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# INJECTION OF RENEWABLES GASES INTO THE EXISTING GAS DISTRIBUTION GRIDS AND EMPLOYMENT OF REVERSE GAS FLOW TECHNIQUE

L. Jansons[1,2*], J. Silina[1], I. Bode[1], L. Zemite[1], N. Zeltins[1], K. Palkova[3]

[1]Riga Technical University,
Faculty of Computer Science, Information Technology and Energy,
Institute of Power Engineering,
12-1 Azenes Str., Riga, LV-1048, LATVIA
[2]Riga Technical University,
Faculty of Engineering Economics and Management,
6 Kalnciema Str. 210, Riga, LV-1048, LATVIA
[3]Riga Stradins University,
Faculty of Social Sciences,
16 Dzirciema Str., Riga, LV-1007, LATVIA
*e-mail: leo.jansons@rtu.lv

Sustainability and longevity of existing gas grid exploitation perspective are closely related to two fundamental issues: their ability to adopt to changing gas fuel production and supply landscape in the context of methane-based fuels, mostly, biomethane, and in the context of non-methane-based fuels, mostly, low carbon and green hydrogen. Renewable gases and their ever-growing presence in gas transmission and distribution systems open up a discussion about the necessity to revise and restructure the original – vertically integrated layout of the gas systems, where gas supply is only technically possible from the transmission system towards distribution one, and not vice versa. Development of numerous decentralized biomethane production facilities connected to the gas distribution system causes a necessity to ensure the possibility to pass biomethane surplus of a certain production area into the gas transmission grid, thus avoiding necessity to install biomethane storage capacities locally and granting other regions an opportunity to use said surplus in their gas consumption immediately. The article addresses biomethane production trends and actions taken towards the development of reverse flow gas stations in France – one of biggest biomethane producers in Europe to date, and opportunities and challenges, which this technique might face in smaller and less active renewable gas markets as the one of Latvia.

***Keywords:*** *Biomethane, gas distribution grids, renewable gases, reverse gas flow.*

## 1. INTRODUCTION

For a long time, natural gas has been perceived as the only viable bridging fuel in transition from fossil fuel dependency to green and sustainable energy future on the road towards European carbon neutrality in 2050. In some countries, natural gas has become the main fuel to generate electricity and heat energy, as the gas sector enjoyed rapid development in the first two decades of 21st century characterised by a considerably steady and favourable price [1]. However, the extensive utilization of fossil gas also had and still has its shortcomings. For instance, the EU dependency on natural gas imports went from 83 % in 2021 to 97 % in 2022, and in 2020 fossil gas that dominated the gas sector accounted for a quarter of European Union's (EU) greenhouse gas (GHG) emissions, which started to decrease steadily only in 2022 onwards. According to Eurostat data, in comparison with 2008 – the first year when statistical information on actual GHG emissions in different sectors of the EU's industry was collected, 2022 showed a significant decrease in emissions in the electricity, gas, steam and air conditioning sectors, accounting to 37% [2]. At the same time, in the gas power generation sector, reduction in GHG and more precisely carbon dioxide emissions is often in correlation with power plant age and the sophistication level of generating equipment: power generation at newer gas-fired plants is up to 30 % lower than that at older ones and up to 50 % lower than that at newer coal-fired plants [3].

Also, the Russian invasion of Ukraine constituted a significant breach of the global geopolitical order, with wide and far-reaching economic consequences. These include, but are not limited to, deterioration and turbulent changes of the world macroeconomic outlook, disruptions in trade, strong shockwaves across financial and commodity markets, and disrupted functionality of global fossil gas market [4]–[8]. It strongly impacted, yet did not completely ruined fossil natural gas positions as bridging fuel in the EU's energy transition. To meet its energy and economy decarbonisation targets, the EU aims at shifting into low-carbon gases whilst reducing the total gas consumption by 25 % by 2030. However, a clear roadmap for this cut-transition still needs to be approved.

