Development of Biomethane Based Fuel Market in Estonia

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List of acronyms

Acronym	Meaning
AB	Aktiebolag is the Swedish term for "limited company" or "corporation". When used in companynames, it is abbreviated AB (in Sweden)
AD	Anaerobic Digestion
AS	Aktsiaselts
BAU	Business As Usual
BEMIP	The Baltic Energy Market Interconnection Plan
BM	Bio Methane=Gas of biological origin that has the same properties as fossil natural gas
CAPEX	Capital Expenditure
CBM	Compressed Bio Methane
CEF	Connecting Europe Facility
CNG	Compressed Natural Gas
CO_2e	CO_2 equivalent
ct	Cent
CWC	Cellulosic Waiver Credit
DICI	Direct Injection Compression Ignition
DISI	Direct Injection Spark Ignition
DSO	Distribution System Operator
EC	European Commission
ECN	Energy research Centre of the Netherlands
EIC	Environmental Investment Centre
ENMAK	Energiamajanduse arengukava
EPA	(United States) Environmental Protection Agency
EU	European Union
EUR	Euro
GHG	Greenhouse Gas
GIPL	Gas Interconnection Poland - Lithuania
GJ	Giga Joule
GoO	Guarantee of Origin
GREAT	Green Region for Electrification and Alternative fuels for Transport
HBE	Hernieuwbare Brandstofeenheid (Renewable Fuel Unit in Dutch)
HHV	Higher Heating Value
HVO	Hydrogenated Vegetable Oil
IEA	International Energy Agency
kg	Kilogram
km	Kilometre
LBM	Liquefied Bio Methane
LCA	Life Cycle Analysis
L-CNG	CNG station that uses LNG as supply
LDV	Light Duty Vehicle
LHV	Lower Heating Value
LNG	Liquefied Natural Gas
MBT	Mechanical Biological Treatment of Municipal Solid Waste, A generic term for mechanical sorting / separation technologies used in conjunction with biological treatment processes, such as composting.
MJ	Mega Joule
MKM	Majandus- ja kommunikatsooniministeerium Ministry of Economic Affairs and Communication (Republic of Estonia)
mln	Million
MoEAC	Ministry of Economic Affairs and Communication (Republic of Estonia)
NEa	Nederlandse Emissieautoriteit (Dutch Emissions Authority)
NG	Natural Gas
NGO	Non-Governmental Organisation
NGV	Natural Gas Vehicle
Nm^3	Normal cubic metre The 'Normal' refers to normal conditions of 0 degrees Celsius and 1

	atmosphere (standard atmosphere = 101.325 kilo Pascal)
OPEX	Operational Expenditure
OÜ	Osaühing
PJ	Peta Joule
PPP	Public-Private Partnership
R&D	Research and Development
RDF	Refuse Derived Fuel, a fuel produced from combustible waste that can be stored and transported, or used directly on site to produce heat and/or power
RED	Renewable Energy Directive
RFU	Renewable Fuel Unit (see Key Solution 2.9)
SD	System Dynamics
SDE+	Subsidie voor Duurzame Energie (Subsidy for Renewable Energy, see Key Solution 2.10)
SUV	Sport Utility Vehicle
TCO	Total Cost of Ownership=Costs of owning and operating a vehicle. Include purchase, maintenance, and use (fuel costs)
TEN-T	Trans-European Transport Network
TRL	Technology Readiness Level
TSO	Transmission System Operator
TtW	Tank-to-Wheel
UN	United Nations
USA	United States of America
USD	United States Dollar
VAT	Value Added Tax

List of units

Name	Abbreviation	Value
Energy		
Joule	J	SI derived unit for energy, equal to the energy transferred (or work done) to an object when a force of one newton acts on that object in the direction of its motion through a distance of one metre
Megajoule	MJ	10^6 J
Gigajoule	GJ	1’000 MJ=10^9 J
Petajoule	PJ	10^6 GJ=10^{15} J
Kilowatt hour	kWh	3.6 MJ=3.6*10^6 J
Gigawatt hour	GWh	10^6 kWh=3.6*10^{12} J
Gross Calorific Value (or Higher Heating Value) (per unit)	GCV (or HHV)	The total energy content of a unit (mass or volume), including the heat of vaporisation of water vapour. This is what is used in gas trading, as some boilers (condensing boilers) are capable of recovering the heat of vaporisation by condensing it.
Net Calorific Value (or Lower Heating Value) (per unit)	NCV (or LHV)	The amount of heat released during the combustion of a unit (mass or volume), with the subtraction of the heat of vaporization of the water vapour from the higher heating value. **This is the quantity we will use throughout this document**, as we are dealing with transport, where the energy from water vapour created during combustion is not recovered, as the water vapour is not condensed back to recover heat to activate a motor.
Mass		
Kilogram	kg	SI unit for mass. Equal to the mass of the International Prototype of the Kilogram
Tonne	t	1’000 kg. Note that “ton” refers to different values. 1 short ton (or ton in the USA)= 907 kg. 1 long ton (or ton in the UK)=1’016 kg
kilotonne	kt	1’000 tonnes=10^6 kg
Distance/size		
Metre	m	SI unit for distance. The metre is defined as the distance travelled by light in a vacuum in 1/(299’792’458) seconds
Kilometre	km	1000 m
Volume		
Cubic metre	m^3	Volume of a cube with edges one metre each.
Normal cubic metre	Nm^3	Normal cubic metre The 'Normal' refers to normal conditions of 0 degrees Celsius and 1 atmosphere (standard atmosphere = 101.325 kilo Pascal)
Litre	l	0.001 m^3

Executive summary

Context

This report provides a practical strategy for bringing biomethane into the Estonian transport sector, with the ambition to cover 3% of transport energy use in 2020. This strategy consists of a set of twelve concrete and impactful key solutions. These key solutions cover all aspects of the value chain: Consumer demand, refuelling stations, vehicles, biomethane production, as well as a cost-effective fiscal framework that provides a competitive fuel price to consumers.

Background

The ambition to roll-out biomethane in transport stems from the Renewable Energy Directive (RED). This directive requires all EU Member States to ensure that 10% of the energy use in transport comes from renewable sources by 2020 (EC, 2009; 2015a, b). Another driver is the importance that Estonia assigns to local production, which results in an ambition to supply 10% of the energy use in transport from local sources by 2030. Biomethane is a leading candidate to provide these 10% (ENMAK, 2016). In addition to climate change mitigation and increased energy autonomy, biomethane in transport has a number of other benefits: It will provide cleaner air in urban areas and offer outlets for sustainable agriculture and husbandry in rural areas.

Most of the 10% RED target (about 7%) will come from liquid biofuels (biodiesel and bioethanol), with biomethane closing the gap of the remaining 3%. Note that there is currently very little renewable energy use in transport in Estonia, as the obligation to blend biofuels still needs to be approved by the parliament and implemented.

The Challenge

The 3% target corresponds to a biomethane demand of about 1.22 PJ (or 35.8 million Nm^3 of biomethane), based on the upper bound for the projected Estonian energy use in transport in 2020 (ENMAK, 2016). To achieve the target, these 1.22 PJ need to reach consumers at a price that is favourable (compared to diesel) while at the same time ensuring that all commercial actors (biomethane producers, vehicle suppliers, and fueling stations operators) can recoup their costs (and get an acceptable margin).

The main challenge in kick-starting the market for biomethane to reach the 3% target is to bridge the financial gap between the price of biomethane and the price of fossil methane (currently imported from Russia). As a result of this price difference the current situation is that the business case for biomethane in transport is not yet competitive with the fossil fuel alternatives (diesel, petrol, natural gas). This means that the Total Costs of Ownership for biomethane in transport is higher than the alternative (often diesel) for most potential customers, if all actors in the value chain need to recover their costs (and make a profit).

Strategy

In developing an effective implementation strategy we have analyzed the various parts of the biomethane value chain by looking at their interactions. By considering these interactions we have condensed our strategy for rolling out biomethane in the Estonian transport sector in a set of practical and cost-effective key solutions that can be implemented in the short term (see Figure 1).

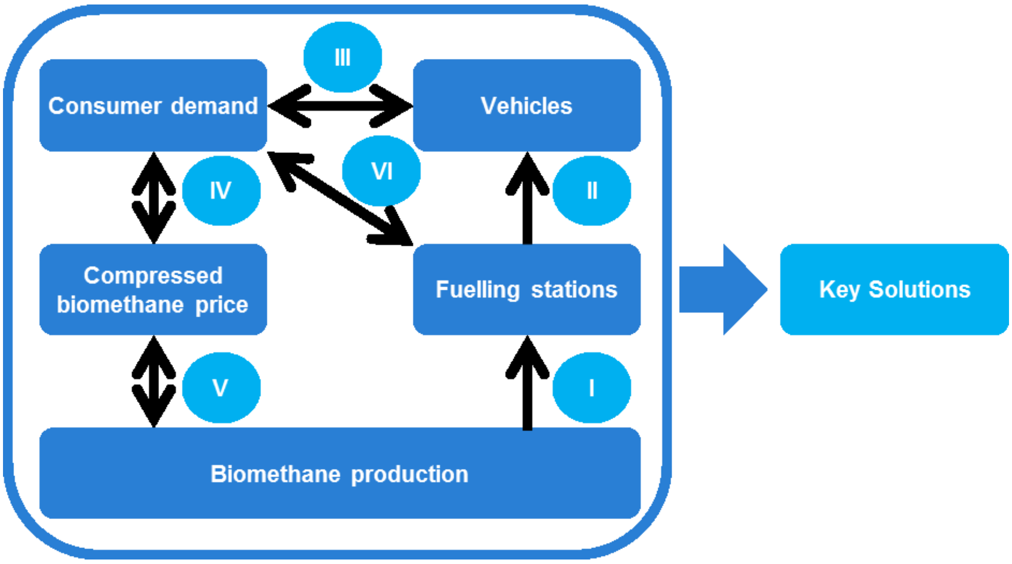

Figure 1: Interactions between the elements of the biomethane system

Policymakers should see these key solutions as a policy toolbox from which they can pick and choose to support the expansion of biomethane use for transport in Estonia.

Currently, the market for biomethane in transport is almost nonexistent. In order to reach a market share of 3% of energy use in transport by 2020 in the most cost-effective way, two things need to occur: First, the business case needs to become positive for a group of early adopters, which should be followed by a market expansion.

This strategy of first improving the business case (in niche markets) and later expanding the market has several advantages: The most important one is that this approach reduces costs (by avoiding to have to go through a big/large-scale support of biomethane in transport, which would be a costly alternative). This strategy also gives the opportunity to work out issues, as a smaller market is easier to correct than a mature one.

Key Solutions

Following this strategy, 12 key solutions have been developed that can be structured in 2 categories. The first category of solutions is geared at improving the business case and therefore needs to be implemented as soon as possible. The second category of solutions is targeted on expanding the market and thus mostly may be implemented slightly later in time.

Key Solutions for improving the business case

I. **Supporting the roll-out of refuelling stations** by mobilizing financial support through different EU framework programmes (see KS 5 on page 46).
II. **Support mechanism to grid connection:** Financial support for construction of connections to the natural gas grid for biomethane producers (see KS 6 on page 49).
III. **Privileges for biomethane-powered vehicles** (and other green vehicles), such as access to environmental zones and/or bus lanes, or free parking (see KS 8 on page 57).
IV. **Renewable Fuel Units.** Improving the business case for biomethane in transport by creating a system that enables fuels suppliers to use biomethane as an additional option to fulfill their blending obligations for biofuels, under the RED (see KS 9 on page 61).
V. **Targeted subsidy biomethane:** Balanced financial support for biomethane producers to cost-effectively bridge the price gap with to fossil natural gas (see KS 10 on page 71).
VI. **Certifying digestate as fertilizer:** Certifying the process of digestate formation (a co-product of biomethane production) and set legislation to allow its use as a fertilizer (KS 12 on page 83).

Key Solutions to expand the market

VII. **National platform** biomethane in transport: Linking all stakeholders to facilitate information exchange and cooperation and to create and expand business opportunities (KS 1 on page 23).

VIII. **National vision** on biomethane in transport, coordinated by the government in cooperation with the market, thereby providing clear targets and rules and associated favorable investment conditions (see KS 2 on page 28).

IX. **Customer information**: Campaigns to inform potential users on the benefits of driving on biomethane and to reduce (perceived) barriers such as range anxiety (see KS 3 on page 34).

X. **Roll-out strategy refuelling stations**: Establishing a plan on the optimal locations and sequence of building new biomethane fuelling stations (see KS 4 on page 39).

XI. **Green public procurement:** Setting criteria that will boost the government as launching customer for biomethane vehicles in public fleets (buses, vans, waste collection trucks etc.) (see KS 7 on page 52).

XII. **Increased organic waste digestion:** Introducing obligations to separate the biofraction from municipal waste, as feedstock for biomethane production and more favourable gate fees for biomethane from biowaste (see KS 11 on page 78).

Other issues

Another issue to keep in mind is that rolling out infrastructure on a country scale is very expensive. First movers are a at disadvantage, as there will be a larger delay between their investment and a large enough income compared to a more mature market. This is due to the wait for the market to expand. As such, financial support and new approaches are needed.

