D4.2 Market uptake measures at national level (7 target countries)

Deliverable n.4.2

GREENMEUP

Document control sheet

Project	**GreenMeUp - Green biomethane market uptake**
Call identifier	HORIZON-CL5-2021-D3-02: Sustainability and educational aspects for renewable energy and renewable fuel technologies
Grant Agreement n°	101075676
Coordinator	CRES - Centre for renewable energy sources and saving foundation
Work package n°	4
Work package title	Market uptake measures
Work package Leader	CRES
Document title	D4.2 Market uptake measures at national level (7 target countries)
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Reference period	01/08/2022 - 31/07/2024
Due date	31/07/2024 (M24)

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

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Chapter 1: Introduction

In the context of the GreenMeUp project, it is foreseen the design of market uptake policy measures and financial frameworks, which will allow the biomethane markets to operate efficiently and effectively in the advanced and target countries where results could be replicated.

The current deliverable intends to provide a comprehensive list of market uptake measures at national level for the seven target countries (e.g., Czech, Danube region, Estonia, Greece, Latvia, Spain and Poland), which will inform their national energy and climate plans (NECPs).

The identification and definition of the most effective market uptake measures will be occurred in close collaboration with the involved stakeholders within the framework of the different hubs (e.g. policy, market and society hubs). The focus and typology of future policy interventions, which can be developed and implemented to improve the market uptake and cross border trade of biomethane value chains in EU and the target countries, will be resulted through the co-design of the market uptake measures.

The active involvement of the stakeholders will be implemented with the application of the fuzzy cognitive mapping technique, which in combination with the competitive priorities and performance-based indicators, as resulted within the framework of the GreenMeUp project, will facilitate the interpretation of the policy relevant attributes, which are critical for both the establishment and operation of biomethane value chains.

The recommended combinations of policy measures will be targeted towards a level playing field between different market segments(buildings, industry, power and transport), while they will incorporate and address the main risks and challenges ensuring that the required future policy interventions will be well integrated into the national policy planning for each target country separately.

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Chapter 2: Methodology

The objectives of the current deliverables have been fulfilled with the development of a specialized methodological approach, which consists of five different steps (Figure 1).

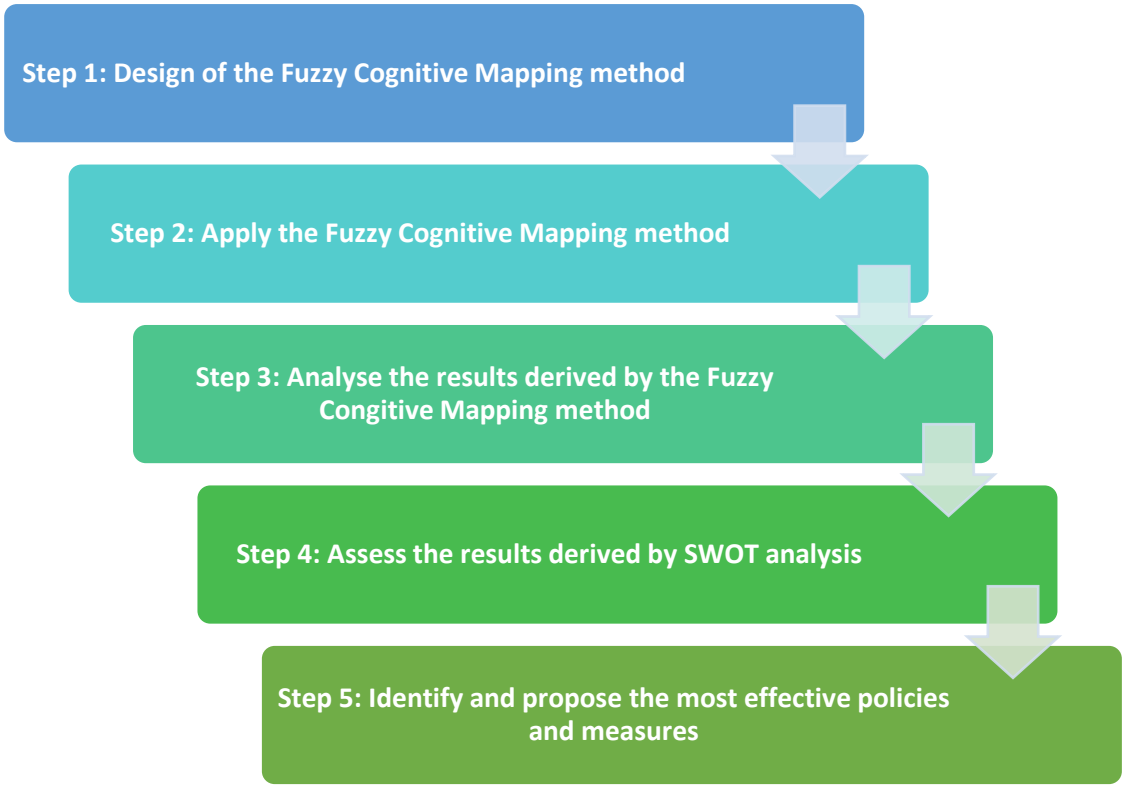

Figure 1 : Applied methodological approach for identifying and proposing the most effective policies and measures in the targeted countries.

Firstly, the design of the Fuzzy Cognitive Mapping method was carried out (Step 1), which has been utilized for identifying the main policies and measures for the further deployment of biomethane.

The Fuzzy Cognitive Mapping method was applied in the seven targeted countries (Step 2) based on the prepared guidelines for the implementation of the Fuzzy Cognitive Mapping (Annex I: Guidelines for the implementation of the Fuzzy Cognitive Mapping (FCM)) and the template for describing the performed activities for each interview separately (Annex II: Template for describing the performed activities for each interview separately).

It should be mentioned that the question, which was explored within the framework of the Fuzzy Cognitive Mapping method, focused on the most crucial parameters for the effective penetration and utilization of biomethane in the examined countries. Obviously, the main risks and challenges are taken into consideration during the identification of the main parameters, while the proposed policies and measures will ensure that they will be

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addressed effectively and the main defined targets for the further penetration of biomethane will be achieved.

The obtained feedback from the interviews were analyzed (Step 3) so as to unveil the main parameters, which should be taken into consideration for the design and implementation of targeted and effective policies and measures.

Finally, the identification of the most effective policies and measures (Step 5) was occurred taking into account the derived results of the SWOT analysis (Step 4).

The Fuzzy Cognitive Maps is considered as a powerful tool, which is based on neural networks, to solve complicated chains of casual relationships. The FCMs manage initially to depict the fuzzified relationships among nodes quantifying the degree of relationship between two specific concepts. Moreover, the FCMs construct a connection matrix and calculate the activation levels of the identified nodes as state vectors.

The construction of the FCMs is resulted by the collection of the various feedback from face-to-face interviews. The procedure for constructing the individual FCMs consists of various steps. More specifically, the various concepts, which are associated with the examined problem should be identified. Then, each interviewee assesses the causal relationship among the identified concepts with a qualitative scale, which has been determined. The utilized scores are then aggregated so as to estimate an overall qualitative weight, which is transformed into a numerical weight by utilizing the defuzzification method of the centre of gravity. It should be noted that all the specified weights are quantified from the previously transformed weights. Each produced weight provides information about the relationship between the two concepts and specifies the grade of causality between them.

The construction of the individual FCMs signals the respective construction of the collective FCMs. The procedure for resulting in the collective FCMs include the identification of the associated parameters with the examined problem, the classification of the individual parameters into groups, the determination of the causal relations and their strengths, the calculation of the strength of each link within the framework of the collective FCM, the presentation of the collective FCM and the conduction of various simulation runs for assessing the impact of each parameter separately.

The collective FCM is characterized from additional metrics, such as number of transmitters, the number of receivers and the number of the ordinary concepts. These concepts are characterized by their out-degree and in-degree. Out-degree provides an indication about how much a given concept affects the other concepts. In-degree depicts the cumulative strength of the identified concepts.

Furthermore, the complexity of the collective FCMs is analyzed taking into account the number of Receiver to Transmitter ratios (e.g. indicating more complex FCMs in the case of higher values of ratio), the Density (e.g. presenting how connected or sparse the FCMs are) and the Centrality(e.g. displaying the overall interaction strength of each mentioned concept).

The analysis of the collected questionnaires from the participants was conducted with MS Excel based simulation tool FCMapper (available at: http://www.fcmappers.net/joomla/).

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Chapter 3: Policy measures in Czech Republic

In Czech Republic, the majority of the identified parameters refer to medium- and long-term basis according to the results of SWOT analysis (see Figure 2). More specifically, emphasis is given of the required economic support as displayed by the provision of operating and investment aids and the preservation of the competitiveness of biomethane. Moreover, the role of the infrastructure is also critical taking into account the need for modernizing the current biogas plants to supply biomethane to the gas network and constructing new biomethane stations. Only one parameter that refers to the establishment of the regulatory framework (e.g. the update of the NECP and biomethane targets) has been characterized as a short-term factor.

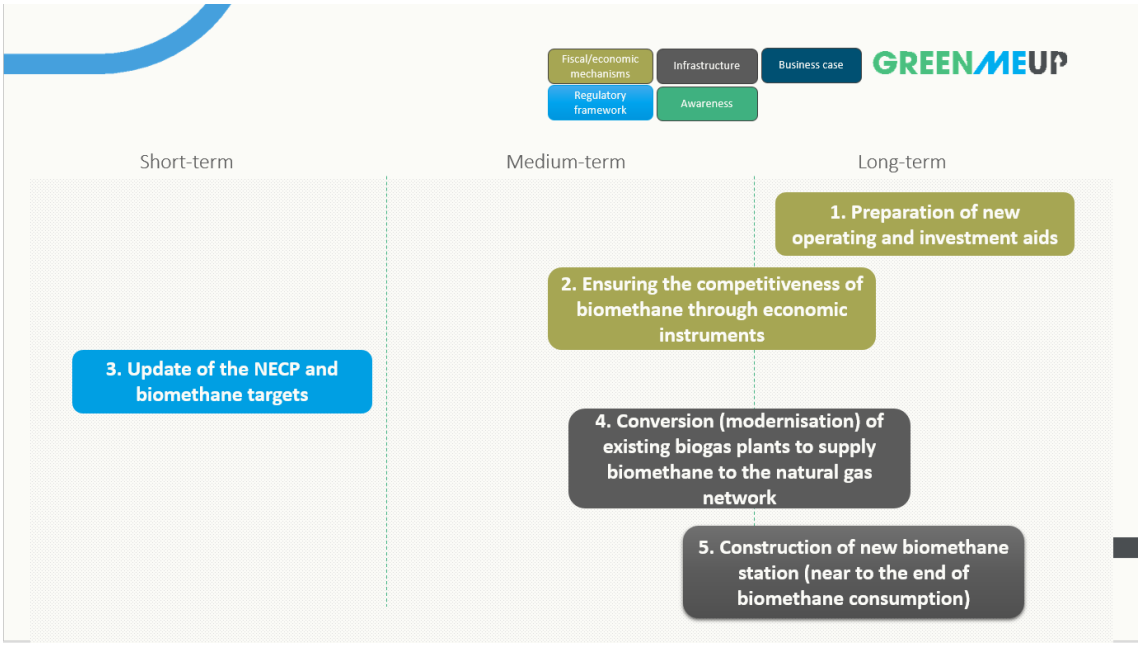

Figure 2 : Results of SWOT analysis in Czech Republic.