At the same time, reduction of fossil gas presence in the EU energy sector poses a question – whether the gas sector will be thrown into total decline, thus gradually losing all the infrastructure investment done in this sector during the last 60 plus years, or it will be renewed by means of introduction of both methane and non-methane based renewables gases (RGs) to the grids [9]. According to the European Agency for the Cooperation of Energy Regulations and the Council of the European Union, such RGs as biomethane and hydrogen, have the potential to cover 30 % to 70 % of the total EU gas consumption by 2050 [10]–[11].

In terms of existing gas infrastructure and its availability, the EU gas networks provide an extensive integration potential for a wide range of RGs. The EU gas network is capable of transporting and storing large quantities of energy: it constitutes more than 200 000 km of transmission pipelines, over 2 million km of distribution network and over 20 000 compressor and pressure reduction stations. The value of the total infrastructure investments is approximately 65 billion euro (EUR) in EU gas transmission system operators' (TSO) regulated asset bases. Distribution system operators' (DSO) assets add to that figure at least by a factor of 3 [3]. In many cases, transformation and repurposing of the existing gas networks both at transmission and especially – distribution level, for RG application may prove itself to be more cost-efficient solution than building of new gas pipelines.

For the most well-known RG in the EU – biomethane, even special gas pipeline fittings are not necessary, as biomethane is chemically, and in its physical properties, indistinguishable from fossil natural gas [12]. As for mid-2023, Europe reached a total of 1322 biomethane-producing facilities, which is quite a decent share in comparison with total amount of biogas producing facilities, which then stood at approximately 20 000 [13]. In 2020, 4 % of total consumed gas in the EU and UK was RG, chiefly biogas and its derivates, like biomethane. Total volumes have more than doubled in the past 10 years.

Europe's combined biogas and biomethane production in 2022 amounted to 21 billion cubic meters (BCM). This is more than Poland's entire inland natural gas demand and represents 6 % of the EU's natural gas consumption in 2022. Biomethane production alone grew from 3.5 BCM in 2021 to 4.2 BCM in 2022. In the case of Denmark, the share of biomethane in the gas grid was close to 40 %. There are also plans to increase this production to substitute 100 % of the gas demand by 2030. The versatility of biomethane as a renewable energy source is reflected in its balanced distribution pattern across end-uses, all in urgent need for decarbonisation: 22 % was used for buildings in 2022, whereas a further 14 % was used in industry, 19 % for transport and 15 % for power generation [14].

It is a bit different in a case of the most promising RG of the future – hydrogen. In the transitional phase from methane based to non-methane-based RGs, forms of low-carbon hydrogen, for example, its blends, are needed to replace the existing natural gas and kick-start an economy of scale. The gas networks may use hydrogen blend of 5–20% [15] by volume and be tolerated by most systems without the need for major infrastructure upgrades or end-use appliance retrofits or replacements. The transmission of existing gas networks to hydrogen networks is one of the main aspects to achieve the hydrogen availability and in the meantime large-scale transportation. The promotion of hydrogen networks as future energy centres of the EU is gaining momentum, and the development of hydrogen related activities in all segments of energy sector are ongoing [16]. To decarbonise the natural gas grids, the threshold of hydrogen allowance in the existing grid systems must be increased. To create a consistent and long-lasting plan, the current energy sector players must participate in the development of the strategy, as actors in the field have command of currently used facilities and technologies.

However, in the mid-term perspective, along with emerging green and low-carbon hydrogen, biomethane will play an important role to achieve EU's energy decarbonisation, diversification of gas supplies and reduction of the EU's dependence on external energy deliveries, while simultaneously reducing exposure to volatile natural gas prices [17].

As a renewable and dispatchable energy source, scaling up the production and use of biomethane also help address the climate change. For these reasons, according to the EC, biomethane production needs to reach 35 BCM per year by 2030. To achieve this ambitious target, the EC presented in 2022 a Staff Working Document accompanying *REPowerEU* plan that includes a number of possible actions to unlock the potential of biogas and biomethane across the EU [18]. The proposed actions aim at supporting production to a sustainable potential volume of biogas to further upgrade it to biomethane and to direct biomethane production from waste and residues, avoiding the use of food and feed feedstocks leading to land use change issues. These actions should also create the preconditions for sustainable upgrading and safe injection of biomethane into the gas grid.