A starting point for the biomethane roll-out strategy, and the key solutions associated, is to focus on the market introduction of 100% biomethane, rather than blends of biomethane and fossil methane. Although this latter strategy would allow biomethane to be more expensive than fossil methane (as long as the blend price would be competitive compared to diesel and petrol) this strategy would eventually temper the business case for biomethane. In addition, the strategy of bio/fossil blends of methane would require a proportionally larger market share of vehicles and refueling infrastructure, which would be extremely challenging to achieve before 2020.The strategy of introducing 100% biomethane from the start requires long-term economic incentives to kick-start the biomethane expansion, such as if implementing targeted subsidy (KS 10).

Finally the economics of biomethane also needs to be valued on its societal benefits, regarding rural development, sustainable agriculture and husbandry, climate mitigation and cleaner air in urban areas as this is the key reason underlying the biomethane ambition.

References

EC (2009): Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC. Http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32009L0028.

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Table of Contents

1 Introduction

1.1 Goal

The main objective of this study is to provide a practical strategy for phasing in biomethane in the Estonian transport sector, with the ambition is to reach around 3% market share in 2020. This strategy is condensed in a set of Key Solutions, thereby comprising all aspects in the value chain: consumer demand, refuelling stations, vehicles, biomethane production, as well as financial measures to ensure the cost effectiveness of the transition.

The Renewable Energy Directive (RED) (EC, 2009) sets a number of targets for the use of renewable energy. Firstly, the RED sets a European target of 20% renewable energy use by 2020 (divided into country specific targets). In addition, the RED sets a specific sub target for the transport sector by obliging all EU Member States to ensure 10% renewable energy in transport in 2020. This 10% target will mostly be achieved by blending biofuels into the fuel mix. The biofuel blending level in Estonia is currently very low, as the national blending obligation is still under implementation. In addition to liquid biofuels (biodiesel and bioethanol) Estonia sees an important role for biomethane, produced from local feedstocks, with a target to cover in 2020 about 3% of energy use in transport by biomethane. For 2030 the target for energy use from domestic sources in the transport sector is even higher, 10%, with a dominant role for biomethane (ENMAK, 2016)

The RED 10% target for renewable energy in transport, as summarized by Ecofys (2013), can be formulated as follows:

$$10\% = \frac{\textit{All}\text{ Renewable Energy in }\textit{all}\text{ forms of transport}}{\text{Petrol, diesel, }\underbrace{\text{biofuels,}}_{\text{In road and rail transport}}\ \underbrace{\text{electricity}}_{\text{In all transport}}}$$

Note that the RED also includes a set of sustainability criteria for biofuels consumed in transport. To address the negative environmental consequences of indirect land use change by some kind of biofuels the RED was amended in 2015. The amounts of different biofuels produced from energy crops grown on agricultural land is capped at 7% of all final transport energy use in 2020. In accordance member states are to set national targets for advanced biofuels in their legislation (EU, 2015a, 2015b):

1.2 Practical implications of the 3% target

In order to design the strategy for phasing in biomethane in Estonia, the target of 3% biomethane in transport needs to be converted in a practical manner to units of energy consumption. To this end the ENMAK (2016) scenarios provide an upper and lower bound for the projected Estonian energy use in transport by 2020:

- Low projection – 'Knowledge economy' scenario: 31.3 PJ in transport in 2020
- High projection – 'Business as Usual' scenario: 40.7 PJ in transport in 2020.

Following discussions with the client, our study is based on the higher projection of 40.7 PJ in transport in 2020. By taking this higher projection as a starting point the target of 3% biomethane in transport corresponds to a biomethane demand of about 1.22 PJ. This value (equaling 35.8 million Nm^3 of biomethane) is the basis for our study: It is the target that needs to become available for the transport sector at acceptable costs, and similarly the target in terms of vehicles, stations and fuel supply. Note that this amount corresponds approximately to the current energy use by buses in Estonia.

1.3 Strategy

We have analyzed the various parts of the biomethane system by looking at the interactions between the different parts. Our strategy for rolling out biomethane in the Estonian transport sector is condensed in a set of practical and cost effective ‘Key Solutions’ that can be implemented in the short term. The Key Solutions (each described in about 3-6 pages; see Chapter 3) are to be considered as a (policy) toolbox from which policy makers may pick and choose actions to implement. Some of the solutions overlap in their impact, so not necessarily all solutions need to be selected. This also means that if a certain solution cannot be implemented (sufficiently) it will be mostly possible to achieve (part of the) impact required by the implementation of other solutions.

Amendments to the original proposal

During the Kick-off Meeting Tallinn July 28th 2016, the original proposal and associated work plan was substantially overhauled. The main change was to have much more focus on an end product in the form of concrete and cost effective actions which can be implemented immediately. To this end it was agreed to modify the original work plan and instead focus the study on the development of the above described set of Key Solutions and spend the remaining capacity on the other elements that are presented in the table of contents.

1.4 References

EC (2009): Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC. Http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32009L0028.

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2 Approach

Introduction/Goal

This chapter explains the approach we used to develop our key solutions to help expanding the biomethane market for transport in Estonia. It discusses the various elements of the value chain that are relevant for our proposed key solutions and explains our general approach with these key solutions. This chapter also explains the features of the cover page, which highlights the main characteristics of each key solution.

Approach to develop and manage key solutions

Elements of the value chain and key solutions

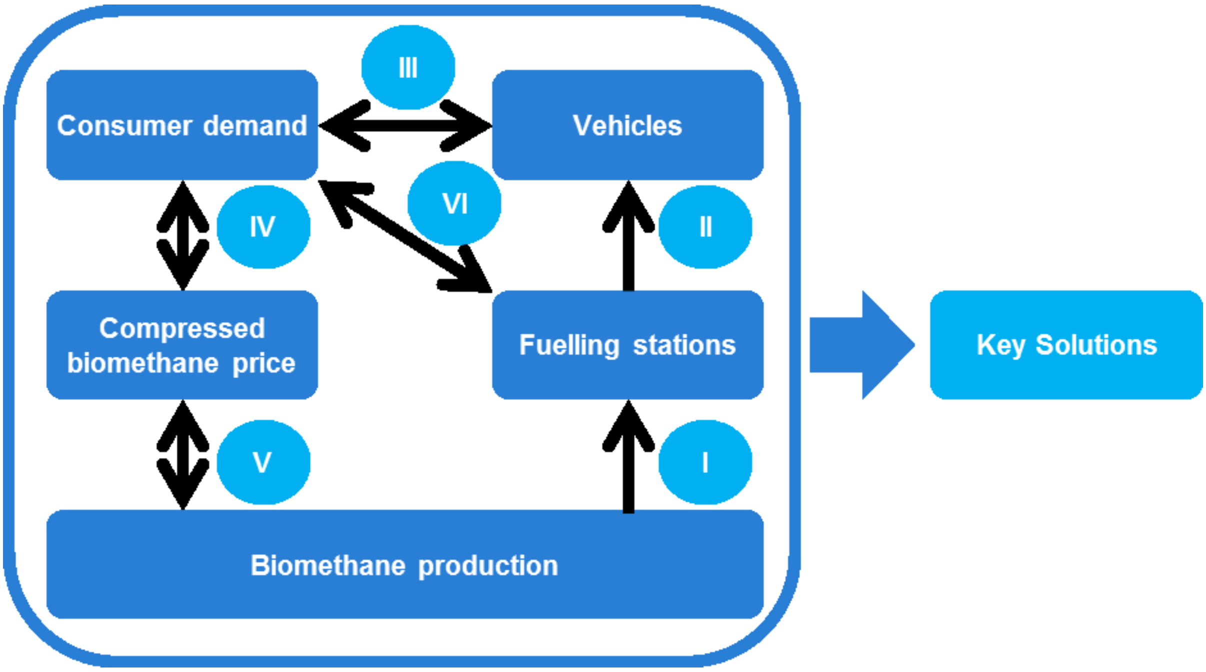

Figure 2: Interactions between the elements of the biomethane system

An essential element to keep in mind when analysing the biomethane system is that its various parts should not be assessed in isolation. Rather, we need to take a closer look at the interactions between the different parts. This will help facilitate the understanding of the system and also why the different key solutions are needed.

Figure 2 shows the five elements of the biomethane system and their interactions, including showing if these interactions go both ways or not. In total, there are six relations, which are briefly explained in the list below:

I. CNG/CBM cannot in an economically feasible way be transported by truck over longer distances (exact distance on country specific costs and retail prices) unless the gas is liquefied. This means that refuelling stations supplied with compressed gas should either be located close to production facilities or close to the natural gas pipeline network. Liquefaction increases the road transportation range, at the expense of increased CAPEX, both regarding trucks and refuelling stations.

II. The location, capacity and density of refuelling stations will influence which CNG vehicles will be available, as these vehicles will need these stations to fuel CNG. If the vehicles have a range that is shorter than the distance between stations, then it won't make sense to introduce these vehicles.

III. The availability of certain types of vehicles will determine which consumers can be targeted for using biomethane. For example, if gas powered LDV models suitable as taxis are available, then the corresponding consumer group will be taxi drivers, or bus companies if buses are available. On the other hand, a demand from a certain consumer segment might stimulate the import or manufacture of certain types of vehicles. For example, if public transport operators are interested in biomethane buses, this might stimulate their import.

IV. On the one hand, fuel distributors will set the prices of fuels at the level consumers are willing to pay. On the other hand, the fuel prices set by fuel distributors (because of production costs) will have an influence if consumers are willing to use biomethane for transport.

V. The production costs of biomethane are a key component of the price of fuel, but the interaction also goes the other way: The price fuel distributors can charge to consumers will determine which portion of biomethane will go to transport versus other applications (such as the production of electricity) that command different prices.

VI. The location and density of available stations will have an influence on demand, as consumers will want to fuel their vehicles in the most reliable and convenient way possible. If stations are only built in urban areas, then only people refuelling in these areas will be part of the target group. This also works the other way around, especially for heavy duty captive fleets: A strong consumer demand might influence the decision to establish a refuelling station.

These elements in the value chain of CBM and their interactions form the basis of our approach for developing key solutions, as they will be targeted to one or more of these elements.

Reaching the target with key solutions

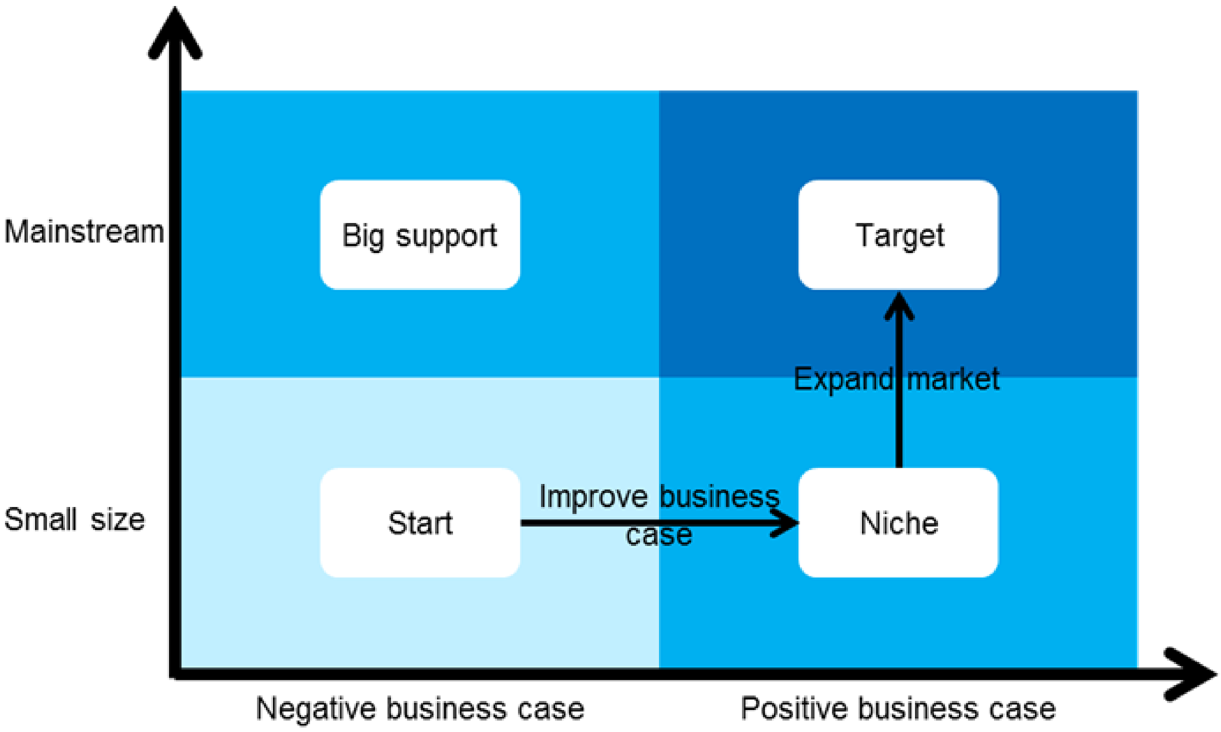

Figure 3: Overall approach for key solutions to reach the target

Figure 3 shows how the key solutions help achieve the 3% target for biomethane in transport in Estonia. The start/current situation is that the business case is negative. By that we mean that the Total Costs of Ownership[1] (TCO) are higher than the alternative (often diesel) for most potential customers, if all actors in the value chain need to recover their costs (and make a profit). On the other hand, the size of the market is currently essentially non-existent. To bring it to the target of a sustainable, mainstream (3% in 2020) option,

[1] which sum up purchase, maintenance, and fuel costs

two things need to occur: The business case needs to become positive for a number of customers, and the market needs to expand. The optimal order is to improve the business case first and expand the market second. This strategy has two advantages: First, it reduces costs (by avoiding to have to go through a big/large-scale support of biomethane in transport, which would be a costly alternative). Second it gives the opportunity to work out issues, as a smaller market is easier to correct than a mature one. This sequential order is, of course, a simplification, as some key solutions will do both or some will expand the market while others are still busy improving the business case. Nevertheless, it provides a useful framework to understand how to design the key solutions, how they work together, and how they should be prioritised.

