D4.1 Policy briefings with key policy requirements for improved market uptake of biomethane (EU and 7 target countries)

Deliverable n.4.1

GREENMEUP

Document control sheet

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Contents

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

List of figures

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 bioCH_4 markets to operate efficiently and effectively in the advanced and target countries where results could be replicated.

The achievement of the before-mentioned target will be carried out through the coordinated interaction of the foreseen activities within the framework of GreenMeUp project steering and enabling the development of more informed and targeted policies in the target countries and supporting them in building a robust and incentive-compatible bioCH_4 market in their final energy consumption by 2030 and beyond.

The aim of this deliverable is to provide a comprehensive list of policy briefings with key policy requirements for improved market uptake of biomethane in the seven target countries (Danube region, Czech, Greece, Latvia, Poland, Spain and Estonia) and at EU level.

The identification of the comprehensive list of policy briefings should be resulted with the actual and active involvement of key stakeholders so as to identify, outline and formulate the need and rationale of future policy interventions.

The applied methodology intends to provide insights to the following questions:

- Which are the key issues under consideration for bioCH_4 to contribute to EU/ national renewable targets for 2030 and the Fitfor55 ?
- Why is the government intervention necessary ?
- What are the policy objectives and envisioned results ?

Chapter 2 presents in detail the applied methodology, while the obtained results both for the examined countries and the different categories of stakeholders are presented analytically in Chapters 3 and 4 respectively. Finally, Chapter 5 summarizes the key findings and Annex in the final chapter illustrates the developed questionnaire, which was utilized in order to obtain the responses from the involved stakeholders.

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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).

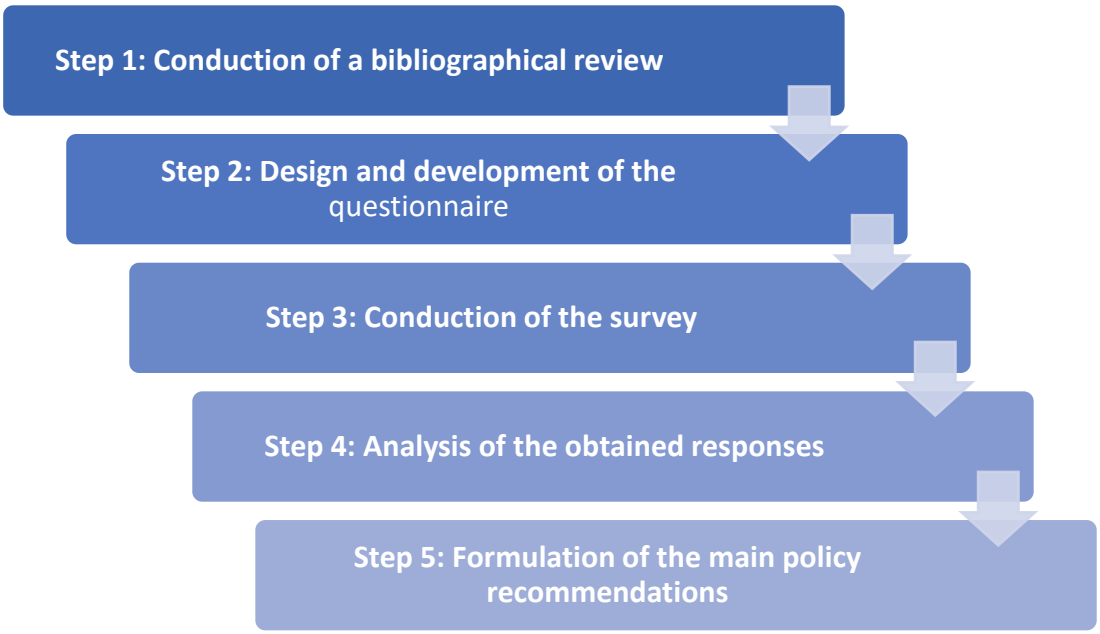

Figure 1 : Applied methodological approach.

Firstly, an in-depth bibliographical review was conducted in the 1st step focused on relevant scientific publications for the design of renewable gases. In the 2nd step, a questionnaire was developed incorporating the main identified aspects, which must be taken into consideration during the design of policies and measures so as to promote the biomethane. The developed questionnaire is presented in Annex including information about the utilized scales.

Then, the developed questionnaire was distributed to the different stakeholders in the 3rd step in order to elicit their perceptions and expectations in regards the penetration of biomethane. Totally 85 stakeholders participate into the conducted survey representing six countries (e.g., Czech, Danube region, Estonia, Greece, Latvia, Spain and Poland. The allocation of the collected questionnaires to the different examined countries is displayed in Figure 2. It should be noted that the involved stakeholders were classified into three different categories of stakeholders (e.g., decision makers, market players and society). The allocation of the collected questionnaires to the different categories of stakeholders is displayed in Figure 3.

The collected responses were analysed thoroughly in the 4th step, while the obtained results were scrutinized taking into account the different countries and categories of stakeholders. Finally, the main policy recommendations were formulated in the 5th step taking into account the results of the previous step. It should be noted that the responses, which were assessed with a score higher than four, were taken mainly into account for the identification of the most important policy recommendations.

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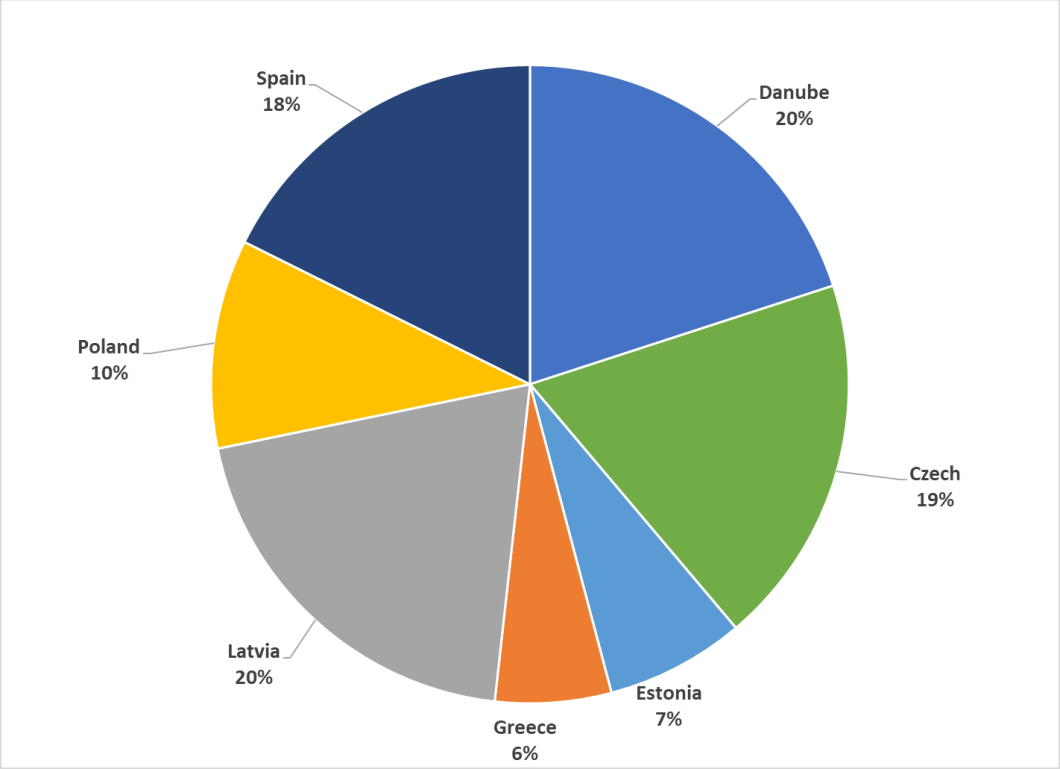

Figure 2 : Allocation of the collected questionnaires to the different countries.

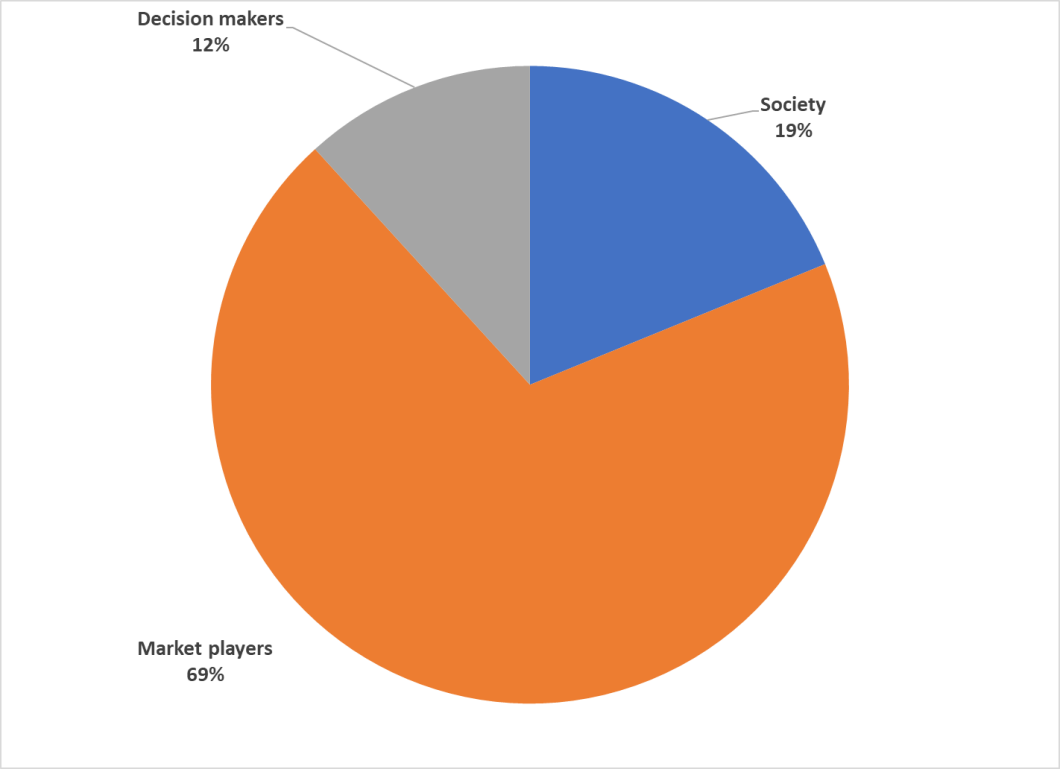

Figure 3 : Allocation of the collected questionnaires to the different categories of stakeholders.

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Chapter 3: Policy design according to the involved countries

Biomethane is considered as the most prominent alternative in all examined countries for the fulfilment of the 2030's energy and climate targets (Figure 4). Biogas will have also meaningful role in three countries (Danube region, Greece and Estonia), while BioLNG and BioCNG seem to have leading role in Czech, Estonia, Spain and Greece. Moreover, bioH_2 is expected to have a vital role also in Greece until 2030.

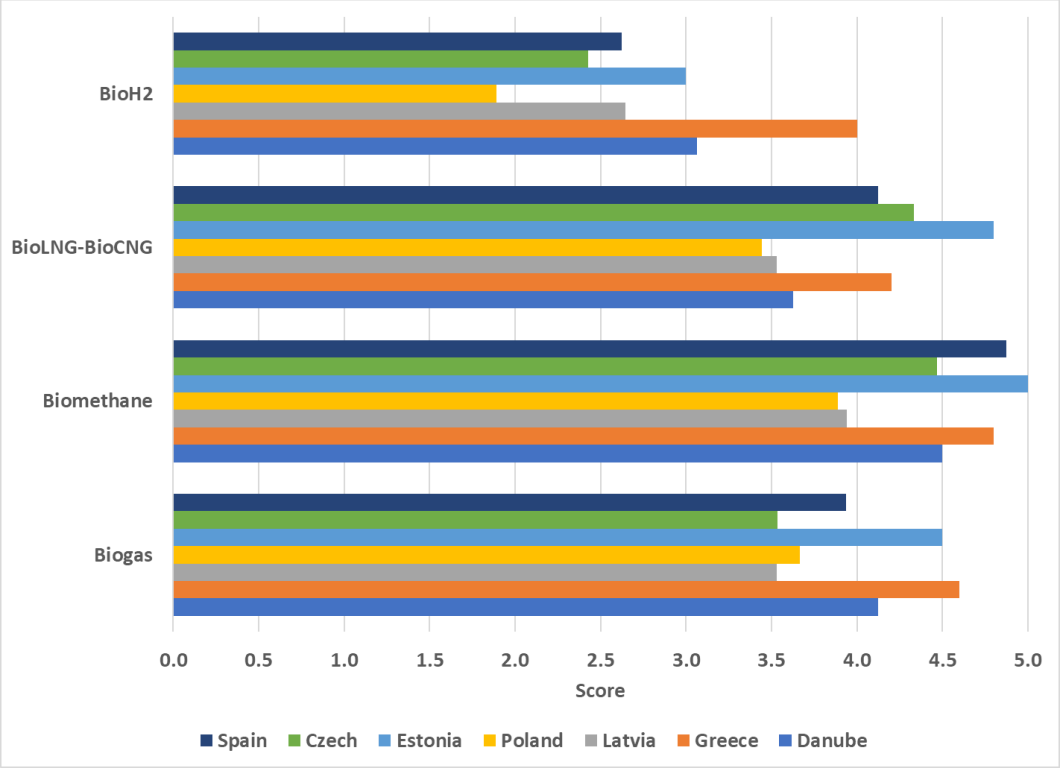

Figure 4 : Potential role of the different alternative fuels to the fulfillment of the 2030's energy and climate targets in the examined countries.

Biomethane will continue to be the most prominent alternative in all examined countries for the fulfilment of the 2050's energy and climate targets with the exemption of Estonia, which is expected to be the forerunner in the promotion of BioLNG and BioCNG (Figure 5). The penetration of biogas will be significant in Danube region, Estonia and Greece, while BioLNG and BioCNG will be deployed considerably in Greece and Spain also. Moreover, the prospects of the bioH_2 are auspicious for the case of Czech, Estonia, Spain and Greece.

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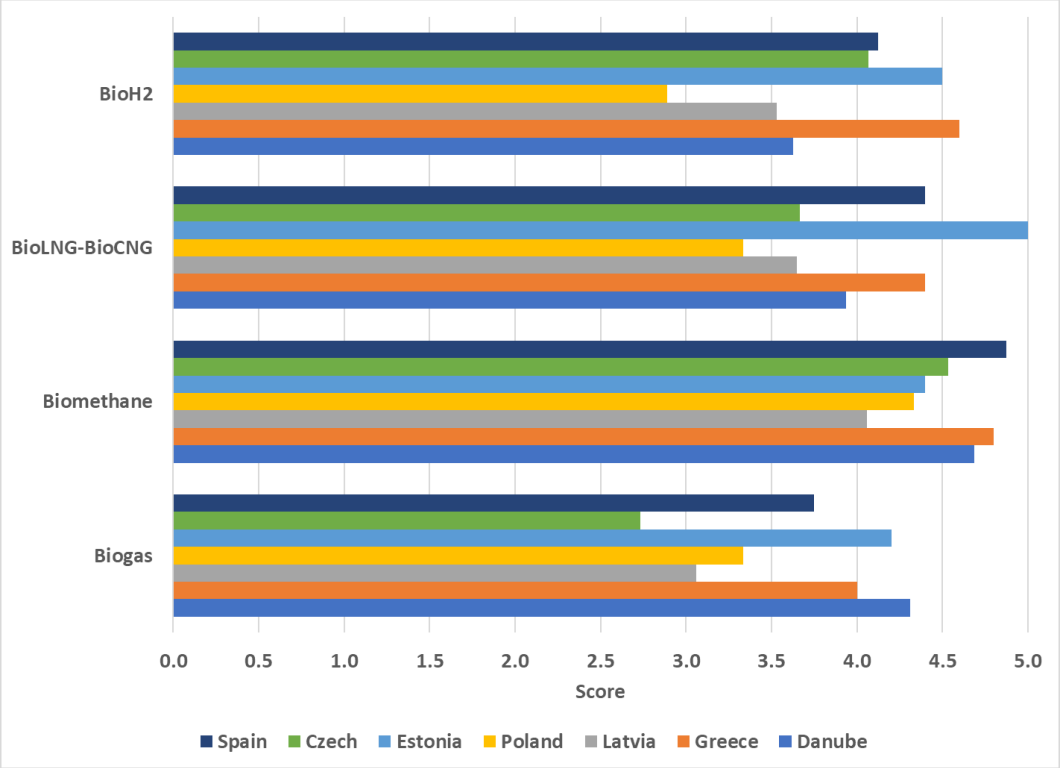

Figure 5 : Potential role of the different alternative fuels to the fulfillment of the 2050's energy and climate targets in the examined countries.