Also, for Latvia, which has rather developed and historically well-maintained gas TS and distribution system (DS), covering approximately 40 % of the country's territory, decarbonisation of the gas grids by means of introduction of biomethane and, with time, green and low-carbon hydrogen is one of the priorities in its energy agenda. It will allow not only using gas DS assets in the closest future, but also upgrading this system for successful exploitation in at least next fifty years.

## 2. PRINCIPLE OF REVERSE GAS FLOWS BETWEEN TS AND DS

Historically, the EU and the Latvian gas networks only worked in one direction. It meant a vertically integrated one-way operation, where the gas, once it got in the transmission system (TS), was routed at high pressure throughout TS and towards gas DS. In DS, its pressure is lowered to supply industrial facilities or pass through the network as far as individual residential consumers. As it has been described above, the EU gas network is very extensive at both transmission and distribution level [3].

As a result of these one-way operations, the predicted impact of biomethane development is blunted, unless its production points are connected directly to the TS. However, the gas DS is much more extensive, the probability that anaerobic digestion units are located close to one of the loops of this system is much higher, especially when full advantage is taken of the tremendous potential of raw materials in the form of household waste in and around urban areas. With the employment of reverse-flow station, gas systems become bi-directional; the surplus biomethane from DS can enter the TS and continue a conventional path to any consumption point.

*Fig. 1.* Noyal-Pontivy reverse gas flow station.

*Source:* GRTgaz

Industrial and agricultural waste treatment plants produce biomethane, which is equal in its quality to fossil natural gas, and can be used directly in the commercial and private markets. These units, featured by constant biomethane production throughout the year, are often connected to gas DS in urban or rural areas, where consumption is usually lower than production and is subjected to additional fluctuation challenges like seasonality. This excess represents added value if recovered and used in areas where demand exceeds supply. In this perspective, a number of green solutions have been designed to recover and reuse biomethane surplus, such as storage and the reverse flow techniques. The reversal technique consists of compressing unconsumed biomethane till distribution network working pressure level and then injecting it into the network at a higher pressure allowing locally produced RG to be supplied to a wider a consumption area.

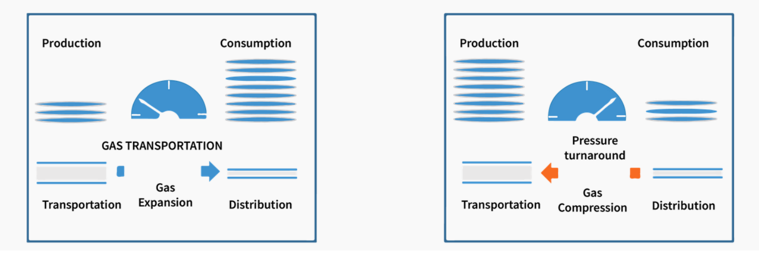


*Fig. 2.* The functionality of traditional gas TS and DS (a), and employment of reverse flow techniques between DS and TS (b).

The main function of a reverse gas flow station is that of a compressor: gas produced and unconsumed is compressed to a pressure equivalent to that of the transportation network. The mechanism works automatically: the compression unit starts up when the network pressure reaches the maximum expected threshold, above the estimated consumption of the biomethane station area. Then, the excess gas is compressed and injected into another network, bringing the initial network pressure to a low threshold where the compressor will stop.

With this versatile solution, the network becomes bi-directional and excess biomethane can join the transportation network at any point of consumption. These compression systems, from the distribution network to the transportation network, maximize the efficiency of the entire energy system because, thanks to a play of pressure peaks, they encourage the circulation of any surplus gas for immediate consumption or, otherwise, in storage units for future consumption. This avoids saturation of the system and the consequent dispersion of exceeding gas.

