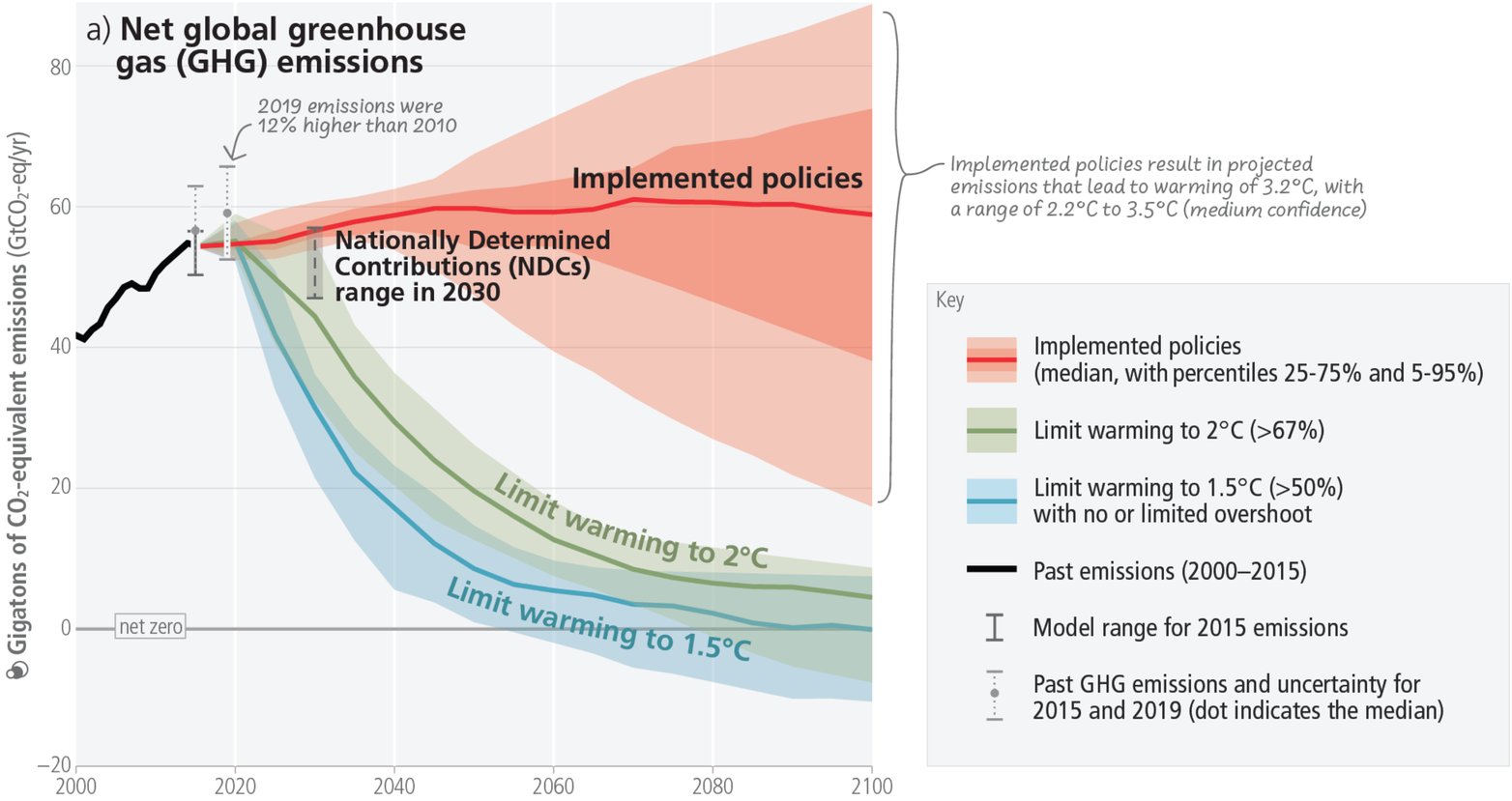
- The NZIA addresses technologies that will make **a significant contribution to the decarbonization**. Among those, **advanced technologies to produce energy from nuclear processes** with minimal waste from the fuel cycle, small modular reactors, and related best-in-class fuels.
- **Only a set of specific technologies - the "strategic net-zero technologies"** (below) - **will receive particular support**: these will be also subject to the **40% domestic production benchmark (no target)** – commercially available / good potential for rapid scale-up.



Call for action: IPCC 6th assessment synthesis

Limiting warming to 1.5°C and 2°C involves rapid, deep and in most cases immediate greenhouse gas emission reductions

Net zero CO_2 and net zero GHG emissions can be achieved through strong reductions across all sectors



- To keep the 1.5° C limit, **emissions need to be reduced by at least 43% by 2030** compared to 2019 levels, and **at least 60% by 2035**
- **Public and private finance flows for fossil fuels are still greater** than those for climate adaptation and mitigation
- Needed: **substantial reduction in overall fossil fuel use**, **minimal use of unabated fossil fuels**, **use of CCS** in the remaining fossil fuel systems; **energy conservation and efficiency**; **greater integration** across the energy system
- Viability of humanity living within planetary boundaries depends on **actions** we'll take in the **next seven years**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The role, the EU perspective and R&I policies for biomethane in Europe

Dr Maria Georgiadou

Senior Expert

European Commission

DG Research and Innovation

EUBCE 2023 - Delivering on REPowerEU: bringing research and industry closer to accelerate innovation and uptake of biomethane – 07 June 2023, Bologna, Italy

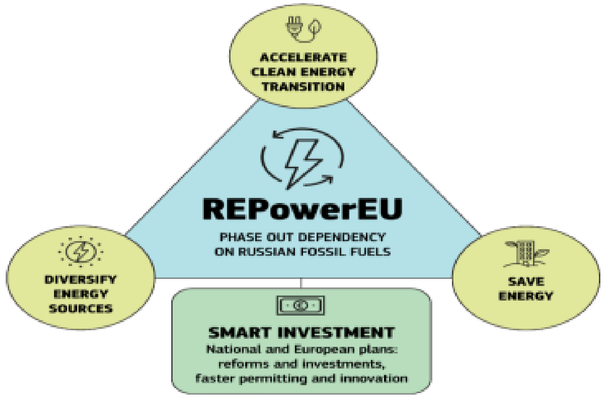
REPowerEU Plan COM(2022) 230 final

Pillar I- Energy savings

- Increased energy efficiency target from 9 to 13%

Pillar II – Diversification of energy supplies

- Secured LNG imports and higher pipeline gas deliveries
- EU Energy platform for voluntary common purchases of gas, LNG, and hydrogen
- EU Energy External Engagement Strategy build long-term partnerships with suppliers



Pillar III – Accelerate roll-out of renewable energy

- Hydrogen Accelerator for production, infrastructure and storage
  - 10 Mt domestic production and 10 Mt imports in 2030 to to replace natural gas, coal and oil
  - 2 Delegated Acts on definition and production of renewable hydrogen
  - 200 million €additional to support Hydrogen Valleys
  - Complete first Important Projects of Common European Interest by summer
- Increased RES target from 40 to 45% - massive scaling-up and speeding-up of renewable energy in power generation, industry, buildings, transport
- EU solar strategy to double PV capacity in 2025, install 600 GW in 2030
- EU solar rooftop initiative with legal obligation for all types of new buildings
- Double rate of deployment for heat pumps, integrating geothermal and solar thermal in district and communal heating
- Speed up permitting for major renewable projects, and include in the Renewable Energy Directive recognizing renewable energy as an overriding public interest

- Bio methane Action Plan to double the EU bio methane production to 35 billion m^3/y by 2030
  - Bio methane Industrial Alliance
  - Financial incentives to increase production, also through Common Agricultural Policy
  - R&I support to innovative technologies

- Decarbonize industry by accelerating the switch to electrification and renewable hydrogen
- EUR 225 billion already available in loans under the RRF
- R&I for materials, circularity, bio methane innovative production, solar flagship, hydrogen valleys, Cities Mission, regulatory sandboxes

NOT LEGALLY BINDING

Biomethane Action Plan SWD(2022) 230 final

Sustainable **production and use of biogas and bio methane** at EU and national/ regional level and injection of bio methane into the gas grid	Bio methane industrial **partnership/ forum** promoting sustainable production and use
	Bio methane **national strategies** or integrate in **NECPs**
	Broadening the scope of the **fuel supply obligation** in RED
	Participatory **multi-stakeholder engagement**
	Speed up **permitting**
	Co-operation with neighboring and enlargement countries
Incentives for biogas **upgrading** into bio methane	**Reduce the costs** for economic operators
Adaptation and adjustment of existing and deployment of new **infrastructure** for the transport of increased shares of bio methane through the EU gas grid	Regional assessment of **network development**
	Assess **infrastructure challenges**
	Standardization
R&I gaps	Development of **innovative technologies for production**
	Innovative technologies for the upgrade of biogas to bio methane
	Innovative solutions and research on **barriers and integration** of bio methane to the gas grid
	Expansion of the sustainable biomass potential to ensure availability of resources for reaching the bio methane production target
Access to **finance**	Access to **grants and loans**
	Innovation Fund
	Access to **other** financial instruments

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Biomethane Industrial Partnership

BIP Europe
Biomethane Industrial Partnership

Teaming up to achieve 35 bcm of sustainable biomethane

Task Force 1
National biomethane targets, strategies and policies

Task Force 2
Accelerated biomethane project development

Task Force 3
Sustainable potentials for innovative biomass sources

Task Force 4
Cost efficiency of biomethane production and grid connection

Task Force 5
Research, Development and Innovation needs

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The Green Deal Industrial Plan

Built the industrial capacity for the clean technologies that make up the Green Deal

A predictable and simplified regulatory environment

- Quick deployment of manufacturing capacity
- Critical Raw Materials Supply
- Affordable and sustainable energy

- Net-Zero Industry Act
- Promote regulatory sandboxes
- Electricity Market Design reform

Enhanced skills

- Green and digital skills

- European Skills Agenda, Partnership for Skills

Faster access to funding

- National and EU funding

- InvestEU, REPowerEU, Innovation Fund, State aid Temporary Crisis and Transition Framework, a European Sovereignty Fund

Open trade for resilient supply chains

- Diversified access to critical inputs

- Free Trade Agreements, Critical Raw Materials Club, Clean Tech/ Net-zero Industrial Partnerships

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EU Net-Zero Industry Act: Making EU the home of clean tech industries

Scale up in the EU net-zero technology manufacturing to provide **at least 40%** of its annual deployment needs for strategic net-zero technologies by 2030

- Simplifying the regulatory framework for net-zero technologies
- Scaling up manufacturing of net-zero technologies
- Fostering competitive and resilient European net-zero industry

Strategic net-zero technologies that are commercially available or soon to enter the market, and have significant potential for rapid scale-up

- Solar photovoltaic and solar thermal
- Onshore wind and offshore renewables
- Batteries and storage
- Heat pumps and geothermal energy
- Electrolysers and fuel cells
- **Sustainable biogas/ biomethane**
- Carbon capture and storage
- Grid technologies

Other net-zero technologies are also supported

- **Sustainable alternative fuels technologies**
- Advanced technologies to produce energy from nuclear processes, small modular reactors, related best-in-class fuels

Actions to stimulate investment into net-zero technologies

Net-Zero Strategic Projects	Priority projects essential for reinforcing the resilience and competitiveness of the EU net-zero industry
CO2 injection capacity target	CCS projects, notably by enhancing availability of CO2 storage sites
Facilitating access to markets	Sustainability and resilience criteria in procurement procedures and auctions of renewables
Enhancing skills	Net-Zero Industry Academies for training and education
Cutting red tape and accelerated permitting	Lower administrative burden and simpler and faster permitting notably for strategic projects
Attracting investment	Net-Zero Europe Platform and Hydrogen Bank
Innovation	Regulatory sandboxes for innovation

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Financing of net-zero industry

- Coordination of existing financing mechanisms
- Net-Zero Europe Platform: MS, EC, relevant financial institutions discuss private funding, investment needs and existing financial instruments and EU funds
- EIB and other InvestEU implementing partners to scale up support to investment in the net-zero industry supply chain, including via setting up of blending operations
- Private investment by companies and financial investors essential
- Public support, including State aid providing possibilities to crowd-in private investments and new rules allow flexibility for MS to grant aid to speed up and simplify investments, while limiting distortions to the Single Market and preserving cohesion objectives
- Recovery and Resilience Facility, InvestEU, Cohesion policy Programs, Innovation Fund
- European Sovereignty Fund, a structural instrument building on the experience of coordinated multi-country projects under the Important Projects of Common European Interest and seek to enhance all Member States' access to such projects

Delegated Act to RED II: Update of list of sustainable biofuel feedstock

- Commission requested to regularly review the list of feedstock in Parts A and B of Annex IX of RED II with a view to **adding** feedstock to the Annex if they meet criteria in the third subparagraph of Article 28(6)

- Public consultation texts- ***DA not Adopted***

  Part A : to add among others

  - Non-food crops grown on severely degraded land, not suitable for food and feed crops.”.

  Part B : to add among others

  - Intermediate crops, such as catch crops and cover crops that are grown in areas where due to a short vegetation period the production of food and feed crops is limited to one harvest and provided their use does not trigger demand for additional land and provided the soil organic matter content is maintained.”

The contribution of EU Research & Innovation to the REPowerEU objectives

BOOSTING THE HYDROGEN PRODUCTION AND IMPORTS

R&I is needed to further develop the technology to boost hydrogen production from 5.6 million tonnes to 20 million tonnes by 2030.

DECARBONISING INDUSTRY

R&I actions will further accelerate the pathway to a decarbonised industry. The Commission together with the aviation, steel, hydrogen, waterborne, rail, and process industries, is co-investing €13.1 billion through Horizon Europe Partnerships.

ACCELERATING THE ROLL-OUT OF SOLAR ENERGY

The European Commission's Solar Strategy Communication has a strong R&I component:

The Commission will co-invest with Member States €1.1 billion through the Clean Energy Transition and Driving Urban Transition co-funded Partnerships and will revamp the Strategic Energy Technology Plan by the end of 2022, to align its activities with REPowerEU and the European Green Deal.

SPEEDING UP RENEWABLE PERMITTING

R&I provide direction to minimise the time for roll-out of renewable projects and grid infrastructure improvements.

DOUBLING THE EU AMBITION FOR BIO METHANE AND PRODUCE 35 BILLION CUBIC METERS PER YEAR BY 2030

R&I in innovative technologies are needed to boost the bio methane and renewable fuels production.

ENERGY SAVINGS AND ENERGY EFFICIENCY IN BUILDINGS

Based on innovative solutions developed through previous EU R&I programmes, current R&I activities will focus on scaling up solutions to realise energy savings and efficiency.

FURTHER STRENGTHENING EU INTERNATIONAL ENERGY ENGAGEMENT

- MISSION INNOVATION AND THE BREAKTHROUGH AGENDA
- COOPERATION WITH AFRICA AND THE MEDITERRANEAN REGION

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EU publication

- https://op.europa.eu/en/publication-detail/-/publication/c4651f9b-eaf2-11ed-a05c-01aa75ed71a1/language-en
- video Innovative Biomethane for REPowerEU – A Cordis info Pack – YouTube
- 💡 How can the #EU reduce its... - EU Science & Innovation | Facebook
- https://twitter.com/EUScienceInnov/status/1655551077368963074?s=20
- https://twitter.com/HorizonEU/status/1657314740698243073?s=20

European Commission

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FOREWORD

"Biomethane is essential for the EU to achieve its energy autonomy and climate neutrality fast and in a cost-effective way. Research and innovation is key to advancing novel and competitive biomethane solutions to boost its share in the EU energy mix by 2030 and 2050 and help reach Europe's ambitious goals for a green and secure energy transition."

Marc Lemaître
Director-General,
Directorate-General for Research and Innovation

Biomethane is a renewable gas that can substitute fossil natural gas in all of today's applications, using the existing gas infrastructure. It can be used in power plants to generate electricity, in industrial plants to meet the demand for electricity and heat, in buildings for heating, in transport as fuel, in chemical processes as feedstock and for energy storage as an energy carrier for hydrogen. It can therefore displace and reduce natural gas imports, while accelerating the green energy transition and contributing to the European Green Deal's climate and energy targets for 2030 and beyond.

For this reason, REPowerEU names biomethane as a priority for diversifying the EU gas supplies and aims to double its targeted production levels by 2030. This will bolster Europe's energy security and speed up its independence from fossil coal, oil and natural gas.

Biomethane today is commercially produced in small quantities by upgrading biogas. However, to reach the ambitious EU targets in a cost-competitive way and diversify our energy mix, in particular in the gas-consuming sectors, we need to develop and demonstrate advanced technologies for the efficient production of biomethane. This is where research and innovation has a key role to play in making the gas supply cleaner, more secure, reliable and competitive.

The EU's research and innovation framework programmes Horizon 2020 and Horizon Europe have continuously supported novel, sustainable and circular biomethane technologies and their market uptake with EU public funds. In this specially commissioned Projects Info Pack, you will discover 15 selected projects on innovative biomethane that are contributing to boosting its production and place in the EU energy market.

European Commission

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.

Wastes / Feedstock

Biomethane

Recycle

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.

European Commission

Delivering the future

Increasing biomethane production in the EU is not solely a technological challenge.

"To increase the biomethane share in the EU gas market, we need to understand non-technological barriers to deploying production technologies, for example regulatory, financing and social, and develop appropriate market uptake measures and mechanisms to overcome them."

Maria Georgiadou, Senior Expert at the Directorate-General for Research and Innovation

Here follow four EU-funded projects that highlight the multiple ways in which researchers are bringing clean, renewable domestic energy to market.

Bin2Grid: Turning unexploited food waste into biomethane supplied through local filling stations network

Over 88 million tonnes of food are thrown away in the EU every year. The Bin2Grid project promoted the collection of food waste, and its conversion to biogas and upgrading into biomethane, supplying stations in Zagreb, Skopje, Malaga and Paris.

To bridge the gaps between waste management and renewable energy production, the project investigated technologies related to biowaste separation and treatment, biogas production and upgrading, and economic tools to boost profitability of the concept.

Project dates:
1 January 2015 – 31 December 2017

Coordinated by:
Zagrebacki Holding in Croatia

Funded under:
Horizon 2020-ENERGY

CORDIS factsheet:
cordis.europa.eu/project/id/646560

Total budget:
EUR 709 468

EU contribution:
EUR 709 468

BiogasAction: Promotion of sustainable biogas production in EU

The BiogasAction project developed the European biogas sector across 14 European regions by focusing on the removal of non-technical barriers to widespread production from manure and other organic waste.

As well as a comprehensive biomethane market web portal, the project created a guidance document for investors on financing biogas and biomethane projects, and advice for policymakers and local authorities on improving national framework conditions for biogas and biomethane deployment.

Project dates:
1 January 2016 – 31 December 2018

Coordinated by:
Energy Consulting Network in Denmark

Funded under:
Horizon 2020-ENERGY

CORDIS factsheet:
cordis.europa.eu/project/id/691755

Total budget:
EUR 1 999 885

EU contribution:
EUR 1 999 885

BIOSURF: BIOmethane as SUstainable and Renewable Fuel

By harmonising biomethane registration, labelling, and certification, we can streamline cross-border trade in biomethane. The BIOSURF project extended national registries of biogas injection to the whole of Europe, enabling movements of biomethane through the European natural gas infrastructure.

It also developed a calculation to quantify the greenhouse gas emissions of biomethane that is compliant with both the RED framework and the EU Emissions Trading System.

Project dates:
1 January 2015 – 31 December 2017

Coordinated by:
Institute of Studies for the Integration of Systems (I.S.I.S), Cooperative Society in Italy

Funded under:
Horizon 2020-ENERGY

CORDIS factsheet:
cordis.europa.eu/project/id/646533

Project website:
biosurf.eu/en_GB

Total budget:
EUR 1 872 912

EU contribution:
EUR 1 872 912

ISABEL: Triggering Sustainable Biogas Energy Communities through Social Innovation

Sustainable biogas technologies have been slow in catching up with community energy developments.

Founded on the principles of Social Innovation, the ISABEL project carried out work in Germany, Greece and the United Kingdom to pave the way for the transition from traditional supply chains to community ownership, allowing citizens to take full advantage of the ample societal benefits of local community-driven biogas systems.

Project dates:
1 January 2016 – 31 December 2018

Coordinated by:
Q-Plan International Advisors in Greece

Funded under:
Horizon 2020-ENERGY

CORDIS factsheet:
cordis.europa.eu/project/id/691752

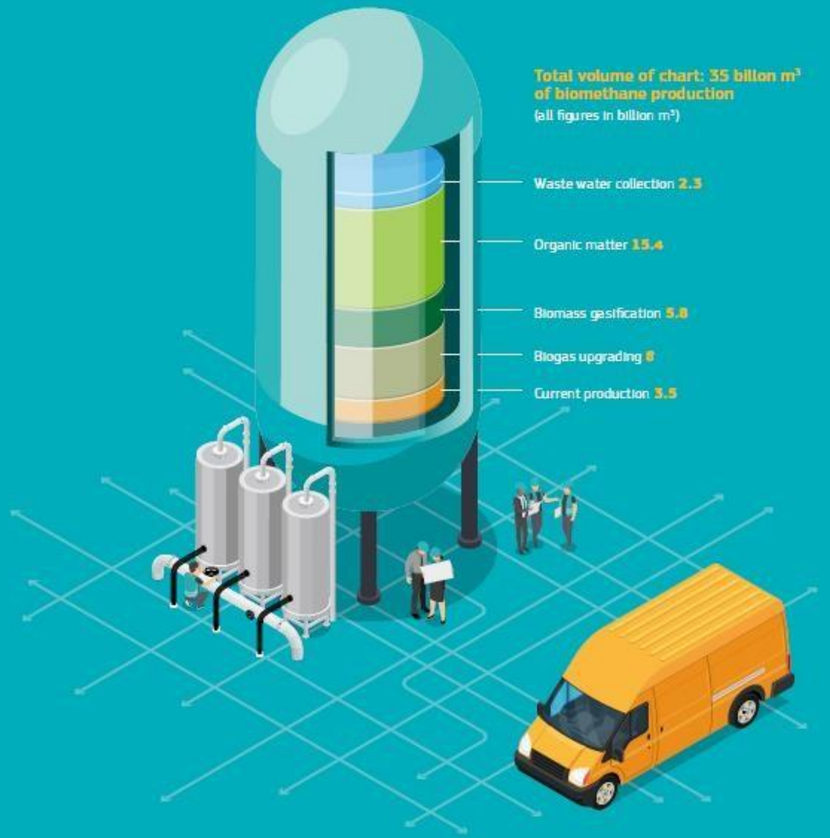
Total budget:
EUR 1 897 437

EU contribution:
EUR 1 897 437

European Commission

Filling the tank

The REPowerEU initiative has set an ambitious target for Europe's biomethane industry, seeking to increase domestic production to 35 billion cubic metres (bcm) by 2030, reducing dependence on foreign imports of fossil fuels. This tenfold increase over current production will draw from a range of sources. Upgrading all existing biogas facilities to produce biomethane is expected to contribute 8 bcm, while the remainder is generated from increasing the collection and processing of feedstocks such as woody biomass, organic matter and waste water. Innovative technologies will shape the exact contribution of each element to the 2030 target: improvements to gasification technology, for example, could relieve demand for organic material and therefore pressure on farmland.



Source data: Directorate-General for Research and Innovation, European Commission

INNOVATION FOR SUSTAINABILITY, CIRCULARITY AND THE FUTURE

Investing in a greener future

Through the Horizon 2020 and Horizon Europe programmes, the EU has invested tens of millions of euros in targeted research to grow Europe's biomethane industry over the last decade. The 17 projects below represent more than €75 m of EU funding, distributed across more than 180 research organisations, public bodies, and SMEs. These grants were awarded through three mutually synergistic streams: Research and Innovation Actions (relating to exploratory scientific research and prototype development), Innovation Actions (relating to demonstrating, large-scale product validation and market replication), and Coordination and Support Actions (relating to accompanying and market uptake measures).

Through investments such as these, Horizon Europe works to strengthen the impact of research and innovation, boosts European competitiveness and growth, and helps deliver on ambitious targets for climate, energy and the economy in line with the European Green Deal and the REPowerEU priorities.

UPSCALING INNOVATIVE PRODUCTION

Horizon Europe Work Programme 2023-2024

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

Renewable Fuels
- Advanced biofuels
- Synthetic renewable fuels
- Microalgae and direct solar fuels
- Intermediate bioenergy carriers

Bioenergy
- Biomass heat and CHP including cc
- Biogenic flue gases carbon fixation

Energy systems, grids & storage
- Renewable gases, other than H2 or CH4

International
- Integrated energy-driven bio refineries
- Africa

Cross -cutting
- Renewable Energy Valleys
- Emerging renewable energy technologies
- Market up take measures

Other actions
- Study advanced biofuels industrial capacity
- InvestEU blending including SAF

The European Green Deal

REPowerEU:

European Commission

NOT LEGALLY BINDING

Renewable Fuels

HORIZON-CL5-2023-D3-01-06	**Demonstration of advanced biofuel technologies for aviation and/or shipping**	IA, 9 M per project, opens 13 December 2022, closes 30 March 2023) ***Closed***
HORIZON-CL5-2023-D3-01-07	**Demonstration of synthetic renewable fuel for aviation and/or shipping**	IA, 9 M per project, opens 13 December 2022, closes 30 March 2023) ***Closed***
HORIZON-CL5-2023-D3-02-07	**Development of next generation advanced biofuel technologies**	RIA, 4 M per project, opens 4 May 2023, closes 5 September 2023
HORIZON-CL5-2024-D3-01-03	**Demonstration of improved intermediate renewable energy carrier technologies for transport fuels**	IA, 10 M per project, opens 12 September 2023, closes 16 January 2024
HORIZON-CL5-2024-D3-02-02	**Development of next generation synthetic renewable fuel technologies**	RIA, 3 M per project, opens 17 September 2024, closes 21 January 2025
HORIZON-CL5-2023-D3-02-08	**Development of microalgae and/or direct solar fuel production and purification technologies for advanced aviation and /or shipping fuels**	RIA, 4 M per project, opens 4 May 2023, closes 5 September 2023
HORIZON-CL5-2024-D3-01-04	**Improvement of light harvesting and carbon fixation with synthetic biology and/or bio-inspired/ biomimetic pathways for renewable direct solar fuels production**	RIA, 4 M per project, opens 12 September 2023, closes 16 January 2024

Bioenergy	HORIZON-CL5-2023-D3-02-01	**Development of near zero-emission biomass heat and/or CHP including carbon capture**	RIA, 4 M per project, opens 4 May 2023, closes 5 September 2023)
	HORIZON-CL5-2024-D3-01-05	**Development of carbon fixation technologies for biogenic flue gases**	RIA, 4 M per project, opens 12 September 2023, closes 16 January 2024
Energy systems, grids and storage	HORIZON-CL5-2023-D3-03-02	**Integration of renewable gases, other than hydrogen or methane, and which have not access to gas grids and interfacing with electricity and heat sectors**	IA, 6 M per project, opens 4 May 2023, closes 10 October 2023
International	HORIZON-CL5-2024-D3-02-03	**Development of smart concepts of integrated energy driven bio-refineries for co-production of advanced biofuels, bio-chemicals and biomaterials**	RIA, 3.5 M per project, opens 17 September 2024, closes 21 January 2025
	HORIZON-CL5-2023-D3-02-16	**Accelerating the green transition and energy access in Africa**	IA, 5 M per project, opens 4 May 2023, closes 5 September 2023
Cross- cutting	HORIZON-CL5-2024-D3-01-10	**Next generation of renewable energy technologies**	RIA, 3 M per project, opens 12 September 2023, closes 16 January 2024
	HORIZON-CL5-2024-D3-02-10	**Market Uptake Measures of renewable energy systems**	CSA, 2 M per project, opens 17 September 2024, closes 21 January 2025
	HORIZON-CL5-2023-D3-01-01	**Renewable Energy Valleys to increase energy security while accelerating the green transition in Europe**	IA, 20 M per project, opens 13 December 2022, closes 30 March 2023 ***Closed***
Other actions		**Study on how to mobilize industrial capacity building for advanced biofuels**	other action, 0.5 M, 2nd quarter 2023
		Contribution to InvestEU blending operation under the Green Transition product *(including Sustainable aviation fuels)*	Indirectly managed action through EIB, 100 M, as of 1st quarter 2023 and 1st quarter 2024

CET Partnership Joint Call 2023

- 30+ Countries: EU MS + ACs + International Partners, 50+ Funding Partners Funding Agencies & Ministries,13 Coordination Units, Coordinators: Austrian Ministry of Climate Action Swedish Energy Agency ,
- Annual Joint Calls for RTDI Projects 100 – 130 Mio €a2021 – 2027
- 10 Call modules
  1. Direct current (DC) technologies for power networks
  2. Power production technologies, storage and system integration

  3A/3B. Advanced renewable energy technologies for power production

  4. Carbon capture, utilisation, and storage (CCUS)

  5. Hydrogen and renewable fuels

  6. Heating and cooling technologies

  7. Geothermal energy technologies

  8. Integrated regional energy systems

  9. Integrated industrial energy systems

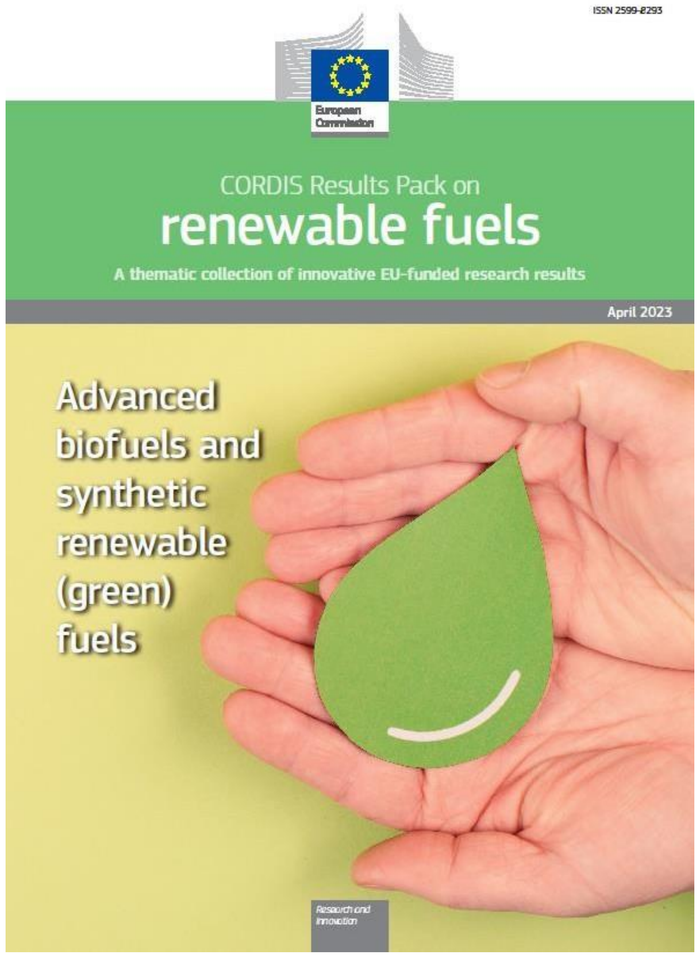
  10A/10B. Clean energy integration in the built environment

Joint Call 2023 - Call launch event
13 September 2023 Public - online

5. Hydrogen and renewable fuels

Objectives	To accelerate the development of technologies for hydrogen and renewable fuels to facilitate their use in ”hard-to-abate” carbon sectors and to serve flexibility and sector coupling needs in the energy system.
Topics	Technological development, demonstration, and deployment of renewable and synthetic fuels production, including hydrogen and energy storage
Activities	Targeting technological solutions for end users
Stakeholders	Research organisations, Universities, Companies, Public organisations, NGOs
TRLs	Final TRL = 5–9

EU Publications



https://op.europa.eu/en/publication-detail/-/publication/c4651f9b-eaf2-11ed-a05c-01aa75ed71a1/language-en

European Commission

Useful links

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

  Destination 3: Renewables (general topics) / Bioenergy / CCUS

  https://research-innovation-community.ec.europa.eu/events/6wKEl7CncTdqVAWmeWEASd/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

European Commission

Thank you!

