Report on co-creation actions in the 7 target countries.

Deliverable 3.2

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Abbreviations

AD: Anaerobic digestion
AEBIG: Spanish Biogas Association
AIB: Association of Issuing Bodies
Capex: Capital expenditure
CCU: Carbon Capture and Utilisation
CNG: Compressed Natural Gas
CRES: Center For Renewable Energy Sources
CZ Biom: Czech Biomass Association
DEDA: Gas distribution network operator in Greece
EBA: Estonian Biogas Association
ERGaR: European Renewable Gas Registry
EU: European Union
FiT: Feed-in Tariff
FiP: Feed-in Premium
GoO: Guarantee of Origin
GreenMeUp: GREEN bioMEthane market UPtake
GWh: Gigawatt hour
INCE: Central European Initiative – Executive Secretariat
iLUC: Indirect Land Use Change
IPO: Initial Public Offering
LBA: Latvian Biogas Association
LBM or BioLNG: Liquified Biomethane
LNG: Liquified natural gas
MAT: Mutual Agreed Terms
MW_{th}: Megawatt thermal as unit of thermal power produced.
NECPs: National energy and climate plans
NGO: Non-Governmental Organisation
NRRP: National Recovery and Resilience Plan
PIGEOR: Polish Economic Chamber of Renewable and Distributed Energy
PSA: Pressure Swing Adsorption
RePowerEU: Joint European Action for more affordable, secure and sustainable energy
TGE: Polish Power Exchange
TSO: Transmission System Operator
TWh: Terawatt-hour
YPEN:Greek Ministry of Environment and Energy

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Executive Summary

The GreenMeUp project aims to promote the market introduction of biomethane as part of the efforts to reduce fossil fuel dependency in the EU and to contribute to the implementation of the REPowerEU plan. Projects efforts are focused in selected EU countries with high potential for biogas and biomethane production, and defined as target countries, including the Czech Republic, Estonia, Latvia, Greece, Poland, Spain and the Danube region (comprising Romania, Serbia and Hungary). As part of the status quo analysis of biomethane market, identification of barriers and most importantly proposal of necessary solutions and measures, stakeholders are engaged along all project stages. This is achieved by specifically planned co-creation activities supported on the established Hubs (Social, Market and Policy) introduced as participatory approach in GreenMeUp.

This report details the execution of PESTEL workshops in each of the target countries used as co-creation action to structure the collective knowledge of actors and their perspective on a further development of the biomethane sector. For the preparation and implementation of the workshop a guideline was provided to partners representing the target countries to guide them in each step. Utilising previously collected information in GreenMeUp was suggested as well as findings from previous stakeholder exchanges.

Main results for each target country reported here includes a validation of key challenges to the development of biomethane sector, and based on stakeholder discussions a list of proposed solutions to identified hindering factors. Likewise, workshop participants proposed and prioritised exemplary technologies and practices, as well as political measures from other EU countries with potential application or adaptation to their national case. These proposed solutions and measures discussed during the workshop will be utilised as basis information for the SWOT analysis of target countries in Task 2.4. Work package 4 will for the country´s biomethane market. Finally, the description of the establishment of Spanish´s Biomethane Hubs is also here included, as co-creation action with selected participant stakeholders.

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1 Introduction

During the first year of GreenMeUp project and as strategy for stakeholder engagement, the policy, market and society Hubs were established in Target Countries. Two main co-creation activities were priority during this project period, namely the identification of hubs needs and structures during a Hubs´ kick-off meeting and the analysis of influencing and hindering factors to country biomethane market, through PESTEL workshops. This report shows the advance on co-creation actions carried out by the Hubs and key findings that will guide the subsequent actions in WP3, and engagement of stakeholders in each of target country, namely Czech Republic, Estonia, Latvia, Greece, Poland, Spain and the Danube region (comprising Romania, Serbia and Hungary).

This deliverable report specially on the PESTEL workshops celebrated between November and December 2023 among Target Countries, and highlight relevant findings for the development of the SWOT analysis in Task 2.4 a policy design in Task 4.2 and 4.3. With this second workshop, target countries show an advance on stakeholder engagement activities and co-creation actions, and align these with biomethane sector analysis tasks in WP2 and the definition of strategic measures. As shown in the figure below, two more stakeholder meetings and a final event are expected during the project lifetime. These are intended towards consolidating co-created strategic measures and proposed solutions, promote exchange and discussion among the stakeholders and to disseminate the ideas and results collected by GreenMeUp project.

Jan - Feb 2023	1st Meeting: first approach to stakeholders	First approach with key biomethane stakeholders to explore interest in the creation of the hubs and topics of relevance from stakeholder´s perspective.
April 2023	2nd Meeting: Hub´s Kick-off & analysis of needed policy interventions	Key policy implications from 10 advanced biomethane markets will be presented at the official kick-off meeting of the Hubs. Key focus is the feedback to the policy interventions (survey).
Nov. 2023	**3rd Meeting: PESTEL Workshop**	Identification of challenges as well as influencing factors that will enable the development of biomethane market in the country. Political, Economic, Social, Technological, Environmental and Legislative components will be consider.
May 2024	4th Meeting: future policy interventions	What are the necessary future policy interventions for a successful market uptake in the country? – Focus on the active value chains and untapped market opportunities
November 2024	5th Meeting: Market integration indicators	Results from SWOT analysis (interviews) and presentation of final market integration indicators.
May 2025	Final workshop	Final results from all participating countries. Lessons learned and summarized strategic actions co-created in each country for the successful market uptake of EU biomethane.

Figure 1. Upcoming stakeholder engagement activities.

The following chapters will detail the PESTEL methodology as well as the process followed for its application in each Target Country (Chapter 2). Subchapters detailing PESTEL workshop findings are included for each country in Chapter 3, hindering factors (challenges), as well as their co-created solutions and proposals for possible exemplary technologies and policy measures that can be applied. Chapter 4 has been dedicated to report on the establishment of Spanish´s Market, Policy and Society Hubs, with the same

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structure utilised in Deliverable 3.1. Finally, a summary and conclusions of this exercise are included in Chapter 5.

2 Background and methodological approach

2.1 PESTEL tool

PESTEL is a strategic analytical tool used to identify influencing factors over a defined topic of analysis. These factors, can be considered as hindering or supporting factors and identified for each one of the PESTEL elements, that is Political, Economic, Social, Technological, Legal, Environmental. In this way, the six elements serve as a structure for analysis.

Figure 2. Elements of the PESTEL tool.

In the context of the GreenMeUp project and to maintain a motivated participation of Hub´s members, the utilisation of the PESTEL tool was directed towards the co-creation of solutions and propositions to current biomethane market status-quo. In particular, to co-define **strategic actions** that address identified challenges or hindering factors to the biomethane market in the country. To **propose measures** that leverage the enabling factors that have been previously identified in the two previous stakeholder exchanges (2023). Finally, to **identify**, **exemplary practices and measures** from advanced biomethane markets that could be applicable in the country´s specific case.

As preparation for the PESTEL Workshop and to fulfil the workshop´s objectives, Hub coordinators were instructed by means of a descriptive guideline for the collection of baseline information for the analysis, methodology of the workshop, exemplary agenda and actions after the workshop. As background information for the effective use of the PESTEL tool it was suggested to prepare a summary of main challenges (hindering factors) and main opportunities (enabling factors) previous to the workshops and making sure to use data from previous exchanges with Hubs´ stakeholders, as detailed in Table 1.

Table 1. Data to identify challenges (hindering factors) and opportunities (enabling factors) in each of the PESTEL elements.

Data to collect	Potential data sources
Main **challenges** or hindering factors to the biomethane market uptake in the country. Main **opportunities** or enabling factors to the biomethane market in the country.	- Protocol from stakeholder meeting in T2.1 (First approach to biomethane stakeholders in GreenMeUp). - Discussions hold during the Hub´s KoM - Country reports for Deliverable 2.1 and 2.2
Exemplary practices and measures applied in advance biomethane markets or other countries that could be adapted and utilised in the target country. That includes potential technologies, policy	- Deliverable 1.1 - Policy questionnaires

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and market measures, type of collaborations among stakeholders, monitoring frameworks, etc.

The recommended methodology for the development of the workshop is the **World-Café**, to facilitate the identification of strategic actions and proposals to the identified challenges in each of the PESTEL elements.

2.2 Workshop format: World-Cafe

The **World-Café** is a format for hosting medium to large groups dialogue. It is intended to emulate a "cafe ambiance" to allow for more open conversations to take place. That means, setting an environment in which the large group is divided in small-groups of around four to five people seated around a table, discussing a predetermined topic or question and assisted by a moderator per table. It is designed for small groups to move through the different discussion tables in the room, with each table focused on a specific question or topic.

It was suggested to Hub coordinators through the guideline, the division in three main discussion tables. Proposed topics and a distribution of PESTEL elements to be match in each table were also provided with suggested questions (see Figure 3) to jointly encounter possible solutions and to generate propositions. Adaptation of these structure to serve the purposes of the discussion and invited stakeholder groups in the workshop was also encouraged when needed.

Figure 3. Suggested tables and topics to cover all PESTEL elements with a world-café discussion methodology.

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An exemplary agenda for the workshop, as well as didactic formats to collect stakeholder´s feedback in each table were also provided to Hub coordinators, in order to facilitate a similarity among all workshops in the different target countries. By the end of the workshop utilising the PESTEL tool and the World Café methodology, it is expected that participants should have an overview of **possible solutions** that could be explored more in detail in the next GreenMeUp meetings. A prioritisation of identified solutions was suggested as well, based on concerted feasibility among workshop participants for their application according to country specific conditions and its biomethane market dynamics. These results are reported in the following chapter.

The results of the PESTEL Workshop, corresponding to the third meeting with biomethane stakeholders engaged in the target country´s Hubs (Society, Policy and Market) are reported in the following chapter.

3 PESTEL Workshops in GreenMeUp´s Target Countries

Target countries in GreenMeUp have carried out the PESTEL Workshops during the last quarter of 2023, as detailed in Table 2. In this event, they have engaged a total of 195 stakeholders from the Market, Policy and Society Hubs, as well as external interested parties in the discussions to advance their national biomethane sector.

Table 2. Overview of PESTEL Workshops in target countries

Target country	PESTEL Workshop	Number of participants
Czech Republic	25 October, 2023	33
Poland	22 November, 2023	21
Estonia	27 November, 2023	17
Greece	14 December, 2023	58
Latvia	15 December, 2023	18
Danube region		
Hungary	29. November, 2023	28
Romania	19 December, 2023	11
Serbia	05 – 20 December, 2023	9 (interviewed)

After the numerous challenges identified in the Hubs Kick-off-Meeting to the development of biomethane market development, the PESTEL Workshop detailed in this section, presents co-created proposals and strategic actions. These are intended to tackle key challenges and identify potential paths towards a strong production of biomethane and its utilisation in energetic and transport sectors. For each one of the target countries, the details of the workshop's discussion, including as well exemplary technological and political good practices with potential application are hereafter presented.