## 3. BIOMETHANE PRODUCTION AND EMPLOYMENT OF REVERSE GAS FLOW TECHNIQUE IN FRANCE

### 3.1. Biomethane Production in France

The gas TS in France is operated by two TSOs: GRTgaz and Terega. GRTgaz operates 8 110 km of the main network and 24 043 km of the regional networks, which makes around 87 % of the total gas TS in the country. Teréga, on the other hand, operates the remaining 13 % of gas TS, with 650 km of the main network and 4450 km of the regional networks in the south-west of France. The two networks interconnect in Castillon-la-Bataille and Cruzy.

DSs are owned by local communities and are managed through a concession-based system between local authorities and Gaz Réseau Distribution France (GRDF). GRDF operates 95 % of France's gas DSs, while 22 local distribution companies cover the remaining 5 % and offer their own regulated tariffs. The French gas distribution network totals 195 000 km, the second-longest gas network in Europe after Germany. Both TSs and DSs are open to third-party users, including RG producers [19].

As for early 2023, France had 1705 biogas production facilities. About 30 % of them – 514 facilities, purified biogas till the level of biomethane and provided injection of it into the regional gas grids. In comparison with 2020, the amount of biomethane facilities in France more than doubled, as in late 2020 there were only 214 of them in operation in the country.

The role of gas TSOs and DSOs in the development of biomethane production and distribution in France cannot be underestimated, if even many challenges in this process still lay ahead. The first role for gas operators such as Terega is to guarantee the right to inject for any biomethane producer located near a network – be it TS or DS related. Once certain technical and economic conditions are met, operators must make the necessary arrangements to allow access to their infrastructures.

TS, with a support of all DSs located close to production premises, carries out connection zoning: this jointly-run futurology exercise makes it possible to determine the optimal way of welcoming all producers onto the grid who want to inject their biomethane over the coming years. The subtle technical and economic balance found as a result of the process is aimed at creating the best possible conditions for developing the grid at the lowest possible cost. Once the mapping is decided upon, operators will be able to consult the Energy Regulation Commission (CRE) and stakeholders wanting to have a stake in those projects, and then get the investment funding released, to build, operate and maintain the new plants.

This process is part of our public service mission, supporting the creation of energy and jobs in local areas, at the same time guaranteeing sustainability of gas related industry. In France in 2022, close to 7000 gigawatt – hours (GWh) of biomethane were injected into the gas grids (see Fig. 3), representing 10 % of former imports of Russian fossil gas. Thus, these 7000 GWh covered only 2 % of France's gas consumption over the year, the peak levels of biomethane injections were observed in August, 2022, when 10 % of all gas flowing through the grid in the southern part of the country, was biomethane [20].

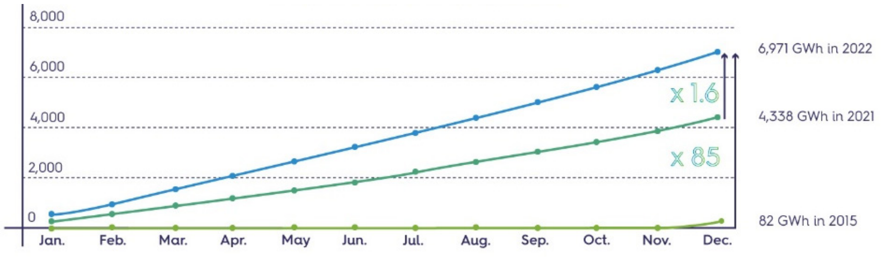


*Fig. 3.* Biomethane injected into the gas grids in France (2015, 2021, 2022, in GWh), [20].

Source: *Terega*

Tools to speed up biomethane markets growth are also considered or introduced in France and a few other EU countries, namely:

- indexation of the regulated purchase tariff to keep up with fluctuation of inflation rates. Announced at the end of 2022, the change in the tariff also considers the hourly cost of labour and the production price index;
- support for biomethane production by invitations to tender. At the end of 2022, public stakeholders decided to launch calls for tender for biogas production. The first tranche was for 500 GWh, at a price judged by producers to be too low. A new round of invitations to tender were launched afterwards;
- issue of biogas production certificates. The idea to put energy suppliers under an obligation to supply a proportion of their portfolio of customers with biomethane. Whether they produce it themselves or buy it from third party producers, that biomethane will give them certificates to prove they are full filling the obligations. This arrangement would help share out the work of developing the industry across the state, producers and energy suppliers;
- biomethane purchase agreement. These direct negotiation contracts are negotiable directly and freely between a biomethane producer and an end consumer. This simplification of the transaction process is meant to speed up the development of a virtuous local ecosystem [21].

