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BARRIERS TO THE IMPLEMENTATION OF BIOGAS PRODUCTION AND BIO-WASTE MANAGEMENT SOLUTIONS

REPORT



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**VISTA
ANALYSE**

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INTRODUCTION

INTRODUCTION

The biogas market in European countries is at varying levels of development. Despite the benefits of biogas production for the environment, a closed loop economy or energy security, there are still a number of barriers that significantly limit the possibilities for biogas and biomethane market development in Poland and Norway. These barriers can be divided into organisational and legal, technical, economic, environmental, spatial and social.

Strongly linked to the issue of biogas production is also the management of bio-waste. This is because biogas plants enable changes to be made to the management of waste from the food industry and the biodegradable part of municipal waste.

The current insufficient level of selective collection of bio-waste in Poland, as well as the limited possibilities for its processing in the existing installations designed for this purpose, contribute to the still negligible exploitation of its potential. One of the main documents in Poland concerning waste management is the National Waste Management Plan until 2028. Among the targets set in the document for municipal waste, including biodegradable waste, it is indicated, inter alia, to increase organic recycling by promoting composting of bio-waste 'at source' by inhabitants, to limit landfilling of bio-waste to a maximum of 35% calculated on the basis of the amount of bio-waste generated in 1995. The document furthermore explicitly mentions the management of bio-waste in biogas plants (including agricultural biogas plants) as one way of dealing with municipal waste, but points to a significant problem of insufficient number and capacity of existing biogas plants for bio-waste management.

Norway has for many years been one of the countries with a very high level of separate waste collection. Norway's Waste Management Plan 2020-2025 indicates that the national goal is to aim for waste growth to be significantly lower than economic growth and for the resources contained in waste to be used in the best possible way through material recycling and energy use. It also noted the need to introduce and develop good solutions for the collection of bio-waste, both from households and businesses.

This report presents a set of identified barriers facing investments in municipal biogas plants (and biomethane plants) and the bio-waste management system in Poland and Norway. Identifying the problems is the first step in seeking and developing appropriate solutions to reduce or remove them altogether.



BARRIERS TO THE DEVELOPMENT OF BIOGAS PRODUCTION

BARRIERS TO THE DEVELOPMENT OF BIOGAS PRODUCTION IN POLAND

Organisational and legal barriers

There are several significant legal barriers to biogas plant development in Poland. One of the most important is the lack of consistent regulations governing biogas production, which makes it difficult for investors to plan and implement biogas projects. The legal separation of agricultural biogas from biogas derived from the processing of other substrates can lead to production start-up problems in the event of an inappropriate choice of substrates.

An important problem is the unequal treatment of agricultural biogas plants (usually small scale) and other biogas plants (e.g. municipal) in the legal system. The legal facilitations introduced for agricultural biogas plants do not result in an increase in biogas production on a sufficient scale. Also related to this is the lack of uniform regulations for the use of certain substrates in biogas plants (not every substrate is considered waste in different situations). The need to interpret regulations is a major barrier to the development of non-agricultural biogas plants. For biogas plants using substrates other than those intended for agricultural biogas plants, problems with the use of the biodegradable fraction of municipal waste are often pointed out. Applying for a permit to process further waste groups in a biogas plant is a lengthy process, effectively blocking the development of the plant.

The process of preparing a project, obtaining decisions and permits for a biogas plant investment is long and demanding. Depending on the size of the planned biogas plant and the type of substrates to be used in biogas production, there may be a need to undergo a full procedure for the environmental impact assessment of the project, as biogas plants can be classified as projects always or potentially significantly affecting the environment.

A barrier which, due to the growing interest in biogas plant investments, is slowly diminishing, is the lack of adequate preparation (knowledge) and approach of officials who issue decisions and permits relating to the specifics of the installation, the technologies used and the processes carried out.

A significant problem is the lengthy procedure for obtaining certificates for the biogas plant-generated digestate, which would allow its use in agriculture as a soil conditioner or certified fertiliser. If waste is used for biogas production, the digestate is classified as waste, which makes it difficult to use. The possibility of using the digestate as a fertiliser or soil conditioner may require the construction of a new plant, e.g. when treating sewage sludge, it may need to be hygienised through the use of highly reactive lime.

Planning documents of municipalities, where biogas plants are not included or their location is prohibited, are also sometimes a barrier to the location of biogas plants. Changing such a planning document is time-consuming and costly, and often impossible due to the reluctance of officials and the local community.