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3.1 PESTEL Workshop in Czech Republic

For the PESTEL Workshop in Czech Republic, a one-day event was organised jointly with EBA in the framework of the European Biomethane Week 2023. This was held in the facilities of an old waste water treatment plant in Prague, which was part of the strategy to attract more participants. Also, including thematic presentations, increased the interest of invited stakeholders to participate in the whole agenda. A total of 33 participants joined the workshop, representing the society, market and policy Hubs, such as delegates from the Ministry of Agriculture and Environment, biogas service companies, and network operators. Participants external to the Hubs also made presence, such as representatives of the Prague city hall, industry and press stakeholders. One of the most discussed topics was the significance of operational support and investment for the expected development of the sector. The importance of good communication between the state administration and market actors was also one of the major take-away messages, for public administrations to learn about the specifics of the biomethane market and also for the industry to understand the specifics of regulating this matter. This is where GreenMeUp meetings are great, because they facilitate the sharing of experiences across the HUBs. The selected challenges for the discussions and co-created solutions during the workshop are described in Table 3.

Table 3. Proposal of solution to encountered challenges in Czech Republic´s biomethane market.

Identified challenges per PESTEL component	**Co-created solutions from the workshop discussions.**
Political • Too much and radical intervention in biomass energy use • Low declaration of the need for biomethane in the public administration and the associated slow development of the sector • Lack of a realistic strategic plan to achieve European targets	• This is primarily a European policy. As an association, we are members of the EBA and we are working together to minimise interference in the energy use of biomass. However, this is an ongoing trend and further obstacles must be considered in the future and alternative ways of growing them must be sought. • It is necessary to communicate as much as possible with the state administration and to convince them of the importance of biomethane • The government recently approved the new National Energy and Climate Plan of the Czech Republic[1], in which we participated and commented on the strategic document on behalf of CZ Biom. This is linked to the need to further communicate the strategy for achieving the given goals.
Economic • Profitability of biomethane projects, concerns of investment in the sector without state support • Concern about investing in biomethane upgrades due to changing conditions during operation • Poor system of guarantees of origin (guarantees of origin are only bought from the market operator[2] - the price is set by the ERU – Energetical Regulation Office[3] based on market prices, so they are expensive and difficult to trade as the business is not profitable)	• We are waiting for the notification of operational support, which, if set up correctly, will be a major breakthrough in the sector • The governance needs to guarantee that it will support the sector for the next x years • CZ Biom proposes a change to the system of guarantees of origin, which I discussed in the framework of the legislative change LEX RES II (Law on Supported Energy Sources[4])

[1] https://www.mpo.cz/cz/rozcestnik/pro-media/tiskove-zpravy/vlada-schvalila-klimaticko-energeticky-plan--nastini-cestudekarbonizace-ceske-ekonomiky--277443/
[2] https://www.ote-cr.cz/cs
[3] https://www.eru.cz/
[4] https://www.zakonyprolidi.cz/cs/2012-165

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Social • Low awareness of biomethane and its benefits • Low demand from society for biomethane	• Information campaign (articles, reports, social media posts, communication with universities...)
Technological • The technology of agricultural biogas plants is often sized for energy crops, which may be a technological problem in the future in the event of a switch to waste only • Difficult connection to the medium pressure natural gas network. • High-pressure networks tend to be distant from current biogas plants.	• The need for a legislative change to allow connection to the medium pressure natural gas network, making it possible to connect another group of biomethane
Environmental • Not ideal digestate marketing in case of gastro waste recovery (contamination with microplastics etc.) • Long-term burden on biogas/biomethane plant sites due to odour, noise and heavy machinery	•Identify better and more precise technologies, but even so, there will always be some contamination of the digestate • Long-term problem associated with the technology, it is necessary to communicate to the municipalities and residents the advantages that this in turn brings (job opportunity, possibility of local use of the heat from cogeneration, etc.)
Legal • Legislation on the biogas/biomethane sector is becoming more and more complicated, adding obstacles to the development of the sector • Adjustment of the system of guarantees of origin • Notification of biomethane support is only for 2 years	• We need to work together to convince legislators of the benefits and importance of biomethane and find ways to encourage development, not overwhelm the industry with legislative barriers • The forthcoming notification of operating aidis only valid until 2025, i.e. we need to start now to prepare new support for notificationfrom 2025+

Among exemplary technological practices with potential to be utilised in the country, the workshop participants mentioned mostly membrane separation. The technology of the membrane separation was prioritised as the most affordable and reliable technology. It is recently the most widespread technology in the Czech Republic. Although, there are three main companies operating in the Czech Republic supplying biomethane upgrading technology, all biogas producers have switched to membrane separation, even thou for instance GasControl offers other technological solutions. On the other side, also exemplary policy measures were identified from advanced countries such as Germany, Denmark and Italy. The most prominent for the Czech Republic case, according to workshop results, is the operational and investment support. Although, investment support is available to investors, despite approved support in the higher tens of percentages of CAPEX, investors without operational support have not been able to ensure the profitability of the project during the operational life of the facility. At the time of the PESTEL workshop, it was still uncertain whether the EC would notify the operating support, but on 31 October 2023 the support was approved.

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3.2 PESTEL Workshop in Danube Region

In the case of the Danube region, the PESTEL workshops were held separately in each of the countries represented in the region. This facilitated the exchange, especially in order to concentrate on the specific case of each country and for the discussion to be conducted in the native language. The details per country are presented below.

3.2.1 PESTEL Workshop in Hungary

The workshop organized by Zero Karbon Központ was conducted the 29 November 2023 in the premises of Technical University in Budapest. The event counted with the attendance of 28 people, representatives of the Social, Market and Policy Hubs, such as the National Energy Authority, Technical University, University of Szeged, Hungarian Biogas Association, major energy companies, and biogas producers.

The agenda of the event included thematical presentations about lessons learned from operating biogas installations, technological options in view of economies of scale, as well as cost and conditions of grid injection. Main components of the biomethane strategy and the importance of - sharing grid injection costs between network operator and producer were also among the main presentations. Afterwards, three block discussions were carried out as suggested in the provided guidance, with lively discussions on the main governmental decision and measures required for the country´s biomethane market development. The discussions yield a consensus about the necessary governmental measures for the advance of the sector, such as the review of earlier national targets, supportive incentives for the biomethane production and use, impulse for the sharing of grid injection cost between network operator and producers, issuance of export-qualified GoO, and certification of digestate as marketable product. In table 4, the stakeholder´s proposed solutions to identified challenges of the biomethane market are presented.

Table 4. Proposal of solution to encountered challenges in Hungary´s biomethane market.

Identified challenges per PESTEL component	**Co-created solutions from workshop discussions.**
Political • Adaptation of EU Policies (Fit for 55, RePowerEU) • Guarantees of Origin scheme for renewable gases Biogas/biomethane action plan	• National Energy Strategy is being updated • Renewed National Energy and Climate Plan to be implemented • The biogas/biomethane action plan is being elaborated
Economic • Turbulence on natural gas markets • Access to European biomethane markets • High costs of establishing the grid injection facility to be covered by the biomethane producer • Excise duty is charged on bio-CNG and bio-LNG used as transportation fuel	• Contract for Difference to be applied in medium-long term purchase agreements • The mandated issuing body for GOs should join the European network • The investment costs for grid injection to be shared between the network operator and the biomethane producer • Bio-CNG and bio-LNG should be released from excise duty

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Social • Low awareness for climate protection in the population • Stakeholders in agriculture don't appreciate the benefits of biogas production • Local residents resist building biogas installations • Reluctance to follow the best practices with source-separated waste collection	• The media and NGOs should expand their information activity • The Hungarian Biogas Association should distribute the information on biogas and biomethane plants successfully operated in the country • Residents must be informed in details about the planned technology and environment safety measures • New organisation (MoHU) to introduce country-wide collection and processing of municipal waste – directing biologically degradable waste streams to biogas plants
Technological • Lack of knowledge and experience on biogas upgrading technologies • Very limited access to natural gas distribution network (due to small distribution loops with low consumption in summer period) • Due to low concentration of biogas substrates the economy of scale cannot be utilised	• The Hungarian Biogas Association – in cooperation with higher educational and relevant research centres – should expand its information dissemination activity • A map is to be prepared identifying areas where biomethane injection into the low-pressure network is feasible • The possibilities for clustering anaerobic digestion installations with a central biogas
Environmental • Huge volumes of untreated manure and slurry are distributed on cultivated land (following the centuries-old practice) • Most of fermentation residue storage facilities (tanks and lagunas) are open, emitting GHG to the atmosphere • Biogas substrates are transported long distances on the roads	• Animal farms to receive investment subsidies and other incentives to direct manure/slurry to biogas installations before field applications • Open storage of fermentation residue to be prohibited or penalised • With the increase of the number of biogas plants new possibilities for handling wastes/by-products without long transportation will arise
Legal • Transposition of EU RED II into national legislation • Guarantees of Origin scheme for renewable gases	• The draft law on transposing the RED II into national legislation, which regulates the issuance of GOs is before the Parliament • It is expected that the scheme will be operational from July 2024

From workshop discussions, stakeholders identified and prioritized three main technologies with potential application in the country. These examples were identified in countries with advance biomethane activities such as Sweden, Finland, the Netherlands, Germany, Italy and Switzerland. In particular, membrane separation which has already been applied in one operating unit, and considered in several projects which are under development. Its simple operation and high product quality make it attractive for Hungary´s biomethane projects with a preference for small scale installations. Chemical absorption, in particular amine scrubbing was also considered, due to its recently application in one large capacity unit commissioned in 2023, although no experience is published yet. Finally, water scrubbing is being considered for several projects under development, due to absence of chemicals and high operating pressure.

On the other hand, two exemplary market and policy measures with potential application in the country were selected by stakeholders. On one side a grid injection regulation (cost sharing between grid operator and biomethane producer) as currently present in Germany and France. On the other hand biomethane

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Guarantees of Origin, from studied activities of AIB and ERGaR with the experiences in several European countries, like Germany, Denmark, Austria.