### 3.2. Employment of Reverse Gas Flow Technique in France

In recent years, France has experienced a fast development of biomethane production. To facilitate this development and maximize its potential, the gas TSO GRTgaz is planned to build more than 30 reverse gas flow stations plants, most of which were commissioned between 2022 and 2024, facilitating the integration of RG into existing gas networks. To date, GRTgaz operates five such plants, and further 13 sites are under construction and CRE has already validated the investment for seven new projects and the study of nine additional ones.

A reverse flow station transfers local biomethane surpluses on the distribution networks to the transmission network, to be transported to another territory or stored. Reverse flow, thus, gives a greater visibility to project owners and encourages concrete plans for anaerobic digestion units, as it allows all local production to be accepted by the network at any time, particularly in summer when production may be higher than consumption. These gas infrastructure developments offering smart biomethane logistics provide renewable energy that is fully controllable and storable, and hence extremely useful for the stability of the energy system.

Maximum reliability and availability are one of the key factors for successful development and utilisation of reverse gas flow stations.  Compression units are installed inside soundproof, water-resistant steel cabins and are equipped with gas and fire detection systems ensuring high levels of safety. The control panel, which manages both the power and the compressor unit, has been designed and installed in a dedicated room. Through manual dryers (present in two out of eight stations) installed upstream the compression unit cleans and dries the gas when the water content of the network is too high. Furthermore, water cooling system cools the gas at each compression stage ensuring that the compressor works properly.

The systems can be equipped with a compressor unit with an installed power of 2.2 kW and a maximum capacity of 3 $m^3$/h. This compressor unit operates over a wide range of pressures in both suction (10 to 500 mbar) and discharge (40 to 67.7 bar). Its operation is automatic and controlled by the control panel fully integrated inside the system: each time the inlet gas exceeds a pressure of 200 mbar, the compressor unit is activated, recovering any gas leaks, thus avoiding dispersion into the atmosphere. Once the gas pressure is reduced to 10 mbar, the compressor unit stops.

It is a technique that makes it possible to optimize the flow of biomethane, confirming that biomethane is a flexible, efficient and programmable source. The solutions highlighted are the result of know-how gained in over 40 years of activity in the compression technology, which has enabled the development of tailor-made and highly innovative projects.

In a decision published in July 2021, CRE approved the launch of studies for the installation of nine new reverse flow projects. GRTgaz currently has a portfolio of 32 reverse flow projects in France, for a total investment of nearly EUR 100 million. GRTgaz already operates five reverse flow stations in Noyal Pontivy, Pouzauges, Mareuil-lès-Meaux and Marchémoret and Marmagne [22].

With its project portfolio, GRTgaz confirms its commitment to RGs and its ability to support the development of the sector by combining the rollout of reliable solutions with targeted investments where necessary. As part of its business plan for 2021–2024, GRTgaz also aims at connecting around a hundred anaerobic digestion sites directly to its network.

## 4. A BRIEF OVERVIEW OF THE LATVIAN GAS DS

The gas DS plays an essential role in the continuous, safe supply of natural gas not only to the households, but also to commercial and industrial consumers.

The technical operation of distribution gas pipeline systems in Latvia is carried out by the gas DS JSC Gaso (GASO), which is the only operator of the natural gas DS in Latvia and ensures the supply of gas from the TS to end consumers. The company ensures development of distribution infrastructure, construction of gas connections, system operation and natural gas accounting, as well as emergency service operation. GASO was founded on 22 November 2017, separating the operation of the gas DS from JSC Latvijas Gāze and fulfilling the EU and state requirements for ensuring the independence of the natural gas DSO. In 2023, the process of selling the company was started, after the Competition Council of Republic of Latvia ruled that the Estonian company Eesti Gaas was allowed to gain decisive influence over GASO [23].

