The voice of renewable gas in Europe

# Policies to incentivize biogas production from waste – European case studies

*16/05/2023*

**Lucile Sever, EBA Policy Officer**

EBA
European Biogas Association

The voice of renewable gas in Europe

- 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**

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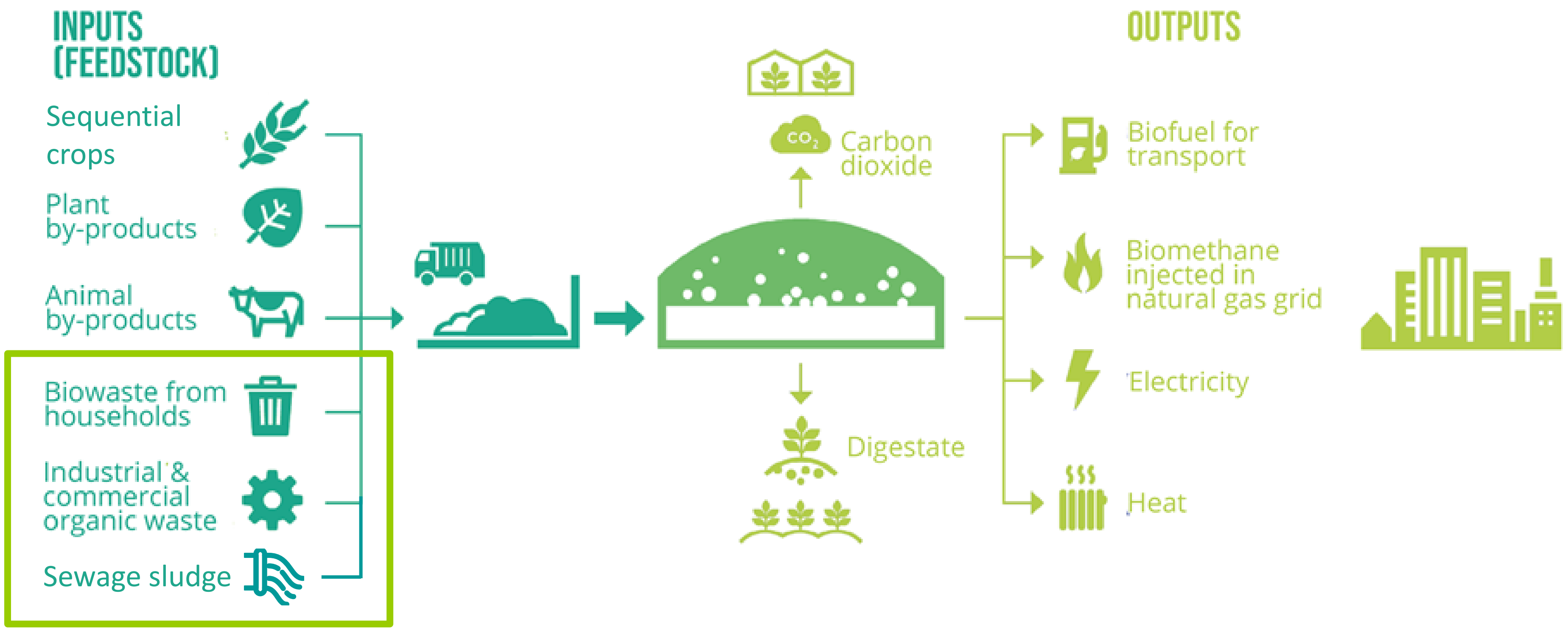
# Overview of the EU biogas and biomethane production from biowaste, industrial waste and sewage sludge

# Re-thinking our economic model switching to a circular economy




Source EBA Statistical Report 2021

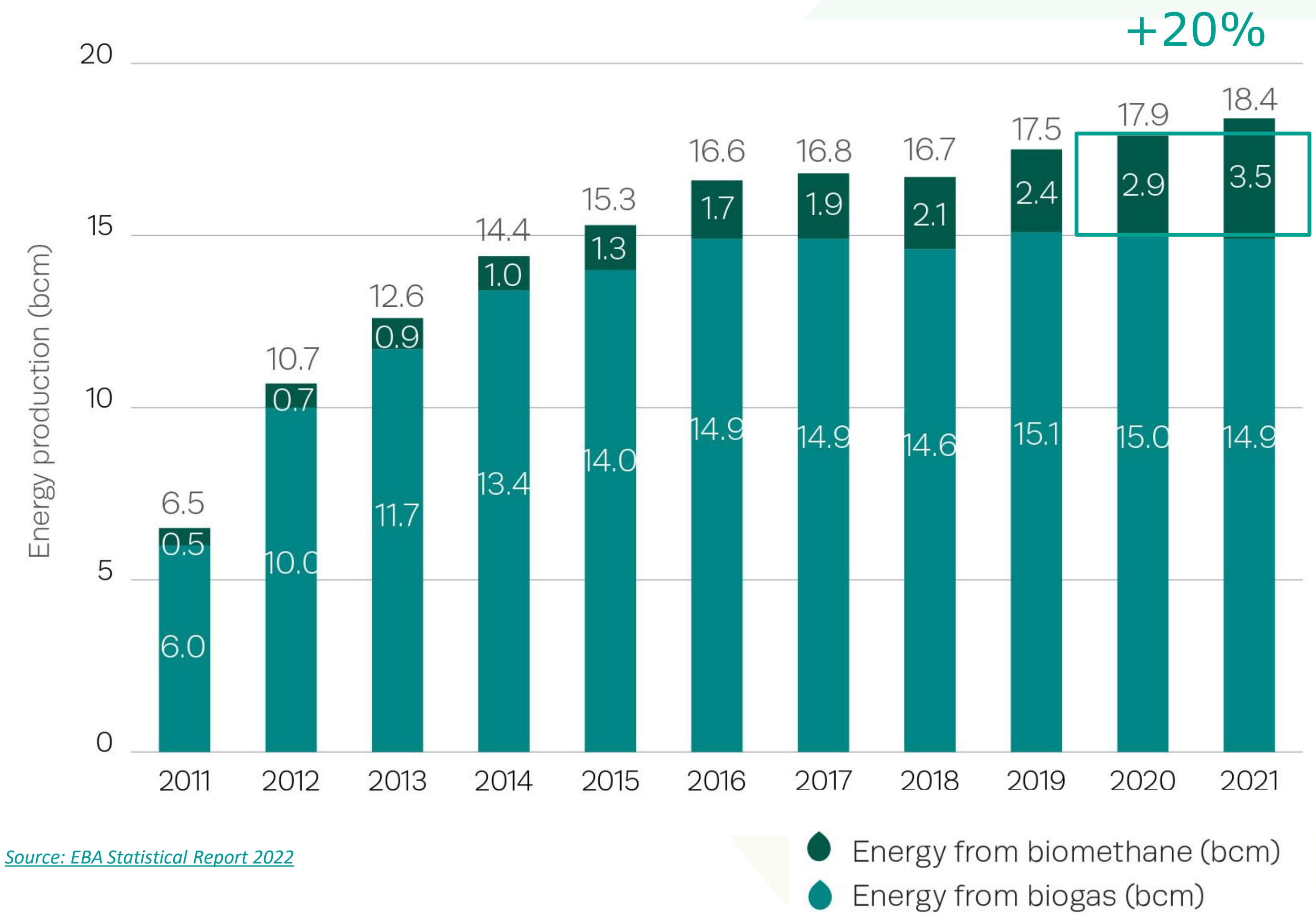
# +18 bcm of biogases are being produced in Europe today

