Biomethane Industrial Partnership

ESNI Conference, 18th of September 2024, 16:00-17:30 CET

Task Force 5.2 Report Presentation:

IMPROVING DIGESTATE VALORISATION: NOVEL TECHNOLOGIES & RESEARCH NEEDS

Session outline

Welcome and framing (Maria Georgiadou, European Commission DG RTD & BIP Task Force 5 Co-chair)

Presentation of the BIP Task Force 5.2 report "Improving Digestate Valorisation: Novel Technologies & Research Needs" (Erik Meers, Ghent University & BIP Task Force 5.2 Leader)

Discussion among experts and the audience (led by Maria Georgiadou)

Introduction to the second part of the session (Laure Baillargeon, European Commission DG GROW & BIP Task Force 2 Co-chair)

Presentation of preliminary findings from the BIP Task Force 2 follow-up report on market implementation of digestate valorisation (Claire-Lise Speisser, TotalEnergies & BIP Task Force 2 member)

Discussion among experts and the audience (led by Laure Baillargeon)

Wrap up and closing (Laure Baillargeon)

Welcome and framing by Maria Georgiadou

Report presentation
by BIP Task Force 5.2

Discussion among experts and the audience

Preliminary findings
by BIP Task Force 2

Discussion among experts and the audience

Meet today's speakers

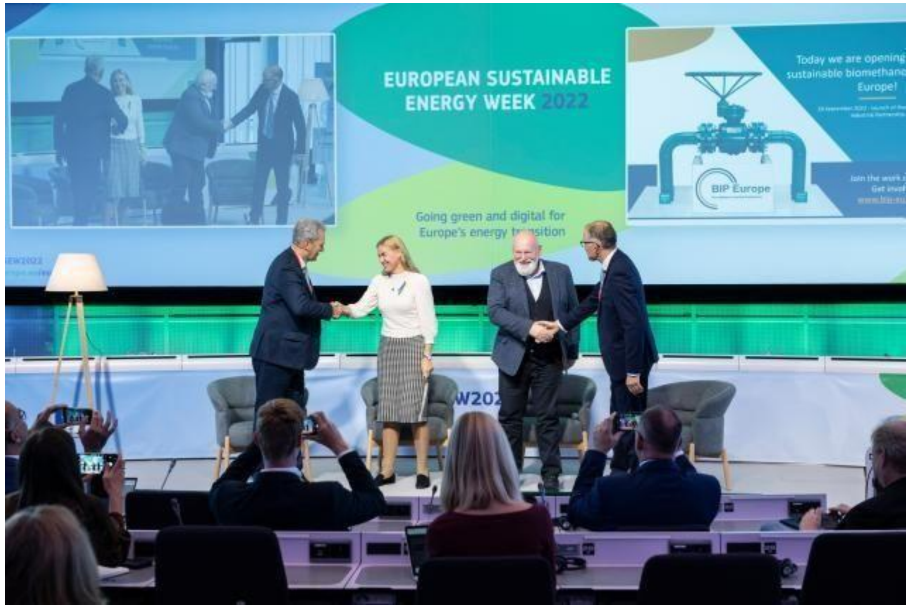
Maria Georgiadou
Senior Expert, DG RTD

Erik Meers
Professor, Ghent University

Laure Baillargeon
Policy Officer, DG GROW

Claire-Lise Speisser
International regulation & advocacy officer biogas, TotalEnergies

About the Partnership



The launch of the BIP by EVP Timmermans and Commissioner Simson on the 28th of September during the European Sustainable Energy Week.

- The Commission's REPowerEU plan set the target of 35 BCM of biomethane by 2030.
- A new Biomethane Industrial Partnership (BIP) was established upon the REPowerEU plan to '*support the achievement of the target and create the preconditions for a further ramp up towards 2050*'.
- Scaling up the biomethane production is vital because of:
  1. The need to reduce European dependency on natural gas imports from Russia;
  2. To achieve EU energy independence;
  3. The high energy prices;
  4. The aggravation of the climate crisis.

BIP Europe
Biomethane Industrial Partnership

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by BIP Task Force 2

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The Task Forces of the Biomethane Industrial Partnership (description)

Task Force 1
National biomethane targets, strategies and policies

Task Force 1 focuses on the creation of national biomethane targets, strategies and policies, feeding into the NECP process.

Task Force 2
Accelerated biomethane project development

The goal of Task Force 2 is to identify and scale up best practices, initiate creative solutions and overcome barriers to speed up investments in new biomethane projects across the value chain.

Task Force 3
Sustainable potentials for innovative biomass sources

Task Force 3 works to identify the EU-wide potential for innovative (additional) biomass sources that help to achieve the 2030 target.