Agricultural residues will be the most prevalent feedstock type for biomethane production in 2030 for all the examined countries (Figure 6). Greece will be also the frontrunner in the exploitation of industrial (food and drink) feedstock, organic municipal solid waste and sewage for biomethane production in 2030. The industrial wastes will have a considerable potential in the Danube region, Poland, Spain and Estonia, while emphasis should be given on the sequential cropping in Estonia and on organic municipal solid waste on Spain.

The same conclusions can be derived also for the exploitation of the different feedstock types for biomethane production in 2050 (Figure 7) highlighting also the increased exploitation of sewage in the Danube region and the organic municipal solid waste and industrial waste in Czech.

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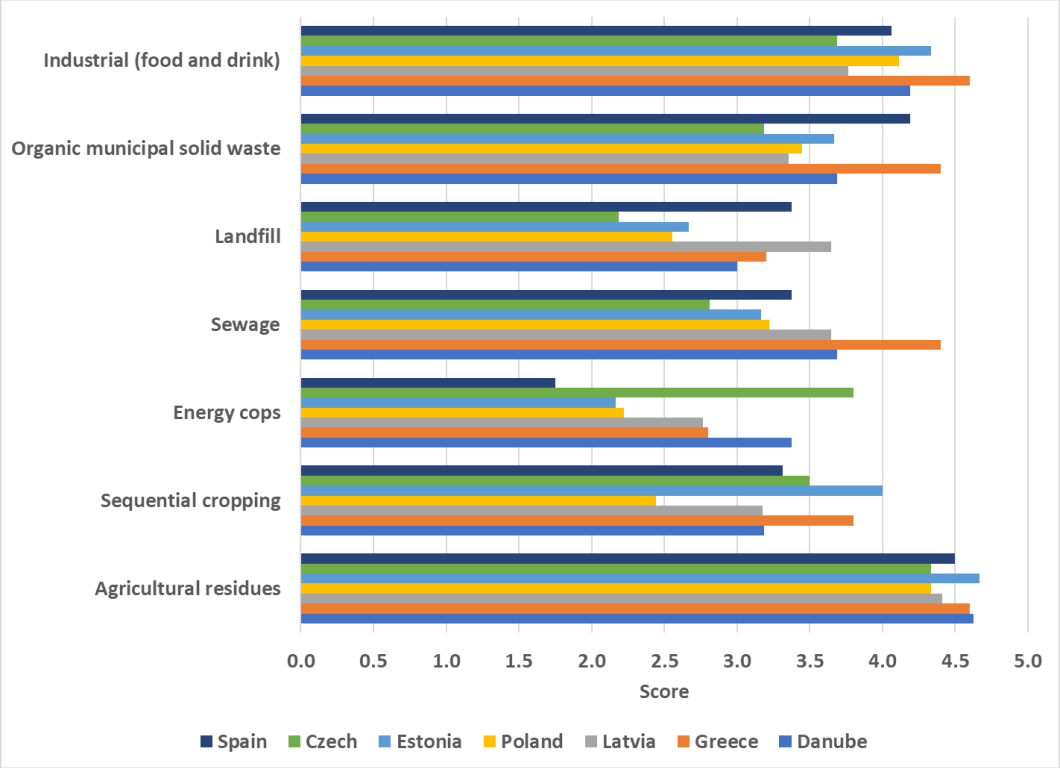

Figure 6 : Degree of exploitation of the different feedstock types for biomethane production in 2030 in the examined countries.

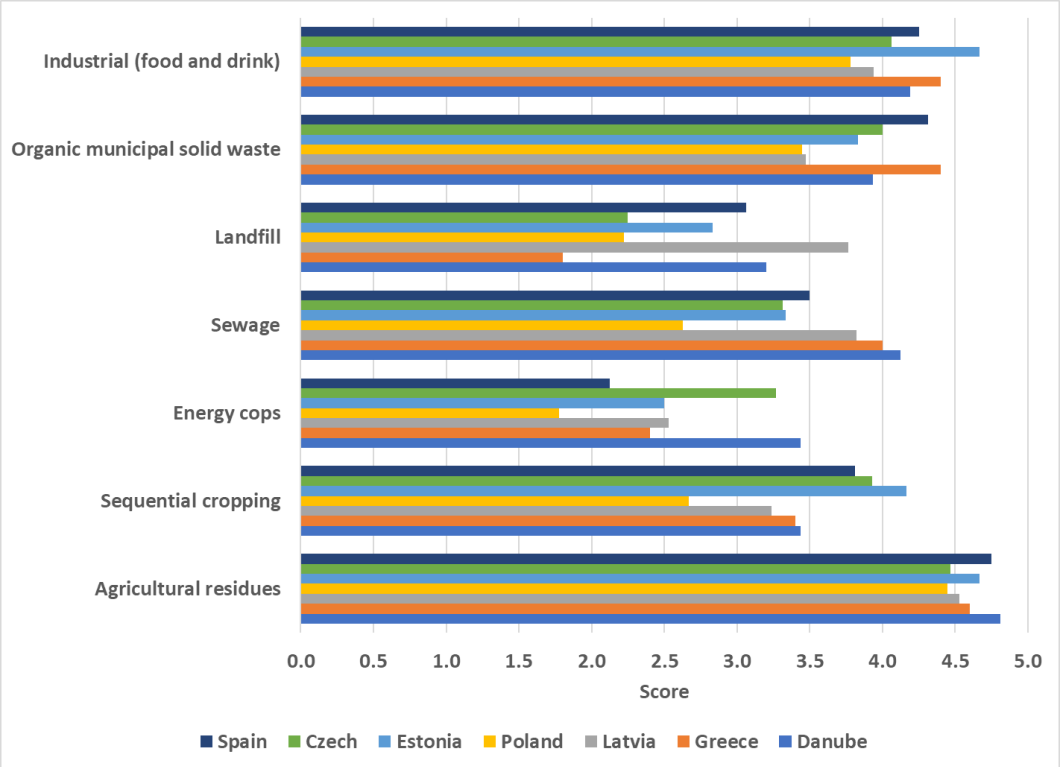

Figure 7 : Degree of exploitation of the different feedstock types for biomethane production in 2050 in the examined countries.

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Membrane separation is considered as the most prevalent upgrading technology for biomethane production in 2030 for all examined countries (Figure 8). Pressure swing adsorption is considered as the second most probable alternative option in Greece, Latvia, Spain and Estonia, water scrubbing in the Danube region and Greece, cryogenic separation in Czech and Poland and physical absorption in Spain.

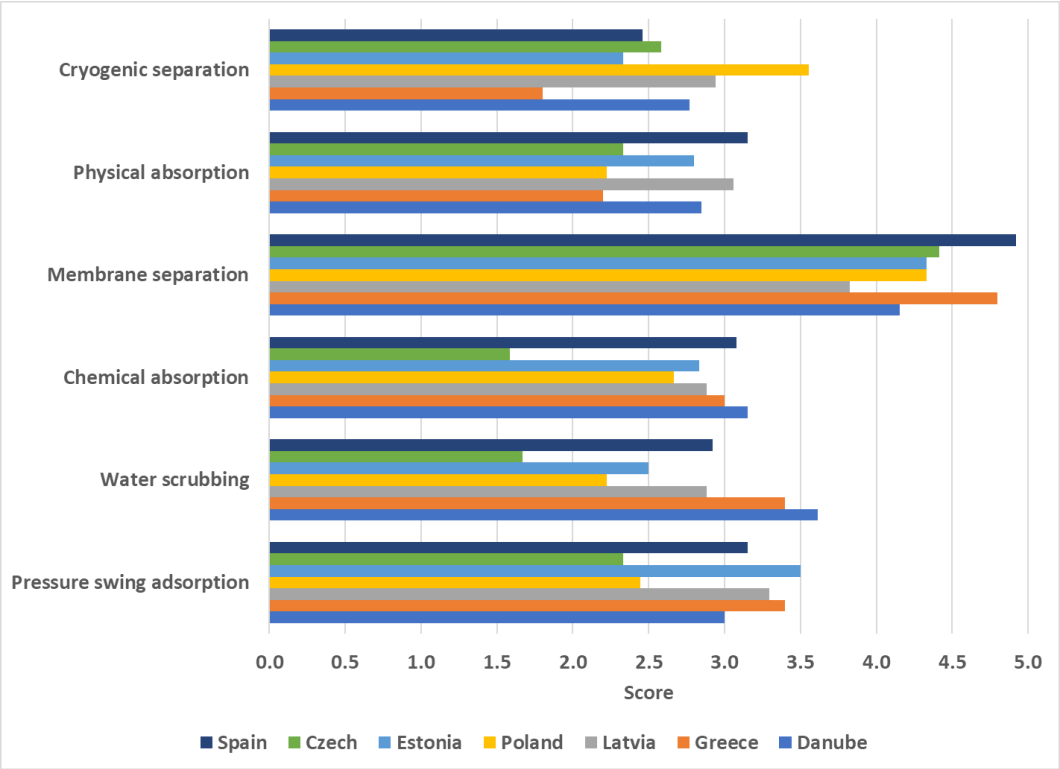

Figure 8 : Degree of utilization of the different upgrading technologies for biomethane production in 2030 in the examined countries.

Membrane separation will continue to be the most prevalent upgrading technology for biomethane production in 2050 for all examined countries (Figure 9). Pressure swing adsorption is considered as the second most probable alternative option in Greece, water scrubbing in the Danube region, chemical absorption in Estonia and Spain, membrane separation in Latvia and cryogenic separation in Czech and Poland.

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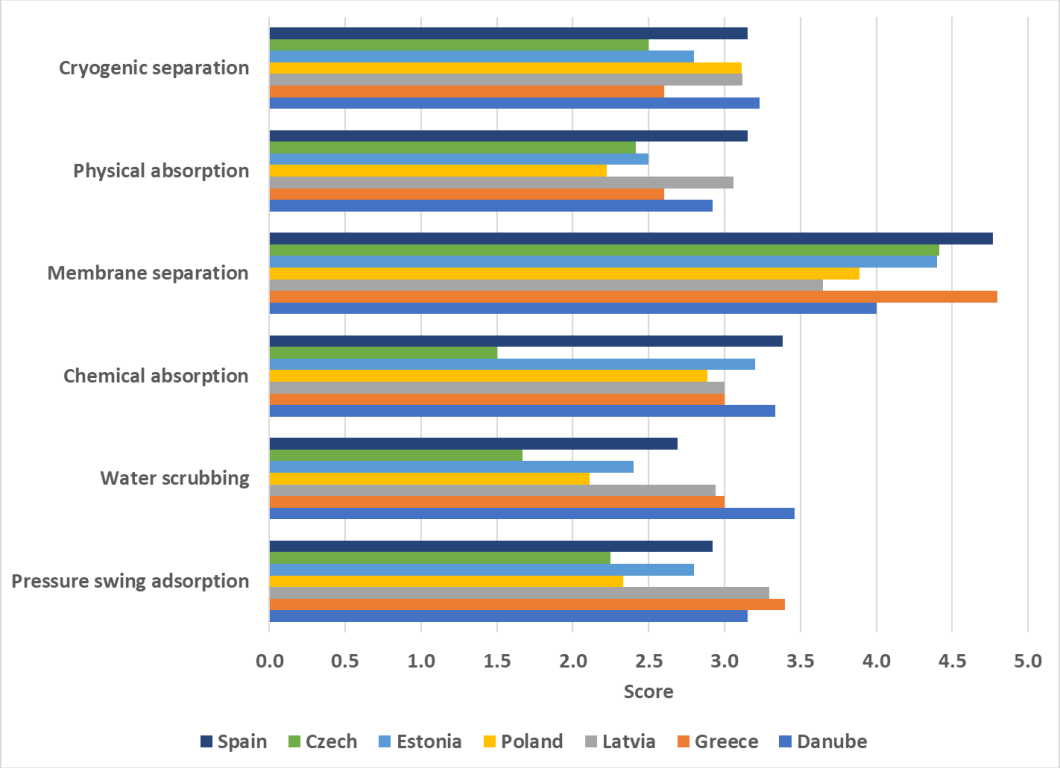

Figure 9 : Degree of utilization of the different upgrading technologies for biomethane production in 2050 in the examined countries.

The distribution of the biomethane will be carried out in 2030 mainly through the distribution grid in Czech, Greece, Estonia, Spain and the Danube region (Figure 10). The transport grid will be preferred in Greece, Spain, Latvia and Estonia, while Poland will avoid the potential connection with the existing grids.

The same conclusions can be derived also for the different connection types for biomethane distribution in 2050 (Figure 11). It should be noted that the utilization of the distribution grid will be increased for the case of Poland, while Estonia will promote biomethane with other means than the potential connection with the existing grids.

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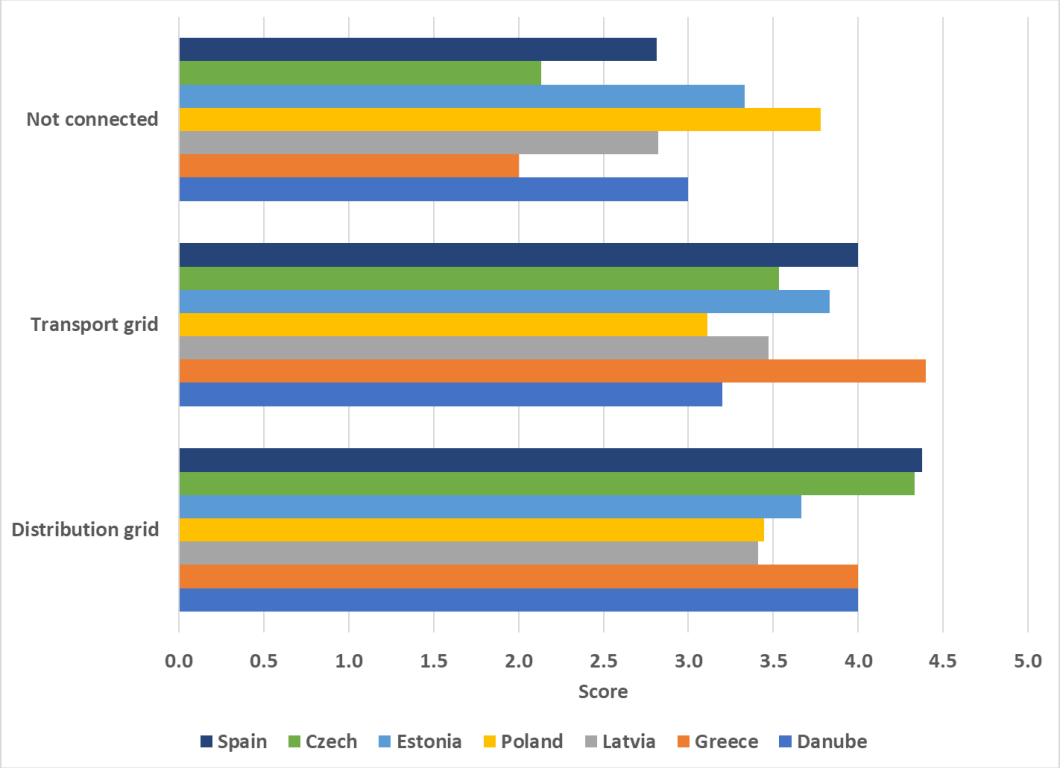

Figure 10 : Probability of using the different connection types for biomethane distribution in 2030 in the examined countries.