**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)



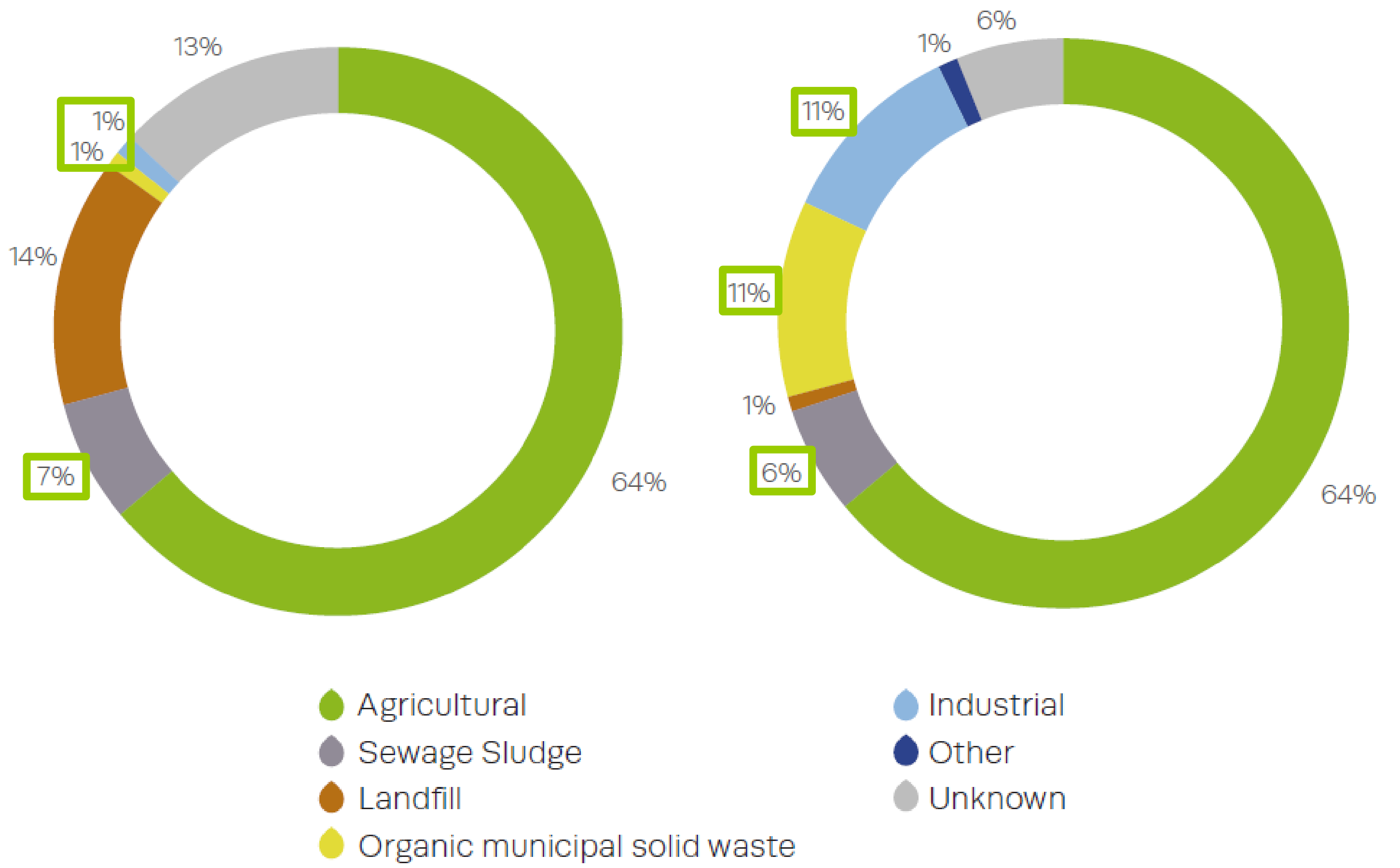

Source: EBA Statistical Report 2022

# Waste is more widely used for biomethane production

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

**Biogas production per plant type in 2021**

**Biomethane production per plant type in 2021**



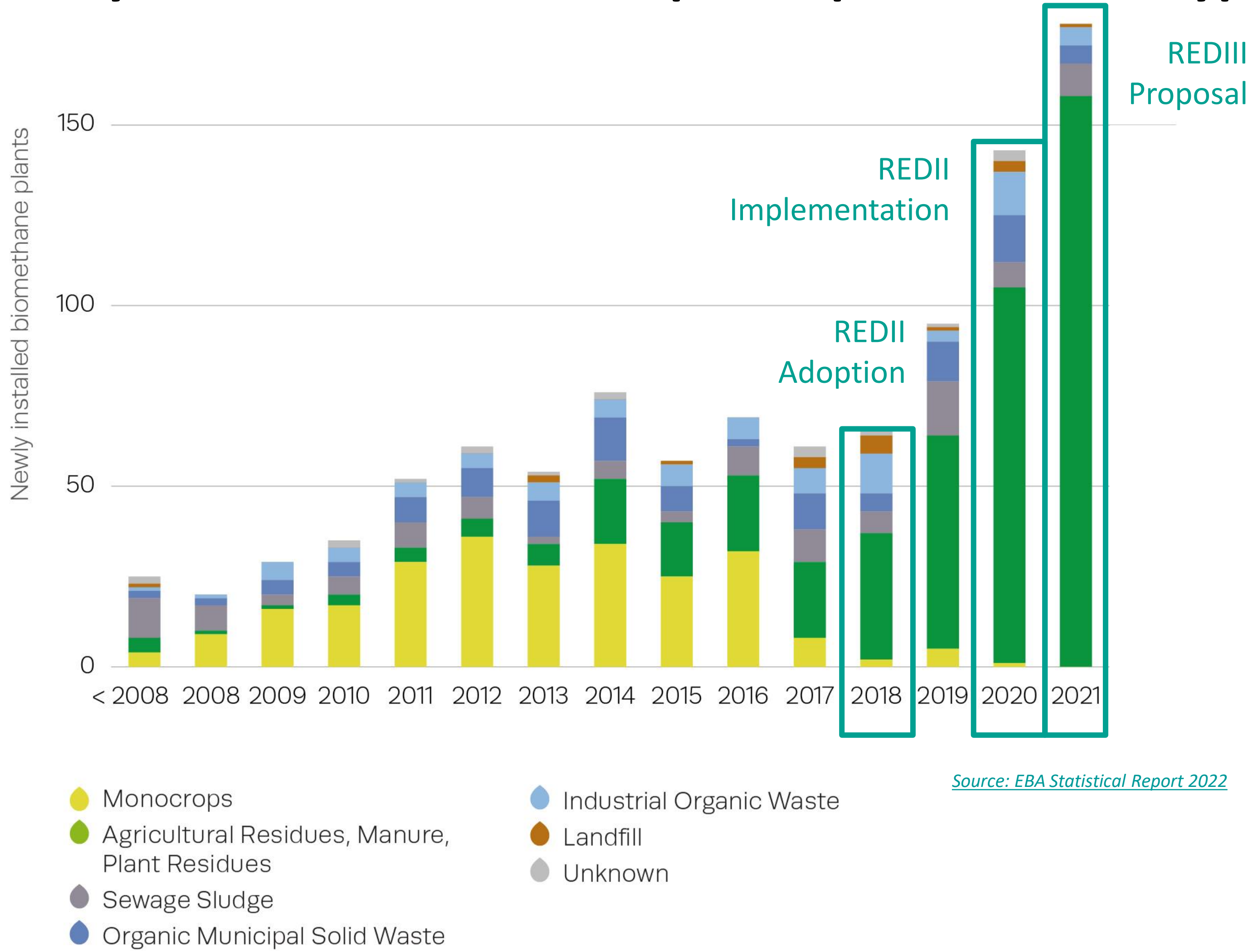



Source: EBA Statistical Report 2022

# Biomethane production from waste is stable

The installation of **new plants digesting biowaste, sewage sludge and industrial waste** is stable over the years.

## Newly installed biomethane plants per feedstock type




Source: EBA Statistical Report 2022