Task Force 4
Cost efficiency of biomethane production and grid connection

The goal of Task Force 4 is to provide insights into best practices for efficient and low-cost biomethane production and grid injection.

Task Force 5
Research, Development and Innovation needs

Task Force 5 works to identify the current status of R, D&I in biomethane production and what is needed for innovation to be commercialised.

Task Force 6
The integration of Ukraine as a supplier of sustainable biomethane

Task force 6 will work to contribute to unlock biomethane production in Ukraine, contributing to reduce dependency on fossil fuel imports from Russia.

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Task Force 5: subgroups

TF 5.1 focuses on evaluating **current innovative technologies**, including **thermochemical**, **biochemical/electrochemical** and **biological** technologies, for biomethane production and its subsequent commercialization

TF 5.2 concentrates on **improving** and **enabling** the **valorization** of **digestate**

TF 5.3 is dedicated to improving **methanation technology** to facilitate the **valorisation of biogenic CO2**, as well as the **integrated production** of **biomethane** and **green hydrogen**

Task Force 5: Identifying the current status of R, D&I to improve biomethane production

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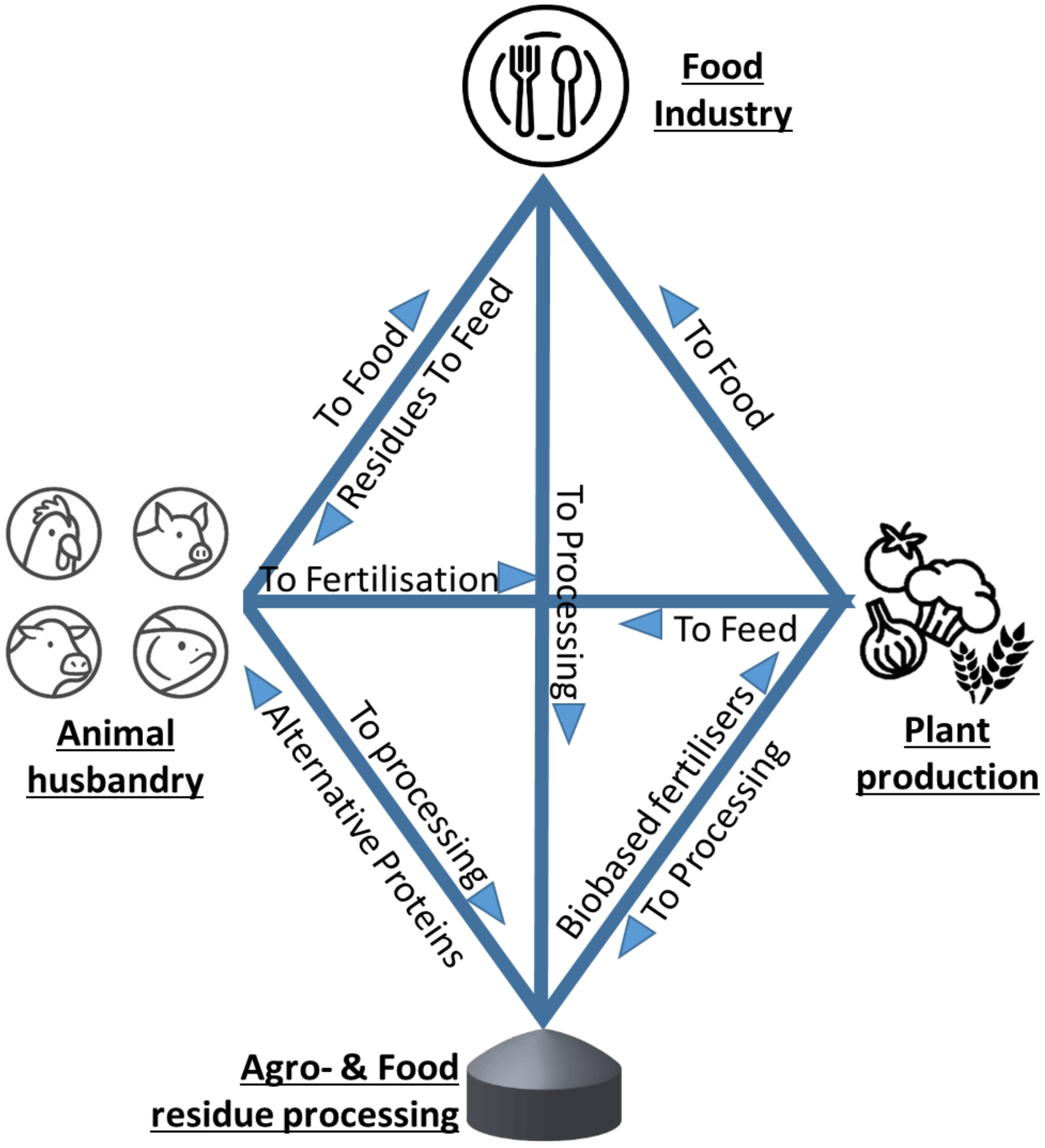
Closing loops