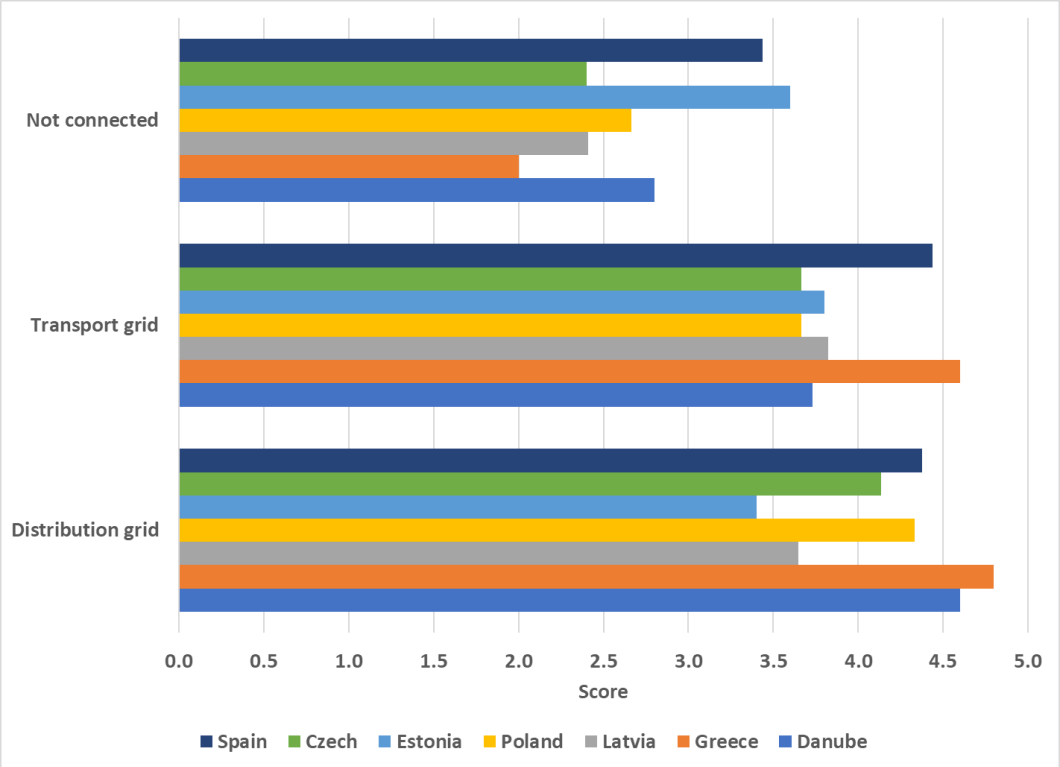

Figure 11 : Probability of using the different connection types for biomethane distribution in 2050 in the examined countries.

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The potential benefits triggered by the biomethane production and consumption are unquestionable in all examined countries (Figure 12). The improvement of the security of energy supply is considered as the most important benefits in Czech and Poland. The reduction of the CO_2 and CH_4 and potentially N_2O emissions are perceived as more significant in Greece, Spain and Estonia, while the increased waste management is considered as the most important one in Latvia. Finally, four different impacts are characterized as equally important in Danube region (improving the security of energy supply, reducing CO_2 and CH_4 and potentially N_2O emissions, enabling the energy recovery from waste and developing a healthier environment). The potential benefits are perceived generally with higher performance in Greece compared to the other examined countries.

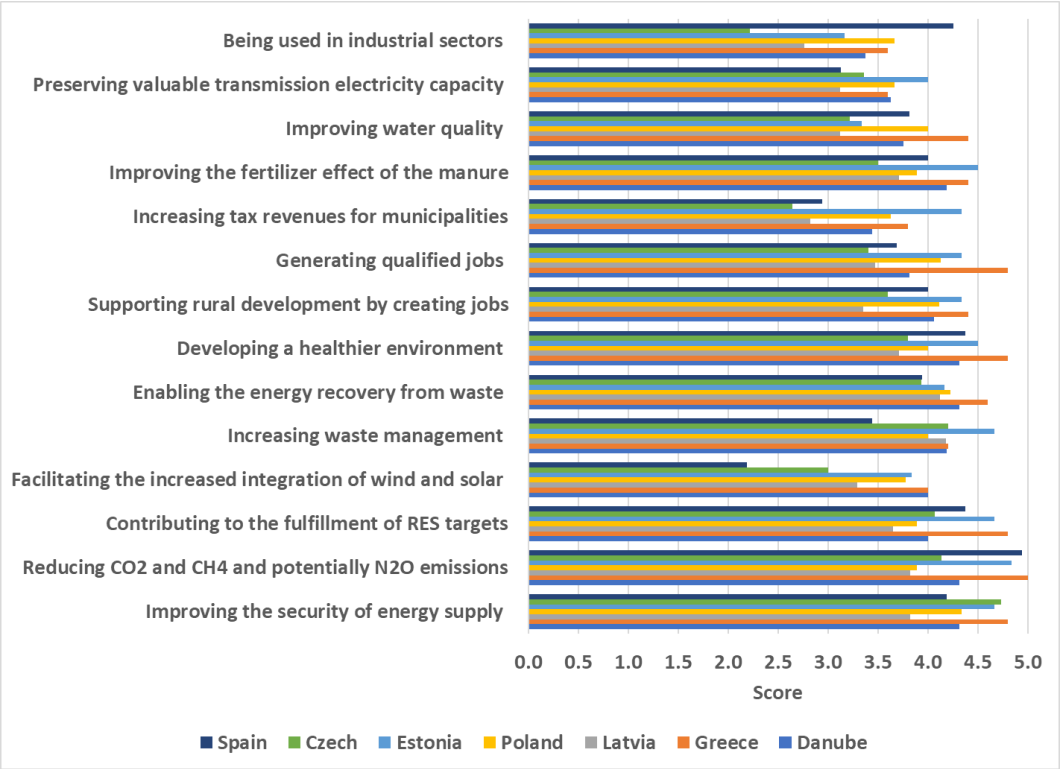

Figure 12 : Significance of the potential benefits triggered by the biomethane production and consumption in the examined countries.

The infrastructural challenges and the poor collection, improper segregation, lack of vehicles and adequate waste transportation have been identified as the most important technical barriers in almost all countries (Figure 13). Furthermore, the lack of specialized technical staff and expertise including the limited technical training and knowledge and the fulfilment of specific characteristics of biogas in Estonia have been pinpointed also as essential barriers. Poland assesses generally the potential technical barriers with higher severity compared to the other examined countries.

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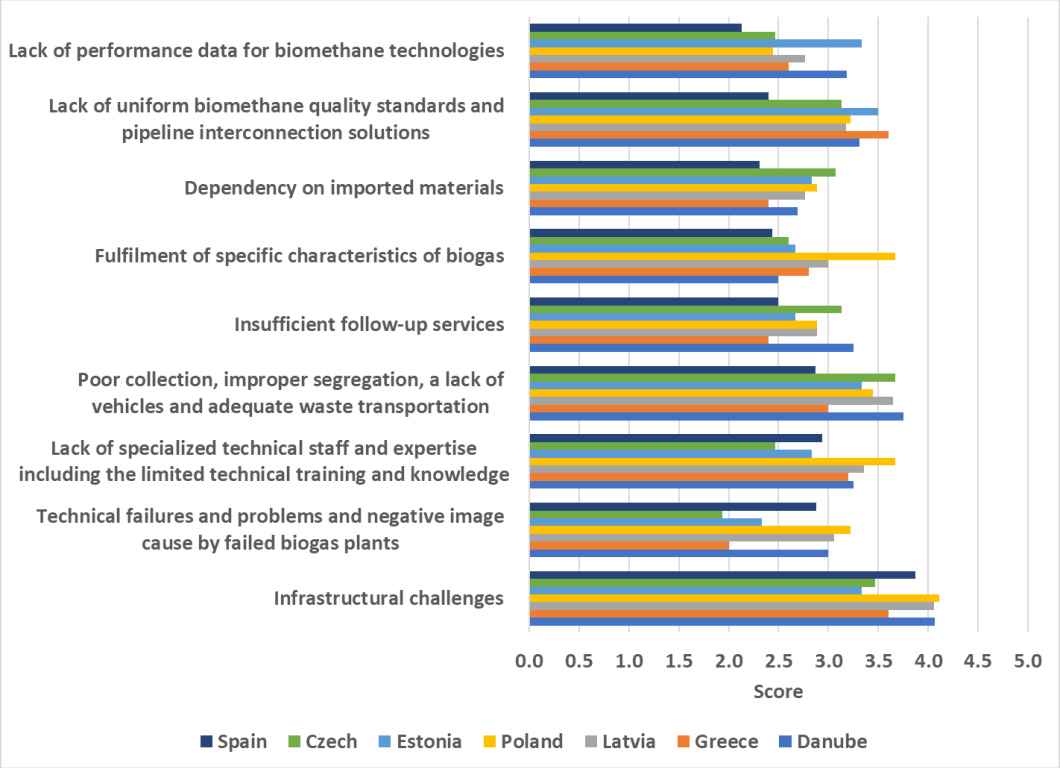

Figure 13 : Importance of the potential technical barriers affecting the biomethane production and consumption in the examined countries.

The most important economic barriers consist of the high investment cost, the lack of subsidies and financial support programmes on a long-term basis and the high cost to interconnect small biogas projects to natural gas pipeline in all examined countries (Figure 14). Moreover, the limited sustainable supply of feedstocks; securing and reliability of long-term supply in Danube region and Poland, the unavailability of bank loans in Greece and Estonia, the lack of R&D funding in Estonia and the difficulties to exploit the small-scale production of biomethane in Estonia and Spain have been characterized also as essential economic barriers.

The intensity of the potential economic barriers seems to be higher in Estonia compared to the other examined countries.

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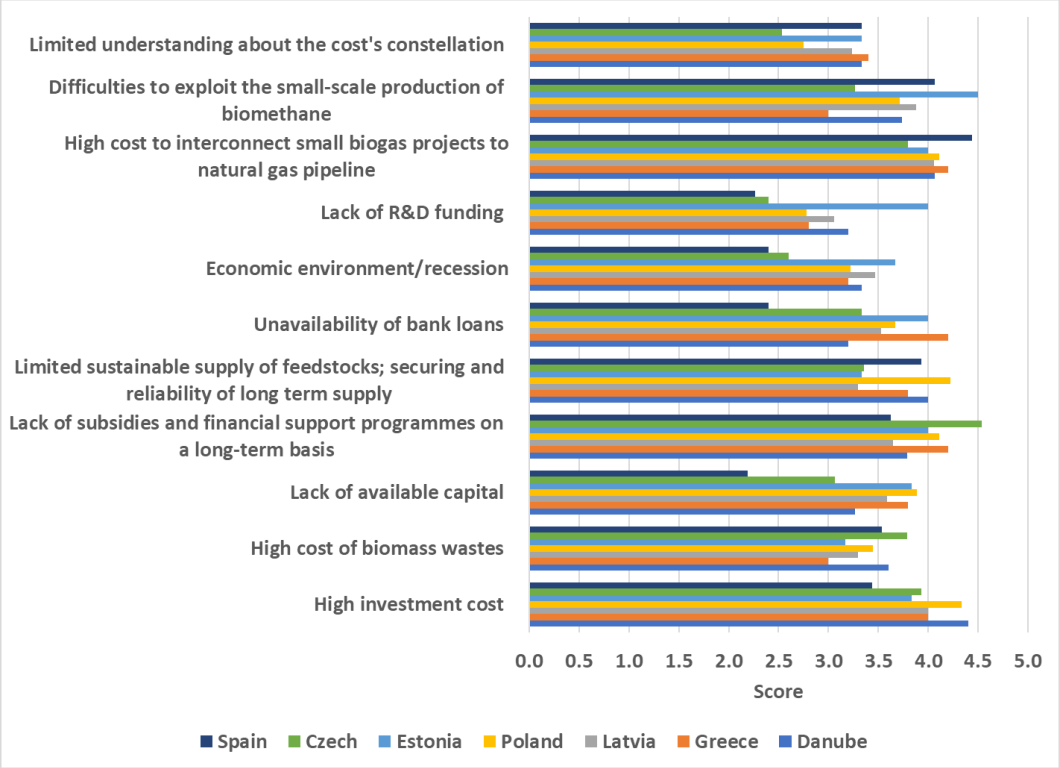

Figure 14 : Importance of the potential economic barriers affecting the biomethane production and consumption in the examined countries.

The high price of biogas/biomethane, the uncertainties and regulatory hurdles related to injection of biogas into the grid and the large amount of waste feedstocks that is currently not being separately collected and diverted for processing are considered as the most important market barriers in all countries (Figure 15). The lower prices of fossil fuels generally and the competition with other fuels/easy availability of fuelwood at zero private cost in Estonia should be taken into consideration also.

Danube region and Estonia evaluate the potential market barriers with higher severity compared to the other examined countries.

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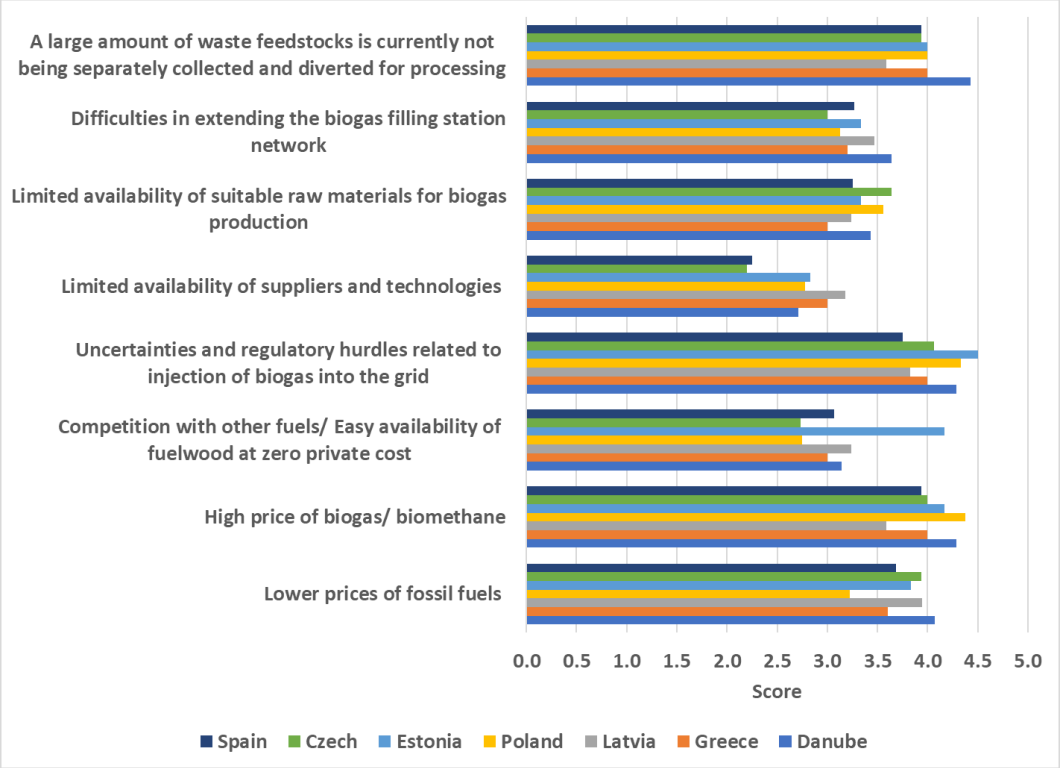

Figure 15 : Importance of the potential market barriers affecting the biomethane production and consumption in the examined countries.

The absence of coordinated policy-making across agriculture, waste management, energy and transport has been assessed as the most important institutional barriers affecting the biomethane production and consumption in all examined countries (Figure 16). The lack of political support/legislation is also significant barrier in all countries with the exemption of Estonia, while the high level of bureaucracy has been recognized in five countries (Czech, Greece, Poland, Spain and Estonia). The stop-start policy support in Danube region, Greece and Poland and the fragmented and conflicting legislative framework in Czech, Greece, Spain and Poland are considered also as crucial institutional barriers. Finally, the jurisdictional concerns in Danube region and the ineffective implementation of the Guarantees of Origin mechanism in Czech should be addressed also.

The potential institutional barriers are considered as more important in Poland compared to the other examined countries.