The lack of a stable energy policy and the absence of a long-term strategy for the development of renewable energy is also a problem, which can create uncertainty about the future of the biogas sector. Biogas and biomethane are insufficiently appreciated and taken into account in the balancing of the country's energy or transport system and in the decarbonisation of the economy, which is questionable with such a huge estimated biogas production potential. The lack of specific

targets for biogas and biomethane in energy policy does not encourage investors to develop production in the sector due to the lack of prospective interest from policy makers. Interest in the potential of biogas and biomethane in the energy, district heating or transport system is slowly beginning to grow, but a long time is needed to create the right legal conditions for market development, which is not facilitated by limited (or sometimes no) inter-ministerial cooperation.

Market development should involve both the public and private sectors. Unfortunately, a noticeable barrier is the poor coordination of cooperation between these sectors, which could support each other in the development of legislation, technology and the improvement of knowledge.

Technical barriers

The technical constraints on the development of the biogas and biomethane market are due to a number of factors. One of the main factors is the limited availability of technology in Poland. The need to import technologies from outside the country is associated with longer lead times and increased risks associated with potential delays. The lack of domestic technology is also linked to the underdeveloped biogas plant servicing industry. There are limited possibilities to service installations or replace parts due to a lack of appropriately trained staff and the need to import spare parts from outside the country.

Biogas plants most often use biogas to produce combined heat and power (CHP) for the company's own use, to ensure the proper operation of the biogas plant, including heating of the separate digesters (PACs) and the operation of the entire plant. Any surplus is fed into the grid. From the point of view of electricity production, a barrier to the construction of biogas plants is the limited access to connection to the electricity grid, as well as the long waiting time for obtaining conditions for connection to the grid. This barrier is due to the limited capacity of the transmission networks to accept energy and the poor state of the electricity infrastructure.

A number of problems are caused by the utilisation of the heat produced in a biogas plant. If the heat cannot be utilised within the plant, efficient utilisation of the resulting surplus requires access to a distribution network (district heating system). Due to the fact that many biogas plants are located in areas far away from potential heat consumers, such as housing estates, commercial buildings or industrial plants, and transporting the heat over long distances is inefficient (as it leads to significant energy losses) and uneconomic, the heat remains unused and is emitted into the environment. Another issue affecting the feasibility of heat utilisation is the seasonal variations in heat demand of both the company and potential consumers (if a connection can be built). The demand for heat varies according to the season which affects the possibility of its efficient use. In this connection, the lack of heat storage systems and the lack of mobile heat accumulators are also important.

Biogas, due to its properties, once treated and converted into biomethane, can be injected into the existing gas network in the country. However, the possibilities of injecting biomethane are limited due to the uneven availability of the network in the country. In addition, the high cost of making the connection and the need to adapt the parameters of the biogas to those required by the grid present technological and financial challenges. As in the case of the electricity grid, long waiting times for a decision and the actual implementation of the connection due to the lack of formalised requirements and legislation in this regard can be a barrier to connecting to the gas grid. The demand for gas in local gas networks, used e.g. for heating purposes, is characterised

by seasonality. In a situation of fluctuating gas demand, it would be a technical problem to store biogas before it is injected, as biogas production is characterised by stability. In areas without a local gas grid, liquefaction of biogas/biomethane and transport by special vehicles to collection points could be a solution, but again the low level of infrastructure development and high costs are barriers.

The biogas produced in a biogas plant, once it has been upgraded to biomethane, has properties similar to those of natural gas and could therefore be used successfully as a propulsion fuel. However, the underdeveloped market for natural gas vehicles (NGVs) in Poland and the availability of refuelling infrastructure for such vehicles are barriers. A similar barrier related to limited access to refuelling facilities is noted for biomethane, which could be used on a wider scale in the transport sector as bioCNG and bioLNG. In Poland, the first biomethane plant will not be built until 2024.

The limited flexibility of a biogas plant when changing the substrate mix is also a technical barrier. The need to change substrates may result, for example, from their variable availability (due to seasonality of agricultural production) and substrate cleanliness (e.g. degree of contamination of bio-waste with other waste fractions). A change in substrate may require an adjustment of plant parameters and a possible change in the process, e.g. an increase in digester temperature. Different substrates have different methane contents, which affect the energy efficiency of the entire installation. For some substrates, additional technical elements may be required to prepare them for the fermentation process, such as grinding or sanitisation, which increases both investment and operating costs. The lack of adequate technical infrastructure limits production flexibility.