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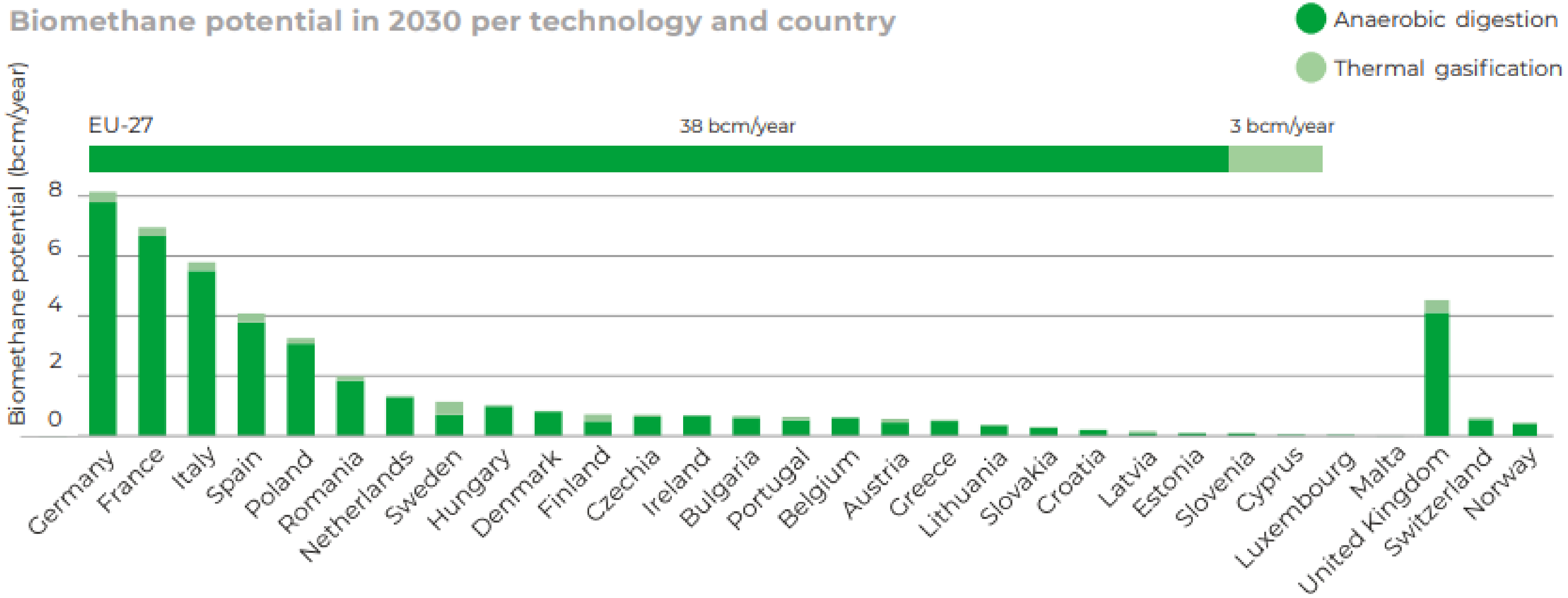
# The sector has the potential to deliver +35 bcm by 2030

## 2030 national biomethane potentials

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

Figure 1.
Biomethane potential in 2030 per technology and country




Source: Gas for Climate 2022

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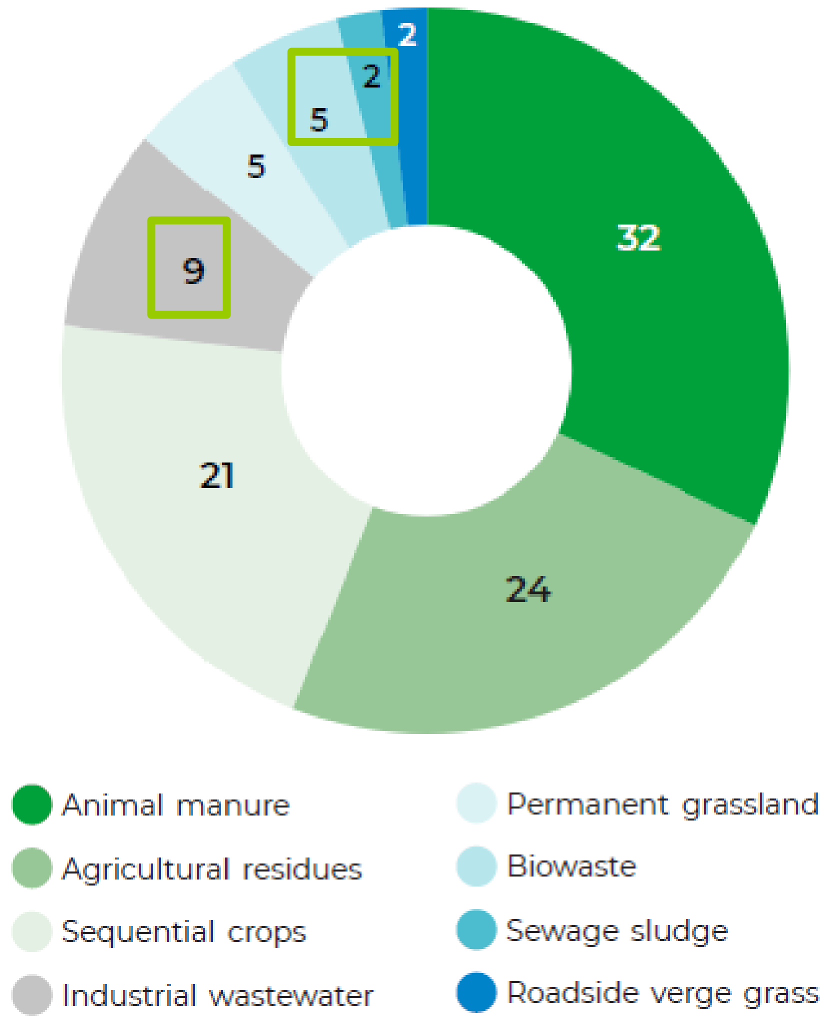
# 16% of biomethane produced from waste in 2030

In 2030, **9%** of EU biomethane will be produced from **industrial wastewater**, **5%** from **biowaste** and **2%** from **sewage sludge**.