Improve business case

- Supporting roll-out of refuelling stations (Key Solution 5)
- Support mechanism to grid connection (Key Solution 6)
- Privileges for biomethane vehicles (Key Solution 8)
- Renewable Fuel Units (Key Solution 9)
- Targeted subsidy biomethane (Key Solution 10)
- Certification and legislation digestate (Key Solution 12)

Expand market

- National platform (Key Solution 1)
- National vision biomethane (Key Solution 2)
- Customer information (Key Solution 3)
- Roll-out strategy CNG/CBM refuelling stations (Key Solution 4)
- Green public procurement (Key Solution 7)
- Increasing digestion of organic waste (Key Solution 11)

Figure 4: Which key solutions improve the business case and which ones expand the market

Figure 4 shows which of our key solutions improve the business case and which ones expand the market (again, some do both, but this is about what they primarily do).

The key solutions that **improve the business case** of CBM are:

I. **Supporting roll-out of refuelling stations (Key Solution 5):** This key solution consists of financially supporting the construction of refuelling stations through different EU framework programmes. Positive experiences in other member states indicate that it should be possible to obtain such funds, which would help station operators with their financial balance, thereby reducing the cost they would need to pass through to customers. This would therefore improve the overall business case.

II. **Support mechanism to grid connection (Key Solution 6):** This key solution consists of financially supporting the construction of connections to the natural gas grid for biomethane producers. Similar to the previous key solution, this would improve the financial balance of biomethane producers, thereby reducing the cost they would need to pass through to customers. This would therefore improve the overall business case.

III. **Privileges for biomethane-powered vehicles (Key Solution 8):** This key solution consists of offering privileges for biomethane-powered vehicles (and other green vehicles), such access to environmental zones and/or bus lanes, or free parking. This would offer a valuable benefit that has a certain financial value to customers, which would reduce their TCO, thereby improving the overall business case.

IV. **Renewable Fuel Units (Key Solution 9):** This key solution consists of creating a system where fuel suppliers can register how much renewable fuel they supply to the market, in the form of Renewable Fuel Units (RFUs). These RFUs can be sold to gasoline or diesel fuel suppliers who have a biofuel blending obligations. These suppliers would purchase these RFUs because it would be less expensive than blending biofuels. This would provide an additional source of income to biomethane suppliers in transport. It would, as in some other key solutions, improve their financial balance and consequently the overall business case.

V. **Targeted subsidy biomethane (Key Solution 10):** This key solution consists of providing subsidies to biomethane producers that close the financial gap they have compared to fossil natural gas.
As for other key solutions, this would improve the financial balance of biomethane producers, helping the overall business case.

VI. **Certification and legislation digestate (Key Solution 12):** This key solution consists of certifying the process of fertiliser production as a co-product of biomethane production. This would provide an additional source of income to biomethane producers, who would be able to sell fertiliser. As for other solutions, this additional income improves the financial balance of biomethane producers and consequently the overall business case.

The key solutions that **expand the market** of CBM are:

VII. **National platform (Key Solution 1):** This key solution consists of creating a national platform for biomethane in transport, which would link the relevant potential providers so that they can learn about the possibilities and advantages of developing biomethane in transport, and network with each other to establish the biomethane market. This will expand the market by increasing awareness opening the possibility of new partnerships.

VIII. **National vision biomethane (Key Solution 2):** This key solution consists of creating a national vision for biomethane in transport. This will allow the creation of a proper framework, within which the market can grow: It will set the right rules, and provide market certainty.

IX. **Customer information (Key Solution 3):** This key solution consists of setting up information campaigns that make potential customers aware of the benefits of biomethane in transport and aim at overcoming non-financial barriers such as range anxiety. Those financial barriers exist even if the business case is positive. By overcoming the barriers, the customer part of the market will expand.

X. **Roll-out strategy methane refuelling stations (Key Solution 4):** This key solution consists of establishing a proper plan on where the refuelling stations should be located. This is a roll-out plan that expands the refuelling stations part of the market.

XI. **Green public procurement (Key Solution 7)**: This key solution consists of introducing green criteria in public procurement, which would increase the demand for biomethane in transport, thereby expanding the market. It is linked to the holistic key design principle in the National Vision Key Solution.

XII. **Increasing digestion of organic waste (Key Solution 11):** This key solution consists of introducing a number of obligations regarding biowaste, namely separation at the source, separate collection from municipal waste. It also proposes to introduce more favourable gate fees for biomethane from biowaste. This would increase the supply of biomethane, thereby expanding the market.

Closing the financial gap with CNG and blending

The main assumption behind the key solutions presented in Chapter 3 is that the key challenge to improving the business case of CBM consists of closing the financial gap between CBM and CNG. This is a focus on reducing the CBM costs/improving its business case and minimising the required market size. The size of the CBM market would be the same as the whole compressed gas market (fossil CNG would not feature). Another strategy would be to have a blend of CBM and CNG. This would require a larger market growth: A 20% CBM blend would mean that gas vehicles must represent 15% of the market instead of 3% in the case of 100% CBM. Such a large market share would be tempered by a lower required effort to improve the business case/reduce the price of CBM, since CBM would be aided by the lower price of CNG. This second element would however hamper adoption, as the price of the product bought by customers would be higher than the case where CBM is brought to parity with CNG. To illustrate this, let's assume that CNG costs €0.80/kg and CBM €1.00/kg. A 20% CBM blend would cost €0.84/kg, which would create less growth than a strategy bringing CBM to €0.80/kg. As such, it appears that the strategy we chose (100% CBM at the price of CNG) is optimal, unless CNG was so attractive compared to diesel that a small price increase would not affect its adoption rate by much. The fact that CNG still has a small market share in Estonia indicates that CNG is not much more attractive than diesel. As such, our strategy appears to be the optimal choice, especially in the short term. In addition, blending of CBG towards a percentage of 3% in overall transport energy use would require a much larger vehicle stock to switch to gas. Such a large switch would cost much more time, while it is questionable if the demand on the vehicle side would be reached at all, since this would imply a dominant role for non-captive fleets.

This strategy implies that stronger and above all long-term economic incentives are needed for the first part of the biomethane expansion, in order to make it happen rather quickly, such as if implementing key solution 3.10 Targeted subsidy. All other key solutions will also be helpful, but without a positive long-term business case, biomethane market actors will not dare starting a new market. A tender where the bid with the lowest added premium is rewarded is a cost-efficient alternative, e.g. as in the Dutch SDE+ system (see Key Solution 3.10).

An important part of the economics of biomethane is to put a value on its societal benefits, regarding rural development, sustainable agriculture and husbandry, climate mitigation and cleaner air in urban areas. This is a key reason behind the target, and should be visible in all aspects of the work in achieving it. With a holistic, sustainable view, it is much easier to see how biomethane fits into the new paradigm of a circular economy, being the favourite technology to scavenge all organic waste streams, and in the process creating a framework for a truly sustainable agriculture with improved nutrient management, including aspects such as increased soil fertility and soil based carbon sequestration, while at the same time increasing the supply of domestic transport fuels, especially as biomethane. It is also a means of tying the urban and rural parts of society closer together, showing how they benefit from each other, not only when it comes to food but also when it comes to waste management and domestic energy production.

Putting all the key solutions together

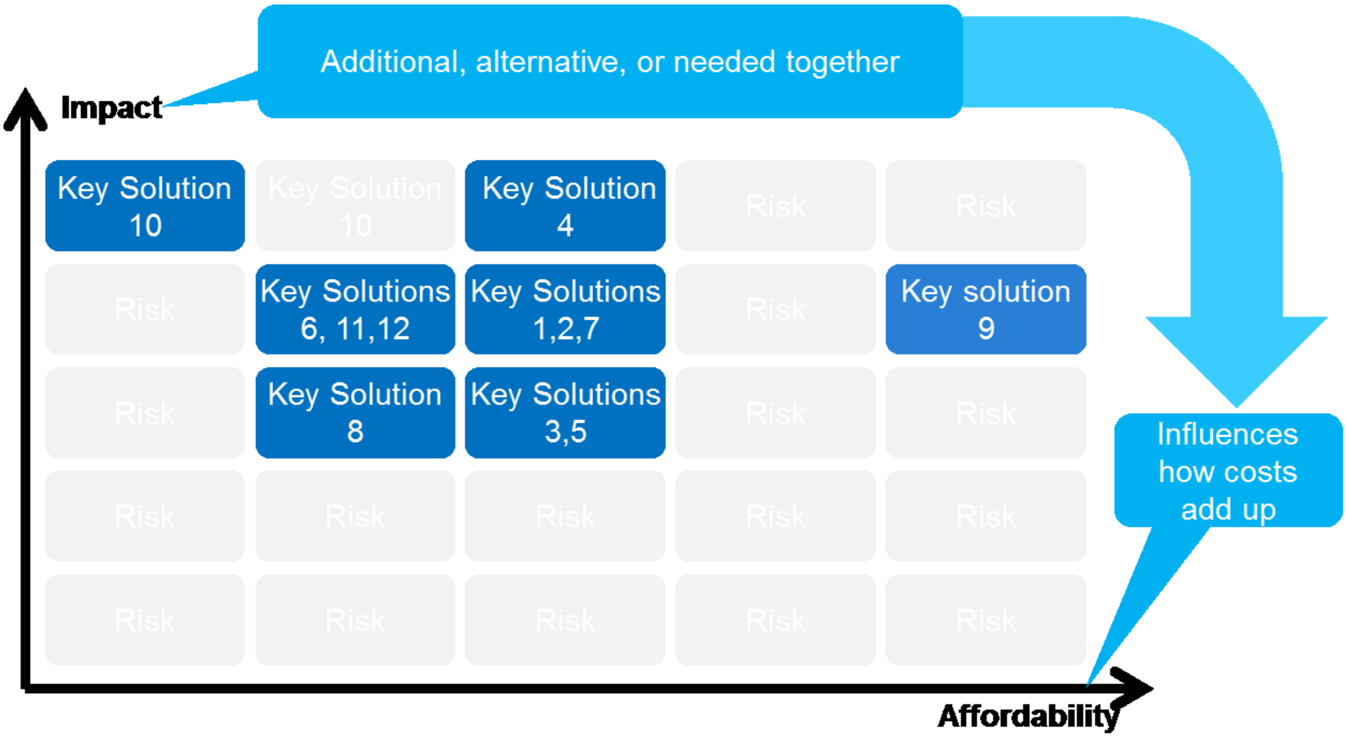

Figure 5: Impact and affordability of key solutions

Figure 5 shows the affordability and impact ranking of all key solutions. The fact that all key solutions have a relatively high impact is due to the fact the key solutions were selected for having a large impact.

One important element when considering implementing the proposed key solutions is how they fit together. Key solutions that address the same domain (such as Renewable Fuel Units and Targeted Subsidies, which address fuel costs) can be alternatives or can be combined/additional. Key solutions that address different domains (vehicles and biomethane production, for example) do not add up in terms of impact, except in the fact that a missing link (not enough available biomethane available, for example) would mean that the whole system would not come off the ground. Their costs, however, add up, since they are independent of each other.

One of the key choices is between Renewable Fuel Units (Key Solution 9) and Targeted Subsidies (key Solution 10). While the strong difference in affordability might plea in favor of the market-based Renewable Fuel Units, this would not be sufficient to reach the target (it would reach about 34% of it). As such, reaching the target would require choosing the target subsidies. This would, however be very costly. As such, an optimal solution would be to introduce both mechanisms in parallel. One combination possibility would be (as in the Netherlands) to give suppliers the choice between the two systems. The idea would be that subsidies would be chosen by the most expensive production options (as the cheaper ones would get more money from the market-based Renewable Fuel Units). This would be a kick-starting mechanism, active until the production gets cheaper and can be sustained by the market-based Renewable Fuel Units. The possibility of obtaining subsidies as an alternative would also act as a floor mechanism for the Renewable Fuel Units. One variation on this combination would be to allow producers with costs higher than what the Renewable Fuel Units can sustain to get both (the subsidy would only cover the part non supported by the market). This variation would be cheaper, but would need a close monitoring of both the production costs (needed for the targeted subsidy scheme) and of the Renewable Fuel Units price development. This underscores the most important actions needed for the fuels part of the biomethane system: Decide which (combination of) mechanism(s) should be put in place, with which levels of financing and timing (how much should be subsidized in which year) and selecting the party that will execute the constant monitoring of production costs and market prices. This is necessary for the execution of these schemes, as well as for approval of these schemes by the European Commission. For details about these mechanisms, see Key Solution 3.9 and Key Solution 3.10.