#HorizonEU

http://ec.europa.eu/horizon-europe
DG Research and Innovation: @EUScienceInnov @EU_H2020
https://www.facebook.com/EUScienceInnov/

Support to the coordination of national research and innovation programmes in areas of activity of the European Energy Research Alliance

SUPEERA workshop

Session 1 - Collaboration between research and industry for identifying R&I needs to accelerate biomethane production

Bologna, Italy , 07.06.2023

R&I to accelerate biomethane production through gasification from the industry perspective

Marion MAHEUT, Lab CRIGEN (ENGIE R&I)

SUPEERA Workshop on bioenergy – Bologna, 7th of June 2023

Lab Crigen
RESEARCH & INNOVATION

ENGIE is a leading global group in low-carbon energy and services, operating in 31 countries*

IN 2022:

- **96,400** employees
- **€93.9 billion** revenue
- EBIT of **€9.0bn**
- **3.9GW** installed renewables capacity added
- **€5.5 billion** growth Capex
- **492 biomethane production units** connected to ENGIE's networks in France
- Further progress on coal exit, coal represents **2.6% of centralised generation capacity**

EBIT WORLDWIDE

OUR BUSINESSES:

- RENEWABLES
- NETWORKS
- ENERGY SOLUTIONS
- FLEX GEN & RETAIL(3)
- NUCLEAR
- OTHERS (including GLOBAL ENERGY MANAGEMENT & SALES)

*Once closing of signed deals is effective

AN INTEGRATED INDUSTRIAL GROUP, WHICH ACCELERATES ITS GROWTH IN THE ENERGY TRANSITION

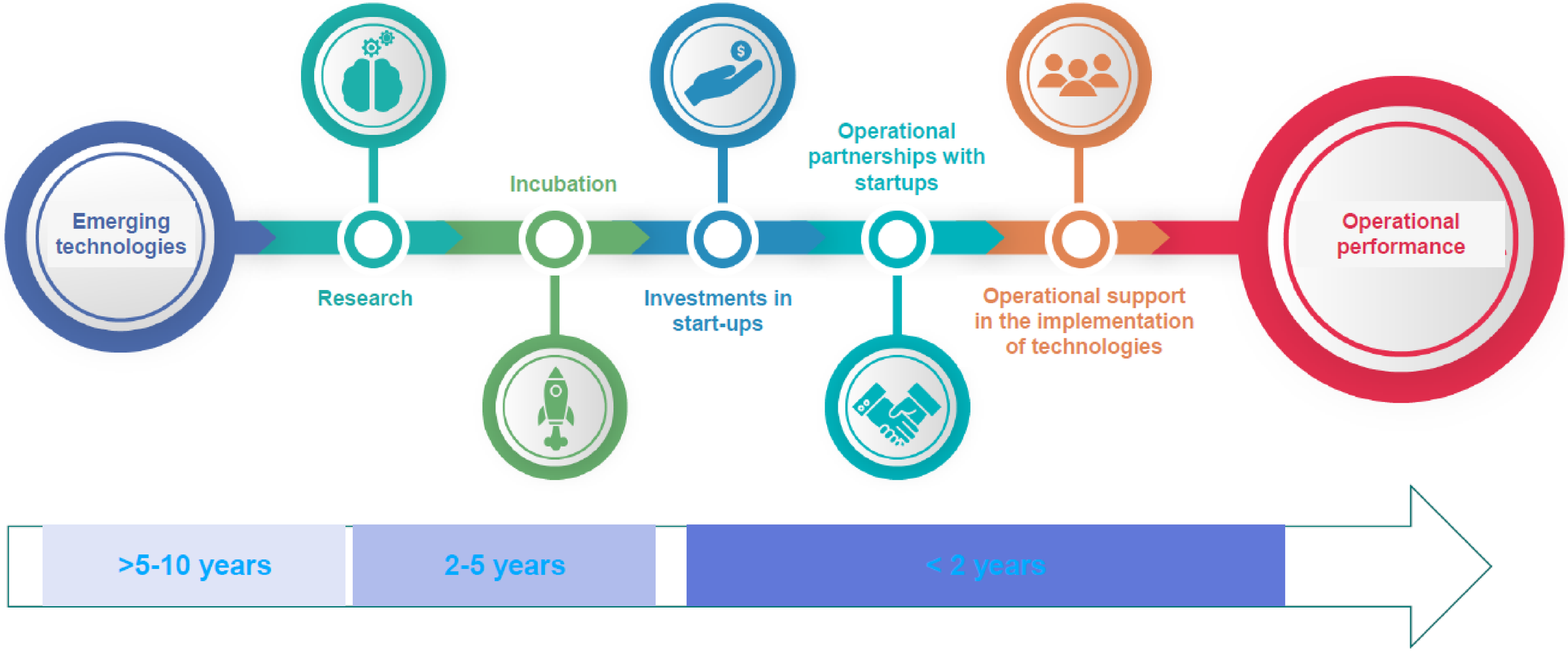
Our beliefs

The energy transition will not be possible with current technologies ; massive recourse to research and innovation is necessary.

The solution will not be unique, it will be necessary to combine several technologies, several approaches, to make possible a decarbonized world in the near future, in an industrial, competitive, reliable and safe way.

ENGIE has its own Research & Innovation (R&I) department combining internal expertise, partnerships and collaborations

ENGIE R&I acts simultaneously on all time horizons



We are developing 45 research programs

Cross-functional programs co-managed by our major businesses thanks to our 4 expert research centers in their fields.

ENGIE Lab CRIGEN (Ile de France)

Mainly dedicated to **green gases** (hydrogen, biogas and liquefied gases), new uses of energy and emerging technologies (digital technology and artificial intelligence, drones and robots, nanotechnology and sensors).

ENGIE Laborelec (Belgium)

Dedicated to **electricity** technologies. specialized. its activities cover the entire electricity value chain: generation, transmission, distribution, storage and end uses of electricity.

ENGIE Lab Cylergie (Lyon)

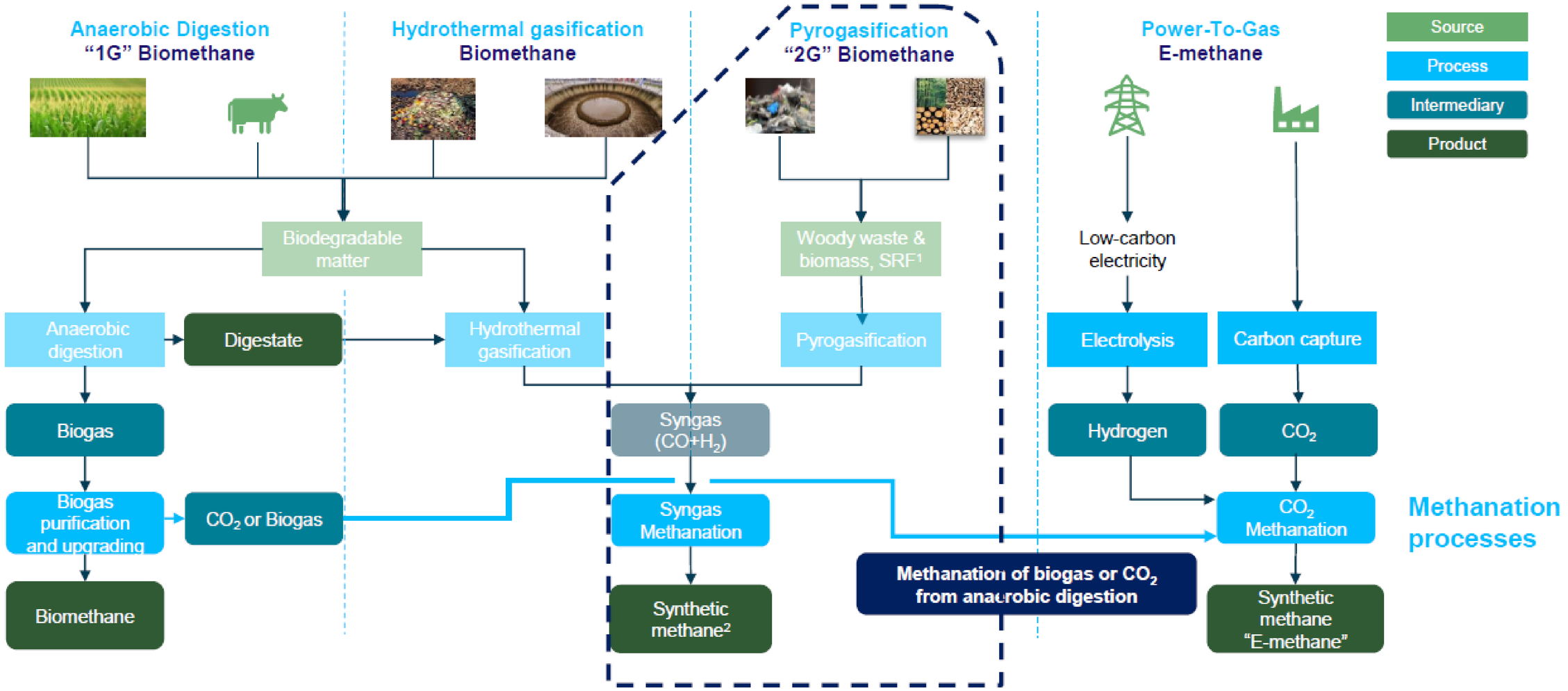
Energy performance expert.

ENGIE Lab Singapour

Dedicated to **intelligent energy management** for to cities and islands, **industrial energy efficiency** and technologies for gas-related cities.

ENGIE lab CRIGEN innovates on a daily basis across all biomethane or Renewable Synthetic Natural Gas (SNG) production pathways

Example of research program



1. Solid Recovered Fuel
2. Also called SNG: Synthetic Natural Gas or Substitute Natural Gas

GAYA was an ambitious R&D project coordinated by ENGIE

It gathered 11 partners all along the value chain from biomass supply to biomethane production

Project co-funded by ADEME within the framework of the Call for Expression of Interest (AMI) and the "Second-generation biofuels" Demonstrator Fund

Objective of the project

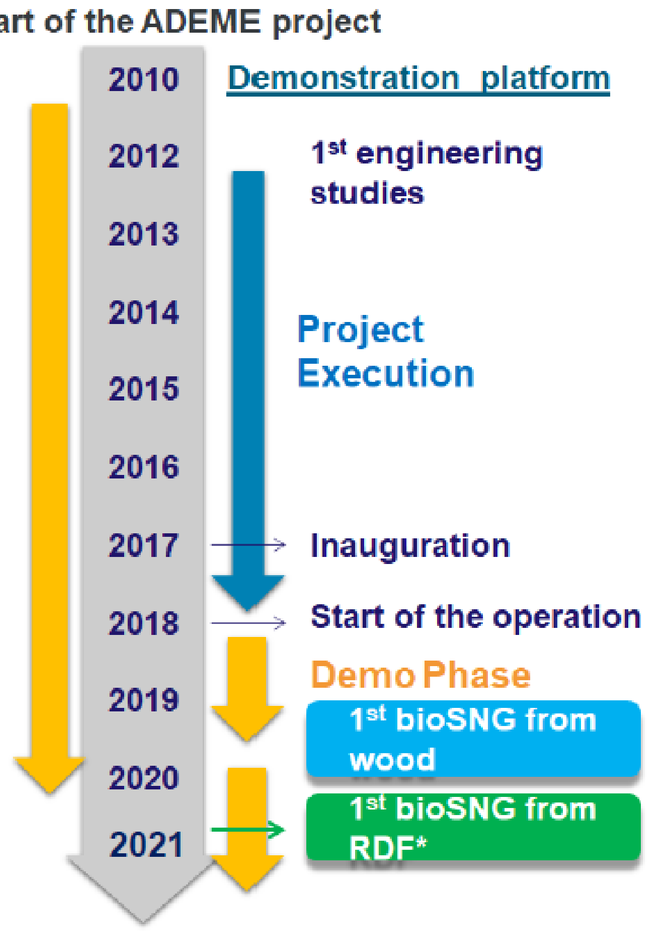
Demonstrate the technical, economic and environmental viability of biomethane production from biomass gasification

A 10-year R&D program

11 partners

gaya

ENGIE Lab, repotec, FCBA, cea, LRGP, cirad, EDF, IFP Energies nouvelles, LABORATOIRE DE GENIE CHIMIQUE, UCFF, UCCS, ctp



With the support of:

ADEME – AGENCE DE LA TRANSITION ÉCOLOGIQUE; INVESTISSEMENTS D'AVENIR; tenerrdis Auvergne-Rhône-Alpes; axeLERA

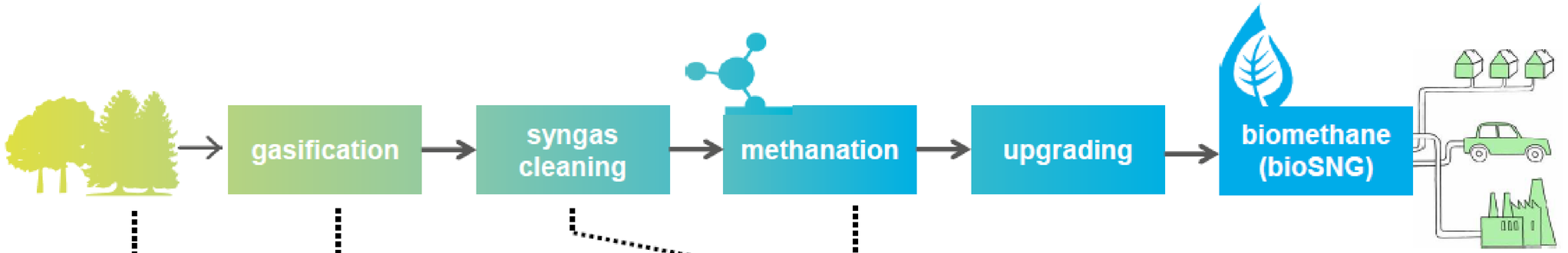
ADEME: French environmental agency
bio-SNG: bio-Substitute of Natural Gas (biomethane)

ENGIE

GAYA Project was built to address different challenges (techno, economic and environmental) all along the process chain

- Integration and optimization of the overall process chain
- Prepare scale-up and industrialization

10 CRIGEN Patents



Flexibility in feedstocks procurement, sustainable supply

Process improvement:
- efficiency,
- syngas quality,
- availability

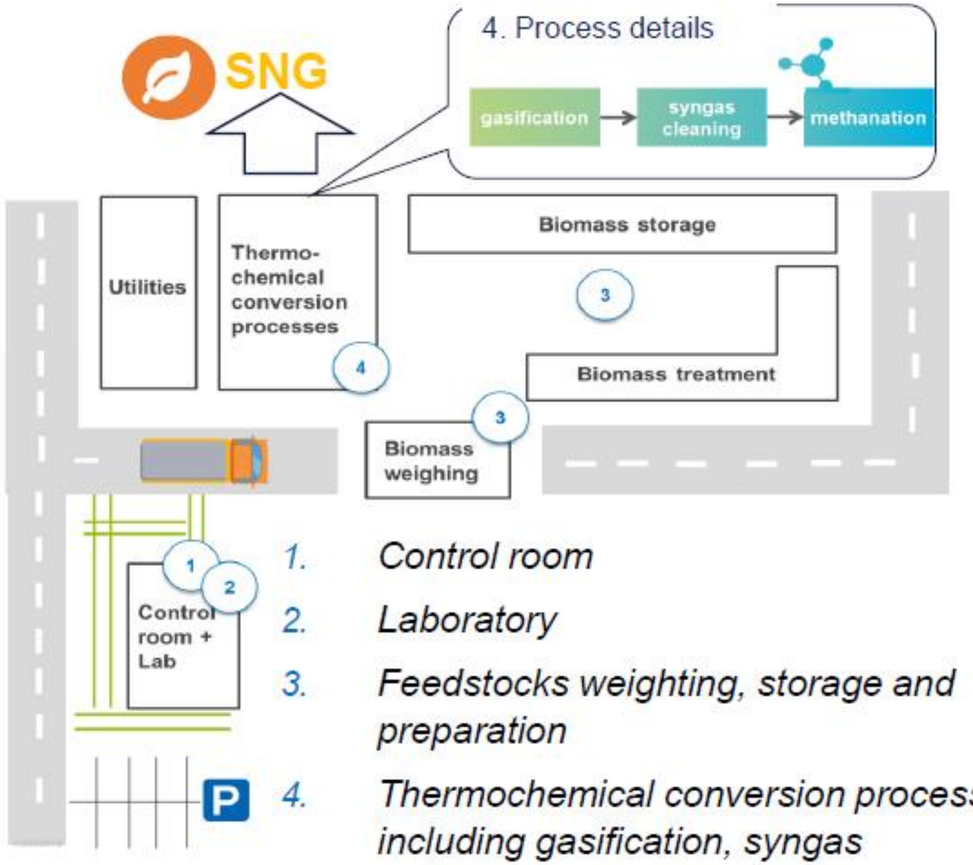
Technological combinations to:
- lower CAPEX and OPEX
- reduce environmental impacts

- Definition and validation of an innovative & competitive process
- Process integration

To do so ENGIE has built and still operates the GAYA demonstration plant

A cutting-edge R&D and highly automatized demonstration plant to produce renewable gas from biomass & waste

Saint-Fons, in the Chemical Valley, in the south of Lyon



1. *Control room*
2. *Laboratory*
3. *Feedstocks weighting, storage and preparation*
4. *Thermochemical conversion process, including gasification, syngas cleaning, methanation*

GAYA platform is a cutting-edge semi-industrial R&D facility...

- With more than 3000 sensors
- Highly automatized with a complete control system
- By design, modular on purification or on upgrading parts
- The only R&D platforom covering the whole production chain

...with 3 main uses

- Research & Development
- De-risk and boost industrialization
- Communication

Thanks to the GAYA project ENGIE succeeded to develop and innovative, robust and more cost-effective production chain than the state of the art…

Technical validation of the process at demo-scale (TRL 7-8)

- > 150 tests performed
- Long duration tests in continuous mode (24h/24h)

The entire production chain has successfully been proven to be robust and flexible to convert several feedstock

Lowering production costs

- Innovations (10 patents)
- Optimization of the process

-30 % of CAPEX and

-10 % to -100%

on feedstocks supply costs compared to the state of the art

Environmental benefit confirmed

- Life Cycle Analysis performed
- Compliance with thresholds imposed by RED II (for heat or bio-fuels)

-86 % of GHG reduction using 2G biomethane compared to fossil fuels (RED II)

...paving the way towards the industrialization and market uptake of biomethane production from gasification

ENGIE is now scaling up and plans to replicate a substantial technology from R&D to industry, through its “ENGIE 2G Program”

Second generation (2G) biomethane or SNG (Synthetic Natural Gas) from gasification is mature

A successful R&D program over more than 10 years (GAYA) led by ENGIE Lab to demonstrate the technical, economic and environmental viability of biomethane production from gasification.

The time has come for industrial scale

A partnership with CMA CGM, world leader in maritime transport, around synthetic methane to decarbonize existing assets and validate the transition to LNG as a long-term maritime fuel.

A contribution to reaching the RePowerEU biomethane production target and greenhouse gas emissions reduction target

Moving forward with 2G biomethane to develop a pipeline of projects to meet Fuel EU's maritime and emissions trading system goals.

Salamander project

ENGIE's first commercial project of SNG from gasification to be installed in Le Havre

Project led by:

storengy (100% ENGIE subsidiary)

170 GWh of SNG

For heavy / maritime transport and intensive industries

+ ~40 GWh of renewable heat

For industrialists and urban networks

70 000 t/year of non-recyclable waste recovered

Supplied regionally and otherwise exported, incinerated or landfilled

Partnerships and funding

Public-private with the French State

Territorial Pact Le Havre Seine Métropole

Innovation Fund candidate
Eligible for the Just Transition Fund

2020 | 2021 | 2022 | 2023 - 2025 | 2026+

Pre-feasibility study → Feasibility → Design → Construction → Operation

Thank you for your attention !

Contact

Marion MAHEUT
Pyrogasification and GAYA R&D project leader
ENGIE CRIGEN
Biogas, Biomass & Waste Lab
marion.maheut@engie.com


PRODEVAL
RNG PROCESS TECHNOLOGIES
MORE THAN VALUABLE PRODUCTS
07/05/2023

INTEGRITY | ENGAGEMENT | INNOVATION | COMMITMENT-TO-SERVICE | OPEN-MINDNESS

PRODEVAL is a a **trusted player** in the energy transiction

The company has enhanced its skills for the purposes of bring to its customers **solutions** in **Biomethane production, distribution** and everything around it.

RENEWABLE GASES UPGRADING

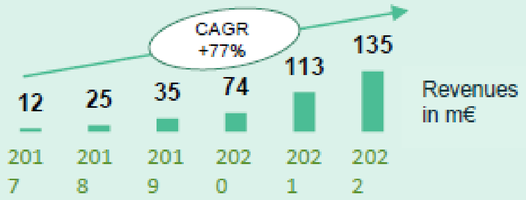
A fast-growing company

SPECIALIZED IN RENEWABLE GASES UPGRADING

2009-2023 An **entrepreneurial success story**

Family business supported by the Suez Group since 2021

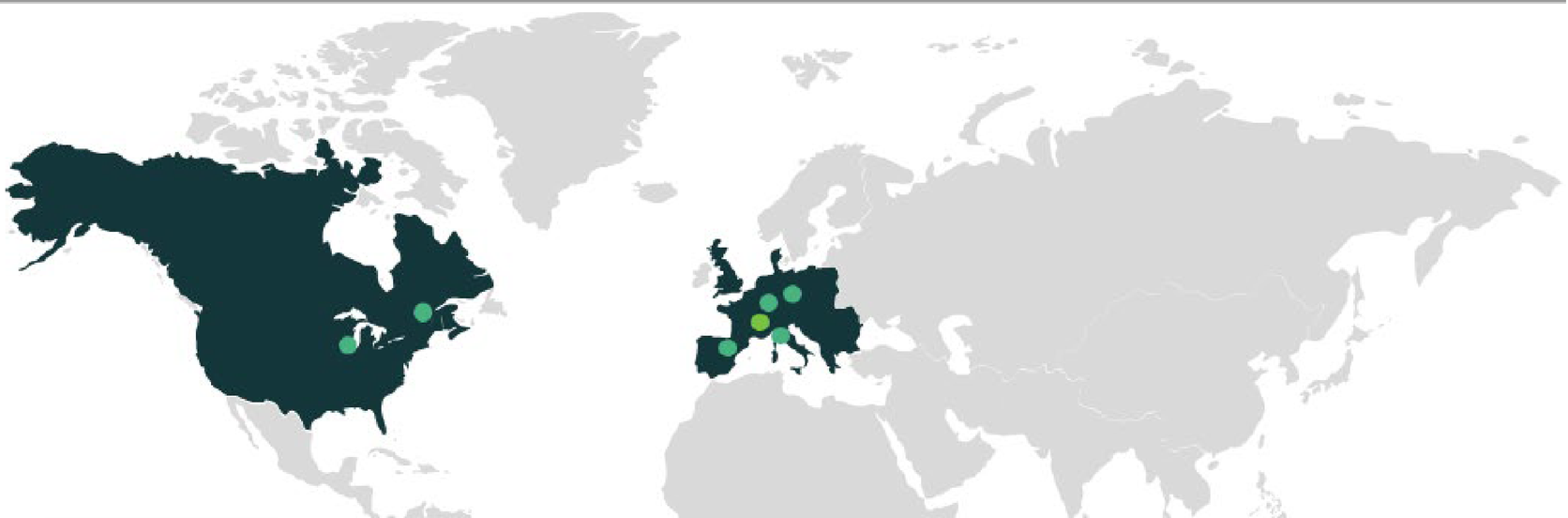
+400 plants all over the world



+350 employees
+100 tehnicians on customers service

Certifications

According to subsidiaries



2009 — **Sébastien PAOLOZZI** bought the company and became the new CEO.
5 employees

2014 — **1st VALOPUR®** reference, Biogas upgrading unit with membrane separation technology.

2018 — **Opening of the Italian subsidiary** in Genoa.
85 employees

2019 — **Opening of the Canadian subsidiary** in Montreal. **Creation of PRODEVAL Formation**
110 employees

2020 — **CN'GREEN®** launch. **International development** in Spain, UK, Belgium, Czech Republic
200 employees

2021 — **V'COOL®** launch. **Opening of subsidiaries in Czech Republic and USA.** ISO 9001, TUV (Module H) and Qualimétha **certifications. Partnership with Suez** (40% of the capital).
300 employees

2022 — **ELECTRICAL SELF-CONSUMPTION** launch. **Opening of the german subsidiary.** Opening of the American subsidiary's offices. **Partnership with 2G Energy and Belenergia. ISO Certifications** 9001 / 14001 / 45001
350 employees

2023 — **Opening of the spanish subsidiary.** LINE Certification.
370 employees (projection)

PRODEVAL

PRODEVAL

MAJOR PLAYER IN THE BIOGAS SECTOR

PRODEVAL is:

+30 years
Of experience

6
Subsidiaries

+350
Employees

135 M€
of revenue in 2022

Our expertise:

+400
Projects in the world (Biogas Upgrading, Mobility, CO_2 and Biogas Networks)

39 241
Nm^3/h of Biomethane injected into the gas grid

75,55
Tons of CO_2 emissions avoided per hour

PRODEVAL references

A GLOBAL PRESENCE






+400 installations in operation worldwide

17% of Biogas membrane upgrading market share worldwide

FEEDSTOCKS

- Agricultural
- Organic waste
- Industrial
- Sewage Sludge
- Landfill

Innovative products and outstanding services related to Biogas and Biomethane upgrading

STANDARDIZED SOLUTION READY FOR LARGE-SCALE DEPLOYMENT

BIOMETHANE

VALOPUR®

- Biogas drying and cooling
- Pollutant capture and treatment
- Membrane Biogas upgrading
- Biogas boiler
- Biomethane Odorization

ELECTRICAL SELF-CONSUMPTION

Biogas cogeneration (CHP)

Self-consumption solution for Biogas application to allow the Biogas sites to be in total or partial electrical self-consumption and thermal self-sufficiency.

MOBILITY

CN'GREEN®

BioCNG Distribution unit

AGRIGNV

BioNGV production / distribution unit

CO_2 Liquefaction

V'COOL®

CO_2 upgrading solution for industry or food industry (EIGA, ISBT)

A FULL RANGE OF SERVICES

Biogas Network	Maintenance	Stock of Spare parts	Gas analysis
Supervision & Data	Operational support	Activated carbon & Leak detection	Hotline

Our services

SUPPORT THROUGHOUT THE BIOMETHANE VALUE CHAIN

A FULL PREMIUM SERVICE

- Maintenance contract
- Technical training for clients
- A Services team of over 100 people
- Intervention capacity (large network of technicians in the field)

Preliminary project

- Feasibility study
- Technico-economic study

Operational support

- Monitoring and operational analysis
- Installations upgrading
- Biogas analysis and leak testing
- Activated carbons sales and reactivation

Operational Services Maintenance & Hotline

- > 97% guaranteed system availability
- 4M€ Spare parts stock (50% critical parts)
- Hotline available 24/7
- Plants supervision

Use of data - Supervision

- Real-time remote visualization and monitoring of system status
- Supervision software for remote control
- Management of electrical consumption
- Data extraction
- Control of the gas distribution contract

Our strengths

TO ACCOMPANY CUSTOMERS FROM THE FEASIBILITY STUDY TO THE DECOMMISSIONING OF PLANTS

RIGHT TECHNICAL SOLUTIONS

MODULARITY: compact and cost effective.
Completed preassembled containerized systems to reduce installation time and costs

SCALABILITY: durable, practical and economical
to meet the needs of our customers over time and easily adapt to the market- integration without stopping the production

HIGHLY AUTOMATED OPERATIONS
Fully instrumented packages, to increase availability, optimize maintenance, and predictive maintenance – no daily interventions- guaranteed performances

HIGH EFFICIENCY
Design to cover larger operating ranges and to allow the maximum availability

INNOVATION

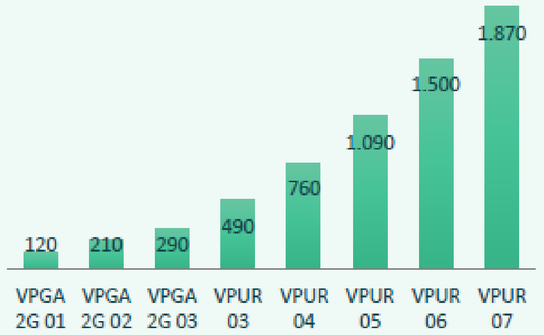
STRONG R&D PROGRAM TO SUPPORT INNOVATION
new technologies and products optimization in compliance with environmental issues

Our upgrading solution

A STANDARDIZED SOLUTION FOR LARGE-SCALE DEPLOYMENT

1 Modular approach depending on the size of the plant

VALOPUR® product range depending on Biogas flow rates to be upgraded into RNG:
(Biogas flow– Nm³/h)



2 Disruption-free integration for operators

- PRODEVAL membrane upgrading units are pre-assembled and shipped as a single unit
- Composed of three stages of membranes which separate CO_2 from CH_4
- A containerized installation for real-time monitoring of the overall process performance

3 Highly automated operations and maintenance services

- No daily intervention
- 24/7 monitoring - remote control
- Yield recovery Guarantee 99,5%
- Supervision: Remote monitoring and maintenance in real-time by our technicians

Our strengths

TO ACCOMPANY CUSTOMERS FROM THE FEASIBILITY STUDY TO THE DECOMMISSIONING OF PLANTS

HIGH INDUSTRIAL PRODUCTION CAPACITY

STANDARDIZED PRODUCTS
Standardizations allows to anticipate procurement

EFFICIENT PRODUCTION LINE
more than 2 VALOPUR® per week on average – production capacity in doubling

SEVERAL PRODUCTION LINES
Tailor made solutions for our partners
Dedicated production lines with reserved production slots

PRODEVAL's industrial capacity

THE LARGEST PRODUCTION CAPACITY OF BIOGAS UPGRADING UNITS BY MEMBRANE WORLDWIDE

Standardized products

- **Wide range** covering needs **from 120 to 1870 Nm³/h of Biogas and more**
- **Wide range of applications:** grid injection, virtual pipeline, CNG refueling station

Reliable and cost-effective solutions

- **Cost-effective**
- **Guaranteed power consumption** under all operating conditions
- **Guarantee of 99.5% upgrading efficiency**

Efficiency and high delivery capacity

- **Average production time of 6 months**
- **Worldwide delivery**
- **Delivery capacity of 150 units / year**
- **Premium quality** for all weather conditions

Our strengths

TO ACCOMPANY CUSTOMERS FROM THE FEASIBILITY STUDY TO THE DECOMMISSIONING OF PLANTS

RESPONSIVE CUSTOMER SERVICE

+100
PRODEVAL technicians

Dedicated Service Team in each area
Quick support and diagnostics

Several service solutions
From qualification of customers as Service Partners to full services, for better address the particular needs

Data Driven Solutions – Supervision
Reports and planning of interventions, project documents, available on the web for all customers

Technical optimization
PRODEVAL 4.0: Development of drone solutions, virtual reality, AI

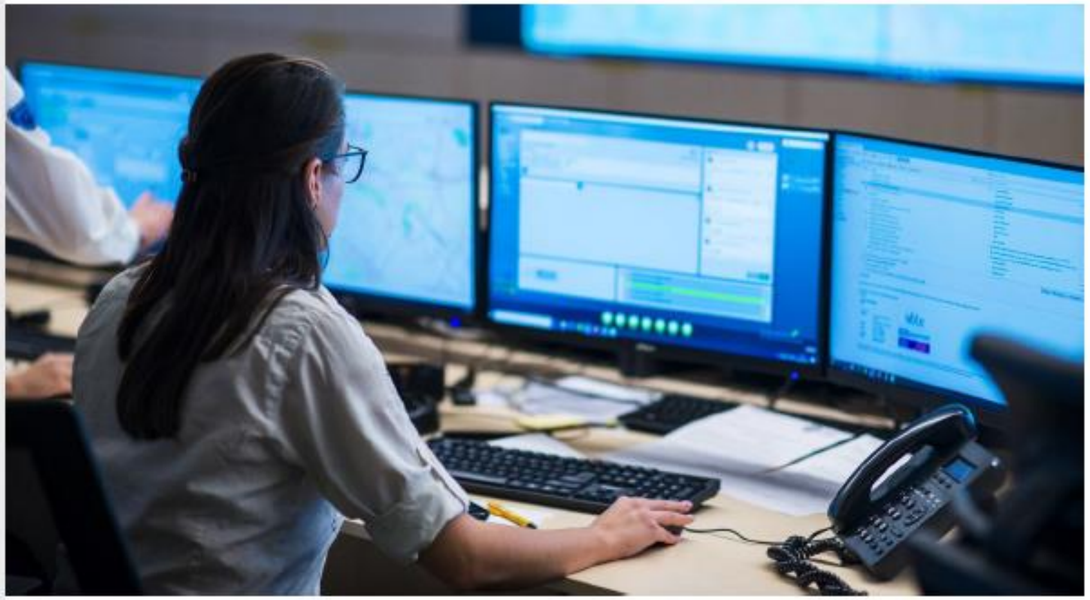
Consumables and recycling
Activated carbon, Biogas Analysis and recommendations, carbon filters

Hotline

- **20 Hotliners**
  Team able to answer customer calls
- **+2.900**
  Average calls per month
- **24/7**
  Hotline
- **35 seconds**
  Average wait time per call
- **95% of restart rate**
  At the first phone call

Our services

SUPERVISION & HYPERVISION



SUPERVISION

Possibility of adjusting the keys parameters and provide all the information to allow an easy and quick troubleshooting
on average, 92% of remote interventions do not require on-site intervention (March 2023 data)

Facilitated operation with simple indicators available at first sight

HYPERVISION

Real-time view of all facilities on an international scale for preventive, curative and predictive maintenances

The operating data collected in real time allows us to secure, control and optimize the performance of installations

