Urban waste for biomethane grid injection and transport in urban areas

Project No: IEE/10/251

Biomethane use for cities: grid injection & transport in Valmiera/Latvia

WP 5 – Task 5.2/5.3 / D5.2/5.3

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UrbanBiogas website: www.urbanbiogas.eu

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Contents

Abbreviations

CHP	Combined heat and power
CNG	Compressed natural gas
EU	European Union
JSC	Joint stock company
LPG	Liquefied petroleum gas
NRRSD	National Road Traffic Safety Directorate
UGSF	Underground gas storage facility
ZAAO	North Vidzeme waste management company

1. Introduction

Latvia's gas market is isolated from the rest of the European Union (except Estonia and Lithuania) and there is currently only one company active in Latvia's gas market. JSC Latvijas Gāze (Latvian Gas) has been granted exclusive rights for the transmission, distribution and storage of natural gas in the territory of Latvia up to 2017. On top of that, Latvia has only one gas supplier – Russia.

The Third Energy Package Directive of the European Commission sets a requirement to ensure the liberalization of Latvia's gas market. A gradual preparation for opening the natural gas market after April 2017 is currently ongoing at political level. Basically the natural gas market liberalization in Latvia is legally and politically difficult process and unless the market is not liberalized, the establishment of biomethane market using natural gas grid infrastructure is almost impossible.

While legal framework for opening natural gas market is being gradually developed in order to ensure third party access to natural gas network, the situation with biomethane use in transportation seems to have less obstructive conditions.

Currently there is no public biomethane or CNG filling infrastructure in Latvia. The three public CNG filling stations operated by Latvijas Gāze were closed in 2010 due to low profitability. Creating a sustainable demand for biomethane use in transport in Valmiera is therefore one of the main tasks to solve.

Demand for biomethane in Valmiera can be ensured by both entity vehicle fleet, and private vehicles. The vehicle fleet of two companies – ZAAO Ltd. (regional waste management company, UrbanBiogas project partner) and VTU Valmiera (municipality owned bus service provider) are considered to be the potential forerunners in Valmiera.

Biomethane use concept for Valmiera city is developed in the UrbanBiogas project, supported by the Intelligent Energy Europe program of the European Commission. It is based on the Waste management concept and on the Biogas & Biomethane production concept that have been developed by ZAAO and Ekodoma earlier in the UrbanBiogas project. The main objective of the biomethane use concept is to identify economical, organisational and technical solutions for biomethane utilization in Valmiera city and North Vidzeme Region.

2. Overview of biogas and gas supply

2.1. Total natural gas supply in Latvia

JSC Latvijas Gāze (Latvian Gas) currently is the only natural-gas transmission, storage, distribution, and sales operator in Latvia. In 1991, following the collapse of the Soviet Union, the Latvian government took over the entire gas distribution infrastructure and institutions in the territory of Latvia, and consolidated it into the state-owned company Latvijas Gāze. The company was privatized in 1997 and according to the contract signed between the company and the Latvian State exclusive licences for the provision of regulated public services were issued to Latvijas Gāze for 20 years.

The company is owned by three main shareholders: ITERA Latvija Ltd. (16.0%), OAO Gazprom (34.0%) and E.ON Ruhrgas International GmbH (47.2%). It ensures the supply of natural gas to 443,000 customers in Latvia, both households and private consumers.

According to the latest report on annual accounts of JSC Latvijas Gāze[1], 1.464 billion m^3 of natural gas were supplied to users in 2012 which was a 6.2% fell in natural gas sales compared to 2011 levels. Decline in natural gas sales was mainly caused by high gas prices

[1] JSC Latvijas Gāze Annual accounts for the year ended 31 December 2012

due to which inland electricity generation in large cogeneration plants was replaced by electricity import.

All natural gas supplied to consumers in Latvia is imported. Natural gas import (59 PJ in 2011) covers around 30% of primary energy consumption and 36% of primary energy import in Latvia. The only natural gas supplier is the Russian Federation.

Total supply of natural gas and biogas was 60.04 PJ in 2011, out of which natural gas shared 98.5% leaving the rest for biogas. In 2011, the proportion of natural gas in total primary energy supply was 31.3% and of biogas – 0.49%.

2.2. Final natural gas consumption in Latvia

In total 1.464 billion m^3 of natural gas were consumed in Latvia in 2012. The consumption pattern of natural gas is illustrated in Figure 1.

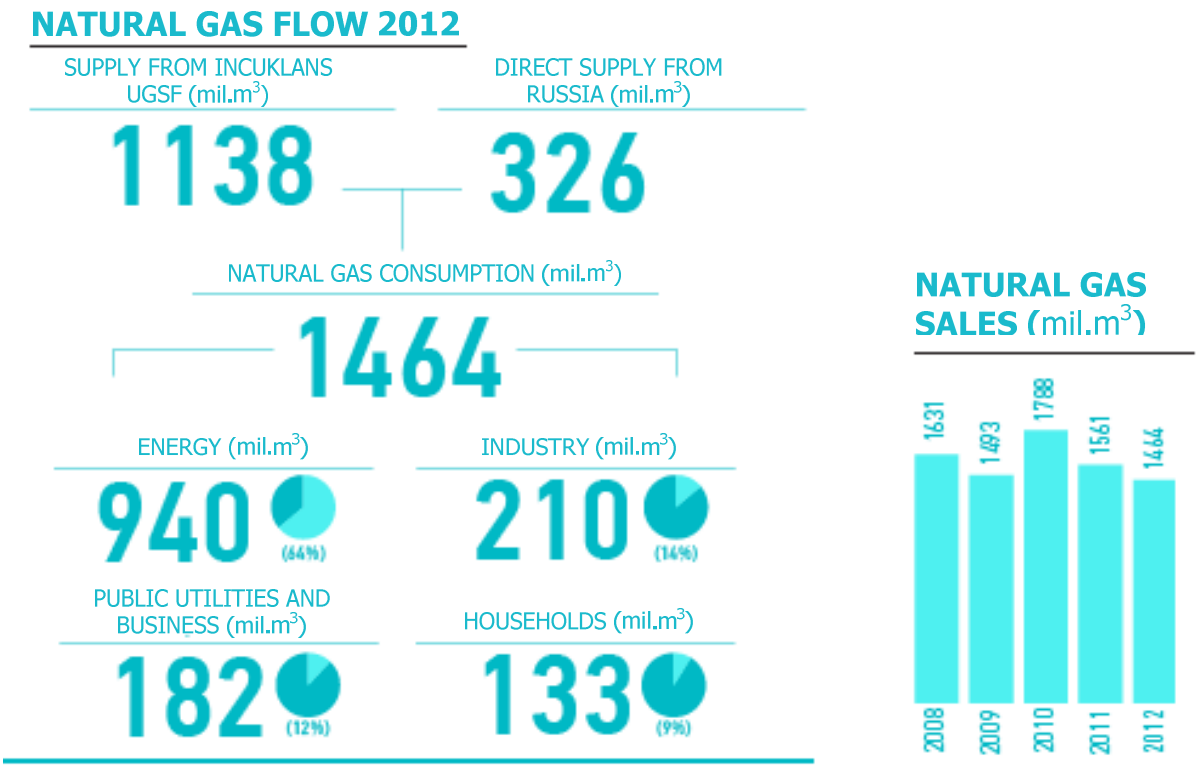


Figure 1: Natural gas consumption in Latvia in 2012[2]

Energy sector (heat and electricity production) was the largest natural gas consumer in 2012 – 65%; followed by industry – 14%, tertiary sector – 12% and households – 9%. Major amount (around 2/3 of all) of natural gas is consumed in the region of capital Riga.

In more detail, natural gas consumption breakdown by sectors is illustrated in Figure 2 (data for 2011). It can be seen that combined heat and power plants consume more than a half of all natural gas. Heat production facilities and the industry consume 13% each, followed by commercial and public sector (8%), and households (8%). The rest natural gas is consumed by the energy sector itself, as losses and elsewhere (agriculture, forestry and fishing).

[2] Yearbook of JSC Latvijas gaze 2012

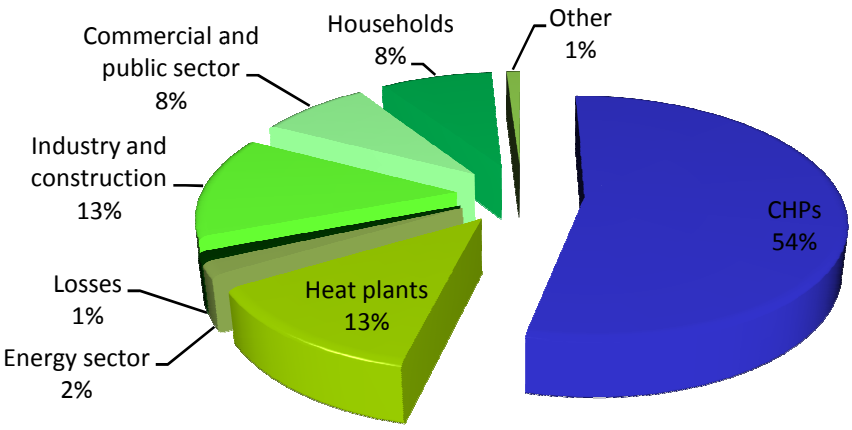


Figure 2: Natural gas consumption by sector in Latvia in 2011[3]

Total primary energy consumption in Latvia was 178.1 PJ in 2011. The share of natural gas was 30.3% and biogas – 0.52% of primary energy consumption. Total gas consumption was 54.03 PJ, out of which natural gas made 98.3% and biogas – 1.7%. There is no statistics showing the use natural gas or biogas for transportation needs.

2.3. Final natural gas consumption in Valmiera city

Natural gas is the main primary energy resource used in Valmiera city. Natural gas is used for heat and electricity generation, technological processes, as well as for cooking in households. Total consumption of natural gas was around 20.2 million m^3 in 2008. Later data (2011-2012; includes only largest consumers) show that the consumption of natural gas has increased compared to 2008 levels (Table 1). Based on these data it is estimated that the consumption of natural gas for district heat supply, technological processes and electricity generation is around 30 million m^3 annually.

Table 2: Largest natural gas consumers in Valmiera, in thousand cubic meters[4]

No	Entity	Capacity, MW	2011	2012
1	Latvijas autoceļu uzturētājs	0.30	31.22	33.80
2	DEPO DIY	0.49	15.75	41.38
3	Valmieras enerģija	41.09	8,209.16	8,669.21
4	Valmieras enerģija	19.40	6,578.58	6,600.07
5	AS Sadales tīkls	2.71	147.05	162.11
6	Karsten-Sanitex Latvia	0.22	0	36.63
7	Valmieras tipogrāfija Lapa SIA	0.25	25.87	31.99
8	Ievas maiznīca	0.58	184.86	-
9	Valmiera Andren	1.0	61.48	-
10	Vamieras stiklašķiedra	12.20	9,086.74	11,308.58
11	Valmieras piens	21.28	4,358.09	4,875.38
12	Valpro SIA	0.89	572.71	661.73
	Total		**29,271.51**	**32,420.88**

Since data on regional level natural gas consumption are not covered by public statistics, consumption of natural gas in households in Valmiera city was estimated based on average indicators (Table 3).