Economic barriers

The main economic barrier is the very high investment costs for biogas plants, which increase further if a biomethane plant is built. Significant costs are also those associated with the connection to the electricity grid, which is required for the production of electricity within a biogas plant. A connection to the gas grid can also generate high additional costs. If biogas is injected into the grid, the purchase of additional infrastructure to purify the biogas and analyse its composition before feeding it into the grid is necessary. The desire to use the heat produced requires the construction of heat distribution infrastructure, including pipelines and heat exchangers, which is also costly.

A barrier to the development of the biogas and biomethane sector is also the limited access to bank loans with preferential conditions for investors and the low interest in granting investment loans. In the absence of funding, e.g. from EU or national programmes, an investment may not be feasible. However, the operation of subsidy programmes may not solve the problem due to the imposition of specific conditions for installations or substrates, often difficult for investors to meet. Due to the high costs and nature of the investment, the problem of insuring the installation may also be a barrier.

A frequent problem when applying for funding for the construction of biogas plants is the sectoral approach of funding institutions. With the great opportunities offered by co-digestion, i.e. the joint digestion of different substrates, e.g. sewage sludge with biodegradable waste from the agri-food industry, the rules for awarding funding often limit the possibility of using different substrate streams in a biogas plant.

A significant constraint for the development of the biogas and biomethane market is also the lack of support for operating costs, which are high. While, in the case of external funds, it is possible

to obtain co-financing for capital expenditures, very often expenditures related to the operation of the installation, labour costs, maintenance, repair or pre-processing of the raw material, remain unsupported. It is worth emphasising that the conditions for co-financing capital expenditures usually differ depending on the type of applicant - different rules for granting support apply for a public investor, private investor or farmer. In addition, the volatility of electricity, biogas and raw material prices can negatively affect the financial viability of a biogas plant.

Biogas and biomethane production can also be affected by the biogas and biomethane guarantee of origin system, which is not sufficiently developed in the country. The extension of the guarantee of origin system for biogas and biomethane in Poland did not take place until 1 January 2024. Importantly, guarantees of origin can be sold, which is an additional source of revenue for producers. In Poland, there is one voluntary certification system, KZR INiG (Sustainability Criteria System of the Oil and Gas Institute). Holding the certificate confirms that a company producing biomethane is pursuing a development strategy that takes into account environmental, social and governance criteria (ESG from: Environmental, Social, Governance). Failure to carry out the certification process prevents biomethane from being recognised as environmentally friendly and meeting ESG objectives. Being certified supports the building of a company's image as environmentally and socially responsible (but is not mandatory).

An economic barrier to the development of larger biogas and, in the future, biomethane installations is limited access to support schemes. Poland has a feed-in tariff (FIT) system for RES installations feeding energy into the electricity grid. The FIT scheme is designed for installations with a total electrical capacity of less than 500 kW, generating energy from, inter alia, agricultural biogas, biogas from landfills or biogas from sewage treatment plants. It guarantees the sale of all or part of the energy not used by the generator at a fixed price equal to 95% of the reference price to a designated supplier or selected entity. The second system is the feed-in-premium (FIP) system, dedicated to larger installations (from 500 kW to 1 MW in the case of biomass energy production). The FIP system allows electricity from biogas to be sold at a fixed price equal to 90% of the reference price only to an entity selected by the generator. The possibility to benefit from the indicated support is limited in time to 17 years. The reference price varies depending on the specific technology and plant performance and is set by regulation. Currently, the highest reference price applies to the smallest installations using agricultural biogas in high-efficiency cogeneration and amounts to PLN 1025 per MWh, which is more than two and a half times the market price of energy. For a biogas plant with a capacity of less than 500 kW using only biogas obtained from a sewage treatment plant, the reference price is PLN 572/MWh. If the energy is produced in high-efficiency cogeneration, the price is PLN 714/MWh. For biogas plants between 0.5 and 1 MWh, the reference prices are 520 and 663 PLN/MWh respectively.

Environmental and spatial barriers

The construction of a biogas plant, whether agricultural or on-site, involves the occupation and transformation of space. Given the technological considerations and storage needs, the availability of space for the construction and operation of a biogas plant is crucial. While the lack of space is not a problem for large farms, it can be a significant barrier for production and processing facilities or other businesses, as they do not always have a suitable area for the construction or expansion of a biogas plant.

Another important barrier to investment can be municipality planning documents, in which the location of a biogas plant is often not included or is prohibited. Changing such a planning document is time-consuming and costly, and often even impossible due to the reluctance of officials and the local community. Until now, the construction of a biogas plant has involved obtaining a planning permission (due to the frequent lack of local planning documents). A recent amendment to spatial planning regulations has strengthened the role of the local spatial planning. In the case of RES installations (and biogas plants are counted among them), additional facilitations in the spatial planning process are possible, but they are costly for the investor. It is worth remembering that the legal facilitation introduced in Poland in 2023 for the realisation of agricultural biogas plants in space applies only to small investments.