**EU anaerobic digestion potential in 2030 per feedstock**



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# 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)


EUROPEAN COMMISSION

Brussels, 26.10.2022
COM(2022) 541 final

2022/0345 (COD)

Proposal for a

DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

concerning urban wastewater treatment (recast)

(Text with EEA relevance)

{SEC(2022) 541} - {SWD(2022) 541, 544}

EN EN

**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

**2018 revision of the Waste Framework Directive (WFD)**

- Target of 65% of municipal waste collected and prepared for reuse and recycling by 2035.
- **Mandatory biowaste separate collection from 1 January 2024 onwards.**

Driver for biogas from biowaste

**2023 revision of WFD**

Proposal of the EU Commission pending for adoption, foreseen for 7/06/23

Will focus on:

- policy options to bring about a more circular and sustainable management of textile waste
- **the feasibility of setting food waste reduction targets.**

Potential driver for biogas from food waste?

**2024 and 2028 revision of WFD?**

Could target the prevention, preparing for re-use and recycling of waste, including specific waste streams

Potential driver for biogas from industrial wastewaters?

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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.

**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.

**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.

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# THANK YOU!

**Lucile Sever, Policy officer**
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*Re-thinking our economy. Making the energy transition happen.*

www.europeanbiogas.eu

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# Production of biomethane from agro-industrial wastes – CASE STUDY OF AN INNOVATIVE TECHNOLOGY FROM FRANCE

Geoffrey KARAKACHIAN

ENGIE Lab Crigen
RESEARCH & INNOVATION

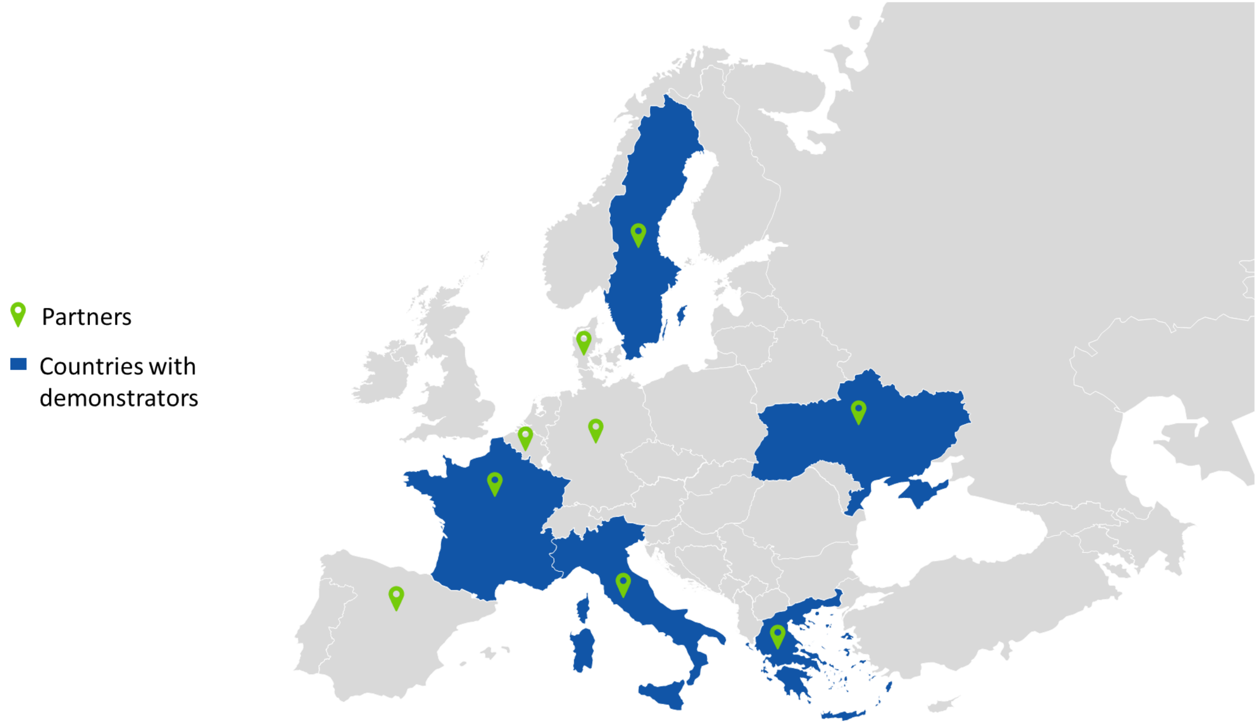
Co-funded by
the European Union

innovations in the BIOMETHAne uniVERSE

16/05/2023

# Project in a nutshell

- **BIOMETHAVERSE**: Demonstrating and Connecting Production Innovations in the **BIOMETHA**ne uni**VERSE (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.



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# 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



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# 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 managing technologies DTU FAU FRIEDRICH-ALEXANDER UNIVERSITÄT ERLANGEN-NÜRNBERG aeris ENGIE Lab



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# Demo Site in France

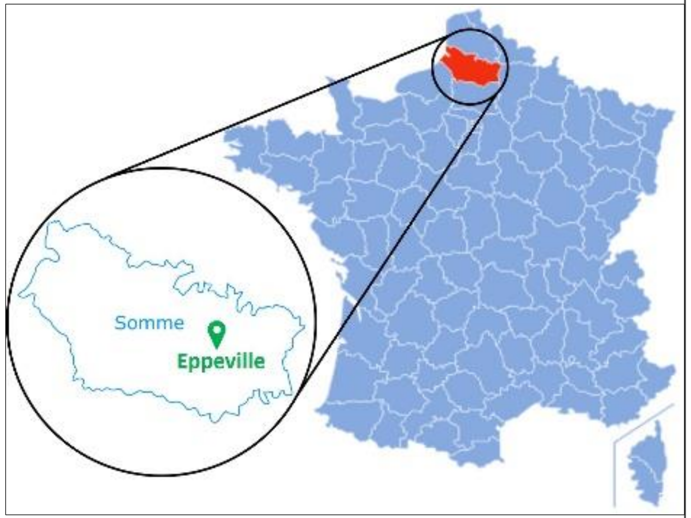
**Demonstration site: EPPEVILLE, HAUT DE FRANCE REGION**

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

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

The unit injected its first $m^3$ of biomethane in December 2016.