The other key solutions have less mutual interactions and can therefore be executed in a more separate fashion (though some attention is needed to ensure efficiency). A list of actions and their timing is provided with each key solution.

3 Key Solutions

This chapter provides a set of 12 practical and cost-effective Key Solutions that can be implemented in the short term. Before presenting the set of Key Solutions, starting at page 22, the next paragraph provides a "Clarification on key solution layout", that explains the structure and criteria applied.

Clarification on key solution layout

Each key solution has a cover page that summarises the key solution, as well as a five-criteria and five-star scoring, a link to the elements of the biomethane value chain, a risk matrix, and a timing chart.

Some Key Solutions have additional supporting information in appendices available on the One Drive folder that was set up for the study

Scoring along five criteria

Criteria	★☆☆☆☆	★★☆☆☆	★★★☆☆	★★★★☆	★★★★★
Affordability	Very large costs (€ tens of millions)	Large costs (€ millions)	Medium costs (€ hundreds of thousands)	Small costs (€ tens of thousands)	Cost neutral (less than €10'000)
Feasibility	Impossible to realise in the given timeframe/Estonian context	Large amount of challenges that would need a major effort/focus	Moderate amount of challenges that would need some special attention	A few small challenges that would be overcome without the need for special attention	No obstacles
Impact	Uptake lower than 0.1% of the target	Uptake between 0.1% and 1% of the target	Uptake between 1% and 10%	Uptake between 10% and 100% of target	Uptake larger or equal to the target
Speed	Would take many years, i.e. beyond 2020	Would take a few years	Would take months	Would take a few weeks	Would be in place (almost) immediately
Readiness	No elements in place	Some elements in place	Most important elements in lace	All needed elements are in place	Already in place

Table 1: Scales for the criteria

Each key solution is rated according to five criteria, which each have five star levels. The criteria and the meaning of each star rating are given in Table 1.

Relevance to elements of the value chain

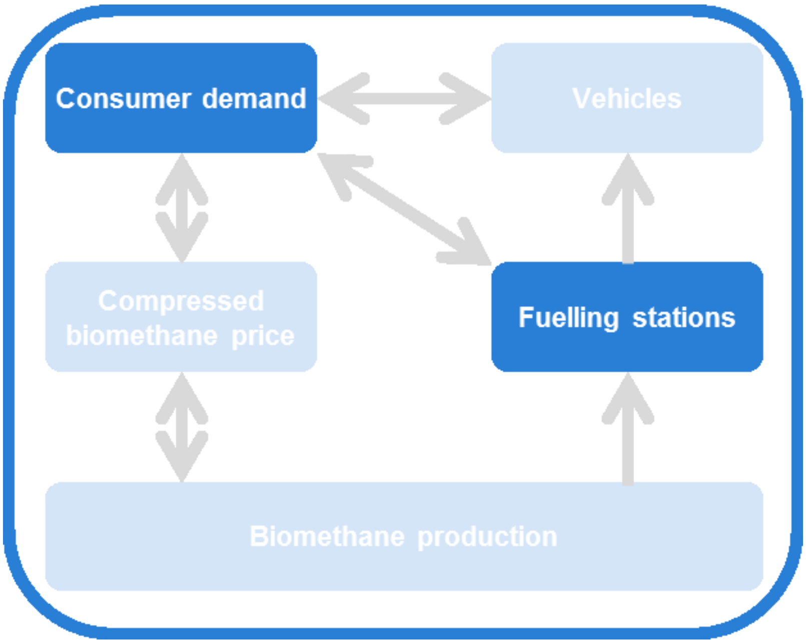

Figure 6: Relevance to the elements of the value chain

For each solution, the relevant elements of the value chain are highlighted, such shown in **Error! Reference source not found.**. This will help the readers interested in specific parts of the value chain to filter the solutions they would be interested in. It also helps readers connect to the background material.

Risk matrix

Figure 7: Risk matrix for key solutions

Each solution includes a risk matrix (see Figure 7), where each risk is assessed according to its likelihood and severity. The matrix uses a five-level scale of to assess these two assessment criteria. The first level means that it is essentially impossible to occur/has no impact). The fifth level means that it is certain to occur/renders the solution nil if it occurs.

Timing

Elements	Stakeholders		2017				2018				2019				2020			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Element	Stakeholder																	
Element	Stakeholder																	
Element	Stakeholder																	
Element	Stakeholder																	
Element	Stakeholder																	
Element	Stakeholder																	
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Element	Stakeholder																	

Table 2: Timing for key solutions

Finally, each key solution has a timing chart that shows the quarterly timing of a list of actions (and their stakeholders). A template for this is shown in Table 2.

3.1 National platform

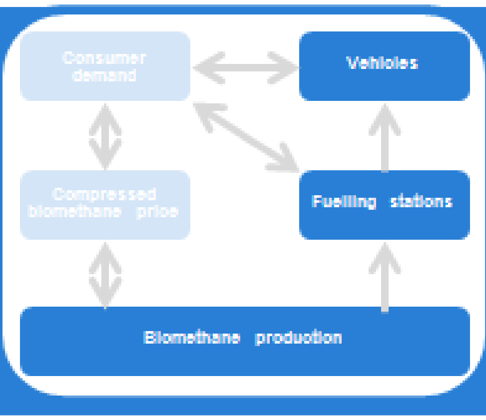
Affordability: ★★★☆☆

Feasibility: ★★★☆☆

Impact: ★★★★☆

Speed: ★★★☆☆

Readiness: ★★★☆☆



Solution summary

A national platform calling upon relevant stakeholders in the sectors of production, distribution and utilisation of biomethane to meet up and 1/get informed on the possibilities offered by the government plan on biomethane uptake; 2/network and form public private partnerships on local, regional and national level, across the value chain. Low cost action when considering the impact it may have on biomethane uptake, + funding possibilities.

Risk matrix

Solution timing by quarter

Elements	Stakeholders		2017				2018				2019				2020			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Formation of the Secretariat	Elering	■	■															
Preparations, outreach work	Secretariat		■	■	■													
Kickoff meeting	PPP candidates				■													
Preparations	Secretariat					■	■	■										
Second meeting	PPPs + new candidates							■										
Possible 3rd meeting	PPPs																	
Preparations	Secretariat						■	■	■	■								
Final Conference	PPPs, exhibitors									■								

Understanding

Mechanism

The national platform is envisaged to be the launch pad and natural starting point for the joint work of decision and policy makers and business actors when addressing the challenges and possibilities of the biomethane 3 % of all transport fuels goal. It is needed in order to inform all actors on the intent of and services provided by the Estonian government in relation to the new 2020 goal for biomethane market uptake, or at least the existing goal of 10 % domestic renewable fuels by 2020 (if the 3 % goal for biomethane is yet to be politically ratified.

The national platform is not supposed to be a predominantly public operation for more than 1-2 years. The first year will be the most active, with the organisation of at least two national network meetings, maybe three. A final workshop or conference concludes the platform, or rather hands the responsibility of it over to the business (annual or biannual conference of the biomethane/CNG sector in Estonia).

- The first meeting is the kick-off, with focus on information from the government and networking activities:
    - New national vision and goal
    - The need for all actors to pull together to make it happen; reports on experiences from abroad, and maybe also national experiences with public private partnerships within other areas
    - Networking session, Plenaries mixed with discussion in smaller groups, based on regional affiliation. The aim of the session is to start seeds of biomethane value chains and regional public private partnerships (PPP).
- The second (and possibly third) meeting follows up the first one, the focus is now on invigorating and nurturing the budding regional networks, and at the same time learn from their experiences. A lesser second motive is to allow the government to inform about the current and future state of supporting policies and regulations, both on national and EU level.
    - Presentations from PPP actors
    - Lessons learnt, barriers identified
    - Matchmaking sessions (“speed-dating”)

In between the meetings, the agents of the action remain available for questions, and can assist as speakers and facilitators at regional meetings of PPPs under formation.

Although not directly measurable in advance, it cannot be overstated how important this action is to meet the 3 % biomethane target. It provides an interface for all contacts and interactions between different stakeholders, probably becoming a clearing house that will address and hopefully set straight all potential problems and barriers in the form of knowledge gaps, confusion over regulations and policies, and shortcomings of individual PPPs.

Experiences abroad and possible variants

PPPs stretching across the value chain of biomethane has time and again been shown to be a common denominator of emerging markets. The complex and capital intensive nature of a joint biomethane/CNG market, together with the extended planning and building timelines is the reason behind their formation; without them there are too many uncertainties too handle. The following elements are often on the agenda of local and regional PPPs:

- Long-term contracts to secure supply and demand growth on par with installed capacity increments; CNG used as backup of biomethane to handle supply interruptions and market build-up and supply-demand imbalances
- Securing availability of feedstock and disposal of digestate as biofertiliser (effectively giving organic farmers access to fertiliser on par with artificial fertiliser)
- Creating new markets and acceptance of new infrastructure through public relations work
- Lobbying for supportive policies and regulations at national level
- Building new market demand by attracting captive fleet owners and freight owners, with the CNG/CBM suppliers as the hub which works closely with the biomethane producers and the vehicle manufacturers and dealerships to present an attractive and sustainable business offer

Reaching a certain target on biomethane (or any other biofuel) preferably shouldn’t be the only objective. If it is part of something bigger, it is easier to attract others to contribute. Strengthening local sustainable economies, self-reliance and clean city centres are possible themes for such an approach. (Further information in KS2.2 National vision biomethane)

A variant is to allow the second meeting as well to be an actual conference, with invited speakers and technology suppliers as exhibitors. If external funding is not secured, this could be a way to improve the economics of the action.

An expansion of the work could be to establish (or using existing one, e.g. the website of Estonian Biogas Association or to establish sub-page to Elering Gas related website) a permanent web site, collecting all information and sending out a regular newsletter and maintain platforms also in social media.

One variant can be developing the platform further to Biomethane Network or to extend the current Gas Market Development Council, chaired by Elering, to cover also the Biomethane issues or to establish sub-section for Biomethane under abovementioned Council. Another variant is to rotate the leadership of Network among its members (similar to rotation of leadership of Estonian Chamber of Environmental Organisations).

The concluding conference may be organised jointly by Elering and Estonian Biogas Association. It may continue as an annual or biannual event, with Elering involved at any level they wish and can be agreed upon. The event in 2020 may act as a review of the success of the program, reporting and analysing reasons behind the actual outcome regarding biomethane production trends, uptake of vehicles, refuelling stations and implementation of biofertiliser.

Another variant is to offer study tours, to offer first-hand experience of proven biomethane uptake solutions in other countries. This is especially apt as part of an application to the Swedish Institute, covering the expenses of all actors involved and the organisational costs.

Risk Mitigation

The major risk is lack of interest among the stakeholders. Without the cooperation of them, the action will not succeed. The interest hinges upon if stakeholders see it feasible, which will depend on whether the actions are designed to secure long-term profitability, sustainability and being market-based (state budget neutral). In addition, it is essential that all stakeholders are well informed about CNG/CBM support schemes. For tenders to be successful, it is important that all partners in the value chain are aware of their roles and responsibilities.

The importance of meticulous preparation and execution of the first event cannot be overstated. No matter if it becomes a smaller or larger event, if it is not perceived as successful and inspiring by the PPP candidates, the whole action will risk to fail, which in turn will undermine the goal of the government to reach the 3 % biomethane target.

A second minor risk is over ambitiousness of the action organisers. It is important to adjust the level of activity to the actual market readiness or nudging its potential into reality. It is easy to become overzealous, and if not getting enough feedback losing faith about the work, which spills over at the market actors contacted.

Impact

Effect on biomethane uptake

Being a soft issue, there is no certain way to estimate the effect of the action on the biomethane uptake. As pointed out earlier, PPPs have been found to be active in all emerging CBM markets, and may be essential in order to reach a critical volume that makes the market more resilient to changes, e.g. lowered benefits and low price of conventional fuels.

Costs

The cost of the government of this action depends on the level of outreach work needed to gather a critical mass of business actors, and the quantity and specifics of meetings held (number of hours spent by organisers, venue pricing level and meeting services provided). Inspirational presentations from experienced local business actors would probably be possible at no cost, while speakers from abroad would need to be reimbursed for travel and hotel costs at a minimum, maybe more if high-level non-commercial speakers are desired.

If involving at least one more Baltic state in the platform, and allowing some time for applications to the Swedish Institute[2], the costs of this action could be co-funded. Other means of co-funding at EU level may also be available. It might be useful at least in kickoff meeting to present positive, working, long-term secured market-based experiences from other countries on uptake of biomethane in transport. Thus, cost of 3-4 foreign speakers could occur.