Local authorities' and communities' concerns about the possible environmental impact of biogas plants are also a barrier, primarily community concerns about odour emissions, as well as greenhouse gas emissions, water consumption. As the substrate in biogas plants is, for example, biodegradable waste or manure, they can be perceived as 'dirty' facilities that attract unwanted noise and odours, which can make it difficult to obtain appropriate decisions and public acceptance. Improper operations, the way substrates are stored or a faulty installation can contribute to environmental pollution and thus have a negative impact on local wildlife. The impact of biogas installations, which are often large in size, on the landscape and the pressure they put on the surrounding nature can also be a problem if an adequate buffer of isolating greenery is not provided or maintained. As well as providing benefits for local ecosystems, including e.g. the continuity of ecological corridors, these buffers can also act as insulation for odour and noise, which is a key issue for neighbouring residential areas. The size of the biogas plant itself, in particular the digesters, affects the local landscape and, in a legal context due to urban planning standards defining the maximum height of buildings in the areas concerned, and in a social context in situations of visual pollution or the introduction of disharmony in the landscape, can cause problems in obtaining the relevant decisions.

The location of biogas plants can also raise public concerns about their perception as noise and odour nuisance facilities. As the substrate in biogas plants is, for example, biodegradable waste or manure, they can be perceived as 'dirty' facilities that attract unwanted noise and odours, which can make it difficult to obtain the relevant decisions and public acceptance. However, any irregularities and environmental hazards can be caught in the course of obtaining permits and decisions, including the environmental decision, which aims to achieve a state in which the biogas plant has no negative impact on the environment and meets all the required legal standards.

Social barriers

Public resistance to the construction of biogas plants may be the most difficult barrier to overcome in the entire investment process at any stage. For many years, the so-called NIMBY (Not In My Back Yard) syndrome has been encountered in the case of various projects with the potential to cause various nuisances. Recently in Poland, as a result of increased investor interest in biogas plant construction, there has been a noticeable increase in the negative perception of biogas plants by residents in the vicinity of potential investment locations. Despite the possible benefits of the project, people do not agree to the construction of an investment in their neighbourhood due to fear of nuisance, especially smell. It is important to note here that in Poland,

despite the discussion that has been going on for many years, there are still no regulations in place to regulate odour air quality standards. In the absence of appropriate regulations, the fear of worsening living conditions in the immediate surroundings is compounded.

A significant problem for the development of the biogas and biomethane market in Poland is the low level of environmental education among the public regarding biogas plants and waste management. The local community is often unaware of the benefits of the investment. Among them, apart from generating energy from biogas (electricity and heat), it is worth remembering the reduction of energy purchase costs, as well as waste management. A persistent problem in the field of waste management is the still insufficient level of knowledge regarding the proper segregation of bio-waste, which can be a suitable substrate for biogas plants. Experts point to serious deficiencies in systemic and widespread waste education in the public space, including in schools and the public media.

Another problem is the lack of adequate education and knowledge among decision makers who are involved in the investment process and have a significant influence on the success of the process from the very beginning. The 'harsh' treatment of biogas plants in spatial planning throughout Poland to date can be traced back, among other things, to a low level of awareness among decision-makers about the aforementioned benefits of building a biogas or biomethane plant for the local community and economy. This lack of awareness translates into a lack of understanding of the need for the project. This is why it is so important to spread knowledge of new technologies and good biogas practices that can meet legal requirements, expectations and public prejudices.

Open communication and cooperation with stakeholders are key steps in convincing the public to build a biogas plant. A very important factor is the reliability and transparency of the decision-making and permitting process for biogas plants, which must include public participation. An important role in the environmental education of the public (including officials) is played by information and education campaigns addressed to various stakeholder groups, aimed at broadening the knowledge of biogas plant operation and raising the level of social acceptance for this type of investment. Increasingly, as part of raising the level of knowledge and acceptance of local communities for biogas plants, study visits to existing installations are also organised, which are attended not only by decision-makers and technologists, but also the local community. Allowing people to see similar investments and talking to people who had similar objections to the investment can be a very good way to convince the public to invest. In turn, education on waste management can bring tangible economic and environmental benefits to residents and investors.