Until the 1990s, mainly steel pipes were used for the construction of distribution gas pipelines. However, now polyethylene pipes are increasingly preferred – this practice is not only in the Baltic States, but also in other parts of Europe. This change in preferences is, accordingly, also reflected in the current share of materials for the production of distribution gas pipelines in the Latvian gas supply system. The percentage distribution of distribution gas pipelines in Latvia according to the material used is 60.5 % steel and 39.5 % polyethylene, from which it can be concluded that most of the pipelines that have been replaced in the past twenty-five years are made of polyethylene.

Therefore, the share of steel distribution gas pipelines in the gas supply system of Latvia is shrinking; however, their further use should be continued in case of good technical condition.

According to the data collected in 2023, the total length of distribution system gas pipelines in Latvia is 6 409 km.

However, gas distribution systems do not consist only of gas pipelines, they also include gas regulation equipment, special structures, shut-off devices, anti-corrosion equipment, as well as other technical devices. At present, there are 175 gas regulation points, 2 383 cabinet-type gas regulation points, 18 979 home regulators, 5 222 home stabilizers in the Latvian gas DS.

The total amount of distribution gas pipelines in Latvia is divided by service districts: the total length of distribution gas pipelines in the territory of Riga district reaches 3 296.9 km, in the territory of Ogre district – 294.9 km, in the territory of Liepaja district – 459.8 km, in the territory of Jurmala district – 468.8 km, in the territory of Jekabpils district – 197 km, in the territory of Jelgava district – 589.4 km, in the territory of Daugavpils district – 227.1 km, in the territory of Cesis district – 473.1 km and in the territory of Bauska district – 401.7 km. According to the percentage distribution, the pressure classes of gas DS pipelines are as follows: low pressure (<=0.05 bar) – 38.6 %, mean pressure (<= 0.1 bar) – 6.6 %, mean pressure (<= 4 bar) – 36.4 %, high pressure I (<=6 bar) – 12.3 %, high pressure II (<= 12 bar) – 3.5 %, high pressure III (<= 16 bar) – 2.6 %. The technical operation of distribution gas pipeline systems is based on LVS 445-1:2011 on "Operation and maintenance of natural gas distribution systems and user natural gas supply systems with a maximum working pressure of up to 1.6 MPa (16 bar)" performing the specified actions, but is not aimed at determining the causes of deterioration (damage) of the technical condition of gas pipelines, as well as predicting further safe operation [24].

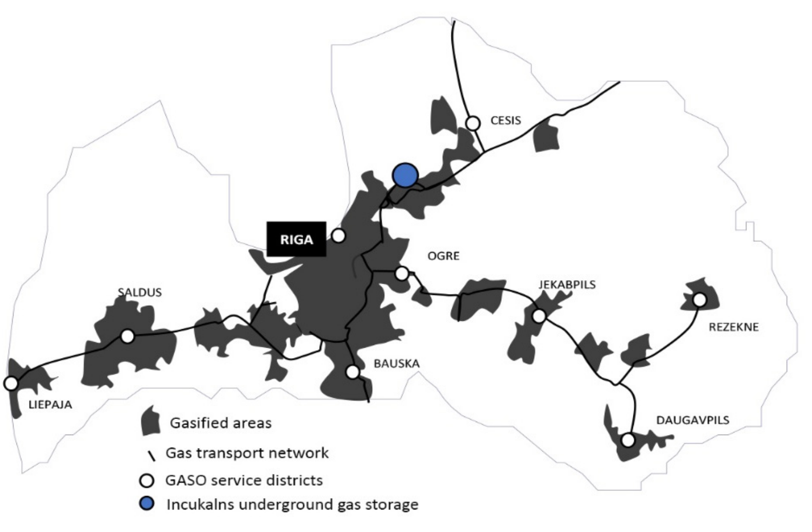


*Fig. 4.* Principal scheme of the Latvian gas TS and DS.