Implementation

[2] https://eng.si.se/areas-of-operation/scholarships-and-grants/baltic-region-seed-funding-grants/;

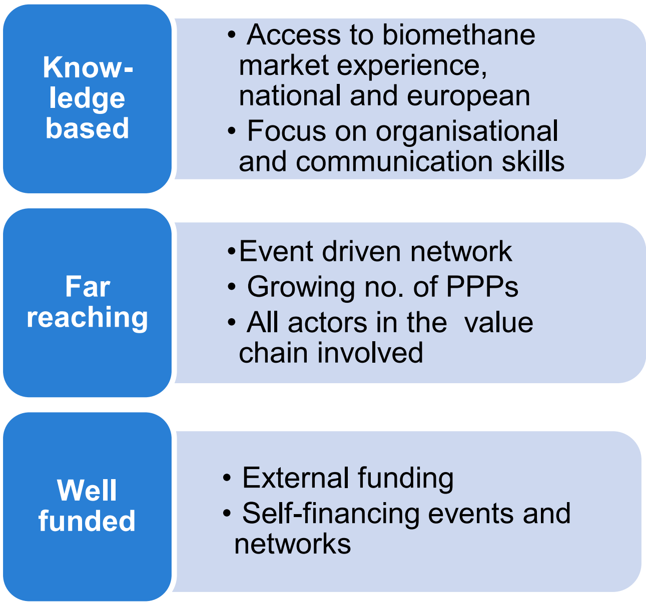


Figure 8: Overview of design principles and their corresponding needs of the National platform for biomethane

Design principles and needs

The design principles and their corresponding needs are that the work of the platform should strive to be:

I. **Knowledge based:** The secretariat personnel should be recruited with organisational and communication skills as their main competence, and hopefully with networking and event experience. The outreach work need to be expedient and flawless in order for this action to be successful. In addition, part-time resources in Estonia and abroad with proven market knowledge are needed to identify PPP candidates and secure speakers and information from the larger European experience in the field.
II. **Far-reaching:** Event based networks are easier to build and maintain. In a smaller country such as Estonia, one network should be enough. Another success factor is the no. of actors the action manages to involve, and the no. of PPPs formed, and their completeness – each value chain needs to encompass all actors, from production all the way to the end-user of the automotive fuel. If one link fails, the business case falls apart.
III. **Well-funded:** Networking platforms need to secure funding to be long-term. The startup of this action may be covered by the government, but it could also be covered by external funding. Either way, from the start there needs to be a focus on achieving self-reliance. Exhibitor and participant fees is one option that should be examined. It could also be one of the deliverables of a national PPP or business organisation, which continue the work of the platform through member fees and by securing and executing EU projects.

Stakeholders

The main stakeholders involved in the action and the PPPs to be formed are:

I. **The Secretariat**, , appointed by the national government. Organizer of all events, responsible for production of information materials.
II. Municipal and regional officials and decision makers,
    a. Waste based feedstock
    b. Public transport authorities.
III. Non-public captive fleet owners,
IV. Biogas producers,
V. CNG/CBM distributors,
VI. Vehicle manufacturers and dealerships,
VII. Agricultural sector,
    a. Feedstock supply (mainly animal manure)
    b. Biofertiliser demand

Associated stakeholders are:

I. Grid owners, TSOs and DSOs,
II. Refuelling station chain companies,
III. Industrial biowaste owners,
IV. Associated authorities,
    a. Fire and safety
    b. Environmental protection
    c. Food and fodder regulators
V. Technology suppliers,
    a. Biogas production and upgrading
    b. CNG and LNG refuelling stations, mobile storage unit technology
    c. Auto workshops retrofitting petrol LDVs to CNG/CBM
    d. Freighting companies and freight owners

Timing

There are essentially three phases/groups in the timing of solutions (see chart on the first page of this key solution):

I. **Formation of the secretariat:** The first decision to be made in this action is who will do the organisational and logistical work in the secretariat proposed. It can either be specializing projects managers at Elering, or out-sourced to consultants via tendering, or found via targeted tender among gas sector NGOs (Estonian Biogas Association, Gas Union, etc). It needs to be done as fast as possible, in order to meet the tight time schedule imposed by the 2020 timeline.

II. **Preparations for the first event:** The outreach work performed for the first event is crucial, since it is defining the impact and reach in the business. Every pertinent actor in Estonia need to be approached at least by telephone. Success is governed by that, and the quality of the event program.

III. **Handing over of the event series:** The decision to hand over or not the event platform to some NGO needs to be decided upon quite soon

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3.2 National vision for alternative fuels

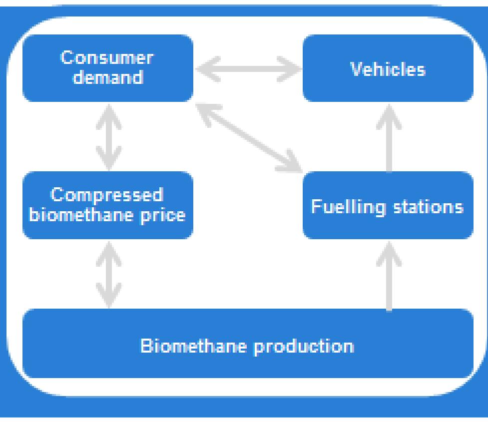
Affordability: ★★★☆☆

Feasibility: ★★★☆☆

Impact: ★★★★☆

Speed: ★★★☆☆

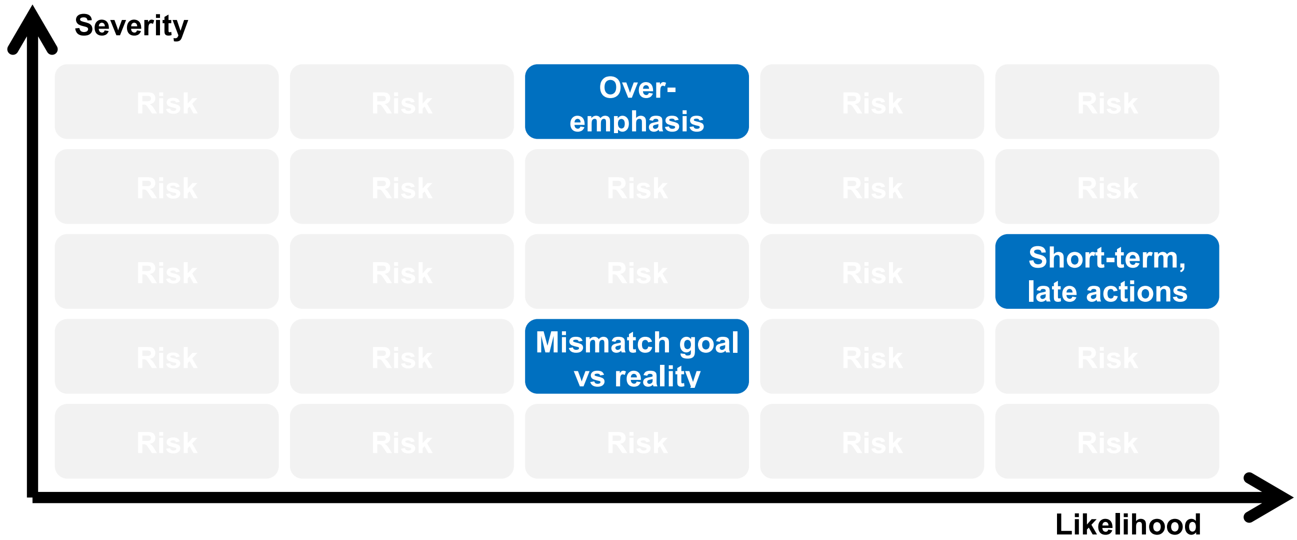
Readiness: ★★☆☆☆



Solution summary

The national vision and attached overarching goals need to be analysed in a technology neutral manner. Each energy carrier however needs more specific targets and policies defined. The true value of biomethane and other alternative fuels is only seen when quantifying its wider societal and environmental contribution. The work at national level to develop a strategy and specify the governance is the fundament of all other actions. It is of utmost importance that it is long-term in character, withstanding changes in economy and government elected.

Risk matrix



Solution timing by quarter

Elements	Stakeholders			2017				2018				2019				2020		
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Creation of joint taskforce	National government	■	■															
Work on national vision and target (biomethane)	Joint taskforce, Elering	■	■	■	■													
Work on cost neutral and simple regulatory changes	Taskforce, Elering	■	■	■	■													
Presentation, vision, target	Joint taskforce					■												
Work on strategy	Joint taskforce, Elering			■	■	■	■	■	■									
Feedback other stakeholders	Business, NGOs			■	■				■	■								
Presentation, strategy, new policies	Joint taskforce, Elering									■								

Understanding

Mechanism

Establishing framework conditions beneficial to the industry are very important in the creation of an emerging market of biomethane used as an automotive fuel. These framework conditions are of course created at all levels of governance, local regional and national, but the ones set by the state at national level are the most important, since they set the playing field for the entire country. It is the message that all other actors heed to, making the work at national level the fundament of all other actions proposed. Therefore, this action is centre in the work to meet the 3% biomethane target. But the vision, targets and supporting policies and regulations need to look beyond 2020, considering the long lead times and high capital intensity of the CNG/biomethane business. It is of utmost importance that plans are long-term in character, withstanding changes in both economy and government elected.

The first step is to create a national vision that takes into account all alternative fuels and which governs the goals of all different decision making bodies in the country. The starting point is of course the internationally agreed goals, such as the ones of EU[3] and the UN[4], and the related national targets for 2030 of 10% biomethane from indigenous sources in the transport sector. The national vision can be more detailed with added constraints and conditions specific to the country (e.g. the environmental goals of Sweden[5]). The next step is to create even more specific goals for each field of interest, in this particular case biomethane. However, biomethane is a true multi-purpose instrument in the conversion to a circular economy, being the scavenger of choice for almost all organic waste streams in society, in addition to its importance in the nutrient management and climate impact mitigation of sustainable agriculture. The traditional division into issues regarding energy, environment and agriculture does thus not work very well. All impacts need to be addressed and estimated at the same time, even though maybe the action is handled by just one governmental authority. A taskforce consisting of representatives from the departments and authorities of energy, environment and agriculture might be necessary to make that happen. Parliamentary committees of Rural affairs, Economic Affairs, Environment and National Defence might also be involved.

The best targets are overarching and general, e.g. a target level for the share of renewable fuels in the transport sector, which is already in place in Estonia. It is technology neutral, which is good. Simultaneously it is important to give guidance and reassurance for the market actors of different energy carriers, such as a target annual biogas production (PJ), with the share of utilisation in the most preferred sector (transport) specified.

The creation of a supporting system of benefits and regulations is the next level, pinpointing the low hanging fruits when it comes to economic efficiency and societal benefits. It is of utmost importance that the benefits are long-term, or at least specified up to a certain market growth or number of vehicles (early adopter premium). In the latter case, it is important to make a stepwise reduction of the benefits. Tax exemptions of biofuels have been a cost-efficient tool, which however no longer is allowed by EU. It is a good idea to support NGOs that give aid in learning about and acquiring EU funds. Experience from other countries show that resilient and sustainable markets can be built by supplying just enough incentives to overcome the gap to reach economic viability. The drawback is of course the extended time needed to build the market.

Examples of targeted actions are listed below. Read also section 2.3 on customer information for an in-depth analysis on overcoming knowledge barriers.

- Clean vehicle definition, used as standard for procurements and minimum standard in environmental city zones. It should be life cycle based, since a holistic approach is important in order not to focus on end-of-tailpipe emissions only, leading to an increase in diesel cars).
- Early adopter benefit for heavy-duty sector (buses and/or trucks).
- Reduction of taxes on employee benefits, notably regarding the private use of company cars. Very good tool (if implemented) since share of new car sales is high. Strong motivator for vehicle manufacturers to prioritize selling their NGV

[3] http://ec.europa.eu/clima/policies/strategies/2030/index_en.htm

[4] http://www.un.org/sustainabledevelopment/sustainable-development-goals/

[5] http://www.miljomal.se/Environmental-Objectives-Portal/

models in Estonia. If long-term, strong interest from buyers. Automatically creates second-hand market for NGVs. Drawback: Loss of tax income.
- Carbon footprint reduction requirements as part of all government issued permits and procurements (e.g. permits for airports, harbours or business permits in general).
- Establish yearly reporting of biogas production and CNG/biomethane sales in order to produce reliable statistics. Used by both business and decision makers for strategy building and public relations work.

In general, it is not good to set too specific goals, e.g. no. and type of vehicles, number of production plants etc., since it restricts the market players from fulfilling the more general goal in the most efficient manner possible. At the same time, it is important to address the specific needs of each energy carrier of interest, acknowledging that they have different barriers to overcome and different levels of market penetration. In the following the needs of biomethane will be explained more in detail.

Experiences abroad and possible variants

In Sweden, the state early on adopted a range of environmental goals, and assigned their fulfilment to the local government. As an incentive, they created funding programmes only eligible for the municipals, which with time became more focused on climate mitigating actions. Biomethane projects have benefitted greatly from these, since they provide good scores in the climate mitigating effect calculations. However, In Sweden there has never been any explicit target for the raw biogas production or the upgraded product biomethane. The consensus in the industry is that it has hampered the development, both policy-wise and business-wise.

There are a number of sectors that are interesting sources of biogas feedstock. The lowest hanging fruits are urban and industrial waste streams, such as sludge from wastewater treatment plants, and organic waste from industries, restaurants and households. These feedstocks are, within reason, quite easy to mobilise.