Totally, ten stakeholders participated in the application of the FCM analysis. The main results of the FCM method are presented in Table 1 for the case of Czech Republic.

Table 1: Overview of the applied Fuzzy Cognitive Mapping in Czech Republic.

Individual maps	**Policy Hub: 3, Market Hub: 4, Society Hub: 3**
Number of variables	64
Number of connections	143
Number of transmitter variables	9
Number of receiver variables	12
Number of ordinary variables	43
Receiver to transmitter ratio	1.33
Density	0.033

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According to the results of the FCM method in Czech Republic (Table 2), the unstable legislative environment, the high administrative complexity and the complex bureaucracy create investment uncertainty in the biomethane sector. The insufficient and slow governmental actions, the political instability and different industry interests are also of high significance and set a hurdle in the development of the biomethane market. Nevertheless, the main advantages of biomethane are mentioned (e.g. it is a renewable, green and local resource and helps stabilize employment opportunities in small towns and villages), while during energy crisis where natural gas shortages are recorded, finding local and renewable options, such as biogas and biomethane, can be considered as a useful alternative.

All the identified concepts are summarized in Table 2 for the case of Czech Republic.

Table 2: Results of the applied Fuzzy Cognitive Mapping in Czech Republic.

Concepts	Centrality	Outdegree	Indegree
Uncertainty of investing in biomethane	2.16	1.10	1.06
The governmental actions are insufficient and slow	1.92	0.92	1.00
Political instability different industry interests over time	1.74	1.02	0.72
Biomethane is a renewable, green and local resource	1.04	0.62	0.42
Biogas/biomethane sector helps stabilize employment opportunities in small towns and villages	0.94	0.32	0.62
Energy crisis, natural gas shortages, finding local and renewable options	0.90	0.58	0.32
Unstable legislative environment in the Czech Republic and rapid change of legislation	0.84	0.52	0.32
High administrative complexity, complex bureaucracy of the whole sector	0.60	0.50	0.10
Strong market demand for advanced biomethane, existing EU/CR targets	0.54	0.24	0.30
Synergies for agriculture	0.52	0.22	0.30
Harmony of resources and uses in the region	0.40	0.18	0.22
A large number of experienced staff and a large selection of supplier companies	0.38	0.10	0.28
Small new construction and conversion of existing ones	0.32	0.12	0.20
Problematic digestate marketing/final fertiliser production	0.32	0.16	0.16
Complex waste recovery (bureaucracy) and lack of waste to meet targets	0.30	0.20	0.10
Very challenging to set the auction bonus for biomethane due to large fluctuations in operating costs	0.30	0.08	0.22
Low demand for non-advanced biomethane	0.28	0.18	0.10
Low awareness of biomethane, lack of information	0.28	0.10	0.18
Lacks a moment of actualization	0.26	0.08	0.18
Interest in biomethane in other sectors (transport)	0.26	0.16	0.10
Insufficient network for collection of waste substrates, use of purpose-grown biomass	0.22	0.10	0.12
Connecting operators and companies interested in cooperation	0.22	0.04	0.18
Insufficiently interesting conditions for the application of biomethane on the Czech market, export of biomethane abroad	0.22	0.06	0.16

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Concepts	Centrality	Outdegree	Indegree
Retroactive change of operating rules, large bureaucratic burden for the state and operators	0.20	0.10	0.10
No guaranteed support for the price of biomethane relative to natural gas to motivate new projects	0.20	0.10	0.10
There is no declaration of green automobility that uses biomethane - ideally to have the same conditions as electromobility	0.20	0.10	0.10
Requirements to save emissions (transport, heating, reduction of carbon footprints in companies	0.20	0.10	0.10
Current investment and operating support	0.20	0.14	0.06
Provides flexibility and accumulation	0.20	0.12	0.08
Biomethane operating aid successfully notified, existing investment support	0.18	0.10	0.08
Biomethane is a great opportunity to extend the life of current BPS	0.18	0.04	0.14
Transnational, national and market targets (ESG...) for biomethane	0.18	0.06	0.12
Great potential in biodegradable municipal waste - up to 2 million tonnes/year	0.16	0.04	0.12
The investment subsidy exists, but some operators will lose it as part of the overcompensation of operations	0.16	0.08	0.08
Robust natural gas network, high potential for BMS connectivity	0.16	0.08	0.08
Recovery of WEEE/WMW	0.16	0.16	0.00
Good connectivity to the natural gas network	0.14	0.10	0.04
NIMBY effect	0.14	0.14	0.00
EU commitments/decarbonisation	0.14	0.00	0.14
Slowdown in biomethane development due to 20 years of support for CHP (2008-2013)	0.14	0.08	0.06
The biogas/biomethane sector is very well developed in the Czech Republic	0.12	0.00	0.12
Possibility of diversification of biogas product production (CHP + biomethane)	0.12	0.04	0.08
Biomethane helps sustain gas industry with RES	0.12	0.04	0.08
Under-utilization of the potential of biomethane in transport	0.12	0.06	0.06
Complex connection to the natural gas network (high pressure is remote, complex permitting processes)	0.12	0.06	0.06
Availability of financing	0.12	0.06	0.06
Insufficient discussion of European legislation	0.10	0.10	0.00
Competition of biomethane with cheaper sources (other electricity support schemes)	0.10	0.00	0.10
Conditions for digestate application/marketing	0.08	0.00	0.08
Network/ST/VT connectivity	0.08	0.00	0.08
Ambiguity in reporting (greenwashing)	0.08	0.00	0.08
High investment costs for biomethane production	0.08	0.02	0.06
Waste recovery conditions	0.08	0.08	0.00

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Concepts	Centrality	Outdegree	Indegree
In the future, electricity production from biogas will be uncompetitive compared to other RES and will stimulate the development of biomethane	0.08	0.08	0.00
Exemption from dependency/energy security	0.06	0.00	0.06
Connection complications (investor's burden with the extraction pipeline)	0.06	0.00	0.06
Still incomplete market for biomethane and allowances	0.06	0.00	0.06
Poor legislative arrangements for the operation of equipment in island systems	0.06	0.00	0.06
More space for biomethane in the media - awareness raising at national level, meeting EU targets	0.06	0.06	0.00
Demand for BioCNG, advanced biomethane in transport	0.06	0.06	0.00
Low social and political acceptance	0.06	0.06	0.00
Support for pre-manufactured waste recovery facilities	0.04	0.04	0.00
Insufficient recovery of WEEE as a resource that ends up in landfills	0.02	0.00	0.02
Insufficient sales of the resulting CO2, problematic use of the by-product	0.02	0.00	0.02

The proposed policies and measures are summarized in Figure 3 outlining the main aspects, which should be taken into consideration in Czech Republic.

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Policy measure No1 **Introducing financial support measures**

- Define and introduce financial support measures for the production of biomethane (e.g. indicatively subsidies, fiscal measures, CfDs etc.)
- Support the conversion of existing biogas plants to biomethane plants

Policy measure No2 **Accelerating the adoption of the legislative improvements**

- Simplify, improve and streamline the existing legislative framework
- Remove any legislative barriers

Policy measure No3 **Ensuring political stability**

- Continue, monitor and improve the existing policy framework
- Assess and improve the legislative framework

Policy measure No4 **Decreasing administrative complexity and bureaucracy**

- Simplify and streamline the permitting procedures to reduce the length and the bureaucracy

Policy measure No5 **Exploiting the available feedstock potential**

- Assess the sustainable feedstock potential
- Identify and incentivise the untapped feedstock potential
- Map the targeted feedstock potential

Policy measure No6 **Capitalizing the experienced staff and the supplier companies**

- Mobilize and exploit the existing staff and the supplier companies

Policy measure No7 **Increasing the ambition of the specified targets**

- Define more ambitious targets for biomethane production and consumption
- Incorporate the increased targets within the policy framework

Figure 3 : Proposed policies and measures in Czech Republic.

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Chapter 4: Policy measures in Danube region

In Danube region, three different SWOT analyses were implemented. As shown in Figure 4, all the parameters refer to short- and medium-term basis for the case of Hungary. More specifically, the elaboration of a national action plan with specific biomethane targets is defined as a crucial short-term parameter, while the strengthening of the regulatory framework through grid injection cost sharing between network operators and biomethane producers can be characterized as an important medium-term parameter.

Similarly, the usage of contracts for difference (CfD) and the provision of fiscal and economic incentives may have a meaningful impact also. Last but not least, the elaboration on financial support measures to sustain CAPEX for building clusters of biogas plants with a centralized upgrading facility along with fiscal and economic incentives have been recognized as important factor at long-term basis.

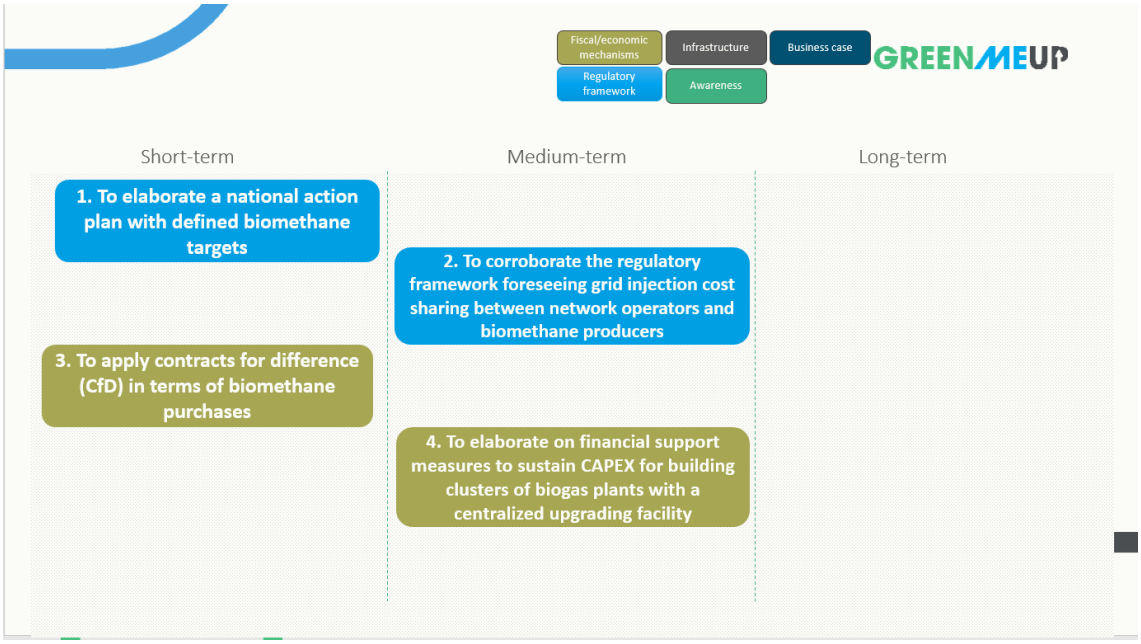

Figure 4 : Results of SWOT analysis in Hungary.