Our strengths

TO ACCOMPANY CUSTOMERS FROM THE FEASIBILITY STUDY TO THE DECOMMISSIONING OF PLANTS

FORMATION TRAINING

- Training programs for **all players of the sector**
- Training courses **adapted to the profiles**
- **Technological and educational innovations** (virtual reality…)

PRODEVAL FORMATION

LAUNCH OF THE PROJECT «ECOLE DU BIOGAZ»
Tending towards the professionalization of Biogas sector

l'École du Biogaz

In 2022

- **2 000** learners
- **14 000** training hours
- **80** training courses
- **87 %** of satisfaction

PROMOTE THE DEVELOPMENT OF THE SKILLS OF BIOGAS ACTORS

MAINTAIN A HIGH LEVEL OF IN-HOUSE SKILLS


PRODEVAL
RNG PROCESS TECHNOLOGIES
www.prodeval.com

Demonstrating hybrid biomethane production from biomass

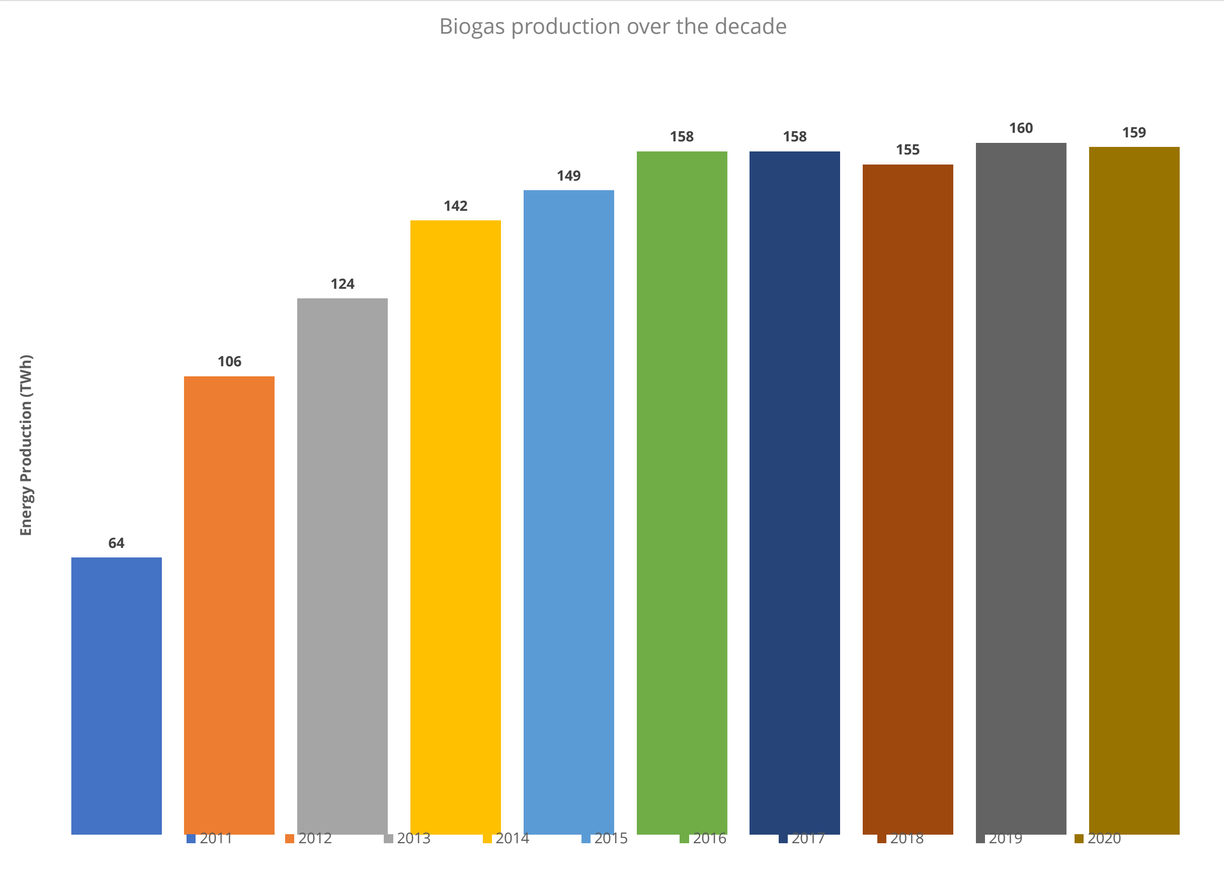
Francisco Gírio
President of the Board of CoLAB BIOREF

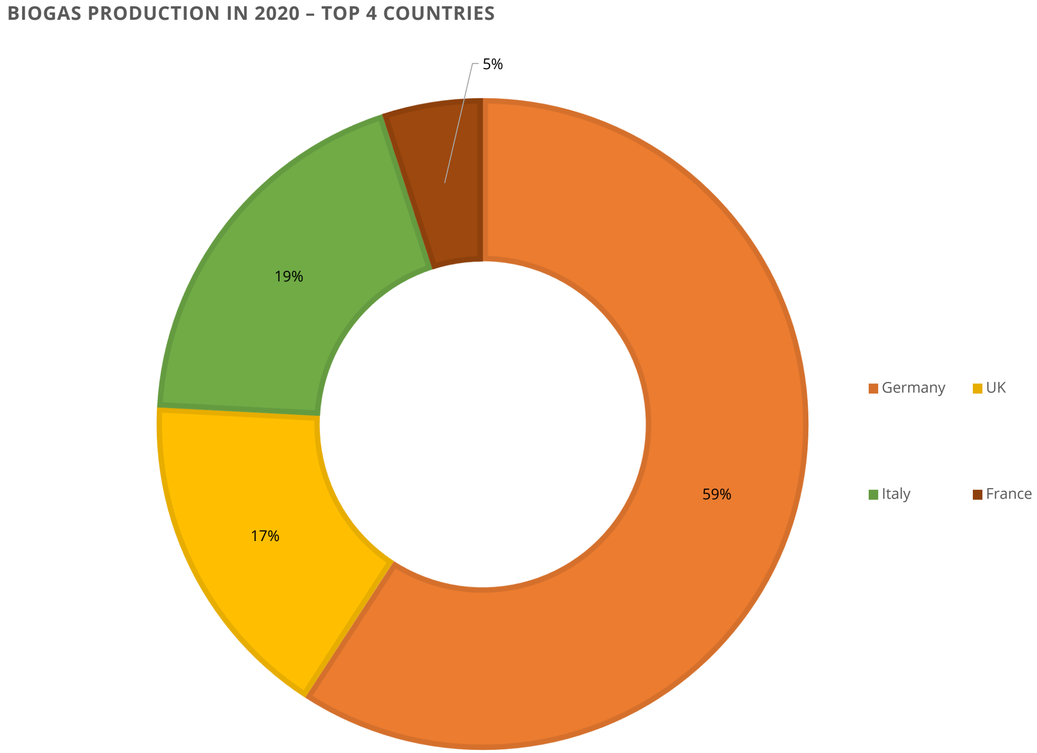
HYFUELUP
Hybrid Biomethane Production from Integrated Biomass Conversion

EUBCE-2023, Bologne,
June 2023

Funded by
the European Union

Biogas: the European market (current status)

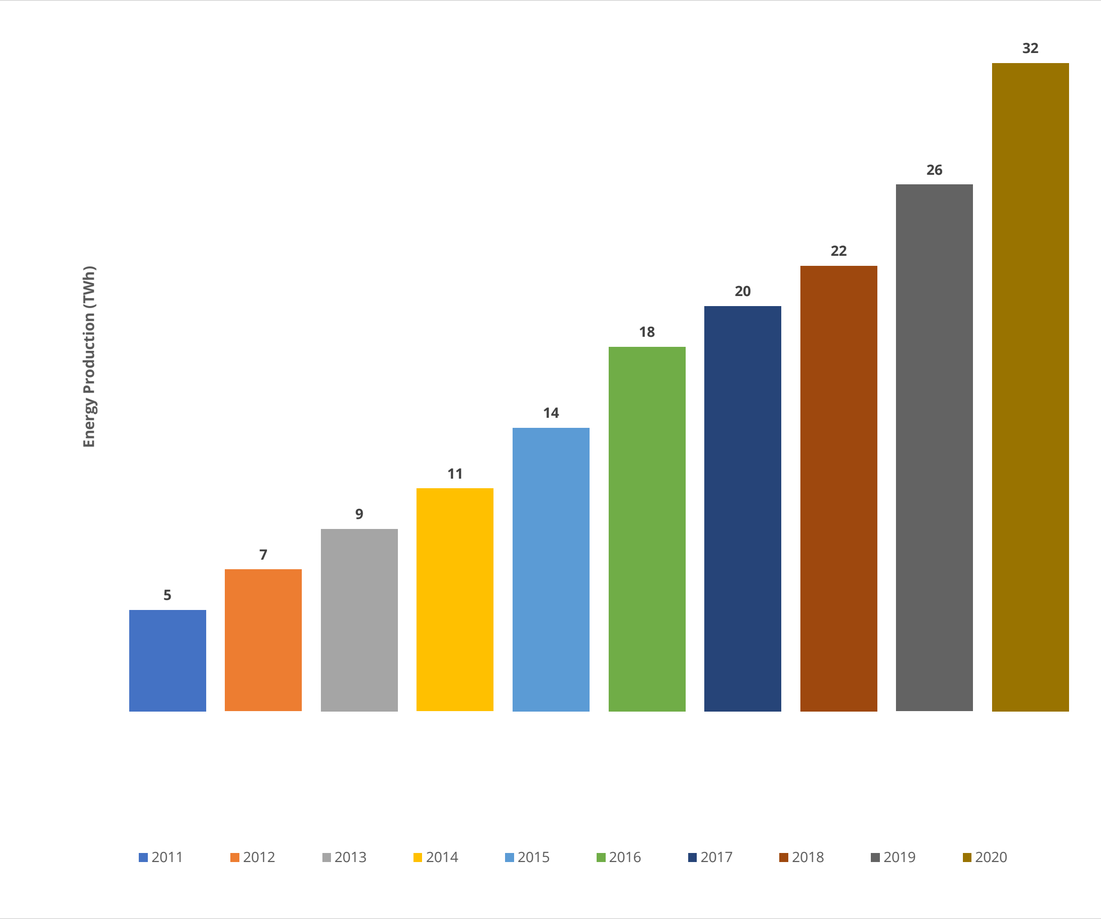


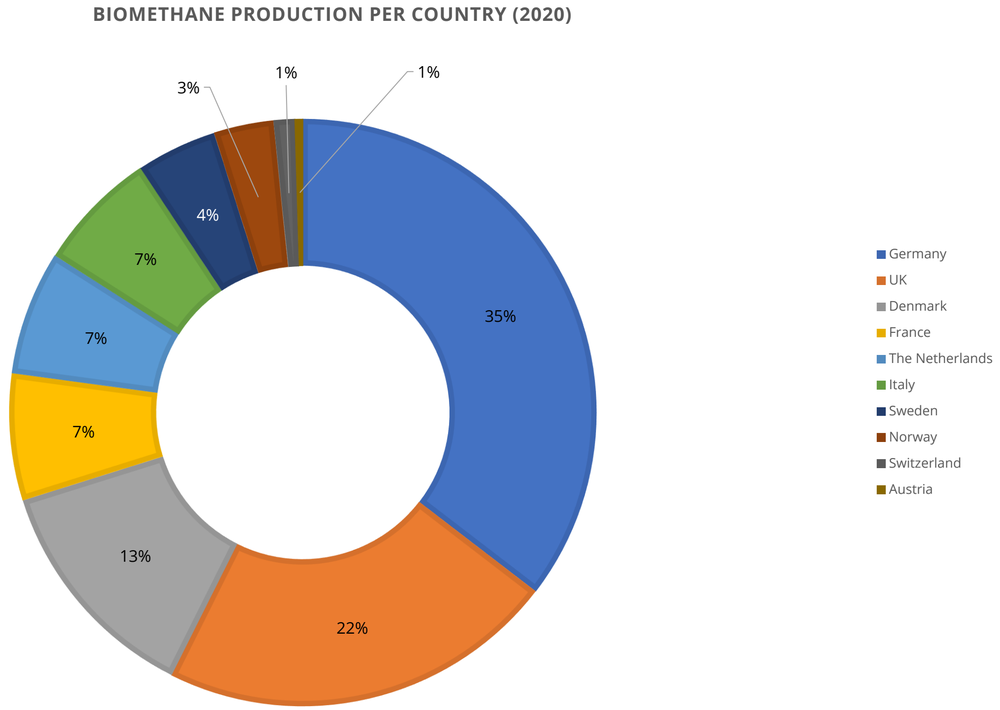


- The **biogas** production in Europe in **2020** was **159 TWh** (~**15.0 bcm** of energy).
- It represents ~**4.0% of the gas consumption** of the EU.
- **Biogas production** has **stagnated** over the past few years (**2016-2020**) ~158 TWh

- **The European biogas** market is clearly dominated by **Germany** (59%), followed by **Italy** (19%) and **the UK** (17%).

Biomethane: the European market (current status)





- Unlike biogas, **biomethane** production shows a **continuous growth** in recent years (particularly 2016-2020).
- Note that the share of biomethane/biogas production is 0,20. This means that **80% of 2020 biogas** produced was used for **electricity** purposes.

Biomethane production in the EU (32 TWh or 3 bcm) differs significantly between countries

BIOREF Laboratório Colaborativo para as Biorrefinarias
HYFUELUP
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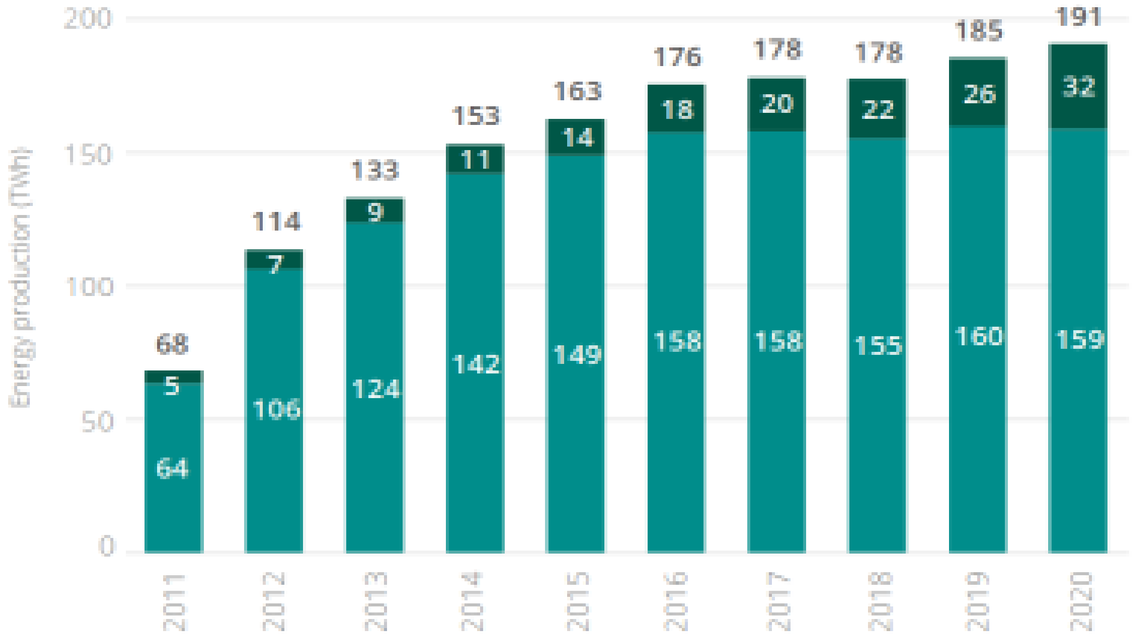
Biogas & biomethane production (2020)



In: European Biogas Association. EBA Statistical Report 2021. (2021)

RePowerEU

Target to reach **35 bcm of biomethane by 2030** in EU,

which is **more than 10X** the 2020 values in EU (32 TWh or 3 bcm)

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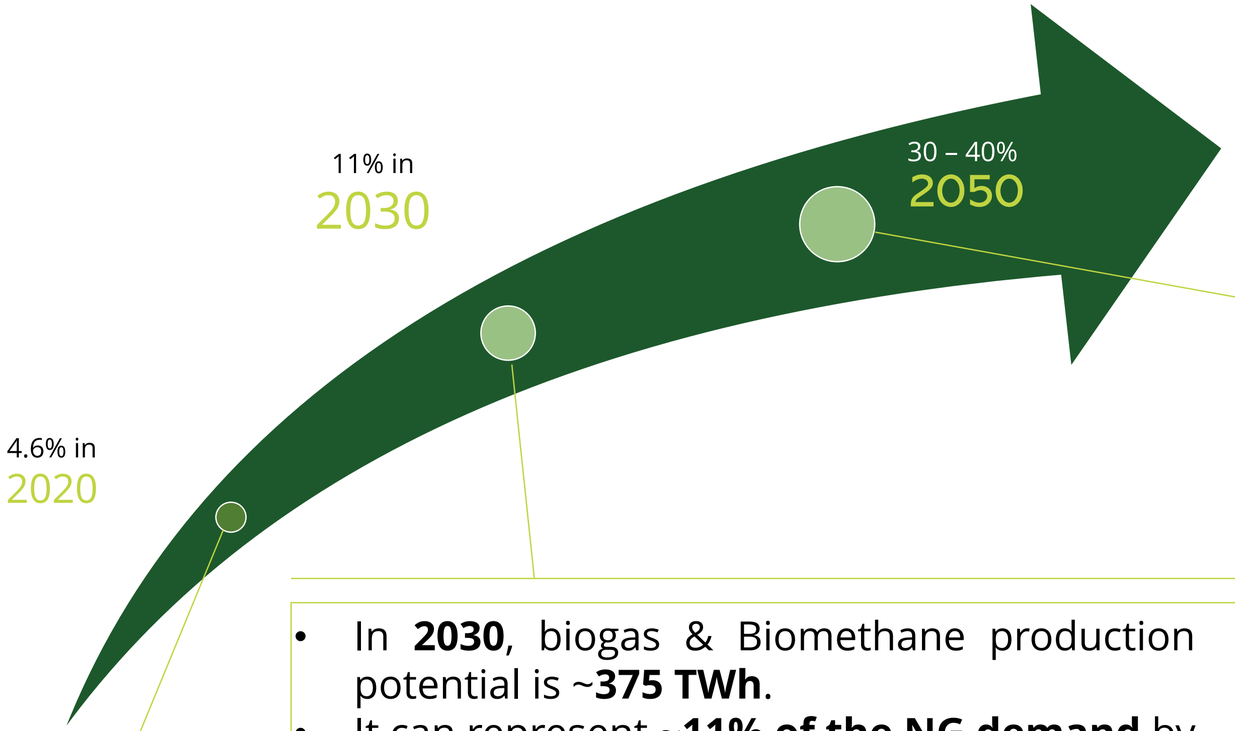
Biogas & Biomethane: potential in Europe



- In **2050**, biogas & biomethane production potential is ~**1015 TWh**, which can cover **30 – 40%** of the **NG demand** by 2050.
- The remaining part could be covered with **green H_2**.

- In **2030**, biogas & Biomethane production potential is ~**375 TWh**.
- It can represent ~**11% of the NG demand** by 2030.

- **Current** biogas & biomethane production (**191 TWh**) can cover **4.6% of EU gas demand**.

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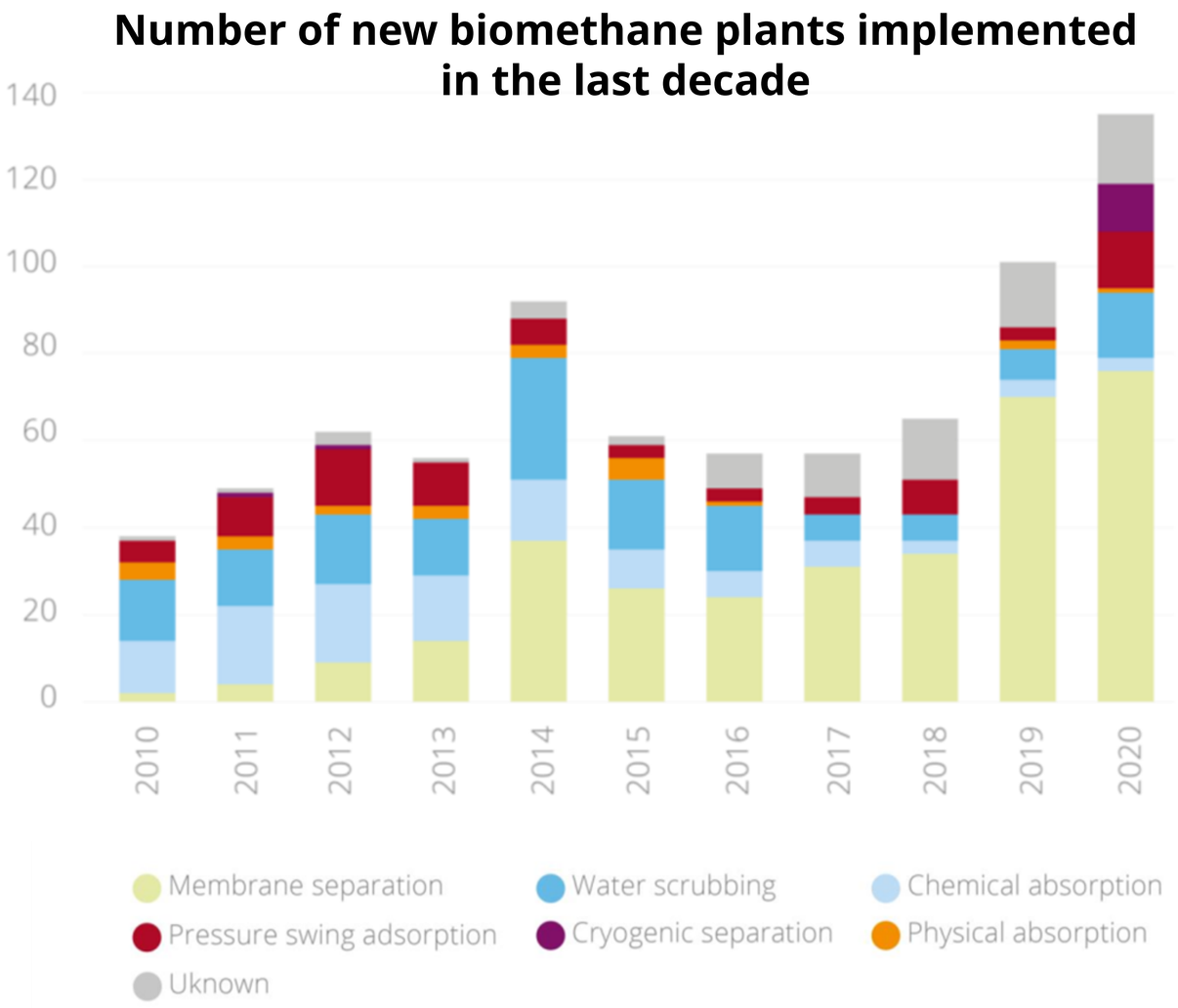
Evolution of upgrading technologies for biomethane production in Europe



The leading upgrading technology in Europe has been changed over the last decade.

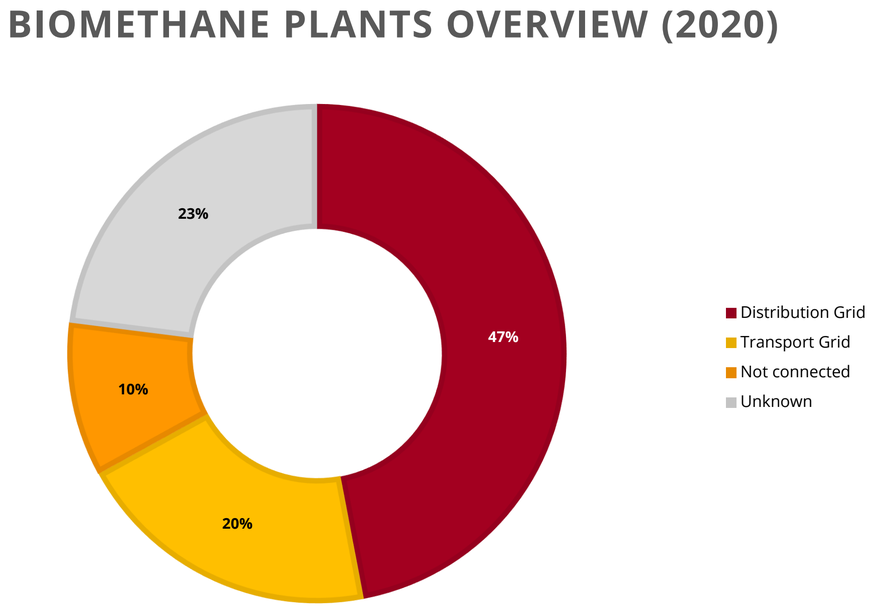
- **Up to 2013:**
  - water scrubbing,
  - chemical absorption
  - PSA

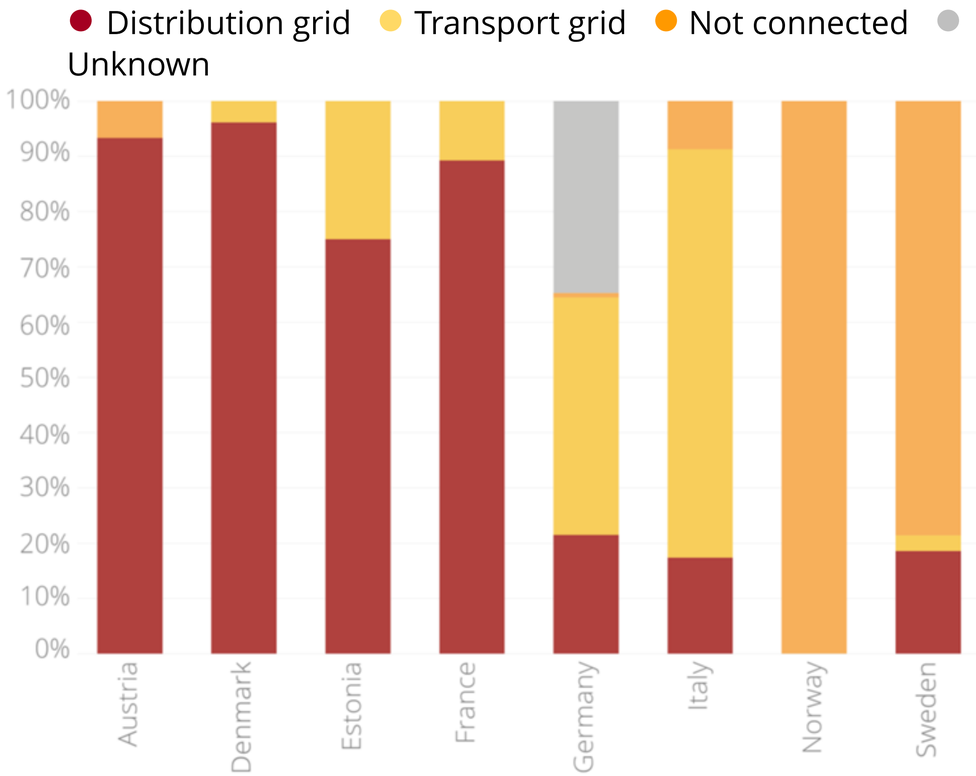
  were the dominant upgrading technologies

- **From 2014 onward:**
  - Membrane separation
  - Cryogenic separation
  - Water scrubbing

- **From 2020,** PSA did increase.

Biomethane injection to the Natural Gas (NG) grid plants (2020)

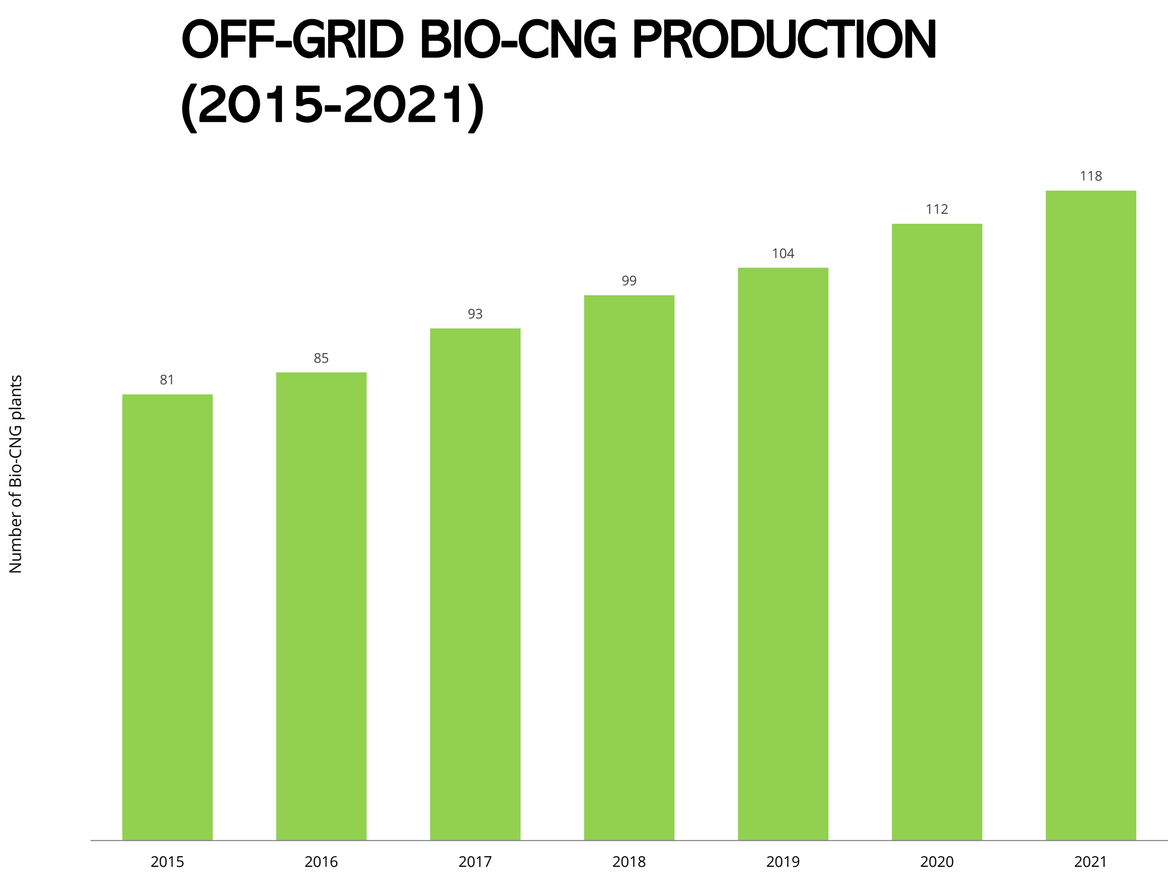




- Most of the European biomethane plants (47%) are connected to the NG distribution grid.
- 20% are to connected to the NG transport network.

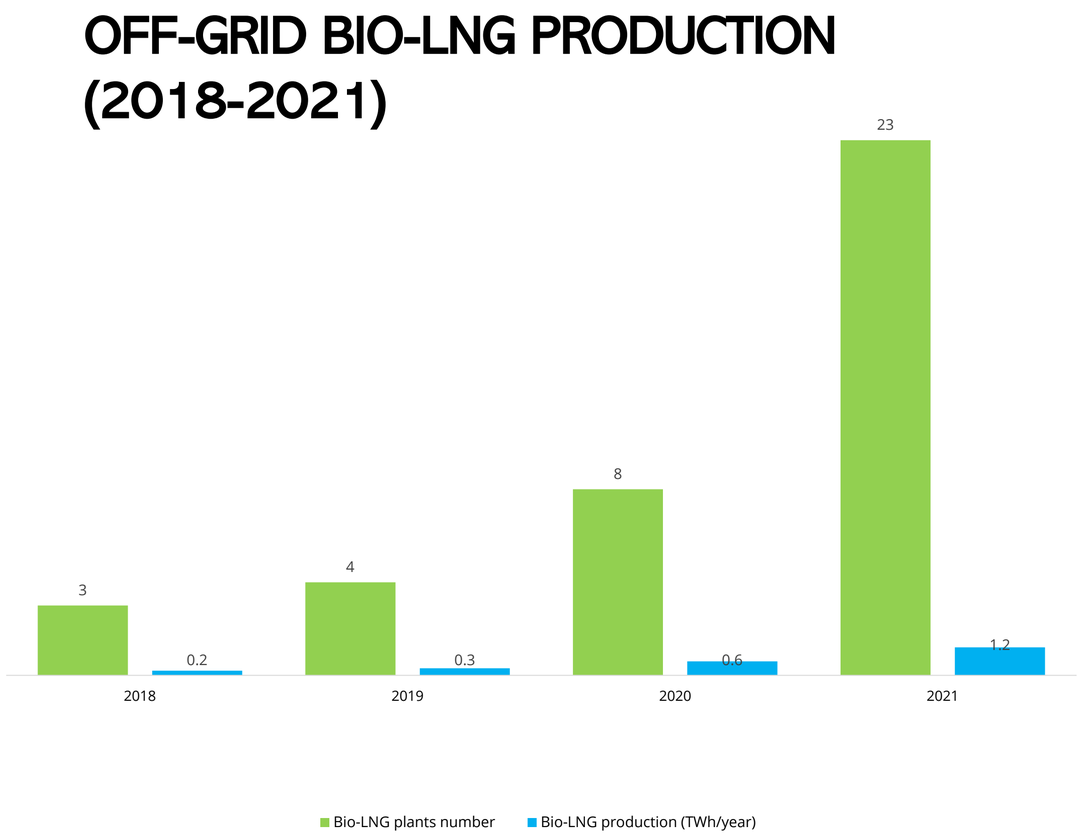
- The connection to the **distribution NG grid** is the preferred choice in **Austria, Denmark, Estonia & France**.
- While **Germany & Italy** have **more** plants connected to the **transport grid**.
- In **Sweden and Norway**, the gas grid infrastructure is limited, therefore **biomethane** production takes place largely **off-grid**.

