Policies to incentivize biogas production from waste – European case studies

16/05/2023

Lucile Sever, EBA Policy Officer
• EBA in a nutshell
• Overview of the EU biogas and biomethane production from biowaste, industrial waste and sewage sludge
• EU policies to incentivize biogas production from waste
EBA in a nutshell
EBA members operate across the whole biogases value chain

+200 companies

46 National Associations

Research Centres
Overview of the EU biogas and biomethane production from biowaste, industrial waste and sewage sludge
Re-thinking our economic model switching to a circular economy

Source: EBA Statistical Report 2021
+18 bcm of biogases are being produced in Europe today

18.4 bcm (196 TWh) of combined biomethane and biogas in Europe

Produced from:
- 18,843 biogas plants in 2021
- 1,067 biomethane plants in 2021

Evolution of biogas and biomethane production (bcm)

Source: EBA Statistical Report 2022
Waste is more widely used for biomethane production

Biomethane plants use relatively more biowaste and industrial waste than biogas plants.

Source: EBA Statistical Report 2022
The installation of new plants digesting biowaste, sewage sludge and industrial waste is stable over the years.
The sector has the potential to deliver +35 bcm by 2030

2030 national biomethane potentials

Europe could produce 41 bcm (400 TWh) of biomethane by 2030 from anaerobic digestion and gasification

Source: Gas for Climate 2022
16% of biomethane produced from waste in 2030

In 2030, 9% of EU biomethane will be produced from industrial wastewater, 5% from biowaste and 2% from sewage sludge.
EU policies to incentivize biogas production from waste
Unlocking sewage sludge potential in the UWWTD

At EU level, the treatment of urban wastewaters is regulated by the **Urban Wastewater Treatment Directive (UWWTD)** ➔ environmental objective (collection and treatment standards for agglomerations)

Recast of the UWWTD – Article 11 of the proposal of the EU Commission:

- Introduces an obligation to **achieve energy neutrality for all urban wastewater treatment plants above 10 000 p.e. by 2040**

  ➔ **Total annual renewable energy produced** at national level by all UWWT plants = the **total annual energy used** by all such UWWT plants.

Huge driver for implementing anaerobic digestion in UWWT plants
Unlocking biowaste (and industrial wastewaters?) potentials in the WFD

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<td>• policy options to bring about a more circular and sustainable management of textile waste</td>
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<td>• the feasibility of setting food waste reduction targets.</td>
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<td>• Target of 65% of municipal waste collected and prepared for reuse and recycling by 2035.</td>
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<td>• Mandatory biowaste separate collection from 1 January 2024 onwards.</td>
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Case studies at national level

Linköping, Sweden
- In 2012, “green bag” separate collection system implemented for food waste in Linköping.
- By 2023, 88% of the municipalities collect source-separated food waste.
- Additional national target: by 2023, 75% of food waste sorted and treated biologically so that plant nutrients and biogas are recovered.

Ljubljana, Slovenia
- From 2011: introduction of a door-to-door collection system + lowering the frequency of collection for residual waste + a strong communication strategy.
- In 2015, landfill centre transformed in waste management centre to perform anaerobic digestion of biowaste.
- By 2016, more than 63% of collected waste was sorted correctly.

Milan, Italy
- In 2012: introduction of the use of transparent bags for the collection of the residual fraction + door to door waste collection system + biowaste collected treated through AD for the production of biogas and compost.
- Milan’s overall separate collection rate already reaching 62.6% in 2020.
THANK YOU!

Lucile Sever, Policy officer
sever@europeanbiogas.eu

Re-thinking our economy. Making the energy transition happen.

www.europeanbiogas.eu
Production of biomethane from agro-industrial wastes – CASE STUDY OF AN INNOVATIVE TECHNOLOGY FROM FRANCE

Geoffrey KARAKACHIAN
Project in a nutshell

• **BIOMETHAVERSE**: Demonstrating and Connecting Production Innovations in the **BIOMETHaNe uniVERSE (HORIZON EUROPE)**;

• **54** months (October 2022- March 2027);

• **22** partners in **9** countries: ISINNOVA, ENEA, CAP, POLIMI, SIAD, CIC (IT), EBA (BE), FAU, DBFZ, EE (DE), UABIO, MHP (UA), BLAG, CERTH (EL), RISE, CORTUS, WARTSILA, SGA (SE), ENGIE (FR), AERIS, LEITAT (ES), DTU (DK);

• **9,871,773 €** of EC funding (**70%** of EU funding);

• To **diversify** the technology basis for biomethane production in Europe, to **increase** its cost-effectiveness, and to **contribute** both to the uptake of biomethane technologies and to the priorities of the SET Plan Action 8.