In Romania the SWOT analysis highlighted (Figure 5) that the strengthening of the knowledge of biogas/biomethane potentials through official assessments and the support of the financial sustainability of biogas/biomethane plants through digestate valorization should be implemented in the short term. In terms of regulatory framework, the elaboration of a dedicated governmental roadmap for biogas/biomethane that could/should be integrated in other strategic documents, the definition of mandatory production/consumption targets for biogas/biomethane in national strategic frameworks as well as the combination of biogas/biomethane targets with waste management policies by fostering anaerobic digestion are categorized as crucial medium-term parameters.

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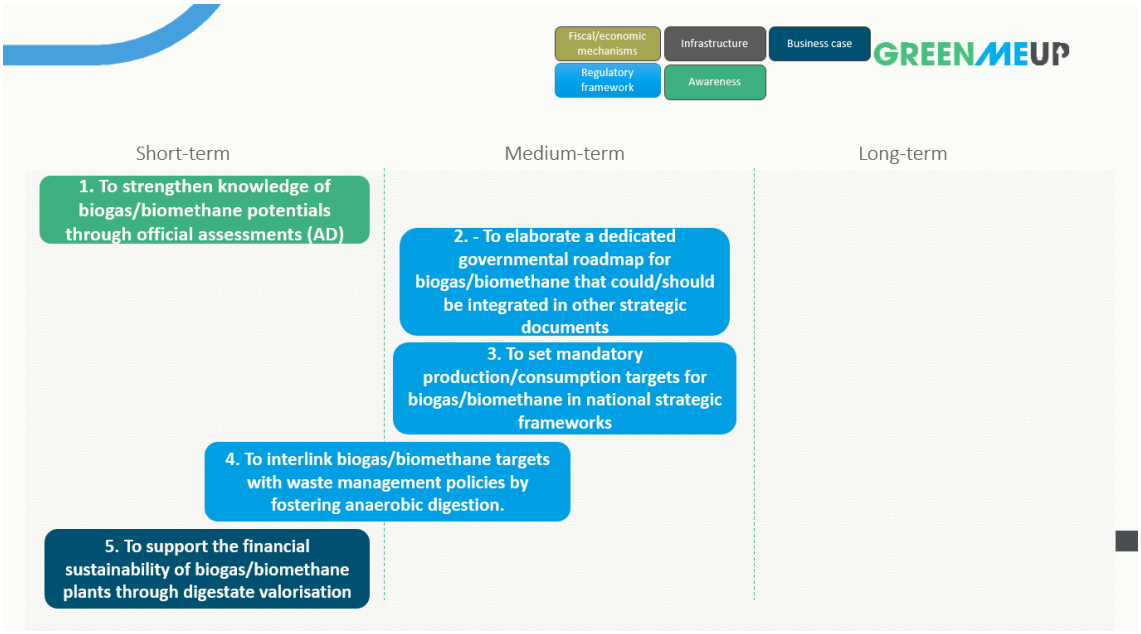

Figure 5 : Results of SWOT analysis in Romania.

According to the results of SWOT analysis in Bulgaria (Figure 6), the implementation of a comprehensive framework analysis to assess the prospects and needs of biomethane integration, the combination of decarbonization and waste reduction targets with biomethane production pathways and goals, the definition of an appropriate incentive scheme to mobilize untapped potential as well as the promotion of biogas/biomethane technology as a multi-purpose technology that contributes to meeting complementary objectives should be applied in the short and medium term. The only parameter that is planned to be implemented in the short term is the enhancement of the cross-sectoral cooperation between different line ministries and/or administrations.

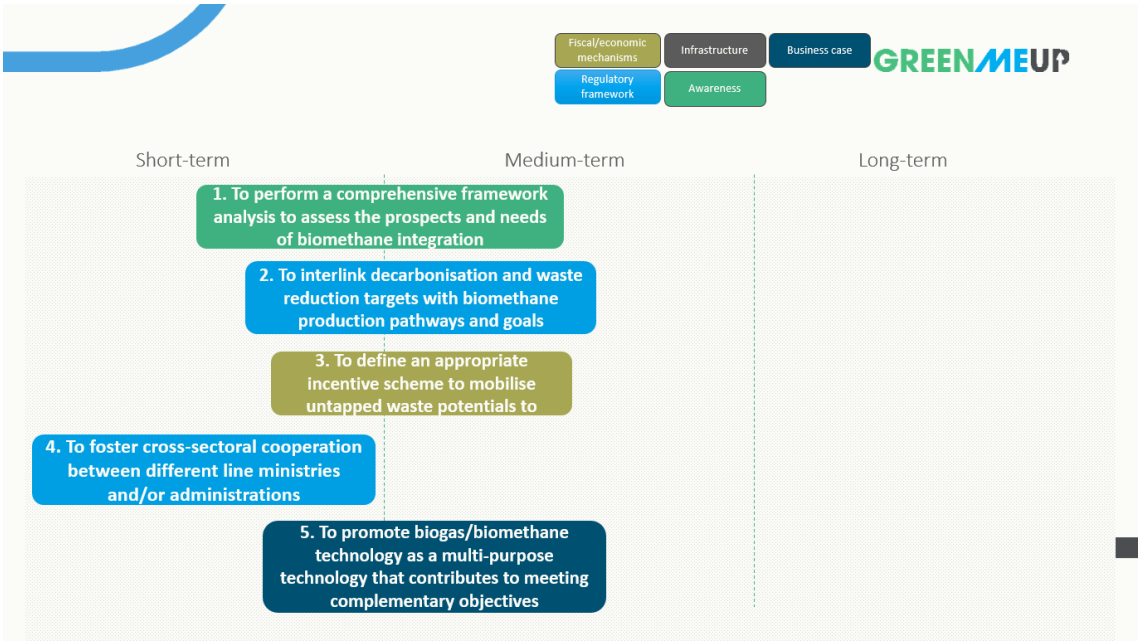

Figure 6 : Results of SWOT analysis in Bulgaria.

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Totally, twelve stakeholders participated in the application of the FCM analysis. The main results of the FCM method are presented in Table 3 for the case of Danube region.

Table 3: Overview of the applied Fuzzy Cognitive Mapping in Danube region.

Individual maps	Policy Hub: 4, Market Hub: 4, Society Hub: 4
Number of variables	19
Number of connections	88
Number of transmitter variables	4
Number of receiver variables	0
Number of ordinary variables	15
Receiver to transmitter ratio	0.00
Density	0.244

According to the results of the FCM method in Danube region (Table 4), the most important factors consist of the definition of national biogas/biomethane strategies/action plans with production targets, the harmonized/enabling regulatory framework and the cooperation among national/sub-national administrations and sector stakeholders. Moreover, the establishment and expansion of biogas/biomethane supply chains, including by-products as well as the knowledge transfer, education, training on up-to-date technologies for biogas/biomethane production are considered also as highly significant parameters.

Furthermore, the support schemes for biogas/biomethane producers and consumers and the feedstock collection logistics networks and mapping of feedstock potentials are also substantial, in parallel with the development of bio-CNG/bio-LNG fuelled transport. Important parameters include the synergies with agriculture and waste management sectors, in combination with the inspection of the aforementioned sectors.

All the identified concepts are summarized in Table 4 for the case of Danube region.

Table 4: Results of the applied Fuzzy Cognitive Mapping in Danube region.

Concepts	Centrality	Outdegree	Indegree
Cooperation among national/sub-national administrations and sector stakeholders	4.02	2.48	1.53
Definition of national biogas/biomethane strategies/action plans with production targets	3.48	2.00	1.48
Establishment and expansion of biogas/biomethane supply chains, including by-products (digestate, CO2)	3.35	1.18	2.17
Knowledge transfer, education, training on up-to-date technologies for biogas/biomethane production	3.03	1.65	1.38
Harmonised/enabling regulatory framework (incl. standards, etc)	2.73	1.42	1.32
Support schemes for biogas/biomethane producers, consumers	2.68	1.20	1.48
Feedstock collection logistics networks and mapping of feedstock potentials	2.48	1.07	1.42
Improve social perception/awareness of biogas/biomethane	2.02	0.92	1.10
Support Development of bio-CNG/bio-LNG fuelled transport	1.30	0.35	0.95
Development of bio-CNG/bio-LNG fuelled transport	0.55	0.18	0.37
Pilot projects (inclusive, circular)	0.52	0.52	0.00

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Concepts	Centrality	Outdegree	Indegree
Offering development as regulations under the num of Res & Ro	0.33	0.17	0.17
Network operators carrying substantial part of grid injection related CAPEX	0.27	0.07	0.20
Synergies with agriculture and waste management sectors	0.17	0.08	0.08
Planning and building of infrastructure	0.13	0.13	0.00
Inspection in Waste Management	0.12	0.12	0.00
Demonstration Projects	0.12	0.12	0.00
Access to finances	0.10	0.05	0.05
Feedstock availability and characteristics	0.03	0.02	0.02

The proposed policies and measures are summarized in Figure 7 outlining the main aspects, which should be taken into consideration in Danube region.