Biomethane in the transportation sector (Bio-CNG & Bio-LNG)



- Biomethane plants also have the option of producing on-site Bio-CNG or Bio-LNG (off-grid), which can be delivered to a filling station or transported to its final end-users.
- Bio-CNG production in Europe is expected to increase steadily.
- In 2021, there were 118 Bio-CNG plants **(~12% of the total biomethane plants)**.
- Sweden (68), Finland (21) & Norway (14) are the larger Bio-CNG producers.

Biomethane in the transportation sector (Bio-CNG & Bio-LNG)



- The **number of Bio-LNG** plants in Europe has significantly **increased since 2018.**
- There were **8** active **plants** in **2020,** which **increased by 3 times** in **2021 (1.2 TWh/y).**
- According to EBA estimates, this number is expected to increase rapidly in the coming years (~**78 plants**; **10.6 TWh/y for 2023**).
- **Germany, Italy & the Netherlands** are expected to dominate the Bio-LNG market in the forecast period.

AD vs. Gasification Technologies for Biomethane

- Most production occurs via **AD biogas production and upgrading**, however there are,
  - Operational problems due to process instability
  - Inhibition and feedstock limitations (lignocellulosic feedstocks use is not straightforward)
  - Rigid and complex process operation and in general, CO_2 stream is flared
  - AD leads to low biogas productivity (days instead of hours)

- **Gasification** is an alternative that needs to be widely implemented
  - Sustainable biomass feedstocks are larger
  - Much higher productivity at similar energy efficiency (62-65%)

Project HYFUELUP

- **HORIZON-CL5-2021-D3-02-016:** Innovative biomethane production as an energy carrier and a fuel
  - Innovation Action (IA)
  - TRL: Activities are expected to achieve **TRL 6-7** by the end of project

- **Project budget:** 11.6 M€ with an **EU contribution of 10.3 M€**

- **Expected outcome:** **Complete plant validation** and first liquified biomethane offtake from gasification technology **expected in 2026**

- **Starting date:** **Nov 1st, 2022 (4 yrs)**

Project HYFUELUP – Consortium

Coordinator: BIOREF – Collaborative Laboratory for Biorefineries, Portugal

HYFUELUP

BIOREF
Laboratório Colaborativo para as Biorrefinarias

PAUL SCHERRER INSTITUT
PSI

University of Stuttgart
Germany

JM Johnson Matthey
Inspiring science, enhancing life

CIRCLE MOLECULE

ΚΑΠΕ
CRES

Bioplat
BIOMASA PARA LA BIOECONOMÍA

AlphaSYNT
Swiss SynFuels

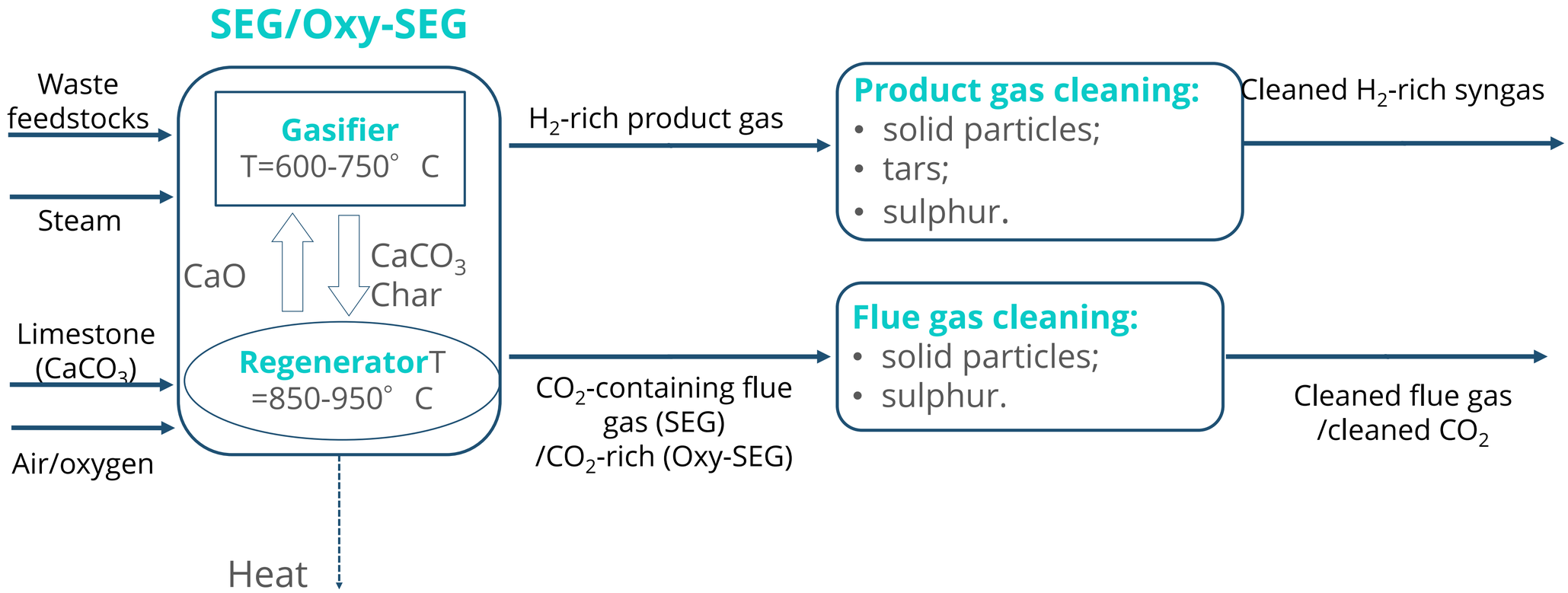
dourogás
renovável

POLITÉCNICO
DE PORTALEGRE

LNEG

Funded by
the European Union

Project HYFUELUP - Concept and Goals



- Demonstrate an **innovative pathway** for the efficient and cost-effective production of biomethane in industrial environment.
- Deploy a **first-of-its-kind** value chain for **biomethane production** using low-grade biomass residues and sludge digestate from AD plants.

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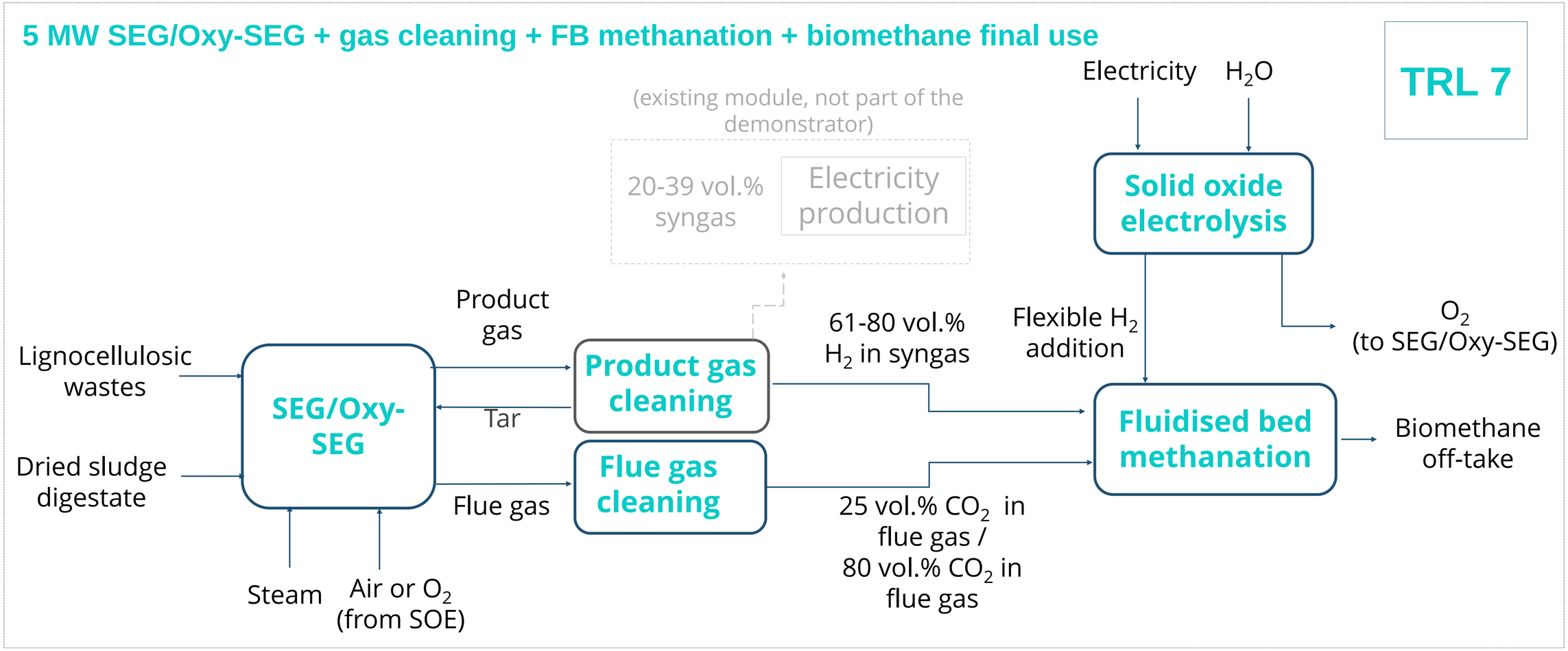
Project HYFUELUP – Main Demo site

Tondela (Viseu)
Portugal

- Retrofitting of an existing CFB gasifier
- Biomethane production capacity: 500 $kW_{th\ LHV}$ or 50 m^3/h or 36 kg/h

CIRCLE MOLECULE

Project HYFUELUP – Basic schematics of the technological demonstrator



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Advances and innovations I (expected)

- Broad technological concept via **advanced gasification**
- Expanded **lignocellulosic crop supply** for biomethane
- **Diversification of feedstocks** using low-grade wastes (digestate)
- **Flexible operation** with fewer steps
- In-situ CO_2 sorption/capture: **enhanced carbon efficiency** (from 65 to >71% as HHV)
- **All CO_2 in flue gas** is potentially **converted into CH_4**.

Advances and innovations II (expected)

- **Hybrid/adaptable operation mode** in the same reactor (avoids downstream CO_2 separation)
- **Flexible H_2 addition** following availability and needs
- **Complete deployment value chain** will be demonstrated
- **Accelerating energy transition in the EU** and increasing sustainability in the transport and energy sector
- **Reducing GHG emissions** and improving competitive sustainable growth
- **Replication** is expected Europe-wide

Funded by the European Union

Thank you for your attention

Francisco Gírio

Francisco.girio@lneg.pt

HYFUELUP

Funded by
the European Union

R&I to unlock feedstock potential for biomethane production

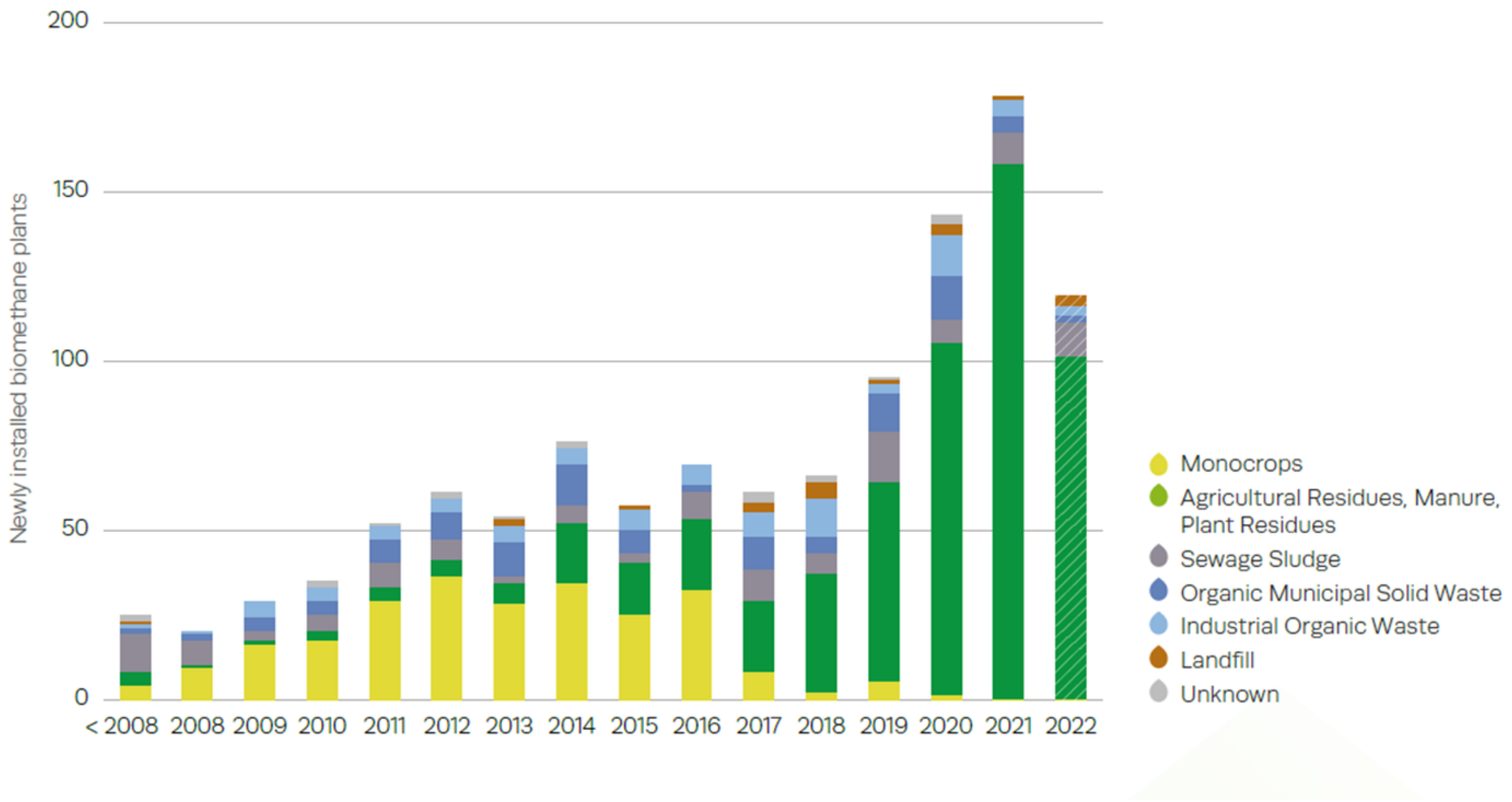
Myrsini Christou

Head of Biomass Department

Centre for Renewable Energy Sources and Saving (CRES)

EUBCE 2023 Bologna 5-9 June 2023

Feedstock for biomethane production in Europe

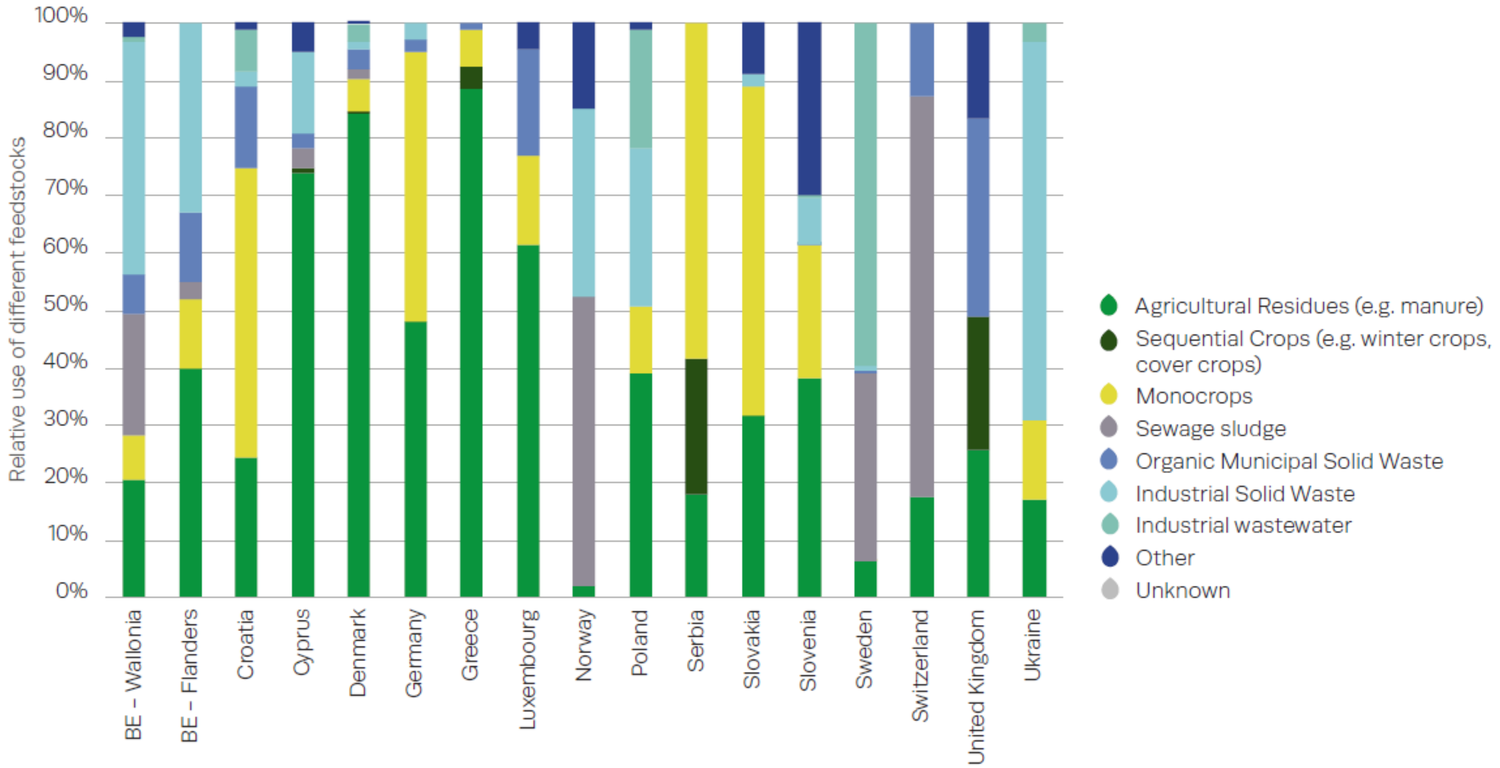


Highlights

- A clear trend towards agricultural residues, manure and plant residues and -to a lesser extend- sewage sludge and organic municipal solid waste.
- Monocrops (maize mostly in Germany) are gradually withdrawn from 2017 onwards

Source: EBA Statistical Report 2022

Feedstock for biomethane production in Europe



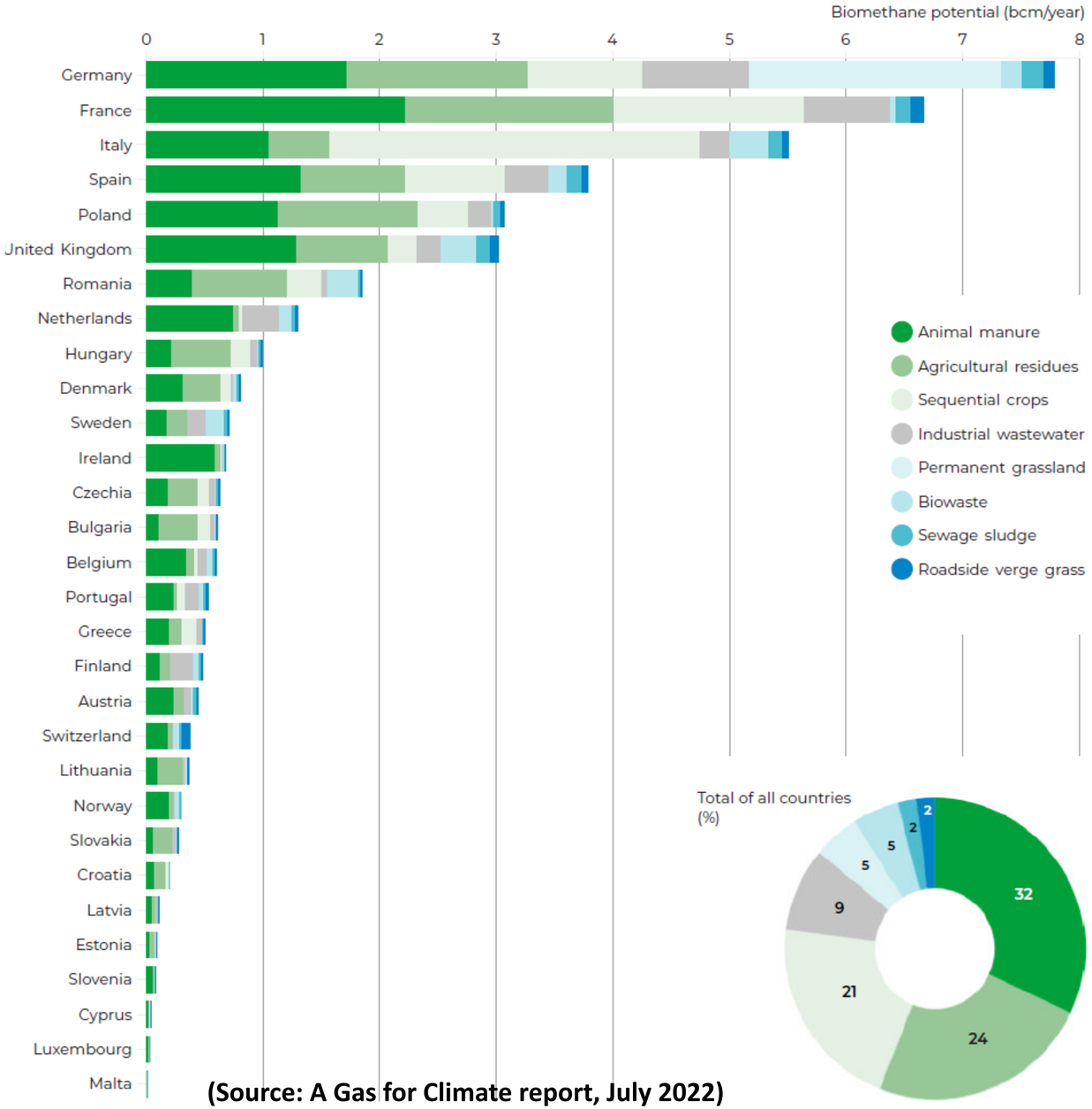
Relative use of different feedstock types for biogas production in selected European countries in 2021

Source: EBA Statistical Report 2022

Highlights

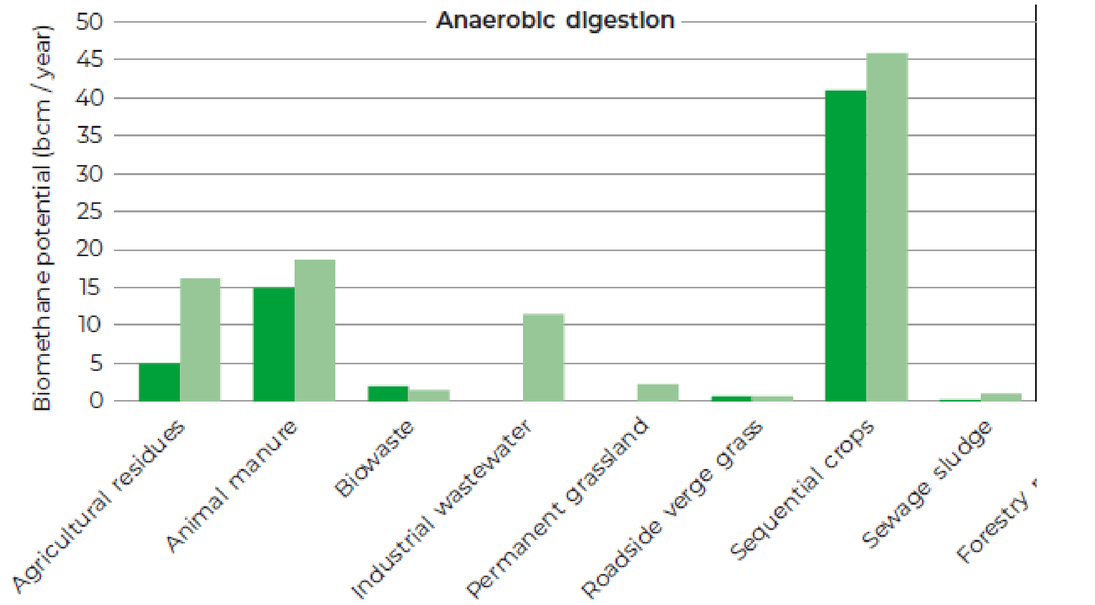
- High country variation
- In several countries, there is one dominant feedstock type
- **Agricultural residues** clearly dominate the biogas market in Cyprus, Denmark, Greece and Luxembourg
- **Monocrops** dominate in Croatia, Serbia and Slovakia
- In Germany **agricultural residues and energy crops** dominate the biogas market in equal terms
- **Sewage sludge** mainly used in Norway, Switzerland, Sweden, Belgium
- **Industrial wastes u**sed in Poland, Sweden, Ukraine, Belgium, Norway.

Anaerobic digestion potential in 2030 per feedstock and country



(Source: A Gas for Climate report, July 2022)

Biomethane potential in 2050 per technology and feedstock

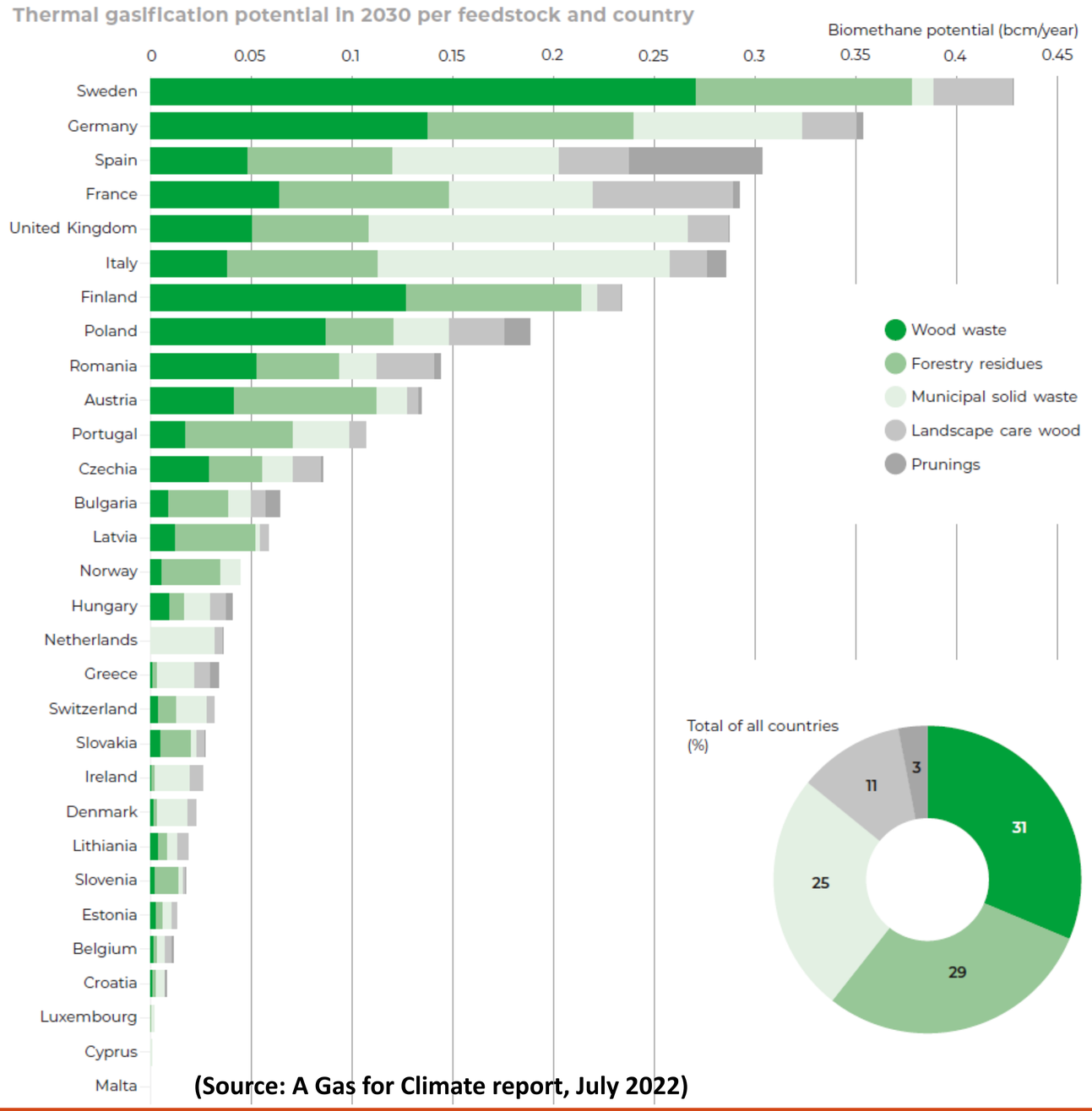


Source: EBA Statistical Report 2022

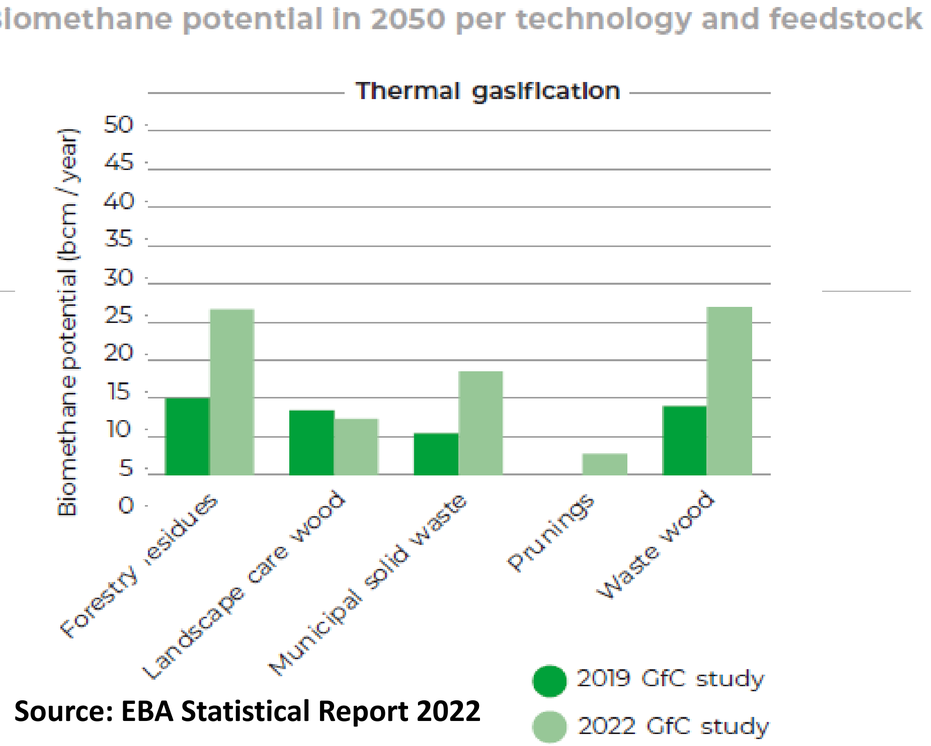
For anaerobic digestion:

Key feedstocks by 2030 and 2050

- ✓ Manure: 33% - 19% ↓
- ✓ agricultural residues: 25% - 17% ↓
- ✓ sequential cropping: 21% - 47% ↑
- ✓ industrial wastewater contributes over 10% of the potential in both 2030 and 2050.



(Source: A Gas for Climate report, July 2022)



Source: EBA Statistical Report 2022

For thermal gasification:

Key feedstocks by 2030 and 2050:

✓ forestry residues and wood waste,

More biomethane potential can be unlocked

✓ by looking at additional feedstocks (e.g. biomass from marginal or contaminated land and seaweed,

✓ technologies (e.g. HTL of wet feedstocks, including organic wastes and residues).