However, a large part of the biogas potential originates in the agricultural sector, in the form of animal manure and crop residues. It is however more challenging to realise this potential: It is more spread out, and the manure part is diluted with water. Mono-digestion of manure is technically possible, but not economic. Centralised co-digestion schemes with industrial waste and other more energy-rich feedstocks have been shown to enable the realisation of the manure and crop residue potential. A great example of that is Denmark, where farmer formed cooperatives in which a larger number of farmers supplied a central biogas plant with feedstocks, and in return got digestate in the form of liquid bio-fertiliser, easy to spread in the fields. The goods provided, besides the biomethane, was the reduced odour of the digestate, making it possible to co-exist as a farmer with a larger number of neighbouring houses. The nutrient management was also improved, since most of the nitrogen could be stored over winter without greater losses, and then spread in the spring in the growing crop. The nutrient management made it possible for animal husbandry farmers in Denmark to increase their production, and still follow the stricter regulations put in place to protect the groundwater from contamination of farmland nutrient losses.

These benefits of biomethane and the anaerobic digestion process do not have a direct economic value, yet they carry a great socio-economic value. When considering the bigger picture, it makes sense to support it. We therefore strongly urge the Estonian government to consider specific support to realise the biomethane potential of the rural sector in Estonia. The evaluation basis should be life cycle based calculations on the environmental benefits, and also an estimation of other socio-economic benefits, such as job creation, reduction of odour and safeguarding potable water sources in rural areas.

What biomethane production target is feasible? As a suggestion, we argue that it is possible to reach an ambitious target of 235 million m3 biomethane/year by 2030 (8,4 PJ; [Oja A., 2014]. It is the economically feasible potential of waste based feedstocks, complemented with a share of added energy crops in crop rotations that will help secure a future more sustainably operated agriculture. The suggested target is slightly lower than the most ambitious scenario in the recent ENMAK study with 380 million m3 (ENMAK, 2016].

Risk Mitigation

Over-emphasis on technology neutrality: Even though it is important to have technology neutrality as a guiding principle (see below), it is important not to solely rely upon it. This is a major risk, where the balancing guiding principles of Plurality and Holistic view has been undervalued or completely neglected. With technology neutrality as the only guidance, the resulting policies will always benefit just one or two technology choices, which will create a less resilient and versatile solution to the fossil free transport challenge.

Short-term and too late actions: Another lesser but often very likely risk is if the national vision work is 1) delayed and/or 2) short-term in character. As earlier described, this doesn't work with the long lead times and capital intensity of the biomethane industry.

Mismatch goal vs reality: A minor risk is that the set target is not fulfilled, creating frustration among decision-makers and the actors in the biomethane business. If not addressed properly, it might lead to an unconstructive culture of blaming between the business and the decision makers. It is important to have regular control stations, and communicate short-term and mid-term goals that are adapted to market realities, while maintaining a long-term target that is more visionary in character, inspiring all actors involved.

Impact

Effect on biomethane uptake

This action is fundamental in the overall promotion of the biomethane uptake. It is the reference point of all other actions. If done properly, it will make reaching the 3 % target more probable. If not, it might undermine the whole effort. The national vision, attached overarching goals and supporting policies and regulations will be the driver and raison d'être for all other actions.

Costs

Environmental vision, target and implementation work is required by the European union, so that part is here considered cost neutral. The state funding programmes that might result from this action, on the other hand, would be very costly. Goal-oriented requirements coupled with an approval based on the highest scoring bids optimise the societal benefit of the funds. It is more cost-efficient to rely on regulations and market-based instruments such as tax exemptions, but they tend to progress slower compared to directed support, e.g. co-funding of investments and feed in tariffs. The goal should always be to create a self-reliant niche market that also without direct support will be resilient and with capacity to grow in size and become a mainstream market.

Implementation

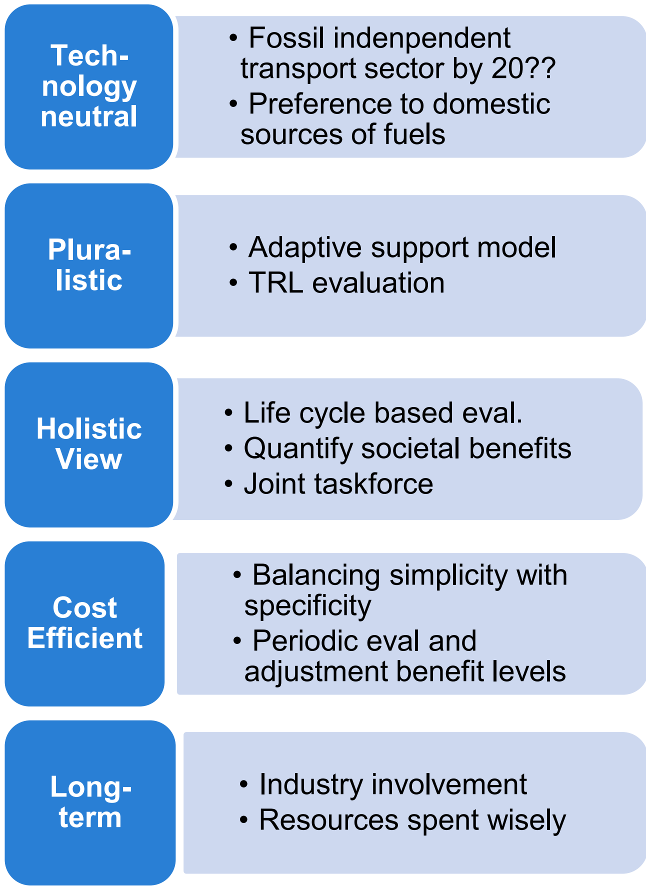


Figure 9: Overview of design principles and their corresponding needs of the National vision for biomethane

Design principles

The design principles of the national vision should strive to be:

I. **Technology neutral:** The vision and target need to encompass all alternatives, current and future ones, therefore the vision and overarching target, which should be set and not changed at a whim, need to be general, without links to specific technologies.

II. **Pluralistic:** All alternatives need to be supported on their own terms, since technologies differ in their needs and potential, both current and future. It is not possible today to foresee what will be working tomorrow. Also, a multitude of technologies and energy carriers are likely to be necessary to replace the conventional fuels of today. Thus, within reason and based on the other design principles, it is justified to support all alternatives, with emphasis on the ones that are commercially available (TRL 9).

III. **Holistic view:** This is to emphasise the new paradigm of the circular economy and the sustainable society. The cheapest is not always the best, when considering the wider picture. That sustainability criteria are life cycle based is important. Biomethane has a unique quality discerning it from the other energy carriers, since the process of anaerobic digestion is the perfect end-station for all biodegradable waste streams. Also, it will facilitate the nutrient management of the future sustainable agriculture, including aspects such as increased soil fertility and soil based carbon sequestration, while at the same time increasing the supply of domestic transport fuels, such as biomethane.

IV. **Cost-efficient:** All alternatives need to be judged based on the cost-efficiency they provide. The basis should mainly be life cycle based carbon dioxide equivalent reductions, but also weighing in changes in eutrophication, acidification and agricultural goods such as increased soil fertility. The low hanging fruits of underused waste streams and residual products should not be overcompensated, it is wise to direct funds to future production technologies, that need more support in order to become competitive in the future. On the other hand, too restrictive, complicated and laborious policies will create unnecessary barriers regarding understanding and simplicity, in addition to increased administrative costs.

V. **Long-term:** All actions need to be implemented with the intention to be in place for at least as long as it takes the biomethane market to reach maturity. The business is complex and capital-intensive, with long lead times. Without certainty, the market actors will hesitate, and the results of the government resources spent will not be optimal. The long-term actions should be sustainable, in the sense that they can be upheld also in times of tighter state budgets, and that they are agreed upon by at least a qualified majority of the elected politicians.

Needs

The following suggestions and guidelines can help realise these design principles:

I. **Technology neutral:** We suggest that the overarching vision for the transport sector would be to set a year by when it in essence should be independent of fossil fuels. Here it is good to make a preference for fuels from domestic sources, creating a driving force for the business to look into business opportunities ahead of more specific targets. Each energy carrier with a current potential need to have its own implementation target, expressed in energy units (PJ).

II. **Pluralistic:** A support model is needed to properly adapt the type and level of benefits for different technologies. The model should be adaptive to the TRL level of the technology. Preference should be given to commercially or close to commercial alternatives. As a small country, it is probably better for Estonia to await the results from abroad of technologies not yet proven. An alternative to that would be joint ventures, e.g. siting a new thermal gasification production facility in Estonia. Here it is possible also to give preference to domestic sources, research and industry.

III. **Holistic view:** The formation of the joint taskforce is giving a clear signal about the importance of considering the wider picture when taking decisions. Implementing life cycle assessment and quantification of societal benefits will create a decision tool at all levels of decision marking

IV. **Cost-efficient:** Most important is to strike a balance between simplicity of the benefit system and its specificity regarding the level of benefit given to different biomethane feedstocks. The growth of the biomethane industry will also lead to changes in the cost of feedstocks, waste streams bringing a gate fee might with time become a commodity. We suggest periodic evaluations of all benefit schedules, in order to accommodate them to the changing business conditions of a growing market.

V. **Long-term:** Securing involvement from industry and the opposition will facilitate the construction of a support model that will be in place for an extended time. Control stations on the way is a good way of checking that it works. A leading principal should be that an adequate, lesser benefit for a long time is better than a disproportionate, greater benefit for a short time.

Stakeholders

The main stakeholders to work directly or indirectly on the formulation of a national environmental vision and associated targets are of course the state actors:

VIII. **The national government**, through its ministries

a. Finance
b. Environment
c. Rural Affairs

IX. **The parliament**, through its committees
    a. Rural Affairs
    b. Economic Affairs
    c. Environment
    d. National Defence
    e. Public transport authorities.
X. The relevant authorities and other relevant state appointed bodies,
    a. Elering
    b. Rural Development Foundation
    c. Environment

Stakeholders working indirectly with the action, by giving feedback on the work of the state:

I. The biogas business,
    a. Business associations
    b. Biogas producers
    c. CNG/CBM distributors
    d. DSOs and TSOs
II. Biomethane users,
    a. Vehicle manufacturers
    b. Private person transport association
    c. Public transport association
    d. Road freighters association
    e. Freight owners association
III. NGOs,
    a. Agricultural association
    b. Environmental organisations
    c. Automotive consumer organisations

The above given lists are not exhaustive.

Timing

There are essentially three phases/groups in the timing of the work (see chart on the first page of this key solution):

IV. **Formation of joint taskforce:** With Elering as secretariat, the Joint taskforce of pertinent Parliamentarian committees and Ministries is formed. The government drafts a work plan, including:
    a. Formulation of a vision and a specific biomethane production target. The vision should include guiding principles, such as the ones mentioned in this.
    b. Formulation of "quick solutions", e.g. changes and additions of supportive regulations
    c. Formulation of a strategy to reach the national biomethane vision and its accompanying target, inclusive of supportive policies
V. **Work of taskforce on national vision:** Includes reference meetings and feedback from external stakeholders, and presentation of the result, hopefully at a significant business event or similar (e.g. National Plan events)
VI. **Work of taskforce on strategy:** Includes reference meetings and feedback from external stakeholders, and presentation of the result, hopefully at a significant business event or similar (e.g. National Plan events)

References

[Oja, A., 2014, p. 32] Oja, Ahto (2014): Local fuel scenarios 2030, Kohalie kütuste stsenaariumid, Eesti Arengufond/Estonian Development Fund, ENMAK 2030, https://energiatalgud.ee/img_auth.php/0/08/ENMAK_2030_kohalike_transpordik%C3%BCtuste_stsenaariumid.pdf.

[ENMAK, 2016, p. 52] Estonian Long Term Energy Action Plan until 2030, Ministry of Economic Affairs and Communication, Tallinn 03.10.2016, https://www.mkm.ee/sites/default/files/enmak_2030_koos_elamumajanduse_lisaga.pdf.

3.3 Customer information

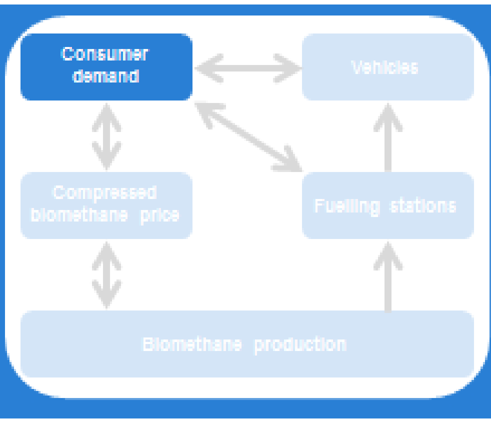
Affordability: ★★★☆☆

Feasibility: ★★★★★

Impact: ★★★☆☆

Speed: ★★★☆☆

Readiness: ★★★☆☆



Solution summary

This key solution looks at ways of overcoming knowledge barriers, where potential users for which CBM would be a positive proposition are reluctant to adopt CBM because of lacking or wrong information. The key principles of this solution consist of delivering useful and trusted information to promising user groups by using adapted methods.