BARRIERS TO THE DEVELOPMENT OF BIOGAS PRODUCTION IN NORWAY

Legal barriers

The existing support systems in Norway to promote biogas production are quite unclear and it can be difficult to get a complete overview. There are different support schemes for biogas use and production, which are managed by different entities that do not necessarily formally cooperate with each other.

Enova is the main source of government investment support for biogas installations. The support programme is aimed at those who wish to start or develop existing biogas production. The Enova programme only provides investment support and there are currently no operational support programmes. Both Sweden and Denmark, which have much higher biogas production than Norway,

have production support programmes that run for a longer period . The lack of production support may make biogas investment too uncertain for those potentially interested in building a biogas plant. Enova's funding for biogas vehicles was stopped in May 2023.

Market barriers

Norway does not have a well-developed gas network, unlike Denmark, so biogas will have to be used in other ways. One option is to use biogas to produce electricity and heat. However, electricity prices in Norway are relatively low due to the availability of hydropower, which may make it difficult for biogas producers to make electricity production economically viable. The biogas market should therefore be based on demand from other sectors. The transport sector could be a major customer for biogas, however, its high degree of electrification and the preference of large cities, such as Oslo, for electric buses over gas buses is a significant barrier. Biogas vehicles are currently uneconomic, the investment cost is 20 to 50 per cent higher and the operating costs are only marginally lower. The additional costs limit the market to those who are willing to accept the extra expense to reduce greenhouse gas emissions.

Uncertainty in the Norwegian biogas market is becoming a barrier to the investment process. Before investing in a biogas plant, the producer should conclude a sales contract to be sure that his product will be sold. Concluding an agreement before the investment decision makes the profitability of the plant more predictable. The lifetime of a biogas plant is about 20 years and the duration of a sales contract is usually no more than five to ten years. In a premature market such as the biogas market, this creates uncertainty about the viability of the plant and reduces the likelihood of investment.

A barrier for biogas producers is the market and use of the digestate. At present, the digestate is a cost for biogas producers and can be a barrier to potentially increasing production if they do not find a way to further utilise it. There is currently limited willingness to pay for the digestate from biogas production.

Barriers to substrate availability

Uncertainty regarding access to substrates is a barrier to increased biogas production in Norway. There seems to be a lack of incentives for owners of substrates that could be used for biogas production, recycling or energy. From January 2023, all municipalities are obliged to ensure that food and garden waste from private households is sorted at source. This should have a positive impact on access to substrates for biogas plants, but there are no regulations that require food waste to be used for biogas production, and composting is still a common method of processing organic waste. At the same time, given the requirements to minimise food waste generation, there is uncertainty about the organic waste content of municipal waste in the future.