• Five innovative biomethane production pathways in five European countries: France, Greece, Italy, Sweden, and Ukraine.
Pillars of the project

• Demonstration of Innovative Biomethane Pathways

• Assessment and Optimisation of Innovative Biomethane Pathways

• Replicability, Planning Decisions, Market Penetration, and Policy Dimension

• Dissemination, Exploitation & Communication
Demonstration of Innovative Biomethane Pathways

- **Design** and **implementation** of demonstration activities:
  - ✓ In-Situ and Ex-Situ Electromethanogenesis (**EMG**) in France
  - ✓ Ex-Situ Thermochemical/catalytic Methanation (**ETM**) in Greece
  - ✓ Ex-Situ Biological Methanation (**EBM**) in Italy
  - ✓ Ex-Situ Syngas Biological Methanation (**ESB**) in Sweden
  - ✓ In-Situ Biological Methanation (**IBM**) in Ukraine

- **EMG Consortium:**
  - LEITAT
  - DTU
  - FAU
  - aeres
  - ENGIE Lab
Demo Site in France

Demonstration site: EPPEVILLE, HAUT DE FRANCE REGION

Feedstock: 35,000 t/y agro-industrial residues

Type: Continuously Stirred Tank Reactor // Mesophilic // Upgrading via membrane

The unit injected its first m³ of biomethane in December 2016.

Several solid and liquid feed lanes, adapted to the type of input.

Main numbers:

- 1,815,000 m³/y of biomethane
- Up to 230 Nm³/h injected into NG grid
- 6,840 m³ digestion volume (HRT > 50 d):
  - 2 Main digesters of 2280 m³
  - 1 Post-digester of 2280 m³
- 27,000 m³ of digestate storage / Valorization of digestate by land spreading
- (6,000 ha, 31 farms).
Electromethanogenesis – technological working principle

- Electromethanogenesis is at the frontier between electrolysis (H₂ production in-situ) and biological methanation (H₂ + CO₂ conversion into CH₄).
- The technology relies on the use of electrodes inserted into digestate or given medium. Under voltage, the micro-organism activity within the biofilm attached to the electrodes is boosted and leads to higher biogas production and/or quality.
- Fine tuning of electrochemistry and biochemistry favorize the production of CH₄.
- Technology aiming at increasing the biomethane production of AD unit and gas quality.
State of the art of electromethanogenesis

1 chamber reactor: Boost of biogas production

- +91% Biogas
- +43% CH₄

2 chamber reactor: Biogas upgrading towards high CH₄ %

- CH₄ ≥ 97.9 ± 2.3%
- 0.8 m³ CH₄/m³ reactor/day

2020 labscale study on 1L reactors (ENGIE x LEITAT collaboration)

2021 labscale study on 0.4L reactors (DTU)
Ambition: Increase biomethane production on the AD unit using the effluent digestate, biogas of the main digestor and external green electricity from solar and wind.

Single chamber reactor (1c-AD-BES)

- Electrodes directly immersed in the digestate.
- **Planned pilot is a reactor of 1 m³ reactor working at the same mesophilic temperature of the main AD plant.**
- **Electrical power source < 2 V** driven by a renewable energy mix from local wind and photovoltaic electricity generators.
- **Enhancement of the bioelectrode geometry and electron transfer properties by prior surface treatment**
- Coupling the 1c-AD-BES downstream the main digester, the aim is to have a surplus production of 100 L CH₄/m³/d to the already existing production.