[3] Central Statistical Bureau of Latvia
[4] Data source: Gaiss 2 data base

Table 3: Calculated natural gas consumption in households in Valmiera city

Variable	Value
Number of inhabitants in Valmiera (Input)	25,100
Persons per one household in Vidzeme region (Input)	2.6
Number of households in Valmiera (Calculation)	9,650
Number of households in Latvia (2012) (Input)	817,000
Household natural gas consumption, mil.m^3 (Input)	133
Natural gas consumption per household, m^3/y (Calculation)	163
Natural gas consumption in household sector in Valmiera, mil.m^3 (Calculation)	1.6

Approximate estimates show that the consumption of natural gas in households in Valmiera is around 1.6 million m^3, which is somewhat less than on average in Latvia. Taking into account these estimates, the total consumption of natural gas in Valmiera city is around 34 million m^3. Natural gas consumption breakdown by sectors is given in Figure 3.

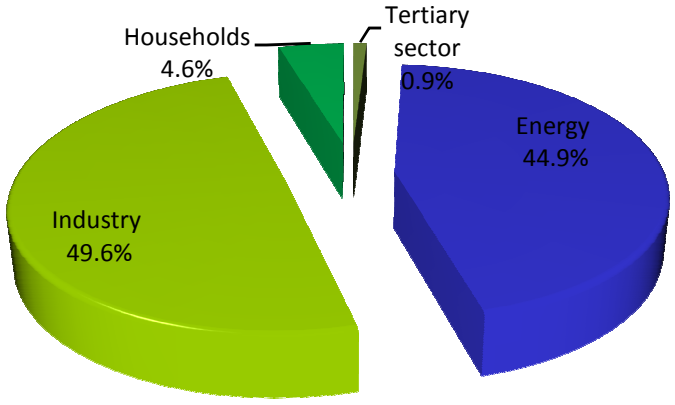


Figure 3: Natural gas consumption by sector in Valmiera in 2012

2.4. Natural gas in transport – Latvia and city of Valmiera

The use of petrol and diesel dominates in transport fuel consumption in Latvia. In 2011, final energy consumption in transport sector was 49.2 PJ, of which renewable energy sources made circa 3%. This considers the use of bioethanol (0.32 PJ) and biodiesel (1.43 PJ) in road and rail transport.

Starting from 2009, national statistics does not report any use of natural gas in transportation sector. This is associated with the fact that there is no public natural gas filling infrastructure in Latvia. The only three[5] publicly available natural gas filling stations, maintained by the JSC Latvijas Gāze, were closed in 2010 due to economic considerations raising from small number of gas-powered vehicles in the market.

According to National Road Traffic Safety Directorate (NRTSD), gas-powered transportation units in all vehicle categories in Latvia total slightly above 200 (0.0% of all). It can be assumed that these are mainly company owned vehicles and are maintained by private filling stations. Some individual car owners have invested in their own gas filling equipment; however there is no statistics on numbers of these.

The use of liquefied petroleum gas (LPG) is more popular in Latvia compared to compressed natural gas. The consumption of LPG in transport has increased from 0.96 PJ in 2008 to 1.18

[5] In cities of Rīga, Liepāja and Daugavpils

PJ in 2011 making 2.4% of primary transport energy consumption. A growing number of companies offers equipping vehicles with the necessary technologies for either LPG or bi-fuel use. Latest data (01.01.2014) from the NRTSD registers show that there are 46.4 thousand cars (7.3% of all), 1,990 heavy duty vehicles (2.5% of all), and 20 buses (0.4% of all) running on either pure gas (LPG), or bi-fuel engines.

Biomethane is currently not used in the transport sector in Latvia. However, there are ongoing studies on this topic. Company Ecogen[6] has conducted an experimental study on methane use in public buses and plans to offer a complete package of services for the use of natural gas or biogas in large fleets. In 2012, Company Gasliner Latvia Ltd. received public financing[7] for gaseous fuel compression technology and biogas bus R&D. The company is offering the new technology for public transport utilities. The system consists of a dual fuel engine and has been installed in buses in Jūrmala city. First, combination of natural gas (60%) and diesel (40%) was used in test regime. In a near future it is planned to use locally produced biogas instead of natural gas.

2.5. Biogas production and consumption in Latvia and city of Valmiera

Until the beginning of 2009 there were five biogas plants in Latvia. Those were located in Rīgas Ūdens Ltd. waste water treatment plant (2 MW_e), farm Vecauce (270 kW_e) and three landfills (6 MW_e) in Riga and Liepaja region. Since then the installed capacity of biogas plants has gradually increased to 42.17 MW_e in 2012 (Figure 4). This can be explained by implementation of national renewable electricity support policy (feed-in tariffs and investment grants) which came into force in 2009. Biogas production amounts have increased from 18 million m^3 in 2008 to 27 million m^3 in 2010 and 48 million m^3 in 2011. In 2012, the annual electricity production from biogas reached 222 GWh which made 3.2% of the total electricity consumption and 5.4% of renewable electricity generation in Latvia.

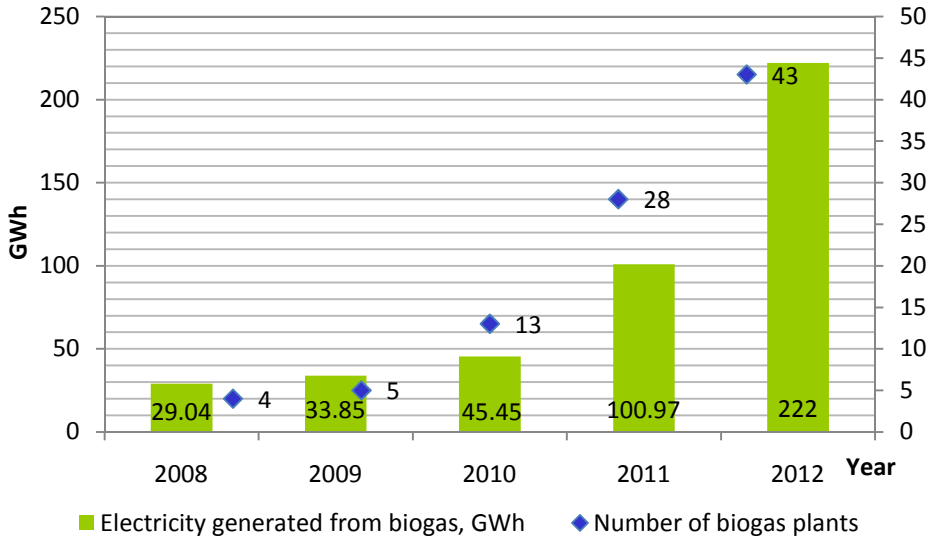


Figure 4: Development of the number of biogas plants and electricity production from biogas in 2008-2011[8]

According to the latest data from Ministry of Economics of Republic of Latvia currently there are 54 operating biogas plants in Latvia (Figure 5). A list of biogas plants can be found in Appendix of this report. The average installed electrical capacity of a biogas plant is around 1

[6] Ecogen. Available at: http://www.ecogen.lv/lv
[7] KPFI "Gāzveida biodegvielas kompresijas tehnoloģijas izpēte un biogāzes autobusu uzpildes tehnoloģijas izstrāde un demonstrācija" (2012).
[8] Data source: Ministry of Economics of the Republic of Latvia and Central Statistical Bureau of Latvia

MW_{el}. The most common substrates used for biogas production are silage crops (e.g. maize, grass) and livestock manure from pig and cattle farms.

Most biogas plants operating in Latvia use biogas in CHP units thus generating both - electricity and heat. Since only electricity is supported by the feed-in tariff, heat is considered as a by-product. Moreover, one of the highest feed-in tariffs in Europe in combination with the investment grant, has allowed Latvian biogas plant operators to run their business profitably even without sound utilization of heat energy. Usually part of the heat is used on site to heat the digesters and to provide heating for farms and local buildings, but most of the heat is wasted.

The rapid development of the Latvian biogas market has brought more competition among biogas producers for the feedstock and has increased plant operation costs. More and more biogas plant owners realize that additional income from heat use would help improving the economic performance of their plant. As a result, increasing number of biogas plants have found a solution for useful heat utilization, e.g. greenhouse heating or using heat in drying facilities.

No plants with biogas upgrading are yet in operation in Latvia.

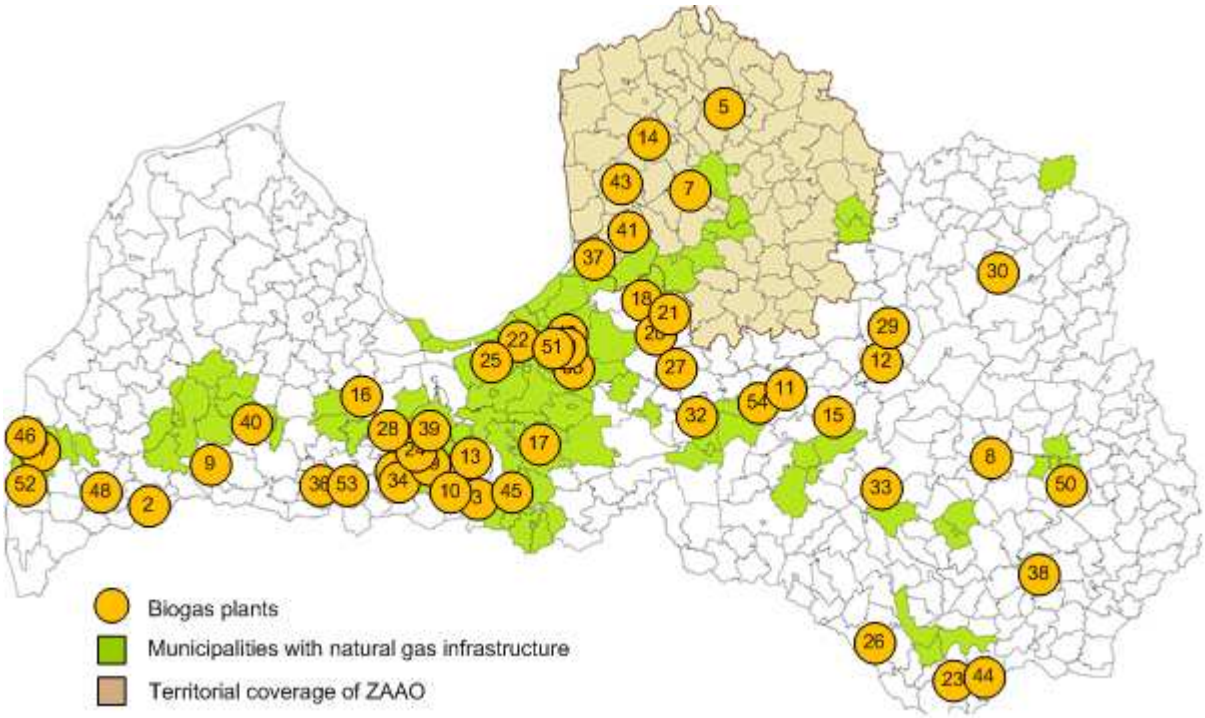


Figure 5: Biogas plants in Latvia (17.02.2014)

3. Gas transmission and distribution

3.1. In Latvia

The use of natural gas in Latvia began in 1960s when the transmission main Dashau-Minsk-Vilnius-Riga reached Riga. In 1968, natural gas was first injected into the Inčukalns underground gas storage facility (UGSF). The decision to build the facility was made owing to the seasonal consumption of natural gas. The gas pipeline Dashau-Riga could not cover the region's consumption during the heating season; therefore it was necessary to provide natural gas reserves closer to the consumers.