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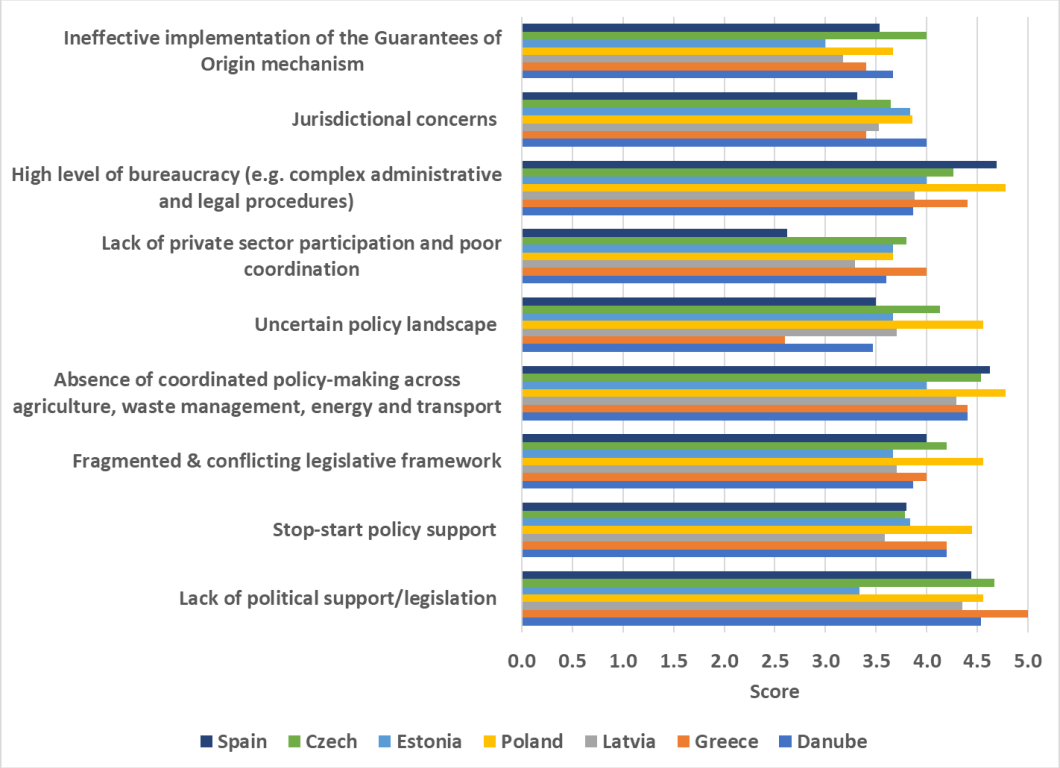

Figure 16 : Importance of the potential institutional barriers affecting the biomethane production and consumption in the examined countries.

The lack of public participation and consumer interest (Danube region, Czech, Latvia and Poland), the desire to maintain the status quo/Resistance to change (Danube region, Latvia and Poland) and the low level of knowledge and limited public awareness (Danube region, Greece, Latvia, Spain and Poland) constitute the most essential socio-economic barriers (Figure 17). Furthermore, the lack of information and information sharing in Danube region and Poland and the low level of education in Poland are recognized as important barriers.

The importance of the potential socio-cultural barriers is higher in Poland compared to the other countries.

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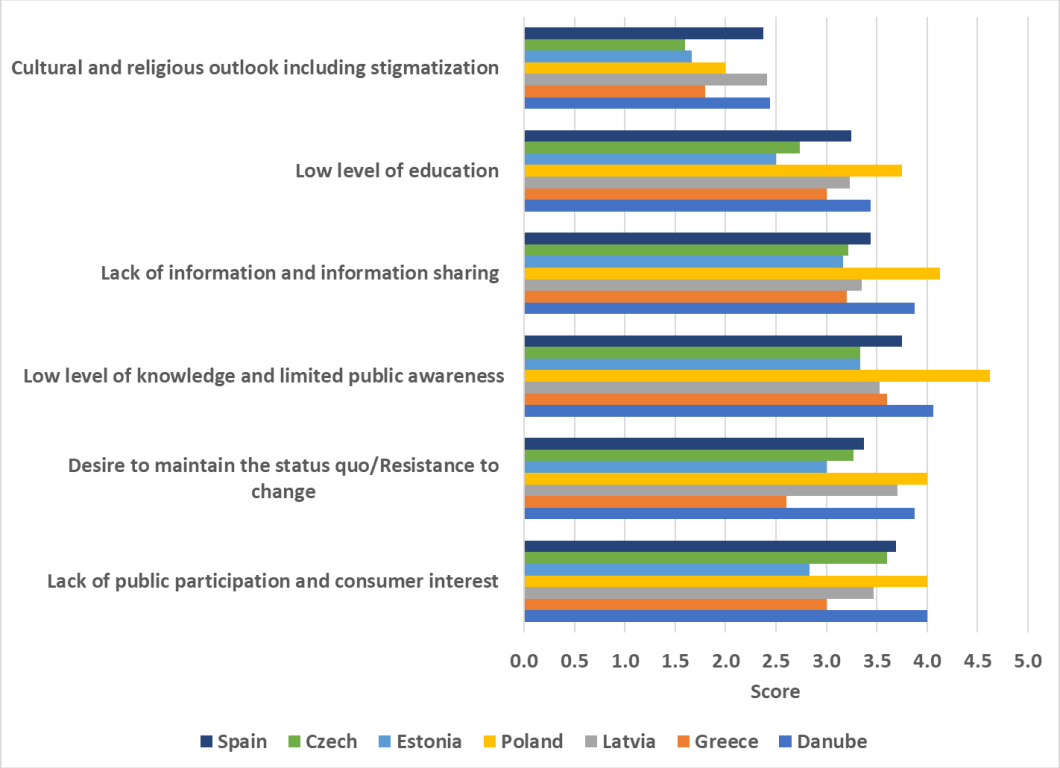

Figure 17 : Importance of the potential socio-cultural barriers affecting the biomethane production and consumption in the examined countries.

The non internalization of the environmental benefits is considered as the most important environmental barrier in the Danube region, Czech, Latvia and Estonia, while the lack of environmental data for biomethane technologies has been stated a barrier in Greece and Estonia (Figure 18). Moreover, the odour and flying insects' complaints is perceived also as significant barrier in Czech, Spain and Poland.

The intensity of the potential environmental barriers is generally higher in Spain compared to the other examined countries.

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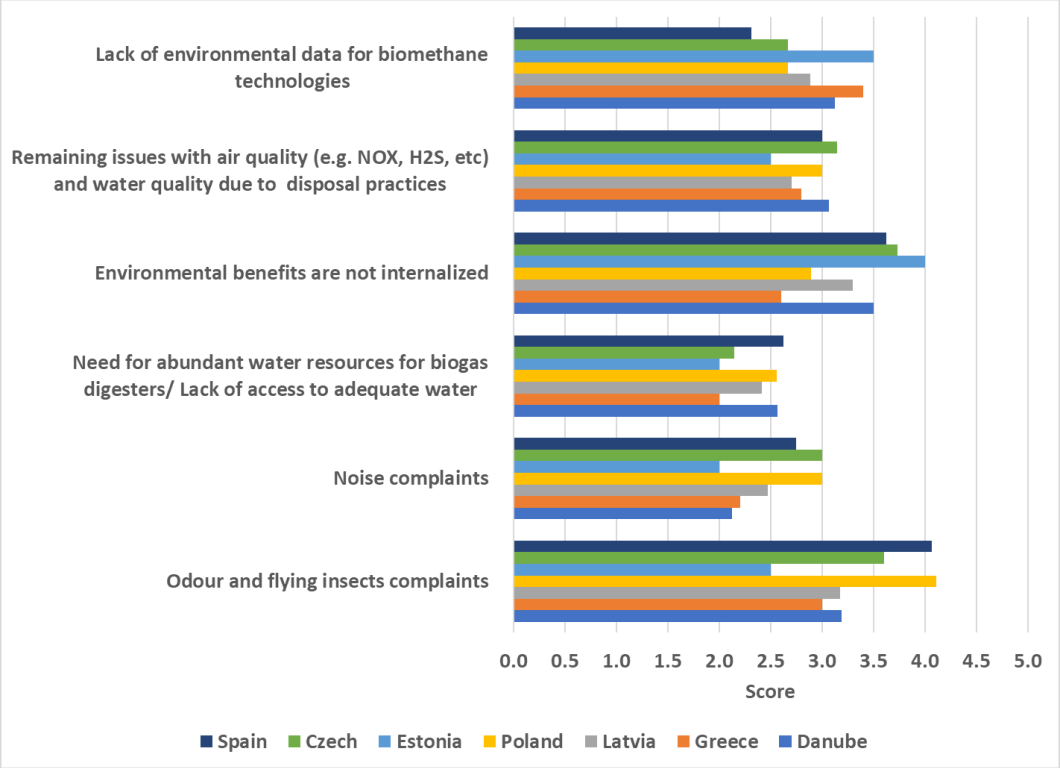

Figure 18 : Importance of the potential environmental barriers affecting the biomethane production and consumption in the examined countries.

The replacement of the natural gas so as to be utilized through the grid constitutes the most popular type of use in all examined countries (Figure 19). Moreover, it is foreseen the substitution of the natural gas for transport fuel usage in Czech, Poland, Spain and Estonia. The production of heat and/or steam is expected in the Danube region and Greece, while the CNG and diesel replacement by bio-CNG for transport fuel usage will be fostered in Czech, Latvia, Poland and Estonia and the LNG replacement by bio-LNG for transport fuel usage in Czech, Poland, Spain and Estonia. Finally, the commercial exploitation of the recycled fertilizers in Estonia and the production of branding agricultural products with a carbon-neutral label in Poland and Spain are considered as alternative options.

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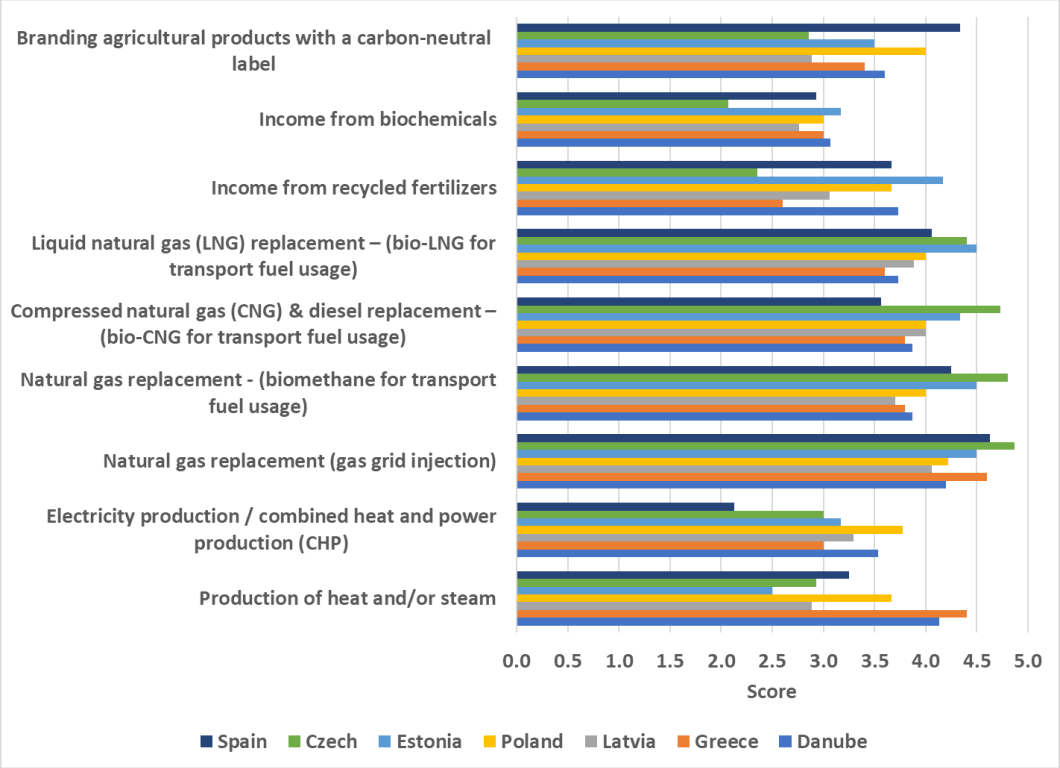

Figure 19 : Probability to utilize the biomethane for the different uses in the examined countries.

The imposition of a stricter CO_2 emission target at European level will facilitate significantly the further penetration of biomethane according to the obtained responses in Czech, Poland, Spain and Estonia (Figure 20). The same impact will have the specification of a stricter RES and CO_2 target at European level and a stricter RES target at national level as stated in the same countries including Greece. The imposition of a stricter energy efficiency target at European level and national level is not expected to lead to the massive penetration of biomethane for all countries with the exemption of Estonia and Greece respectively. The adoption of a target feedstock management policy (Greece and Estonia), digestate policy (Greece, Poland, Spain and Estonia) and biogas utilization policy (Czech, Greece, Poland, Spain and Estonia) can trigger the further deployment of biomethane plants.

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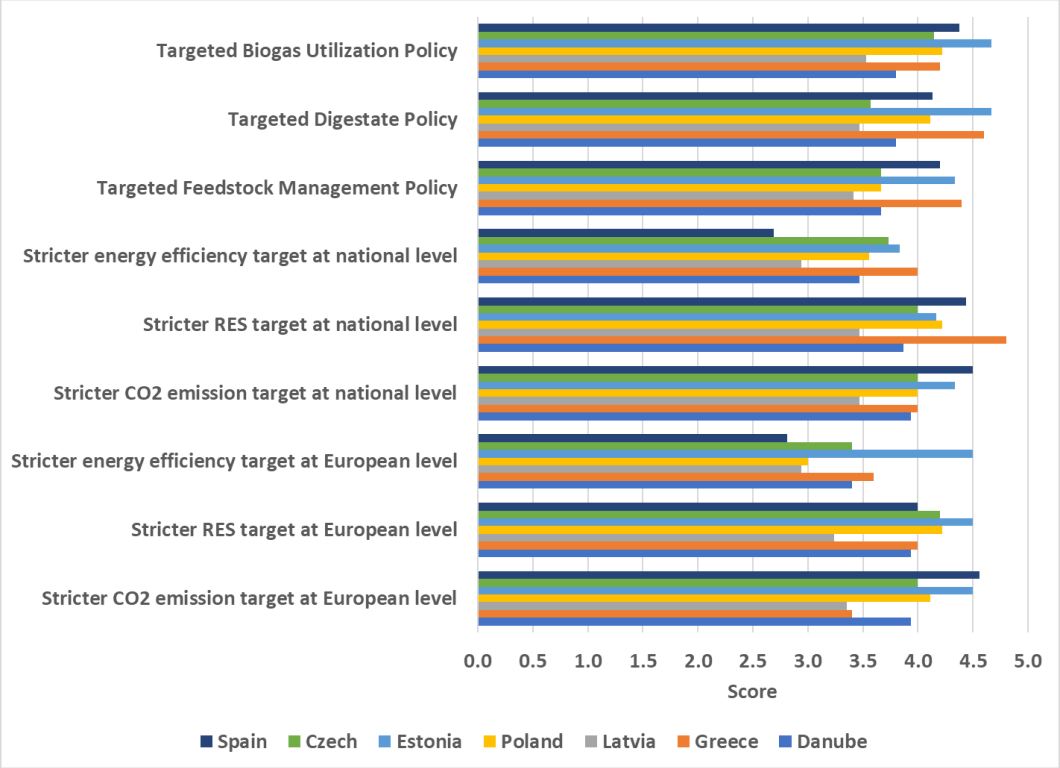

Figure 20 : Effectiveness of the various factors/drivers to the biomethane penetration in the examined countries.

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Chapter 4: Policy design according to the different categories of stakeholders

Biomethane is considered as the most prevailing alternative in all examined categories of stakeholders for the fulfilment of the 2030's energy and climate targets (Figure 21). A similar role was attributed to BioLNG-BioCNG and biogas by the involved stakeholders with the exemption of decision makers, who recognize more significant role for biogas compared to BioLNG and BioCNG. Finally, bioH_2 has considerably lower prospects until 2030.