Double chamber reactor (2c-AD-BES)

- Electrodes separated by a membrane, water oxidation (anodic part) and CO₂ (biogas reduction (cathodic part).
- **Planned pilot is a reactor of 1 m³**
- Injection of biogas (from the main digestor first and then from 1c-AD-BES reactor), enabling an efficient power-to-gas process in a H₂O/CO₂ electrosynthesis cell
- **2c-AD-BES is an upgrading step towards maximum biomethane purity output.** At lab scale, the current two-chamber system can produce 200-1000 L CH₄ per day per m³ reactor volume
Main challenges

Performances challenges:

Previous lab experiences showed that two main parameters contribute to increase biogas/biomethane production in AD-BES:

- Available surface for biofilm growth, due to electrodes presence
- Application of an optimal voltage for the stimulation of electro-active microbes.
  - trials ongoing (2023) : (LEITAT-DTU-FAU)
    1. Pretreatment of electrode materials → maximizing the bioelectrochemical performances
    2. Pretreatment of the substrate (AD digestate) → facilitating the substrate degradation

Operational challenges:

- Feeding conditions at upscaled level: continuous feeding investigation
- Inoculation of anode and cathode with proper electro-active biofilms
  - Pre-pilot testing at 10/15 L scale (2023-2024) (LEITAT-DTU)
- Safe usage of the pilot on an operational demo-site
  - SAFETY Studies (ENGIE-AERIS):
    - HAZID study (Sept. 2023):
      Hazard identification considering the pilot in its environment
    - ATEX study (2023):
      Identification of the ATEX zoning of the pilot and setting-up of mitigation measure → input for the future pilot localisation
    - HAZOP study (Jan. 2024):
      Operational hazard identification on the pilot usage

Pilote Operation

- 1 year testing 2025-2026
Initial Business perspective

Direct usage of electricity to produce **additional biomethane** will allow for a cheap option of energy storage: excess renewable electricity cannot always be injected into the electricity grid or is not economical at peak production times.

→ **EMG systems can be operated intermittently according to the availability of the renewable electricity.**

→ **In the perspective of a full-scale system integrated on an AD unit (at the post-digester level):** EMG offers a possible add on solution for already existing AD plants. With a moderate investment in terms of CAPEX and very low OPEX, a significant increase of biogas production can be achieved which could lead to a **decrease of about 13% of biomethane cost compared to 2022 reference for an increase production of targeted 43% compared to sole AD conditions.**

→ **Policy :** In France, injection **requires a clarified regulatory framework adapted** to these technologies. An **authorisation to inject the gas** within the framework of a "regulatory sandbox" to facilitate the implementation of innovative projects is possible.

➢ **Methodological analysis of the pilot :**
  ➢ Costs (OPEX & CAPEX)
  ➢ Operation (safety, usage, digestate quality)
  ➢ Performances (biogas & biomethane production)
  ➢ Mass and energy balance
  ➢ Bill of material

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<thead>
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<th>Data provision all along the project for:</th>
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<tr>
<td>• <strong>WP3 Assessment and Optimisation</strong> : assessment of the demonstrators as built within the project, and of their potential optimised and upscaled configurations</td>
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<tr>
<td>• <strong>WP4 Replicability</strong> : assessment of the replicability potential of technology pathways adopted and tested by demonstrators.</td>
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Towards market penetration and stakeholder acceptance
Thank you!

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MEETS Methodology – understanding the replicability of national biomethane policies

GBEP Webinar Series 2023: Co-benefits of biogas and biomethane

Promoting anaerobic digestion for waste management

Stefano Proietti, Loriana Paolucci

ISINNOVA
Who we are

• Research and consultant Institute founded in 1971

• Consolidated experience in energy efficiency, sustainable mobility, territorial systems, environmental sustainability

• 15 members staff with multidisciplinary background in engineering, statistics, economics, politics and informatics

• Long story of collaboration at national (Ministries, Regions, Provinces and Municipalities) and international level (European Commission, World Bank, European Bank of Investments, foreigner Ministries, Regions e Municipalities, etc.)