Inčukalns UGSF is still in use. In summer, natural gas from Russia is pumped in the storage facility from where it is delivered to consumers in winter. During heating season natural gas from Inčukalns UGSF is supplied as well for consumers in Estonia, north-western Russia, and Lithuania. Over the season of 2012, 2.2 billion m^3 of natural gas were injected into the

Inčukalns UGS and 2.82 billion m^3 were withdrawn. Total capacity of Ičukalns UGSF is 4.445 million m^3, of which 2.3 million m^3 are in active use.

Latvian natural gas supply system has three international connections (gas tracking stations) with following capacities:

- Cross-border connection with Russia – up to 17 million m^3/day;
- Cross-border connection with Estonia – up to 6 million m^3/day, and;
- Cross-border connection with Lithuania – up to 5 million m^3/day.

The whole Baltic gas transportation system is not connected to EU gas transmission network and Latvia has only one natural gas supplier – Open JSC Gazprom – which fully controls the gas supply system in Russia. The only natural gas supplier in Latvia is the JSC Latvijas Gāze which is responsible for natural gas transmission, distributions, storage and trade.

The network of existing and planned natural gas transmission pipelines is given in Figure 6.

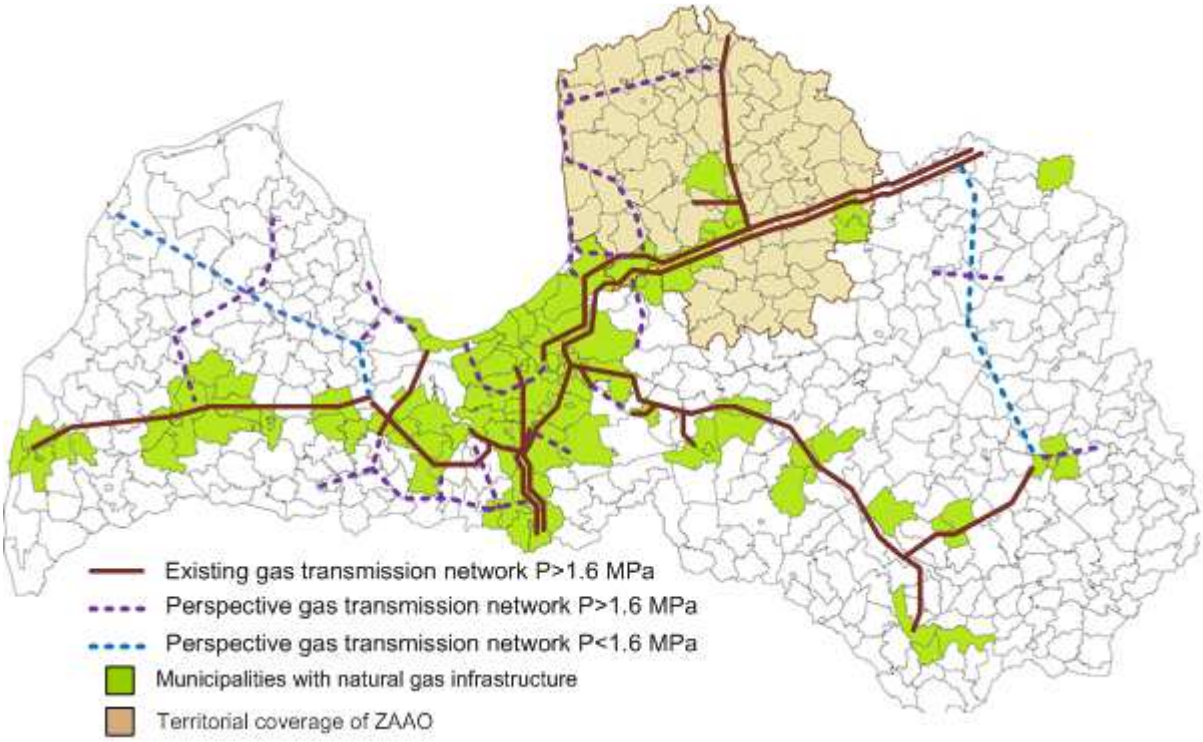


Figure 6: Gas transmission scheme[9]

Total length of natural gas pipelines on May, 2011 reached 6,035 km, including major gas transmission pipelines – 1,239 km and gas distribution pipelines – 4,796 km[10]. The average age of this network is 25 years. Most of the pipes are made of steel; polyethylene pipes are used only in the last 15 years. The pipes are in good working order. Corrosion protection is ensured for most of the pipeline length.

3.2. In city of Valmiera

Figure 7 illustrates natural gas supply infrastructure in the city of Valmiera. Nnatural gas supply is provided from gas transmission pipeline DN 700 mm Vireši-Tallinn and gas regulation stations Valmiera -1 and Valmiera-2, operated by the JSC Latvijas Gāze.

[9] Source: Latvijas Gāze
[10] Source: Latvijas Gāze

Natural gas is used for energy generation and in technological processes, as well for domestic purposes. Existing industrial and municipal users in urban area are provided with medium pressure P<0.4 MPa gas pipeline distribution system. For multifamily apartment houses natural gas is supplied using the existing low pressure gas distribution pipelines. For buildings in individual districts natural gas is distributed through medium pressure (P<0.01 MPa) pipelines (Valmiera municipality, 2006).

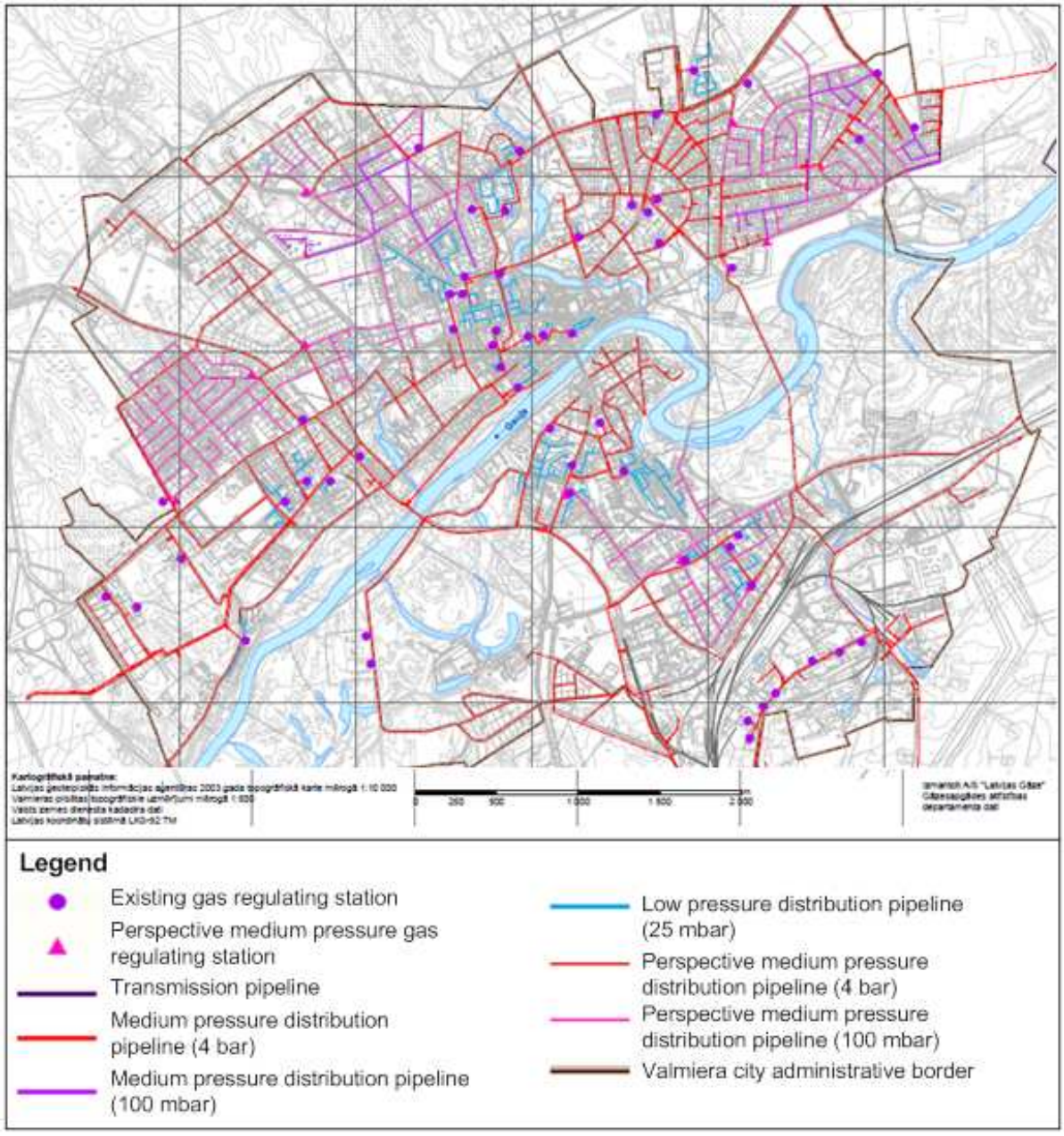


Figure 7: Natural gas supply infrastructure in Valmiera city (Valmiera municipality, 2006)

4. Public transport in target city

Public transport in the city of Valmiera is organised through a bus traffic maintained by VTU Valmiera Ltd. The company is owned by seven regional municipalities[11], of which Valmiera municipality holds the largest share (47.3%).

VTU Valmiera ensures both, urban and long-distance bus routes (Figure 8). The company operates 10 urban, 57 regional and 30 long-distance regular routes.

VTU Valmiera bus fleet consists of 94 buses, including Mercedes-Benz, Volvo, Isuzu and Van Hool vehicles. Company's main garage is located close to city territorial borders in Kocēnu parish at road Riga-Valmiera (Figure 9).

Technical data on VTU Valmiera bus fleet and city routes are given in Table 4.

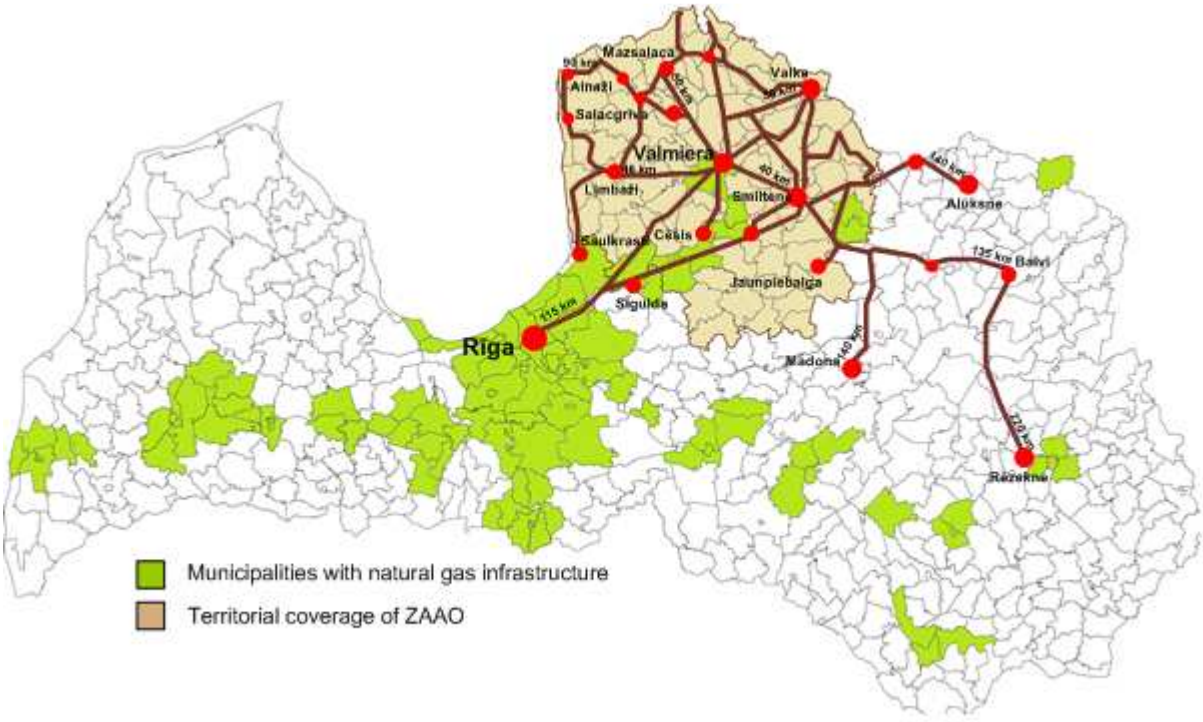


Figure 8: Regional bus routes operated by VTU Valmiera

UrbanBiogas project meetings in Valmiera have shown that VTU Valmiera is interested in reducing fuel costs. The use of biomethane can be considered as one of the alternatives. Although the company is overall positively minded the main limitation is associated with the high capital costs concerning procurement of biomethane buses. Reconstruction of existing buses might be a cheaper alternative. However, as mentioned by company representatives, renewal of bus fleet is gradual and there are no free assets at the moment to be invested in new large-scale projects. It means that external sources of funding are necessary if fuel transition project is to be implemented.