*Source:* GASO

Over time and in the process of operation of the technical equipment and equipment of the system, the technical characteristics of this equipment deteriorate, the adjustment of nodes and the aging of elements occur, as well as the risk of explosive situations increases [25]. Most often, already performing preventive maintenance of the elements of the gas DS, potential faults are detected and eliminated in time. Permanent preventive measures of the whole system are not necessary; it should most often be done only partially – with the aim of restoring damaged or potentially damaged elements [26]. The most effective is prevention, depending on the technical condition of the equipment and facilities of the gas DS [27], but to ensure it, continuous control of the system is required, which is associated with additional financial investments.

## 5. REVERSE GAS FLOW EMPLOYMENT PROSPECTS AND LIMITATIONS

Following gas infrastructure planning, the network has been upgraded or is planned to better match prospects of decentralized biomethane production. In this context, gas DS and TS improvements are required to accommodate the injection of biomethane at various sites different from originally vertical, one-way operation structure of the grid. As a solution, certain reverse flow facilities can be considered to allow the bi-directional flow from the TS to the DS and vice versa. In 2021, 15 reverse flow facilities were operation in Denmark, France, Germany, and the Netherlands, with 25 under construction in Denmark, France, and Belgium and 16 feasibility studies were announced in France and Italy. It is important to consider that reverse flow facilities not always depend on the degree of interconnection in a country's gas systems, which can reduce the need for compression [28].

The European gas TSOs and DSOs are identifying the zones with abundant feedstock availability and developed gas grid infrastructure, with injection technically and economically viable. These zones are sometimes also targeted as priority locations for biomethane hub development. This should speed up permitting procedures in these areas as the grid infrastructure check is already done. Areas with good feedstock availability but weaker grid infrastructure should also be considered important, if the most of the sustainable feedstocks that should be mobilized in the short term are agricultural waste and residues. For these zones, TSOs and DSOs will be able to anticipate the grid upgrades that might be necessary if biomethane projects are to be developed there. The EU Member States could choose to mandate TSOs and DSOs to prepare for potential project connections, so that biomethane can be integrated into the grid in case projects are developed. The overall grid infrastructure assessment should include the potential need for gas grid upgrades including capacities and injection points, but also regarding flows, pressure levels etc. Additional grid equipment installation and reverse flow capacities should also be considered and planned [29].

Currently, more than 40 biogas plants with a total installed capacity of approximately 56 megawatts are operating in Latvia. 41 agricultural biogas stations annually use a total of 1.85 million tons of raw materials, of which 847 thousand tons are different types of manure. The rest of the volume is made up of food production waste, sewage sludge, damaged fodder. All kinds of manure and other waste make up about 70 % of the raw materials for biogas production in Latvia. Approximately 12 % of the Latvian biogas plants use waste landfill resources for biogas production, two percent are sewage sludge substrate biogas plants, five percent are facilities that produce biogas from production residues or wastewater, and the majority – 81 % – are powered by agricultural waste. Most of them are located quite close to both the natural TS and DS. A number of obstacles, such as land ownership and the lack of well-defined and transparent support schemes, may hinder the transfer of biomethane into the gas supply network, and these issues should be adequately addressed in the future.

As for the case of Latvia, employment of reverse gas flow stations would be a beneficial in regions, where biomethane production would constantly exceed its local consumption or were there are no possibilities to distribute the surplus biomethane to local gas consumers via DS connections only. If examining a historical map of the Latvian biogas production facilities locations, and speculating that about ¼ of them would, in passage of time, convert itself into biomethane production facility, it is obvious, that the biogas stations grouping has two obvious patterns.