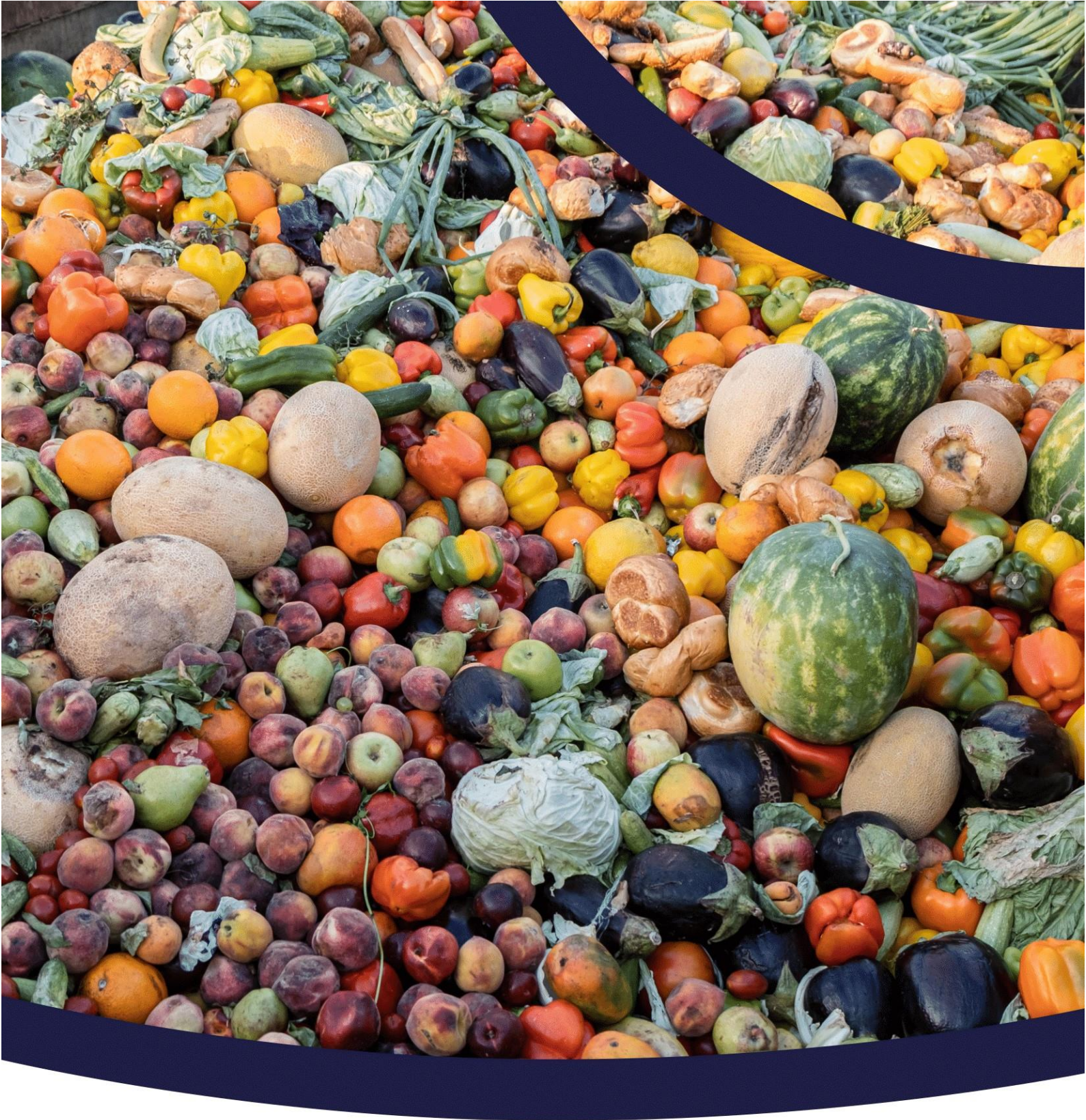
In many regions in Norway, substrate sources are widely dispersed, with some regions having low populations of livestock whose faeces provide a good substrate for biogas production. Despite the existence of subsidies given to those who supply livestock manure to biogas plants, biogas production from livestock manure is low and often unprofitable.

Economic barriers

As in Poland, the main economic barrier to biogas production in Norway is the high investment cost. In addition, due to the low cost of electricity in Norway, the price of biogas energy is not competitive, so investment in a biogas plant requires investment in a biomethane plant at the same time, which increases costs. Agricultural facilities face significant barriers in terms of high production costs, more unstable processes and varying energy demand. The economic benefits of replacing electricity, natural gas or solid biofuels with biogas are minimal, as these are relatively inexpensive energy carriers.

The profitability of biogas production is significantly influenced by the possibility to source substrates locally. Agriculture in Norway, strongly influenced by the country's geography and natural conditions, is characterised by the existence of relatively small areas that are suitable for agricultural production. This makes it difficult for smaller farms to obtain enough substrate to make the investment in a biogas plant profitable, and the high cost of transporting substrate from longer distances reduces the profitability of larger, regional plants.

Small farms cannot exploit the potential for economies of scale in biogas production. Unlike larger agricultural regions, where biogas plants can collect waste and other biomass from multiple sources, Norway's fragmented agricultural landscape makes it difficult to achieve the same level of efficiency and profitability. Smaller biogas plants face higher unit costs, which reduces their overall profitability.



BARRIERS TO BIO-WASTE MANAGEMENT

BARRIERS TO BIO-WASTE MANAGEMENT

Bio-waste, which is defined as biodegradable waste from gardens and parks, food and kitchen waste from households, catering, including restaurants, canteens and caterers, offices, wholesalers and retail units, and similar waste from establishments producing or marketing food, is one of the groups of substrates that are used in municipal biogas plants. They are characterised by a relatively high biogas production capacity. However, the lack of proper bio-waste management limits the biogas production potential from this stream. Selectively collected waste (of all fractions) in 2022 accounted for about 40% of the total collected municipal waste in Poland (for comparison - in Norway over 80%). Bio-waste collected selectively in Poland in the same year accounted for 14.3% of the total waste collected. However, in the stream of mixed (non-segregated) waste collected, bio-waste constitutes about 30% of its content.