[11] Valmiera, Beverīna, Burtnieki, Mazsalaca, Naukšēni, Rūjiena and Kocēni municipalities

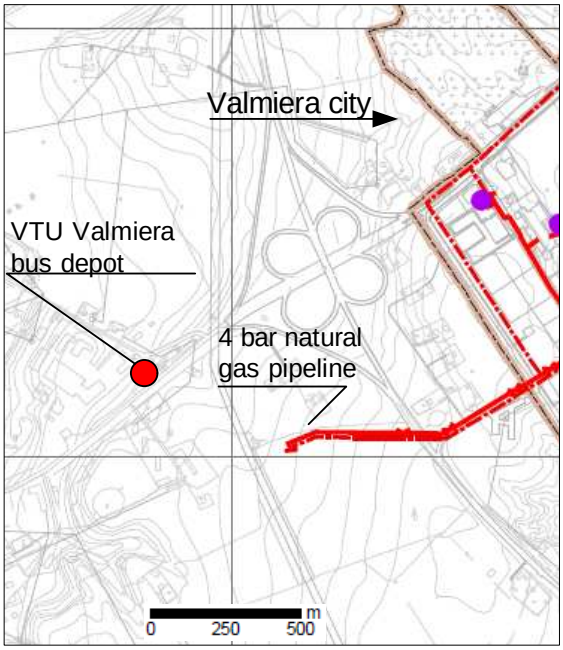


Figure 9: Location of VTU Valmiera bus depot

VTU Valmiera plans to replace 80% of urban buses (8-9 buses) in nearest 3-4 years. However, the current investment plan does not consider possible procurement of biomethane vehicles. As outlined by VTU Valmiera representatives, the initiative of such project should come from the contracting authority (municipality).

Table 4. Technical specification of VTU Valmiera buses

Bus	Fuel	Year	Number of buses
MERCEDES BENZ VARIO	Diesel	2005	1
VOLVO 8700	Diesel	2006	1
VOLVO B10 BLE	Diesel	1994	8
VOLVO 8700	Diesel	2008	1
Total number of buses:			11
Average monthly distance: 4,200 km per bus			

5. Technical requirements for biogas use

Latvia has no considerable experience with biomethane production or use in the transport sector; nor is biomethane injected into natural gas grid. Biogas as type of biofuel is recognized in national legislation; however no specific legal framework has been developed. Similarly, the concept of biomethane grid injection is new in Latvia.

Considering the lack of experience with biomethane applications in Latvia, this and following sections have been developed taking into account lessons learned from European countries with already developed and developing biomethane markets.

5.1. Grid injection

5.1.2. Biomethane quality parameters

Since third party access to natural gas grids is not legally ensured in Latvia (see Section 6 for more information), technical requirements for biomethane grid injection are not determined in national legislation. However, it is almost certain that in order to inject biomethane into the natural gas grid, biogas has to have the same characteristics as natural gas.

According to Cabinet Regulation No.1048 (adopted 16 December 2008) 'Regulation for the Supply and Use of Natural Gas' natural gas quality parameters are specified in the contract between the system operator and the user.

Information[12] provided by the only natural gas system operator in Latvia shows following natural gas quality parameters (Table 5):

Table 5. Natural gas quality parameters in Latvia

Parameter	Value
Net calorific value*, MJ/m^3 (kcal/m^3)	31.8 (7,600)
Upper limit of Wobbe index, MJ/m^3 (kcal/m^3)	41.2 – 54.5 (9,850–13,000)
Wobbe index acceptable deviation, %	+/- 5
Hydrogen Sulphide, g/m^3	<= 0.02
Mercaptan Sulphur, g/m^3	<= 0.036
Oxygen, %	<= 1.0
Particles, g/m^3	<= 0.001
Odour intensity at 1% concentration in the air, scale	>=3

* At pressure of 1.01325 x 10^5 Pa and temperature of + 20^0C

There is no experience with biomethane grid injection in Latvia and biomethane quality parameters are not defined in national legislation. But experience can be gained from other European countries. According to the Green Gas Grid project results (Wellinger, 2013) biogas was upgraded to biomethane in eleven European countries by the end of 2012. In nine of them biomethane was injected into the grid. The longest experience has Sweden and Switzerland which started back in the early 90ies. Both of these countries, as well as Germany and France, have introduced standards (certification systems) for injecting biogas into the natural gas grid. However, a lot of differences could be found in fundamental aspects. Some examples are given in Table 6.

Table 6. Main requirements for gas quality in Sweden, Italy, Spain, and Germany[13]

	Sweden	Italy	Spain	Germany
Wobbe index	49.0-56.9 MJ/Nm^3	47.31-52.33 MJ/Sm³	13.403-16.058 kWh/m^3	37.8-56.5 MJ/Nm^3
Gross Calorific Value	36.5-47.6 MJ/Nm^3	34.95-45.28 MJ/Sm³	10.26-13.26 kWh/m^3	30.2-47.2 MJ/Nm^3
Relative Density	0.555-0.70	0.5548-0.8	0.555-0.700	0.55-0.75
Temperature	50 ℃	<50 ℃		
Hydrocarbon dewpoint	-2 ℃ 70 bar	<= 0 ℃	+5 ℃ 70 bar	
Water dewpoint	-8 ℃ 70 bar		+2 ℃ 70 bar	
Total S (excl. H_2S and odorization)	10 mg S/Nm^3	<=150 mg/Sm³	<=50 mg/m^3	30 mg/m^3
Odorization (yearly average/peak)	6/16 mg S/Nm^3			
H_2S (H_2S+COS)	5 mg S/Nm3	<=6.6 mg/DSm³	(<=15 mg/m3)	5 mg/m^3
O_2	0.1 mol%	<=0.6 %	0.01 mol %	
CO_2	2.5 mol%	<= 3 %	2.5 mol%	6 vol %
Technically free of dust	+		+	
Mercaptans		<=15.5 mg/Sm³		6 mg/m^3

[12] Latvijas Gāze (Latvian gas) Ltd. Available at: www.lg.lv
[13] Green Gas Grids. Available at: http://www.greengasgrids.eu

5.1.2. The technical solution

The strategy of biomethane production and use in Valmiera considers three alternatives for possible biomethane plant location. These are:

1) Daibe landfill;
2) Valmiera city borders, and;
3) Other location in Vidzeme region (e.g. one of the existing biogas plants).

Evaluating possibilities for biomethane grid injection, the first alternative is limited by the lack of natural gas infrastructure at Daibe landfill. The main gas transmission pipeline is crossing North Vidzeme region, however not over the Pārgauja district where the landfill is located. Thus this alternative involves significant cost associated with the construction of gas distribution pipeline.

A well-developed natural gas network is available in Valmiera city. The biomethane in Valmiera can be injected into both medium pressure distribution networks with maximum pressure of 4 bars, and low pressure gas distribution network with pressure under 0.005 MPa. Dutch experience (Butenko & Holstein, 2013) shows that injecting biomethane into the distribution grid is generally cheaper compared to injecting it into transmission grid. At any case, a biomethane injection and monitoring system must be installed which can be either simple or more complex. A general scheme of biomethane injection into natural gas grid is given in Figure 10.

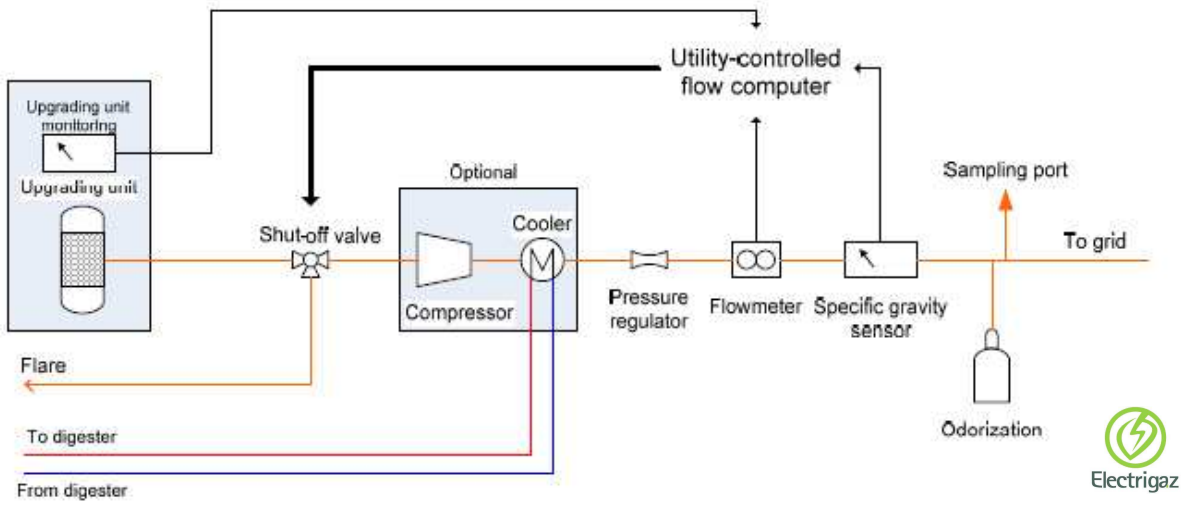


Figure 10: Simple biomethane injection and monitoring system (Electrigaz, 2008)

A simple monitoring system comprises several components (Electrigaz, 2008):

- A three way flow valve that can be closed by the plant or the utility if the biomethane does not meet the quality requirements. The biomethane would then be recirculated in the upgrading unit, flared or recycled into the boiler;
- A compressor (a cooler/dewatering unit can be added if higher pressure is needed);
- A pressure regulator to keep the pressure at the level needed for injection;
- A flow meter for billing purposes;
- A specific gravity sensor to detect variations in gas composition (mainly in the proportion of CO_2 to CH_4) and to indicate the gases heating value;
- A flow computer to be operated by the utility, allowing it to shut the valve off if gas quality becomes off-specification. This computer would also record production rates and enable the utility to bring the injection process back to operation by re-opening the three-way valve;
- A downstream odorizing unit, and;

- A sampling port for discrete sampling at weekly or monthly intervals (mainly to test for H_2S as well as other contaminants of concern).