Risk matrix

Solution timing by quarter

Elements	Stakeholders	2016	2017				2018				2019				2020			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Data gathering	Government agencies	■	■			■	■			■	■			■	■			■
Campaign design	Government agencies			■	■			■	■			■	■			■	■	
Conduct campaign	Managing Authority					■	■	■	■	■	■	■	■	■	■	■	■	■
Provide feedback and participate in campaign	Vehicle users					■	■	■	■	■	■	■	■	■	■	■	■	■

Understanding

Mechanism

Having a positive case on paper, be it financial or technical, does not necessarily mean that CBM will be adopted. This key solution addresses this problem: It proposes to organise an information campaign, using a number of tools that will be discussed below. Note that the customers referred to in this key solution are both individual (private car owners) and collective (bus, taxi, car fleet managers).

We will first look at some of the reasons why a lack of or the wrong kind of information can reduce the adoption of CBM in transport through two examples: Range anxiety and purchase versus ownership costs. Having the right kind and sufficient amount of information would overcome these obstacles and help increase CBM adoption.

Range anxiety

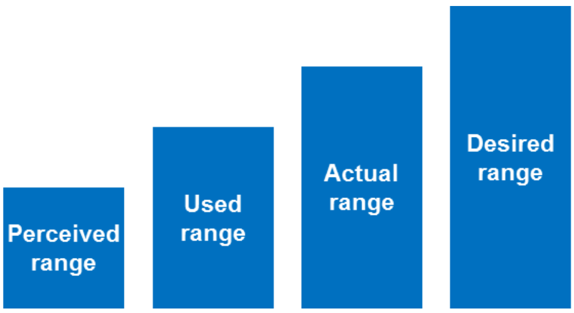


Figure 10: The various types of range

Range anxiety is a reflection of the differences between the different types of range illustrated in Figure 10. It is important to note that the range is a combination of the distance a vehicle can achieve with a full tank and the correspondence of station coverage and the journeys of a given vehicle. The four types of range are:

I. **Perceived range:** This is the range (potential) users think a vehicle has.
II. **Used range:** This is the range that covers the activities of a given user (i.e., their (daily) kilometrage and where it takes place).
III. **Actual range:** The actual performance of vehicles.
IV. **Desired range:** What user say they want.

For many users, the relation between these ranges is shown in Figure 10: The lack of information about the location of the stations and the lack of information about vehicle performance make them think that they won't be able to perform their usual tasks. The fact that they might not have a detailed, numbered measurement of their activities also plays a role in this thinking. The fact that the desired range is the highest is due to the fact that many users base their desires on the most extreme activity they might think of, such as a long trip in a region where no CBM stations are available, even if such activities do not actually take place. Having access to detailed, accessible, reliable information about car performance, station location, and their own use patterns would alleviate these differences and decrease range anxiety. This information could be collected into a phone app that would be developed and certified by a trusted entity, for example.

Purchase versus ownership costs

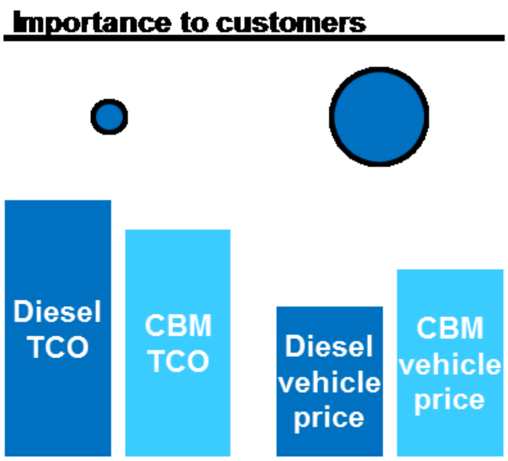


Figure 11: The relative importance of TCO and vehicle price

Another information gap issue is how customers look at financial information (see Figure 11): A more favourable business case for CBM (compared to diesel, for example) on a Total Cost of Ownership (TCO, which takes into account the purchase price, vehicle maintenance, and fuel price) is not a compelling enough argument for some customers, as they give much more weight to the vehicle purchase price, which puts CBM vehicles at a disadvantage. The reason they give more weight to the vehicle purchase price is mainly that this is the only concrete and reliable information they have, as it is readily available. Providing customers with tools that they trust, that are tailored to their situation, and that they can understand, would increase the weight of the positive TCO argument. It would also help with the other factor at play here, namely the fact that some customers strongly favour a reduced upfront price, even if they know it is less favourable over the ownership time of the vehicle. This reduction would happen because customers would have data at their disposal that would show them how much they leave on the table. Note that this barrier does not apply if the price of the CBM vehicle is lower than its diesel equivalent.

Experiences abroad and possible variants

This section gives a few examples of communication tools used in other countries (mostly Sweden).

One way to provide the information discussed in the previous section is through a website, such as the site of the Natural Gas Vehicle Association, which , in addition to providing general information about natural gas in vehicles, also has a map of all natural gas stations in Europe. I t also provides users with directions between addresses in Europe, highlighting stations along the way. [NGVA, 2016] This website could be used directly in communication efforts, or it could be the basis of a specific app or website developed for the Estonian market.

Other examples of web-based knowledge portals are the following:

- Biogas (Biogasportalen)
- Biofertiliser (Biogodsel.se)
- NGVs (gasbilen.se)

Such efforts do not necessarily have to come from institutions, they can also come from motivated individuals. An example is http://biogasakademin.se/, which was started by a hospital employee on his free time and motivated by trying to convince his employer to start collecting their food waste for producing biomethane. Such an effort can be viewed favourably by other similarly-minded citizens, as well as institutions, and helps making the messages more easily accepted.

Another such example is a hotel manager in Tallinn who is also a CNG/CBM enthusiast and is the founder and moderator of a Facebook page (https://www.facebook.com/metaaniautoklubi/) providing news and information about CNG/CBM.

Risk mitigation

The main risks for this key solution are missing potential users and negative anchoring. Both are relatively unlikely to be widespread and have a relatively low impact.

Missing potential users consists of not reaching all the stakeholders that would be positively swayed by an information campaign. To overcome this, it is important to have a proper identification of promising user groups, as discussed below.

Another way to minimise this risk is to use the national platform discussed in Section 2.1

Negative anchoring occurs when a party uses (wrong) arguments that are accepted because they are the first ones to be presented. Such arguments in the case of CBM vehicles could be range anxiety or a link to fossil natural gas and its negative connotations (climate impact, countries of origin, etc.). To overcome this, it is important to be proactive and state positive arguments first, in order to frame (or anchor) the situation in a way that is favourable to CBM. Engaging with Non-Governmental Organisations (NGOs) and the private sector so that they contribute positively instead of opposing CBM in transport is also an option. This can happen with the national platform discussed in Section 2.1

Impact

Effect on biomethane uptake

An actual quantification of the effects of a communication campaign/customer information is difficult. This is because direct effects cannot be measured directly. Nevertheless, the impact is relatively important, as a lack of information could sink a key solution.

Costs

Costs can vary quite a bit, depending on the choice of medium. Nevertheless, focusing efforts, as discussed in the Design Principles below can help alleviate costs and increase efficiency.

Implementation

Design principles

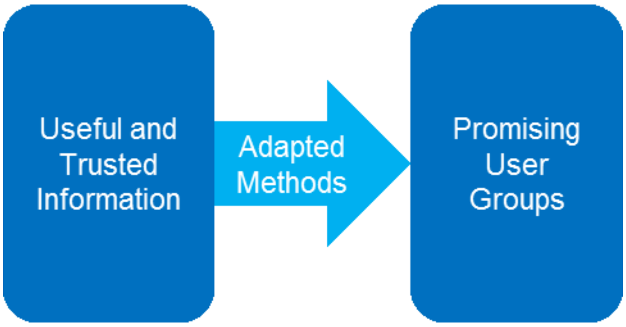


Figure 12: Design principles of a successful information campaign

Figure 12 shows the design principles of a successful information campaign. Such a campaign consists of gathering useful information, and using adapted methods to reach promising user groups.

Useful and trusted information:

The information elements that need to be gathered are the following:

i. **Business cases:** Without a positive business case, the adoption rate of CBM in transport will be very low. The identification of positive business cases should be made with a Total Cost of Ownership (TCO) tool. This tool should then be made available to customers. It will need to be trusted by users, tailored to their situation, and that easy to understand. This tool could be based on the Excel tool already made available for municipalities for busses. The challenge here is not necessarily the data or capturing all nuances. Rather, accessibility and clarity are key.
ii. **The fact that CBM vehicles can satisfy all the needs of their users:** This essentially consists of gathering and arranging data to alleviate range anxiety issues, as well as fears about maintenance. In addition to data gathering, it is also important to construct cases/stories users can relate to, in the form of usage patterns and how they are satisfied. For example, they could describe how a given city manages its CBM bus fleet, or how a driver commuting between two cities manages her commute.
iii. **Energy independence and impact on the local economy:** Gather data and construct relatable stories on how using CBM will allow Estonia reduce its energy dependence on other countries and create job opportunities. This can help support the argument that investing in CBM is making Estonia an innovative country. This can also include information about how CBM can help recycle the waste produced by citizens into something valuable.
iv. **Impact on local air quality:** Gather information on how much of an impact on local air quality CBM can have. This can be supplemented by studies in countries (such as Sweden, Italy, or the Czech Republic) that have a significant uptake of CNG/CBM.
v. **Climate change and sustainability impact:** This element consists of gathering detailed and trusted information about the sustainability of CBM, in particular regarding climate change. It is important that the data is as solid as possible and covers the whole life cycle, since customers that are sensitive to this issues are also likely to be knowledgeable about the subject and might compare it to other alternative forms of transport (such as electric vehicles and public transport).

Adapted methods:

The main elements of an adapted methods are the following:

i. Use a **common base** that consists of the information discussed above, together with a **focus on the elements** that are most important to the targeted group. This will ensure that the right information is delivered to the right group, while being consistent and giving the opportunity for synergies and dialogue.
ii. Use **attractive signage**: Using catchy and attractive signage on CBM vehicles, together with an intriguing branding leads to better awareness of CBM. This branding would go to the exterior and interior of vehicles. It can also apply to flyers that passengers of busses and taxis can take with them (or screens inside these vehicles). Such flyers could also be distributed in highly frequented areas such as malls. The intriguing branding can also lead people to look up the chosen name, which would then bring them to a website that would inform them further. This requires a careful choice of branding, combined with a web search optimisation that ensures that the website with information about CBM is among the first results of a search.
iii. The information should not only be broadcasted, but should be part of an **ongoing dialogue** that allows tailoring the kind and form of information towards what customers are looking for.
iv. Use **champions** to promote CBM. Focussing on a number of champion users (i.e. enthusiastic users who will promote CBM in their network) within a targeted group by tailoring the discussion towards them and empowering them to champion the cause of CBM would be both efficient in terms of money and impactful, as champions would convince their peers better than an external organisation. This can also include champions from other countries with stories of success.
v. **Signal commitment:** Various government levels and agencies should show that they are committed to CBM. They could do so by using the signage discussed above. This would increase customer trust in the information they receive about CBM.

vi. Information should be **accessible and simple**: Doing so will ensures a higher degree of buy-in by the targeted customers.

Promising user groups

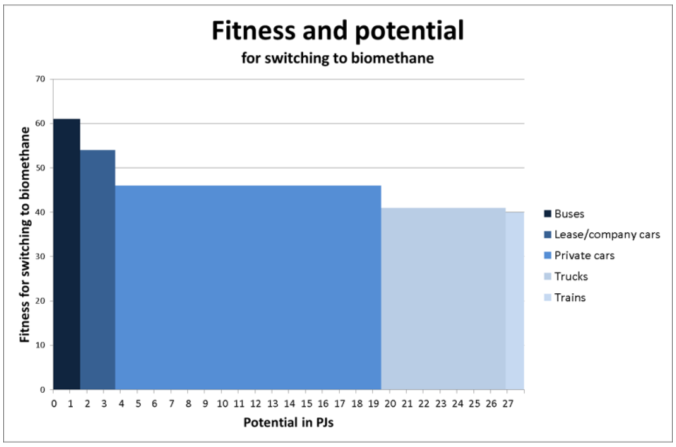


Figure 13: Demand-side merit order, from Text Box 4.6

There are two dimensions to the identification of promising users groups (sorted by vehicle type): How big they are (in terms of energy use) and how likely they are to switch to CBM. This is illustrated in Figure 13, where the horizontal axis shows the energy use of various vehicle segments. The vertical axis shows how fit/likely they are to switch to CBM, on a 70-point scale that takes into account the potential, the influencability, the suitability, and the timing of each segment. See Text Box 4.6 for more details.

Needs

The main needs of this key solution are explained in the design principles. They consist of having the right data to obtain the useful and trusted information discussed above, of the adapted methods to transfer the information to the target groups, and of a thorough identification process to identify the target groups.

Stakeholders

The main stakeholders are the National Government and it agencies that will conduct the information campaign, vehicle users that are both target groups and potential broadcasters/champions. The latter also holds for fuel station operators.

Timing

The key solution will require a preparation by the government agencies in charge of performing the communication strategy. This will require gathering the information discussed above, as well as properly designing methods and identifying target groups. Once this design phase is completed, the agencies should switch to an execution mode (with the participation of vehicle users) which requires a periodic refreshing of the information and methods, based on feedback and evaluations. It can also involve renewed estimates of the promising user groups.

Sources

[NGVA,2016] NGVA, 2016, http://www.ngva.eu/get-directions.