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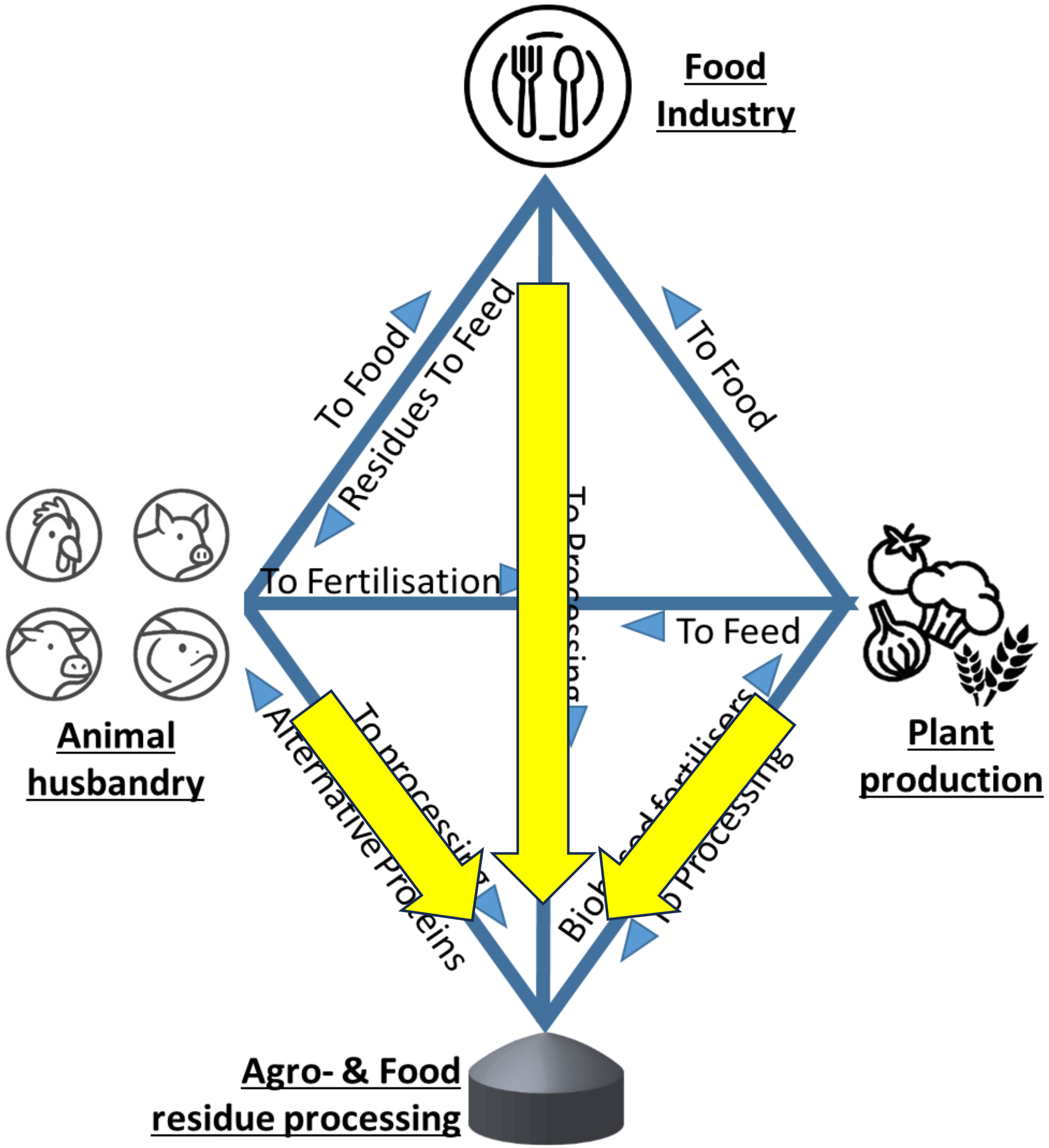
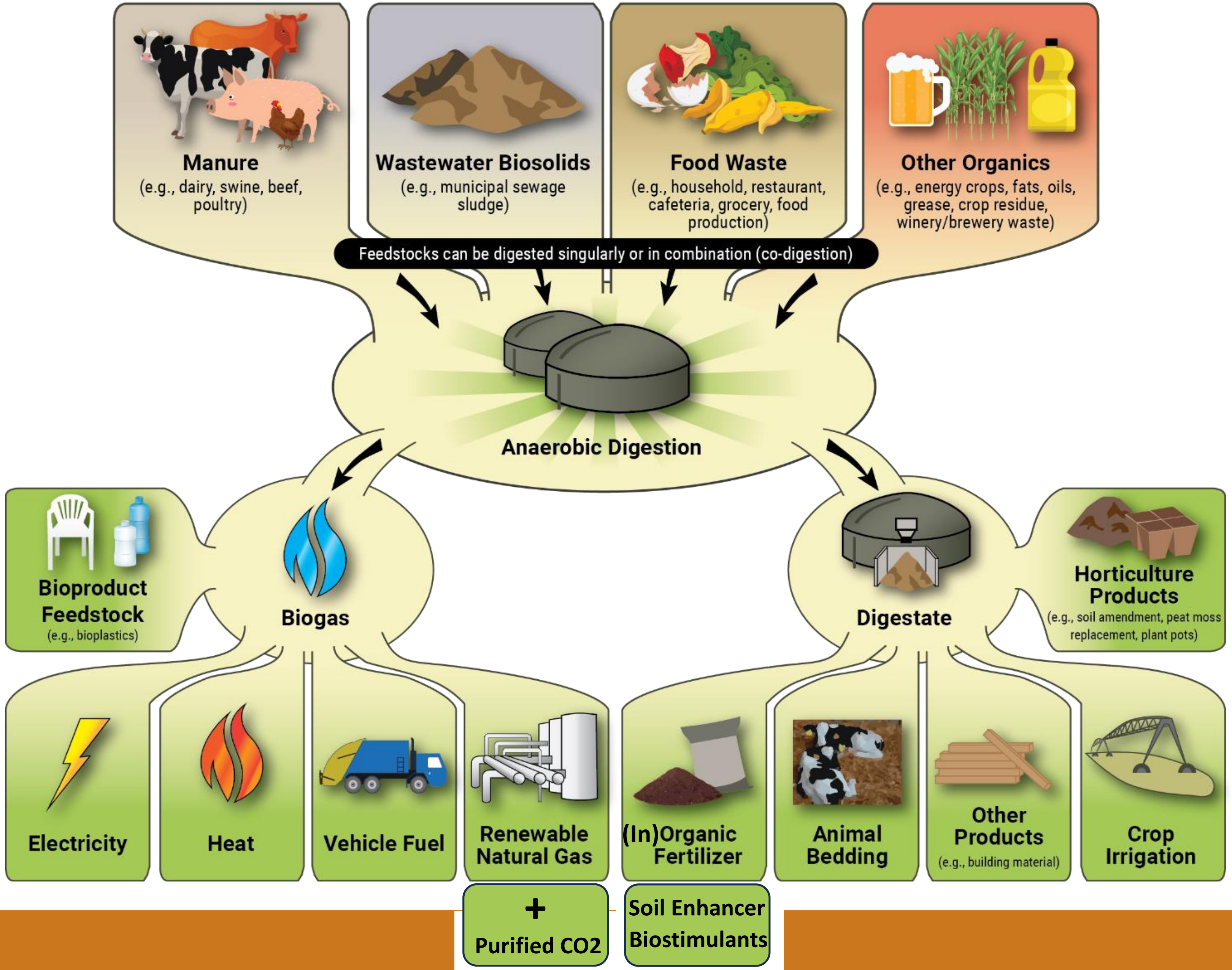