Estimated costs of such equipment are 35,800-71,600 € without compressors (Electrigaz, 2008).

A more complex system would be comprised of additional chromatographs and/or Wobbe index meters (replacing gravity meter), a buffer tank and a second reserve compressor. Estimated costs of a complex monitoring system are 71,600-286,200 € (Electrigaz, 2008).

In case natural gas has a higher energy content than the upgraded biogas, then propane has to be added to reach the same heating value as natural gas (Electrigaz, 2008). A technical scheme of biomethane injection system with additional propane tank is provided in Figure 11. Similar system with a facility to enrich the biomethane with propane gas (if necessary) is installed in Didcot water treatment plant in Oxfordshire, UK[14] (UK).

A system with a propane addition equipment consists of: a LPG tank for propane in liquid phase, a pump for liquid propane, an evaporation unit for propane, and a heat exchanger system for the evaporation unit. Costs to be added are costs for pipes from the propane addition equipment to the natural gas grid.

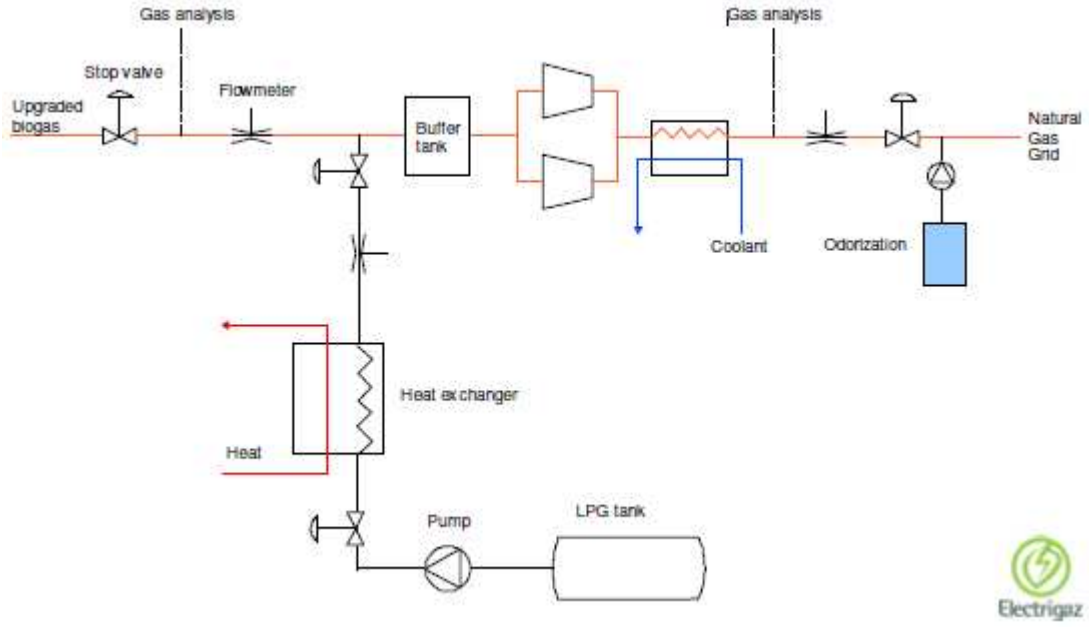


Figure 11. Biomethane injection system with an additional propane supply (Electrigaz, 2008)

If biomethane is produced in other location in Vidzeme region (e.g. one of the existing biogas plants), access to natural gas network should be considered as an important criteria to avoid high pipeline construction costs. Figure 5 shows both municipalities with an access to natural gas infrastructure, and the existing biogas plants in North Vidzeme region.

5.2. Transport

Due to legal restrictions biomethane grid injection in Latvia is currently only a theoretical alternative. From implementation point of view biomethane use in transport is a relatively simpler solution.

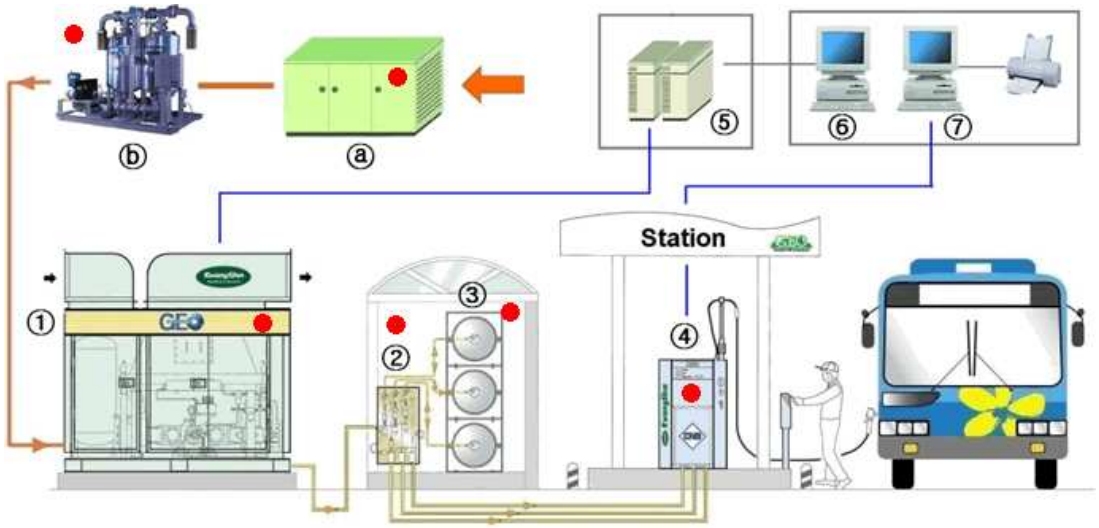
[14] Orbital. Available at: http://www.orbital-uk.com/biomethane-gas-monitoring-systems

Within the context of Latvian legislation biogas is defined as gaseous fuel to be used in internal combustion engines produced from biomass and/or biodegradable fraction of waste and purified to meet natural gas quality.

Biogas quality parameters are determined by Regulation of the Cabinet of Ministers No.772 'Regulations Regarding Requirements for Biofuel Quality, Conformity Assessment, Market Supervision and Procedures for Consumer Information'. The regulation provides that the quality of biomethane should be ensured in accordance with the standard LVS EN ISO 15403-1:2011 Natural gas – Natural gas for use as a compressed fuel for vehicles – Part 1: Designation of the quality (ISO 15403-1:2006). Parameters of the biomethane are determined in accordance with the standard LVS EN ISO 13686:2007 Natural gas – Quality designation, standard LVS EN ISO 6976:2007 Natural gas – Calculation of calorific values, density, relative density and Wobbe index from composition and standard LVS EN ISO 13443:2007 Natural gas – Standard reference conditions.

A technological scheme for biomethane use in transport is shown in Figure 12. A biomethane fuelling station consists of numerous engineered components working together to compress, store, and dispense the fuel:

- A compressor;
- A biomethane dispenser (200 bar filling pressure);
- A priority panel for optimizing and managing the flow of biomethane from the compressor to storage tanks, and;
- A gas dryer.



1 Compressor Package
2 Priority Panel
3 Storage Cylinder
4 Dispenser
5 PLC Controller & Motor Starter
6 SCADA System
7 Card Key System
● Gas Detectors

A Gas Regulating System
B Gas Dryer

Figure 12: A stationary biomethane fuelling system[15]

As shown in Fig.12, the gas is first passed through a compressor, which compresses the gas. In order to avoid icing, the gas is dried and stored in a temporary tank. For filling

[15] DMC Gas Equipment Limited. Available at: http://www.dmc-gas.com.hk/eng/Fueling_System.htm

vehicles with biomethane there are generally two types of filling stations: fast filling and slow filling (Ghazali et al., 2012):

- Fast-filling: the compressor fills high pressure storage canisters with gas to 250-300 bars. When fuelling, the gas will move to the tank of the vehicle until a pressure of 200-250 bars is attained and the tank is full. A bus takes approximately 10 minutes to fill up.
- Slow-filling: the compressor fills the gas directly into the tanks of the vehicle, as pressure increases until the tank is at full capacity. The fuelling takes several hours and usually takes place during the night. This technique is most commonly used by buses and refuse trucks fuelled by biomethane. The whole vehicle fleet is commonly filled at the same time with the same compressor.

Technical data and costs of a gas refuelling station is given in Table 7.

Table 7. Technical data and costs of gas compression and refuelling stations (Gis et al., 2012)

No	Equipment	Investment, €
1	Two double stand dispensers – 4 gas fast filling positions	58,000
2	Two compressors with a capacity of 300 Nm^3/h each	371,500
3	Buffer stores for compressed gas; cylinders with a capacity of about 6,000 dm^3	58,000
4	Station infrastructure	70,000
	Total	**557,500**

The price of equipment for a slow-fill station is estimated to be 30% lower compared to the price of the equipment for a fast-fill station (ERKAS, 2010). E.g., investment costs of a slow-fill biomethane filling station for servicing 5 vehicles in Estonia are estimated to be around 300,000 € (ERKAS, 2010).

An average diesel-powered refuse truck costs over 120,000 €[16]. On average, a natural gas refuse truck costs 30,000 € more than a conventional diesel-powered truck. Repowering a conventional diesel refuse truck to operate on CNG/biomethane (by replacing the engine and fuel system) cost from 20,000-70,000 €.

6. Economic and organisational considerations

6.1. Grid injection

Up to date there is no experience with biomethane grid injection in Latvia; therefore only theoretical cost estimates can be done. According to scenarios described in the Biogas & Biomethane Production Concept in Valmiera (Dzene et al., 2013), revenues from selling biomethane should be at least 0.35 €/Nm^3 or approximately 3.4 €Cent/kWh with annual increase of 3% due to the inflation. For comparison, in Austria where 10 biomethane upgrading plants where in operation in 2012 (Strauch & Krassowski, 2012), the market price of 100% biomethane is 5.5-6.5 €Cent/kWh from urban waste and 6.5-7.5 €Cent/kWh from energy crops (Eggenreich et al., 2013).

Natural gas prices in Latvia are tied to oil and diesel prices in international petroleum exchanges. Further they vary depending on volumes of average annual consumption. From 1 January 2014, natural gas price for households is 0.82 €/m^3 if the annual consumption is

[16] Inform. Available at: http://www.informinc.org/fact_ggt.php

below 500 m^3 and 0.53 €/m^3 if the consumption is in range 501-25,000 m^3. For consumers with the annual natural gas consumption above 25,000 m^3, the price of natural gas depends on the consumption level – it is lower for larger consumption levels and larger for consumers with lower natural gas consumption. Depending on consumption, the natural gas price for consumers with the annual natural gas consumption above 25,000 m^3 is 396-519 €/1,000 m^3 if the natural gas is used as fuel and 509-618 €/1,000 m^3 if the natural gas used as transport fuel (Latvijas Gāze, 2014).

6.2. Transport

If used in transportation, biomethane has to compete with other fuels consumed in Latvia. A list of vehicle fuels with corresponding fuel prices is given in Table 8.

Table 8: Comparison of transport fuel prices in Latvia

Fuel	Price[17], €/l	Price, €/kWh
Diesel	1.279	0.12
Gasoline	1.299	0.14
LPG	0.593	0.08
Biofuel E85	1.198	0.17
CNG*	0.75-1.34**	0.05-0.09

* Average price in Europe[18];
** €/kg

Fossil fuels are a matter of excise tax application. Following excise tax rates are applied in Latvia according to the Law on Excise Tax:

- Gasoline: 411.21 €/1,000 l
- Diesel: 332.95 €/1,000 l
- LPG: 161.0 €/1,000 l
- Natural gas: 99.6 €/1,000 m^3.