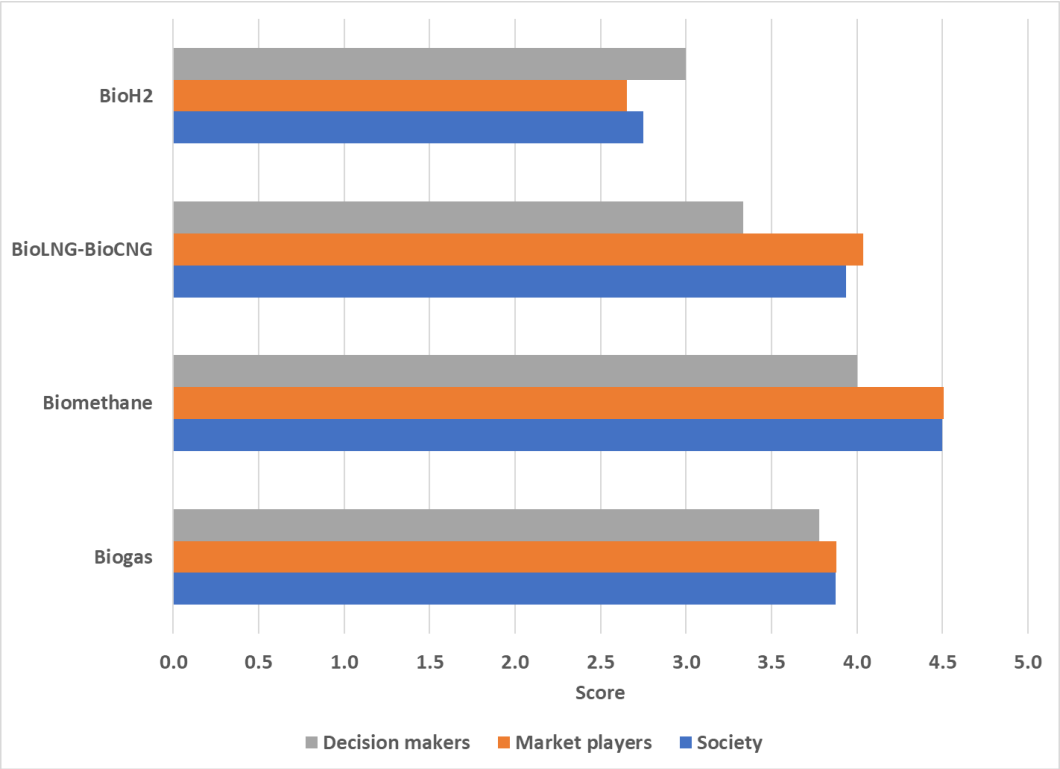

Figure 21 : Potential role of the different alternative fuels to the fulfillment of the 2030's energy and climate targets in the examined categories of stakeholders.

Biomethane will continue to be considered as most prevalent alternative in all examined categories of stakeholders for the fulfilment of the 2050's energy and climate targets (Figure 22). Nevertheless, the penetration of bioH_2 will be reinforced presenting similar performance compared to BioLNG-BioCNG, while the society shows a stronger preference to biogas.

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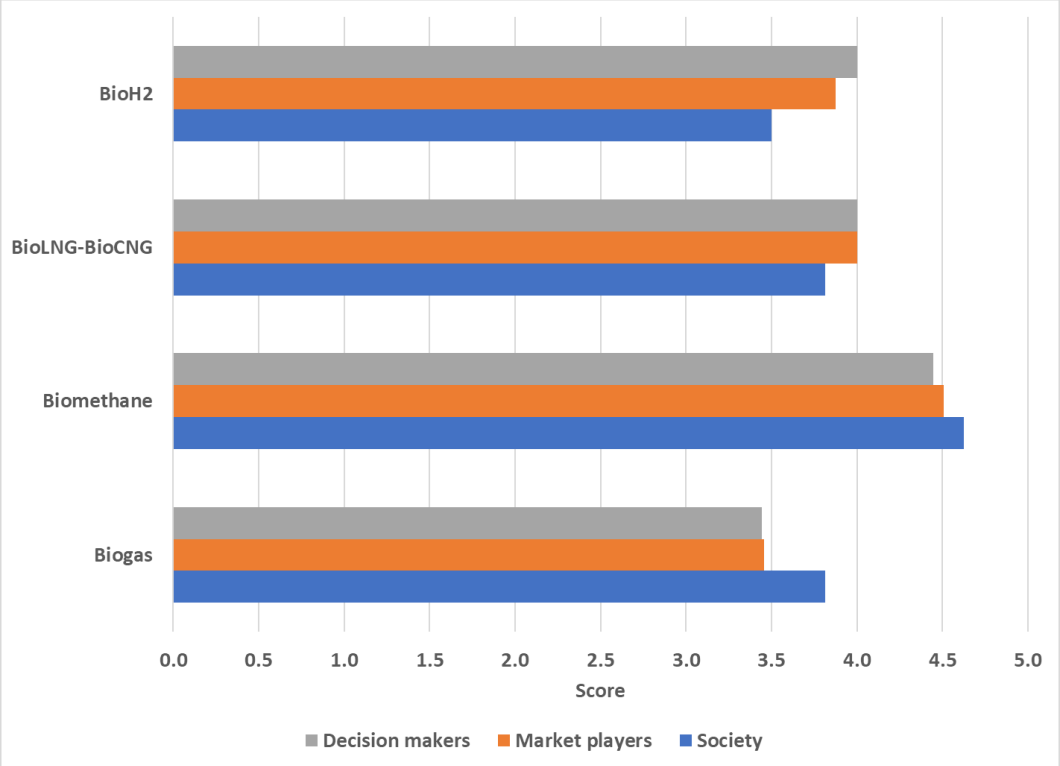

Figure 22 : Potential role of the different alternative fuels to the fulfillment of the 2050's energy and climate targets in the examined categories of stakeholders.

Agricultural residues will be the most prevalent feedstock type for biomethane production in 2030 for all examined categories of stakeholders (Figure 23). Moreover, the potential of the industrial wastes is also meaningful. Finally, the organic municipal solid waste will have a significant role according to the marker players.

The same conclusions can be derived also for the preference on agricultural residues and industrial wastes for biomethane production in 2050 (Figure 24). The sequential cropping, sewage and organic municipal solid waste present increased significance in 2050 compared to 2030 for all the examined categories of stakeholders.

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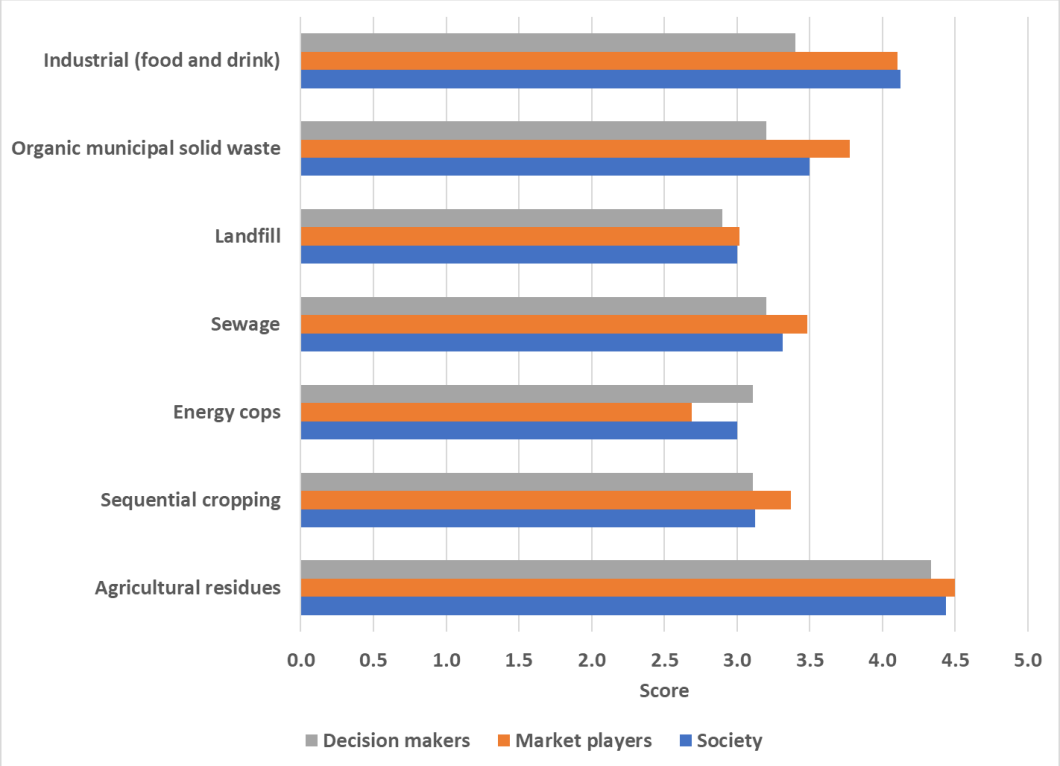

Figure 23 : Degree of exploitation of the different feedstock types for biomethane production in 2030 in the examined categories of stakeholders.

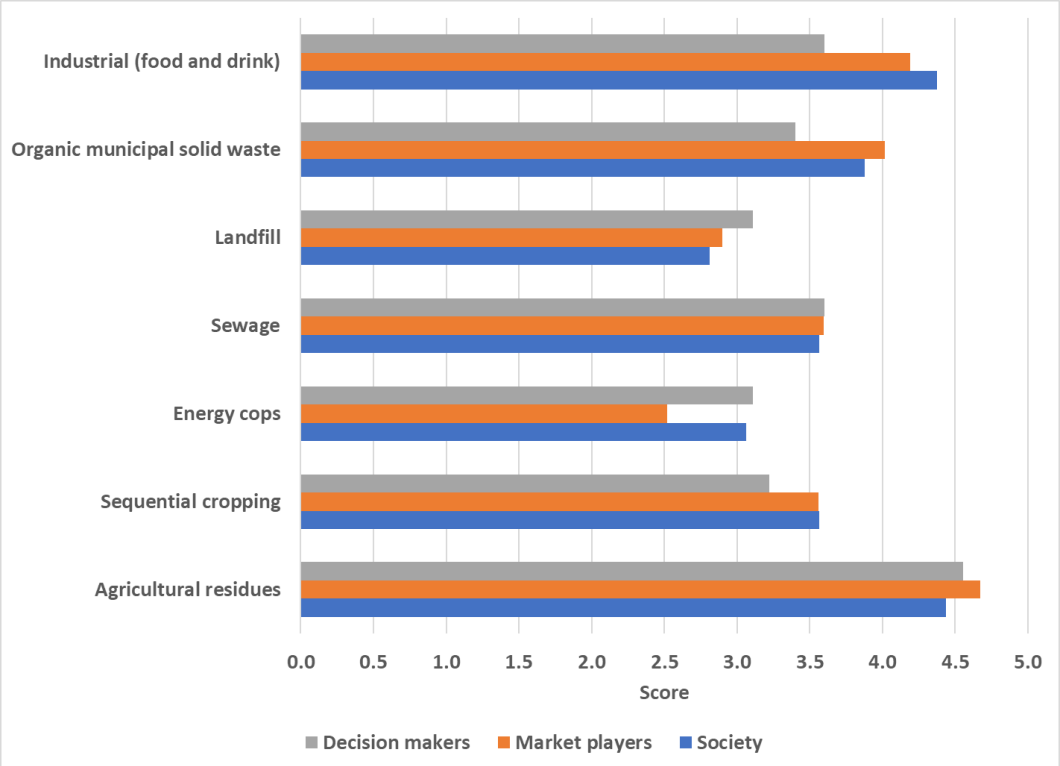

Figure 24 : Degree of exploitation of the different feedstock types for biomethane production in 2050 in the examined categories of stakeholders.

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Membrane separation is considered as the most prevailing upgrading technology for biomethane production in 2030 for all examined categories of stakeholders (Figure 25). Pressure swing adsorption is expected to have a satisfactory penetration according to the decision makers.

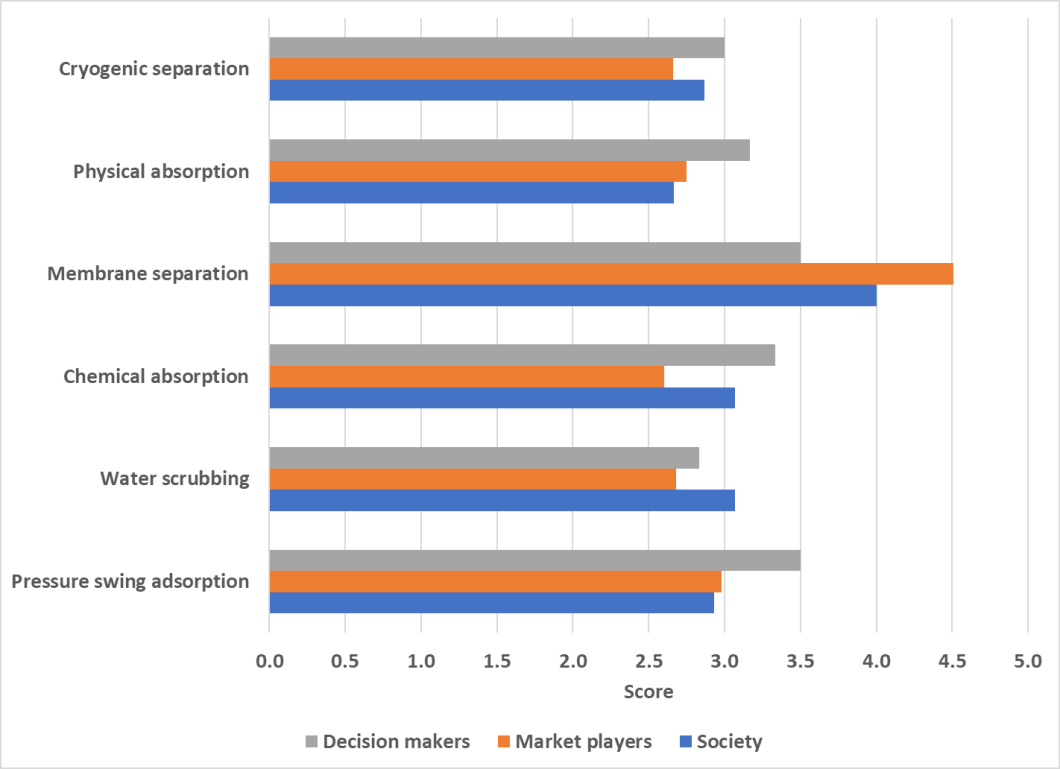

Figure 25 : Degree of utilization of the different upgrading technologies for biomethane production in 2030 in the examined categories of stakeholders.

Membrane separation will continue to be the most prevalent upgrading technology for biomethane production in 2050 for all examined categories of stakeholders (Figure 26). Pressure swing adsorption and chemical absorption are considered as probable alternative options according to the decision makers.

Generally, all the different upgrading technologies have been assessed with higher performances from decision makers compared to the other categories with the exemption of membrane separation.