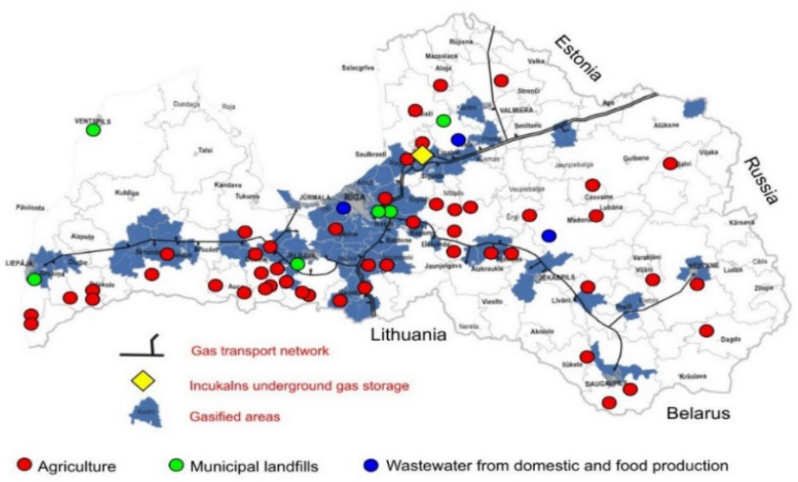


*Fig. 5.* Location and type of biogas plants in Latvia in 2020, with respect to the natural gas network [9].

*Source:* GASO, the Latvian Biogas Association

The first is the proximity of facilities to rather big gas consumption centres and their clustering, where connection to both gas TS and DS is available. The second is slightly different, manifesting remoteness of such consumption hotbeds, but obvious closeness to big amounts of resources for both biogas and biomethane production. The facilities of the second group are not obviously clustering in groups, they are more regionally speeded, and in most cases, geographically closer to DS. Some facilities are also significant, as they stand in locations where the closest point to any gas network is really far away, and, even in case of their conversion for biomethane production, they most likely will not be among contributors to biomethane grid injections.

## 6. CONCLUSION

There are evident benefits to employment of a reverse gas flow technique in large countries and gas markets such as France, but clear benefits from potential employment of it in smaller countries with limited gas consumption such as Latvia are not so obvious in the short- and mid-time perspective. In larger countries with a mature biomethane production portfolio, a large number of biomethane producers, significant fuel output capacities, and a rapidly developing RG market, which is considered both part of gas market as a whole and its exclusive part, entitled to specific and expanding range of support schemes or tools, the use of a reverse gas flow technique could be regarded almost inevitable.

The market situation in smaller countries, such as Latvia, is not manifesting an immediate practical necessity for employment of a reverse gas flow technique, as owners of biogas facilities with a biomethane production potential in any location in Latvia cannot currently evaluate business risks associated with engaging with a reverse gas flow station development project in the foreseeable future. The first, production process unrelated, reason is a lack of legal framework and clear expense sharing blueprint for such a project, as well as a small number of realized biomethane production facilities and projects currently exploring gas grid connection opportunities.

Therefore, employment of a reverse gas flow technique could be immediately suitable only for:

- large and extensive, rapidly growing diversified gas markets at the national scale;
- large and extensive, rapidly growing diversified gas markets at a limited transnational scale (for projects located on the border with one neighbouring country, which has enough gas interconnections with country of biomethane origin, and has regulation allowing passing neighbour's biomethane surplus to its TS);
- smaller countries, but with the same intensive development of diversified gas market, large-scale biomethane production and injection into the grid;
- clusters of smaller countries with both large and extensively developing or/and emerging diversified gas markets (for projects located on the border with more than one neighbouring country, which has enough gas interconnections with country of biomethane origin, and has regulation allowing passing neighbour's biomethane surplus to its TS).

Also, the issue of non-methane-based RG usage in gas TS and DS in respect to the exploitation of reverse gas flow stations should be raised. It should be clarified, can these stations, dedicated to the use of methane-based RG only, in foreseeable future facilitate unknown percentage (in case of Latvia, up to 2 %) of hydrogen by volume in the gas mix. Here only theoretical assumptions can be made, i.e., safe percentage of hydrogen contents in the methane-based fuel should be legally and technically set before realization of any reverse gas flow station project. It would help ensure the longevity of reverse gas flow station equipment in the period of time when designated safe percentage of hydrogen would not be exceeded in TS and/or DS.

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