Reduced excise tax rates are applied for fossil fuels containing a certain volume of biofuels. Pure rapeseed oil is exempted from the excise tax payment.

In Figure 13 a comparison of energy content of various transport fuel alternatives is given. Compared to petrol (gasoline) and diesel, CNG has more energy per unit weight, but CNG's volumetric density is estimated to be 25% that of diesel fuel.

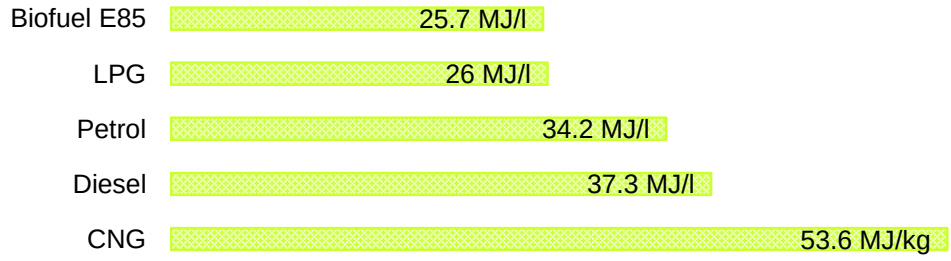


Figure 13: Energy content of different types of fuel

[17] Statoil; fuel prices. Available at: http://www.statoil.lv/lv_LV/pg1334072745785/private/Degviela/degvielas-cenas.html
[18] CNG Europe. Available at: http://cngeurope.com/

It is estimated (Dzene et al., 2013) that by installing a biogas quality upgrading plant in Vidzeme region, around 600,000 m^3 of biomethane could be produced annually starting from 2020. Three possible alternatives are considered:

1) The use of biomethane in ZAAO vehicle fleet (25 refuse trucks);
2) The use of biomethane in VTU Valmiera bus fleet (10 buses), and;
3) The use of biomethane in a public filling station.

6.2.1. Alternative 1: Biomethane use in ZAAO vehicle fleet

ZAAO Ltd. currently operates 25 refuse trucks running on diesel. Annual diesel consumption is around 500,000 liters. Considering diesel price €1.28/l, fuel costs make around 640,000 € annually. Technically there are two solutions how biomethane can be introduced in ZAAO Ltd. vehicle fleet: 1) repowering of the existing diesel-powered refuse trucks to operate on pure biomethane or 2) turning the existing diesel engines into dual fuel to run on biomethane and/or diesel.

First estimates indicated that approximately 10 waste collection trucks of ZAAO Ltd. can be operated on biomethane. This estimation was done based on data on the average daily distance of a ZAAO Ltd. refuse truck which is approximately 140 km. Assuming that 10 of 25 existing diesel-powered refuse trucks are repowered to operate on biomethane, annual biomethane consumption makes around 306,600 Nm^3. Previously calculated (Dzene et al., 2013) biomethane production yield is enough to cover the existing annual diesel consumption of company's vehicle fleet. Project implementation costs are estimated to be around 0.9 mil.€. Assuming biomethane cost 0.5 €/Nm^3 (a relative prime cost assuming that biomethane is produced either by ZAAO Ltd. or its subsidiary company ZAAO Enerģija (ZAAO Energy) Ltd.), annual fuel costs to operate 10 trucks after project implementation would reduce by 60%. However, the reduction in fuel costs of 10 trucks cannot ensure a positive free cash flow of the project. In order to reach a 12-15% IRR of the project, either the number of repowered vehicles needs to be increased (at least 17 trucks), or a source of co-funding of investment costs needs to be found (50% of engine conversion costs and 30% of filling station costs). A combination of both measures allows reducing the number of biomethane trucks to 13, if a 50% subsidy for engine conversion is ensured.

Since there is no natural gas supply infrastructure within the territory of Daibe landfill for direct natural gas supply, other fuel backup options must be considered. One of the possible solutions is to provide natural gas in high pressure containers. This will add container and O&M costs, as well as costs of natural gas purchase and delivery. This report does not include economics of such alternative.

Another opportunity is the installation of dual fuel (bi-fuel) engines allowing to use liquid fuels in case of biomethane production shortages. With a bi-fuel conversion, a switch installed on the dashboard allows the driver to easily switch between CNG/biomethane back over to gasoline or diesel at any time, including while driving, idling or in park. In general, bi-fuel vehicles automatically switch to the reserve tank of conventional fuel when the gas tank is empty (Clarke & DeBruyn, 2012). In a dual-fuel configuration, the engine starts on 100% diesel, and the fuel injection technology increases the biomethane ratio as high as the drive cycle will allow (to a maximum of 90%) (Clarke & DeBruyn, 2012).

Using bi-fuel engines ensures that ZAAO refuse trucks can be refuelled in standard filling stations when they move to further destinations. Turning diesel engine into dual fuel costs about 35,000 € maximum, depending on catalyzers and fuel tank configurations (Engle, 2010). Assuming a common 50-70% diesel substitution rate[19] all 25 ZAAO Ltd. waste collection trucks need to be converted to dual fuel engines. In addition, at least a 25%

[19] Cumminis Dual Fuel Engines. Available at: http://cumminsengines.com/dual-fuel

subsidy for engine conversion needs to be provided from external funding sources in order to project become economically feasible.

In case biomethane is produced at Daibe landfill but biomethane filling station is located in Valmiera city, additional biomethane transportation costs appear which must be covered by the supplier. Theoretically there are two alternatives for biomethane transportation: pipeline transportation or transporting with special trailers. Transportation cost depends on technological alternative. Estonian experience (ERKAS, 2010) shows that a 10 km pipeline costs approximately 575,205 € or 57,500 €/km. These costs are in line with Latvijas Gāze pipeline construction cost estimates of 42.7 €/m[20]. Meanwhile price of two transport containers with the capacity of 3,600 Nm^3 is estimated around 110,000 € a piece (ERKAS, 2010). Biomethane preparation for transportation includes biomethane compression to pressure 25-30 MPa, and then delivery to depot, where refuelling can occur. Estimated biomethane transportation costs from landfill Daibe to a biomethane filling station in Valmiera city are around 1.2 €Cent/Nm^3 (excluding additional investment costs). In case biomethane is transported to Valmiera city, surplus biomethane not utilized by ZAAO Ltd. waste collection trucks can be sold. Such alternative allows significantly improving the project feasibility.

In order to clarify the current market of biomethane/CNG refuse collection truck suppliers, a mail survey was carried out. An e-mail containing a request for further information on company's provided CNG waste collection trucks and their prices was sent to major refuse truck manufacturers (Renault, Scania, Iveco, Volvo and Mercedes-Benz). Up to completion of this report two responses were received, from Renault and Scania respectively. According to Renault representative (Jakniunas, 2014) Renault Trucks is producing CNG rigids for refuse collectors, thought they are not actively offering them in the Baltic region because of low demand and price sensitive potential consumers. Renault Trucks CNG rigids are dedicated for all type and manufacturers of refuse collector bodies. The price can vary significantly depending on body type and rigid specification. Meanwhile Scania provides waste collection trucks with following CNG/biomethane engines (Landsmanis, 2014):

- 280 hp (206 kW), 1350 Nm at 1,000-1,400 rpm;
- 340 hp (250 kW), 1,600 Nm at1,100-1,400 rpm.

Gas storage capacity at 200 bar pressure is around 640 liters corresponding to about 130 liters of diesel. Chassis specification and body specification are case specific and depends on the customer's preferences.

6.2.2. Alternative 2: Biomethane use in VTU Valmiera buses

VTU Valmiera bus fleet is another potential consumer of biomethane in Valmiera. An important prerequisite for VTU Valmiera to become a biomethane consumer is the accessibility of a biomethane filling station in Valmiera city.

VTU Valmiera bus fleet consists of around 90 buses. A CNG bus can drive and estimated of 300 km on a single tank filling (ERKAS, 2010). Since there is no gas filling network through the travel routes of VTU Valmiera bus lines, it is not likely that gas buses will be used for intercity transport in the nearest future. Hence, 10 buses serving Valmiera city urban lines have the potential of consuming biomethane.

Average biomethane consumption of a bus with a standard length of 12 m is about 57 Nm^3/100 km (Gis et al., 2012). The average annual mileage of a city bus in VTU Valmiera is 50,400 km. Technically there are two solutions how biomethane can be introduced in VTU Valmiera bus fleet: 1) repowering of the existing diesel-powered buses to operate on biomethane or 2) turning the existing diesel engines into dual fuel to run on biomethane and/or diesel. Assuming that 10 existing diesel-powered buses are repowered to operate on

[20] Gas connection to a family house. Available at: http://expressshoplv-internetveikals.abclv-raksts.zl.lv/gazes_pieslegums_gimenes_majai/?article=kurinama_cenu_prognoze

biomethane, annual biomethane consumption makes around 278,400 Nm^3/a. Assuming biomethane cost 0.74 €/Nm^3 (3% annual price increase considered), annual fuel costs to operate 10 trucks after project implementation would reduce by 40%. In case no filling infrastructure or biomethane transport is required (ensured by ZAAO Ltd. or its subsidiary company), the project shows a high profitability (IRR=39%). Installation of dual fuel engines is more supported by representatives of VTU Valmiera. The project shows appropriate profitability (IRR=19%) up to 50% diesel substitution rate.

In order to clarify the current market of biomethane/CNG bus suppliers, a mail survey was carried out. An e-mail containing a request for further information on company's provided CNG buses and their prices was sent to major bus manufacturers (Iveco, Scania, Mercedes-Benz, Volvo, MAN, Van Hool, Solbus, and Solaris). Up to completion of this report only one response was received. According to representative of Mercedes-Benz (Bares, 2014) the production of Mercedes-Benz city gas buses will start in the end of 2014.

In general, biomethane buses are 20-25% more expensive than buses with traditional engines (Gis et al., 2012). Price of a new CNG (biomethane) powered bus is around 205,500 € (Gis et al., 2012). The cost of the maintenance and repairs of gas buses is typically 0.06-0.12 €/km above the costs of diesel buses (Goldmann, 2012). In a feasibility study of a biogas filling station in Estonia (ERKAS, 2010), operating costs of a filling station was estimated to be around 42,000 €/a.

6.2.3. Alternative 3: Biomethane for public

Besides ZAAO Ltd. and VTU Valmiera, biomethane is an interesting fuel alternative as well for other vehicle users. The third alternative considers ensuring biomethane availability for all interested parties through a public filling station located in Valmiera city. Although previous experience with CNG use in Latvia has turned out unsuccessful, there are many good examples along Europe how maintenance of public filling stations can be organized. Following models for organizational structure of a public biomethane filling station are found in literature (Biogas Ost, 2008):

- A municipality owned and operated biomethane filling station;
- A private owned filling station (e.g., a gas company or an energy company), and;
- A filling station owned and operated by a consortium of local waste management company and farmers.

Regardless of chosen scheme, there should be at least one large consumer present from the start. In case of Valmiera, municipality could be the first runner. The following questions need to be considered (Biogas Ost, 2008):

- What financial support can be sought? Building a biomethane filling station is a big investment.
- What technical equipment will be chosen for the filling station? Replacement of equipment is very costly.
- Where the filling station will be located? It is often advantageous to localise the filling station at a pre-existing petrol station.
- How will payments be arranged?