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




**Main numbers:**

- **1,815,000 $m^3$/y** of biomethane
- **Up to 230 $Nm^3$/h** injected into NG grid
- **6,840 $m^3$** digestion volume ( HRT> 50 d) :
    - 2 Main digesters of 2280 $m^3$
    - 1 Post-digester of 2280 $m^3$
- **27,000 $m^3$** of digestate storage / Valorization of digestate by land spreading
- (**6,000 ha**, **31** farms).



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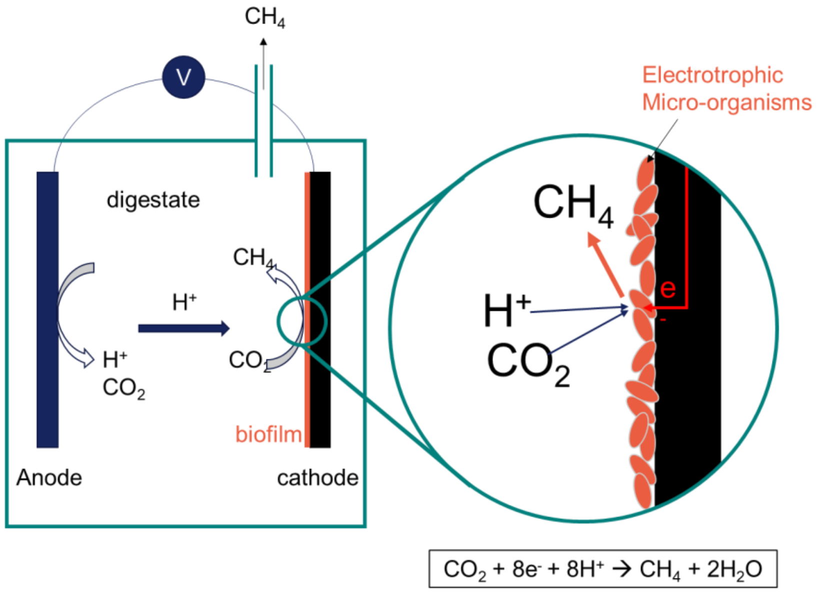
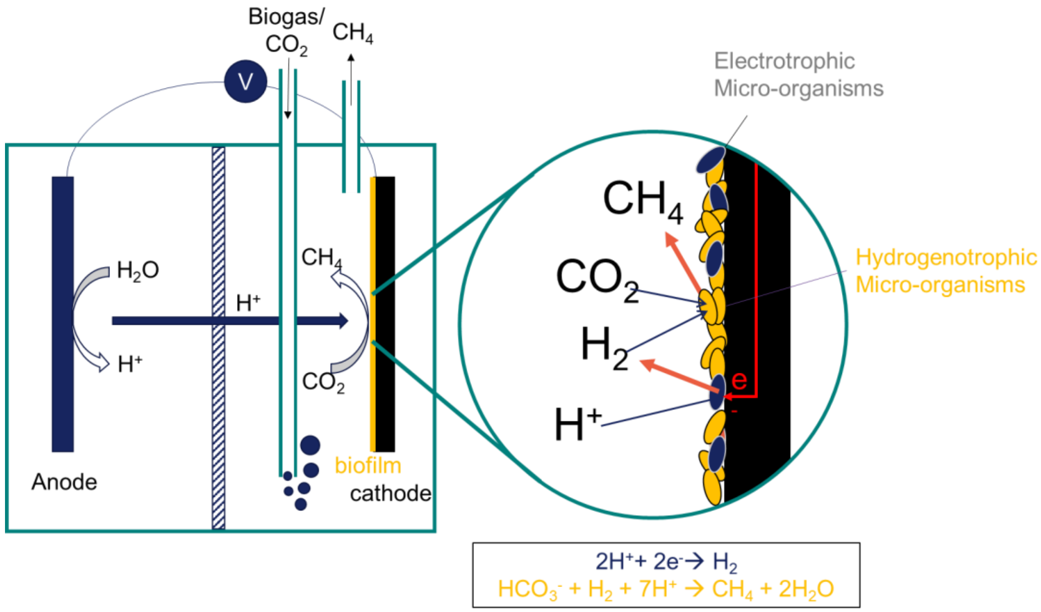
# Electromethanogenesis – technological working principle

**1 chamber reactor :**
**Boost of biogas production**




**2 chamber reactor :**
**Biogas upgrading towards high $CH_4$ %**




- Electromethanogenesis is at the **frontier between electrolysis** ($H_2$ production in-situ) **and biological methanation** ($H_2$ + $CO_2$ conversion into $CH_4$).
- 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 $CH_4$.
- Technology aiming at increasing the biomethane production of AD unit and gas quality.