3.2.2 PESTEL Workshop in Romania

The workshop was organised as an online event by the King Michael I University of Life Sciences in Timișoara. It counted with the participation of 11 members of the Society, Policy and Market Hubs, including a representative of the Ministry of Environment, Waters and Forests, several biogas producers, and representatives from waste management and technology providers (engineering and construction). The event supported the discussion of crucial aspects for the biomethane potential of Romania. The National energy and climate plan lack a specific strategy for biomethane, a significant oversight considering Romania's potential to replace approximately 30% of current natural gas imports with biomethane. Such a substitution could enhance energy security and contribute to reducing greenhouse gas emissions from the energy sector.

Additionally, there is no existing legislation to promote energy production from renewable sources. The absence of a connection between agriculture and biomethane and the absence of a biomethane register hinders cross-border trading through Guarantees of Origin (GoO) that in other countries generates significant returns. Furthermore, the underdeveloped infrastructure is a challenge, preventing the development of larger biomethane plants or hubs that could capitalize on economies of scale. Moreover, the insufficient number of compressed natural gas (CNG) filling stations limits the accessibility of biomethane to the wider public.

From the event´s presentations and co-creation lab session, the following solutions, as presented in Table 5 are suggested to encountered challenges in Romanian biomethane market.

Table 5. Proposal of solution to encountered challenges in Romanian´s biomethane market.

Identified challenges per PESTEL component	**Co-created solutions from workshop discussions.**
Political • Lack of adopted laws and governmental decisions of either strategic, legislative, regulatory or technical level dedicated to biomethane • Not recognizing biogas and biomethane as significant energy carriers for the renewable energy targets • Importance of implementation of National Strategy for Circular Economy is not enough recognized and circular bioeconomy is not part of this national strategy • There is need for a strong lobby at the governmental level for a transformative change related to the need of producing biomethane and biogas. • The market of biomethane need to be developed and supported • Among the very first triggers should be start-ups strategic and financial support with the participation of research and higher education in the process of IPO (initial public offers) as a long-term process	• Governmental strategy and roadmap for biogas and biomethane. It can be a section within the renewable energy strategy. • Action plan with annual financial costs associated based on win-win solutions • Inspiring decision makers in Romania from Danish vision or other successful strategies of the role of biogas and biomethane, adopting a dedicated “green gas strategy”. • Official targets on production & consumption of biomethane to be adopted on the national strategy. • Official binding targets anchored into national legislation promoting organic waste management by anaerobic digestion. • Research support for IPO and public-private partnership for delivering innovative solutions in solving barriers related to peculiarities of the country. • A monitoring system should be in place for long term as part of the capacity building in the field

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Economic • Underestimation of feedstock potentials, • Linear bioeconomy in place, dysfunctional circular bioeconomy, • unique energy price dictated by market, leads to unsustainable economic landscape in RES in general and in biogas & biomethane in special, • Lack of incentives for CAPEX in biomethane, • Dysfunctional system of Green Certificates supporting RES in Romania, • High costs for transporting low-energy containing materials (such as animal manure)	• Government-mandated assessment of biogas and biomethane production potentials. Common agricultural policy as a financing tool to develop anaerobic digestion plants, • Circular bioeconomy action plan should include anaerobic digestion of organics generated in every sector of economy, • Fit and FiP calculated to support the additional production costs of biomethane from residues and biomass, • Establishing AD and biorefinery projects as part of financial programs, large national projects and as part of IPO and innovation in research. • Quality of "prosumer" in Romania enhance the economic sustainability by obtaining a fit comparing with the lower price of energy on free market. • The national strategy on economy and agriculture need to include an action plan also for circular bioeconomy. • A monitoring system should be in place for long term as part of the capacity building in the field
Social • Reticence of local communities regarding new biogas & biomethane projects managing (bringing) wastes in their vicinity • History in complains of local communities regarding smells issues connected with biogas plants • Local administration and representatives prioritizing and promoting other projects (high-tech devices, e-mobility or attractive constructions for instance) as being more attractive for local community than investments in circular bioeconomy, green energy and waste management projects.	• A communication strategy and action plan to be adopted for long term is needed (Info days, workshops) for social transformative change, including the following actions: ○ Correct information of local communities regarding benefits of biomethane projects in their vicinity ○ Fighting against disinformation affecting environmental issues in general and biomethane sector in particular ○ Consensus among political forces in order to ensure continuity through successive governments and facilitate social acceptance of circular bioeconomy and sustainable development among institutions and citizens • Correct operation of biogas plants in order to avoid discomfort generated in local communities in special connected with smells issues • Urban landscape strategies should include for the future a potential location for constructing anaerobic digestion plants and creating the environment for social acceptance. In this regard, natural barriers such as forests corridors may further support also this strategy as well as biodiversity conservation and climate change. • A monitoring system should be in place for long term as part of the capacity building in the field

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Technological • Technologies developed abroad are expensive and can be available in long time frame, which can delay development of projects, • Long processes are a major barrier identified in constructing biogas plants - engineering and permitting/licensing procedures to be addressed, • Large scale plants are economically more efficient, although dealing with challenges regarding availability of feedstock to support installed capacity, • Small plants easier to manage and less sensitive to availability of feedstock but economically less efficient • Underdeveloped infrastructure is a challenge, preventing the development of larger biomethane plants or hubs that could capitalize on economies of scale, • Insufficient number of compressed natural gas (CNG) filling stations limits the accessibility of biomethane to the wider public.	• Development of biogas technologies with local companies from similar sectors (oil&gas, wastewater, energy etc) • Involvement of research and academia institutions in engineering and permitting/licensing procedures, • Strengthening of national agencies by more personal involved in analysis of projects for issuance of permits and licenses • Improve profitability of biomethane plants, valorising digestate and biogenic CO2 • Removing technical barriers to digestate marketing in the fertilizer market • Subsidising the utilisation of manure in biomethane production • Micro-biogas plants, technologies for managing organic waste in the residential area, generating not only biogas, but especially fertilizer to close the cycle of the circular economy • The strategy and action plan for supporting innovation and research in Romania on long term is essential. Capacity building related to this subject is relevant in creating an IPO platform as well as public-private partnerships clusters on long term functional based on contractual MAT (mutual agreed terms) • A monitoring system should be in place for long term as part of the capacity building in the field
Environmental • Conditionalities for the protection of the environment and natural resources bring with them the risk of abandoning agricultural activities/practices in certain areas. These risks are expected to intensify as the effects of climate change intensify • Romania risks to pay fines of 30,000 euros/day for failing to close 44 illegal landfills where organic wastes are deposited; • Majority of manure in Romanian animal sector managed in open space, emitting GHG • Sectors generating organics, such as food processing sector not supported to implement circular bioeconomy	• Biomethane can be used for the cogeneration of electricity and thermal energy, contributing to the achievement of energy targets from renewable sources and the reduction of CO2 emissions having a positive contribution to mitigating climate change • Micro-economic benefits - sources of additional income through energy production • Macro-economic benefits - decentralization of energy sources, import substitution of energy and environmental protection • Incentives to farmers and industry for diverting organic wastes to be processed by anaerobic digestion • National projects supporting organic wastes clean management through AD; • National projects supporting transition to circular bioeconomy, including biogas & biomethane technologies • A national strategy in supporting a specific national programme on annual basis for long term at least 20 years is needed. This programme should support also win-win solutions and innovation and the major role should be for Ministries of Environment, Agriculture, Internal Affairs and Economy

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Legal • The only support scheme for RES (expired since December 2016) - green certificates are currently calculated per MWh energy fed into the national electricity grid registry (no support scheme per MWh biomethane) • Right to inject, grid connection; • Quality specifications for biomethane; • The term digester does not exist in the legislation (only composter) to be offered for the management of organic residues from households; • Absence of a connection between agriculture and biomethane and the absence of a biomethane register hinders cross-border trading through Guarantees of Origin (GoO)	• The analysis of needs and gaps for the national legal framework should be in place to reflect the legal and capacity building needs at all levels. • A new draft legal framework should be assisted by an action plan for long term and integrated into the legal agenda of all involved authorities at the Government level on a yearly basis with all associated costs. • New regulation incentivizing AD as part of circular economy and support the additional production costs of biomethane • In the national plan for resilience and reconstruction, a financing line has been allocated for at least 5 biogas stations (minimum 300 kw installed power), for the management of manure obtained in farms containing at least 1000 cattle units, • Grid connection facilities, reducing plant operators' CAPEX • "right to injection" for project developers • Set-up of government-mandated issuing body and registry for Guarantees of Origin, before the adoption of a new Renewable Energy Directive including biomethane as essential fuel

Finally, hub members suggested good practices such as biomethane production in processing food companies (e.g. sugar processing plants); using marginal lands (polluted areas) for production of feedstock for biomethane; incentives for large methane consumers (such as nitrogen, chemical plants) to consume biomethane instead of natural gas and state aid scheme for the financing of biomethane production facilities from agricultural, industrial and municipal organic wastes.

Looking ahead, it is expected that the prices of natural gas and all fossil fuels will increase at a faster rate than the price of electricity. Biofuels production costs can be higher than the selling price of energy, therefore, the sector need to be subsidized through a fair and stable legislative framework. Current legislation in Romania establishes as only support for RES, the granting of green certificates for electricity supplied from renewable sources in general. This support is not applied for projects developed after January 2017. FiT and FiP is needed to be implemented in Romania to support the additional production costs of biomethane from residues and biomass.

3.2.3 PESTEL analysis in Serbia

As previously mentioned, semi-structured interviews with identified experts in the country were carried out as basis for the PESTEL analysis during December 2023. Stakeholders were initially contacted by e-mails. The established contact list that was created for the GreenMeUp HUB Kick-Off Meeting was used for this activity to inform and attract stakeholders from Serbia and additionally those active in Serbia, but from abroad, to participate in the process of creating output planned for the PESTEL workshop. Firstly, the PESTEL (Political, Economy, Social, Technological, Environment, and Legal) approach was explained, aiming to identify relevant challenges for the development of biomethane market in Serbia. Also, objectives to propose strategic actions that address identified challenges or hindering factors to the biomethane market in the country, and to

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identify exemplary practices and measures from advanced biomethane markets that could be applicable in Serbia, which could include e.g. specific technologies, policy measures, type of collaborations among stakeholders, were presented as well. Likewise, the context of the PESTEL workshop within the GreenMeUp project was explained. Appropriate documents were submitted to the stakeholders (Deliverable 1.1; Deliverable 2.1; Guidance: PESTEL Workshop; Reporting Template) by e-mails and approaches to provide information were descriptively explained. Additional phone calls were organized to resolve the doubts of the stakeholders on how to fill in the tables and provide appropriate information.

The collected findings complementing the previously identified challenges and proposals for their solution are presented in Table 6. Proposal of solution to encountered challenges in Serbia´s biomethane market.Table 6 as follows.

Table 6. Proposal of solution to encountered challenges in Serbia´s biomethane market.