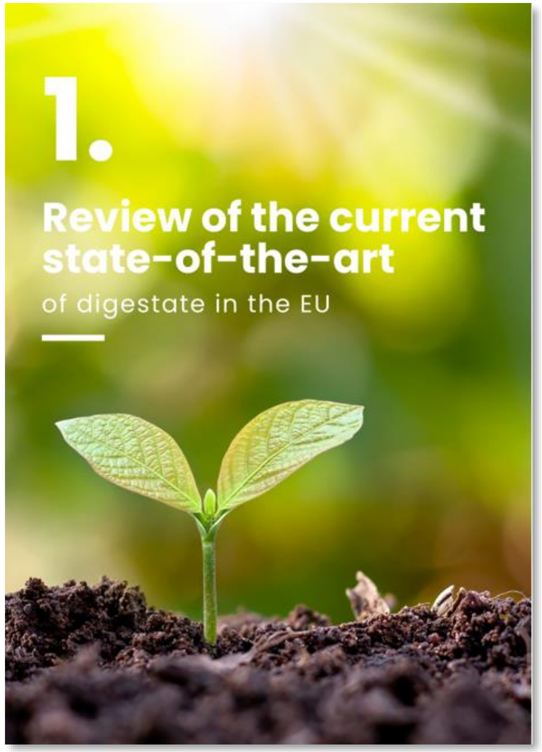
Biogas biorefineries



Presentation of the Report by Task Force 5.2

Improving Digestate Valorisation:
Novel Technologies & Research Needs

Download the report!