Modern gas containers on private cars can hold an average of 15 kg of gas, enabling them to drive 200-250 km (ERKAS, 2010). Therefore it is not possible to drive more than 100 km radius from Valmiera. The cost of developing a biomethane fast filling station is around 250,000-300,000 € (Biogas Ost, 2008; Gerbio, 2011). The filling station should be open 24 hours per day at least for paying with credit cards. The own fleets should if possible not be filled in rush hours (Gerbio, 2012).

6.3. Organizational aspects

Organizational alternatives for biomethane production and utilization in transport in Valmiera region are presented in Figure 14.

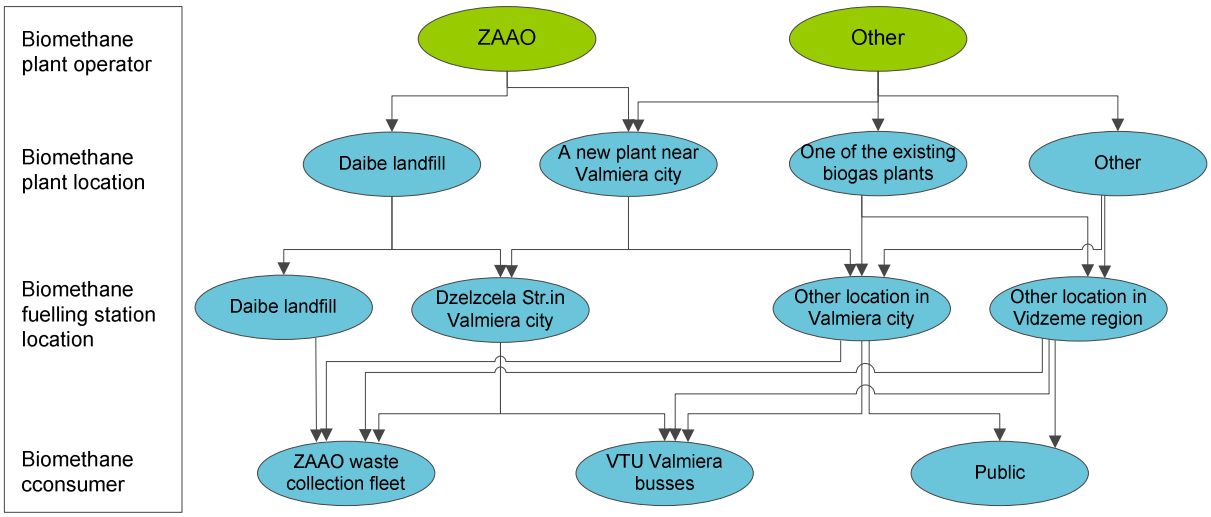


Figure 14: Alternatives for biomethane utilization in Valmiera city

As shown in Figure 14 there are two potential biomethane plant operators: 1) regional waste management company ZAAO Ltd. which operates a landfill gas plant in Daibe landfill and 2) another operator (possibly one of the existing biogas plant operators in the region). Following four places for biomethane plant location are proposed:

1) Daibe landfill which is located 30 km from Valmiera city border;
2) ZAAO Ltd. operated plant near Valmiera city;
3) A biomethane plant located next to one of the existing biogas plants in the region, and;
4) Other.

As well four alternatives for biomethane filling station location can be distinguished:

1) Daibe landfill;
2) Dzelzela Str.5, Valmiera (a ZAAO Ltd. owned property);
3) Other location in Valmiera city owned by other company than ZAAO Ltd., and;
4) Other location in Valmiera region owned by other company than ZAAO Ltd.

Based on the provided scheme three biomethane utilization alternatives are considered: (1) the use of biomethane in ZAAO Ltd. waste collection trucks; (2) the use of biomethane in public buses of Valmiera public transport company, and (3) distribution of biomethane to a filling station for public use.

In case of the first alternative owner of the biomethane upgrading plant is ZAAO Ltd. (Alternative A). Biomethane production plant can be located either at Daibe landfill (Alternative A1) or in Valmiera city (Alternative A2). Biomethane filling station in this scenario can be located either at Daibe landfill (Alternative A1-1) or in Dzelzcela Str.5, Valmiera (Alternative A1-2). In case ZAAO Ltd. owned biomethane plant is located near Valmiera city, as well biomethane filling station is located at the same place (Alternative A2).

In case of the second alternative (Alternative B) owner of the biomethane upgrading plant is other operator than ZAAO Ltd. Biomethane production plant can be located either near the Valmiera city (Alternative B1) or in a strategically advantageous location somewhere in Vidzeme region (Alternative B2). Alternative B2 distinguishes two possible locations for biomethane filling station: in Valmiera city (Alternative B2-1) or near to the biomethane production plant (Alternative B2-2).

Alternative A1-1 ensures that only ZAAO Ltd. waste collection trucks can be filled with biomethane; while Alternative A1-2 and Alternative A2 provides filling possibilities as well for VTU Valmiera according to agreement between the involved parties. Alternatives B theoretically can be organized in a way than any of consumers (ZAAO Ltd., VTU Valmiera, and public) can have access to biomethane filling infrastructure. Within this study only Alternative B is considered to ensure biomethane filling access for public consumers (municipality fleet in this case can act as a forerunner).

List of proposed alternatives for biomethane use in transport in Valmiera city is presented in Table 9.

Table 9: Biomethane utilization alternatives in Valmiera city

Alt.	Biomethane upgrading	Biomethane filling	Biomethane transportation
A1-1	**Operator:** ZAAO Ltd. **Location:** Daibe landfill	**Fleet:** ZAAO waste collection trucks **Location:** Daibe landfill	Not necessary
A1-2	**Operator:** ZAAO Ltd. **Location:** Daibe landfill	**Fleet:** ZAAO waste collection trucks and Valmiera public transport buses **Location:** Valmiera, Dzelzcela Str.5	Road transport
A2	**Operator:** ZAAO Ltd. **Location:** Valmiera city	**Fleet:** ZAAO waste collection trucks and Valmiera public transport buses **Location:** Valmiera, Dzelzcela Str.5	Not necessary, if located near
B1	**Operator:** other **Location:** Valmiera city	**Fleet:** any **Location:** Valmiera city	Not necessary, if located near
B2-1	**Operator:** other **Location:** Vidzeme region	**Fleet:** any **Location:** Valmiera city	Road transport
B2-2	**Operator:** other **Location:** Vidzeme region	**Fleet:** any or based on agreement **Location:** Vidzeme region	Not necessary

7. Legal requirements for biomethane use

7.1. Grid injection

The natural gas market in Latvia is purely monopolistic with the only entity licensed to transport, distribute, store and supply natural gas being JSC Latvijas Gāze. According to the agreement between the company and the Latvian government, Latvijas Gāze has a monopoly rights to use natural gas networks till 10 February 2017. This agreement delays the liberalization process of the natural gas market in Latvia and no legal framework has been developed to allow the third party access to the natural gas grids.

On 26 May, 2005, the amendments to the national Energy Law were adopted providing the framework conditions for opening the natural gas market according to the requirements of the Directive 2003/55/EC of the European Parliament and of the Council concerning common rules for the internal market in natural gas and repealing Directive 98/30/EC, which will come into force from 4 April 2014. This date indicates ten years from the first commercial supply of natural gas under the first long-term contract and following expiration of 'new market' exception that allowed Latvia to delay the opening of natural gas market according to Directive 2003/55/EC. After expiration of the 'new market' status Latvia is obliged to provide third-party access to the natural gas system and separate the distribution operator.

However, according to the Directive 2009/73/EC which came into force in 2009 repealing the Directive 2003/55/EC, after 4 April 2014 Latvia will correspond to the status of an 'isolated market' which allows several further derogations of requirements of the Directive (separation of transmission system and transmission system operators, independent system operators

etc.). This exception means that Latvia is able to postpone the liberalization of its gas market till establishment of a gas connection with a third EU country other than Lithuania, Estonia of Finland or till the share of the dominant gas supplier falls below 75%.

Currently amendments to the national Energy Law are being approved providing a gradual opening of gas market. The amendments provide that the gas market opening will take place in several stages, starting from April 4, 2014. This will include separation of Latvijas Gāze accounts by type of activity with respect to transmission pipelines, gas storage and trading. It is also planned that gas system operator is obliged to ensure that all users of the system have equal and open access to the system for providing gas transmission, distribution, or storage services.

According to the new amendments, company splitting will take place no later than in April 3, 2017, unless earlier Latvian natural gas system is directly connected to any of the EU Member State natural gas system, or the share of the dominant gas supplier falls below 75%. This means that for the coming years biomethane grid injection is only possible in agreement with JSC Latvijas Gāze.

7.2. Transport

Following legal aspects are relevant for the use of biomethane in the transport sector:

- Cabinet Regulation No.674 'Regulation on transport of dangerous goods' establishes procedure for taking dangerous goods (including gas and flammable liquids) in international and domestic road transport operations.
- Cabinet Regulation No.466 'Regulation on the technical inspection and roadworthiness' with respect to gas-powered vehicles requires:
  - If vehicle is powered by a gas engine, it shall be equipped with class ABC fire extinguisher;
  - It is allowed to install CNG equipment in accordance with legal requirements for vehicle modification. All changes must be fixed in vehicle registration. The installed gas power equipment must be certified and labelled in accordance with vehicle certification regulations.
  - Provisions relating to location of a gas storage system in a vehicle.
  - Provisions relating to technical requirements of gas supply system in a vehicle.
- Cabinet Regulation No.725 'Regulation on vehicle conversion' governs installation or removal of a gas supply installation.
- Handling with dangerous equipment is regulated by the Law 'On technical supervision of dangerous equipment' and related Cabinet regulations:
  - Cabinet Regulation No.953 'Technical supervision of liquefied petroleum gas cylinder filling stations'
  - Cabinet Regulation No.500 'Regulation on transportable pressure equipment'
  - Cabinet Regulation No.518 'Technical supervision of pressure equipment'
  - Cabinet Regulation No.384 'Technical supervision of storage tanks containing dangerous substances'
- According to the Law 'On biofuels' public biomethane filling stations must be equipped with an information sign 'Biogas'. A document confirming the quality of biofuel must be present.

7.3. Recommended amendments

7.3.1. Grid injection

- The main legal barrier is the lack of legal framework for biomethane grid injection. However, to overcome the legal barriers, first the political barrier – liberalization of

natural gas market – must be overcome. If this is done, the set of legal documents must be elaborated, including:

- Provision of rights to the third party access to the natural gas grid;
- Technical standards for biomethane injection;
- Methodology and system for the biomethane tariff calculation, and;
- Other incentives for biomethane as renewable fuel.

- Inclusion of biomethane in national energy strategic documents and papers.
- Development of transparent and reasonable biomethane support policy.

7.3.2. Transport

- Inclusion of biomethane in national energy strategic documents and papers.
- Development of transparent and reasonable biomethane support policy.
- Strengthening the role of public authorities in promoting the use of biomethane for transport.
- Latvia have good infrastructure and framework for waste collection, however, the waste is not separated, and largely ends up in landfill sites. To implement biogas waste treatment and energy production facilities the collection, sorting and recycling economy must be brought up to a standard that treating efforts make sense from the economic point of view.

8. Actors involved in the biomethane supply chain in Valmiera city

The list of actors involved in the biomethane supply chain in Valmiera city is given in Table 10.