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Policy measure No1 **Promoting a holistic framework for cooperation and dialogue**

- Engage actively all the involved stakeholders with targeted activities
- Establish a network with the balanced participation of all the involved stakeholders
- Ensure the cooperation of the involved stakeholders

Policy measure No2 **Drafting a strategy and adopting the required legislation**

- Formulate a dedicated strategy for the further penetration of biomethane with specific targets and policies
- Adopt the required legislation for achieving the specified targets

Policy measure No3 **Establishing the required supply chains**

- Stimulate and support the development of a reliable and competitive equipment supply chain
- Facilitate the technology transfer and provide training to the involved stakeholders

Policy measure No4 **Raising awareness with capacity building activities**

- Conduct capacity building activities to increase the existing level of knowledge
- Understand and disseminate the economic, social and environmental benefits and risks

Policy measure No5 **Harmonising/enabling the regulatory framework**

- Simplify, improve, streamline and harmonize the existing legislative framework
- Establish a trasnparent grid injection cost sharing approach among network operators
- Remove any legislative barriers

Policy measure No6 **Introducing financial support measures**

- Define and introduce financial support measures for the production of biomethane (e.g. indicatively subsidies, fiscal measures, CfDs etc.)
- Support pilot and demonstration projects

Policy measure No7 **Assessing the feedstock potential**

- Assess the sustainable feedstock potential
- Identify and incentivise the untapped feedstock potential
- Map the targeted feedstock potential

Policy measure No8 **Promoting the use of bio-CNG/bio-LNG**

- Support the use of bio-CNG/bio-LNG with economic measures
- Develop the appropriate infrastructure
- Identify and boost additional demand related to the consumption of bio-CNG/bio-LNG

Figure 7 : Proposed policies and measures in Danube region.

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Chapter 5: Policy measures in Estonia

In Estonia, the construction of biomethane injection facilities to the Category D gas network to support biomethane feed-in to transmission network, the simplification of digestate certification and expansion of marketing opportunities as well as the reduction of market uncertainty, stabilization of price and demand with regulations, common market port, etc. are considered as the most important parameters at short-term basis according to the results of SWOT analysis (see Figure 8). The provision of subsidies and incentives for transport companies for the purchase of gas trucks and buses should be fostered in the medium term, while the expansion of the use of biomethane into new areas of use, including liquefied, such as shipping, should be implemented in the long run.

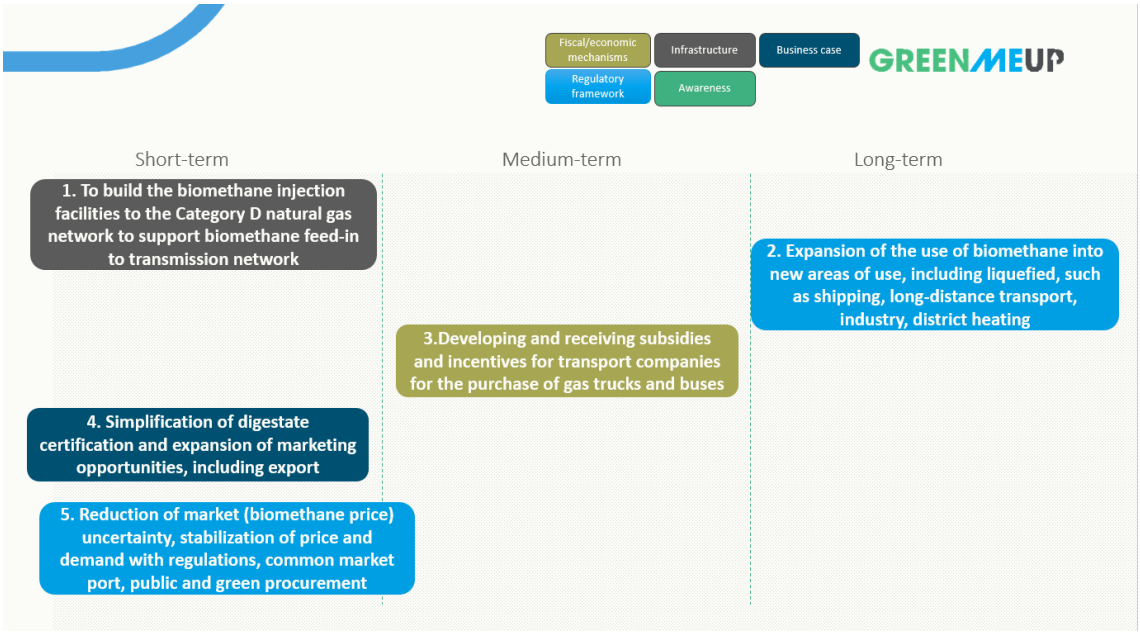

Figure 8 : Results of SWOT analysis in Estonia.

Totally, eight stakeholders participated in the application of the FCM analysis. The main results of the FCM method are presented in Table 5 for the case of Estonia.

Table 5: Overview of the applied Fuzzy Cognitive Mapping in Estonia.

Individual maps	Market Hub: 5, Society Hub: 3
Number of variables	92
Number of connections	120
Number of transmitter variables	31
Number of receiver variables	25
Number of ordinary variables	34
Receiver to transmitter ratio	0.81
Density	0.014

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According to the results of the FCM method in Estonia (Table 8), the formulation of a vision to promote both biomethane and digestate production and consumption, the identification of the required funds and the targeted promotion of biomethane in all end-use sectors so as to create the required demand can be characterized as the most essential parameters for the development of biomethane market. Moreover, the development of a digestate market and the active role of the policy makers are considered also as highly significant parameters during the design of policies and measures.

All the identified concepts are summarized in Table 6 for the case of Estonia.

Table 6: Results of the applied Fuzzy Cognitive Mapping in Estonia.

Concepts	Centrality	Outdegree	Indegree
Government does not have vision to promote biomethane and digestate production and consumption	1.37	1.13	0.23
Lack of funding	1.13	0.27	0.87
Which technology and fuels will prevail (2035) H2, engines, electricity	1.10	0.17	0.93
Enlarging the biomethane use in other sectors, when internal combustion engine is banned	0.93	0.17	0.77
To support the biomethane production	0.93	0.43	0.50
Production and consumption of the BioCH4 is good, cheap, ready-technology	0.90	0.23	0.67
Non-decisive – not taking responsibility	0.87	0.20	0.67
To finance biogas plants is complicated	0.73	0.00	0.73
Uncertainty of biogas plant developers about the biogas production feasibility	0.73	0.00	0.73
Unclear messages from EU – is the H" really solution, if 95% H2 is made from fossil fuels	0.67	0.67	0.00
Digestate market is unregulated, the demand is unclear, and the price is unclear	0.63	0.50	0.13
Soil fertality and it connection, impact from cattle breeding	0.63	0.50	0.13
To get certificate for the biogas digestate as fertilizer is complicated	0.63	0.50	0.13
The consumption of the CBM / LBM in heavy duty vehicles is not enough high	0.60	0.00	0.60
The unpredictability of the European institutions on for how long the biogas considers as green fuel	0.57	0.57	0.00
Na-batteries might be the solutions	0.53	0.53	0.00
The impact of increased number of green biomass harvesting to the natural diversity	0.53	0.53	0.00
Car manufacturing regulations should be life-cycle based rather than fuel-type based	0.53	0.27	0.27
Public procurements should be considering environmental impact rather than price and are not fulfilled	0.53	0.27	0.27
Awareness of biogas, biomethane, impacts, energetic nature, how it contributes to climate goal	0.50	0.40	0.10
We can maybe exceed the GHG targets, which gives others breathing room or a quota will be created, 24% to reduce the generation of GHG in transport	0.50	0.10	0.40

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Concepts	Centrality	Outdegree	Indegree
Heavy transport should differentiate taxes for renewable fuel vehicles compared to fossil fuel vehicles	0.47	0.23	0.23
NH3 is with the same space-volume RUUMALA, H2 more compared to the liquefied H2	0.40	0.27	0.13
Public procurement requirements are not fulfilled	0.40	0.13	0.27
Bank guarantee demand from environmental civil servants is nonsense, if you use biowaste	0.40	0.40	0.00
Slow process of the certification of the digestate, before certification you can't sell the digestate	0.40	0.10	0.30
Unpredictable Change in consumption and among consumers	0.40	0.00	0.40
Low awareness of the civil servants and lack of practical [biogas related] experiences	0.37	0.27	0.10
Estonian companies do not have strategic goal to use biofuels	0.33	0.27	0.07
The consumer's fee is too high of using natural gas /biomethane from distribution natural gas grid	0.33	0.33	0.00
The last day to inject to transmission grid is end of 2038?	0.33	0.33	0.00
The status of the transmission grid in future is unclear	0.33	0.33	0.00
Missing biomethane promoting strategy will affect the decisions of the banks to lend money for biogas plants	0.33	0.10	0.23
The long term GO and green certificate off-take contracts are missing, no confidence, that producer can sell the biomethane certificates next ten years	0.33	0.10	0.23
To build the CNG/CBM filling station is more expansive compared to the classical fossil fuels' filling station	0.33	0.10	0.23
Confusing messages from the EC, and from the Estonian Government	0.33	0.23	0.10
Need for the biomethane injection points to the NG transmission grid	0.33	0.00	0.33
The cost of the injection point to transmission grid is too expensive for producers	0.33	0.00	0.33
Lack of qualified experts/labor force in rural areas	0.30	0.00	0.30
City buses will start to use HVO instead of the biomethane	0.27	0.27	0.00
Competition in energy market	0.27	0.27	0.00
Farming emission tax and fossil fertilizer tax might raise interest among farmers to construct new biogas plants	0.27	0.27	0.00
Biomethane plants should be bigger to bring down production costs	0.27	0.13	0.13
ETS 2 reduces the price difference of the biomethane and other renewable fuels	0.27	0.13	0.13
The price of the biogas/biomethane is much higher than the natural gas, only the molecule price Is not competitive	0.27	0.13	0.13
Universities are making unprofessional research on biogas	0.27	0.17	0.10
Existing infrastructure, lower cost (due to Sweden blending obligation drop) and higher availability	0.27	0.10	0.17
"Silo towers" effect	0.27	0.00	0.27
Safety issues are not fully recognized in the case of using bioH2 in transport	0.27	0.00	0.27
The narrow mindset of the digestate-fertilizer certification auditor	0.23	0.10	0.13