• Specialised skills in coordination of projects, analysis of and support to policies, impact assessment, evaluation of policies and technologies energy efficiency, monitoring of participation processes to policies.

• www.isinnova.org
Replication methodology

- **Inspirational methodology** for decision makers, project developers, etc.
- **INSPIRE** allows to estimate the Replication Potential of specific projects, technological solutions, policies, etc. in different contexts (cities, countries, etc.)
- Developed by ISINNOVA and already applied in other EU projects
- **Versatile method** that can be applied to different topics and scales
- Relies on different tools based on the same mathematical approach
MEETS: Replication Potential of National Policies

To assess the Replication Potential of biomethane policies (of Advanced countries) in Follower countries (applied in REGATRACE project, www.regatrace.eu)

1. Policy Evaluation
   ✓ Policy Evaluation Criteria → Ranking of policies in each Advanced Country

2. Replication Assessment
   ✓ MEETS Policy Replicability Method:
     o quantitative approach for estimating the Replication Potential that specific policies might have in different contexts
     o The results and conclusions of this analysis could be relevant for other countries with similar characteristics and priorities of the Follower Countries.
## Dimensions and Variables

<table>
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<tr>
<th>MEETS Dimension</th>
<th>POLICY Variables</th>
<th>CONTEXT Variables</th>
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<tbody>
<tr>
<td>MARKET</td>
<td>Potential for market transformation</td>
<td>Interest from key players to invest in the specific policy</td>
</tr>
<tr>
<td>EFFECTIVENESS</td>
<td>Cost Efficiency</td>
<td>Readiness of the regulatory framework</td>
</tr>
<tr>
<td>ECOSYSTEM</td>
<td>Environmental impact</td>
<td>Acceptance from relevant stakeholders</td>
</tr>
<tr>
<td>TIME</td>
<td>Persistency of impacts over time</td>
<td>Government/Institutional stability</td>
</tr>
<tr>
<td>SIDE EFFECTS</td>
<td>Support of positive side-effects</td>
<td>Responsiveness to National Plans /Institutional Priorities</td>
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*ISINNOVA*
Replication Diagram

INPUT

- **X-axis**: Variables dependent on the specific characteristics of the **POLICY**

- **Y-axis**: Variables dependent on the specific characteristics of the **CONTEXT** where the policy is supposed to replicated

OUTPUT

**Replicability???**
## Overview of Results

<table>
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<tr>
<th>Policy</th>
<th>MARKET Replication Potential</th>
<th>ECOSYSTEM Replication Potential</th>
<th>EFFECTIVENESS Replication Potential</th>
<th>TIME Replication Potential</th>
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### OVERALL REPLICATION POTENTIAL

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<td>Policy 5</td>
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<tr>
<td>Policy 6</td>
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### OVERALL REPLICATION POTENTIAL - COUNTRY X

- P6
- P2
- P1
- P4
- P5
- P3

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*ISINNOVA*
## Concrete Application

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<th>Measure</th>
<th>Replicability Potential (RP)</th>
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<tr>
<td></td>
<td>BE</td>
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<tr>
<td>AT2 - Guarantee of Origin system for gas labelling</td>
<td>42%</td>
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<tr>
<td>AT3 - Regulation on Transportation Fuels</td>
<td>58%</td>
</tr>
<tr>
<td>AT6 - Investment Grants</td>
<td>56%</td>
</tr>
<tr>
<td>AT7 - Green Gas Service Agency</td>
<td>52%</td>
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<tr>
<td>AT9 - National Emission Trading System</td>
<td>78%</td>
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### Replication Potential: Austria - Ireland

### Replication Potential: Austria - Czech Republic

### Replication Potential: Austria - Belgium
Use of Replication Methodology

✓ This methodology helps to identify:
  • successful policies
  • policies that have *not generated important impacts* in terms of development of the biomethane sector
  • most replicable policies in the various national contexts.

✓ Useful in understanding how replicability is influenced by:
  • several *factors* that can go well *beyond the political priorities* identified by a country
  • *intrinsic and specific characteristics* of the policy
  • *context* where it is supposed to be replicated
THANK YOU
FOR YOUR ATTENTION!

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