Identified challenges per PESTEL component	Co-created solutions from workshop discussions
Political • No clear political will yet for this RES field. • Other RES technologies (solar, wind) favorized. • Monopoly in energy supply (natural gas, electricity). • Other political problems turn out priorities than RES. • There are no incentive measures for Biomethane. • The importance of the energy independence of the Republic of Serbia. • Lack of clear political willingness towards decarbonization in all sectors. • Absence of long-term political framework stability. • Lack of national plan and strategy for biomethane, both in transition period and post feed-in period of biogas to electricity.	• EU countries and their practices are good examples to follow. • Enable cross sectoral cooperation and coordination for RES/circular bioeconomy. • Increase public pressure to government for environmental issues. • Create a roadmap for biogas and biomethane. • Incorporating biomethane in national transport strategy. • Change Sub-legislation related for energy production from biomethane. • Conduct concrete actions to attain goals for bioeconomy sector. • Introduce incentive measures for biomethane production.
Economic • Fossil fuels are traditionally broadly represented in all sectors. • Low natural gas price as energy carrier and low electricity price (coal power plants). • High investment cost in plants. Availability of gas network to existing plants. • CO_2 taxes will have a negative impact on the competitiveness of RS products on the EU market. • Development of the domestic construction industry. • The organic fertilizer appropriate to be used in organic food production is not always available in the required quantities and comes at a high price. • Risks for farmers to introduce new crop production. • Defining quality of the end mixture of the injected biomethane and natural gas, delivered to the consumers. The quality of natural gas in Serbia is determined centrally, nearby Belgrade, and the cost of natural gas for consumers is determined according to this quality (energy content). • Increased investment costs for consumers (e.g. adapted/special transport vehicles).	• Raise the awareness of businessmen about how biomethane can positively affect the reduction of the CO_2 footprint. • Raise the awareness of the Government and the economy that the biogas and biomethane industry is an opportunity for the construction industry as well. • Enabling biomethane injection in magistral pipelines (costly) or direct connection of biomethane producer to the nearby trader (natural gas and biomethane filling station). • Introducing feed-in tariffs not only for biomethane producers, but for consumers as well, to motivate them to invest in special equipment if needed. • Adopting supporting measures for efficient and environmentally friendly digestate utilization. • Introducing the supporting measures for farmers that are producing new energy crops able to response challenges related to climate change. • Supporting incentive measures for biomethane should incorporate inflation in the dynamic calculation of the actual incentive measure relevant for actual year.

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• Inflation. Low revenue from the digestate. High costs for waste collection and transport. Lack of private financing opportunities. • Insufficient level of support in all waste sectors and agriculture as providers of feedstocks for biomethane production. • Security to market the product, i.e. biomethane.	• Introduction of supporting measures for farmers that use organic fertilizer (digestate). • Introduction of Gate-fee principle, wherewith the waste generator would have to pay for its disposal and biomethane producer would generate additional income. • Cost sharing and benefits for delivered feedstock used in biomethane production.
Social • Negative opinion of general public towards subsidization of renewables in general ("rich investors are becoming richer"). • Paradox in the state of the mind of general public: We want cleaner environment. – We do not want to pay more for it / invest effort, but we blame the government for the status of environment. • Possible negative opinion on location of waste to biomethane plants in local community. • Farmers have no tradition and established practices for unconventional crop production. • Migration of young people from rural areas. • Distrustfulness of the local community regarding the quality of consumed natural gas from the local network in the case biomethane is injected from biomethane facility in the vicinity.	• Raising knowledge and awareness of citizens regarding the relevance of renewable energy sources for depollution, climate change reduction, human health improvement. • Conducting proper environmental impact assessment studies for all potential plants, which include also influence on local communities (odor, noise, etc.). • Attaining awareness and education of farmers for new business and market opportunities with production of unconventional crops. • Increasing the number of employees and the quality of jobs in rural communities, by developing biomethane sector and green transition in general. • Co-creation of innovation actions through lighthouses, living labs, policy innovation labs within HE projects for new farming opportunities. • Waste to biomethane cities. Public transport fueled by local waste. • In analyzing the profitability of certain projects, it is necessary to observe the wider social interest.
Technological • Insufficient technology maturity (high investment costs) of the technology that allow for crop residues use as a substrate to produce biomethane/biogas. • Exclusion of coal-based power plants in the future could lead to the importance of electricity from RES, which would reintroduce biogas plants for electricity. • Insufficient technology maturity for waste to biomethane plants where waste is contaminated, and plants cannot fulfill all environmental criteria in digestate use. • Variable RES have a negative effect on the stability of the power system of the RS. New amounts of balance reserve are needed. • Preservation of soil fertility/structure with new pathways of unconventional crops. • High logistical costs of biomass provision, as feedstock to produce biomethane. • Waste collection reliability. AD technology efficiency for waste. • Biomethane for chemical industry.	• Conducting studies for applicability and profitability of technologies for AD of crop residues. • Promoting investment in other RES (wind, solar, hydro) which could only generate renewable electricity and not biofuels/bioliquids, i.e. biomethane. Regarding stability of the power system, new or revitalized large hydro power plants are desired. • Developing strategies for environmentally friendly digestate disposal. • Introduced production practice of new energy crops resilient to climate changes in Spain, Italy, Canada, Poland, Australia, Great Britain. • Networking of biogas plants with the aim of consolidating units for the production of electricity and the possibility of providing auxiliary services to the power system. • To establish local biomass storages, in municipalities or settlements and plan biomethane facility on sites with sufficient feedstock from the vicinity.
Environmental • Waste is (almost) completely unused potential (slaughterhouse, sewage sludge, organic municipal). If used, the digestate disposal on agricultural soil is challenging.	• Developing strategies for environmentally friendly contaminated digestate disposal. • Introducing green certificates for biomethane production.

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• Setting environmental standards accordingly so all the produced digestate finds proper unharmful use. • Implementation of Waste Management Legislation. • Conducting proper of Environment Impact Assessment Study on a local level. • High specific investment costs not able to return by secured long-term income.	• Education and training of the inspection bodies and employees at local level related to waste management / environmental protection. • Education and training of local administration (in municipalities) to conduct proper assessments of new (biomethane and other RES) facilities. • Opening and connecting of markets to BAT with lowest investments costs.
Legal • No coordinated activities among relevant ministries to adapt existing / adopt new legislation for this field. • Low capacities of policy makers to respond to the needs of new and dynamic RES field. • Frequent changes in RES law and by-laws to harmonize with EU is not secure environment for investors. Time period within which the biogas sector is developed is relatively much shorter than in EU countries. • Inconsistency of law and by-law regulations. • Clearer definition in Laws/Decrees about energy crops limits in biogas/biomethane production (types, sustainability criterion, iLUC). • No clear technical conditions regarding connection of biomethane facility to the natural gas network (gas chromatograph accuracy class and calibration frequency, pressure control, etc.). • Low Administrative capacity for issuing the permissions in local administrations (municipalities, cities). • Lack of clear biomethane strategy and non-recognition of biomethane as a product. • Short period of validity of legislative documents. • Insufficiently transparent conditions and market for trading of biomethane (examples are stocks in Vienna, Frankfurt).	• Enable cross sectoral cooperation and coordination for RES/circular bioeconomy. • Education and training of the state administration employees related to waste management / environmental protection / decarbonization / renewable energies. • Education and training of local administration (in municipalities) to conduct proper assessments of new (biomethane and other RES) facilities. • Create procedures for connecting biomethane producers to the existing natural gas infrastructure. • Implementation of EU Alternative Fuels Infrastructure Directive.

A myriad of exemplary technological practices with potential for application in the country have been identified and later on prioritized by interviewed partners. In order to show all prioritized options, these have been included in the Annex I: Prioritised exemplary technologies, policy and market measures with potential application for Serbia´s biomethane sector development. However, here a couple of these selected technological good practices are presented. As in other countries the membrane separation technology for biogas upgrading to biomethane was prioritised. Since there is not a single biomethane facility in Serbia yet and there is no appropriate experience in this field, it is of high importance to develop the first projects that are highly reliable and facilitate possibly lowest biomethane production costs. These criteria for the technology part for the biogas upgrading could be fulfilled with membranes. This technology is the most represented one in practice. Also, the technology is applicable for smaller biomethane production capacities (e.g. 500 kW_e equivalent), providing opportunities also to develop projects on sites with sufficient, but not enormous feedstock potential.

Cryogenic separation technology for biogas upgrading to biomethane for the production of liquid CH4 (liquified bio-methane) has also been selected. This will allow to marketed as LNG and enables a high-purity

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and liquid CO2 produced that could be marketed in the future in Serbia. Due to high investment costs, this technology could be considered only in the future for more advanced biomethane projects in Serbia, e.g. biofuels production for heavy transport (bio-LNG trucks).

Now, in regards to the policy exemplary practices that could be applied in the country, several of them were informed by the biomethane sector in Denmark. In May 2020, a joint industry-government roadmap included an indicative target of 13,3 TWh/year biomethane in 2030 ("Powering Denmark's Green Transition", May 2020). This was later confirmed by in the "Green Gas Strategy" published in December 2021 by the Danish Energy Agency. In Serbia it is necessary to define the Vision of Development of biomethane, since to the date there is not one available, nor established goals. It is necessary to set a vision that will determine the targets, according to the potential and the current stage of development of the biomethane industry. Other practice that can be transferred is the utilization of Feed-in tariffs for biomethane producers and users (flexible according to energy share provided by biomethane), motivating the end users to maximize biomethane utilization.

Stakeholders that contributed to the PESTEL workshop in Serbia positively assessed the opportunities for biomethane in Serbia, although ongoing activities of decision makers and policy makers related to the biogas/biomethane are practically negligible. Serbia should start with few good practice projects, not too ambitious, with possibly lowest production cost and simplest logistic for biomethane delivery to the end users. These should be the demonstration projects to overcome legal, administrative, and technical barriers, to allow for other investors to step-in the field of biomethane. Finally, awareness raising and capacity building among state administration and all other stakeholders are the most important measures to conduct, since further development of the biomethane sector depends on mutual effort. However, this is not possible without the presence of critical knowledge about this topic, which is cross sectoral issue.

3.3 PESTEL Workshop in Estonia

The online workshop in Estonia was organised by the Estonian Biogas Association and conducted the 27 November, 2023 in an online format with 17 participants from the GreenMeUp hubs. The workshop gathered stakeholders from policy, production, marketing, using and gas-grid operating sides. For the PESTEL analysis, time-slots were dedicated in the event for focalised discussion of each element with all participants.