Problems

- Lots of solid manure available, with high energy content but difficult to handle
- Slurry is easy to handle but low energy content
- Solid biomass difficult to handle but with high gas potential (for example farm yard manure/deep litter, straw, grass, vegetable waste)

- Maize silage no longer acceptable at large scale

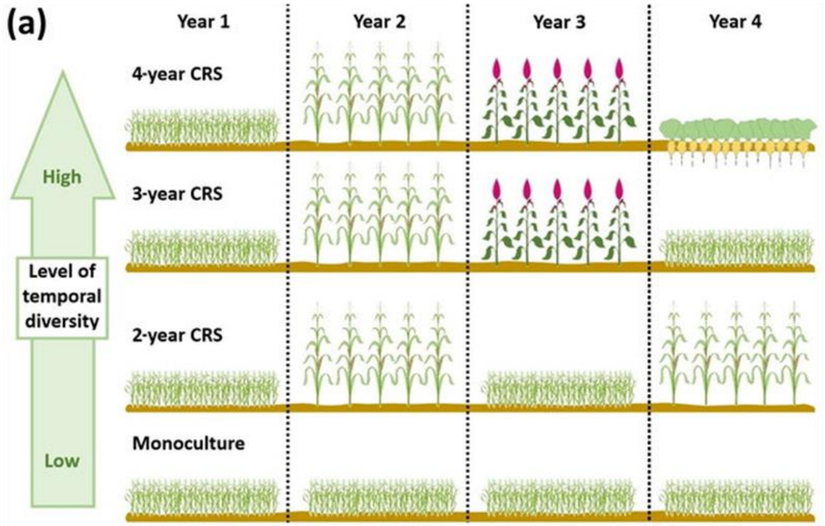
R+I Recommendations

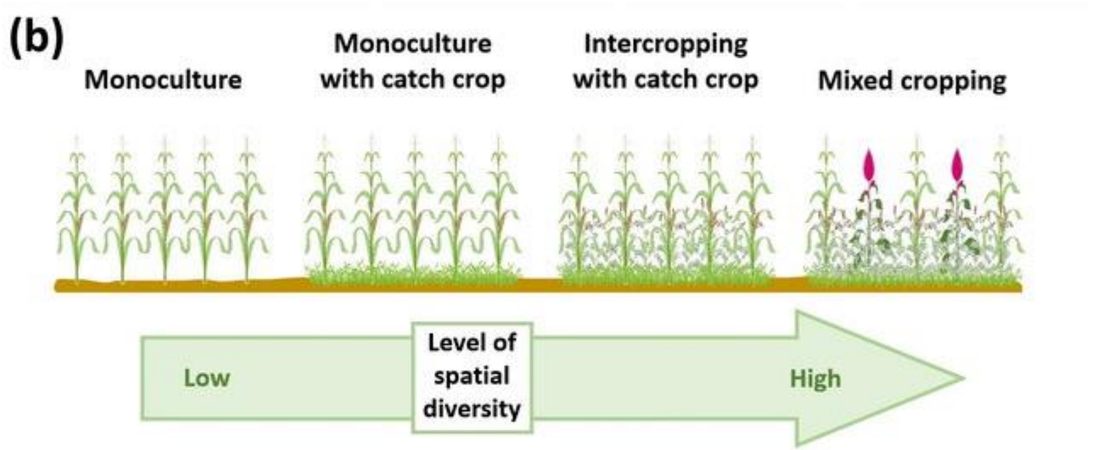
- Pre-treatment of the solid manure and similar waste streams before entering the digester
  - Ensiling of chopped straw
  - Briquetting of straw
  - Pressure cooking

- R&I on new non-food energy crops and sustainable growing techniques

R&I in growing crops

- Sequential cropping (a) (double, triple etc; i.e BIOGASDONERIGHT concept, BECOOL, BIKE projects, intercropping (b) (raw, patch, strip, etc)



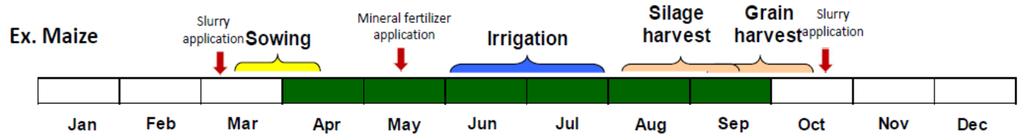


- Minimal/low tillage
- Growing perennial crops
- Growing crops (annual, perennial) on marginal lands (i.e projects MAGIC, MIDAS) for land phytoremediation (i.e projects GOLD, PHY2CLIMATE, CERESIS, FORTE, GRACE,)

The BiogasDoneRight concept

Conventional Agriculture

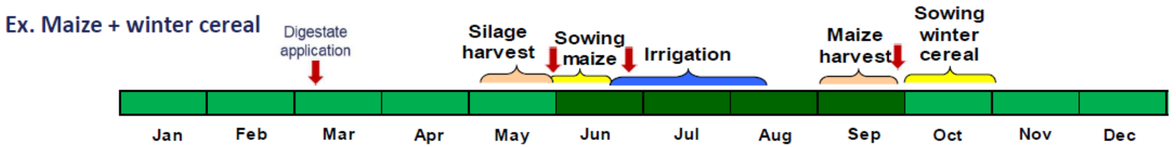
- Dairy farm, crop production to feed/food
- Arable crops, one-two crops per year (mainly maize)
- Fertilisation based on livestock manure + mineral



- ✓ Soil covered **6 months** per year
- ✓ Total above ground biomass around **23 DM t/ha/year (grain 13)**
- ✓ Irrigation: **necessary**
- ✓ Herbicides: **necessary**
- ✓ Soil tillage: **heavy (ploughing)**
- ✓ Organic matter level in soil: **steady or slightly down**

BiogasDoneRight® concept

- Dairy farm, crop production to feed/food/energy
- Arable/no till crops, two crops per year (several)
- Fertilisation based on digestate



- ✓ Soil covered **12 months** per year
- ✓ Total above ground biomass around **30 DM t/ha/year (maize 18 + triticale 12)**
- ✓ Irrigation: **necessary**
- ✓ Herbicides: **reduced** (especially if agricultural work happens quickly)
- ✓ Soil tillage: **reduced**
- ✓ Organic matter level in soil: **increasing**

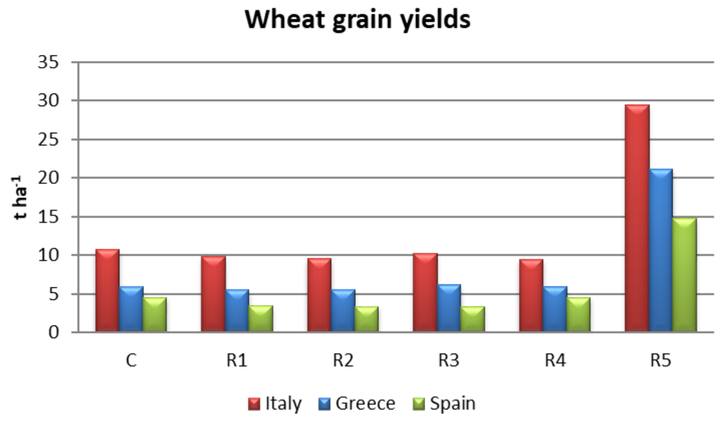
The BECOOL project

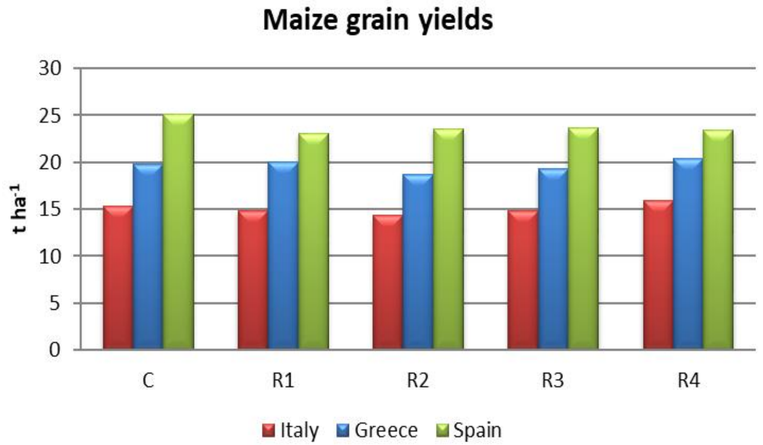
BECOOL
Brazil-EU Cooperation for Development of Advanced Lignocellulosic Biofuels

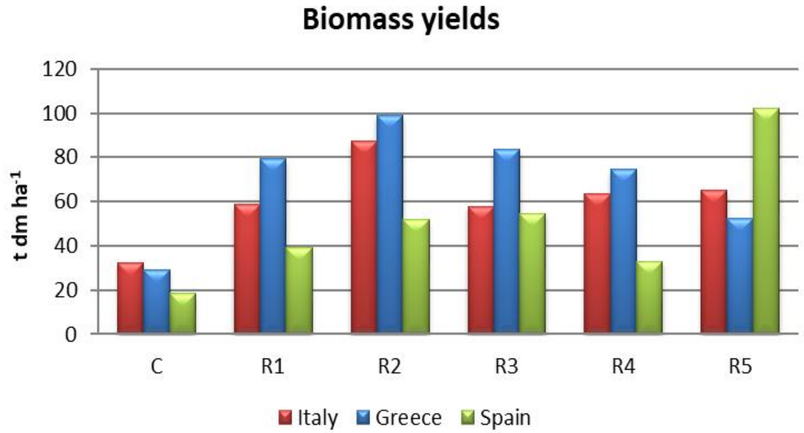
The integrated cropping systems including food and lignocellulosic crops are:

green: food crop
orange: energy legume
blue: energy crop

	2017									2018										2019										2020										2021							
	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S
C	Maize																		Wheat															Maize																				
R1	Maize												Sunn Hemp						Wheat									Sunn Hemp									Maize													Sunn Hemp				
R2	Maize												Fiber sorghum						Wheat									Sunn Hemp									Maize													Fiber sorghum				
R3	Maize												Kenaf						Wheat									Sunn Hemp									Maize													Kenaf				
R4	Maize												Hemp						Wheat									Sunn Hemp									Maize													Hemp				
R5			Sunn Hemp					Wheat									Sunn Hen		Wheat									Sunn Hen		Wheat								Sunn Hen		Wheat											Sunn Hen				





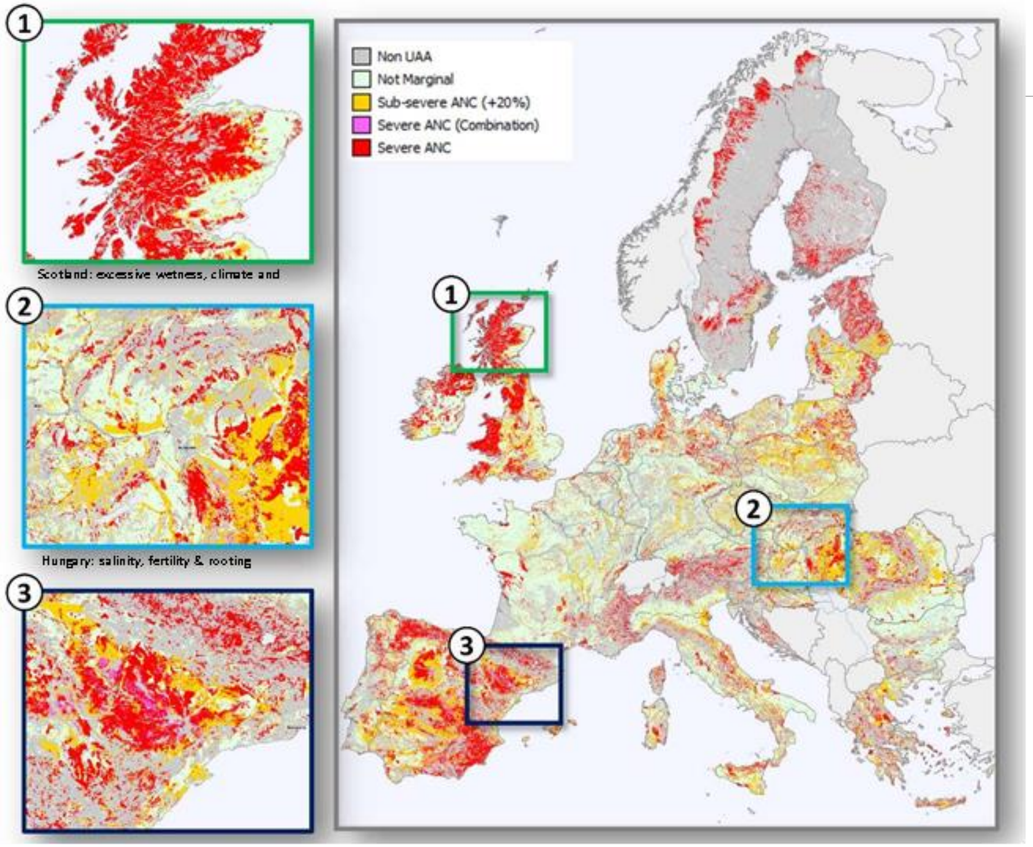


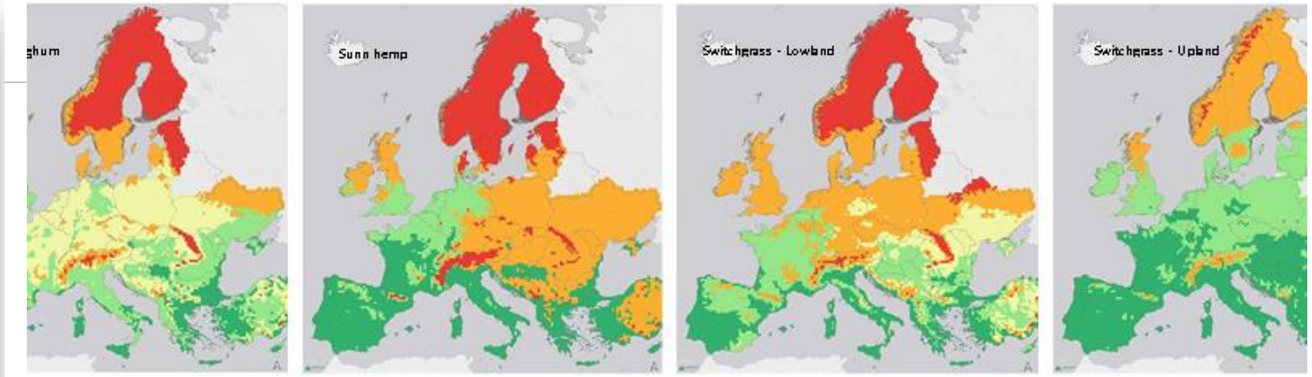
- Wheat grain yields were not affected by the rotations, apart from R5 where they were the highest, in all environments
- Maize grain yields were not affected by the rotations in all environments
- R2 and R5 rotation resulted in highest biomass yields in Italy and Greece, while in Spain R3 was on top

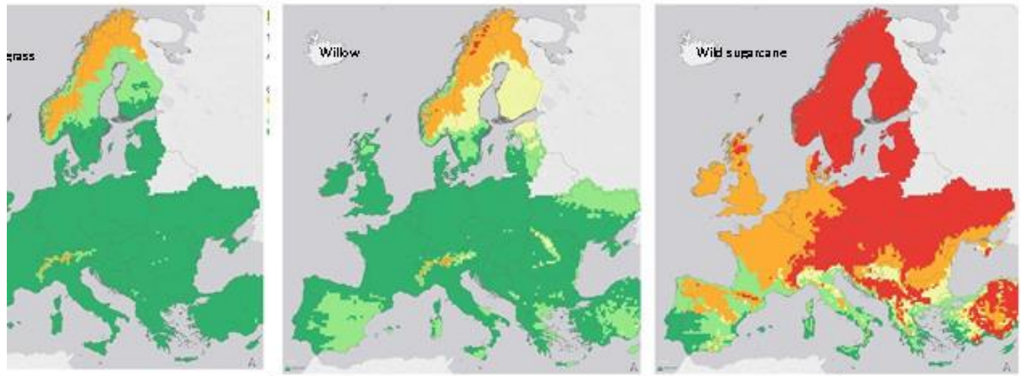
Advantages	Disadvantages
• Enhanced soil fertility and higher yields.	• Required higher levels of farm organization and farmer skills.
• Improved soil structure and maintenance of long-term productivity and organic matter	• Increased need of diversified agricultural equipment and agricultural supplies.
• Longer period of land cover with subsequent lower erosion.	• Reduced land availability for the most profitable crop.
• Reduced use of agricultural inputs such as agrochemicals and synthetic fertilizers.	• Unfamiliarity of farmers with several crop rotations', cultural and management requirements.
• Diversified production with greater market opportunities and lower economic and climatic risks.	• The fact of having to keep scheduled crop sequences leaves no choice to farmers to select crops contingently.
• Increased biodiversity and less monotony of the landscape.	
• Time-diluted farming activities.	

Source: Zegada-Lizarazu and Monti . Energy crops in rotation. A review. Biomass and bioenergy 35 (2011), 12-25.

Marginal lands from Magic project







Crop Suitability
- Not suitable; multiple limiting factors
- Not suitable; one limiting factor
- Suitable; one factor near limit
- Suitable

- In total 29% of the agricultural area is marginal in EU-27 & UK. The most common are rooting limitations (12% of the agricultural land), adverse climate (11%) and excessive soil moisture (8%)
- Suitability maps for a large number of non-food crops

https://magic-h2020.eu

Highlights

- ✓ A clear trend towards:
  - ➢ agricultural residues, manure and plant residues for biomethane production
  - ➢ AD-based biomethane at present, gasification expected to progress fast from 2030 to 2050
- ✓ High variation of feedstock across technologies and countries
- ✓ R+I needs also vary across technologies and countries
  - ➢ On technologies: focus on
    - ▪ solid biomass pre-treatment
    - ▪ gasification
  - ➢ On feedstock: focus on
    - ▪ sequential cropping, minimum tillage,
    - ▪ use of marginal lands, perennial crops
    - ▪ phytoremediation of soils, soil health

ΚΑΠΕ
CRES

For further reading:

https://www.becoolproject.eu/
https://magic-h2020.eu/
https://www.gold-h2020.eu/
https://www.bike-biofuels.eu/the-project/
https://www.midas-bioeconomy.eu/

Thank you for your attention!

More info:
Myrsini Christou mchrist@cres.gr

PANEL SESSION

Research/industry collaboration for identifying r&i needs to accelerate biomethane production

Moderator: Berta Matas Güell

EC – DG RTD & Task Force 5, BIP Europe	Maria Georgiadou
Engie	Marion Maheut
Prodeval	Luisa Brega
LNEG	Francisco Girio
CRES & EERA JP Bioenergy	Myrsini Christou

Support to the coordination of national research and innovation programmes in areas of activity of the European Energy Research Alliance

SUPEERA workshop

Coffee Break

Bologna, Italy , 07.06.2023

Support to the coordination of national research and innovation programmes in areas of activity of the European Energy Research Alliance

SUPEERA workshop

Session 2 - Cross-sectorial dialogue to facilitate the biomethane market deployment

Bologna, Italy , 07.06.2023

Removing Technical Barriers to Biomethane Standardisation

SUPEERA Workshop on bioenergy - 7th June, Bologna

Erik Büthker, Chairman CEN TC 408, Business Developer, TotalEnergies Gas Mobility

There are no technical barriers, Standards are available !!!

Committee

CEN TC 408

Natural gas and biomethane for use in transport and biomethane for injection in the natural gas network

Chair:

Erik Büthker:
TotalEnergies

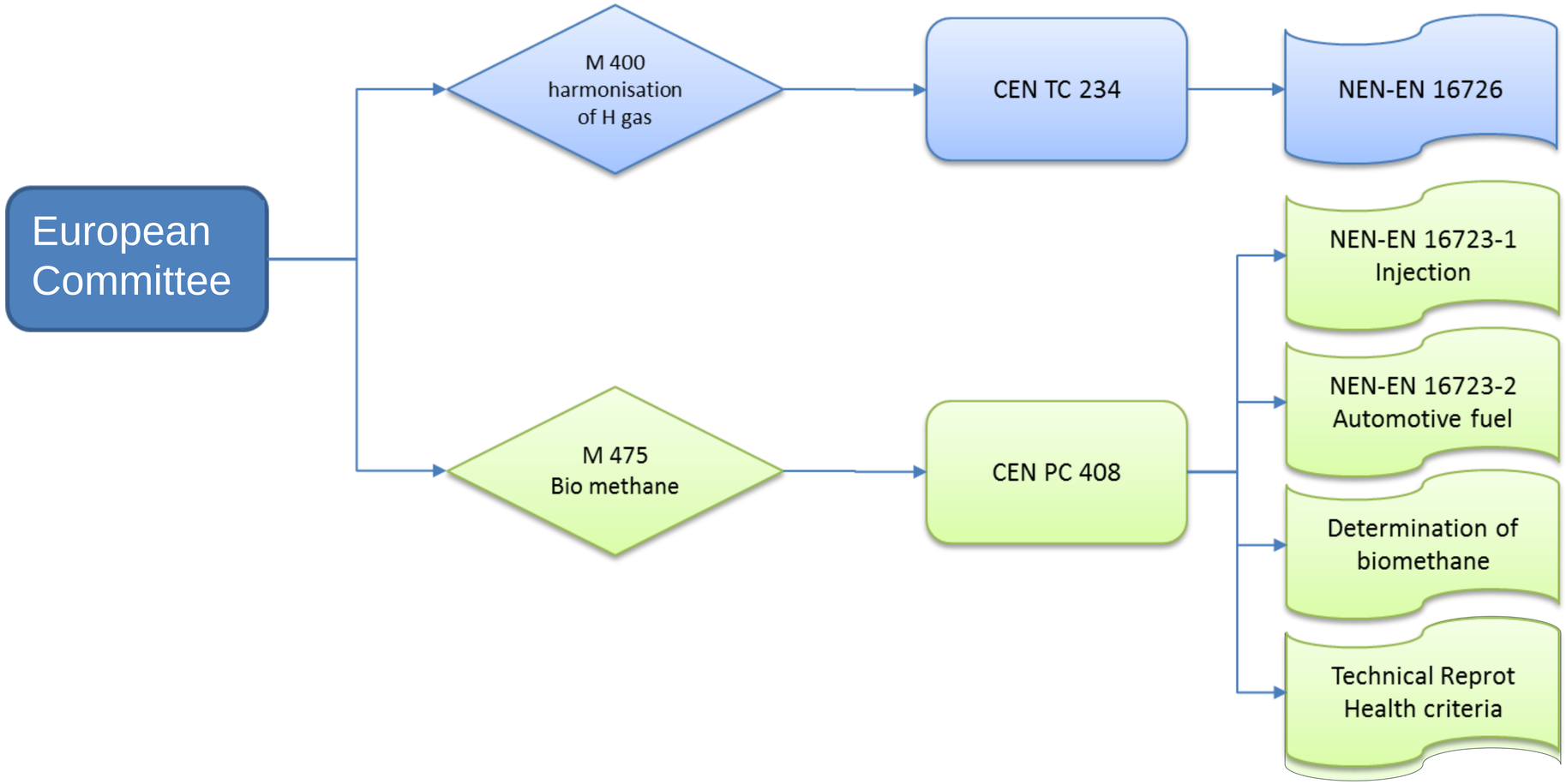
Secreteriat:

Christophe Erhel:
Francegaz

Published standards

- **EN 16723-1 : 2016**
  - Part 1: Specifications for biomethane for injection in the natural gas network
- **EN 16723-2 : 2016**
  - Part 2: Automotive fuels specification
- **TR 17238: 2018**
  - Limit values for contaminants in biomethane based on health assessment criteria
- **Cooperation with ISO**
  - Determination methods: Halogenated compounds, ammonia, terpenes, silicon content
  - EN ISO 2613: 2023 silicon content of bio methane
  - EN ISO 23306:2020 specification of LNG as fuel for maritime applications

Background of the establishment TC 408



What is the status of these standards

- It is a national standard without alteration

EUROPEAN STANDARD **EN 16723-1**

NORME EUROPÉENNE

EUROPÄISCHE NORM November 2016

ICS 27.190

English Version

Natural gas and biomethane for use in transport and biomethane for injection in the natural gas network - Part 1: Specifications for biomethane for injection in the natural gas network

Gaz naturel et biométhane pour utilisation dans le transport et biométhane pour injection dans les réseaux de gaz naturel - Partie 1 - Spécifications du biométhane pour injection dans les réseaux de gaz naturel

Erdgas und Biomethan zur Verwendung im Transportwesen und Biomethan zur Einspeisung ins Erdgasnetz - Teil 1: Festlegungen für Biomethan zur Einspeisung ins Erdgasnetz

This European Standard was approved by CEN on 17 September 2016.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION

GERG research program

Biomethane trace components and their potential impact on European gas industry

Biomethane trace components and their potential impact on European gas industry

Towards the removing of technical barriers to biomethane injection into the natural gas grids

A multi-phase project aiming to revise the standards limits regarding trace component in biomethane

Phase 1

GERG gas industry priorities:
Status review and gap analysis:
- Siloxanes
- Corrosive components
- Micro-organisms

Phase 2a

January 2018

Combination of GERG priorities & CEN immediate priorities:
- Status review and gap analysis
  - Sulfur
  - Oxygen
  - Health impact assessment
- Experimental program: impact of siloxane on:
  - Industrial boilers
  - Heavy duty vehicles performance

SA/CEN/RESEARCH/475/2017-07

Phase 2b

October 2020

Follow up from Phases 1 & 2a

WP1: Experimental program on siloxanes impacts
- Engines: test on switching type oxygen sensors

WP2: Experimental program on the impact of sulfur on vehicles After Treatment System (Catalysts)
- Lab test using dedicated burner with given sulfur concentration in natural gas

WP3: preparation for Experimental program on the impact of oxygen and corrosive components on gas facilities:
- Gas grid
- Underground Gas Storage

WP4: Improve knowledge on biomethane
- Biomethane quality database (UK data)
- Literature review on siloxane purification process

CEN/2019/ENER/C2/452-2019

Phase 2c

Follow up from Phases 1, 2a & 2b

WP1: Experimental program on siloxanes impacts
- Industrial boilers: cycling mode (start and stop)

WP2: Experimental program on the impact of sulfur on vehicles After Treatment System (Catalysts)
- Ageing test
- Vehicle test
- Sulfur ageing modeling

WP3: Experimental program on the impact of oxygen and corrosive components on gas facilities:
- Gas grid
- Underground Gas Storage
- Impact of hydrogen on type 1 CNG steel tanks

WP4: Improve knowledge on biomethane
- Biomethane quality database (Swedish data)
- BioSNG & bioLNG quality data (French data)
- Upgrading process database

Phase 3

Revision of standard EN 16723 part 1&2

On going research

Maximum hydrogen content

- Impact on steel cylinders, limited to 2 % for CNG vehicles

Maximum sulpher content

- Impact on catalitic converter and vehicle performance

Maximum silicon content

- Impact on industrial boilers
- Impact on heavy duty engines
- No impact with the current limit values in the standard (0,3 mg Si/m3)

Maximum oxygen content

- Impact on underground storages

Oxygen sensor pre-catalyst after 600h

Impact of the standard

For producers of biomethane clear production specifications are set.

- In the update of the standard
  - The specifications will depend upon the source of bio methane
  - The new developed testmethods dedicated for biomethane will be included

For the gasoperators clear acceptance criteria for bio methane are set

  - Specifications for injecting biomethane into the grid are clear
- In the update of the standard
  - The new developed testmethods dedicated for biomethane will be included
  - Ongoing discussion about oxygen content in underground storage
    - Where to remove the oxygen, during production or when injecting it into underground storage facility

Next steps

- The Gerg research program will give clarity on the discussion points
- Based upon the outcome of the Gerg research program proposals will be made to update the biomethane standards

- Update of the standards
  - Update the new developed test methods dedicated for bio methane
  - Update the specifications based upon the source of biomethane

- Please be invited to participate in this development
  - Become member of your national standardization body
  - Give coments to the draft standards produced through your national mirror committee
  - Or become member of the working group and activly participate in the drafting of the sandards

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Annex

EN 16723-1

Natural gas and biomethane for use in transport and biomethane for injection in the natural gas network - Part 1: Specifications for biomethane for injection in the natural gas network

Standard	Parameter	Value
EN 16726	hydrocarbon dewpoint	max -2 °C
EN 16726	sulfur	The standard for injection will follow the specification for sulfur in EN 16726.
ISO 8573-2	Compressor Oil	The biomethane shall be free from impurities other than “de minimis” levels of compressor oil and dust impurities. In the context of this European Standard, “de minimis” means an amount that does not render the biomethane unacceptable for conveyance and use in end user applications.
ISO 8573-4	Dust Impurities	The biomethane shall be free from impurities other than “de minimis” levels of compressor oil and dust impurities. In the context of this European Standard, “de minimis” means an amount that does not render the biomethane unacceptable for conveyance and use in end user applications
EN 1911	Chlorinated components	
ISO 15713	Fluorinated components	max 1 %
EN 16723-1	CO	max 0,1 % The 0,1% limit was taken from the CLP-Regulation (EC) No 1272/2008.
EN 16723-1	Total Silicon	0,3 – 1 mg Si /m3 Studies have demonstrated that continuous exposure to 100 % biomethane for 15 years should require a specification as low as 0,1 mg Si/m3. However, a limit set at this level would present difficulty in terms of analytical measurement (current quantification limits are at best 0,10 mg Si/m3, which would imply setting a limit of 0,30 mg Si/m3). Moreover, this would not recognize the mitigating effects of dilution of injected biomethane by natural gas. It is therefore suggested that the limit value to be applied [in a Network Entry Agreement] should be agreed between biomethane producer and gas transporter [grid operator] taking into account both performance of current analytical methods and dilution opportunities through, e.g. capacity studies
EN 16723-1	NH3, Amine	in absence of water no need, else 10 mg/m3

EN 16723-2

Natural gas and biomethane for use in transport and biomethane for injection in the natural gas network - Part 2: Automotive fuels specification

	Parameter		
EN 16726	Hydrogen sulfide + Carbonyl sulfide (as sulfur)	5 mg /m3	
EN 16726	hydrocarbon dewpoint	max -2 oC	
EN 16726	Methane number	min 65	
EN 16723-2	Methane number dedicated spec.	min 80	
EN 16723-2	water dewpoint	max -10 ^{o}C at 200 bar	Class A
		max -20 ^{o}C at 200 bar	Class B
		max -30 ^{o}C at 200 bar	Class C
EN 16723-2	dust impurities	**de minimis** proposal < 5 micron dust < 10 micron liquid	
EN 16723-2	S total (including odorization)	30 mg S /m3	
EN 16723-2	Total Silicon	0.3 mg Si /m3 0,1 mg Si /m3 can severely harm switching type oxygen sensors of some vehicles (see DNV GL report). However, a limit set at this level would present difficulty in terms of analytical measurement (current quantification limits are at best 0,10 mg Si/m3, which would imply setting a limit of 0,30 mg Si/m3). And currently biomethane production processes cannot guarantee a level of siloxanes below 0,5 mgSi/m3.	

EN 16723-2

Natural gas and biomethane for use in transport and biomethane for injection in the natural gas network - Part 2: Automotive fuels specification

	Parameter	
EN 16723-2	Compressor oil	The fuel shall be free from impurities other than “de minimis” levels of compressor oil and dust impurities. In the context of this European Standard, “de minimis” means an amount that does not render the fuel unacceptable for use in end user applications.
EN 16723-2	Dust impurities	• The fuel shall be free from impurities other than “de minimis” levels of compressor oil and dust impurities. In the context of this European Standard, “de minimis” means an amount that does not render the fuel unacceptable for use in end user applications. • Fuelling stations providing LNG should include a filter with maximum size of 5 µm nominal and 10 µm absolute with 90 % efficiency and giving maximum particle contamination of 10 mg/L of LNG to protect the vehicle system from debris.
EN 16723-2	Amine	10 mg /m3
EN 16723-2	Hydrogen	2 % mol /mol
EN 16723-2	Oxygen	1 % mol /mol

TR 17238

Proposed limit values for contaminants in biomethane based on health assessment criteria

Example of different sources of HCVs

These examples given in Table A.1 are extracted from a French study by INERIS. For a set of several compounds, sources to define HCV come from several countries or National experts' panel. They are defined under specific conditions which are further explained in the references.