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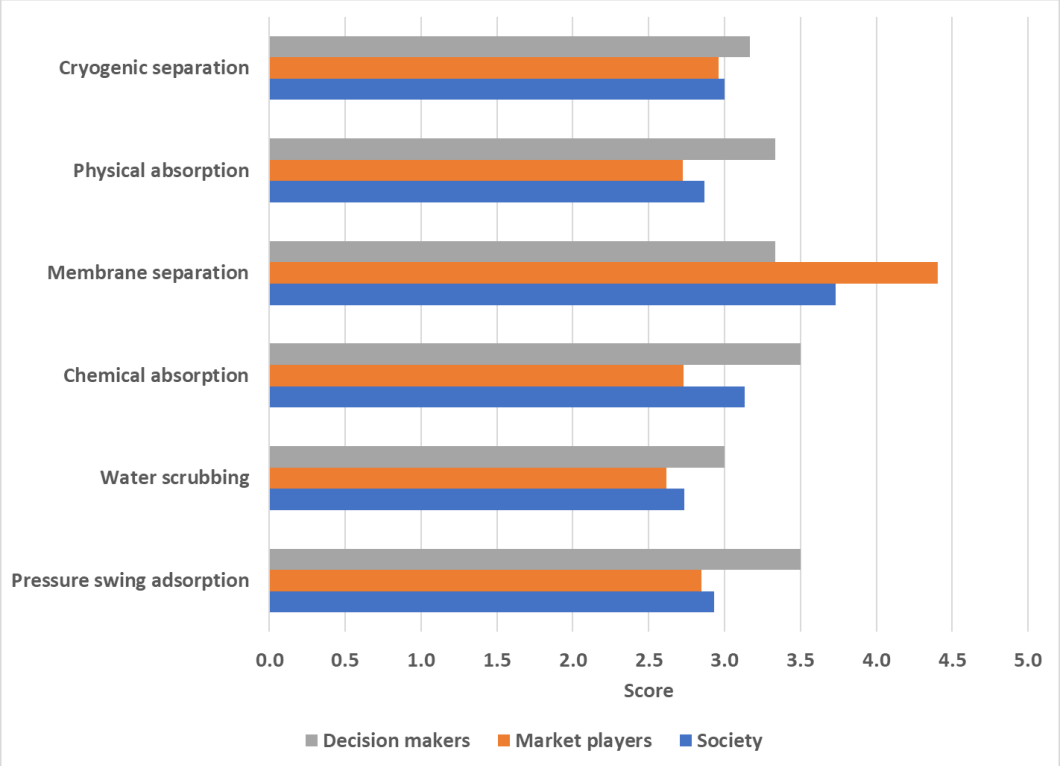

Figure 26 : Degree of utilization of the different upgrading technologies for biomethane production in 2050 in the examined categories of stakeholders.

The distribution grid concentrates the highest probability to be utilized as the main mean for the distribution of biomethane in 2030 from all categories of stakeholders (Figure 27). Moreover, the transportation grid is considered also as an alternative option according to the market players for the period until 2030.

The same conclusion can be derived also for the different connection types for biomethane distribution in 2050 (Figure 28). Nevertheless, the role of the transportation grid will be reinforced significantly in 2050 according to the decision makers and market players. The society does not foresee any essential prospects to the other connection types than the utilization of distribution grid.

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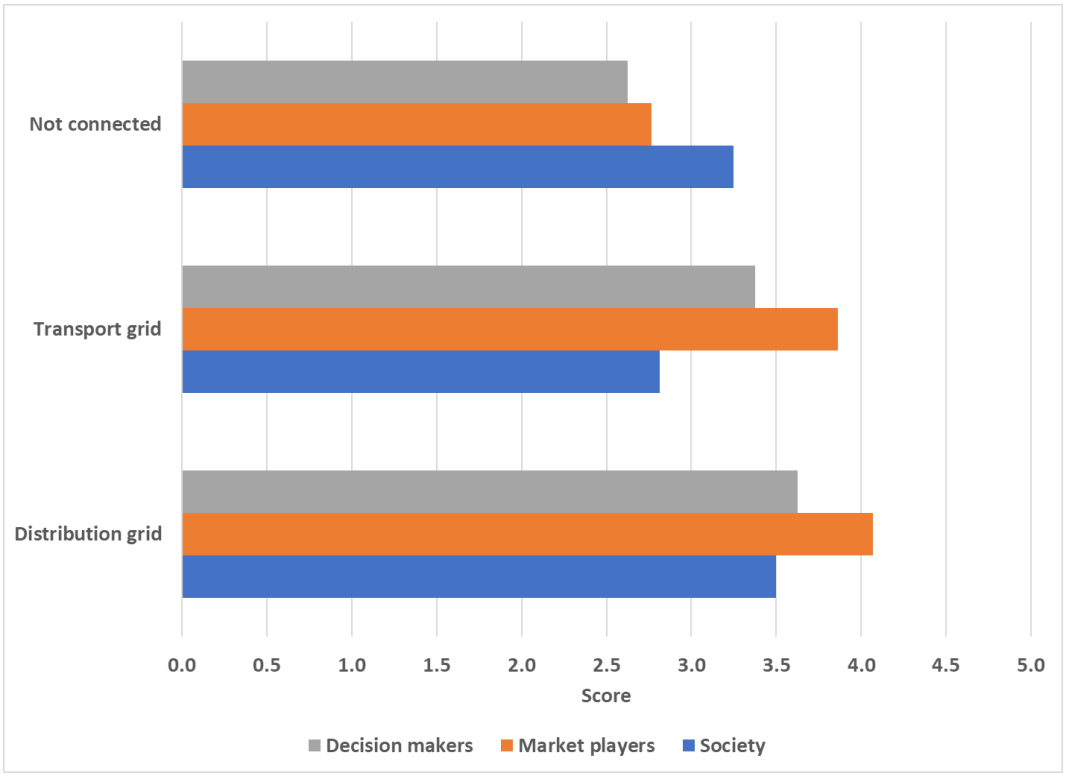

Figure 27 : Probability of using the different connection types for biomethane distribution in 2030 in the examined categories of stakeholders.

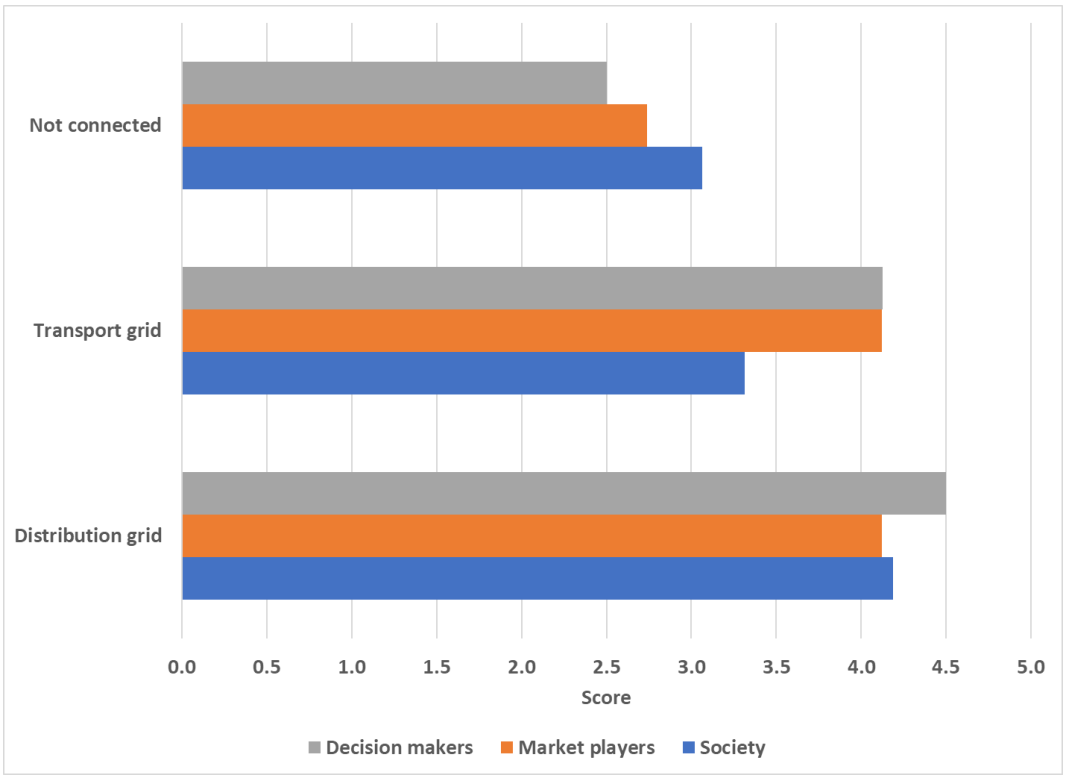

Figure 28 : Probability of using the different connection types for biomethane distribution in 2050 in the examined categories of stakeholders.

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The potential benefits triggered by the biomethane production and consumption are unquestionable by all the examined categories of stakeholders (Figure 29). The improvement of the security of energy supply, the reduction of the CO_2 and CH_4 and potentially N_2O emissions and the energy recovery from waste have been outlined as the most important benefits unanimously by all the involved stakeholders. Moreover, the market players have highlighted the triggered benefits due to the increased waste management, the development of a healthier environment and the fertilizer effect of the manure. Finally, the society recognizes the development of a healthier environment and enhancement of the rural development by creating jobs locally.

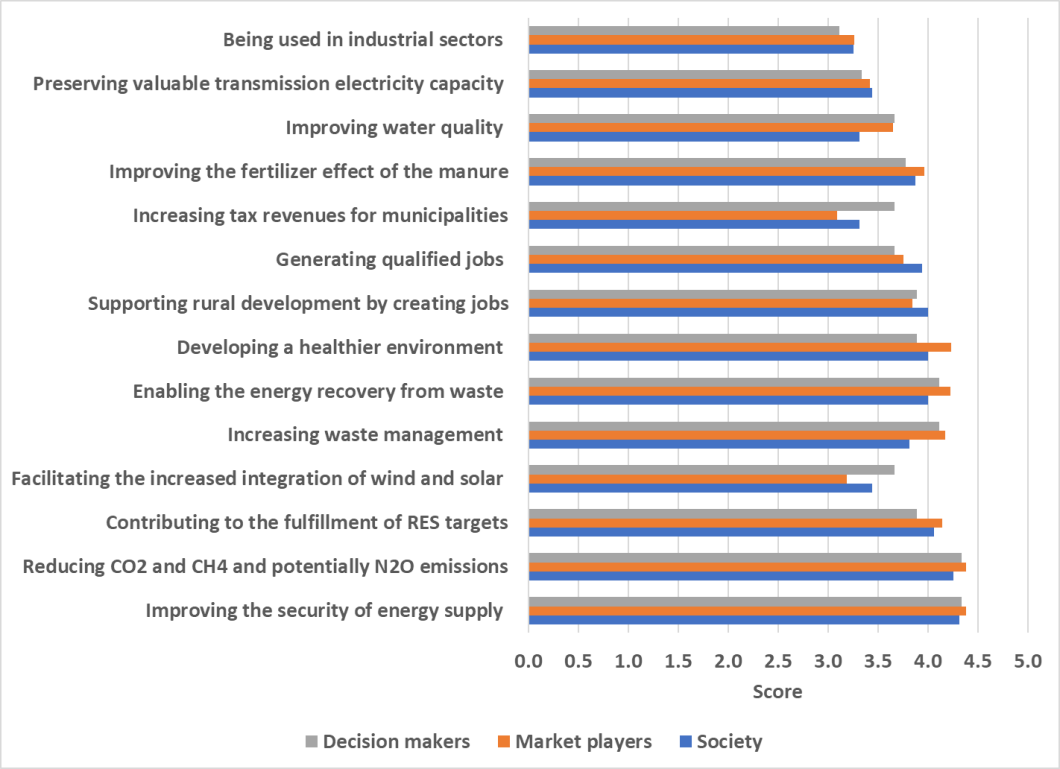

Figure 29 : Significance of the potential benefits triggered by the biomethane production and consumption in the examined categories of stakeholders.

The infrastructural challenges have been identified as the most important technical barrier by all the examined categories of stakeholders (Figure 30). Furthermore, the lack of specialized technical staff and expertise including the limited technical training and knowledge (from decision makers' point of view), the poor collection, improper segregation, lack of vehicles and adequate waste transportation (from society and market players' point of view) and the lack of uniform biomethane quality standards and pipeline interconnection solutions (from society's point of view) have been mapped as additional barriers.

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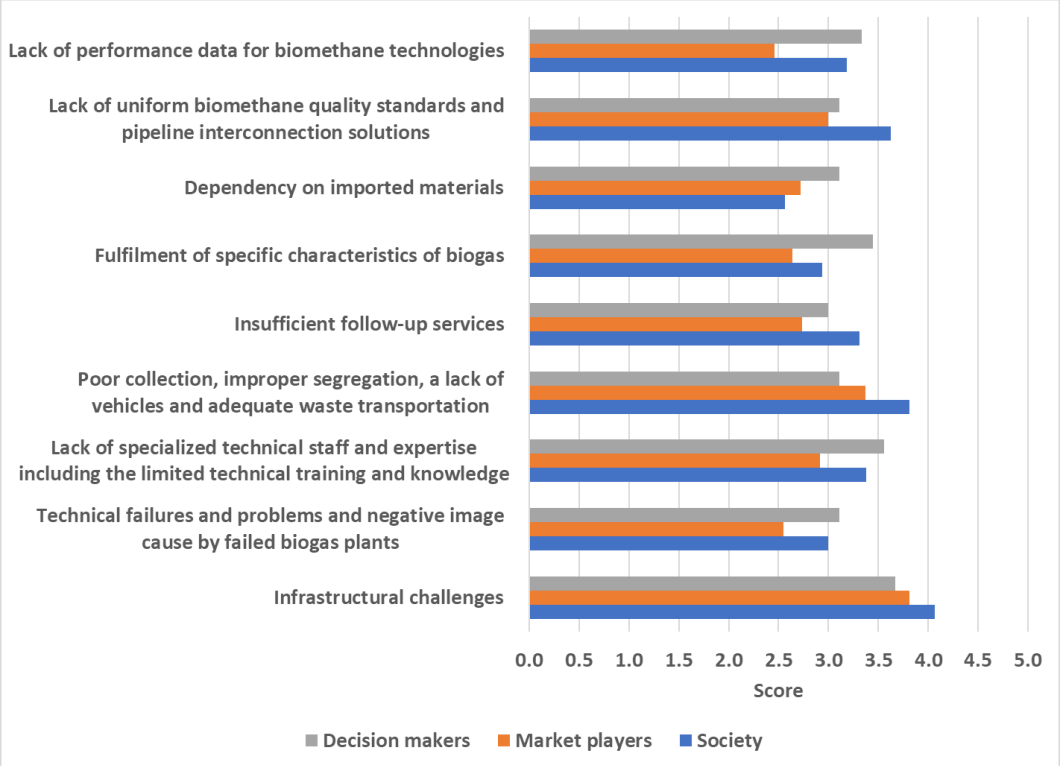

Figure 30 : Importance of the potential technical barriers affecting the biomethane production and consumption in the examined categories of stakeholders.

The most important economic barriers consist of the high investment cost and the high cost to interconnect small biogas projects to natural gas pipeline in all examined categories of stakeholders (Figure 31). Moreover, the lack of subsidies and financial support programmes on a long-term basis has been highlighted by the society and the market players, while the difficulties to exploit the small-scale production of biomethane should be addressed according to the concern that have both the society and the decision makers. Finally, the limited sustainable supply of feedstocks on a long-term period may hinder the further penetration of biomethane according to the society and the decision makers.

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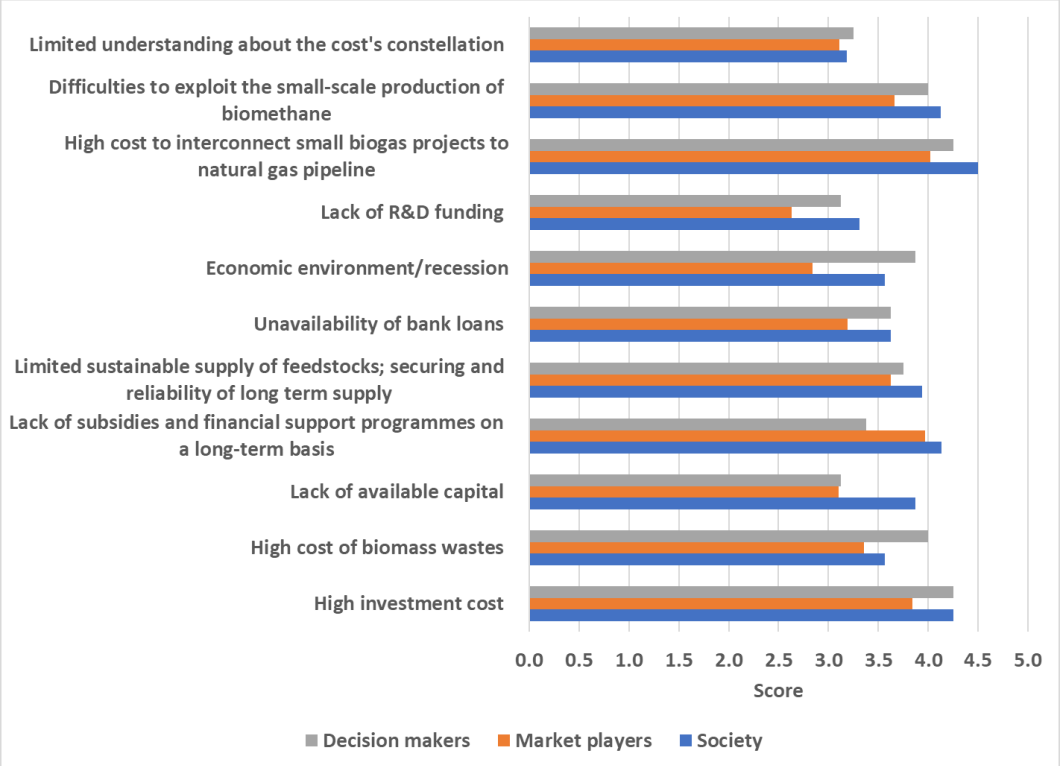

Figure 31 : Importance of the potential economic barriers affecting the biomethane production and consumption in the examined categories of stakeholders.