Among the most discussed topics, stakeholders focalised in the injection of biomethane, feedstock potential and international gas trade, which would create security to biogas plants business model.

Regarding to current market situation, where production of biomethane is getting dangerously close to the demand of CNG in transport sector, future options for produced gas utilization gained the most interest. As the stakeholders of the meeting were from production, market, TSO and policy side one of the most interesting topics of course was option to enter international market of renewable gas and guarantees of origin. Other options of course were utilizing biomethane in maritime and industry, but there is not yet enough framework to encourage producers and market players to count on that.

Conclusion about socio-cultural impact was to spread more knowledge about biogas production via public gatherings, study visits to existing plants and seminars, since negative feedback for some new projects under development has been occurred and reasoning has been quite often irrelevant.

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Table 7. Proposal of solution to encountered challenges in Estonian´s biomethane market.

Identified challenges per PESTEL component	Co-created solutions from workshop discussions.
Political • Incentives for construction and production • Demand-side support • Reduction of taxes or excise duties	• Estonia has upcoming support mechanism for biogas plant construction. It is common understanding, that biogas plants should focus on biomethane production, therefore minimal plant size that will be subsidized should be at least 15-20GWh/a • Due to rapid uptake in biomethane production and focuses on using biomethane in transportation, 65% of CNG/LNG is already from biogenic origin. To grant local demand for produced biomethane which will be doubled in next 3 years, there should be subsidy for transportation companies for purchasing gas-trucks and buses to their fleet • Biomethane is already tax-free in Estonia, but to uptake biomethane usage in transport sector, gas vehicles should also get exemption- from truck-tax, road-tax and car- tax.
Economic • Target markets • Infrastructure availability • International trade • Valorization of biogenic CO2	• To grant security to existing and upcoming biogas plants, international trading will be crucial. From 2024 there will be Guarantees of Origin system that will allow Estonian producers to inject biomethane in Estonia and sell the gas with GO to other European customers. • Biogenic CO2 market at the moment has rather low demand, but there are upcoming projects in Estonia, that can raise demand of CO2 to 200 000t per year.
Social • Co-benefits perception • Workforce • Rural development	• Social feedback in different parts of Estonia has different. Most biogas plants are built near farms, which are already remote from bigger villages and towns. But to build new plants closer to municipalities and to use more benefits biogas production, companies will have to face negative feedback regardless new jobs and local development opportunities. Solution to that problem would be more education about biogas production benefits and impact to local job market.
Technological • Efficiency of Biogas plant operation • Feedstock pre- treatment technologies • Natural gas network • Biogas pathways	• Biogas plants efficiency shall be improved with next generation technologies implementation such as power-to-X, fertilizer production and thermal gasification. • There is no gas-grid development planned, but Estonian TSO is investigating options to build 3-4 injection points on the existing grid. • Most biogas produced in Estonia is upgraded into biomethane. Biomethane is 100% used in transportation sector, but in the future, there might be uptake in biomethane usage by local industries.
Environmental • Feedstock potential • Digestate-Integrated fertilizer management and Integrated water management • Feedstock guarantee	• Main feedstock in Estonia is manure and silage, with marginal amounts of additional substrates such as food industry residues and biowaste. To grant more potent biogas production, we will have to re-assess land use and digestate legislation. • Digestate fertilization properties will have to be taken more into account and digestate will have to be treated/upgraded to lower the need for fossil fertilizers • To have guarantee of feedstocks to existing and upcoming biogas plants, waste management has to improve and also Estonia will have to implement sequential cropping and energy crops that will have a good impact on the soil.
Legal • Strong regulatory law	• Since Estonian has a lot of out-of-use land and abandoned peat fields, it will have to be allowed to use this land for feedstock production.

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• Feedstock requirements • Right to inject	• In August 2023 there was a change of law, that will allow biomethane injection into transmission grid.

Several exemplary technologies were suggested during the workshop with a potential for application in Estonia and which are currently used in Latvia, Italy, Germany, Sweden, Finland, among other countries. In particular the following three practices were prioritised. First, the pyrolysis of digestate for heat, electricity and biochar production could be a successful practice, given that Estonia, as a Nordic country, has a high demand of heat of up to 8 months per year. Carbon cycles supporting soil enrichment with the resultant biochar is also needed in the agricultural sector and will contribute to two major issues in the country. Second, power to methane technology which is considered with the potential to increase biomethane production from existing substrates and also would add value to guarantees of origin via CCU. Third, Liquefied Biomethane production (LBM), which will make biomethane more desirable as maritime and long-haul fuel.

Regarding exemplary market and policy measures with potential application in Estonia, three measures have also been prioritised. First, Tax exemption to methane powered vehicles, in order to increase their desirability and market adaptation, which would uptake biomethane local usage. Second, the subsidy to gas injection points, which is expected will grant security to biomethane producers about the reach of the product in the energy market and for expansion of production. Finally, the third measure is faster permitting processes for new technology applications. Easing the process for producers, that would like to install new technological solutions. It was suggested to integrate study trips for policymakers in order to learn from countries with interesting solutions to procedural matters.

3.4 PESTEL Workshop in Latvia

In Latvia the PESTEL workshop was organised as an online event by the Latvian Biogas Association. This took place in the 15 December, 2023 with the participation of 18 participants from the GreenMeUp Hubs, as well as other invited experts, external to the hubs. The workshop included the presentation of biomethane market developments in Europe, an explanation of the PESTEL and World-café methodologies, to give way to the two planned discussion sections.

Based on the insights of workshops participants, crucial barriers hindering biomethane production, distribution, and utilization were identified. Afterwards, steps to mitigate them were outlined. This collaborative effort provided valuable perspectives on addressing the challenges facing the biomethane industry, laying the for strategic interventions to foster market growth. The discussion promoted the collaboration among stakeholders from government, industry, and academia to address barriers and drive innovation in the biomethane sector. The importance of regulatory support and policy incentives to foster investment and growth in biomethane projects was once more highlighted. By the end of the event participant reinforced the commitment towards further research, knowledge sharing, and capacity building to promote biomethane as a viable solution for energy security and environmental sustainability.

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Table 8. Proposal of solution to encountered challenges in Latvian´s biomethane market.

Identified challenges per PESTEL component	Co-created solutions from workshop discussions.
Political • **Lack of Regulation and Slow Development in Policy Frameworks**: The absence of comprehensive and specific regulations, coupled with sluggish progress in developing supportive policy frameworks, significantly impedes the growth and stability of strategic sectors. • **Delays in Implementing Necessary Amendments**: Protracted processes and inefficiencies in updating and amending policies create barriers to timely adaptation and response to sector needs and innovations. • **Absence of Support and Accountability Within the Governing Bodies**: A notable lack of proactive support and clear accountability mechanisms within regulatory and governing entities undermines confidence and reliability, further challenging operational and strategic planning efforts.	• **Enactment of a Transportation Energy Law**: Establishing a comprehensive transportation energy law would provide a clear regulatory framework, guiding the development and adoption of sustainable energy solutions such as biomethane in the transportation sector. • **Thorough Evaluation of International Experience and Practices:** Conducting a thorough assessment of international experiences and best practices in biomethane utilization would facilitate informed decision-making and the adoption of effective strategies tailored to local needs and conditions. • **Addressing the Lack of Subsidies:** Implementing subsidies or financial incentives for biomethane production and utilization would help address financial barriers, promoting investment and accelerating market uptake. • **Managing Stakeholder Pressure on the Ministry:** Developing effective mechanisms for managing and balancing stakeholder interests and pressures on the ministry would ensure transparent decision-making processes and foster cooperation and collaboration among diverse stakeholders.
Economic • **Unstable Political Climate and Regulatory Environment**: The inconsistency and unpredictability in policy and regulations create a challenging atmosphere for biomethane market development, deterring investment and innovation. • **Lack of Financial Support for Equipment Installation**: Insufficient financial incentives and support mechanisms for the installation of biomethane production and processing equipment hinder the expansion and technological upgrade of the sector. • **Limited Number of Transportation Units**: The scarcity of transportation units equipped to handle biomethane contributes to logistical challenges, affecting the distribution and accessibility of biomethane for consumers. • **Varying Interest from Industrial Biomethane Consumers**: While there is some interest in biomethane from the industrial sector, it remains inconsistent, impacting the demand and market stability for biomethane producers.	• **Implementation of Support Schemes:** Execute targeted support schemes to incentivize and facilitate the development and adoption of biomethane technologies and infrastructure, ensuring financial and regulatory assistance where needed. • **Transition Support for Bus Fleets to Biomethane**: Provide comprehensive support to transit companies and operators to transition their bus fleets from conventional fuels to biomethane, encompassing funding, technical assistance, and infrastructure development. • **Initiatives to Improve Raw Material Availability**: Launch initiatives aimed at enhancing the availability and accessibility of raw materials required for biomethane production, including organic waste streams and agricultural residues, through collaboration with stakeholders and the implementation of resource management strategies.
Social • **Underestimation of the Circular Economy in Latvia**: There's a noticeable lack of recognition and understanding of the circular economy's potential benefits, leading to missed opportunities for sustainable development and resource efficiency.	• Public Education: Enhance community awareness and knowledge about the benefits and importance of biomethane through targeted educational campaigns and informational resources. • Increased Municipal Involvement in CNG Transport Acquisition: Encourage local governments to invest in Compressed Natural Gas (CNG) vehicles that