Table A.1 — examples of different sources of HCVs

CAS	Substances	HCV - Inhalation pathway - Threshold toxicity	
		(mg/m3)	Références
75–01–4	Vinyl chloride	56	RIVM, 2001
156–59–2	cis-1,2-Dichloroethene	6	RIVM, 2007
71–55–6	1,1,1-trichloroethane (1,1,1-TCA)	1	OEHHA, 2008
79–01–6	Trichloroethylene (TCE)	2	US-EPA, 2011
127–18–4	Tetrachloroethylene (PCE)	4	US-EPA, 2011
75–09–2	Dichloromethane	4	OEHHA, 2000
67–66–3	Trichloromethane (chloroforme) (TCM)	63	AFSSET, 2008
56–23–5	Tetrachloromethane (TCC)	38	AFSSET, 2008
75–25–2	Tribromomethane	No value	

New activities

Analysis methods in cooperation with ISO TC 193 SC1

Published standards

ISO/DIS 2611-1
Analysis of natural gas — Biomethane — Determination of halogenated compounds — Part 1: HCl and HF content by ion chromatography

ISO/DIS 2612
Analysis of natural gas — Biomethane — Determination of ammonia content by Tuneable Diode Laser Absorption Spectroscopy

ISO/DIS 2613-2
Analysis of natural gas — Biomethane — Part 2: Determination of siloxane content by gas chromatography ion mobility spectrometry

ISO/FDIS 2614
Analysis of natural gas — Biomethane — Determination of terpenes' content by micro gas chromatography

ISO/DIS 2615
Analysis of natural gas —Biomethane — Determination of the content of compressor oil

ISO/DIS 2620
Analysis of natural gas — Biomethane — Determination of VOCs by thermal desorption gas chromatography with flame ionization and/or mass spectrometry detectors

Standards under developement

ISO/TS 2610:2022
Analysis of natural gas — Biomethane — Determination of amines content

ISO/DIS 2611-1
Analysis of natural gas — Biomethane — Determination of halogenated compounds — Part 1: HCl and HF content by ion chromatography

ISO/DIS 2612
Analysis of natural gas — Biomethane — Determination of ammonia content by Tuneable Diode Laser Absorption Spectroscopy

ISO 2613-1:2023
Analysis of natural gas — Silicon content of biomethane — Part 1: Determination of total silicon by atomic emission spectroscopy (AES)

ISO/DIS 2613-2
Analysis of natural gas — Biomethane — Part 2: Determination of siloxane content by gas chromatography ion mobility spectrometry

ISO/FDIS 2614
Analysis of natural gas — Biomethane — Determination of terpenes' content by micro gas chromatography

ISO/DIS 2615
Analysis of natural gas —Biomethane — Determination of the content of compressor oil

ISO/DIS 2620
Analysis of natural gas — Biomethane — Determination of VOCs by thermal desorption gas chromatography with flame ionization and/or mass spectrometry detectors

Research

Results of the previous research on siloxanes

- Siloxanes research
  - report on behaviour of silicon for domestic boilers (executed on Dutch gas)
    - failure of ionization safety device
    - clogging of stainless steel heat exchangers
    - carried out in L gas situation

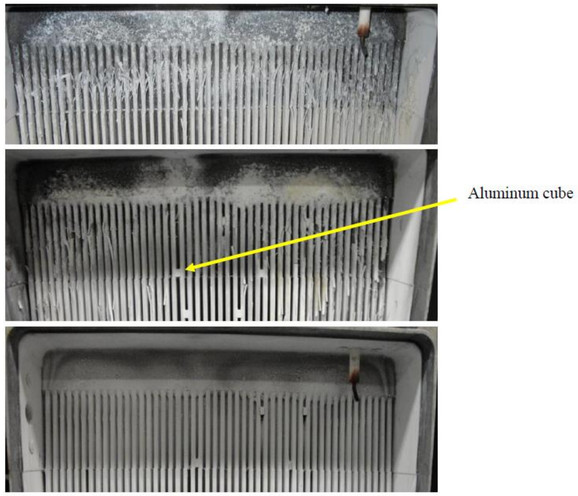
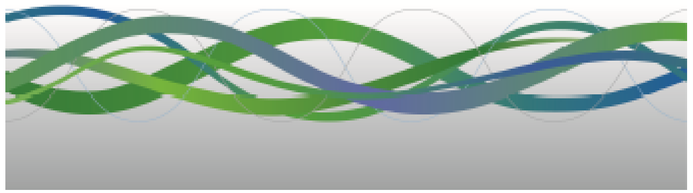


Figure 21: Photographs taken of the lamellar heat exchanger of boiler 1 taken after experiments with different siloxane concentrations. From top to bottom, the siloxane concentrations were 264.0 mg Si/m^3_n L2, 56.3 mg Si/m^3_n L2 and 33.2 mg Si/m^3_n D5. For each experiment ~50 grams of silica was produced.

Report

Regarding specifications for siloxanes in bio-methane for domestic equipment

Groningen, February 6, 2013



Research

research on Siloxanes as automotive fuel

- research on behavior of gas engines exposed to silicon
  - failure of spark plug
  - sensors performance like Lambda sensors
  - performance of catalyst
  - Silica build up in lubrication oil

- conclusion
  - No big difference between the limit value for siloxanes for injecting biomethane into the grid or the limit value for use as automotive fuel
  - Not all biomethane production sites produces siloxanes
  - The installations for upgrading raw biogas to distribution specifications will take out most of the siloxanes.

SILOXANEN CNG

Towards well-founded standards for siloxanes in bio-CNG

AFNOR Normalisation

Report No.: GCS.102568

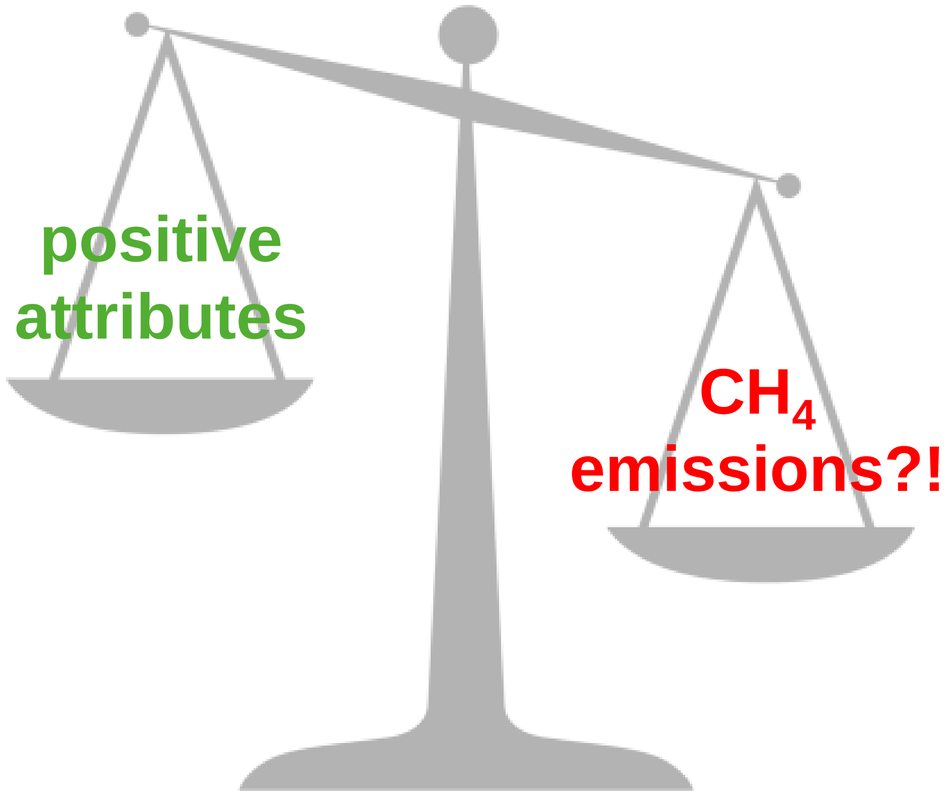
Date: 3-10-2016

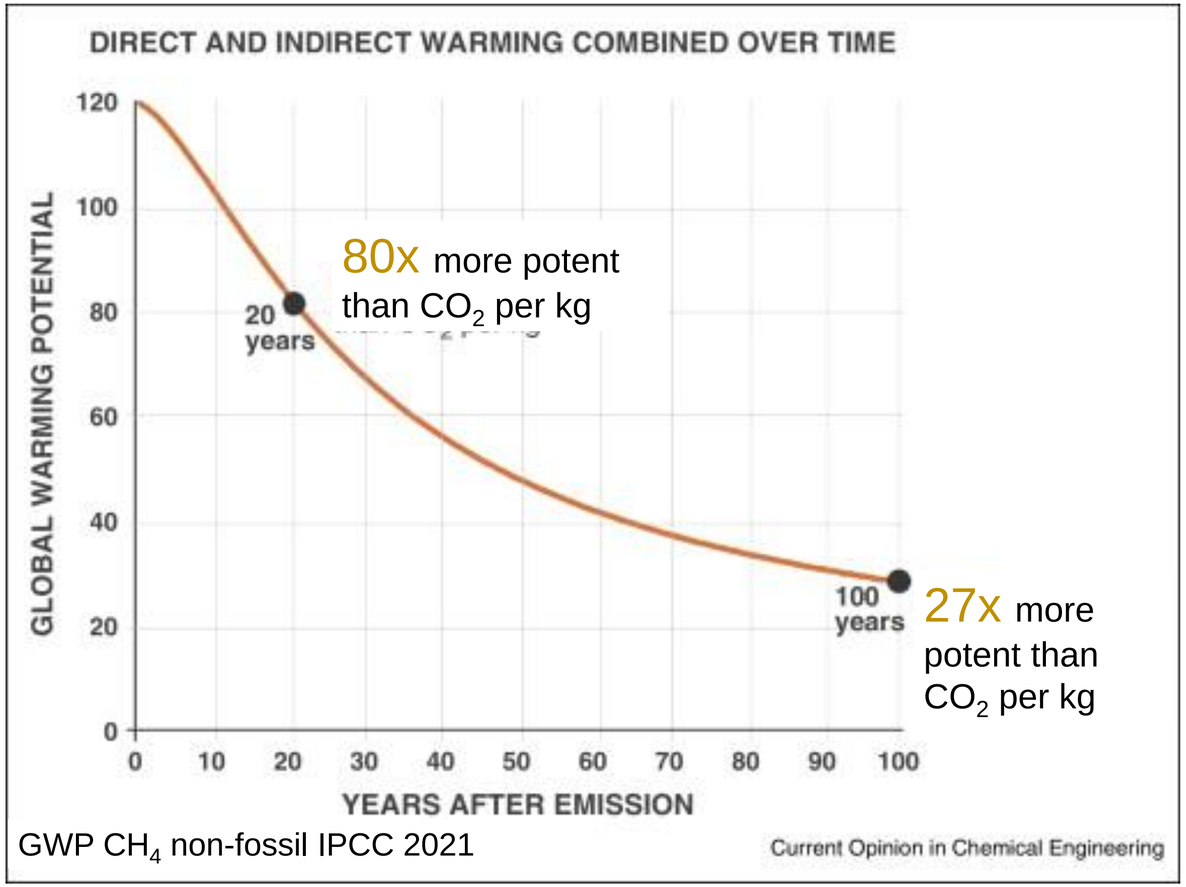
Figure 26: Ionization probe from boiler 1 covered with silica.

Sustainability of biogas and biomethane production

DI Dr Marlies Hrad

GHG balance of biogas and biomethane production



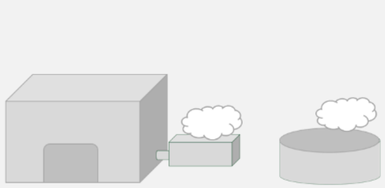


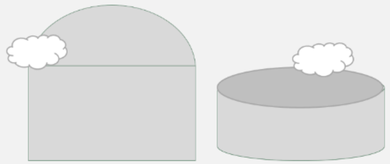
GWP CH_4 non-fossil IPCC 2021

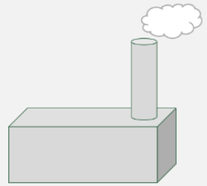
Potential methane (CH_4) emission sources

Substrate supply

Technology specific emission sources[1]







Substrate receiving & storage

Storage/mixing/hydrolysis
- Open/not-gastight tanks
- Ventilation air (after bio-filter)

(Bio-waste) receiving/processing halls
- Ventilation air (after bio-filter)

Biogas production

Digestion/biogas storage
- Membrane diffusion through foil roofs

Digestate storage
- Open/not-gastight storage
- Membrane diffusion through foil roofs
- *Post-treatment*

OTNOC
- Leakages
- *Activation of pressure relief valves*
- *Digester openings*

Biogas utilization

CHP
- Off-gas/methane slip

Biogas upgrading
- Off-gas/methane slip

OTNOC
- Leakages
- *Flaring*

CHP: combined heat and power, **OTNOC:** other than normal operating conditions

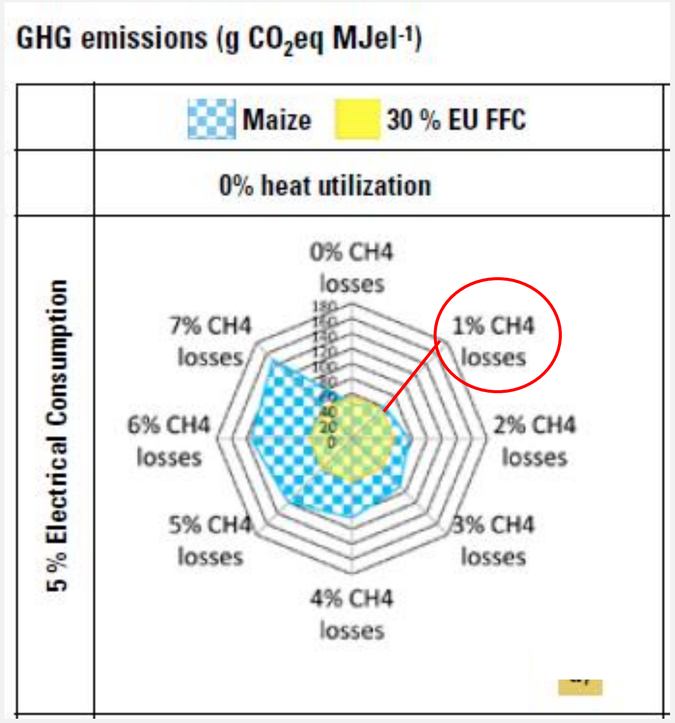
Post-treatment of digestate

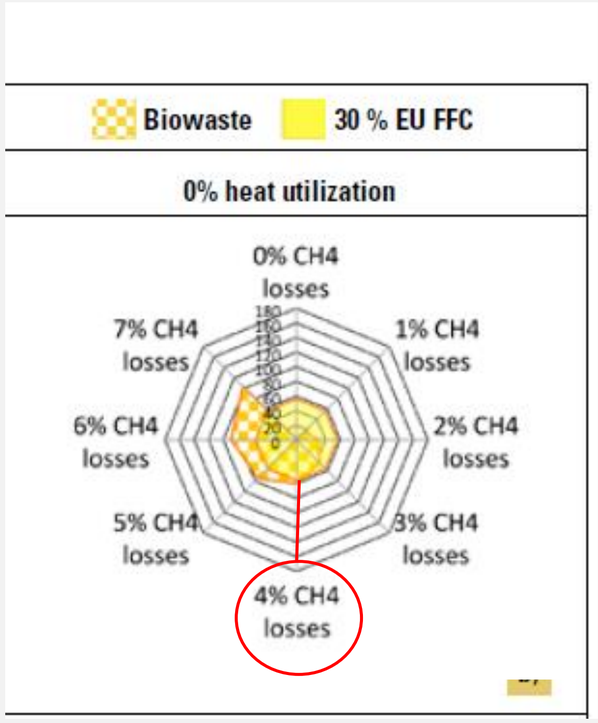
Digestate spreading

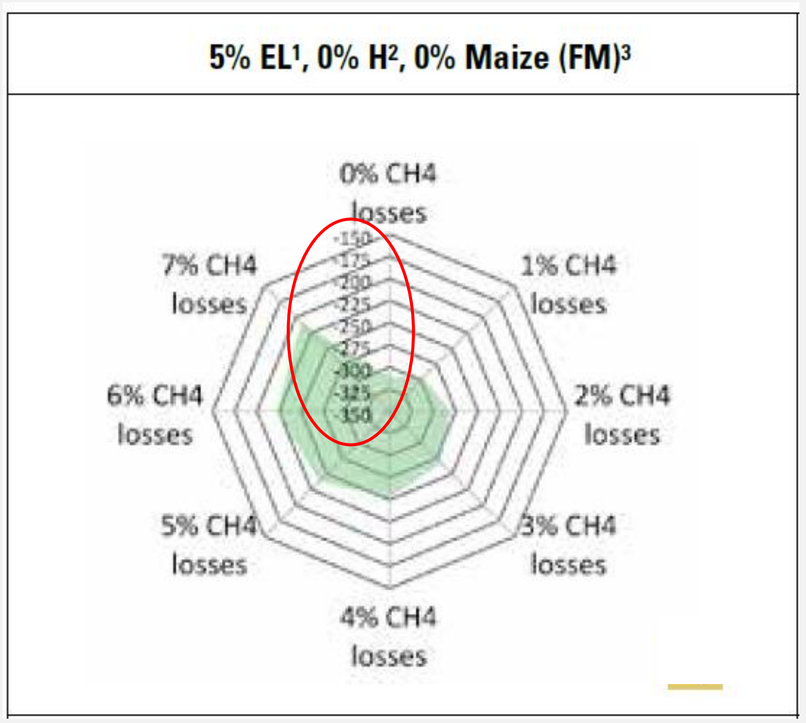
Solid/liquid separation

Post-composting

Impact of CH_4 emissions on GHG balance
Substrate supply[2]

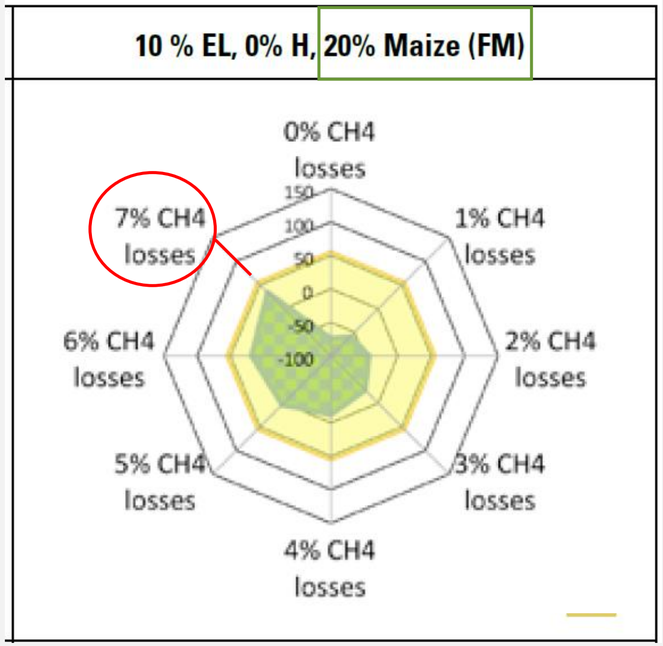


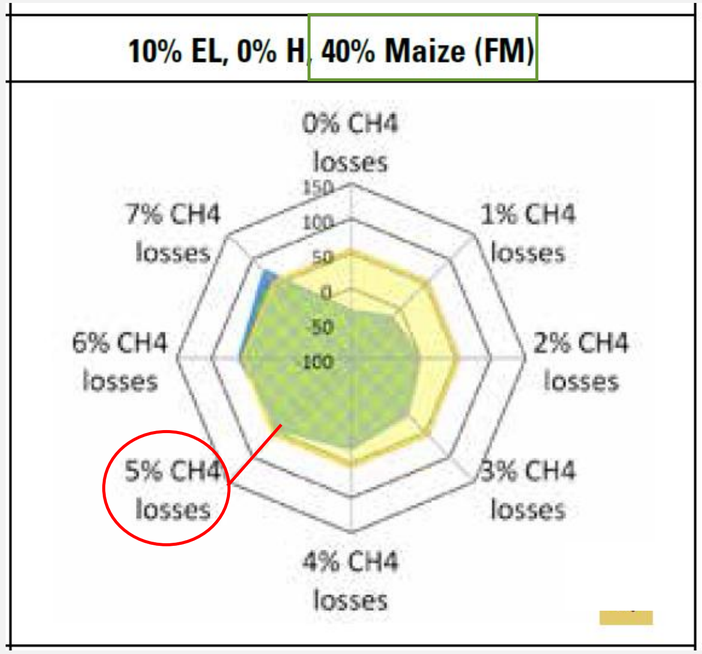


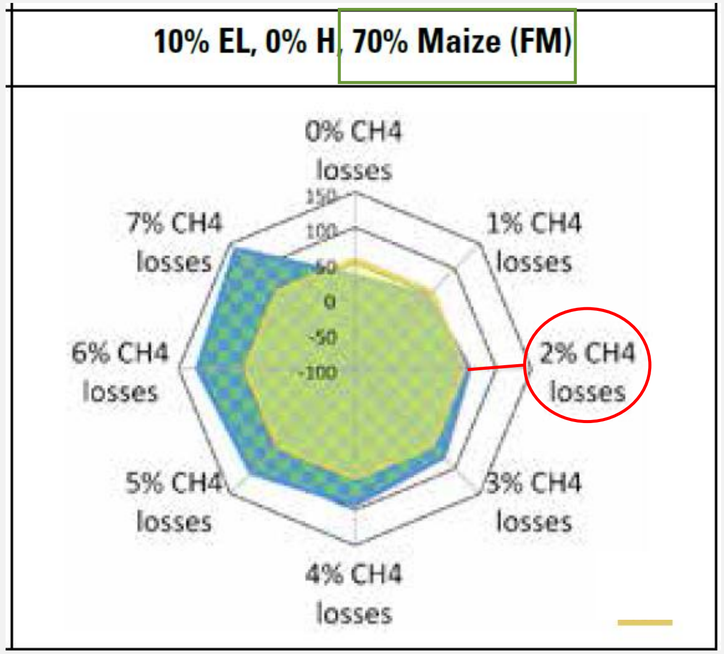


Fossil Fuel Comparator (FFC) = 186 g CO_2eq. per MJ of electricity

Impact of CH_4 emissions on GHG balance
Substrate supply[2]





Fossil Fuel Comparator (FFC) = 186 g CO_2eq. per MJ of electricity

Measuring CH_4 emissions – EvEmBi Project (2018-2021)

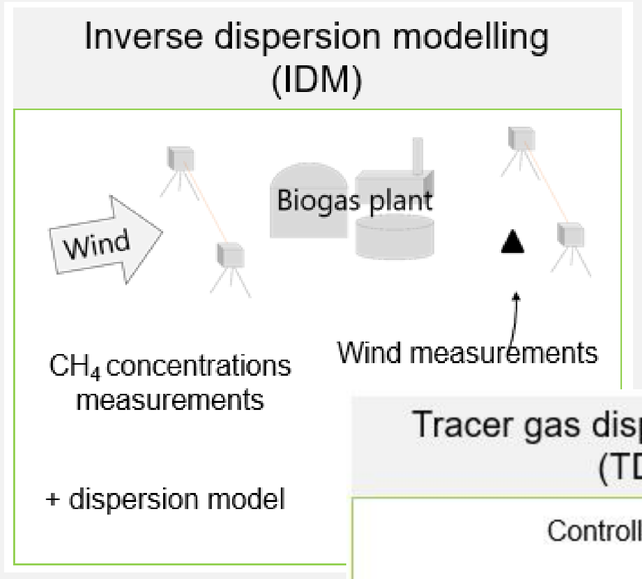
On-site approach (component scale)

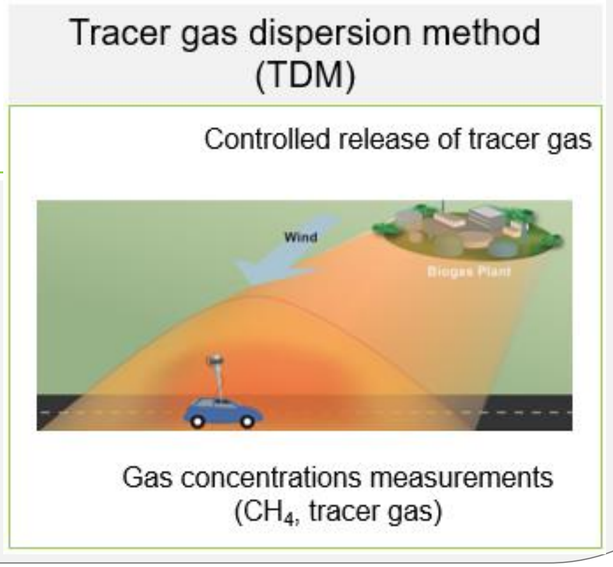
1. Leak detection

2. Emission mass flows

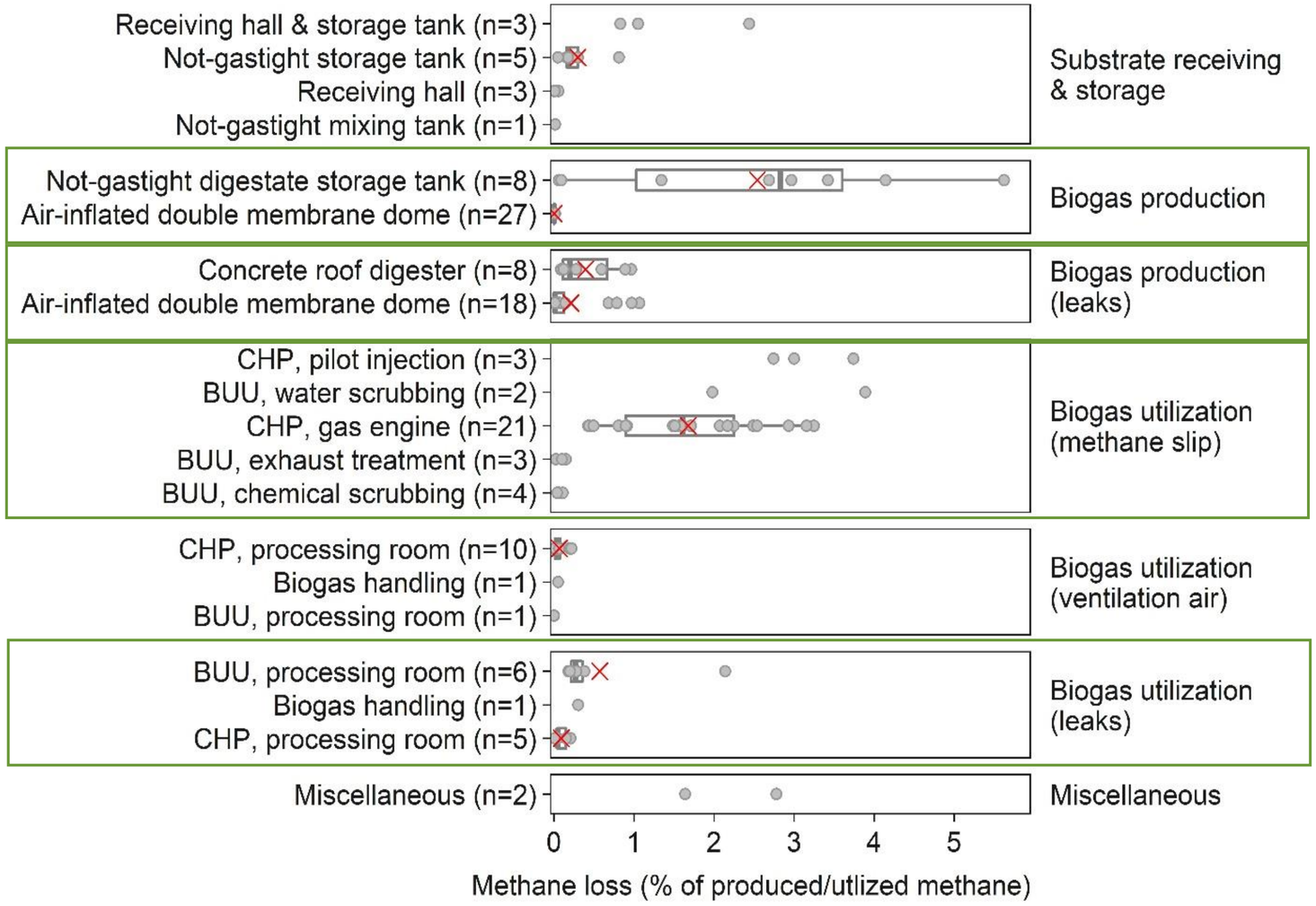
CHP: combined heat and power, **BUU:** biogas upgrading unit

Remote sensing approach (facility scale)



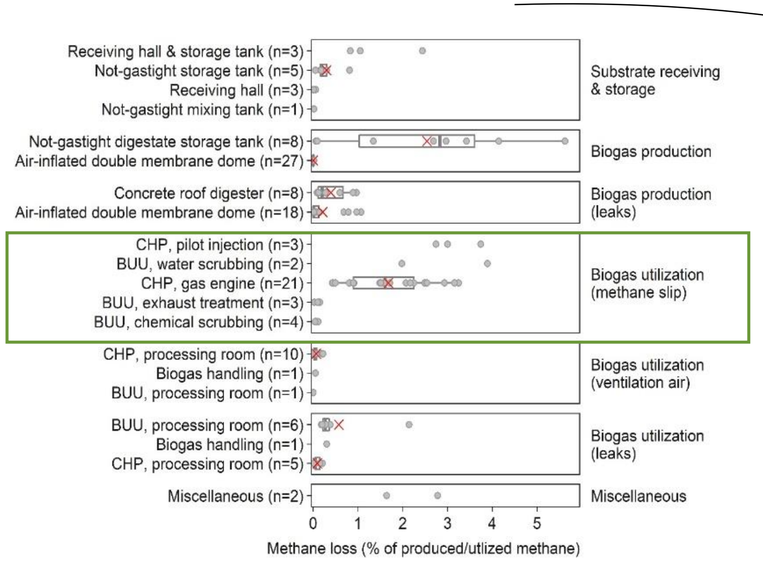


Impact of CH_4 emissions on GHG balance
Technological implementation[1]



CH_4 loss of
33 AD plants
(EvEmBi)

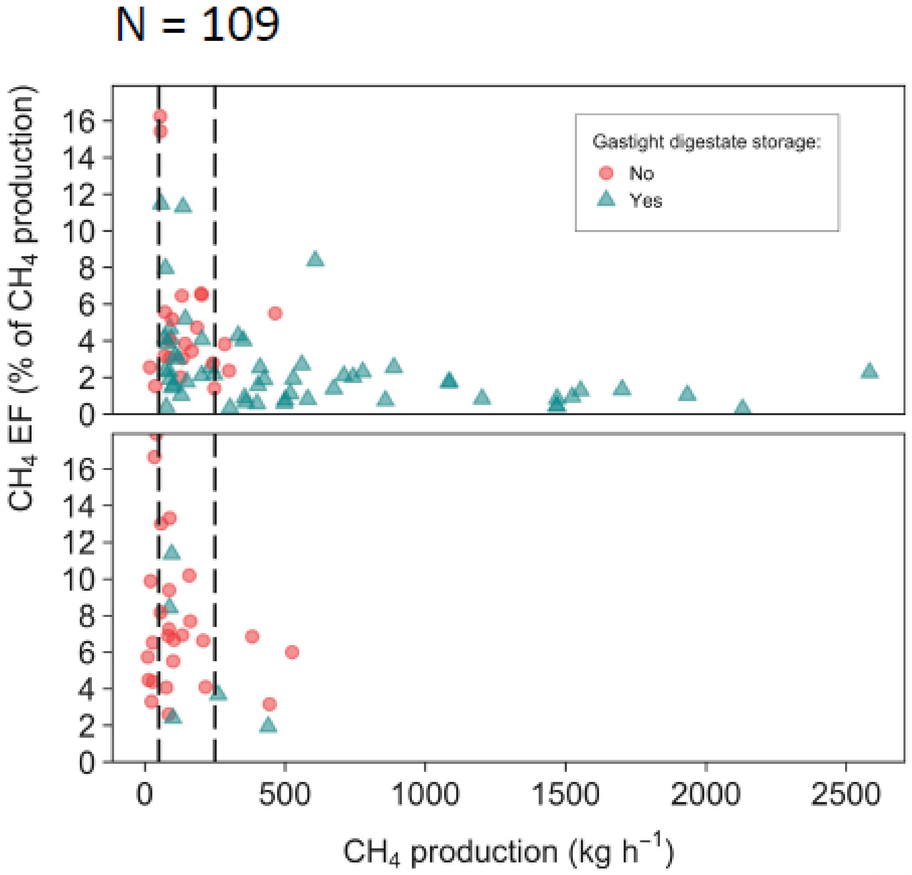
Impact of CH_4 emissions on GHG balance
Technological implementation[1]

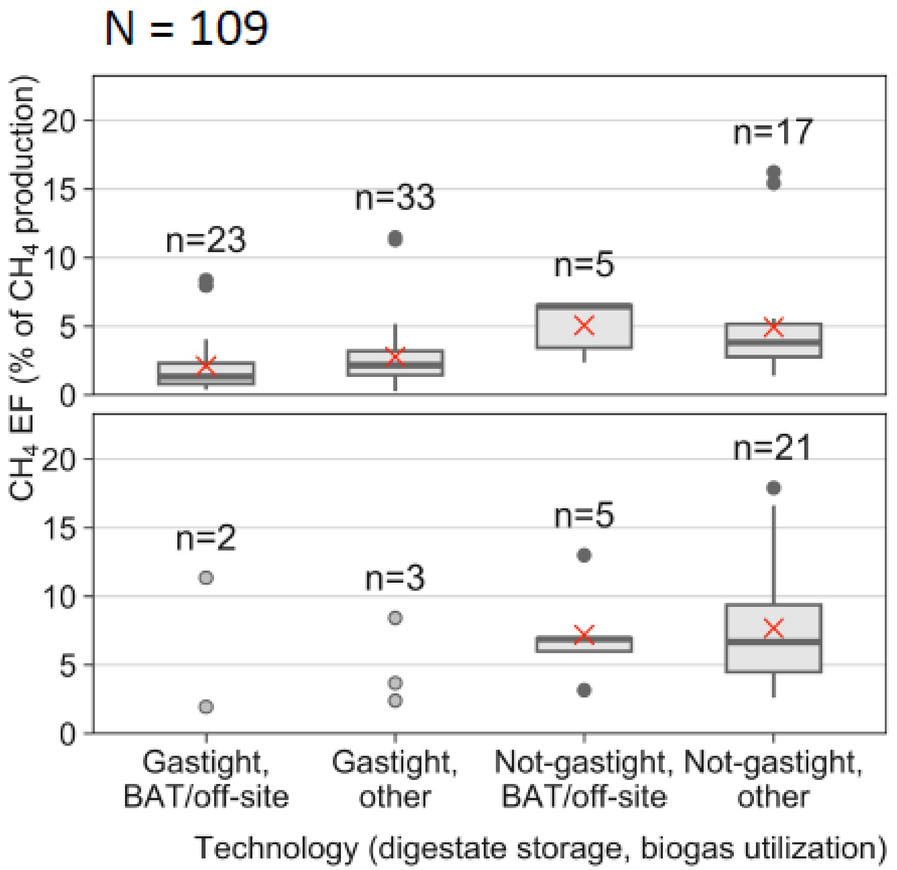


Biogas utilization technology		Median methane loss [% of utilized methane]	
		EvEmBi	**Previous studies[6-12]**
CHP	pilot injection	**3.0** (n=3)	**2.0** (n=6)
	gas engine	**1.6** (n=21)	**1.1** (n=29)
BUU	water scrubbing	**2.9** (n=2)	**1.2** (n=21)
	chemical scrubbing	**<0.1** (n=4)	**<0.1** (n=12)
	exhaust treatment	**0.1** (n=3)	**<0.1** (n=8)

BUU: biogas upgrading unit, **CHP:** combined heat and power

Impact of CH_4 emissions on GHG balance
Facility-scale methane emissions





BAT (best available technology):
- BUU (chemical scrubbing)
- BUU/CHP + exhaust gas treatment

Sources: [3-5], *Klimoneff, MetHarmo, UTE B., QuantiSchluMBF, EvEmBi*

Conclusions
Recommendations for the reduction of CH_4 emissions

- **Feedstock selection**
  - manure digestion reduces GHG emissions of co-digestion systems
- **Choice of best technology options** (for newly constructed biogas plants)
  - gas-tight construction of tanks (hydrolysis/mixing, digestate storage)
  - biogas upgrading:
    - So far, chemical scrubbing or exhaust gas treatment have shown the lowest CH_4 emissions.
    - Measurements are necessary for newly installed membrane separation units.
- **Operational aspects:**
  - regular maintenance and leak detection (self- and external inspection)

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Thank you for
your attention!