Table 10: Main actors involved in the biomethane supply chain in Valmiera city

Stakeholder	Main responsibilities
City council	Responsible for organisation of the waste management services in the city. Potential forerunner of biomethane use in municipality vehicle fleet. Potential operator of a public filling station and a contact point in public awareness raising.
Waste processing company and landfill operator ZAAO Ltd.	Collection of waste in the territory of the region, waste treatment and processing.
Biogas producer ZAAO Enerģija Ltd.	Operation of landfill gas recovery plant, operation of a CHP plant.
Natural gas grid operator JSC Latvijas Gāze	Natural gas supply, transmission, distribution.
Public transport company VTU Valmiera	Provision of public transportation services.
Biomethane producer	Not existing. Potentially ZAAO Enerģija Ltd.
Biomethane trading company	Not existing. Potentially ZAAO Enerģija Ltd.
Fuel distribution company	There are several fuel distribution companies existing and operating in Valmiera region; however, none of them is distributing and selling compressed natural gas or compressed biomethane. Potentially ZAAO Enerģija Ltd.

9. Proposal of best solutions of biomethane use in Valmiera city

Given the fact that no legal framework for biomethane grid injection has been developed in Latvia and that third party access to natural gas grids will be ensured only in 2017, the use of biomethane as a transport fuel is proposed.

Preferable solution for biomethane use in Valmiera city is the use of biomethane in ZAAO Ltd. refuse trucks. 25 ZAAO Ltd. refuse trucks currently running on diesel guarantee safe consumption of produced biomethane. This alternative provides the most economic and technologic/organizational benefits. Considering the high investment costs of vehicle modifications and of a filling station, the project follows the rule – the greater the number of biomethane trucks, the shorter the payback period. Installation of dual fuel engines requires a full replacement of ZAAO Ltd. vehicle fleet for project to become feasible. In addition, a certain external financing is still required. Repowering the existing trucks to run on pure biomethane allows reducing the number of vehicles but a backup fuel (natural gas) needs to be ensured. Installation of a biomethane filling station near the upgrading plant will allow avoiding biomethane transportation costs and additional investments.

VTU Valmiera buses serving 10 city routes are a perspective consumer of biomethane if the filling station is located in Valmiera city. This solution is the most beneficial for society and inhabitants of Valmiera city since they will benefit from improved environmental quality and reduced noise level compared to diesel-powered buses.

In the long term perspective, installation of a public biomethane refilling station in Valmiera city has considerable benefits. Besides environmental gains, these include raising public awareness about sustainable transport means and promoting local economy. Building of a biomethane filling station could lead to an increase in the number of biomethane/CNG vehicles and promote further market penetration of the technology.

10. Strategy for a biomethane project in Valmiera city

10.1. Creating and maintaining a sustainable demand for biomethane

Currently there is no demand for biomethane in Valmiera city. Largely it is because of the absence of biomethane infrastructure. In future, economic conditions will continue to be important catalysts for the use of gas (both liquid and compressed). Ensuring public access to a biomethane filling station in Valmiera will give positive signal to private car owners who have the most potential to increase consumption volumes. Meanwhile companies with relatively large vehicle fleets, such as ZAAO Ltd. and VTU Valmiera, can ensure that station's selling volumes remain stable.

Valmiera municipality can have a great role in creating and maintaining demand for biomethane. From one side, municipality can be a forerunner by installing biomethane equipment in its vehicle fleet and thus promoting the use of biomethane among society. At the same time, municipality can promote the use of gas vehicles through introducing regulations related to the environmental pollution in the city, providing advantages for less polluting means of transport.

If the network of gas filling stations is expanded in Latvia, it would also be possible to use gas buses on long-distance lines.

10.2. Inspiring investors

Investors will be inspired if they see a clear economic benefit for making the investment. Both ZAAO Ltd. and VTU Valmiera are interested in reducing their fuel costs. Although companies are overall positively minded the main limitation is associated with the high capital costs of modifying vehicle fleet and developing a biogas filling infrastructure. It means that external sources of funding are necessary if fuel transition project is to be implemented. Availability of state support measures for biomethane vehicle purchase could be a positive stimulus for possible investors.

10.3. Convincing authorities and oppositional groups

Overall, biomethane project in Valmiera should not have much opposition because of the number of benefits of using this type of fuel in vehicles over conventional fuels. The main challenges are associated with financial and organizational aspects of biomethane supply and use. Especially in case of a public biomethane filling station, the best solution for organizational and management structure of the project must be found. Involvement of an external service supplier (responsible for operating the public filling station) might be a reasonable solution.

10.4. Ensuring a sound project operation

The knowledge and technology exist to fuel vehicles using biomethane. Also economics appear to be attractive. In general the project operation is sucessful, if there is a sustainable demand for produced biomethane. In order to create the demand for biomethane use in the transport, gradual change of conventional vehicles to biomethane vehicles is needed. Development of a pilot project demonstrating the production and use of biomethane in locally recognizable vehicles will raise public awareness and create increasing demand for biomethane powered vehicles among the society.

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Appendix

Table 1: Biogas plants in Latvia (17.02.2014)

No	Operator	Address	Installed capacity (MWe)
1	SIA "BIO FUTURE"	"Pūcītes", Vaiņodes pagasts, Vaiņodes novads	0.999
2	SIA "GAS STREAM"	"Ērglīši", Vaiņodes pagasts, Vaiņodes novads	0.999
3	SIA "RZS Energo"	Lāses, Sesavas pagasts, Jelgavas novads	0.998
4	SIA "BIO Auri"	"Pogas 1", Kroņauce, Auru pagasts, Dobeles novads	0.6
5	SIA "Zemturi ZS"	"Zemturi", Burtnieku pagasts, Burtnieku novads	0.68
6	SIA "Kņavas granulas"	Granulas, Radopole, Viļānu pagasts, Viļānu novads	1
7	SIA "ZAAO Enerģija"	CSA poligons "Daibe", Stalbes pagasts, Pārgaujas novads	0.35
8	AS "Viļānu selekcijas un izmēģinājumu stacija"	"Piziči", Viļānu pagasts, Viļānu novads	0.95
9	SIA "Pampāļi"	"Auniņi", Pampāļu pagasts, Saldus novads	0.99
10	ZS "Līgo"	"Līgo", Lielplatones pagasts, Jelgavas novads	0.5
11	SIA "Conatus BIOenergy"	"Graudiņi", Sausnējas pagasts, Ērgļu novads	1.96
12	SIA "Bioenerģija-08"	"Jaunlīci", Poļvarka, Sarkaņu pagasts, Madonas novads	1.96
13	SIA "Zemgaļi JR"	"Bionārzbūti", Vircavas pagasts, Jelgavas novads	0.6
14	ZS "Jaundzelves"	"Jaundzelves", Katvaru pagasts, Limbažu novads	0.52
15	SIA "Biodegviela"	Rūpnīcas iela 15, Kalsnavas pagasts, Madonas novads	2
16	SIA "Agro Lestene"	"Agro Lestene", Lestene, Lestenes pagasts, Tukuma novads	1.499
17	SIA "Agro Iecava"	"Latvall-Jaunlūči", Iecavas novads	1.95
18	SIA "BP Energy"	"Krastmalas", Allažu pagasts, Siguldas novads	0.25
19	SIA "MC bio"	"Mežacīruļi", Zaļenieku pagasts, Jelgavas novads	0.795
20	SIA "Sidgunda BIO"	"Niedras", Sidgunda, Mālpils novads	0.8
21	SIA "Bērzi Bio"	"Bērzi", Mālpils novads	0.6
22	SIA "Rigens"	Dzintara iela 60, Rīga	1.998
23	SIA "AD Biogāzes stacija"	"Skaista", Skrudalienas pagasts, Daugavpils novads	1.96

No	Operator	Address	Installed capacity (MWe)
24	SIA "Daile Agro"	"Vecsmildziņas", Glūdas pagasts, Jelgavas novads	1
25	SIA "Zaļā Mārupe"	"Imaku ferma", Jaunmārupe, Mārupes novads	1
26	SIA "NOPA LTD"	"Asinovka", Šēderes pagasts, Ilūkstes novads	0.25
27	SIA "LB Energy"	"Rukši", Lauberes pagasts, Ogres novads	0.21
28	SIA "BIO ZIEDI"	"Kalna Oši", Dobeles pagasts, Dobeles novads	1.998
29	SIA "EcoZeta"	"Bioslovašēni", Cesvaines pagasts, Cesvaines novads	1.4
30	SIA "Agro 3"	Cemeri, Litenes pagasts, Gulbenes novads	0.76
31	SIA "Piejūra Energy"	"Līvi", Nīcas pagasts, Nīcas novads	2.2
32	SIA "Zaļās Zemes Enerģija"	"Veibēni 1", Skrīveru novads	0.547
33	SIA "International Investments"	"Gandrs", Turku pagasts, Līvānu novads	0.499
34	AS "Agrofirma Tērvete"	"Jātnieki", Tērvetes pagasts, Tērvetes novads	0.5
35	KS "Baltijas dārzeņi"	"Jaunbajāri", Salaspils novads	0.999
36	Sabiedrība ar ierobežotu atbildību LATVIJAS LAUKSAIMNIECĪBAS UNIVERSITĀTES MĀCĪBU UN PĒTĪJUMU SAIMNIECĪBA "VECAUCE"	"Līgotnes", Auces pilsēta ar lauku teritoriju, Auces novads	0.26
37	SIA "Biopab"	"Jurku Ferma", Sējas novads	0.6
38	SIA "BIOPLUS"	"Pakalni", Sopuški, Kastuļinas pagasts, Aglonas novads	0.6
39	SIA "Brakšķu Enerģija"	"Brakšķi", Līvbērzes pagasts, Jelgavas novads	0.16
40	SIA "Druvas Unguri"	"Jaunstraumēni", Saldus pagasts, Saldus novads	0.5
41	SIA "Ekorima"	"Veckļaviņas", Lēdurgas pagasts, Krimuldas novads	0.95
42	SIA "Getliņi EKO"	CSA poligons "Getliņi", Stopiņu novads	6.28
43	SIA "Grow Energy"	"Gravas", Limbažu pagasts, Limbažu novads	1.995
44	SIA "Importex Group"	"Māras", Salienas pagasts, Daugavpils novads	0.9
45	SIA "Lielmežotne"	"Mežotnes Selekcija", Mežotnes pagasts, Bauskas novads	0.999
46	SIA "Liepājas RAS"	"Šķēde", Lībiešu iela 24, Liepāja	0.45

No	Operator	Address	Installed capacity (MWe)
47	SIA "Liepājas RAS"	"Ķīvītes", Grobiņas pagasts, Grobiņas novads	1.05
48	SIA "Priekules BioEnerģija"	"Nodegu skola", Priekules pagasts, Priekules novads	1.2
49	SIA "Rekonstrukcija un Investīcijas"	CSA poligons "Getliņi", Stopiņu novads	0.735
50	SIA "Sprūževa M"	"Ferma Staroščiki 1", Janopole, Griškānu pagasts, Rēzeknes novads	0.499
51	SIA "Ulbroka"	Acones iela 10, Ulbroka, Stopiņu novads	0.221
52	SIA "Vegi Eco"	"Līvi", Nīcas pagasts, Nīcas novads	0.8
53	SIA "Zemgales Enerģijas Parks"	Rūpniecības iela 2D, Bēne, Bēnes pagasts, Auces novads	1.2
54	ZS "Vecsiljāņi"	"Liellopu ferma", Bebru pagasts, Kokneses novads	0.5