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• **Overpromotion of Electric Vehicles**: The current emphasis on electric vehicles overshadows other sustainable transportation solutions, potentially limiting the adoption of diverse renewable energy sources like biomethane. • **Prevailing Belief that Biomethane Will Not Be Necessary**: A widespread assumption exists that biomethane will not play a critical role in the future energy mix, undermining efforts to develop and integrate this renewable energy source into Latvia's energy strategy.	utilize biomethane, supported by incentives and comprehensive support programs to facilitate this transition.
Technological • **Proximity to Infrastructure**: Address the issue of biogas stations being located far from necessary infrastructure by developing targeted strategies to integrate these facilities with existing networks or by planning new infrastructure developments closer to the stations. • **Lack of Gas Injection Points and Funding**: Overcome the shortage of gas injection points and the absence of financing for their creation by seeking partnerships with government and private investors, and exploring grants and subsidies aimed at renewable energy infrastructure. • **Efficient Conversion of Small Biogas Stations**: Implement best practices and innovative technologies to efficiently upgrade small biogas stations, including technical support programs and financial incentives to encourage modernization efforts.	• Clear Vision for New Biomethane Station Development Near Natural Gas Infrastructure: Establish a strategic plan to facilitate the creation of new biomethane stations in proximity to existing natural gas infrastructure, ensuring seamless integration and access. • Support Programs for Transportation: Introduce comprehensive support programs for vehicles and transportation systems utilizing biomethane, including subsidies, tax incentives, and funding for conversion initiatives to encourage widespread adoption.
Environmental • **Utilization of Separated CO2**: Develop and implement strategies for the productive use of CO2 separated in the biomethane production process, such as in agricultural, industrial, or carbon capture and utilization (CCU) applications. • **First-Generation Feedstocks**: Explore sustainable and efficient use of first-generation feedstocks for biomethane production, ensuring that these resources do not compete with food supply and are utilized within ethical and environmental guidelines. • **Promotion of Evidence on Biomethane's Environmental Impact**: Engage in widespread dissemination of research and data highlighting the positive environmental impact of the entire biomethane cycle, to raise awareness and support among policymakers, industry stakeholders, and the public.	• Demonstration Projects for CO2 Utilization: Launch demonstration projects showcasing innovative and practical applications of CO2 utilization from biomethane production, aiming to inspire adoption and investment in similar technologies. • Incentives for Captured CO2: Implement incentive programs for the collection and utilization of CO2, offering financial or tax benefits to companies that effectively capture and repurpose CO2 emissions. • Adapt Waste Management Regulations Favorable to Biomethane Producers: Revise and adapt waste management regulations to support biomethane production, ensuring that policies encourage the use of organic waste as a resource for biomethane generation, thus benefiting producers and promoting sustainability.
Legal • **Legislative Changes and Lack of Clear Regulation**: Advocate for clearer and more consistent regulations within the biomethane sector by engaging with policymakers to address the	• Tariff Discounts for Grid Injection: Implement tariff discounts within the grid network to incentivize biomethane injection, encouraging producers by reducing associated costs and facilitating market integration.

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ambiguities and fluctuations in current laws, ensuring stability and predictability for industry participants. • **Natural Gas Market Regulatory Framework**: Examine and propose adjustments to the regulatory framework governing the natural gas market to accommodate and foster the integration of biomethane, ensuring equitable access and treatment for biomethane within the energy mix. • **Potential for New Obstacles**: Establish a proactive monitoring and response system to identify and address potential new barriers to biomethane development, facilitating swift action to mitigate these challenges and support the sector's growth ….	• Adoption and Organization of Regulatory Acts and Planning Documents (TEL, NECP, etc.): Ensure the acceptance and organization of regulatory acts and planning documents such as the Transport Energy Law (TEL) and the National Energy and Climate Plan (NECP), streamlining procedures and providing clarity for stakeholders in the biomethane sector. • Long-term Biomethane Strategy: Develop a comprehensive long-term strategy for biomethane, outlining clear objectives, targets, and action plans to guide sustainable development and maximize the potential of biomethane as a renewable energy source

Among identified technologies with potential application in Latvia, the stakeholders suggested Pressure Swing Adsorption (PSA), Bio-LNG and membrane biogas upgrading systems. The latter was prioritised due to their versatility and adaptability to various feedstocks and biogas compositions. This flexibility allows them to be used with different types of organic waste and biomethane production facilities, which may vary in scale and technology. While the initial investment in membrane biogas upgrading systems may be higher compared to other upgrading technologies, their operational and maintenance costs are often lower in the long term. This cost-effectiveness makes them an attractive option for biomethane production projects in Latvia.

Under policy and market measures of interest for the country and identified in advanced countries such as Denmark, Italy and Germany are: (i) Minimum 80% Financial Support for Injection Point, (ii) Minimum 30% Financial Support for Injection Point, (iii) Investment support for biomethane plants of at least 70% of CAPEX, (iv) obligation for biomethane share in transport sector at last for 10% share, and (v) the increase of vehicle number on CNG.

3.5 PESTEL Workshop in Greece

The workshop was conducted in the facilities of the Ministry of Environment and Energy (YPEN), joint with the presentation of a study assigned by YPEN on the "Techno-economic analysis report of biomethane production units and determination of the equalized cost of biomethane production". The meeting attended by 58 persons, representing mostly the Policy and Market Hubs, including the whole team of YPEN working on the drafting of the biomethane legal framework. The topics of the event were questions and clarifications regarding the results of the techno-economic report and the European project GreenMeUp, as well as recommendations for the formulation of policies to promote the production of biomethane in the country in order to subsequently form the relevant legislative and regulatory framework

The meeting focused first on discussing the content and recommendations regarding the techno-economic assessment of the biomethane production is Greece, to identify incentives and funding mechanisms. Good

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practices were then presented by the GreenMeUp to support the dialogue and facilitate the decision-making process.

Major questions by the policy makers referred to whether the country has the requested biomass resources that would support the biomethane production and reach the relevant targets. Forest biomass would be suitable only for biomethane production through gasification, which is still under development. Municipal wastes are not expected to be largely used before 2025, while agricultural and agro-industrial residues have challenging logistics and are managed mainly by the Ministry of Rural Development and Food. Although biomethane is not a key policy tool due to the limited livestock, the biomethane market is extremely important in the National policy strategies because of the well-established natural gas grid in the country that could be gradually shift to using biomethane, as hydrogen is still at an early maturity stage.

A second topic that drew attention was on demand-side support for the utilization of biomethane through the provision of incentives in order to mobilize off-takers (e.g. quota, CO2 targets), potential taxes for deterring the use of natural gas, incentives for the connection to the grid (low, medium or high pressure), and licencing procedures.

Table 9. Proposal of solution to encountered challenges in Greece´s biomethane market.

Identified challenges per PESTEL component	**Co-created solutions from workshop discussions.**
Political • Uncertainty for achieving the target for the promotion of biomethane due to the time that is required for the construction of the biomethane plants and the low maturity of the relevant market.	• Transform the existing biogas plants so as to produce biomethane instead of electricity. • Promote bio-LNG and bio-CNG. • Construct decentralised distribution networks • Focus on all available biomethane potential including those that can be exploited in the existing landfills. • Enable the collection of all available feedstocks through the establishment of appropriate supply chains.
Economic • Economic problems of the current biogas plants for electricity production due to the limited operational hours. • Lack of a targeted support scheme for the construction and operation of the biomethane plants. • Increased costs for handling the produced soil conditioner. • Uncertainty about the connection to the distribution network. • Limited access to finance and difficulties in financing the construction of the biomethane plants.	• Design of a support scheme based on other characteristics of the biomethane plants than the installed capacity taking into account the provisions of the natural gas market. • Provide feed-in tariffs (below 3 MW_{th}) or feed-in premiums (above 3 MW_{th}) as operational aid for the economic support of the biomethane plants. • Examine the implementation of auction scheme as a supplementary instrument taking into account the characteristics of the participated plants and the maturity of the market. • Provide economic support for collecting the required feedstocks. • Introduce gate fee for facilitating the collection of the available feedstocks. • Exploit the produced digestate as soil conditioner to improve the economic profitability of the biomethane plants. • Ensure additional profits for the biomethane plants from the avoided CO_2. • Foster the use of the GoOs. • Define with clarity and transparency the undertaken cost by the operator of the distribution network.

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	• Support the development of demand-side for the utilization of biomethane through the provision of incentives in order to mobilize off-takers (e.g. quota, CO_2 targets). • Exploit potential taxes for deterring the use of natural gas so as to promote the production and consumption of biomethane. • Facilitate the financing of the planned biomethane plants by the banking sector with dedicated financing instruments.
Social • Potential social resistance	• Avoid the imposition of additional economic burden to the society triggered by the production of biomethane.
Technological • Limited feedstocks	• Promote hybrid plants (producing both electricity and biomethane). • Exploit the produced wastes in tourism sector as potential feedstocks. • Construct compression points for the production of bio-LNG and bio-CNG.
Environmental • Low visibility of the delivered environmental benefits.	• Highlight the delivered benefits by the consumption of biomethane, which are related to the circular economy.
Legal • Lack of the legislative and regulatory framework for licencing, supporting and connecting biomethane plants.	• Develop the legislative framework for the installation and operation of the biomethane plants. • Improve and simplify the legislative framework for the production of soil conditioner. • Support the development of the framework for the virtual liquification in conjunction with the GoOs. • Allow the connection of biomethane units in all types of natural gas networks.

Regarding the exemplary policy and market measures with potential application in Greece, two were mentioned from those identified from advance biomethane markets, such as Germany, Belgium, and Italy. More specifically, the experience in regards the provision of virtual liquefaction service and the establishment of a transparent procedure for the allocation of the connection cost will greatly facilitate the market uptake through the unhampered installation and operation of the biomethane plants. It should be noted that the initiated measures should be depicted within the legislative framework, which will be developed.

3.6 PESTEL Workshop in Poland

21 representatives of companies and institutions interested in launching the biomethane production in Poland joined the workshop "*The future of the biomethane market in Poland*" organised by PIGEOR on the 22nd of November 2023 as part of the GreenMeUp project. The event was held at the organiser's headquarters in Warsaw. The meeting was opened by Klaudia Juga from PIGEOR, who welcomed the participants and presented the agenda. Then Beata Wiszniewska from PGB (the Polish Biogas Group) took the floor providing information on the current legal situation of biomethane in Poland. She presented the recently introduced regulations regarding biomethane and pointed out what is missing for investors planning to build biomethane plants. The next point of the meeting was the presentation of Ewa Krasuska from NCBiR (the National Centre for Research and Development) on the biomethane plant in Brody, which

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is being built as part of the "Innovative biogas plant" project. This plant will be put into operation at the turn of 2023/2024. After that, Laura Garcia from DBFZ (Deutsches Biomasseforschungszentrum gemeinnützige GmbH) explained the world-café methodology and PESTEL structure to collaboratively propose solutions to existent biomethane market barriers. The next point of the event was the division into groups and discussion on proposed solutions to encountered barriers in the Polish biomethane market. It was moderated by Marta Wierzbowska-Kujda from Teraz Środowisko, online journal for people working in the environmental protection sector. The discussion focused on 3 key areas: legal, economic and environmental factors. Participants had the opportunity not only to present their perspectives, but also to jointly identify challenges and propose potential solutions. After a short introduction by Magdalena Rogulska from PIGEOR, the participants also discussed the best-case approaches and their potential applicability in Poland. Then the moderators of each group presented the summary of results in groups. The meeting ended with the presentation „Guarantees of origin for biomethane" prepared by Kacper Sędek from TGE (the **Polish Power Exchange).** The commitment and diversity of the sectors represented, including public administration, academic institutions and business representatives, created a unique environment that stimulated the exchange of thoughts and ideas.

Table 10. Proposal of solution to encountered challenges in Poland´s biomethane market.