The high price of biogas/biomethane and the uncertainties and regulatory hurdles related to injection of biogas into the grid have been recognized as the most important market barriers in all examined categories of stakeholders (Figure 32). The large amount of waste feedstocks that is currently not being separately collected and diverted for processing have been identified as barrier by the society and the market players, while the lower prices of fossil fuels have been mentioned by all the stakeholders to a lower extend as a potential market barrier.

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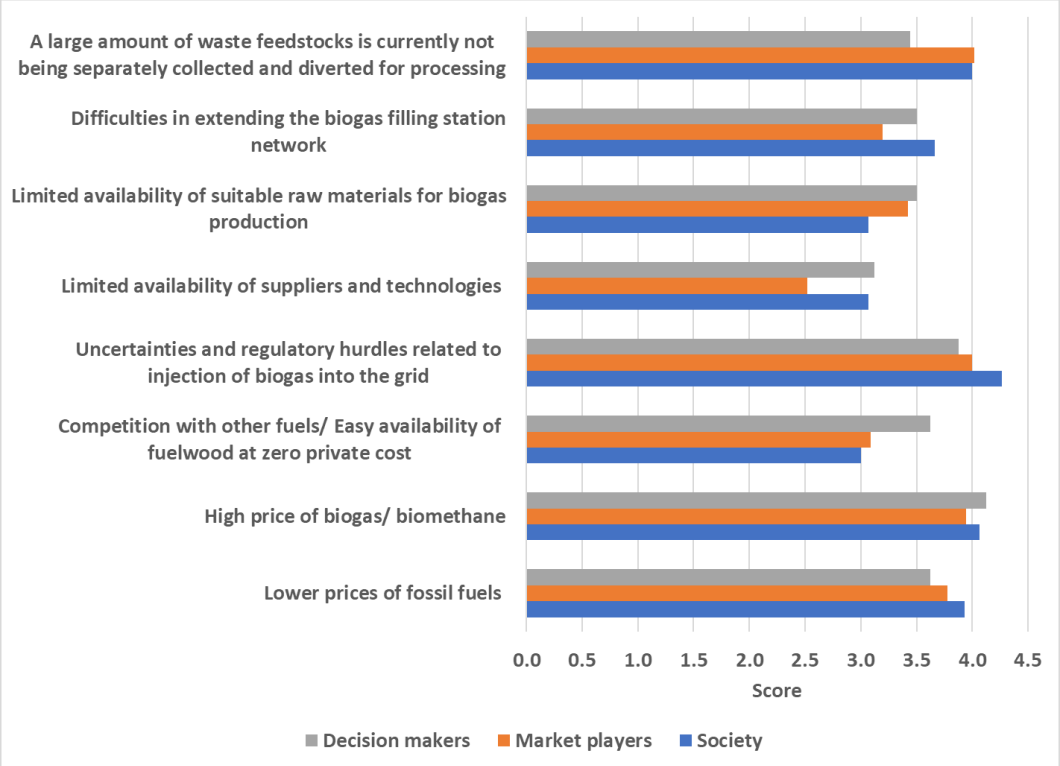

Figure 32 : Importance of the potential market barriers affecting the biomethane production and consumption in the examined categories of stakeholders.

The absence of coordinated policy-making across agriculture, waste management, energy and transport and the lack of political support/legislation have been assessed as the most important institutional barriers affecting the biomethane production and consumption as stated unanimously by all the different categories of stakeholders (Figure 33). The stop-start policy support, the fragmented and conflicting legislative framework and the high level of bureaucracy are considered as important barriers mainly by the society and the market players, while the uncertain policy landscape and the ineffective implementation of the Guarantees of Origin mechanism have been pinpointed by the society as additional barriers.

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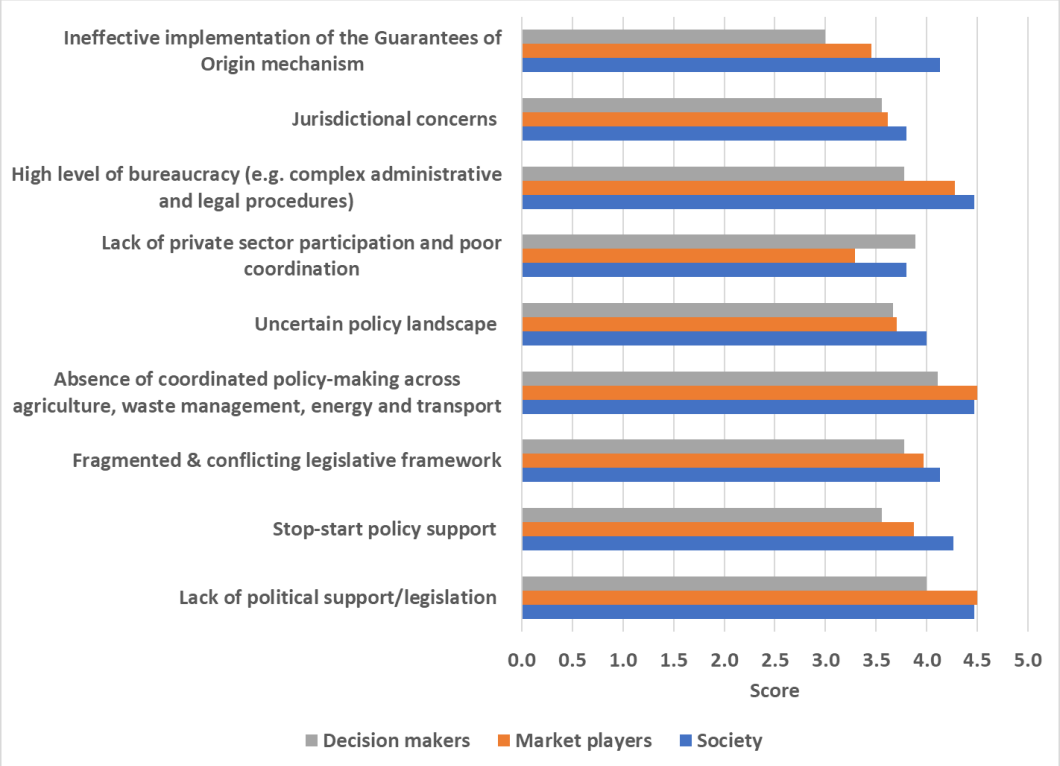

Figure 33 : Importance of the potential institutional barriers affecting the biomethane production and consumption in the examined categories of stakeholders.

All the examined socio-cultural barriers present similar performance irrespective the category of the stakeholders with the exemption of the cultural and religious outlook including stigmatization (Figure 34). It should be noted that the low level of knowledge and limited public awareness has been identified as the most significant barrier from the society and the market players, while the lack of public participation and consumer interest has been highlighted also by the market players. The decision makers perceive almost all the different barriers with equivalent significance.

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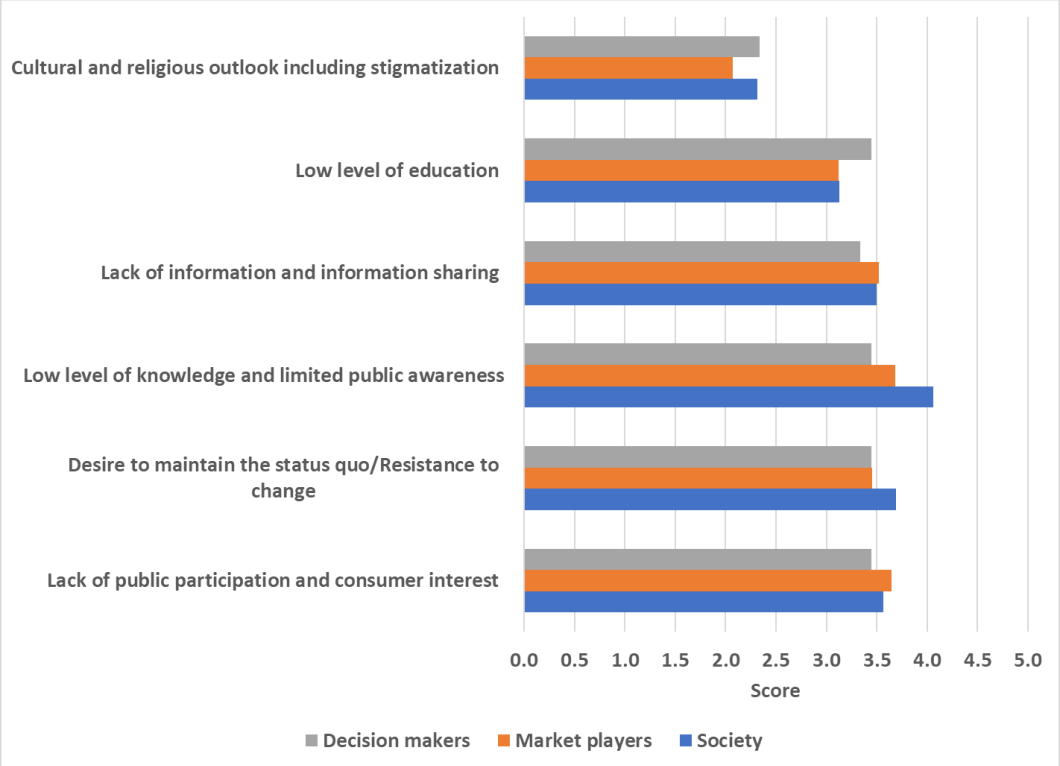

Figure 34 : Importance of the potential socio-cultural barriers affecting the biomethane production and consumption in the examined categories of stakeholders.

The non-internalization of the environmental benefits and the odour flying insects' complaints are considered as the most important environmental barriers according to the obtained responses by all examined categories of stakeholders (Figure 35). Furthermore, the lack of environmental data for biomethane technologies has been highlighted also by the decision makers presenting the highest performance among the examined barriers.

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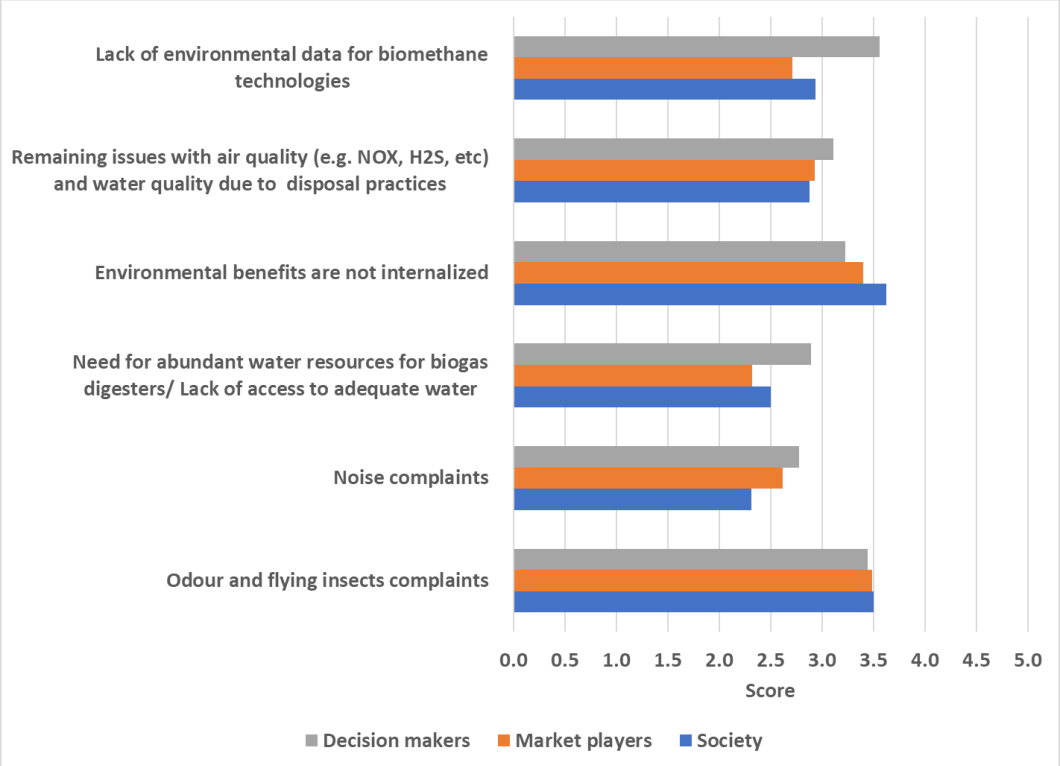

Figure 35 : Importance of the potential environmental barriers affecting the biomethane production and consumption in the examined categories of stakeholders.

The replacement of the natural gas as resulted by the injection of the biomethane into the distribution grid is supported by all examined categories of stakeholders (Figure 36). Moreover, the substitution of the natural gas and the CNG and diesel replacement by bio-CNG for transport fuel usage is preferred also to a lower extend compared to the injection of the biomethane into the distribution grid. The decision makers tend to support the electricity and the combined heat and power production, while the LNG and diesel replacement by bio-LNG for transport fuel usage is supported also by the market players.

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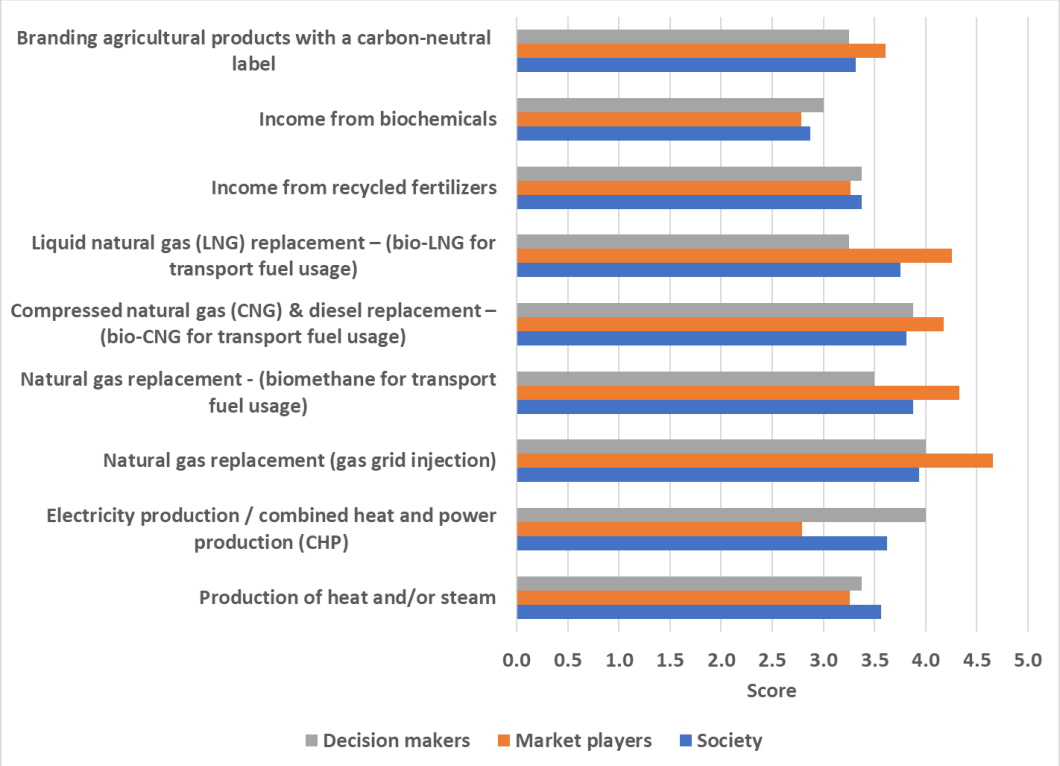

Figure 36 : Probability to utilize the biomethane for the different uses in the examined categories of stakeholders.