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Improving
Digestate
Valorisation
Novel Technologies &
Research Needs
Microbial valorisation
Extraction
Other compounds
Ec. optimisation
Social acceptance
Mineral extraction
N
P
K
Trans-sectoral use
Agronomic use
Environmental
Impact

Agronomic use of digestate

- The effective organic carbon (EOC) after amendment of digestate derived products and their forecasted build-up requires robust models and field-scale validation of such models over sufficiently long periods (years to decades). In this, also the net increase of EOC compared to a baseline of direct application of undigested manure needs to be assessed to determine effective gains in carbon sequestration. This line of research needs to feed and substantiate “carbon farming” principles and ambitions.
- Fertiliser replacement value (FRV) of digestate or liquid fraction of digestate needs to be better understood from soil nitrogen dynamics and crop availability perspective. This in order to better understand the substitution potential of synthetic chemical fertilisers – at the moment liquid fractions are found to have a chemical fertiliser substitution potential but this needs to be further corroborated. This line of research needs to assess nutrient use efficiency of digestates in raw form or with minimal treatment (mechanical separation) with expected crop uptake as opposed to potential losses to the environment.
- Combined use of precision farming techniques (sensors, telemetric visualisation using drones or satellite imagery, variable rate application etc.) with the inherent heterogeneous nature of digestate (in terms of composition) needs to be researched. The combination with precision agriculture, can help to address the current ‘handicap’ these digestates face compared to synthetic chemical fertilisers, as being themselves unformulated and unstandardised products in terms of composition.

Mineral nutrient extraction and valorisation

- At the level of nutrient extraction, much focus has been placed on N and P recovery techniques, yet by comparison less attention has been paid to recovery of other (micro-)nutrients. An expansion on the minerals being investigated and assessed for recovery and re-use is therefore merited in the upcoming periods – including K, S, Ca, Mg, Mn, Fe, Cu, Zn, B, Co, Mo.
- Even though N and P recovery has been studied in more detail than other minerals, still remaining research gaps and opportunities need to be addressed also for these two macro nutrients.
  - In terms of Nitrogen, technologies based on adsorption, membrane systems or bioelectrochemical systems are still in lower TRL.
  - Technologies focusing on Phosphorus can further expand on the various possible precipitates beyond struvite (e.g. vivianite, brushite..).
  - Also, more research is needed to extract P from solid fractions so one that the resulting OC rich soil enhancers after P-extraction could be used as soil enhancer and the recovered P be valorised separately as a mineral fertiliser. Rationale for this required decoupling of P and OC from solid fractions, is the current high P saturation status in agricultural soils in agro-intensive regions (so no to little extra P required), while these soils do require additional SOC from such solid fractions to increase soil health.
- Also, mass balances and crop balances of the various minerals needs further scrutiny. For example, when applying digestate derived products based on macro-nutrient crop requirement, other elements might be added in insufficient amounts (requiring additional fertilisers) or in excess (leading to accumulation).
- This soil and crop-based information needs to be translated in more refined digestate treatment processes that result in Tailor Made Fertilisers (TMFs) which are more closely related to the complex crop and site-specific fertilisation requirements for each of wide range of the abovementioned mineral nutrients.
- Combination of thermochemic (pyrolysis, gasification, HTC) in conjunction with anaerobic digestion has received increasing attention and cascades of biological, thermochemical and/or electrobiochemical processes form a largely under-explored research domain.

Extraction of other valuable compounds

- Biostimulating effects of organic substances present in digestate in terms of stress alleviation or increased nutrient use efficiency are at the moment insufficiently understood from a mechanistic perspective. Most existing evidence of significant stimulating effects in existing scientific and commercial literature are empirical in nature without fully understanding yet the underlying principles of induced stimulations.
- Fermented or digested biomass produce a wide range of organics, such as volatile fatty acids, which have economic uses within and outside of conventional agriculture. Compounds such as acetic acid, (iso)butyric acid, propionic acid, valeric acid, all can be considered as platform chemicals for further valorisation pathways.

Trans-sectoral use of digestate

In the previous chapter, a non-limitative number of alternative uses of digestate has been mentioned. In reality, the alternative non-agricultural uses has been largely un-explored at this stage. Considering the vast amounts of digestate being produced and the indicative values this bulk resource can hold for biobased materials or other non-agricultural endpoints therefore requires further research in a broad range of possible pathways.