Despite the steadily increasing level of separate collection of municipal waste, including bio-waste, municipalities responsible for waste management in their area face a number of barriers to effective waste management. Barriers of a legal nature are very important, especially the multiplicity of legal acts relating to bio-waste management and their frequent amendment. In both Poland and Norway, waste management issues are regulated in several legal acts. The lack of comprehensive legislation may effectively hinder the organisation of an efficient waste collection, collection and treatment system. At the European level, the lack of an effectively binding policy or legal obligations to achieve minimum standards for separate waste collection is cited as a significant barrier. It is stressed that current policies that focus on recycling and landfill targets are not effective enough to lead to the implementation of the envisaged changes in waste collection. The differing approaches of local authorities in interpreting and enforcing legislation is also a significant legal problem.

Moreover, the targets set in legal documents and policies for the level of waste segregation are sometimes difficult to achieve due to the lack of prior adaptation of the infrastructure for waste management. In 2022, nearly 26% of selectively collected bio-waste in Poland was sent to landfill after stabilisation, instead of being subjected to an appropriate composting or fermentation process. In order to start a comprehensive, selective collection of bio-waste and subsequent treatment, facilities for bio-waste treatment must first be available. This is one of the main obstacles to be solved in many European countries, which requires a long lead time and legal/administrative resources.

A frequently indicated barrier is the low level of environmental awareness, regardless of the level of economic development of the country. Waste management education, which is part of environmental education, is a very important element affecting the lives of all inhabitants. Experts point out significant deficiencies in systemic and widespread waste management education in public spaces, including schools and public media. Conducting various information campaigns should support the public education system from the youngest grades, but it is important to reach all age groups with knowledge. It is very important to educate and inform residents on a continuous basis. This is because residents are part of the whole organisational structure and waste management system, as they are key actors in terms of separate collection and participation in the system (and its financing). Different municipalities may have slightly different guidelines for segregation, especially for bio-waste, which may cause problems for proper segregation in the case of people changing their place of residence temporarily or permanently. Noticeable differences can also be seen between countries - in Norway, unlike in Poland, meat leftovers, bones, fish, leftover soiled paper or tea bags and coffee filters are disposed of as bio-waste.

A major problem is the level of qualification of municipal employees and companies. Education and training is needed for the employees of municipalities and businesses due to changing legislation and the development and modification of the waste collection system. The government's interaction with municipalities, as organisers of the waste collection system and thus the most important link in the entire system, cannot end with communicating the rules and setting targets to be achieved without appropriate educational activities. The different conditions found in the individual municipalities, as well as the changes that occur over time, mean that waste management systems must be monitored, adapted and updated on an ongoing basis to fit local conditions. Overcoming this barrier requires skilled people and knowledge development.

In smaller towns or rural municipalities, where the number of inhabitants and households is smaller and more dispersed than in large urban centres and agglomerations, a major problem is to adapt the frequency of waste collection, including bio-waste, which requires more frequent collection due to its characteristics to the expectations of the inhabitants. Bio-waste, especially during higher temperatures (spring and summer seasons), generates odours, tends to rot and attract insects and rodents, which is problematic in both single-family households and in multi-family housing. In addition, the high variability in the amount of waste generated at different times of the year (greater production of bio-waste, including green waste from gardens during the growing season) translates into the need to vary the frequency of collection throughout the year.

A popular solution used by municipalities with smaller populations across Europe is to encourage the composting of biodegradable waste (kitchen and green waste) in home composters, e.g. by introducing fee reductions. This reduces the extent to which waste management is carried out in the municipality and the costs incurred, and thus the fee for household waste collection. The home composting solution, however, limits the availability of bio-waste to the collection company and thus limits the supply of potential substrate for the biogas plant. Furthermore, from a financial point of view, the amount of relief for individual composting is perceived by residents as very low in relation to the monthly fee for bio-waste generation and is judged to be disproportionate to the mass of the bio-waste stream and the costs of collection and treatment in industrial facilities.

A significant problem is also the lack of sufficiently effective tools to control the quality of separate collection of bio-waste, especially in multi-family housing. A sense of anonymity among residents often leads to inappropriate segregation of municipal waste. Due to staff shortages in companies, as well as the increasing costs of the waste management system, companies and municipalities are not able to carry out sufficiently effective control, including control of backyard composters. However, ideas are emerging for solutions to increase the effectiveness of quality control of selective collection, such as a system of red warning cards and the imposition of financial penalties (increased fee), as well as a system of individual barcodes for waste bags (e.g. in Mszana Dolna).