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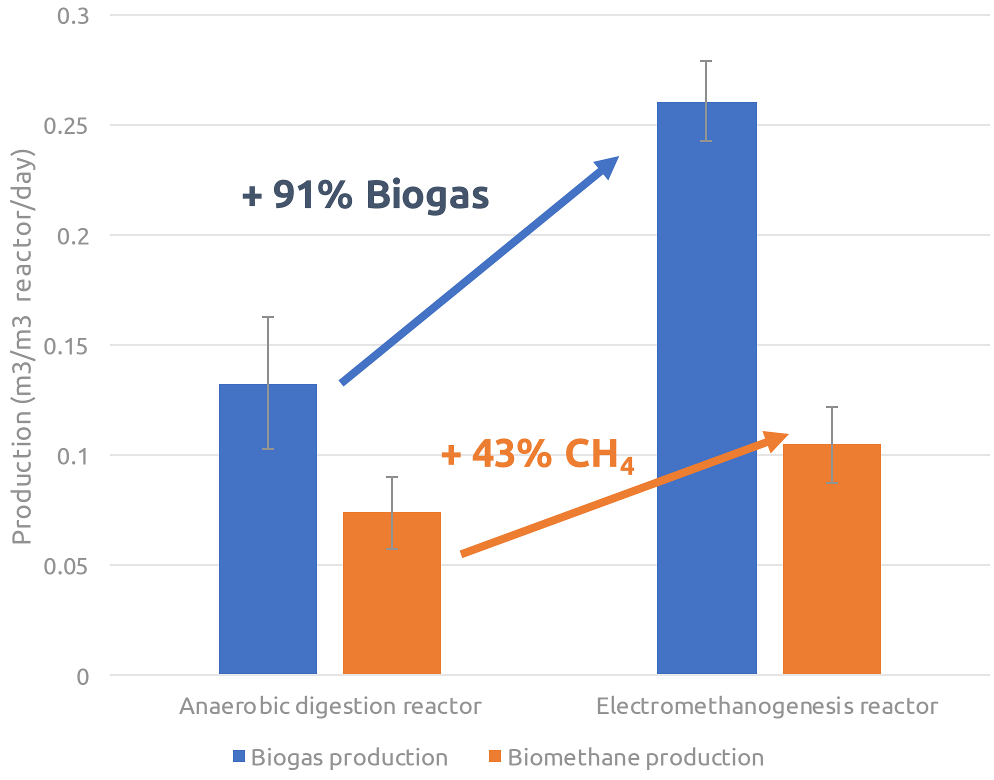
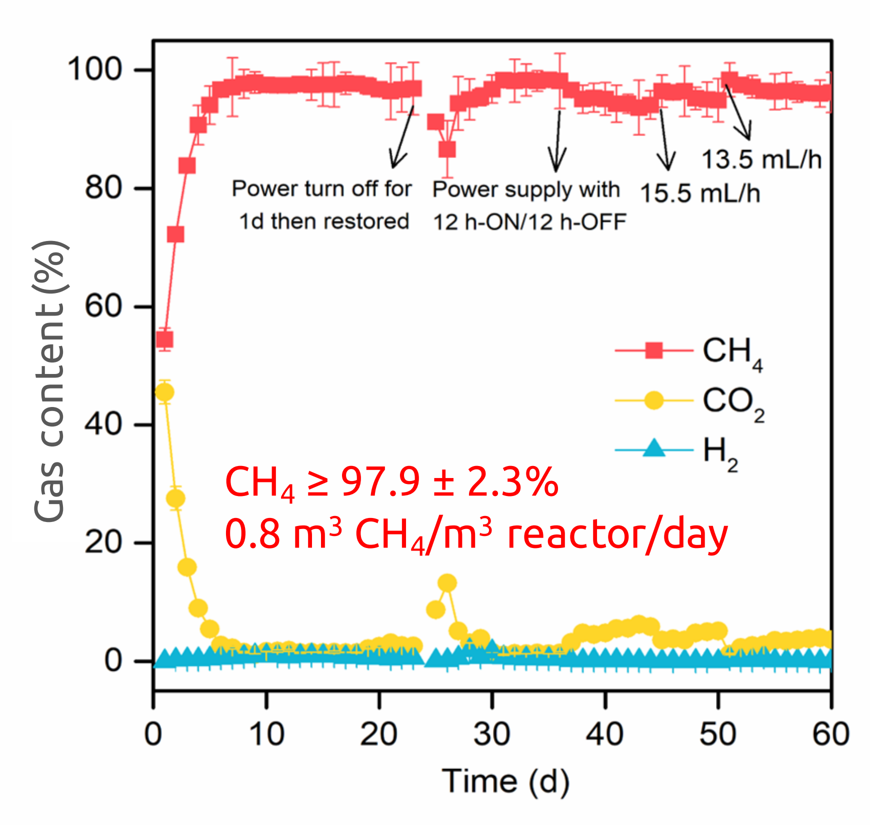
# State of the art of electromethanogenesis

## 1 chamber reactor : Boost of biogas production




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

## 2 chamber reactor : Biogas upgrading towards high $CH_4$ %




2021 labscale study on 0.4L reactors
(DTU)



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# Ambition and progress beyond the state of the art

**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.

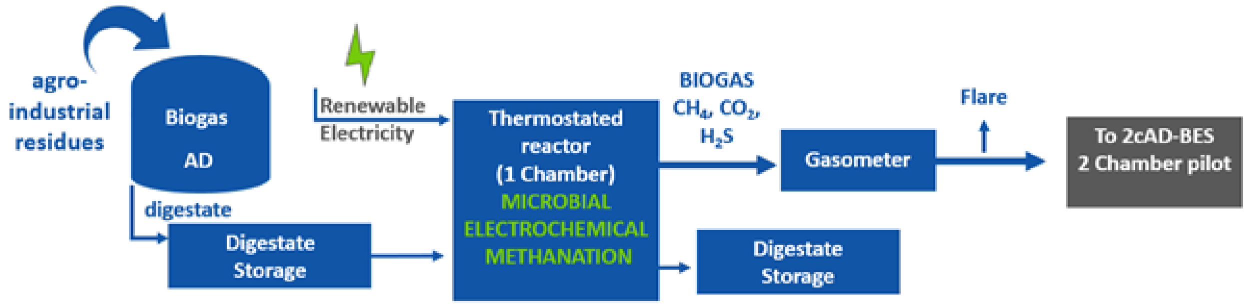
TRL

Objective :

4⟶ 6-7

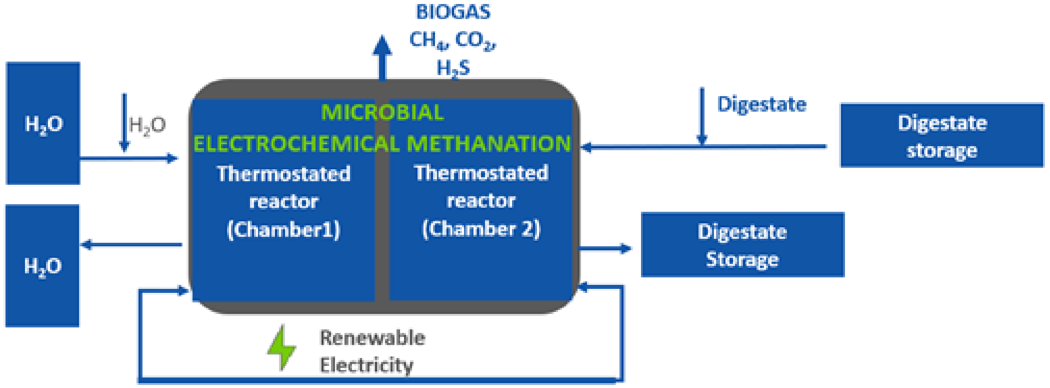
## Single chamber reactor (1c-AD-BES)

- Electrodes directly immerged 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-$CH_4$/m$^3$/d to the already existing production.**




## Double chamber reactor (2c-AD-BES)

- Electrodes separated by a membrane, water oxidation (anodic part) and $CO_2$ (–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 $H_2O/CO_2$ 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 $CH_4$ per day per m3 reactor volume**



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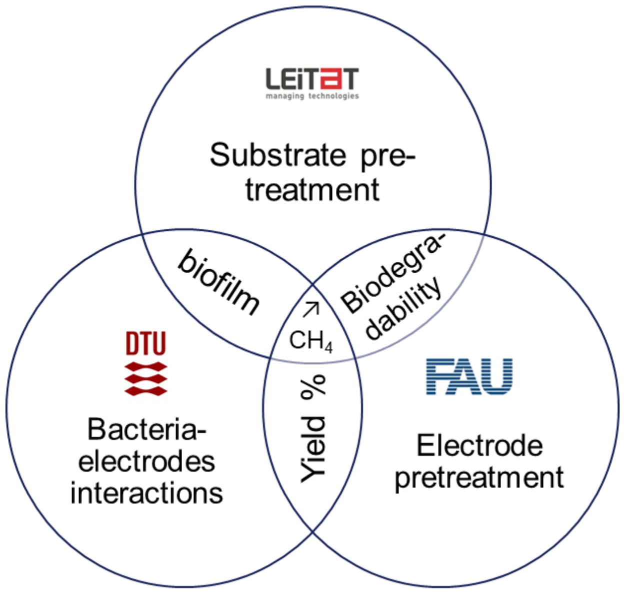
# Main challenges