Identified challenges per PESTEL component	**Co-created solutions from workshop discussions.**
Political • Lack of strong political incentive to develop the biomethane market	• Development and implementation of governmental strategy stating the present and future actions of the government to support biomethane production, distribution and consumption • Creating a strategy to increase the absorption capacity of the gas network through infrastructure expansion and modernization, as well as incentives for network operators to invest in the development of distribution capacities • Defining specific goals regarding the share of biomethane in the overall energy structure of the country
Economic • There are no clear guidelines regarding substrate prices, which makes it difficult to forecast the costs of biomethane production • Determining the price of biomethane at a level that will be attractive to investors • High investment and operational costs related to the construction and maintenance of biomethane plants • Lack of flexible business models adapted to the specific nature of biomethane production and limited cooperation between producers • Lack of appropriate economic valorization of the reduction of greenhouse gases (GHG) and gas with greenhouse potential (GO2) • Difficulties in obtaining financing for biomethane projects, as well as the lack of effective cost optimization strategies	• Introduction of financial support mechanisms for biomethane producers, taking into account the diversified costs of raw materials, and development of a system of long-term contracts • Creation of a stable tariff system or price guarantees for biomethane, taking into account production costs and market competitiveness • Introduction of financing systems such as subsidies, tax breaks and preferential loans to minimize investment costs. Optimization of operational processes for efficiency • Supporting the development of new business models that can increase production efficiency, reduce costs and enable better market integration • Establishing attractive financial rates for achieved GHG reductions and introducing a system of incentives and compensation related to environmental benefits • Facilitating access to various sources of financing, such as EU funds, private investments, and special

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	government programs. Developing a cost optimization strategy at all stages of biomethane production
Social • Low level of knowledge about biomethane plants • Social protests against biomethane projects • Biomethane plants may generate impacts on the local community, such as increased car traffic or odor emissions	• Conducting educational and information campaigns addressed to local communities about the benefits and risks associated with local biomethane plants • Development and implementation of effective strategies for managing impacts on the local community, including emission control, minimizing nuisance to the local community, as well as investing in infrastructure adapted to local needs
Technological • Lack of experience related to the production of biomethane requires the use of technologies developed in other countries • No effective mechanisms conducive to the closure of the raw material circulation in the biomethane production process	• Supporting the development of technologies adapted to the Polish market • Supporting research and technological innovation aimed at closing the raw material cycle in biomethane production
Environmental • Lack of effective mechanisms facilitating closing the raw material cycle in the biomethane production process • The use of synthetic fertilizers in agriculture contributes to environmental degradation, leading to loss of biodiversity and water pollution • Agricultural farms generate a significant carbon footprint and greenhouse gas emissions, especially those related to the production of synthetic fertilizers and intensive animal husbandry • Lack of effective management and utilization systems for organic waste, which can be a valuable source of raw materials for biomethane • Biomethane plants may generate environmental impacts, such as increased car traffic, odor emissions, or the need to maintain infrastructure • Lack of effective mechanisms for the recovery and reuse of organic matter and biogenic elements from organic waste • Intensive agriculture and the use of synthetic fertilizers can lead to soil depletion and water pollution • The variety of substrates used can lead to greenhouse gas emissions and other pollutants associated with the biomethane production process	• Introducing recycling and recovery systems for raw materials, promoting side-uses and supporting innovative technological solutions aimed at closing the raw material cycle • Introducing regulations promoting the replacement of fertilizers with natural ones, which are more environmentally friendly and contribute to improving soil quality • Introduction of programs and financial incentives for farmers promoting agricultural practices with a low environmental impact, such as the dissemination of sustainable agriculture technologies • Introduction of a policy promoting selective collection and processing of organic waste into biomethane, thereby reducing the amount of waste stored in landfills • Development and implementation of effective environmental impact management strategies, including emission control, minimizing nuisance to the local community, as well as investing in infrastructure adapted to local needs • Introduction of technologies and systems that will enable effective recovery of organic and biogenic components from the biomethane production process, thus supporting sustainable waste management • Promoting agricultural practices that support soil enrichment, such as the use of natural fertilizers, as well as introducing measures to protect soil and water from pollution related to biomethane production • Creation of standards regulating the types of substrates, reducing emissions and promoting more sustainable sources of raw materials

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• Traditional agricultural practices and fertilizer storage can lead to the discharge of nitrogen pollutants into water bodies	• Introducing regulatory and technological measures that will limit the discharge of nitrogenous substances, such as avoiding excessive use of fertilizers and using modern soil maintenance technologies

Legal
• Lack of precise regulations regarding substrates used in biomethane plants, which makes it difficult for investors to plan and implement projects
• Issues related to the relation between gas system operators and producers, as well as adaptation to the tariff system and technical standards
• There are no regulations regarding the use of biomethane in transport, which limits the potential of this renewable fuel
• Long and complicated process of obtaining permits and administrative decisions
• Unclear regulations regarding digestate, which may affect the stability of production processes
• Low absorption capacity of the gas network
	• Introducing flexible regulations that take into account the diversity of available substrates while ensuring quality standards
	• Establishing clear rules of cooperation between gas system operators and producers, taking into account the tariff system and technical standards. Quick adaptation of procedures for injecting biomethane into the existing gas network
	  • Urgent introduction of regulations regulating the use of biomethane in transport
	  • Integration of administrative procedures, shortening the waiting time for decisions, making them immediately enforceable and enabling simultaneous obtaining of permits
	  • Development and introduction of precise regulations regarding digestate, taking into account its role and use in the biomethane production process
	  • Developing a strategy to increase the absorption capacity of the network, through infrastructure development, incentives for network operators and setting goals for the share of biomethane in gas networks

During the workshop several technological practices were identified from EBA reports, and exemplified used in other EU countries. The workshop participants prioritised the use of membrane separation. It is the most widespread in Europe and considered nowadays the most promising gas purification technology. This technology presents a low energy consumption, a simple operation, cost effectiveness, smaller footprint, a negligible chemical consumption and low environmental impacts. When adapting it to Polish conditions, it should be considered that small farms predominate in Poland. Therefore, the most useful would be a biomethane production technology with relatively low biogas efficiency.

As exemplary policy and market measures with potential application, EBA reports have also been utilised for the overview of options and three main measures were prioritised. First, policy support through a national strategy stating the present and future actions of the government to support biomethane production, distribution and consumption. This would be a strong political incentive to start the biomethane production in Poland. It would help in the necessary expansion and modernization of the network and in building cooperation between gas network operators and investors. Second, the establishment of a support system for the co-financing of infrastructure, (e.g. France, where network operators pay part of the network connection costs) could help investors struggling with high costs related to the connection to the network. Lastly as third measure, the introduction of FiT, FiP support systems. The experience of more advanced countries show that the guaranteed tariff system is one of the most important stimuli for the development of the biomethane market. The legal regulations adopted in Poland introduce FiP support for installations below 1 MW. There is a lack of support system for larger

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installations. It is also crucial to establish clear emission reduction targets and invest in research into new technologies and business models.

4 Co-creation activities in Spain

The activities for the establishment of the Society, Market and Policy Hubs in Spain have been reactivated. Following the same structure as in Deliverable 3.1, this section reports on the objectives set, the central topics of discussion, details on the stakeholder meetings with the members of the Hubs, synthesizing the main conclusions, as well as the current constellation of stakeholders participating as members. Finally, the organisational structure or governance defined for the Spanish Hubs is explained.

4.1 Stakeholder Hubs in Spain

Objectives and targeted stakeholders of the Spain's Biomethane Hubs

Spain counts with five (5) biomethane stations currently operating, while others are expected to be launched by the end of 2023. In 2022, there were around 250 active biogas plants in Spain, which provided a total biogas production that roughly amounted to 8,000 GWh. By the end of 2022, there were 5 active biomethane plants in Spain injecting into the gas grid and Spain's total biomethane production in 2022 amounted to 250 GWh. The coming years will be important for the development of the Spanish biomethane sector. Sectoral actors are approaching the Spanish government about the approval of support mechanisms for renewable gas (a system of financial and fiscal incentives for the development of projects) and its injection into the gas grid (CAPEX aid for the Producer's investment in the infrastructure for connecting biomethane plants to the grid). It's essential a reasonably stable regulatory framework and long-term foresight to attract investment and foster both supply and demand side; in agreement with the European Green Deal commitment and with the European priorities identified in the recent Gas Package.

Permitting processes are another bottle-neck. It is needed a "One-stop management". Standardized and equal procedures in all Regional Public Administrations, simplifying the administrative burden of projects and establishing reduced response times by the Administration in the delivery of authorisations and permits (updating of knowledge).

According to the EUROPEAN COMMISSION – "STAFF WORKING DOCUMENT: 2023 Country Report – Spain"[5], Spain has high additional potential capacity to produce biomethane by 2030 (approx. 4.1 bcm/year). This would allow Spain to replace approximately 13% of its current natural gas consumption with biomethane. Spain will need to increase its renewable energy target in the updated National Energy and Climate Plan to reflect the more ambitious EU climate and energy targets in the Fit for 55 Package and in the REPowerEU Plan.

[5] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023SC0609

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The establishment of the Spain's Biomethane Hubs is a step towards engaging national biomethane actors to identify together the best path towards beneficial business environment and set targets for a more favourable biomethane market.

The following objectives were defined:

- Key objectives: To engage all interest parties of the Spain´s biomethane sector, from policy, market and social stakeholder groups. This includes the exchange of diverse perspectives in the discussion to improve the sectoral development.
- Key thematic focus: To identify applicable strategies to be implemented for the development of the biomethane sector in Spain. This includes:
    - Main barriers for the development of the biogas/biomethane market in Spain
    - Main drivers for the development of the biogas/biomethane market in Spain

Characteristics of Spain's Biomethane Hubs

In March 2022, the Spanish Ministry established in the Biogas Road Map the biomethane target as "minimum" 1% biomethane over gas consumption by 2030. In June 2023, the Spanish Ministry published the NECP Spanish plan as draft, establishing a biomethane target as 12 TWh of biomethane production (20 TWh of biogas production). Nevertheless, the sector is waiting for a definitive updated version of the NECP Spanish plan and consequently a new Biogas Road Map, hoping to have a much more ambitious target, in line with REPowerEU Plan and other European countries.

The development of the biogas/biomethane sector has taken place through a combination of basic levers for the development of the biogas/biomethane sector: Circular Economy, Renewable Energy, environmental improvement, waste valorization, demographic challenge, etc. Additionally, it has included a corresponding holistic approach within the framework of the European Green Deal.