The different factors/drivers, which affect the biomethane penetration, seem to have similar performance with minor fluctuations for the all the examined categories of stakeholders (Figure 37). The decision makers believe that the adoption of stricter targets at European level (both CO_2 and RES target) will accelerate the penetration of biomethane, while the introduction of targeted management policy, digestate policy and biogas utilization policy is preferred by the market players along with the imposition of a RES target at national level. Finally, the society supports the specification of stricter CO_2 targets both at European and national level along with the adoption of a targeted biogas utilization policy.

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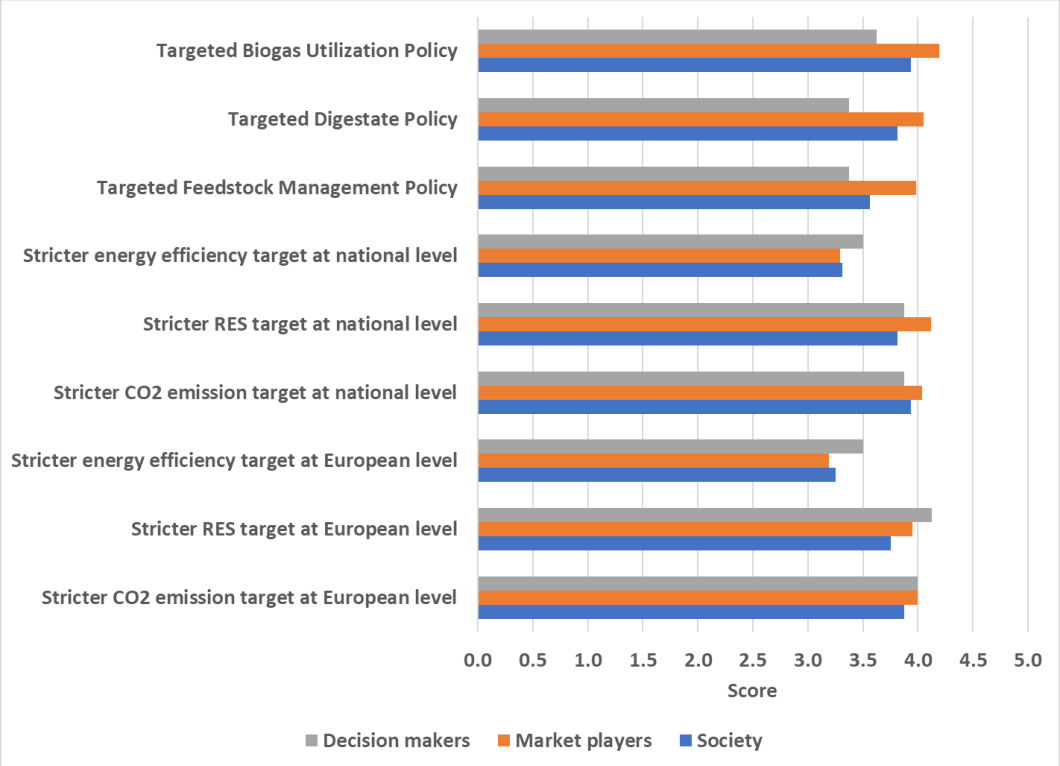

Figure 37 : Effectiveness of the various factors/drivers to the biomethane penetration in the examined categories of stakeholders.

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Chapter 5: Conclusions

The implemented analysis led to the following policy recommendations, which must be taken into consideration during the design of policies and measures for the promotion of the biomethane:

Production side:

- Facilitate the effective exploitation of the agricultural residues, which is the most prevalent feedstock type for biomethane production.
- Focus also on the utilization of industrial wastes, organic municipal solid waste and sewage for biomethane.
- Promote the utilization of membrane separation as the most prevalent upgrading technology for biomethane production.
- Support the maturation and commercialization of other innovative upgrading technologies (e.g., pressure swing adsorption, water scrubbing and cryogenic separation).
- Facilitate the injection of the biomethane into the distribution grid.
- Enable both the injection of the biomethane into the transportation grid and the mobilization of off-grid applications.
- Ensure the sustainable supply of feedstocks on a long-term basis.
- Ensure the acquisition of the environmental data for biomethane technologies.
- Handle the potential odor and flying insects' complaints with transparency and arguments.

Policy and demand side:

- Promote biomethane in order to fulfil 2030's energy and climate targets in all countries.
- Continue the massive penetration of biomethane until 2050.
- Foster the penetration BioLNG-BioCNG and bioH_2 until 2030.
- Prioritize the production of BioLNG-BioCNG and bioH_2 along with the biomethane after 2030.
- Communicate with a coordinated approach all the unquestionable benefits triggered by the biomethane production and consumption.
- Focus on the delivered benefits due to the increased waste management and the exploitation of the various by-products.
- Design measures so as to address the main technical barriers (e.g., the infrastructural challenges and the poor collection, improper segregation, lack of vehicles and adequate waste transportation).
- Reinforce the existing level of knowledge and the skills of the technical staff with the provision of dedicated technical training.
- Launch financial instruments to confront the main economic barriers (e.g. the high investment cost, the lack of subsidies and financial support programmes on a long-term basis and the high cost to interconnect small biogas projects to natural gas pipeline).

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- Address the main market barriers (e.g., the high price of biogas/biomethane, the uncertainties and regulatory hurdles related to injection of biogas into the grid and the large amount of waste feedstocks that is currently not being separately collected and diverted for processing).
- Establish a coordinated policy-making framework across agriculture, waste management, energy and transport.
- Ensure the continuous political support for the promotion of biomethane and avoid the adoption of the initiation of a fragmented and conflicting legislative framework.
- Reduce the bureaucracy during the construction and operation of the biomethane plants.
- Co-design the required policies and measures with the organization of public consultation procedures so as to increase the interest of the end-users.
- Enhance the existing level of knowledge and the public awareness.
- Internalize the environmental benefits into the fuel prices so as to improve the competitiveness of the biomethane compared to the fossil fuels.
- Expand the type of use so as to include additionally to the replacement of the natural gas from the grid alternative uses, such as indicatively to use bio-CNG or bio-LNG as transport fuels, to produce heat and/or steam, to exploit the recycled fertilizers and to produce branding agricultural products with a carbon-neutral label.
- Adopt stricter CO_2 emission and RES targets at national level than those are foreseen at European level accompanied by targeted feedstock management, digestate and biogas utilization policies.

It should be mentioned that the conducted analyses for the different countries and the different categories of stakeholders led to similar conclusions without major differences.

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Chapter 6: Annex: Questionnaire: Design of policy instruments for biomethane market uptake

Name of the stakeholder:	
Institution/Organisation:	
Position:	
Country:	
1. Please assess the potential role of the following alternative fuels to the fulfilment of the 2030's energy and climate targets. ***(Scale for scoring 5: Very important, 4: Important, 3: Medium important, 2: Unimportant, 1: Very unimportant)***	
Biogas	
Biomethane	
BioLNG-BioCNG	
$BioH_2$	
Additional comments (please insert):	
2. Please assess the potential role of the following alternative fuels to the fulfilment of the 2050's energy and climate targets. ***(Scale for scoring 5: Very important, 4: Important, 3: Medium important, 2: Unimportant, 1: Very unimportant)***	
Biogas	
Biomethane	
BioLNG-BioCNG	
$BioH_2$	
Additional comments (please insert):	
3. Please assess the degree of exploitation of the following feedstock types for biomethane production in 2030. ***(Scale for scoring 5: Very high, 4: High, 3: Medium, 2: Low, 1: Very low)***	
Agricultural residues	
Sequential cropping	
Energy cops	
Sewage	
Landfill	
Organic municipal solid waste	
Industrial (food and drink)	
Other (please specify):	
Additional comments (please insert):	
4. Please assess the degree of exploitation of the following feedstock types for biomethane production in 2050. ***(Scale for scoring 5: Very high, 4: High, 3: Medium, 2: Low, 1: Very low)***	
Agricultural residues	

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Sequential cropping	
Energy cops	
Sewage	
Landfill	
Organic municipal solid waste	
Industrial (food and drink)	
Other (please specify):	
Additional comments (please insert):	
5. Please assess the degree of utilization of the following upgrading technologies for biomethane production in 2030. ***(Scale for scoring 5: Very high, 4: High, 3: Medium, 2: Low, 1: Very low)***	
Pressure swing adsorption	
Water scrubbing	
Chemical absorption	
Membrane separation	
Physical absorption	
Cryogenic separation	
Other (please specify):	
Additional comments (please insert):	
6. Please assess the degree of utilization of the following upgrading technologies for biomethane production in 2050. ***(Scale for scoring 5: Very high, 4: High, 3: Medium, 2: Low, 1: Very low)***	
Pressure swing adsorption	
Water scrubbing	
Chemical absorption	
Membrane separation	
Physical absorption	
Cryogenic separation	
Other (please specify):	
Additional comments (please insert):	
7. Please assess the probability of using the following connection types for biomethane distribution in 2030. ***(Scale for scoring 5: Very high, 4: High, 3: Medium, 2: Low, 1: Very low)***	
Distribution grid	
Transport grid	
Not connected	
Other (please specify):	
Additional comments (please insert):	
8. Please assess the probability of using the following connection types for biomethane distribution in 2050. ***(Scale for scoring 5: Very high, 4: High, 3: Medium, 2: Low, 1: Very low)***	
Distribution grid	
Transport grid	

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Not connected	
Other (please specify):	
Additional comments (please insert):	
9. Please assess the significance of the potential benefits triggered by the biomethane production and consumption. ***(Scale for scoring 5: Very high, 4: High, 3: Medium, 2: Low, 1: Very low)***	
Improving the security of energy supply by increasing indigenous production and reducing dependence on fossil fuel	
Reducing CO_2 and CH_4 and potentially N_2O emissions	
Contributing to the fulfilment of RES targets	
Facilitating the increased integration of wind and solar by proving flexibility	
Increasing the cost-effectiveness of waste management by using organic waste	
Enabling the energy recovery from waste	
Developing a healthier environment for future generations	
Supporting rural development by creating jobs in the rural economy	
Generating qualified jobs in planning, engineering, operating and maintaining of biogas and biomethane plants	
Increasing tax revenues for municipalities	
Improving the fertilizer effect of the manure by degasifying it and as a result increases the crops yield	
Improving water quality by reducing nitrogen discharge	
Preserving valuable transmission capacity for the delivery of wind and solar energy and optimizing public investments due to the fact that existing natural gas pipelines are utilized	
Being used in industrial sectors (e.g. iron-ore reduction processes and production of short chain olefins in chemical industries)	
Other (please specify):	

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Additional comments (please insert):	
10. Please assess the importance of the potential technical barriers affecting the biomethane production and consumption. ***(Scale for scoring 5: Very high, 4: High, 3: Medium, 2: Low, 1: Very low)***	
Infrastructural challenges (e.g. plant size, lack of resource availability, limited number of gas filling stations)	
Technical failures and problems and negative image cause by failed biogas plants	
Lack of specialized technical staff and expertise including the limited technical training and knowledge	
Poor collection, improper segregation, a lack of vehicles and adequate waste transportation	
Insufficient follow-up services	
Fulfilment of specific characteristics of biogas	
Dependency on imported materials	
Lack of uniform biomethane quality standards and pipeline interconnection solutions	
Lack of performance data for biomethane technologies	
Other (please specify):	
Additional comments (please insert):	
11. Please assess the importance of the potential economic barriers affecting the biomethane production and consumption. ***(Scale for scoring 5: Very high, 4: High, 3: Medium, 2: Low, 1: Very low)***	
High investment cost of biogas production, transportation, clean-up, and upgrading	
High cost of biomass wastes (and other feedstock for co-digestion) including the high transportation cost of these feedstocks	
Lack of available capital	
Lack of subsidies and financial support programmes on a long-term basis (incl. fossil fuel subsidization)	
Limited sustainable supply of feedstocks; securing and reliability of long-term supply	

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Unavailability of bank loans (incl. with preferential terms)	
Economic environment/recession	
Lack of R&D funding	
High cost to interconnect small biogas projects to natural gas pipeline	
Difficulties to exploit the small-scale production of biomethane due to the fact that the natural gas grids have been designed to transport gas from large point sources to densely populated regions	
Limited understanding about the cost's constellation of the procedures for the production and injection of biomethane	
Other (please specify):	
Additional comments (please insert):	
12. Please assess the importance of the potential market barriers affecting the biomethane production and consumption. ***(Scale for scoring 5: Very high, 4: High, 3: Medium, 2: Low, 1: Very low)***	
Lower prices of fossil fuels	
High price of biogas/ biomethane	
Competition with other fuels/ Easy availability of fuelwood at zero private cost	
Uncertainties and regulatory hurdles related to injection of biogas into the grid	
Limited availability of suppliers and technologies	
Limited availability of suitable raw materials for biogas production	
Difficulties in extending the biogas filling station network	
A large amount of waste feedstocks is currently not being separately collected and diverted for processing	
Other (please specify):	
Additional comments (please insert):	
13. Please assess the importance of the potential institutional barriers affecting the biomethane production and consumption. ***(Scale for scoring 5: Very high, 4: High, 3: Medium, 2: Low, 1: Very low)***	
Lack of political support/legislation	
Stop-start policy support	

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Fragmented & conflicting legislative framework	
Absence of coordinated policy-making across agriculture, waste management, energy and transport	
Uncertain policy landscape (incl. political instability)	
Lack of private sector participation and poor coordination between the public and the private sectors	
High level of bureaucracy (e.g. complex administrative and legal procedures)	
Jurisdictional concerns should be addressed regarding waste ownerships, disposals, landfill gas concessions etc.	
Ineffective implementation of the Guarantees of Origin mechanism	
Other (please specify):	
Additional comments (please insert):	
14. Please assess the importance of the potential socio-cultural barriers affecting the biomethane production and consumption. ***(Scale for scoring 5: Very high, 4: High, 3: Medium, 2: Low, 1: Very low)***	
Lack of public participation and consumer interest	
Desire to maintain the status quo/Resistance to change	
Low level of knowledge and limited public awareness	
Lack of information and information sharing	
Low level of education	
Cultural and religious outlook including stigmatization	
Other (please specify):	
Additional comments (please insert):	
15. Please assess the importance of the potential environmental barriers affecting the biomethane production and consumption. ***(Scale for scoring 5: Very high, 4: High, 3: Medium, 2: Low, 1: Very low)***	
Odour and flying insects complaints	
Noise complaints	
Need for abundant water resources for biogas digesters/ Lack of access to adequate water	

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Environmental benefits are not internalized	
Remaining issues with air quality (e.g. NOX, H_2S, etc) and water quality due to disposal practices	
Lack of environmental data for biomethane technologies	
Other (please specify):	
Additional comments (please insert):	
16. Please assess the probability to utilize the biomethane for the following uses. ***(Scale for scoring 5: Very high, 4: High, 3: Medium, 2: Low, 1: Very low)***	
Production of heat and/or steam	
Electricity production / combined heat and power production (CHP)	
Natural gas replacement (gas grid injection)	
Natural gas replacement - (biomethane for transport fuel usage)	
Compressed natural gas (CNG) & diesel replacement – (bio-CNG for transport fuel usage)	
Liquid natural gas (LNG) replacement – (bio-LNG for transport fuel usage)	
Income from recycled fertilizers	
Income from biochemicals	
Branding agricultural products with a carbon-neutral label	
Other (please specify):	
Additional comments (please insert):	
17. Please assess the effectiveness of the various factors/drivers to the biomethane penetration. ***(Scale for scoring 5: Very high, 4: High, 3: Medium, 2: Low, 1: Very low)***	
Stricter CO_2 emission target at European level	
Stricter RES target at European level	
Stricter energy efficiency target at European level	
Stricter CO_2 emission target at national level	
Stricter RES target at national level	
Stricter energy efficiency target at national level	
Targeted Feedstock Management Policy	
Targeted Digestate Policy	

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Targeted Biogas Utilization Policy	
Other (please specify):	
Additional comments (please insert):	

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