Microbial valorisation of digestate

The potential use of digestate for microbial cultivation in form of fungal or bacterial biorefineries, for production of enzymes or other added-value compounds.

Future studies are needed to investigate the potential of digestate in a biorefinery with the aim of obtaining:

- Microbial active biomass to be used in agriculture as microbial biostimulant (fertilisers) or biocontrol agents (plant protection).
- New drug discovery. Microbes fermenting digestate might produce bioactive molecules for medical and/or agriculture applications (agrochemicals).
- Organic acids in chemical, food, and pharmaceutical industries. Recently, crude extract containing citric acid was used for bioleaching of precious metal from RAEE [127].
- Enzymes (cellulase, amylase, xylanase, maltase, laccase, protease, alone or in cocktails) [128] for a wide range of industrial applications.
- Engineered composite construction biomaterials
- Mushroom production
- Another microbial pathway potentially stemming from digestate or digestate-derived nutrients is associated with micro-algae production [129], [130]. Although the authors validated the combinations of AD and algal technologies, there still remains uncertainty relating to food safety on the final applicability of algal biomass grown on digestate. Bauer et al. (2021) [131] provided an overview of the challenges and prospects of digestate as a sustainable nutrient source for microalgae. Further research is therefore needed to reconcile real and perceived risks associated with this end use. Other non-food endpoints are also being considered, such as use as fertiliser, biofuels and biostimulants [132].

Economic optimisation and social acceptance

Future technico-economic research on the volorisation of "fertilisers from digestate" should focus on:

- Cost reduction in fertilisation by completely replacing synthetic fertilisers with biogas-derived products. effects of the conflict in Ukraine/gas crisis, there has also been a staggering increase in the price of nitrogen fertilisers.
- Investing in technological innovation/machinery/efficient machine equipment for agronomic distribution for maximum operation capacity in precision agriculture. The synergy between innovations in precision agriculture and the opportunities (and challenges) of utilising and valorising biobased products, which in origin tend be heterogeneous in nature, offers multiple win-wins in environmental and techno-economic systemic improvements of the entire agro-food value chain.
- Marketing effect by promoting regenerative agriculture that utilises renewable resources, specifically the use of renewable fertilisers and the elimination of synthetic fertilisers.
- Introduction within biogas systems for the production, valorisation, and distribution of renewable fertilisers derived from AD, centralised and through consortia, to promote sustainable agricultural systems (precision farming and conservation agriculture) thus moving towards approaches that lead to reduced waste management and fertilisation costs for farmers.

In terms of social and societal acceptance, the high value is clear for those dealing with digestate yet is less known and less appreciated by those further away from this general topic. Acceptance amongst end-users and policy makers should be further researched and understood in relation to available scientific evidence and demonstration, but also quality assurances guaranteed through sound monitoring schemes in place. Such systems also require due attention for dealing with emerging pollutants and attention to overlooked performance indicators such as soil quality and biodiversity.

Policy and legislation in themselves are not research objectives. Nonetheless, lessons learned from EU projects need to find a productive way of engaging and supporting policy makers at European and national level. The legislative framework related to biobased products, including digestate at the moment is in ongoing flux of changes to stimulate a transition towards a more sustainable and more circular society. Some frameworks are under evaluation or revision; others (such as the FPR) have a continuous eye for adopting innovations and developments in the market, and yet other frameworks appear to be in need of changes in order to meet requirements arising due to emerging threats and opportunities.

As evidenced in section 12 above, there already exists a significant and bold body of legislation at EU level affecting digestate and its possible uses. As several streams of research explore alternative pathways of valorisation, a general policy could favour legislation that remains flexible and becomes an enabling factor, rather than just a controlling means. Without removing boundaries that are necessary to protect human and animal health, prevent pollution and maintain the equilibrium of ecosystems, for digestate research, development and experimentation, EU legislation could create regulatory 'sandboxes' as has happened in other fields where uncertainty due to technological complexity and speed of development suggested a more cautious approach. An experimental sandbox is a controlled environment where regulatory restrictions are temporarily eased to allow for innovation and testing of new products, services, or business models. This concept is often used in sectors such as finance, technology, and education to foster innovation while managing risks. In these sandboxes, companies can experiment with new ideas without the full burden of regulatory compliance. This allows them to test the viability and safety of their innovations in a real-world setting but within a contained and monitored space.