Policy framework to facilitate biomethane market development

07.06.2023, Bologna, EUBCE

Giulia Cancian
EBA Secretary General

The voice of renewable gas in Europe

EBA members operate across the whole biogases value chain

+200 companies

46 National Association

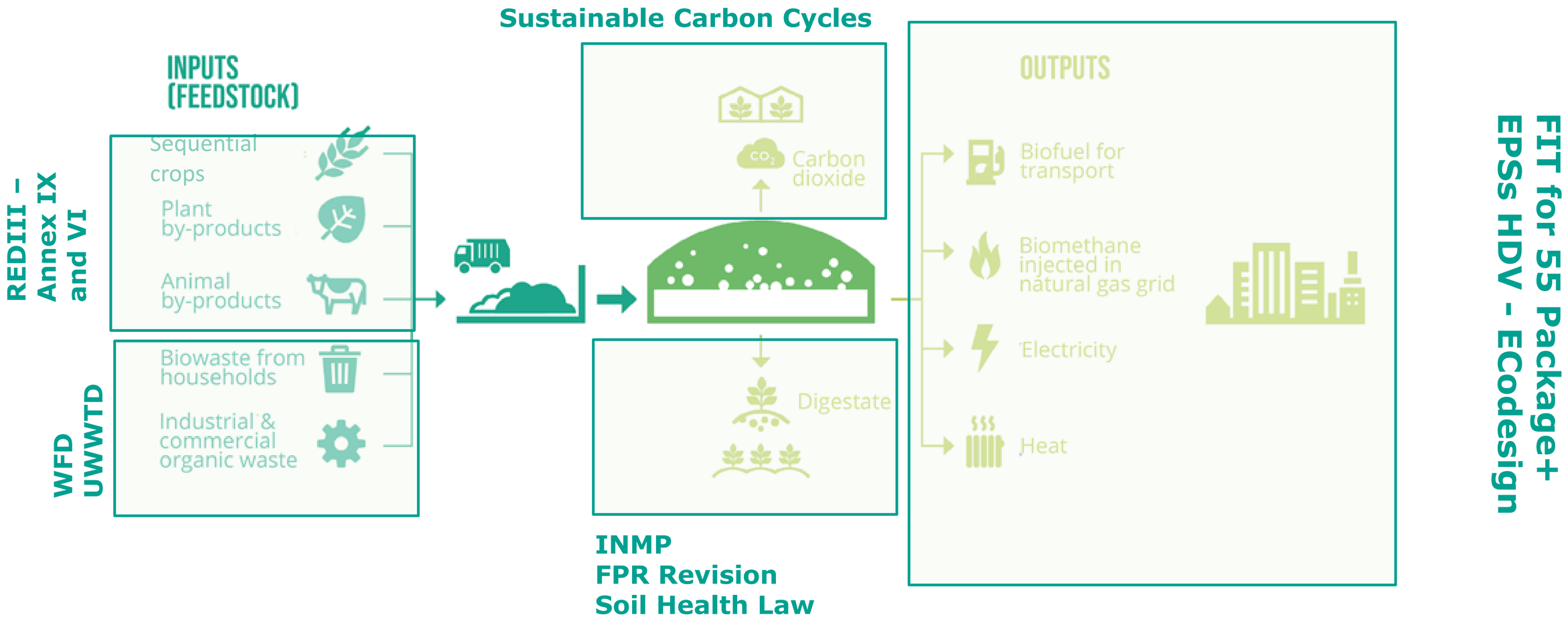
Research Centres

1 EU POLICIES

2 BEST CASES

EBA
European Biogas Association

IMPACT OF UPCOMING LEGISLATION



Source EBA Statistical Report 2021

REDIII - Targets and subtargets

BUILDINGS

49%

Indicative Target,
measures justified
in NECPS

0.8 pp/y 2021-2025

1.1 pp/y 2026-2030

2030 OVERALL EU RES

42.5%

+ 2.5%

INDUSTRY

1.6 pp/y

Indicative Target + Subtarget
RFNBOs / H2 > 42%

TRANSPORT

29% or **14.5%**
GHG intensity

Mandatory Target,
measures justified
in NECPS

EBA
European Biogas Association

1 EU POLICIES

2 BEST CASES

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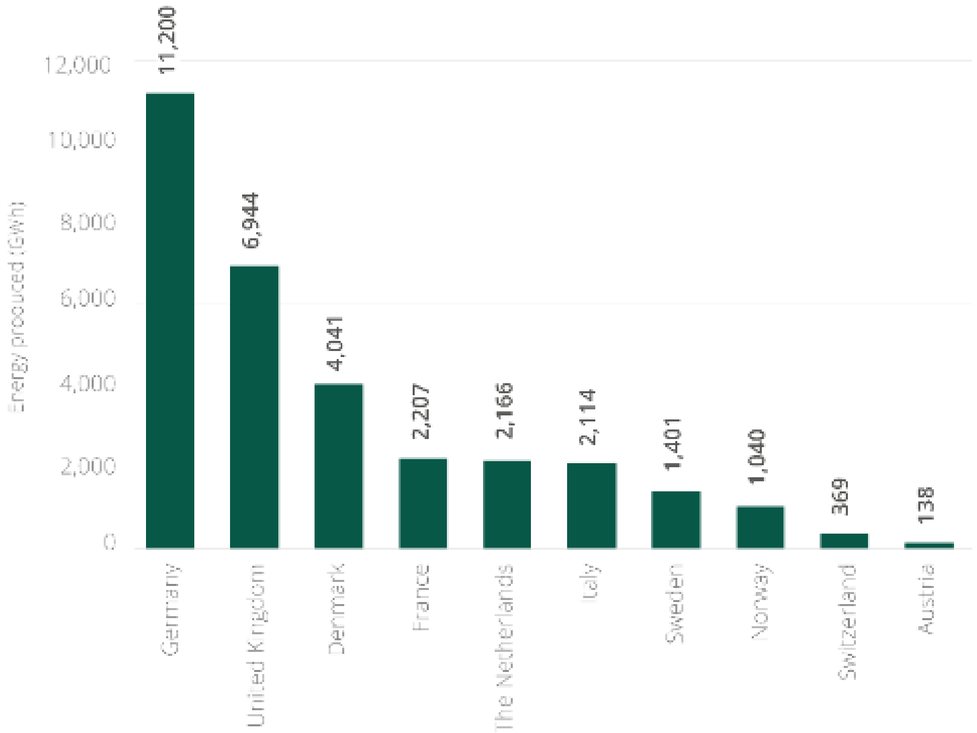
European Biogas Association

Country scope

Austria, Denmark, France, Germany, Italy, the Netherlands, Norway, Switzerland, Sweden and the United Kingdom

- **10 first European countries** in biomethane production in 2020
- **96%** of European biomethane production



EBA Statistical Report 2022

The top- 10 European countries experienced significant growth over the 2011-2021 period

2 biomethane forerunners: Germany and Sweden

- Early market emergence (before 2011)
- Most of European market share in 2011
- Significant growth over the decade

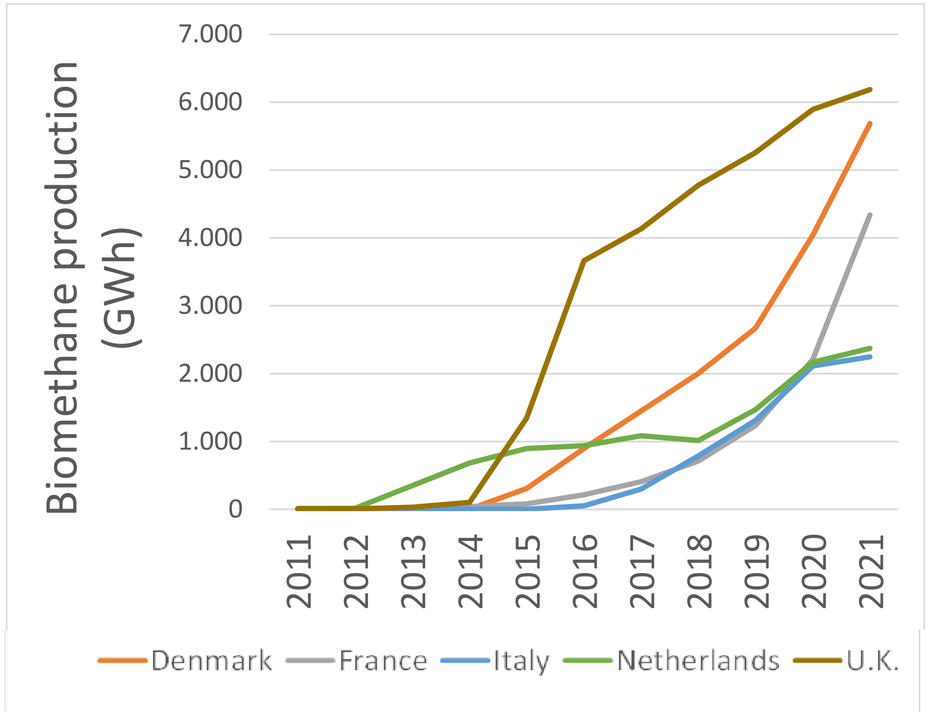
5 soaring biomethane markets: Denmark, France, Italy, the Netherlands and the U.K.

- Emergence between 2013-2017
- Steep growth after kick-off year
- Over +50% in 5 years (2017-2021)

3 slow growth markets: Austria, Norway and Switzerland

- Marked increase during the decade
- Slow growth

Biomethane production in the 5 soaring biomethane markets (2011-2021)



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Scope of measures

A **Vision and targets**

B **Direct investment and production support**

- Feed-in Tariffs
- Feed-in Premiums
- Contract of Difference
- Investment subsidies

C **Indirect production support**

- Regulatory incentives
- Financial incentives

D **Market access enabling regulation**

- *Injection into networks*
- *Trade*: Registry of Certificates of Origin

E **Demand-side incentives**

- Tax incentives
- Quota system
- Public procurement rules

EBA European Biogas Association

Good practices of biomethane supportive policies

Vision for the sector's development

- Strategy or an action plan on biogas and biomethane (Norway).
- Binding RE-gas target (France) and, where H2 is predominant in public policy, add at least an indicative target for biomethane development on medium term (France).
- Identify biomethane in NECPs and their underlying scenario (Climate and Energy Plan towards 2030) (Denmark, Austria).

"**Action plan for biogas**" published in January 2021

- Clarifies the GHG reductions enabled by biogas
- Outlines existing and future support measures

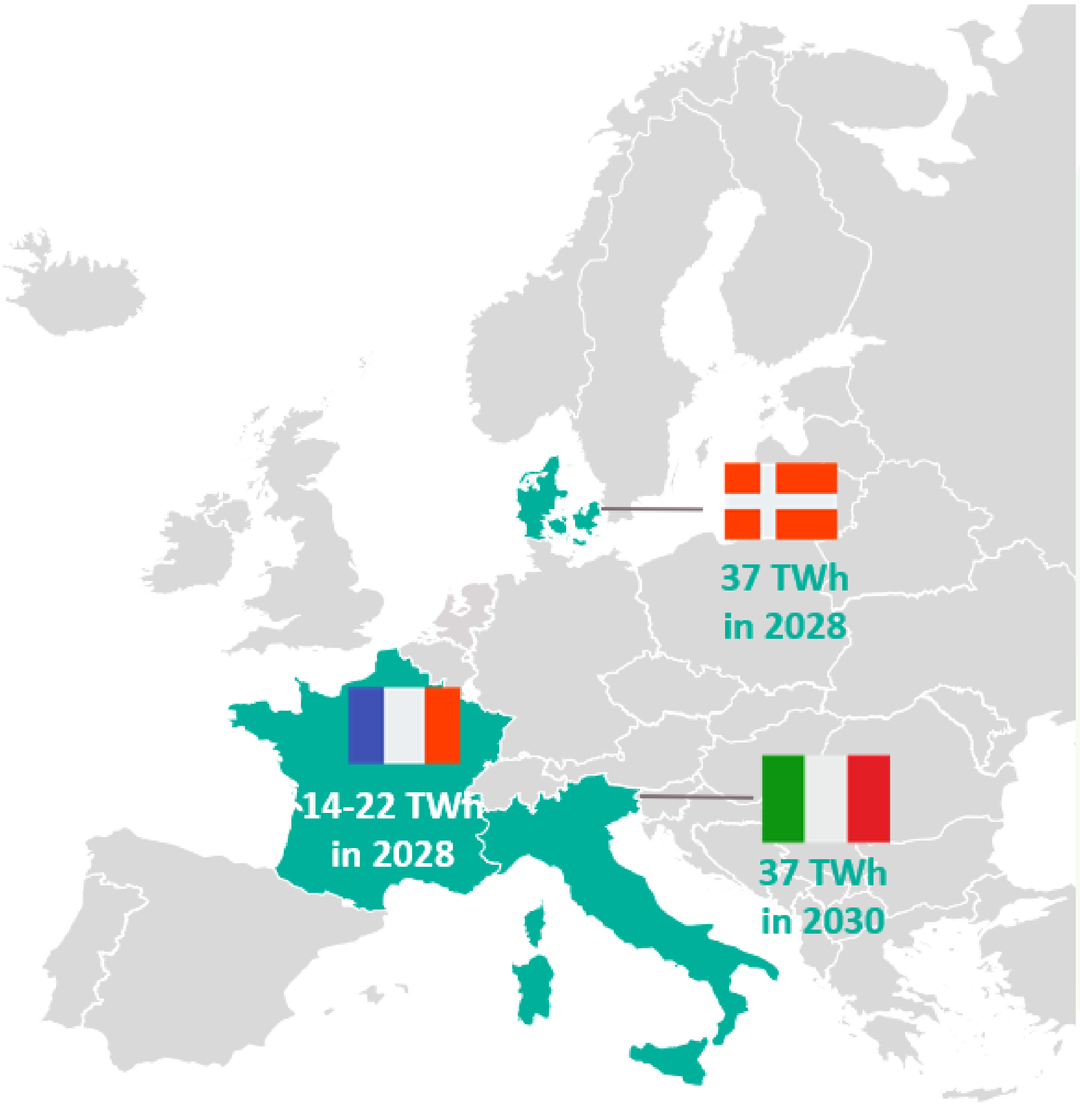
From 2009 to 2020, Denmark **progressively laid out a vision** through its Acts on support schemes, its Climate Plan of 2019 and recently its private-public Green Transition Roadmap

- From a focus on manure utilization to produce RE to a wider utilization of feedstock types and a focus on biomethane injected into grids
- Biomethane identified in its forecast of 2018

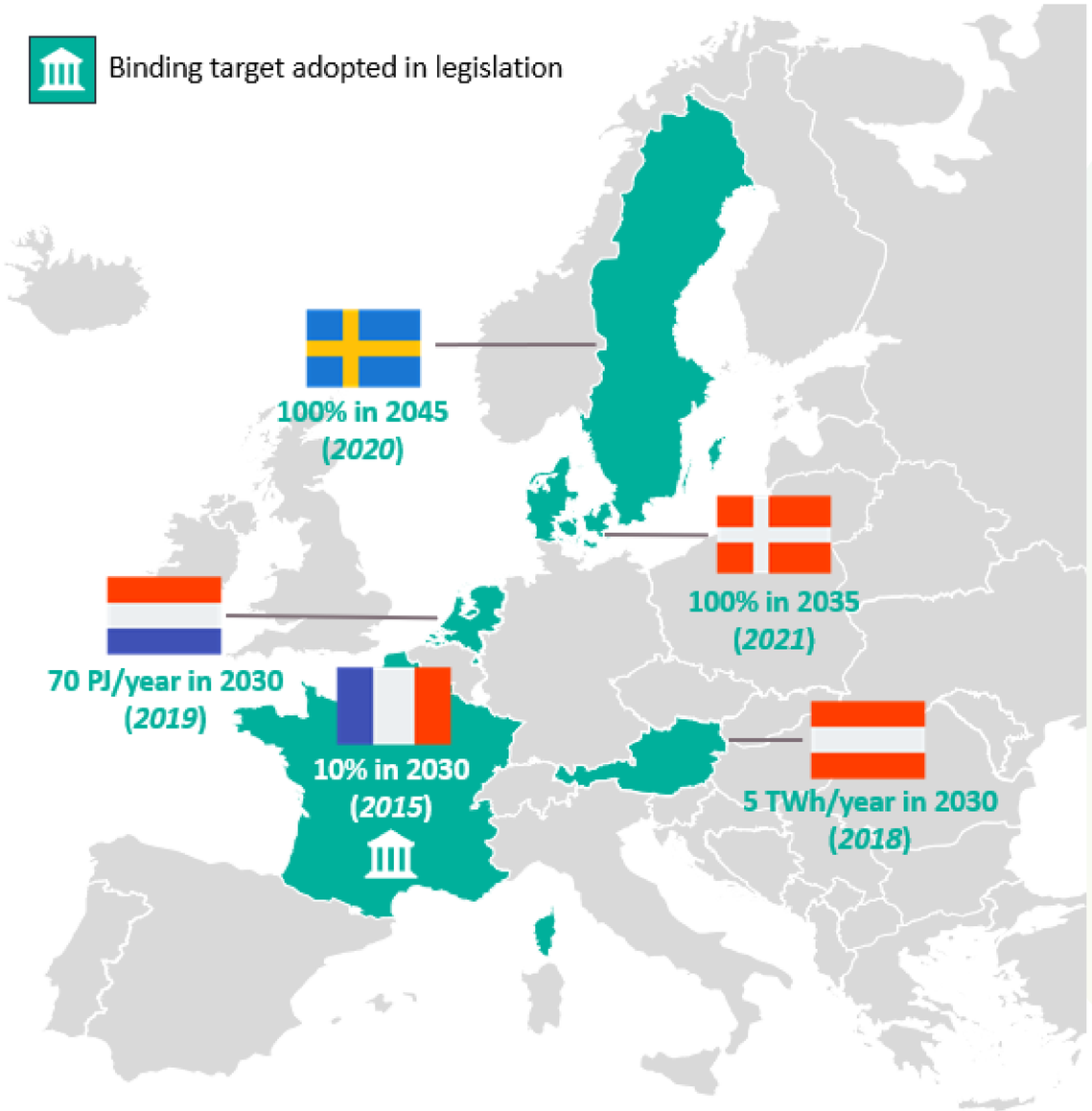
The adoption in 2015 of **a binding renewable gas target** for 2030 was a strong mobilising signal for emerging biomethane market and gas grid operators. It was supplemented in 2018, 2019 and 2020 with **specific indicative biomethane target**.

Biomethane clearly identified in the Climate and Energy Plan (NECPs) with **forecast figures**. Gives indication of the expected biomethane's contribution to RE uptake.

Official biomethane targets adopted in Europe (2011-2021)



Renewable gas targets adopted in Europe (2011-2021)



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Good practices of biomethane supportive policies

Trigger a quick start through direct support

- Open-access feed-in tariff for biomethane production and injection is the most effective means to launch a market in the first years.
- It can switch to an auction-based system once the industry is mature enough to incentivize cost-effectiveness and keep public spending under control.

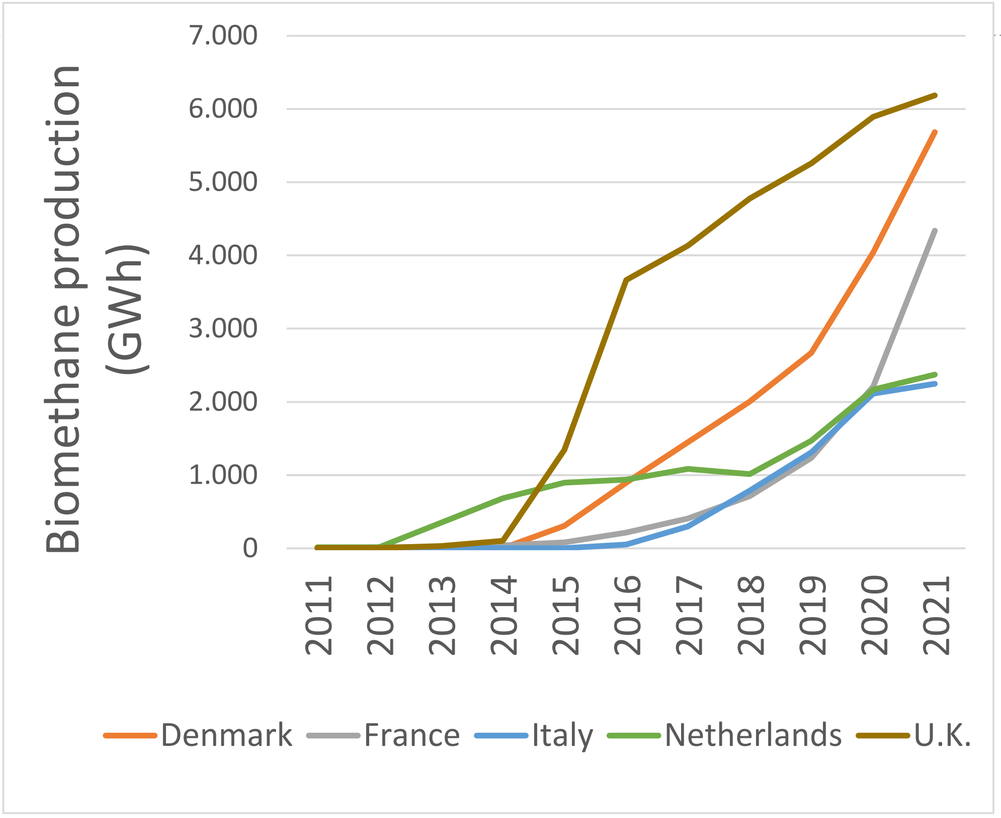


A **guaranteed feed-in tariff** was implemented in:

- Denmark (2012-2020),
- France (2011-2020) and
- the U.K. (2011-2021).

In all three countries, it was instrumental in the production take-off in the following 3-4 years (*see the graph*).

A **feed-in premium** that makes up for the difference between natural gas price and biomethane costs. The level of the feed-in-premium is linked to the feedstock used and biomethane's reported greenhouse gas emission reduction.



Good practices of biomethane supportive policies

Improve the business case of producers through indirect support

- Removing barriers to digestate marketing in the fertilizer market.

A government-launched **quality assurance scheme** built trust in **digestate as a fertilizer** from 1999 onwards.
As a result, in 2016, 99% of digestate produced in co-digestion plants (most of them using food waste from households as substrate) was already used on agricultural lands.

Good practices of biomethane supportive policies

Enable grid injection and market recognition as soon as possible

- Create a right to inject for project developers, whether they are in a gas-served area or not.
- Implement a cost-sharing mechanism for grid connection CAPEX.
- Create a Guarantees of Origin system that will enable green premium recognition.

Right to inject based on 2 principles:

- Obligation for grid operators to address connection requests
- Denial must be transparently justified on technical and economic reasons

Sharp growth of biomethane production and injection.

Grid operators can pay up to 60% of **CAPEX for grid connection**. Investments are monitored and regulated.

In Germany, CAPEX is fully borne by TSOs; for connection to the distribution grid, producers pay max. €250,000 for pipelines up to 1 km.

A **government-mandated GO Registry** since 2015. This enabled the emergence of green gas offers by energy suppliers and at refilling stations.

A **voluntary Registry of CoO (Certificates of Origin)** is operational since 2012. It issues “biomethane certificates” as a basis for the renewable power Feed-in Tariff from biomethane producers.

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Good practices of biomethane supportive policies

Strong demand signals

- Mandatory target of advanced biofuels and biomethane or a GHG reduction obligation are also effective towards motor fuel suppliers
- Tax exemption or reduction are effective market signals towards end-consumers.
- Equal treatment between biomethane and other RES fuels in public procurement.

Motor **fuel suppliers** are included in the national ETS with a **GHG reduction obligation** since 2015. Waste-based biomethane benefits from a market premium.

In Sweden, **tax exemption** from carbon and excise duty from 2011 to 2023 (while natural gas was exempted from carbon tax only).

In Norway, full tax exemption for biomethane as a motor fuel.

In Switzerland, waste-based biomethane is exempted from carbon tax and mineral oil tax which has been the main driver for its use in transport

Electricity, biomethane and hydrogen are treated equally in **public procurement policies**.

EBA European Biogas Association

Measures on substrate sectors and permitting issues have been left outside of the policy mix

Few or no significant good practices have been identified in the 10 countries in these 3 areas

Leveraging national programs of the Common Agricultural Policy

- No use of the CAP 2014-2022 was reported
- Funding streams under the new national CAP programs not investigated

Indirect support through agriculture, waste, wastewater sectors

- Few regulatory or financial measures identified.
- Only 1 reported as successful.

Permitting issues

- 8/10 countries: long permitting time is an issue
- No significant good practices reported

GREENMEUP

Enhancing the uptake of biomethane in Europe

Analyses were elaborated by EBA in the context of the GreenMeUP project

This project has received funding from the European Union's Horizon Europe Research and Innovation Programme under Grant Agreement No. 101075676.

EUROPEAN BIOMETHANE WEEK

COUNTDOWN TO 2030: FROM TARGETS TO ACTION!

24 to 26 October 2023, Brussels

EBA
European Biogas Association

THANK YOU!

cancian@europeanbiogas.eu

Aston University
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Energy & Bioproducts Research Institute

Social acceptance in socio-political and community dimensions

Mirjam Röder, Dan Taylor, Joanna Sparks
EBRI, Aston University

Aston University
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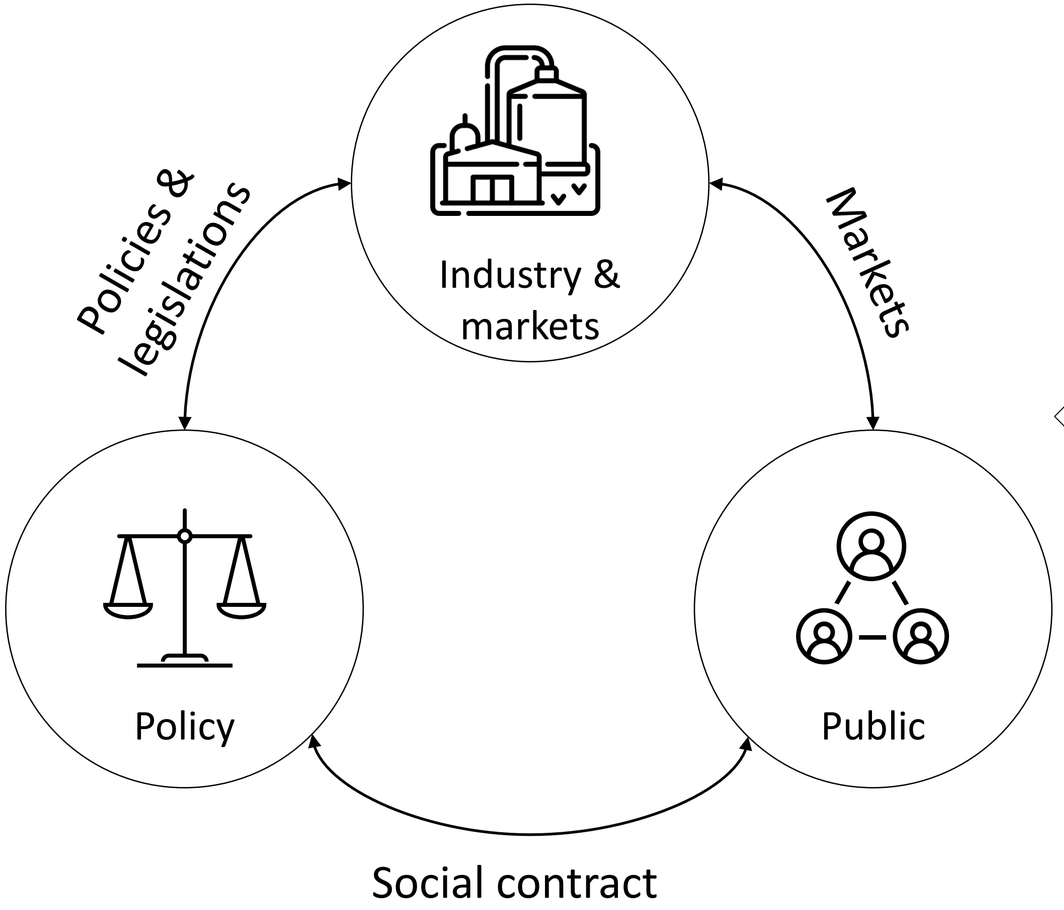
Stakeholders and their drivers

Stakeholders, drivers, perceptions



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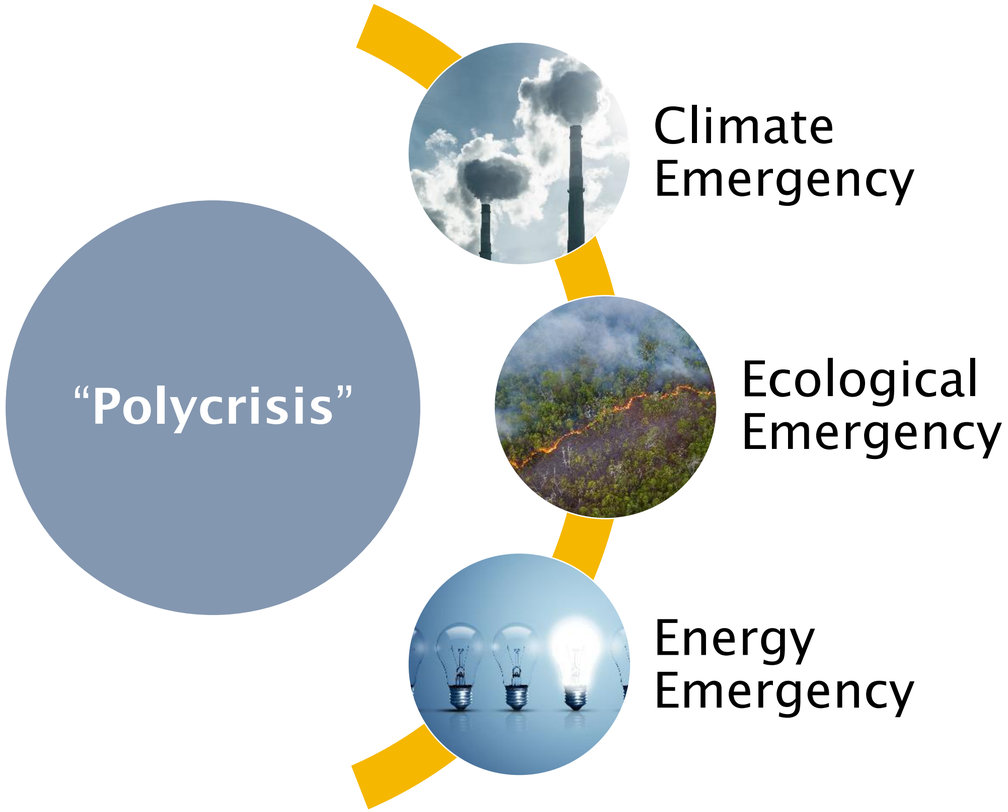