The establishment of the Spain's Biomethane Hubs was reached trough singular meetings coordinated by the Spanish Biogas Association – AEBIG with targeted institutions and a wrap up meeting on 13 March, 2024. In this ocassion, AEBIG organized an extraordinary meeting (face to face), for the opportunity to meet with the vast majority of them and double check their interests and needs. Challenges to reaching all interested parties in a single Kick-off Meeting for the hubs, included the geographical dispersion of targeted stakeholders. Although, a videoconference would have been also possible, AEBIG´s team decided for a face-to-face meeting in order to promote the debates, brainstorming, and exchanging of opinions.

The total participants in the hubs are 33 stakeholders, divided between 3 participants in the Policy Hub, 8 participants in the Market Hub and 4 participants on the Society Hub. Further details of the currently engaged stakeholders are found below in Table 11.

Table 11. Engaged stakeholders in the Spain's Biomethane Hubs

Institutions	Interests and needs
Policy Hub	

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1. Ministry of Ecological Transition and Demographic Challenge - MITERD 2. Center for Energy, Environmental and Technological Research - CIEMAT 3. Spanish Biogas Association – AEBIG	Given the current Biogas Road Map and the NECP plan draft, the Policy Hub Topics are focused on a definitive updated version of the NECP Spanish plan and consequently a new Biogas Road Map, hoping to have a much more ambitious target, in line with REPowerEU Plan and other European countries
Market Hub	
1. AXPO 2. ENGIE 3. NATURGY NUEVAS ENERGÍAS 4. NORTEGAS 5. REDEXIS 6. REPSOL 7. SUMA CAPITAL 8. Spanish Biogas Association – AEBIG	Given the current "momentum" of the Spanish biomethane sector, the Market Hub Topics are focused on Strategies to be implemented for the development of the biomethane sector in Spain • A legal positioning and legal certainty for the development of projects, this is essential; including a sustainable system of Guarantees of Origin • A system of economic and fiscal incentives for the development of projects: investment incentive mechanisms (FiT, FiP, tax benefits, etc.) • CAPEX aid for the connection of biomethane plants to the grid. Recognition of investment for the reinforcement of gas infrastructures for the connection of biomethane plants • Consumption incentive system with quotas for gas traders: increasing percentages over time • Proposal for Circular Economy cooperation • Need to open a specific Declaration of Interest for the biomethane sector • Promote a common framework for cooperation and dialogue among stakeholders: producers, investors, traders, final consumers.
Society Hub	
1. University of Barcelona 2. University of Santiago Compostela - Biogroup 3. University of Valladolid – ISP 4. Spanish Biogas Association – AEBIG	Given the current social alarm against the macro-sized biogas plants, the Society Hub Topics are focused on getting a better picture of what will happen in the green energy market and its relations with the Agriculture and Demographic Challenge in the coming years and how is it going to affect the businesses and daily lives.

Governance structure

The hub coordinator for the Spain's Hubs is the Spanish Biogas Association – AEBIG. AEBIG is responsible for organizing Hubs meetings, facilitating communications and cooperation among the hub's participants. It also provides guidance based on its expertise in the biogas and biomethane sector and collect feedback from the exchanges with engaged stakeholders.

The communications channels established are e-mails and the project´s social media channels, as well as direct contact through personal meetings or calls.

5 Summary and conclusions

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The PESTEL Workshop has contributed to move towards a propositional phase in the project with the participation of stakeholders from the Market, Policy and Society Hubs, as well as other experts interested and involved in this exercise. These results provide a base for further work in GreenMeUp. Not only due to the validation of challenges to biomethane sector in each involved country, but also due to clear priorities to tackle them, now identified and validated by all interested parties. It is of clear importance the utilisation of PESTEL Workshop insights for the development of WP4 task in relation to policy design, that place relevance not only on common necessities among all 7 target countries, but also specific design for each country.

These findings also influence further participatory activities, since the topics of relevance have now been refined. For instance, target countries have indicated the necessity to further discuss the implementation of supportive schemes and sources of financing biomethane projects, the details of operational and investment support, co-financing options and subsidize gas-grid injection points creation. The utilisation of digestate as integral part of the business model is of great importance, which not only will improve the economic profitability of the biomethane plants but benefit soil quality. Solutions to regulatory barriers or procedural obstacles are also a key area in which together industry and decision-makers should be working. Finally, several aspects have been identified towards the business model development, such as fostering partnerships and coordination among various stakeholders, identification of innovative opportunities with industry partners (Market Hubs), new opportunities for liquified bio-CH4, sharing of grid injection costs between network operator and biomethane producer, among others.

It is important for the next exchanges planned for the GreenMeUp hubs to consider their role in the operationalisation of these proposed solutions. Also, target country hubs can promote the establishment of connection among biomethane interested parties, establishing bridges of communication towards cooperation and communicating key information to policy makers in each country.

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Annex I: Prioritised exemplary technologies, policy and market measures with potential application for Serbia´s biomethane sector development.

Selected/prioritized technologies with potential for application in Serbia	
Exemplary technologies	**Why is this technology applicable in the target country? How could it be applied/adapted to the country´s conditions?**
Membrane separation technology for biogas upgrading to biomethane	Since there is not a single biomethane facility in Serbia yet and there is no appropriate experience in this field, it is of high importance to develop the first projects that are highly reliable and facilitate possibly lowest biomethane production costs. These criteria for the technology part for the biogas upgrading could be fulfilled with membranes. This technology is the most represented one in practice. Also, the technology is applicable for smaller biomethane production capacities (e.g. 500 kW_e equivalent), providing opportunities also to develop projects on sites with sufficient, but not enormous feedstock potential.
Cryogenic separation technology for biogas upgrading to biomethane	This technology produces liquid CH_4 (liquified bio-methane), which could be marketed as LNG and enables a high-purity and liquid CO_2 produced that could be marketed in the future in Serbia. Due to high investment costs, this technology could be considered only in the future for more advanced biomethane projects in Serbia, e.g. biofuels production for heavy transport (bio-LNG trucks).
Bio-CNG in transportation https://www.biogasworld.com/news/vehicle-ngv-biongv-sweden/	This exemplary technology can be a measure for decarbonization of the transport sector according to the Green Agenda for Western Balkans. It is necessary to introduce lower taxes for biomethane compared to natural gas in traffic. Due its strong push for BIOCNG in public procurement by local governments a large share of the bus fleet also runs on BIOCNG. Also, it is necessary to provide state subsidies for buying of bus and trucks which use of BIO-CNG.
"Dry" AD technology for municipal organic waste	In Serbia, primary separation of organic fraction of municipal solid waste (OFMSW) is not conducted. However, there are some pilot activities to introduce this practice in large cities. Dry anaerobic digestion is a resilient technology which can process waste with many impurities. However, this technology is comparingly significantly more expensive that commonly applied "Wet" AD technology and therefore could be applicable in Serbia for larger scale projects, e.g. for anaerobic treatment of OFMSW collected in larger cities.
Common and mature AD technology for waste and by-products	In the previous period, several biogas projects in Serbia are based on the new technologies that are promoted to have high performance when applied to waste and by-products that may cause process instability. Although they are more expensive (higher CAPEX), they are for the first time commissioned in Serbia and high performance was not proved. Such omissions should be avoided in the future, and it is important to apply reliable technology (proven in practice).

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Selected/prioritized market and policy measures that could be adapted to the Serbia´s necessities and conditions.	
Exemplary market and/or policy measure	**Why is this measure applicable in the target country? How could it be applied/adapted to the country´s conditions?**
In May 2020, a joint industry-government roadmap included an indicative target of 13,3 TWh/year biomethane in 2030 ("Powering Denmark's Green Transition", May 2020). This was later confirmed by in the "Green Gas Strategy" published in December 2021 by the Danish Energy Agency.	It is necessary to define the Vision of Development of biomethane, because we do not have one, as well as the goals. It is necessary to set a vision that will determine the targets, according to the potential and the current stage of development of the biomethane industry.
Feed-in tariffs for biomethane producers and users (flexible according to energy share provided by biomethane), motivating the end users to maximize biomethane utilization.	Environment friendly, Better way to use biogas energy
Denmark created in 2013 a right to inject and a framework for contractual relation between grid operators and producers. This, in combination with the production support scheme and the voluntary green certificate scheme, created a shift in interest from biogas to biomethane production.	Better way to use biogas energy, very important for the energy independence of the country.
The Swedish government launched in 1999 the quality assurance scheme “Certified recycling” (“Certifierad återvinning”) to build trust among users of organic fertilizers, including digestate from anaerobic digestion. In 2016, 99% of digestate produced in co-digestion plants (most of them using food waste from households as substrate) was used on agricultural lands. This certificate scheme was a technical enabler for marketing digestate successfully on the national market and thus securing an additional revenue stream.	Measures that involve and motivate all participants in the value chain are needed. This is a very good stimulative measure for farmers to trust the quality of the digestate and safely dispose digestate even from treated municipal organic waste.
Regulatory and financial incentives for feedstock providers and farmers to deliver manure and other organic waste to anaerobic digestion plants	Currently in Serbia farmers don’t have incentives to deliver manure to anaerobic digestion plants, and they illegally dump it in ditches or on the fields. In case manure and organic waste is delivered to biogas producer, producer is the one paying for it. A subsidy would incentivise farmers, and relief some costs from biogas producer.
National Recovery and Resilience Plan (NRRP)	Italy. It considers improving the reconversion and efficiency of existing agricultural biogas plants towards partial or total biomethane production as well as the development of new plants in other sectors, such as industry and waste treatment.
Tax incentives (VAT deliberation, free toll) for biomethane producers and users. Tax incentives for transport fuel. Tax incentives for businesses that would use biomethane as a energy or heating solution.	It provides both incentive for use of biomethane instead of natural gas, and a target audience to which producers can distribute biomethane as end product. Distributors can pump biomethane into the grid, that end users using certificate of origin have a proof that their energy resource comes from environmentally friendly solution, which reliefs them of taxes. In such way as the biomethane fuel is exempt of a certain tax it becomes very competitive to other fuels, such as CNG. It is the easiest way to incentivise without monetary back flow (state does not need to pay incentives).
Public companies are potentially excellent opportunities to switch from natural gas to biomethane. They are large consumers and could potentially reduce operating costs either with lower the price of biomethane than natural gas or through incentive measures. Gradual introduction of	Many stakeholders should be included in the process, but if it is possible to generated savings or additional income, it could be used to encourage farmers and producers of organic waste to dispose these in biogas plants, which would again increase biomethane production, but it would simultaneously resolve

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biomethane as energy carrier in energy sector, e.g. in district heating plants (5-10% at the beginning).	several issues related to the aspects of the environment and the economy.
Subsidy measures to stimulate growing of new cover crops intened for energy crops or other purpose, to preserve and improve (agro)biodiversity.	It generates additional income for farmers, improves sustainability of agricultural production.

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