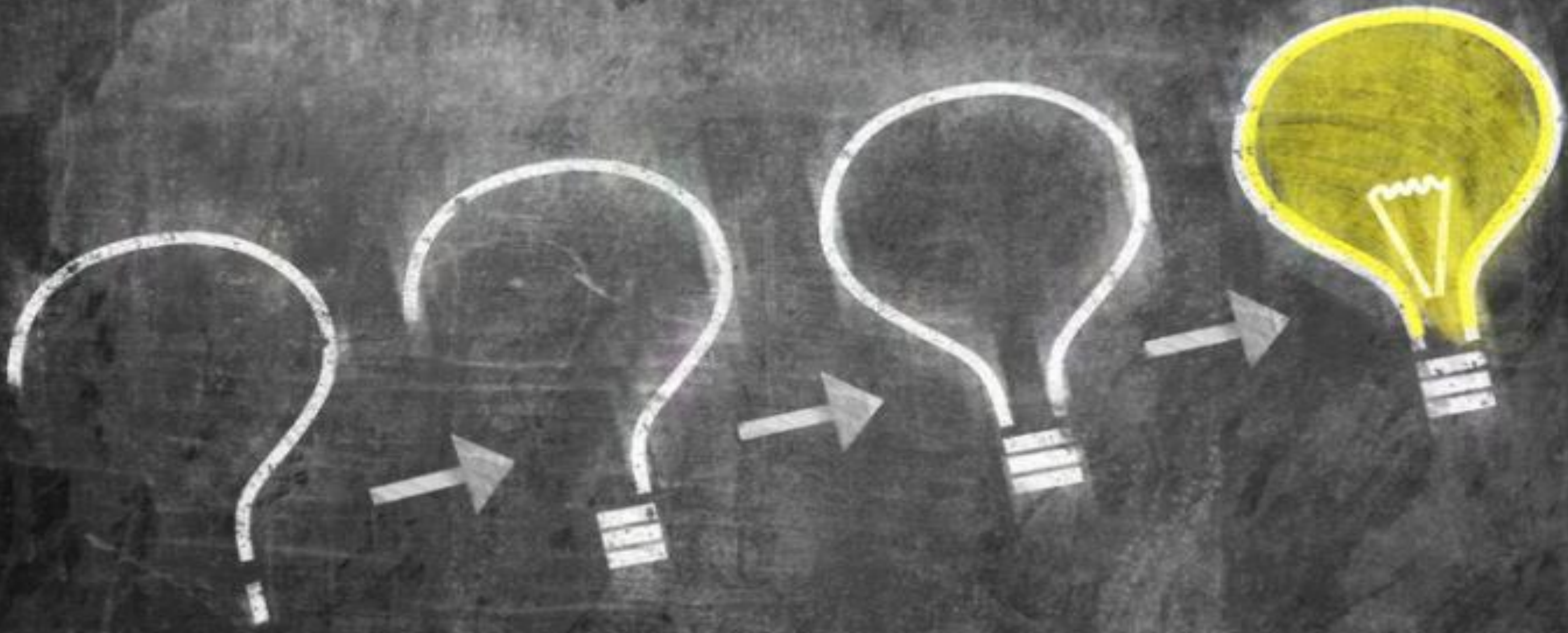
By creating sandboxes, on the one hand researchers could enjoy a reduced burden to clear ex ante the regulatory framework in which they are supposed to work, thus favouring all possible technical solutions. On the other hand, policy makers and legislators could monitor the evolution of the technologies with the double aim of refining existing legislation (as seen above, some of the EU regulations mentioned in 12 are undergoing revisions) and creating better conditions for the deployment of technologies that, other things being equal, are promising in terms of improved use of digestate.

Further research should be conducted to map the benefits of various digestates towards soil quality, soil health, soil biodiversity and soil organic matter, depending on the soil type and other parameters. Positive and balanced contributions in terms of organic carbon and mineral nutrient household require further investigation.

Digestate treatment systems as well as monitoring systems will require improvement to provide adequate and transparent quality assurances. In the past, quality systems in place have been based on a well-defined list of inorganic pollutants and limitative list of organics. In recent years and in various regions, novel pollutants (or long existing pollutants with emerging policy interest) have received new attention such as PFAS/PFOS, amphetamines or other compounds.

Also evaluating potential causes and solutions for the rebound in selected antimicrobial resistant genes in digestates is critical.

Questions ?