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Concepts	Centrality	Outdegree	Indegree
5% of livestock will have to be grazed, which will lower 2nd generation feedstock availability for the plants	0.23	0.23	0.00
Economic factors - HVO footprint, the competence of this certificate if it is from third countries	0.23	0.00	0.23
Methane fuels have the future on heavy duty transport	0.23	0.00	0.23
There is no technology neutrality - there is CAPEX support to the H2 filling station but not to CBM filling station	0.20	0.20	0.00
Biogas/biomethane is local, renewable fuel of Future	0.20	0.10	0.10
Different depths and speeds of procedural processes	0.20	0.10	0.10
Fuel excise tax is 0 for biomethane, which supports the biomethane	0.20	0.10	0.10
The punctuality in demands (in permitting process) not understanding the biogas technologies	0.20	0.10	0.10
Lack of less packaging system to ensure the “floor price” of the biomethane	0.20	0.00	0.20
General too low awareness of the biogas and biomethane	0.17	0.17	0.00
There is no feedback in development	0.17	0.17	0.00
The negative attitude and tease of the neighbors and if they comply constantly to the local municipality and the civil servants in this municipality is afraid of making decisions	0.17	0.00	0.17
Cheap price of the fossil fuels, again, not the combustion engine is not bad, but fossil fuel usage in it courses climate change	0.13	0.13	0.00
Children of the biogas plant workers; to pay to the children for the spatial plan; but the right to pay is only for the actual costs for the beginning decision of the spatial plan	0.13	0.13	0.00
H2 promoters unfortunately distribute negative messages about biomethane (e.g. leakages from the production) with aim to increase the importance of the H2	0.13	0.13	0.00
Natural gas grid should become 2 pipe=2 direction meaning the if you inject at the end of the distribution network, injected biomethane can be transported to upstream	0.13	0.13	0.00
Subsidies, discounts	0.13	0.13	0.00
The (safety) regulations of filling stations are fixed, clear and working well in Estonia, it is pan-European	0.13	0.13	0.00
There is political certainty/continuity	0.13	0.13	0.00
Transport sector does not value biomethane as green fuel. Footprint calculations should evaluate CI score not volume	0.13	0.13	0.00
Wood based heating systems have better energy class than biomethane based heating systems	0.13	0.13	0.00
1000ha/a will be covered with forest, which will lower the feedstock availability for biogas plants	0.13	0.00	0.13
1000ha/a will be turned into wetland, which might or might not raise the availability of feedstocks for biogas plants	0.13	0.00	0.13
Lack of regulations for biomethane use in heating	0.13	0.00	0.13
The problems of certifying the digestate	0.13	0.00	0.13
Virtual pipeline is more expensive, but the local distribution grid is not able to take in all the produced biomethane	0.13	0.00	0.13
GHG objectives of the agricultural sector	0.10	0.10	0.00

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Concepts	Centrality	Outdegree	Indegree
Not moving towards CO2 based GHG emission reduction calculation methodology in transport	0.10	0.10	0.00
Permitting process is long, annoying – the circle of the stakeholders to be invited to the public hearing should be bigger	0.10	0.10	0.00
The extreme diligence of the civil servants without seeing the "bigger picture"	0.10	0.10	0.00
The impact of foreign markets - the market is bigger and the prices are harmonizing	0.10	0.10	0.00
Which is better, RED III options for GHG reduction: volume based or CO2 reduction based	0.10	0.10	0.00
Biomethane was cheaper in the filling station compared to the price of the biofuels	0.10	0.00	0.10
Making changes in spatial plan as part of the permitting process	0.10	0.00	0.10
No biogas cluster - cooperation with hydrogen cluster	0.10	0.00	0.10
People are the root cause - where there are leaders, things happen	0.10	0.00	0.10
There are no Biostation initiatives - novelty, involvement of young people, consumption and supply	0.10	0.00	0.10
Conflict of interest, interest of market participants may be different	0.03	0.03	0.00
How the GHG calculation will be carried out	0.03	0.00	0.03
Nonsense circularity – Finnish company produces H2 from natural gas, and then e-methane from this fossil H2	0.03	0.00	0.03
Estonian message – all busses must be with 0-emissions	0.00	0.00	0.00
The single civil servant is not able to make decision will lead to the "collective responsibility" where nobody will be responsible of the consequences the "collective" decision	0.00	0.00	0.00

The proposed policies and measures are summarized in Figure 11 depicting the main aspects, which should be taken into consideration in Estonia.

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Policy measure No1 **Formulating a vision for the promotion of biomethane**

- Prepare a dedicated strategy for the further penetration of biomethane with specific targets and policies
- Adopt the required legislation for achieving the specified targets

Policy measure No2 **Introducing financial support measures**

- Define and introduce financial support measures for the production of biomethane (e.g. indicatively subsidies, fiscal measures, CfDs etc.) to reduce the investment uncertainty
- Support the construction of filling stations and injection points

Policy measure No3 **Fostering the consumption side**

- Provide simplified financial support for accelerating the consumption of biomethane (e.g. such as indicatively subsidies, fiscal measures etc.)
- Define targets for biomethane consumption in specific end-use sectors (e.g. heavy goods vehicles, industry etc.)

Policy measure No4 **Promoting digestate based biofertilizer production**

- Design targeted regulatory and economic measures for the exploitation of the municipal and agricultural waste
- Promote the use of digestate as soil fertilizer into a regulated digestate market
- Simplify the certification of the digestate based biofertilizer

Policy measure No5 **Reinforcing the implementation of the public procurement procedures**

- Review and adapt the public procurement legislation so as to select the utilization and consumption of biomethane
- Incentivise the use of biomethane-based transport solutions

Policy measure No6 **Raising awareness with capacity building activities**

- Conduct capacity building activities to increase the existing level of knowledge
- Provide trainings to the respective professionals to enhance their skills

Policy measure No7 **Strengthening the role of the policy makers**

- Develop and apply specialised decision-making procedures with clear duties and responsibilities
- Support technically the policy makers to identify and implement the most effective solutions

Figure 9 : Proposed policies and measures in Estonia.

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Chapter 6: Policy measures in Greece

In Greece, the conduction of SWOT analysis (Figure 10) revealed that biomethane plants should be supported with capital and/or operational subsidies as it is considered as a crucial factor. The maximum exploitation of the theoretical biomethane potential is another substantial parameter, while the promotion and utilization of the digestate as soil fertilizer and the sequential cropping can facilitate the further penetration of biomethane. Finally, the promotion of the gas market as this will be the main carrier of biomethane is also.

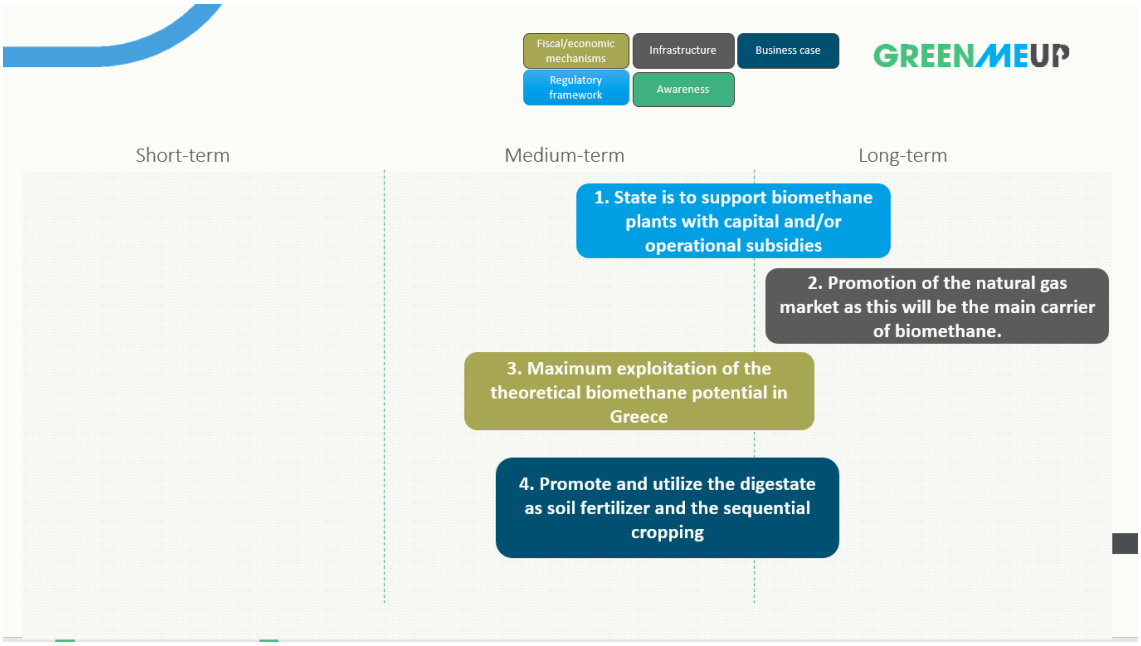

Figure 10 : Results of SWOT analysis in Greece.

Totally, eight stakeholders participated in the application of the FCM analysis. The main results of the FCM method are presented in Table 7 for the case of Greece.

Table 7: Overview of the applied Fuzzy Cognitive Mapping in Greece.

Individual maps	Policy Hub: 2, Market Hub: 5, Society Hub: 1
Number of variables	58
Number of connections	139
Number of transmitter variables	18
Number of receiver variables	3
Number of ordinary variables	36
Receiver to transmitter ratio	0.17
Density	0.041

According to the results of the FCM method in Greece (Table 8), the preparation of a national strategy, the adoption of a legislative framework, the introduction of investment and operational support scheme and financial incentives, the availability and collection of raw materials along with the location and licensing of units can be characterized as the most

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important parameters for the development of biomethane market. It should be noted that the promotion of waste management and the social acceptance are considered also as critical factors, which must be taken into account during the design of policies and measures.

All the identified concepts are summarized in Table 8 for the case of Greece.

Table 8: Results of the applied Fuzzy Cognitive Mapping in Greece.

Concepts	Centrality	Outdegree	Indegree
Development of biomethane market	5.83	0.05	5.78
Raw materials	2.02	1.22	0.80
Social acceptance	1.28	0.63	0.65
Location of units	1.10	0.78	0.32
Waste management	0.95	0.73	0.22
National Strategy and legislation	0.85	0.85	0.00
Licensing of units	0.83	0.48	0.35
Investment support scheme	0.75	0.42	0.33
Financial incentives	0.75	0.62	0.13
By-product management	0.75	0.47	0.28
Supply chain	0.72	0.22	0.50
Operational support scheme	0.70	0.45	0.25
Availability and collection of raw material	0.63	0.42	0.22
Consumer awareness campaign	0.60	0.35	0.25
Environmental impact of units	0.53	0.37	0.17
Legal framework	0.43	0.30	0.13
Problem solving for biogas production	0.40	0.23	0.17
Demand increase in the final consumption sectors	0.33	0.13	0.20
Disposal of digested residue	0.30	0.25	0.05
Legal framework for waste/biomass management	0.27	0.22	0.05
Virtual liquefaction	0.25	0.25	0.00
Staffing and organization of services for the licensing and control of the operation of units	0.23	0.13	0.10
Cost of gas network connection and use	0.23	0.15	0.08
Proper utilization (not electricity production)	0.23	0.15	0.08
Targets	0.22	0.13	0.08
Coverage of needs provided for by the legislative framework	0.22	0.08	0.13
Biomethane specifications	0.22	0.22	0.00
Difficulty of building large units	0.22	0.05	0.17
Existence of LNG bunkering market	0.22	0.05	0.17
Gas mobility market maturity	0.22	0.05	0.17
Use of bioLNG and bioCNG near urban area	0.20	0.15	0.05
PPAs	0.20	0.20	0.00
Certification as renewable gas	0.17	0.12	0.05
Support for upgrading existing units (anaerobic digestion and gasification) to biomethane units	0.17	0.12	0.05
Disincentives for unsustainable waste management	0.15	0.15	0.00
Terms of connection to the national grid	0.15	0.08	0.07
Economic sustainability	0.13	0.13	0.00
Technological progress (gasification)	0.13	0.08	0.05