## 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 identificaton on the pilot usage

**Pre-pilot operation**
- Overcoming of operational challenges on performances

**Safety studies**
- Ensuring the safe usage of the pilot without impacting AD unit operation

**Pilote Operation**
- 1 year testing 2025-2026



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# 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-digestor 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

Data provision all along the project for :

- **WP3 Assessment and Optimisation** : *assessment of the demonstrators as built within the project, and of their potential optimised and upscaled configurations*
- **WP4 Replicability :** *assessment of the replicability potential of technology pathways adopted and tested by demonstrators.*

→ Towards market penetration and stakeholder acceptation



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# 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

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research innovation sustainability

# 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](http://www.isinnova.org)

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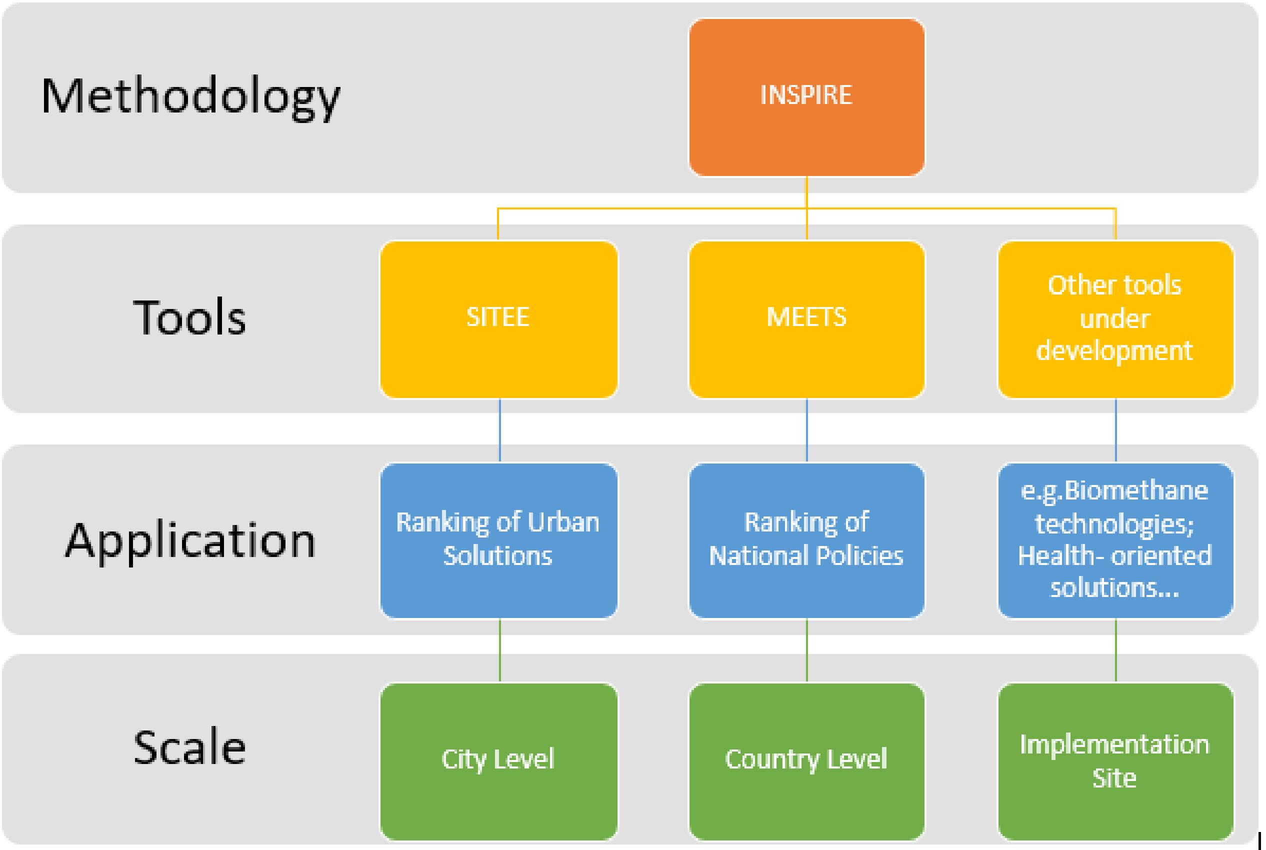
# Replication methodology

- **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**

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# 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:
     - quantitative approach for estimating the Replication Potential that specific policies might have in different contexts
     - The results and conclusions of this analysis could be relevant for other countries with similar characteristics and priorities of the Follower Countries.