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BIP Europe
Biomethane Industrial Partnership

Welcome and framing by Maria Georgiadou

Report presentation *by BIP Task Force 5.2*

Discussion among experts and the audience

Preliminary findings *by BIP Task Force 2*

Discussion among experts and the audience

Open discussion:

Slido question

What **research needs** you think are **most important** to address?

a. Fertiliser NPK extraction and valorisation
b. Extraction of other valuable compounds
c. Microbial valorisation of the digestate
d. Trans-sectoral use of digestate
e. Economic optimisation and social acceptance
f. Environmental impact
g. Other

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Biomethane Industrial Partnership

ESNI Conference, 18th of September 2024, 16:00-17:30 CET

Preliminary findings from the BIP report on

USE AND VALORISATION OF DIGESTATES: A PRACTICAL REVIEW

Scope of work and process

BIP Europe
Biomethane Industrial Partnership

Initial scope of work

Task Force 2

Accelerated biomethane project development

f. Assessing the positive impacts on **related industrial sectors**, such as fertilizers and soil amendments, bioplastics, food industry and waste water treatment.

Scope of work

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⇨Two planned reports

1. Waste-based feedstocks (coordinated by FEAD)

2. Use and valorisation of digestates

Scope of digestates report

Practical review of the current state of play and way forward for the use and valorisation of digestates

- Benefits of (untreated) digestates for GHG emissions, soil and plants
- Current and good practices for return to soil & barriers for adoption
- Role of (untreated) digestates in biogas/biomethane economic model
- Existing commercial processes (>TRL9) for transforming digestates into fertilising products; benefits & barriers for further deployment

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Drafting team

Drafting by

- Yvette Jones, Gas Networks Ireland
- Piero Gattoni, a farmer and President of Consorzio Italiano Biogas
- Claire-Lise Speisser, TotalEnergies

With help from

- Laure Baillargeon, BIP TF2 co-chair, DG GROW, European Commission

Drafting process

Early 2024	Call for volunteers across the BIP membership
Mar.-Apr. 2024	Informal exchanges
Mid-April	First online meeting on scope of work with all volunteers
May	In-person meeting : confirmation of scope of work
June	Gathering inputs
Summer 2024	First draft (drafting team)
September	First draft circulated to volunteers
October	Meeting to review comments, BIP consultation
November	Publication (tbc)

Preliminary findings

Biogas/biomethane with digestates’ return to soil…

… allows reducing GHG emissions in (at least) 3 ways

- Substituting fossil gas or electricity
- Reducing methane otherwise emitted by the initial feedstock (if landfilled or spread)
- Substituting fossil-based fertilisation

… fosters the European food security and independency

- Substituting of mineral fertilisation
- Nutrient recycling and management
- Contributing to soil healthy conditions
- Reducing dependency on natural gas and phosphate rocks

Digestate are mostly used raw or separated

Raw digestate

- Direct return to nearby soils (high transportation costs)

Liquid/solid separation

- Distinct uses; solid part as soil amendment, liquid as fertiliser

Further post-processes

- Better valorisation of nutrients
- Transportation when economically feasible
- Mostly done in highly vulnerable zones to N and P

Untreated digestates…

… present higher benefits than the initial feedstock for soil and plants

- Fertilising efficiency
- Neutral or positive impact on soil organic carbon & microbiology
- Reduced pathogens

Untreated digestates…

… present risks that can be mitigated by implementing good practices for their use

- Ammonia and methane emissions during storage and spreading
- Nitrates leaching
- Contaminants

Untreated digestates…

… can’t be spread in certain regions of Europe where processes are used to transform digestates into exportable fertilising products

- Review of existing processes
- Commercial stage (> TRL9)
- Many with economic model
- However facing barriers for further growth and market deployment

Digestate-based…

… biobased organic and organo-mineral fertilisers

- Present benefits for soil and plants, typically higher than untreated digestates
- Can have a busines case
- Face market barriers to their further deployment

Remaining data gaps (non-exhaustive)

- Non-agri based feedstocks
- Economic model (untreated and post-processed digestates)
- Local practices and encountered barriers
- Regulatory barriers and good practices

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by BIP Task Force 2

Discussion among experts and the audience

We'd welcome your views

We'd welcome your views

Slido.com with #EUBIP

Let’s see your views

Slido results

Further contact

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Laure Baillargeon, laure.baillargeon@ec.europa.eu

Joining the BIP
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secretariat@bip-europe.eu

Don’t’ miss tomorrow session!

ESNI Parallel session 4 – Market
September 19, 14:55 – 15:55

Driving circular fertilisers adoption in Europe. The FER-PLAY project partners showcase their findings on policy barriers hindering the uptake of the circular fertilisers selected in the project.

BIOMETHANE INDUSTRIAL PARTNERSHIP

QUESTIONS? Contact the BIP secretariat secretariat@bip-europe.eu

DOWNLOADS The published report is available on the BIP website: www.bip-europe.eu/downloads

MEMBERSHIP Want to become a BIP member? Sign-up at www.bip-europe.eu/get-involved

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