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Concepts	Centrality	Outdegree	Indegree
Limited quantities	0.13	0.00	0.13
Market mechanisms	0.12	0.12	0.00
Positive environmental impact of units	0.12	0.12	0.00
European interconnection/harmonization	0.10	0.05	0.05
Biogas power generation incentives	0.08	0.08	0.00
Low level of knowledge	0.08	0.08	0.00
Workforce training and specialization	0.08	0.08	0.00
Transparency	0.08	0.03	0.05
Access to the distribution/transmission network	0.07	0.07	0.00
Expertise in building. operating and managing units	0.07	0.07	0.00
Non-cooperation of manure/wastewater producers – supply problem	0.07	0.07	0.00
Utilization of national and European resources	0.07	0.07	0.00
Disincentives at the biogas production stage	0.07	0.03	0.03
Secondary raw material market	0.07	0.03	0.03
Availability of urban and other wastewater treatment units	0.07	0.00	0.07
Competition with RDF/SRF	0.05	0.05	0.00
High level of bureaucracy	0.05	0.05	0.00
Use of existing infrastructure for heating buildings	0.05	0.00	0.05
RES competitive advantage	0.03	0.03	0.00
Availability/connectivity of networks	0.00	0.00	0.00

The proposed policies and measures are summarized in Figure 11 depicting the main aspects, which should be taken into consideration in Greece.

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Policy measure No1 **Assessing the feedstock potential**

- Assess the sustainable feedstock potential
- Identify and incentivise the untapped feedstock potential
- Map the targeted feedstock potential

Policy measure No2 **Raising awareness with capacity building activities**

- Conduct capacity building activities to increase the existing level of knowledge
- Understand and disseminate economic, social and environmental benefits and risks
- Facilitate the technology transfer and provide trainings to the respective professionals

Policy measure No3 **Establishing efficient permitting and spatial procedures**

- Simplify and streamline the permitting procedures to reduce the length and the bureaucracy
- Conduct spatial gas grid planning based on the mapping of biomethane production potential

Policy measure No4 **Introducing financial support measures**

- Define and introduce financial support measures for the production of biomethane (e.g. indicatively subsidies, fiscal measures, CfDs etc.)

Policy measure No5 **Adopting the regulatory framework for waste management**

- Design and adopt a long-term regulatory and legal framework for the targeted exploitation of available wastes

Policy measure No6 **Fostering the exploitation of the by-products**

- Design targeted regulatory and economic measures for the exploitation of the available by-products
- Promote the use of digestate as soil fertilizer

Policy measure No7 **Establishing the required supply chains**

- Stimulate and support the development of a reliable and competitive equipment supply chain
- Provide training to the involved stakeholders to improve their skills and to ensure quality

Policy measure No8 **Drafting a strategy and adopting the required legislation**

- Formulate a dedicated strategy for the further penetration of biomethane with specific targets and policies
- Adopt the required legislation for achieving the specified targets

Figure 11 : Proposed policies and measures in Greece.

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Chapter 7: Policy measures in Latvia

In Latvia, the conduction of SWOT analysis (Figure 12) outlined that the provision of targeted investments and incentives as well as the leverage of current infrastructure for EU funding are perceived as the most important parameters. The strengthening of the regulatory framework and the conduction of awareness-raising and education campaigns should be foreseen in the short term, while the integration of biomethane with circular economy is anticipated in the long run.

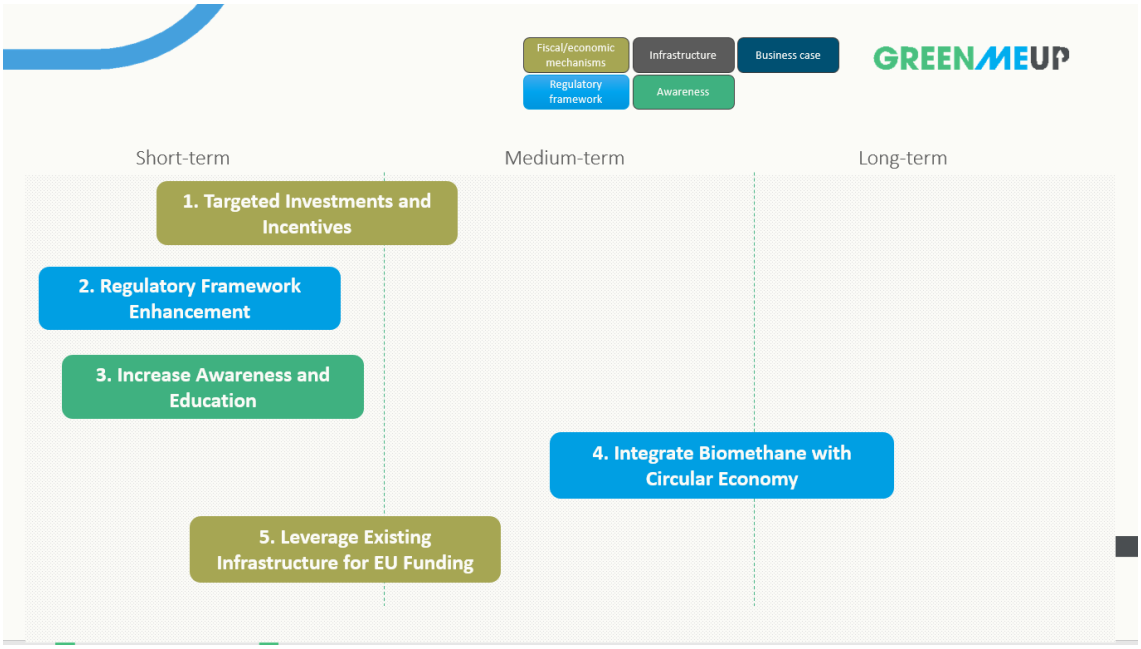

Figure 12 : Results of SWOT analysis in Latvia.

Totally, eight stakeholders participated in the application of the FCM analysis. The main results of the FCM method are presented in Table 9 for the case of Latvia.

Table 9: Overview of the applied Fuzzy Cognitive Mapping in Latvia.

Individual maps	**Policy Hub: 2, Market Hub: 6**
Number of variables	54
Number of connections	108
Number of transmitter variables	6
Number of receiver variables	11
Number of ordinary variables	37
Receiver to transmitter ratio	1.83
Density	0.037

According to the results of the FCM method in Latvia (Table 10), the lack of current legislation, the frequent change of regulations, the willingness to invest in biomethane as well as the developed targets for biomethane use in transport sector appear to be of high importance. At the same time, the low potential and the need for investments of biomethane production,

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the incentives for biomethane consumption, the lack of support for infrastructure development as well as the existence of an appropriate infrastructure in terms of input into the network and for the consumption and transmission filling are also vital factors.

All the identified concepts are summarized in Table 10 for the case of Latvia.

Table 10: Results of the applied Fuzzy Cognitive Mapping in Latvia.

Concepts	Centrality	Outdegree	Indegree
Willingness to invest (availability of funds, support for equipment, infrastructure)	1.18	0.18	1.00
Frequent change of regulations	1.02	0.90	0.13
Lack of support for infrastructure development	0.97	0.45	0.53
Low potential of biomethane production	0.70	0.35	0.35
Lack of current legislation	0.62	0.32	0.30
Developed targets for biomethane use in transport sector	0.60	0.17	0.43
Investments in production	0.58	0.00	0.58
Normative regulation. its existence	0.55	0.30	0.25
Biomethane consumption. consumption incentive	0.50	0.30	0.20
Infrastructure (input into the network) and also for filling (consumption and transmission)	0.50	0.20	0.30
Lack of support for transport	0.50	0.22	0.28
Unstable electricity generation price/market price fluctuations	0.47	0.40	0.08
Local businesses lack motivation to purchase locally produced biomethane	0.45	0.22	0.23
CAPEX support	0.43	0.28	0.15
EU energy and climate targets	0.43	0.38	0.05
Biogas is not a priority in energy policy	0.40	0.15	0.25
Restrictions on methane utilization in gas supply	0.40	0.20	0.20
Availability of raw materials	0.35	0.30	0.05
Wide applicability of gas as a transport fuel	0.35	0.10	0.25
Lack of support from municipalities for biomethane development	0.35	0.17	0.18
Clearly defined goals (in policy planning documents)	0.32	0.32	0.00
Lack of long-term strategy	0.30	0.13	0.18
Public opinion	0.30	0.25	0.05
Public awareness of biomethane	0.30	0.30	0.00
Project profitability	0.28	0.10	0.18
Availability of vehicles	0.25	0.13	0.13
Transport energy law	0.25	0.25	0.00
Cross-border trade (import/export)	0.23	0.03	0.20
Opportunities for companies to use biomethane as green energy to meet their sustainability goals	0.23	0.13	0.10
Political settlement	0.22	0.17	0.05
Negative previous experience of support mechanisms	0.20	0.13	0.08
Unstable and unclear political environment	0.20	0.00	0.20
Employment in the industry	0.18	0.08	0.10
Lack of infrastructure/specificity	0.18	0.08	0.10
Tax policy	0.18	0.10	0.08

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Concepts	Centrality	Outdegree	Indegree
Equipment prices	0.18	0.00	0.18
The price difference between biomethane and methane	0.13	0.08	0.05
Support of commercial banks for project implementation (not financed)	0.13	0.05	0.08
Low biofuel targets	0.13	0.00	0.13
Low fines in the transport sector for failure to meet targets	0.13	0.00	0.13
No standardized methodology for biogas statistics	0.13	0.00	0.13
Support for infrastructure	0.13	0.13	0.00
Vehicle policy for CNG/LNG (lower taxes. purchase support)	0.13	0.13	0.00
Lack of recognition in society and government	0.10	0.05	0.05
Support for transport development	0.10	0.00	0.10
Bureaucratic disorder from a legal perspective involves establishing points of pressure	0.08	0.03	0.05
Clear and reasonable technical requirements that must be met for the injection point	0.08	0.03	0.05
The issue of land property rights	0.08	0.00	0.08
Equipment delivery time limits	0.05	0.05	0.00
Lack of support for producers in purchasing biomethane equipment. insufficient utilization of EU financial resources	0.05	0.03	0.03
Restriction of fossil fertilizers and untreated manure in agriculture	0.05	0.03	0.03
Stability in the market	0.05	0.00	0.05
The desire to farm more efficiently. to produce electricity more efficiently	0.05	0.00	0.05
Integration and system ambiguity of GO and POS systems	0.03	0.00	0.03

The proposed policies and measures are summarized in Figure 13 presenting the main aspects, which should be taken into consideration in Latvia.