The economic barrier is the overhead, investment and operating costs associated with ensuring the operation of the waste management system. As in the case of biogas investments, also in the construction of other waste treatment facilities, investment costs may determine the non-implementation of investments and the development of the system. Due to the organisation of the system and the need for the waste management system to be self-financed from residents' fees, raising funds for investment is very difficult. External funds, e.g. from the EU and various types of subsidies as available, can help here. In the case of limited financial resources and the possibility to increase them, municipalities do not take steps to modernise or modify the bio-waste management

system. The possibility of agreements/contracts between municipalities for joint waste collection services (including bio-waste) or operation of treatment facilities (economic scale efficiency) is helpful in reducing costs as well as increasing the efficiency of waste management. Such inter-municipal associations are relatively popular in Norway, while they are less common in Poland and usually involve smaller municipalities.



SUMMARY

SUMMARY

This report identifies a number of barriers to biogas production and improved bio-waste management in Poland and Norway, some of which are similar in both countries, while others depend on country specifics and internal conditions.

In Poland, legal, technical and economic barriers prevail. The lack of domestic technology contributes to higher investment costs. Social barriers are also important, pointing to the need for continuous education. Many of the legal and economic barriers have their sources indirectly in the still present lack of knowledge of Polish society and authorities about the benefits of biogas production. Vagueness or misinformation resulting from lack of knowledge consequently leads to a mostly reluctant attitude of the general public.

In Norway, on the other hand, social and technological barriers are less important, and economic barriers are more important, as the need to treat biogas to biomethane and transporting it significantly increases investment costs.

In terms of bio-waste management, the underdevelopment of bio-waste management facilities (including an insufficient number of biogas plants) can be highlighted among the barriers. Complicated regulations, the number of legal acts and their frequent updates introduce uncertainty about the future functioning of the waste management system and the biogas market.

The Norwegian and Polish achievements to date are the results of very good cooperation between the municipal and private sectors. In view of the new objectives facing waste management, support is needed for local governments in implementing activities related to green transformation and the closed loop economy. As part of this support, there is a need to increase communication, education and public awareness, and to build and expand networks of expert stakeholders at all levels of governance.



SOURCES

SOURCES

Bednarek A., Klepacka A.M., Siudek A. (2023). Development barriers of agricultural biogas plants in Poland. *Economics and Environment*, 1(84), ss. 229-258. DOI: 10.34659/eis.2023.84.1.528

Czarkowska A., Czarkowski M. (2021). Wykorzystanie technologii energetyki biogazowej w systemie bezpieczeństwa energetycznego. *Zeszyty Naukowe Państwowej Wyższej Szkoły Zawodowej im. Witelona w Legnicy* nr 41(4)/2021, ss. 11-34. DOI: 10.5604/01.3001.0015.7769

Deloitte Advisory (2020). *Problemy gospodarki odpadami komunalnymi. Poradnik dla gmin.*

Głuszyński P., Kobylińska A., Chodkiewicz E. (2024). *Wyzwania gospodarki odpadami komunalnymi w gminach.* Instytut Spraw Publicznych.

Ignaciuk W., Sulewski P. (2021). Uwarunkowania rozwoju sektora biogazu rolniczego w Polsce w kontekście doświadczeń historycznych i wyzwań Europejskiego Zielnego Ładu. *Zagadnienia Ekonomiki Rolnej*, 3(368) 2021, ss. 55-77. DOI: 10.30858/zer/140413

IOŚ-PIB (2022). *Biologiczne przetwarzanie komunalnych bioodpadów zbieranych selektywnie w 2020 r. Raport.*

Krajowy plan gospodarki odpadami 2028 (M.P z 2023 r., poz. 702).

Life BIOBEST (2024). *D5.2 Policy brief including the regulatory barriers.* Report.

NIK (2021). *Bariery rozwoju odnawialnych źródeł energii. Informacja o wynikach kontroli.* KGP.430.014.2020. Nr ewid. 190/2020/P/20/016/KGP

Pawlak J. (2013). Biogaz z rolnictwa – korzyści i bariery. *Problemy inżynierii rolniczej*, PIR 2013 (VII–IX): z. 3 (81) ss. 99–108.

Ustawa z dnia 14 grudnia 2012 r. o odpadach (t.j. Dz. U. 2023 poz. 1587 z późn. zm.)

Ustawa z dnia 20 lutego 2015 r. o odnawialnych źródłach energii (t.j. Dz.U. 2023 poz. 1436 z późn. zm.)

Teraz Środowisko (2024). *Biogaz i biometan w Polsce 2024.*

The Norwegian Environment Agency (2019). *Waste management plan 2020-2025.* Report M-1582.

The Norwegian Environment Agency (2020). *Policy measures for increased use and production of biogas.* Report M-1652.

The Norwegian Environment Agency (2022). *Biogass i Skandinavia – En sammenligning og gjennomgang av virkemidler.* Report M-2275.