The public

- Cost
- Reliability
- Resilience
- Low risk
- End-use (Fit-for-purpose rather than energy)
- Undisruptive (landscape, clean, no noise, no smell)
- Values and ethics (Trees, public spending)

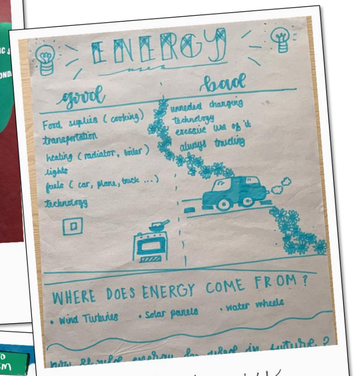
Future generations

Birmingham, UK

Kigali, Rwanda


Biñan, Philippines

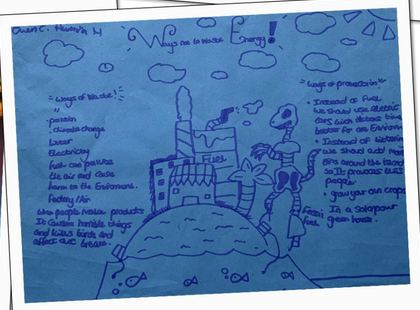
Hyderabad, India



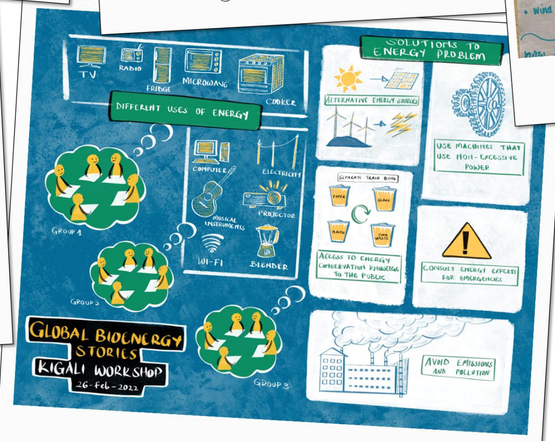
Colchester, UK


Hyderabad, India

Biñan, Philippines



Birmingham, UK



Kigali, Rwanda

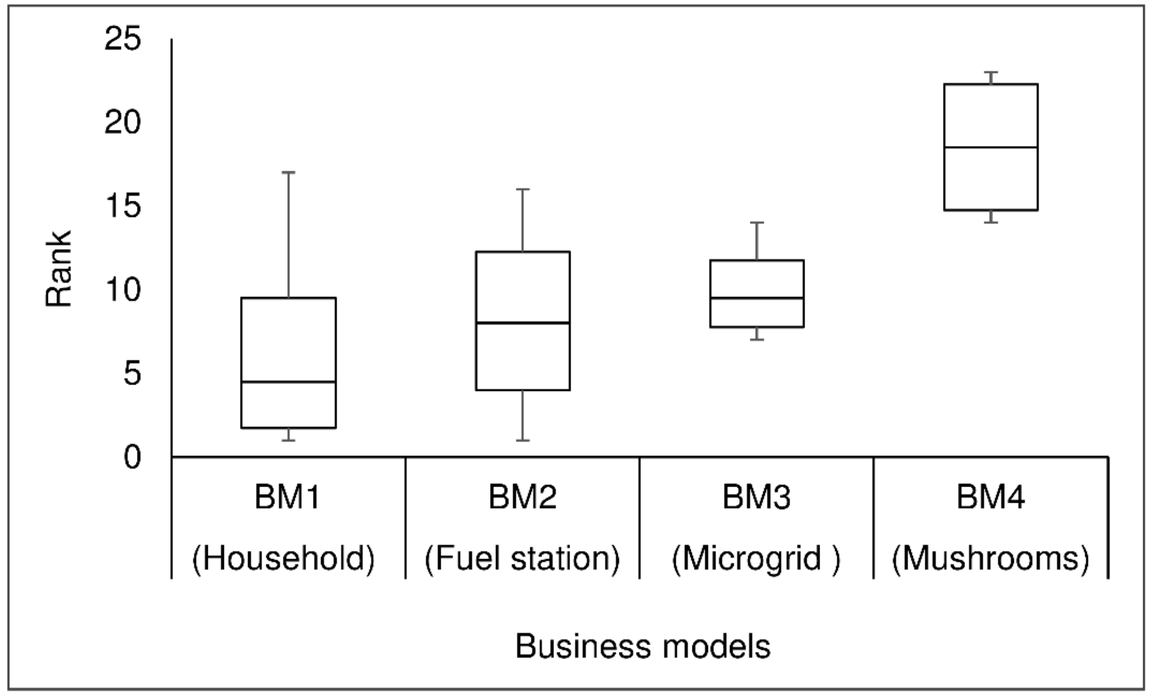

Colchester, UK


Biñan, Philippines

Industry and markets

- Profit
- Performance
- Growth
- Market power
- Managing risk
- Consumer
- Employment
- Reputation
- Innovation

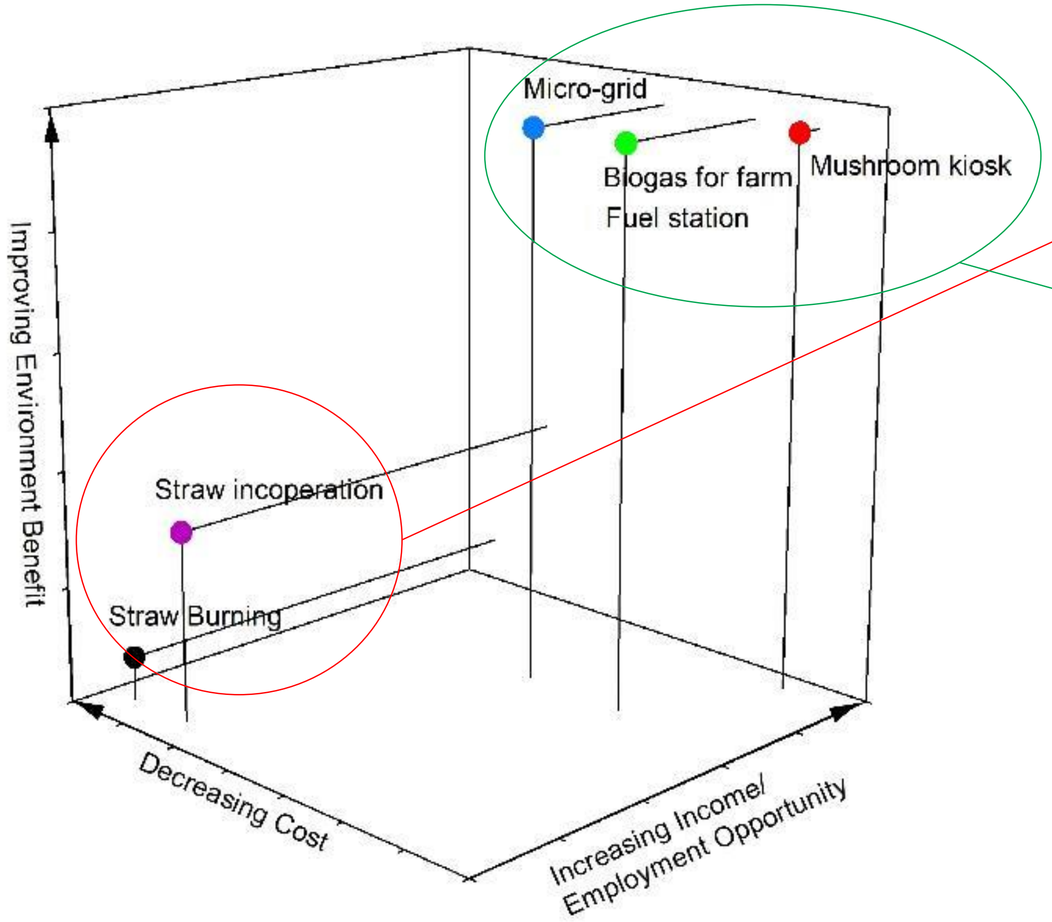
Farmers’ preferences



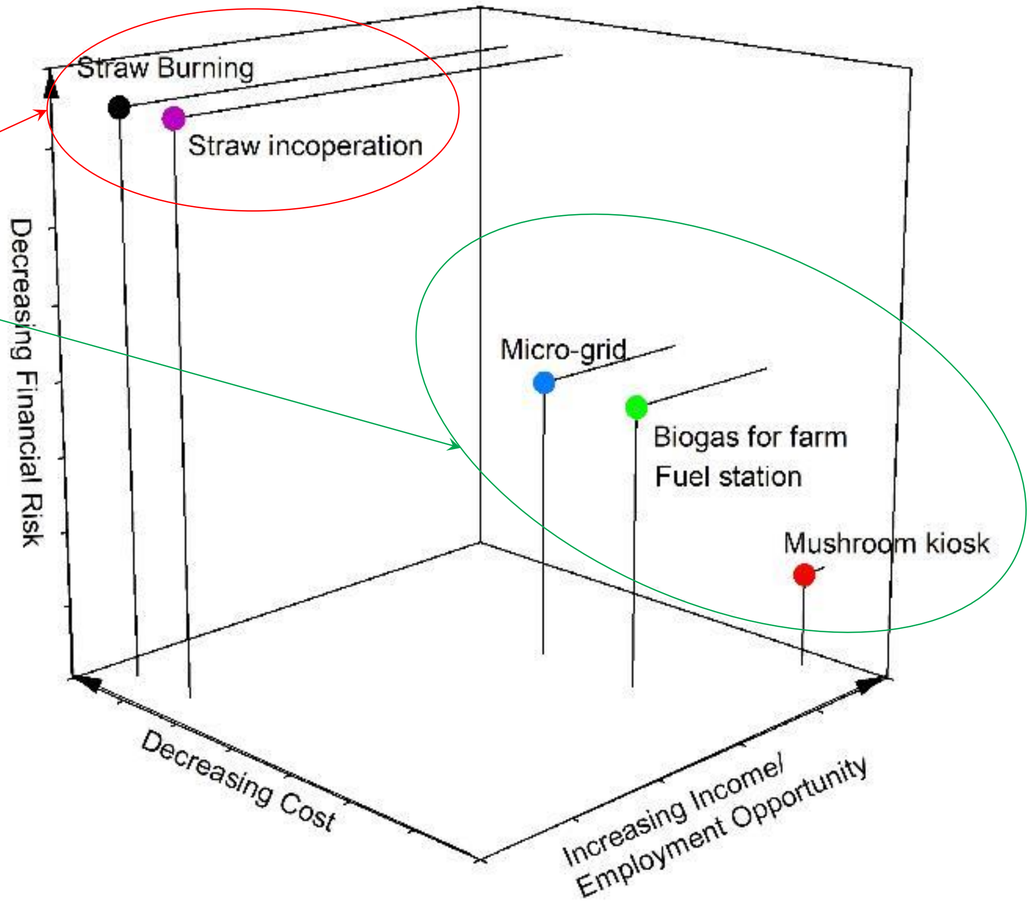
- Farmers don’t want to be energy users only
- Farmers want to be part and benefit from the intervention

Energy providers

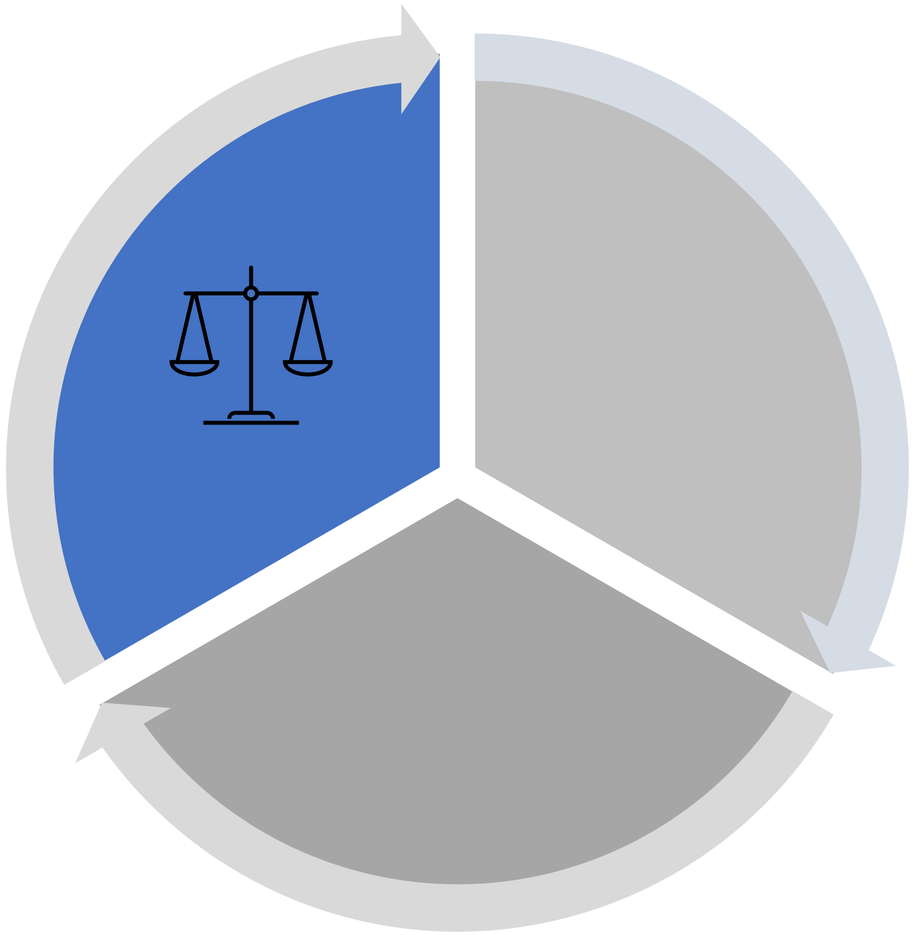
Environmental – socio-economic comparison



Financial risk – socio-economic comparison

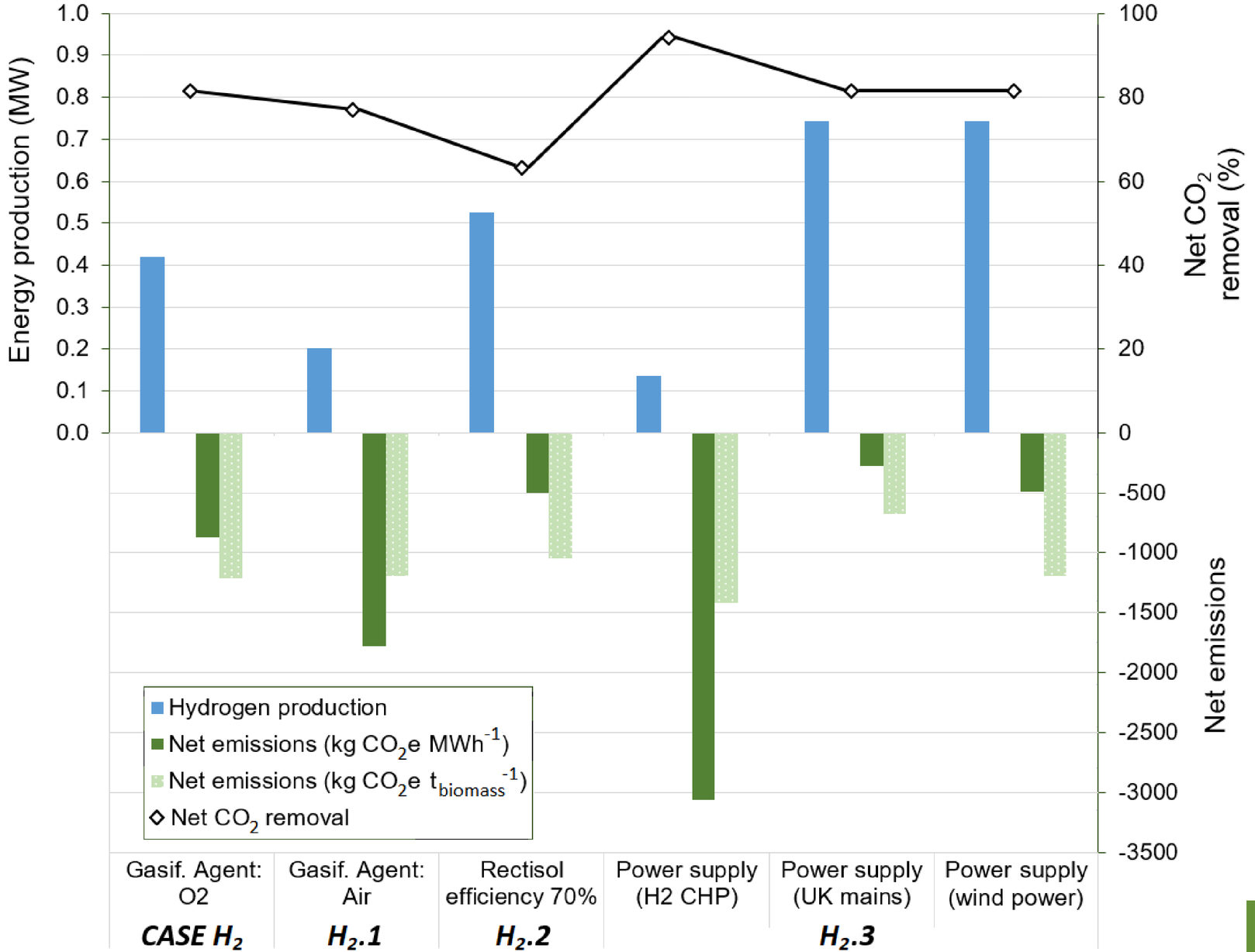


Policy

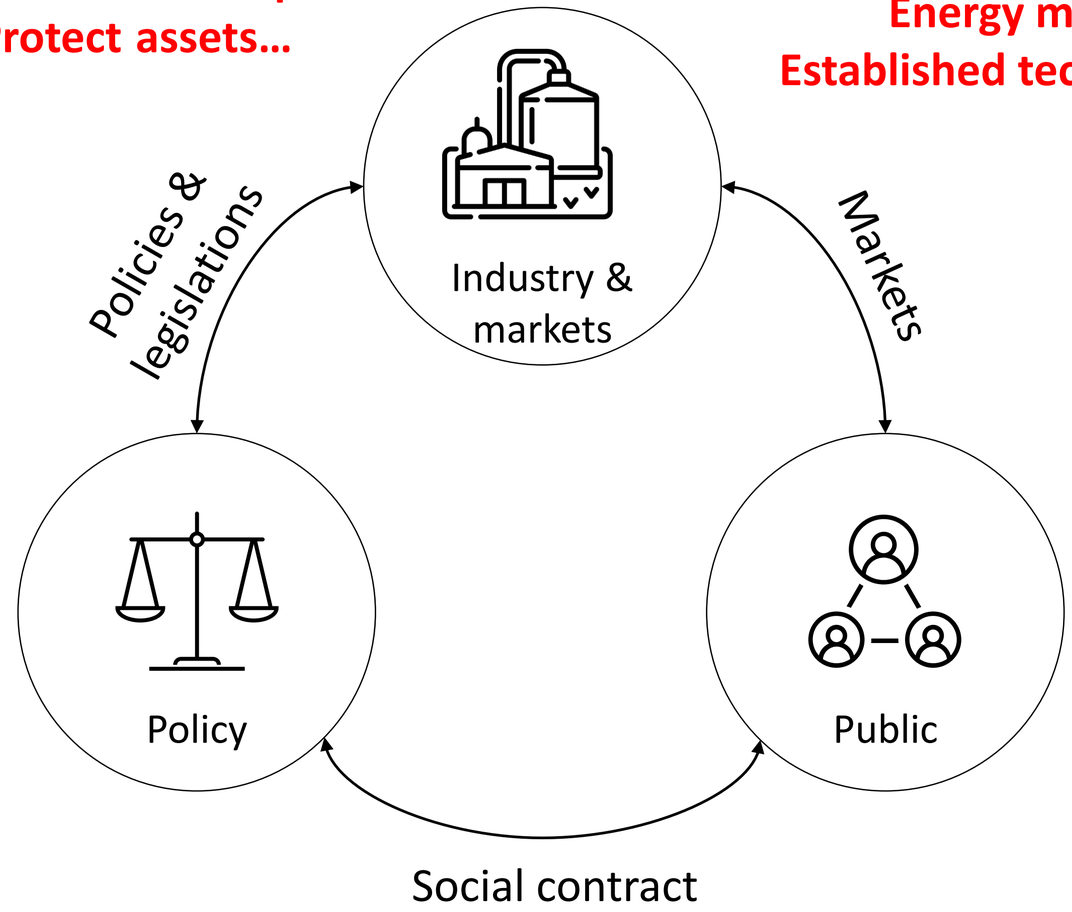


- Net zero / climate change mitigation
- Growth
- Jobs
- Skills
- Managing risk
- Cost for consumer and industry
- Innovation
- Markets
- Power

Role of drivers, decisions and outcomes



Stakeholders, drivers, perceptions



Maintain status quo
Protect assets…

Asset retention
Energy markets
Established technologies…

Reliable energy supply
Maintain public needs
Geopolitical power…

Demand
Cost
Reputation…

Energy: National, Affordable, Reliable…

Votes…

Aston University
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Understanding opportunities

Opportunities, benefits and trade-offs

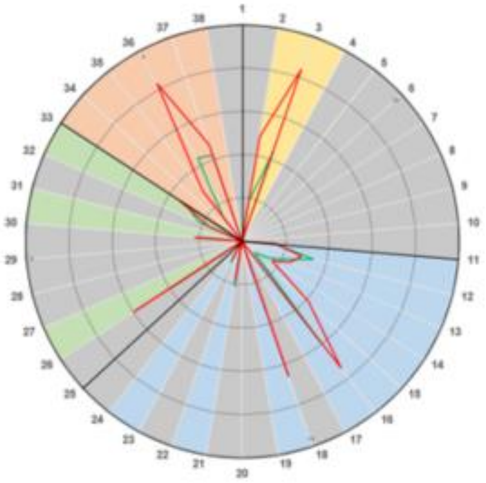
Supergen Bioenergy
SUSTAINABLE BIOENERGY SYSTEMS FOR OUR LOW-CARBON FUTURE

Key

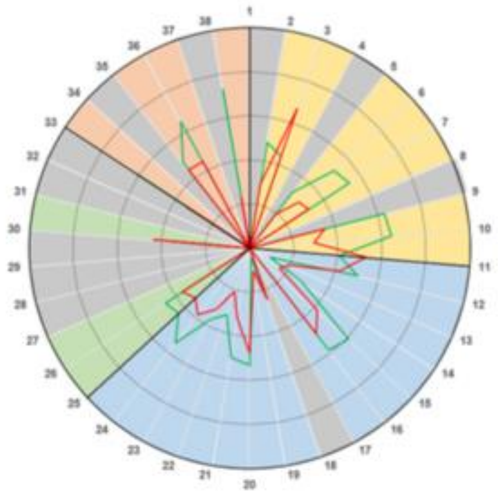
Sustainability Benefit | Sustainability Risk | Indicators not Included in Sustainability Assessment

People Sustainability Indicators		Development Sustainability Indicators		Natural System Sustainability Indicators		Climate Change & Emissions Sustainability Indicators	
1	Health & Wellbeing	11	Economic Performance	26	Ecosystems	33	Climate Action
2	Food Systems	12	Economic Stimulation	27	PM Pollutants	34	Standards
3	Land Management	13	Infrastructure Requirements	28	Oxide Pollutants	35	Whole Life Cycle Emissions
4	Decent Work	14	Production Processes	29	Heavy Metals	36	Land & Carbon Stocks
5	Jobs & Skills	15	Mobilisation	30	Water Use & Efficiency	37	Counterfactual Considerations
6	Change in income	16	Distribution	31	Water Quality	38	Replaced Fuels
7	Equality	17	Innovation	32	Water Systems		
8	Strong Institutions	18	Supply & System Efficiencies				
9	Partnerships	19	Techno-Economics				
10	Energy Access	20	Bioenergy				
		21	Energy System Performances				
		22	Added Value Products				
		23	Complementing Wider Sectors				
		24	Land Characteristics				
		25	Soil				

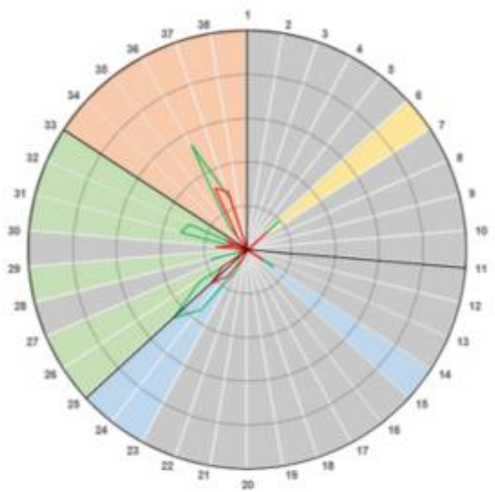
CS-1



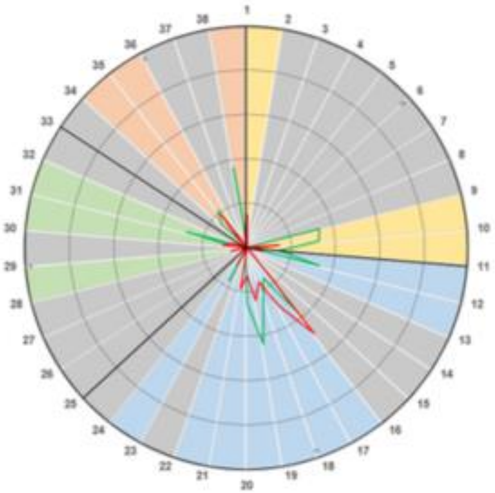
CS-2



CS-3



CS-4



Supergen Bioeconomy Sustainability Indicator Model

Opportunities, benefits and trade-offs

Supergen Bioenergy
SUSTAINABLE BIOENERGY SYSTEMS FOR OUR LOW-CARBON FUTURE

Opportunities Across Case Studies:

People:

Jobs & Skills / Changes in Income / Partnerships / Energy Access

Development:

Economy / Energy Sector / Bioeconomy / Land Utilisation

Natural Systems:

Soil / Heavy Metals / Water Systems

Climate Change & Emissions

Climate Action / Emissions / Replaced Fuels

Risks Across Case Studies:

People:

Land Management

Development*:*

Infrastructure / Feedstock Mobilisation / Techno-economics / Efficiencies

Natural Systems:

Air Pollutants/ Water Use & Efficiency

Climate Change & Emissions:

Emissions / Carbon Stocks

Aston University
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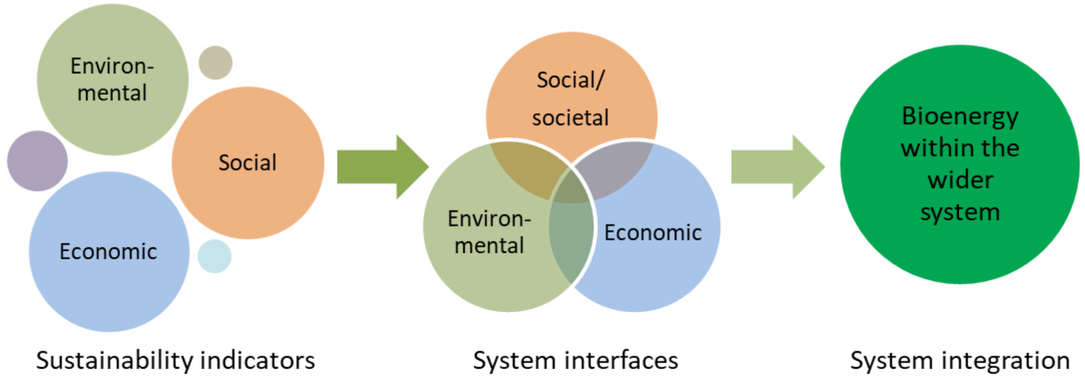
Enabling knowledge transfer and stakeholder engagement

Developing opportunities to engagement

- Build relationships and talk to people
- Consider who you engage with
- Be clear on uncertainties and complexities, but still find simple ways to communicate information
- Collaboration and cooperation
- Platforms for conversations to happen
- Knowledge brokers

Key message

- Opportunities will vary depending on societal, economic and policy context, perception
- Understanding governance frameworks to understand who make what decision and who is affected in what way
- System interfaces are often complex, however, they offer opportunities to improve overall system performance then just a single indicator
- Community or stakeholder-based approach to enable opportunities and maximise benefits for all



Contact details

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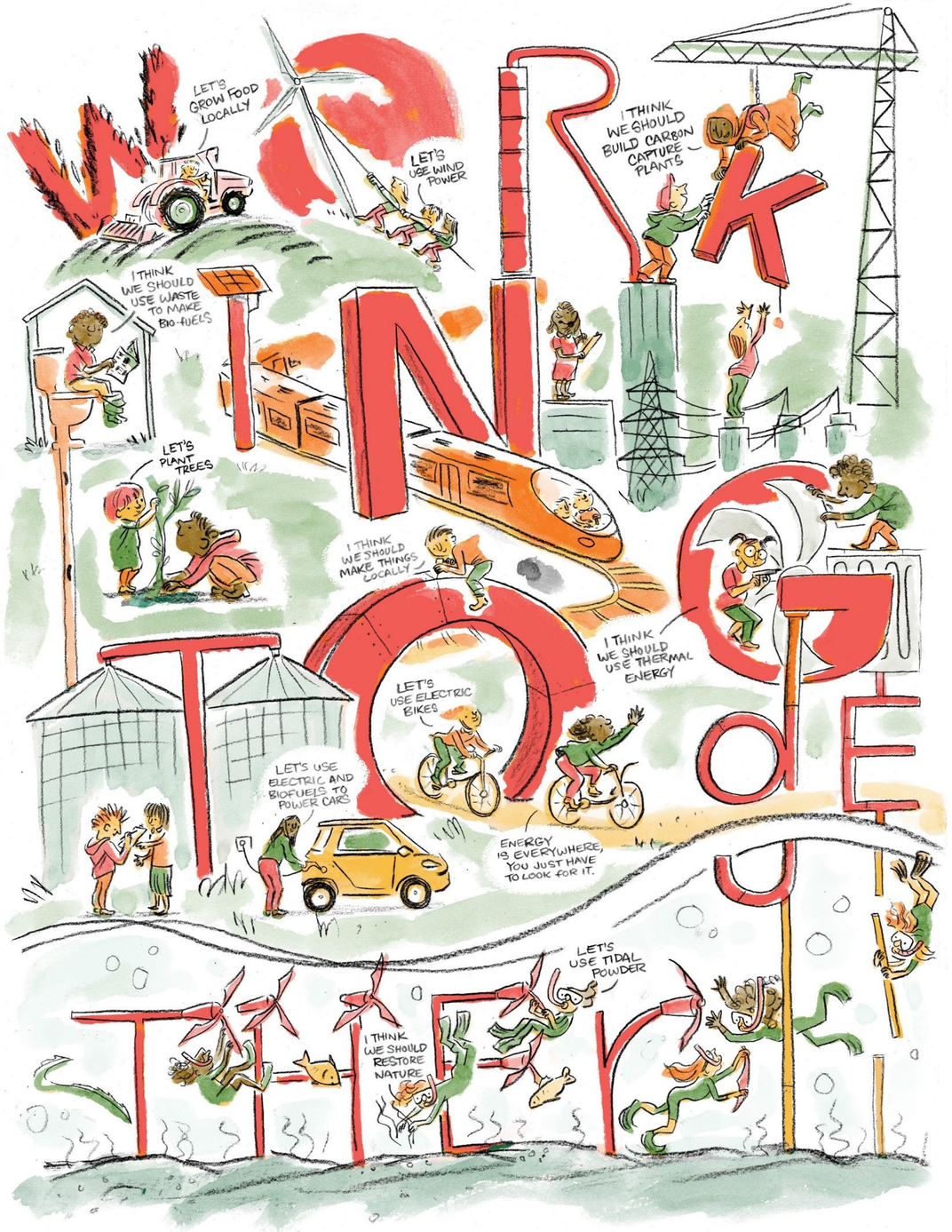
Dan Taylor - **Can Sustainable Biomass Help Us Achieve Net Zero? The Politics of People and the Planet** (Thursday, 9am, 2DO.2)

Joanna Sparks - **Carbon for Chemicals - How Can Biomass De-fossilise the Chemical Sector?** (Thursday, 11.45am, 2DO.5)



PANEL SESSION

Cross-sectorial dialogue to facilitate the biomethane market deployment

Moderator: Myrsini Christou

TotalEnergies and CEN PC 408	Erik Büthker
BOKU	Marlies Hrad
EBA	Giulia Cancian
Aston University	Mirjam Röder

Support to the coordination of national research and innovation programmes in areas of activity of the European Energy Research Alliance

SUPEERA workshop

Light Lunch

Bologna, Italy , 07.06.2023