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Policy measure No1 **Ensuring political and regulatory stability**

- Continue, monitor and improve the existing policy framework
- Assess and improve the legislative framework
- Remove any legislative barriers

Policy measure No2 **Drafting a roadmap and adopting the required legislation**

- Prepare a roadmap for the further penetration of biomethane with specific targets and policies
- Adopt the required legislation for achieving the specified targets

Policy measure No3 **Introducing financial support measures**

- Define and introduce financial support measures for the production of biomethane (e.g. indicatively subsidies, fiscal measures etc.)

Policy measure No4 **Assessing and increasing the feedstock potential**

- Assess the sustainable feedstock potential
- Identify and incentivise the untapped feedstock potential
- Map the targeted feedstock potential

Policy measure No5 **Fostering the consumption side with targeted incentives**

- Provide financial support for accelerating the consumption of biomethane (e.g. such as indicatively subsidies, fiscal measures etc.)
- Define targets for biomethane consumption

Policy measure No6 **Developing the required infrastructure**

- Accelerate the construction of the required infrastructure based on the mapping of biomethane production potential
- Develop a zoning approach according to infrastructure grid and assess future needs

Policy measure No7 **Raising awareness with capacity building activities**

- Conduct capacity building activities to increase the existing level of knowledge
- Understand and disseminate economic, social and environmental benefits and risks
- Facilitate the technology transfer and provide trainings to the respective professionals

Figure 13 : Proposed policies and measures in Latvia.

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Chapter 8: Policy measures in Poland

The development of a biomethane strategy in Poland with a clear target in different energy sectors, the promotion of the decarbonisation of the transport sector by including biomethane as key transportation fuel, the promotion of the involvement of local actors in knowledge transfer and innovation as well as the introduction of improvements to obtain required permits are considered as the most important factors at short-term basis according to the results of SWOT analysis (Figure 14). The only parameter that refers to the short and medium term is the introduction of economic instruments to support the biomethane market.

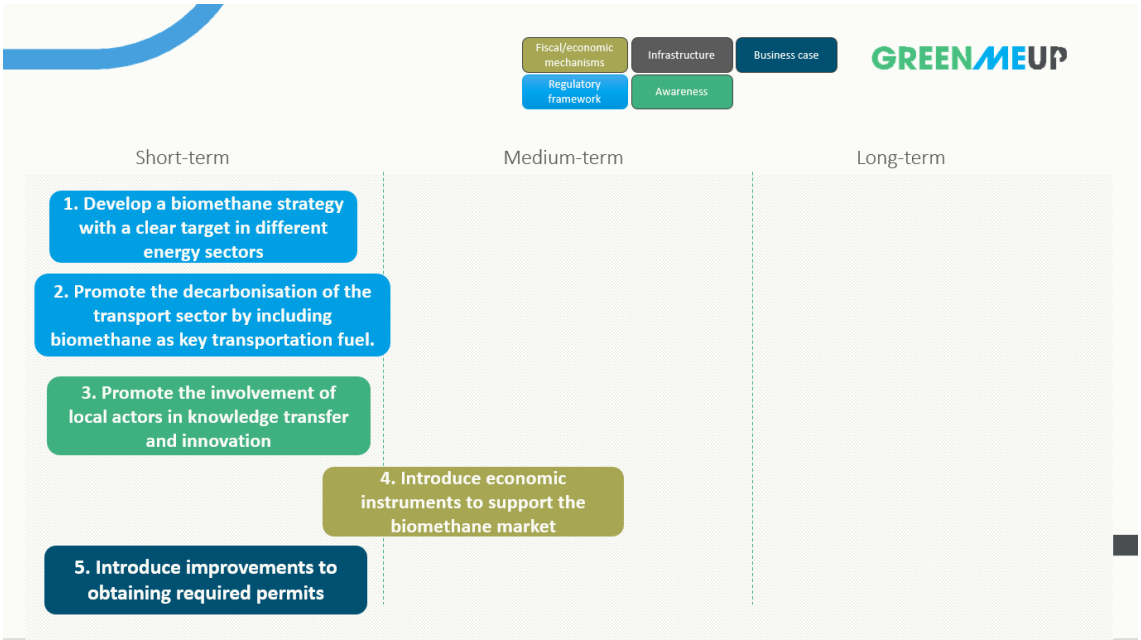

Figure 14 : Results of SWOT analysis in Poland.

Totally, ten stakeholders participated in the application of the FCM analysis. The main results of the FCM method are presented in Table 11 for the case of Poland.

Table 11: Overview of the applied Fuzzy Cognitive Mapping in Poland.

Individual maps	**Policy Hub: 2, Market Hub: 3, Policy-Market Hubs:4 and Policy-Society Hubs: 1**
Number of variables	23
Number of connections	66
Number of transmitter variables	5
Number of receiver variables	2
Number of ordinary variables	16
Receiver to transmitter ratio	0.40
Density	0.125

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According to the results of the FCM method in Poland (Table 12), the large feedstock potential resulting from the agri-food industry and waste management and its interest in using green gas in conjunction with closed-loop waste management are the most important parameters that will help protect the environment. In addition, the introduction of reference prices for biomethane, the financial support for renewable energy projects, the further development of gas network, gaining some independence from imported gas, as well as several difficulties with fulfilment of EU requirements concerning share of RES in transport in RED are of paramount importance.

All the identified concepts are summarized in Table 12 for the case of Poland.

Table 12: Results of the applied Fuzzy Cognitive Mapping in Poland.

Concepts	Centrality	Outdegree	Indegree
Large feedstock potential resulting from the agri-food industry and waste management	2.48	1.66	0.82
Industry e.g. agri-food sector are interested in use of green gas - reduction of GHG emissions from their production	1.30	0.48	0.82
Closed-loop waste management will help protect the environment	1.24	0.58	0.66
Amendment of the RES Act in 2023	1.04	0.78	0.26
Introduced reference prices for biomethane	0.96	0.52	0.44
Financial support for renewable energy projects	0.90	0.68	0.22
Developed gas network	0.78	0.28	0.50
Difficulties with fulfilment of EU requirements concerning share of RES in transport in RED	0.70	0.10	0.60
Gain some independence from imported gas	0.66	0.16	0.50
EU climate policy	0.64	0.32	0.32
Increasing demand for carbon dioxide from renewable sources will improve the return on investment	0.48	0.16	0.32
Ability to replace about 20% of current natural gas imports with biomethane	0.46	0.18	0.28
10% of gaseous fuels transported via gas grids should be renewable and low-emission ones in 2030 (PEP2040)	0.42	0.00	0.42
OPEX support by biogas plants	0.30	0.12	0.18
Plans of the distribution companies for the increase of the absorption capacity of the gas networks	0.28	0.14	0.14
Introduced new biofuels – biomethane and biohydrogen for the fulfilment of the national indicative target	0.20	0.00	0.20
Current geopolitical situation (war in Ukraine, gas and energy prices)	0.16	0.10	0.06
An amendment of PEP 2040 is under preparation	0.16	0.16	0.00
Lack of a biomethane development strategy with clear targets	0.12	0.06	0.06
Social protests against biogas and biomethane projects	0.10	0.10	0.00
Problems with obtaining administrative permissions	0.10	0.10	0.00
No clear rules of cooperation between gas system operators and producers	0.08	0.08	0.00
Lack of support system for larger biomethane installations (> 1 MW)	0.04	0.04	0.00

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The proposed policies and measures are summarized in Figure 15 summarizing the main aspects, which should be taken into consideration in Poland.

Policy measure No1 **Exploiting the feedstock potential**

- Assess the sustainable feedstock potential
- Identify untapped feedstock potential that should be targeted
- Map the targeted feedstock potential

Policy measure No2 **Introducing financial support measures**

- Define and introduce financial support measures for the production of biomethane (e.g. indicatively subsidies, fiscal measures, CfDs etc.)

Policy measure No3 **Promoting waste management**

- Design targeted regulatory and economic measures for the exploitation of the available wastes

Policy measure No4 **Fostering the consumption side**

- Provide financial support for accelerating the consumption of biomethane (e.g. such as indicatively subsidies, fiscal measures etc.)
- Define targets for biomethane consumption

Policy measure No5 **Improving the legislative framework**

- Simplify, improve and streamline the existing legislative framework
- Remove any legislative barriers

Policy measure No6 **Setting more ambitious targets**

- Define more ambitious targets for biomethane production and consumption
- Incorporate the increased targets within the policy framework
- Exploit the developed natural gas network

Figure 15 : Proposed policies and measures in Poland.

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Chapter 9: Policy measures in Spain

In Spain, the conduction of SWOT analysis (Figure 16) led to the conclusion the adjustment of a realistic roadmap with clear biomethane targets, in line with the REPowerEU objectives, the implementation of a consumption incentive system with quotas for gas traders and the increase of the intensity of coordination to integrate the solutions that biogas/biomethane brings to the issues of environment, agriculture, livestock and depopulation are considered as vital factors for the further deployment of biomethane.

Similarly, the promotion of a common framework for cooperation and dialogue between stakeholders (i.e. producers, investors, traders, final consumers, etc.) and the proposal of a system of economic and fiscal incentives for the development of the projects should be fostered in the short term.