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# Dimensions and Variables

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

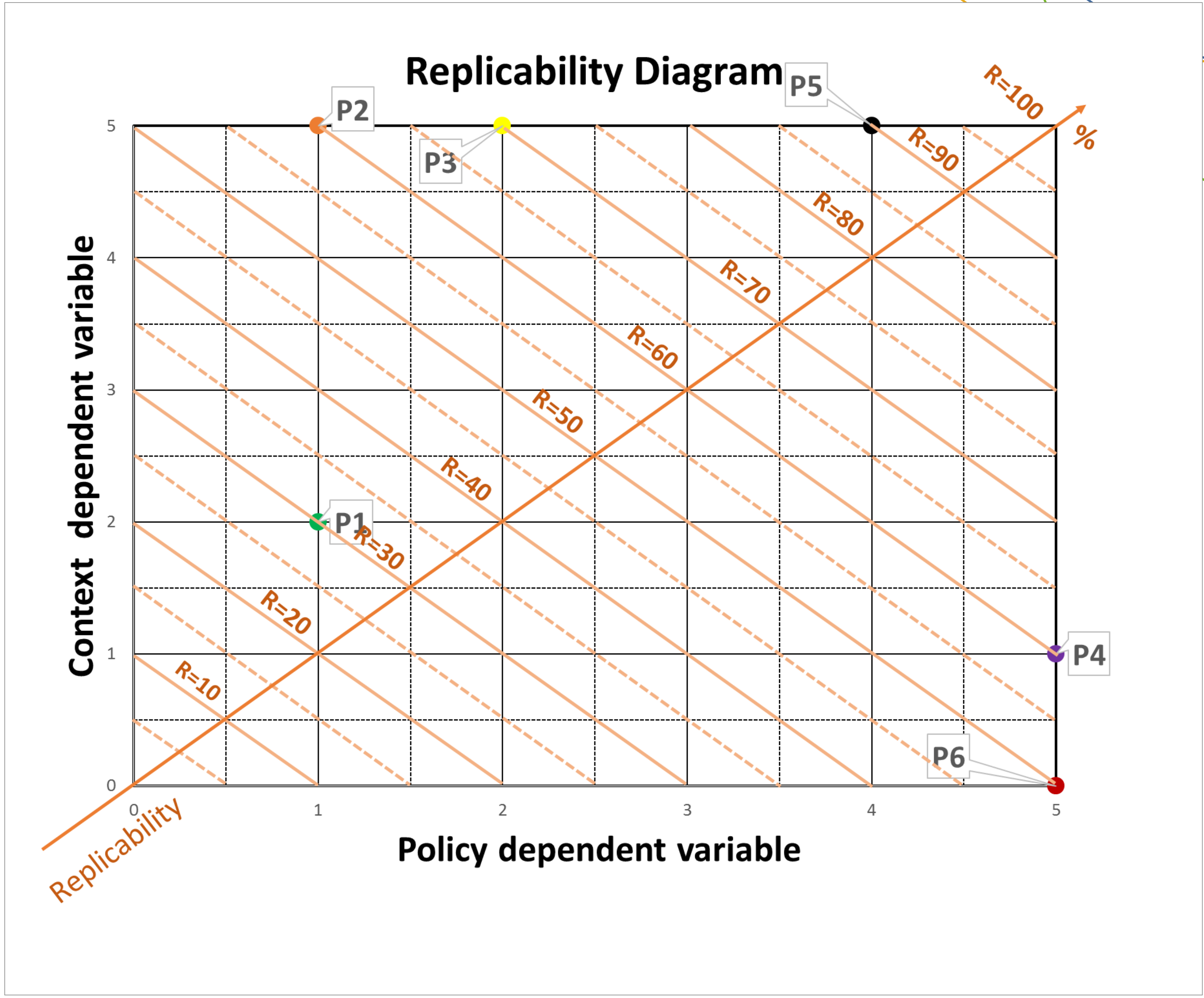
# Replication Diagram

## 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???**

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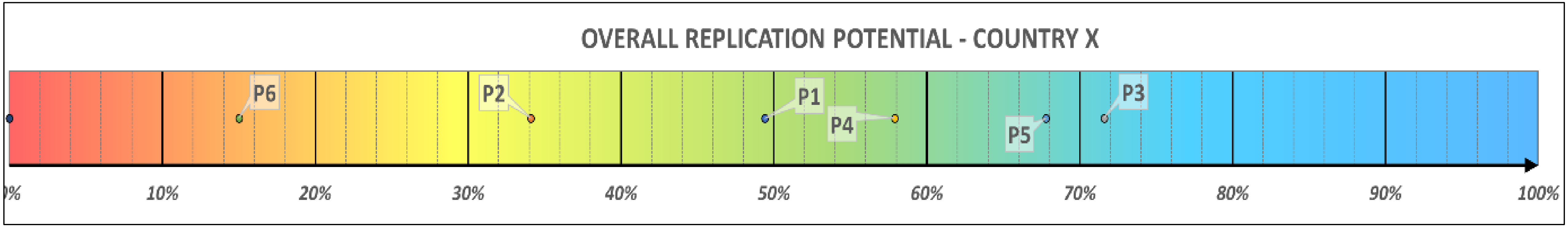
# Overview of Results

| | MARKET Replication Potential | ECOSYSTEM Replication Potential | EFFECTIVENESS Replication Potential | TIME Replication Potential | SIDE EFFECTS Replication Potential | OVERALL REPLICATION POTENTIAL |
|---|---|---|---|---|---|---|
| Policy 1 | ? | ? | ? | ? | ? | ? |
| Policy 2 | ? | ? | ? | ? | ? | ? |
| Policy 3 | ? | ? | ? | ? | ? | ? |
| Policy 4 | ? | ? | ? | ? | ? | ? |
| Policy 5 | ? | ? | ? | ? | ? | ? |
| Policy 6 | ? | ? | ? | ? | ? | ? |

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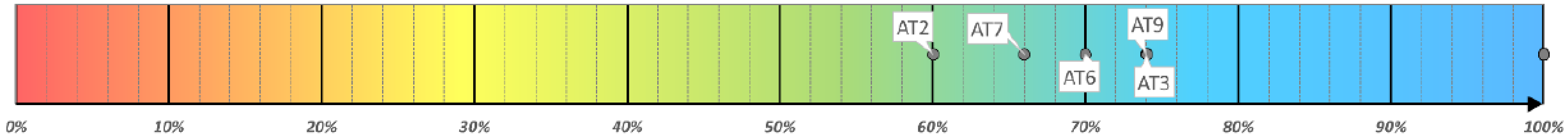
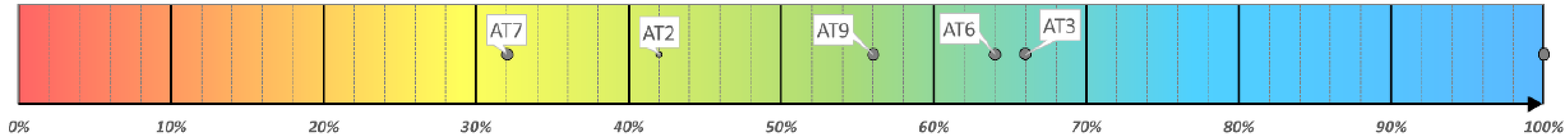
# Concrete Application

| Measure | BE | CZ | IE | IT | LT | PO | ES |
|---|---|---|---|---|---|---|---|
| | Replicability Potential (RP) | | | | | | |
| AT2 - Guarantee of Origin system for gas labelling | 42% | 42% | 60% | 46% | 36% | 46% | 44% |
| AT3 - Regulation on Transportation Fuels | 58% | 66% | 74% | 60% | 68% | 68% | 66% |
| AT6 - Investment Grants | 56% | 64% | 70% | 68% | 68% | 62% | 48% |
| AT7 - Green Gas Service Agency | 52% | 32% | 66% | 56% | 46% | 38% | 54% |
| AT9 - National Emission Trading System | 78% | 56% | 74% | 78% | 60% | 72% | 74% |

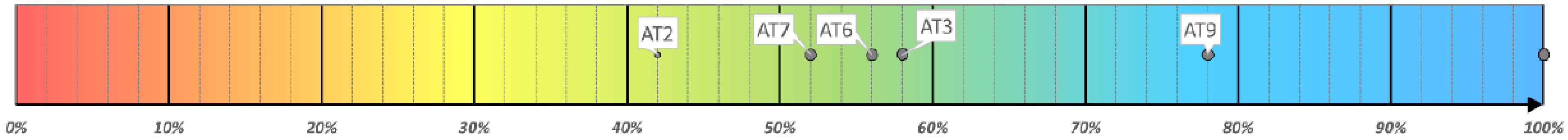
REPLICATION POTENTIAL: AUSTRIA- IRELAND




REPLICATION POTENTIAL: AUSTRIA- CZECH REPUBLIC




REPLICATION POTENTIAL: AUSTRIA- BELGIUM

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# 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

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# THANK YOU

## FOR YOUR ATTENTION!

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