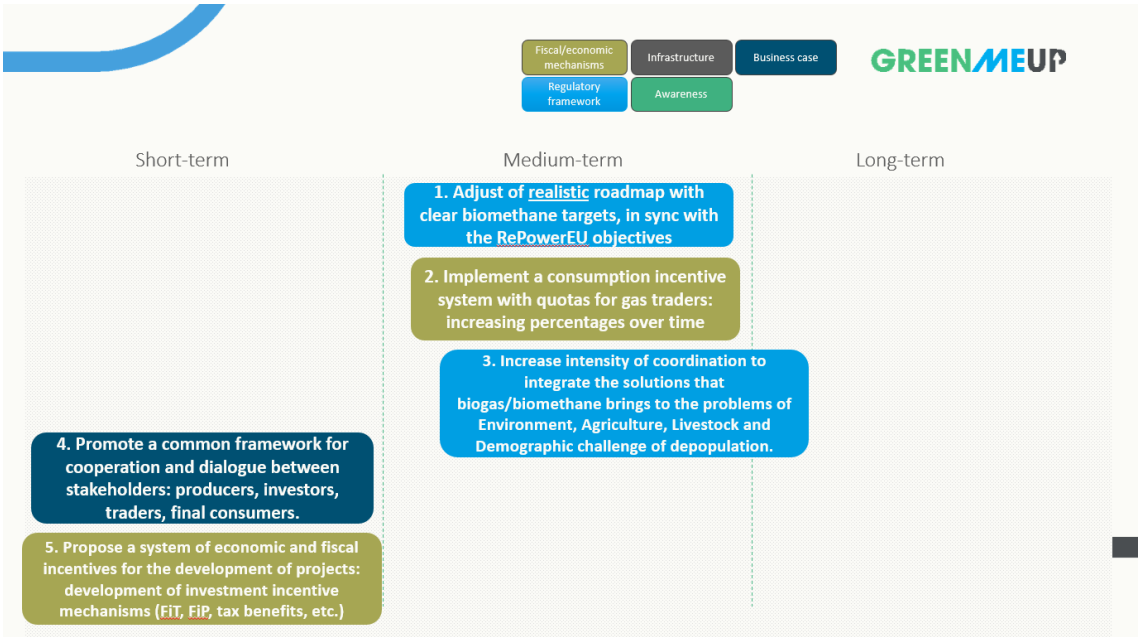

Figure 16 : Results of SWOT analysis in Spain.

Totally, twelve stakeholders participated in the application of the FCM analysis. The main results of the FCM method are presented in Table 13 for the case of Spain.

Table 13: Overview of the applied Fuzzy Cognitive Mapping in Spain.

Individual maps	**Policy Hub: 1, Market Hub: 8, Society Hub: 3**
Number of variables	13
Number of connections	29
Number of transmitter variables	1
Number of receiver variables	3
Number of ordinary variables	9
Receiver to transmitter ratio	3.00
Density	0.172

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According to the results of the FCM method in Spain (Table 14), a system of economic and fiscal incentives, with a focus on positive externalities, as well as a consumption incentive scheme should be initiated. Moreover, the legal framework and legal certainty, the development of a realistic roadmap with clear objectives, the adoption of a clear legislation on digestates and the establishment of a common framework for cooperation and dialogue are also required taking into account their importance.

All the identified concepts are summarized in Table 14 for the case of Spain.

Table 14: Results of the applied Fuzzy Cognitive Mapping in Spain.

Concepts	Centrality	Outdegree	Indegree
Economic and Fiscal Incentives System	0.78	0.38	0.40
Focus on positive externalities	0.77	0.08	0.68
Consumption Incentive Scheme	0.70	0.20	0.50
A legal framework and legal certainty	0.70	0.57	0.13
Realistic roadmap with clear objectives	0.38	0.32	0.07
Clear legislation on digestates	0.33	0.28	0.05
Need for Reverse Flow Units	0.23	0.17	0.07
CAPEX aid	0.18	0.12	0.07
Regulate the establishment of the Polluter Pays Principle	0.17	0.08	0.08
Influence of increased coordination in the implementation of biogas/biomethane policies	0.15	0.15	0.00
Promoting a common framework for cooperation and dialogue	0.12	0.00	0.12
Circular Economy and Cooperation Proposal	0.12	0.00	0.12
Creation of a quota system for gas traders	0.07	0.00	0.07

The proposed policies and measures are summarized in Figure 17 outlining the main aspects, which should be taken into consideration in Spain.

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Policy measure No1 **Introducing financial support measures**

- Define and introduce financial support measures for the production of biomethane (e.g. indicatively subsidies, fiscal measures, CfDs etc.)
- Encourage the operation of Reverse Flow Units

Policy measure No2 **Integrating positive externalities into the decision-making**

- Develop a methodology for assessing and quantifying the triggered externalities by the production and consumption of biomethane
- Adopt the respective legislative framework for taking into consideration the quantified externalities

Policy measure No3 **Fostering the consumption side with targeted incentives**

- Provide financial support for accelerating the consumption of biomethane (e.g. such as indicatively subsidies, fiscal measures etc.)
- Define targets for biomethane consumption

Policy measure No4 **Adopting the regulatory framework for the by-products**

- Design and adopt a long-term regulatory and legal framework for the targeted exploitation of the produced by-products

Policy measure No5 **Drafting a roadmap and adopting the required legislation**

- Prepare a roadmap for the further penetration of biomethane with specific targets and policies
- Adopt the required legislation for achieving the specified targets

Policy measure No6 **Promoting a common framework for cooperation and dialogue**

- Engage actively all the involved stakeholders with targeted activities
- Establish a network with the balanced participation of all the involved stakeholders
- Ensure the cooperation of the involved stakeholders

Figure 17 : Proposed policies and measures in Spain.

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Chapter 10: Conclusions

Totally, 68 stakeholders participated into the application of the FCM identifying 323 concepts, which are related to the further penetration of biomethane.

A synopsis of the main outcomes of the FCM in the seven target countries is presented in Table 15.

The analysis of the numerous maps in combination with the obtained results by SWOT analysis led to identification of the most effective policies and measures in the examined target countries.

Table 15: Overview of the applied Fuzzy Cognitive Mapping in the target countries.

Individual maps	**68**
Number of variables	323
Number of connections	693
Number of transmitter variables	74
Number of receiver variables	56
Number of ordinary variables	190

The identified policies and measures are displayed in Table 16.

It should be noted that the 49 proposed policies and measures are characterized by both considerable similarities and differences demonstrating that both the main national conditions and priorities have been taken into consideration during the applied co-designed approach within the framework of the GreenMeUp project.

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Table 16: Overview of the proposed policies and measures in the target countries.

Czech Republic	Danube Region	Estonia	Greece	Latvia	Poland	Spain
PM1: Introducing financial support measures **PM2**: Accelerating the adoption of the legislative improvements **PM3**: Ensuring political stability **PM4**: Decreasing administrative complexity and bureaucracy **PM5**: Exploiting the available feedstock potential **PM6**: Capitalizing the experienced staff and the supplier companies **PM7**: Increasing the ambition of the specified targets	**PM1**: Promoting a holistic framework for cooperation and dialogue **PM2**: Drafting a strategy and adopting the required legislation **PM3**: Establishing the required supply chains **PM4**: Raising awareness with capacity building activities **PM5**: Harmonising/enabling the regulatory framework **PM6**: Introducing financial support measures **PM7**: Assessing the feedstock potential **PM8**: Promoting the use of bio-CNG/bio-LNG	**PM1**: Formulating a vision for the promotion of biomethane **PM2**: Introducing financial support measures **PM3**: Fostering the consumption side **PM4**: Promoting digestate based biofertilizer production **PM5**: Reinforcing the implementation of the public procurement procedures **PM6**: Raising awareness with capacity building activities **PM7**: Strengthening the role of the policy makers	**PM1:** Assessing the feedstock potential **PM2**: Raising awareness with capacity building activities **PM3**: Establishing efficient permitting and spatial procedures **PM4**: Introducing financial support measures **PM5**: Adopting the regulatory framework for waste management **PM6**: Fostering the exploitation of the by-products **PM7**: Establishing the required supply chains **PM8**: Drafting a strategy and adopting the required legislation	**PM1**: Ensuring political and regulatory stability **PM2**: Drafting a roadmap and adopting the required legislation **PM3**: Introducing financial support measures **PM4**: Assessing and increasing the feedstock potential **PM5**: Fostering the consumption side with targeted incentives **PM6**: Developing the required infrastructure **PM7**: Raising awareness with capacity building activities	**PM1**: Exploiting the feedstock potential **PM2**: Introducing financial support measures **PM3**: Promoting waste management **PM4**: Fostering the consumption side **PM5**: Improving the legislative framework **PM6**: Setting more ambitious targets	**PM1**: Introducing financial support measures **PM2**: Integrating positive externalities into the decision-making **PM3**: Fostering the consumption side with targeted incentives **PM4**: Adopting the regulatory framework for the by-products **PM5**: Drafting a roadmap and adopting the required legislation **PM6**: Promoting a common framework for cooperation and dialogue

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Annex I: Guidelines for the implementation of the Fuzzy Cognitive Mapping (FCM)

I. Conduct the required preparatory activities

Please organize the interviews, which have to be carried out for the implementation of the FCM.

At least ten interviews should be conducted with the most important stakeholders.

Ideally, three stakeholders from each of the different category of stakeholders (namely decision makers, market and society) have to participate into the planned interviews.

The foreseen work should be implemented for the seven targeted countries (e.g., Czech, Danube region, Estonia, Greece, Latvia, Spain and Poland).

II. Formulate the question

Firstly, present very briefly the main objective of the interviews, which is to identify the most important design aspects for achieving the design and implementation of the required market uptake measures for the further penetration of the biomethane.

It is recommended to present very briefly the obtained results within the framework of both the D4.1 and the performed SWOT analysis.

Then, please make the following question:

- ***What are the most important enabling factors for the market uptake for the further penetration of biomethane in your country?***

It is recommended to mention indicative key words according to the priorities as outlined within D4.1 and the SWOT analysis (such as the provision of investment and operational subsidies, the establishment of the required supply chain, the selection of the most effective technology etc.)

III. Draw the main factors

Please display all the factors into a sheet as identified by the interviewee.

Please ask from the interviewee to elaborate about the reasons for selecting them.

It is recommended to mention potential factors without affecting his judge.

IV. Connect the identified factors

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Please connect with an arrow the identified factors, which are affected. It should be noted that the line ⟶ indicates that the one factor affects the other one, while the line ⟷ indicates that a mutual interaction exists between the identified factors.

V. Quantify the influence of each connection

Please quantify the influence of each connection with the following Likert scale:

- -5 negatively very strong connection
- -4 negatively strong connection
- -3 negatively medium connection
- -2 negatively weak connection
- -1 negatively very weak connection
- 1 positively very weak connection
- 2 positively weak connection
- 3 positively medium connection
- 4 positively strong connection
- 5 positively very strong connection

VI. Complete interview protocol

Please complete the template, which is presented in Annex, for each interview separately in order to summaries the performed activities.

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Annex II: Template for describing the performed activities for each interview separately

i. Information about the interview

Please provide information about the conducted interview such as:

- Place
- Date
- Name of the interviewee
- Position of the interviewee
- Other

ii. Identified factors

Please elaborate briefly about the main rationale, which led the interviewee to the selection of the factors.

iii. Relationships among the identified factors

Please document briefly the reasons for the specified direction of the arrows among the identified factors.

iv. Influence of the identified relationships

Please document briefly the reasons for the specified strength of influence of the arrows among the identified factors.

v. Fuzzy Cognitive Map

Please insert the developed Fuzzy Cognitive Map as resulted by the previous steps.

vi. Areas of improvement

Please mention briefly potential difficulties, which confronted during the conduction of the interview.

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