3.4 Roll-out strategy methane fuelling stations

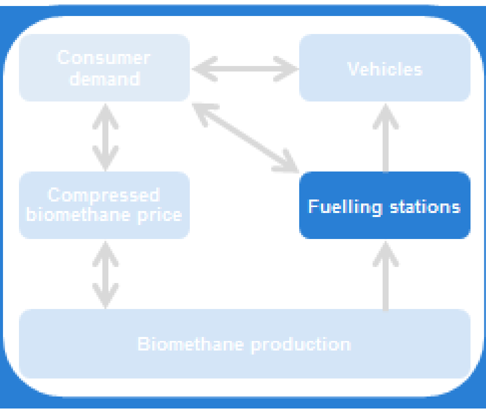
Affordability: ★★★☆☆

Feasibility: ★★☆☆☆

Impact: ★★★★★

Speed: ★☆☆☆☆

Readiness: ★★☆☆☆



Solution summary

Current solution gives an overview where should be established new CNG/CBM fuelling stations. According to ENMAK scenarios (Knowledge economy or BAU) there is a need for 21 or 27 new public fuelling stations. Key Solution should emphasize that the vision and number of new fuelling stations could be ideally more far-seeing and greater than just covering the 3% biomethane target that corresponds minimum 21 or 27 fuelling stations. Therefore totally up to 50 new fuelling station locations were suggested under this Key Solution.

Risk matrix

Solution timing by quarter

Elements	Stakeholders	2016	2017				2018				2019				2020			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Disclose CNG annual volume sales	Statistics Estonia, Elering, MoEAC,	X																
Roundtable (part of National platform)	All stakeholders	X																
Interest mapping (MS Excel tool)	All stakeholders	X																
Series of (NGV) events for CNG/CBM/L-CNG market current and future stakeholders (part of National platform)	All stakeholders			X	X	X	X	X	X	X								
Introducing the idea to stakeholders of joint proposal to Horizon 2020	Chosen stakeholders	X	X	X														
Construction of new stations (ongoing process)	Funded stakeholders by EIC (3 million €)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Understanding

Mechanism

Natural gas is a major fuel for multiple end uses and is increasingly discussed as a potential pathway to reduced oil dependence for transportation as CNG. It is known that fuelling stations are connectors between demand and supply. In total 21 cities of Estonia has natural gas grid, that surrounds approximately 750 000 people, so there will be a potential market for CNG/CBM demand. Based on "Analysis of the biomethane resources deployment of Estonia[6]" there are totally 437 fuelling stations in Estonia and 158 of them are closer than 200 m to natural gas grids (including A-category gas grids - 0,1 bar).

Table 1. Number of fuelling stations in Estonia and their distance from natural gas grid (considering closeness to A, B, C and D-category)

Distance from natural gas grid (m)						
Operator	Up tp 200	201 - 300	301 - 500	501-1000	>1000	In total
Statoil	31	3	2	3	13	52
Neste	28	2	4	3	14	51
Alexela	25	1	2	2	29	59
Olerex	18	1	2	2	27	50
Lukoil	10	2	3	2	20	37
Premium 7	8	1	2	3	18	32
Euro Oil	4	1	2	1	10	18
MahtaKütus	3	-	-	-	5	8
Favora	2	2	-	-	3	7
Krooning	2	1	-	-	10	13
Others	27	6	5	6	66	110
In Total	158	20	22	22	215	437
Proportion, %	36	5	5	5	49	100

Notice: Since June 2015 Estonian petroleum company Olerex have purchased the Estonian assets of Russian oil giant Lukoil.

Based on information by Elering AS gas technology specialist[7] only B (0,1-5 bar), C (5-16 bar) and D-category (over 16 bar) gas grids are technically important for CNG stations. Therefore existence of A-category gas grids (up to 0,1 bar) have been amended to minimum as possible on the following zoomed region maps.

Current Key Solution brings out the most optimum locations for new possible fuelling stations network. The following rastermap (see: Figure 1) was created in coordination with Reach-U and Teede Tehnokeskus AS. This map gives a general overview about the density of regular fuelling stations per 25 km^2, traffic frequency (vehicles/24h) and location of D-category gas grid.

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[6] http://www.arengufond.ee/wp-content/uploads/2015/10/Eesti_biometaani_ressursside_kasutuselev%C3%B5tu_anal%C3%BC%C3%BCs.pdf

[7] Jüri Viirmaa, gas technology specialist at Elering AS

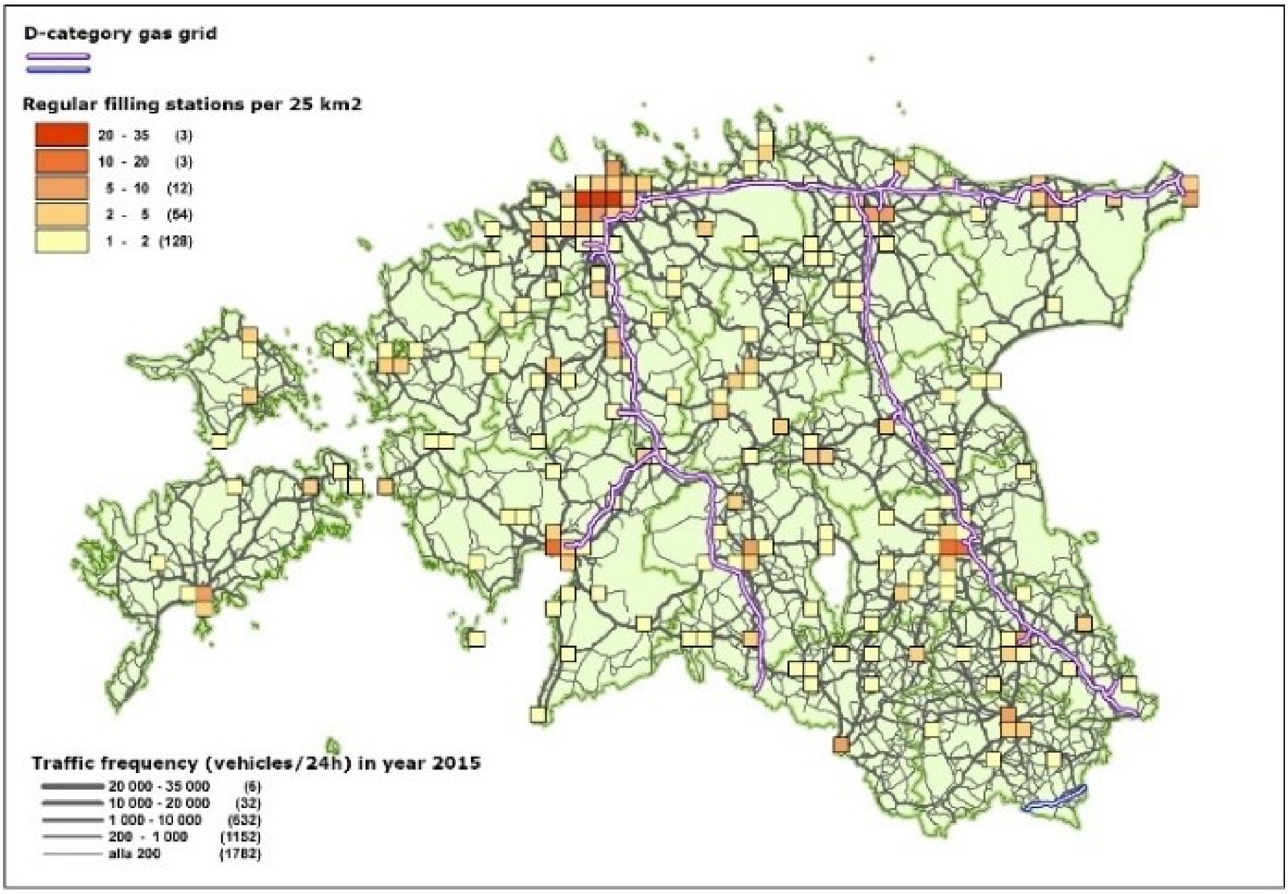


Figure 14. Map of Estonia with D-category gas grid, traffic frequency and regular fuelling station locations.

Based on map (Figure 14) we can see that the biggest density of regular fuelling stations locates in Tallinn where are in total 75 regular fuelling stations in most dense areas (3 x 25 km^2) area. In Tartu there are 3 0 regular fuelling stations in most dense areas (per 2 x 25 km^2) and in Pärnu there are 12 regular fuelling stations in most dense area per 25 km^2.

In order to be more precise, zoomed maps of important regions were created for 3 counties and 7 cities, where are the most comprehensive, mostly B and C-category gas grid network and highest population in Estonia (Figure 2). Therefore selected counties are: Harjumaa, Tartumaa, Ida-Virumaa and cities are: Tallinn, Tartu, Narva, Pärnu, Rakvere, Kohtla-Järve linnastu and Viljandi.

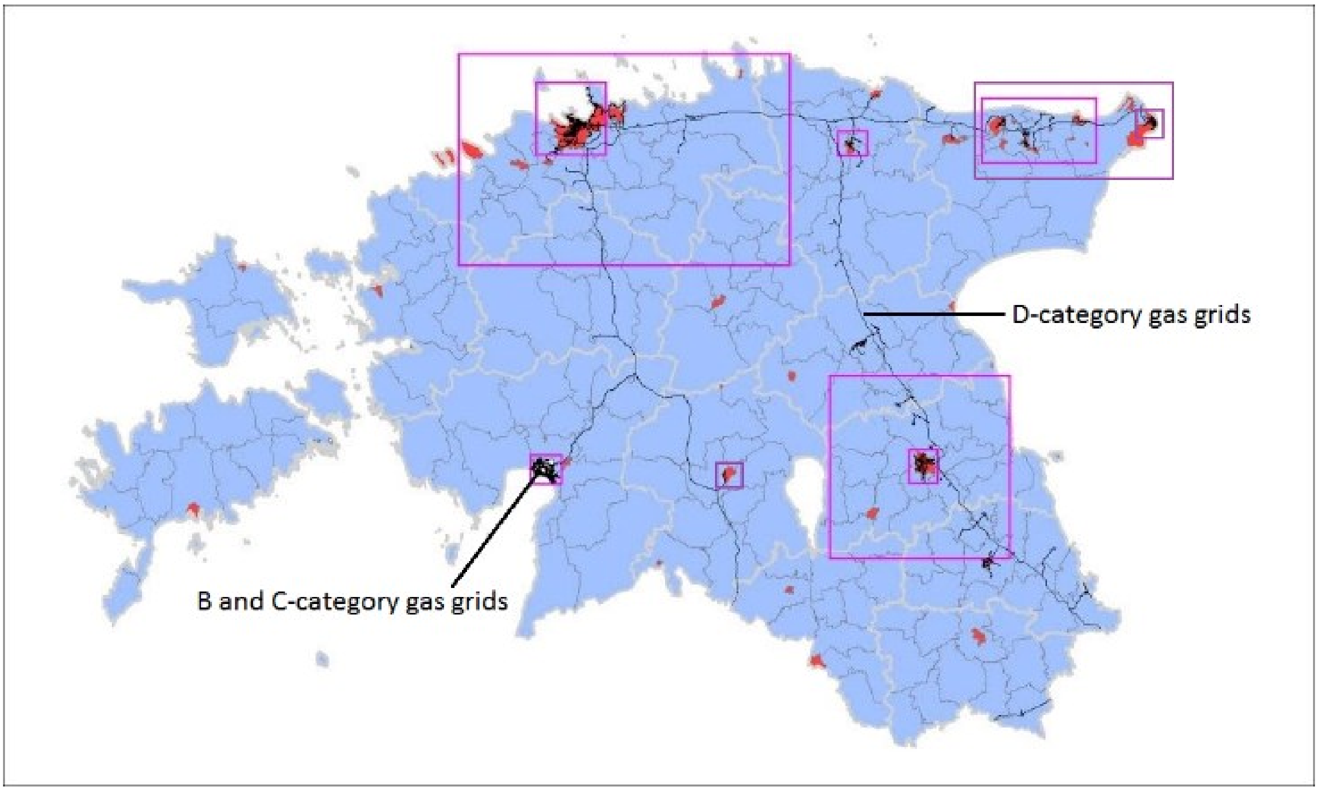


Figure 15. More specific areas (in purple squares) where are most comprehensive, mostly B and C-category gas grid network and highest population.

Suggested and more specific criteria for optimal loc ation for new gas fuelling stations (in counties and cities) are following:

In case of counties:

- Natural gas grids (mostly B, C and D-category);
- All current petrol/diesel fuelling station operators considering their proximity to gas grids with existing CNG fuelling stations;
- Traffic frequency on main roads in counties, categorized by passenger vehicles, trucks and buses (long distance pattern).

In case of cities:

- Natural gas grids (mostly B, C and D-category);
- All current petrol/diesel fuelling station operators considering their proximity to gas grids with existing CNG fuelling stations;
- All main roads (streets) in the cities (short distance pattern). It should be mentioned that in cities there is not possible to display traffic frequency (categorized by vehicles) at all, because Teede Tehnokeskus AS measu res that kind of statistics only on main roads in counties, not in cities. Despite that the main roads (streets) in the cities reflects quite well traffic frequency.

Also off-grid locations are mapped (based on traffic density, main roads and area population).

On the following maps mostly B and C category gas grids are depicted and existence of A-category gas grids are minimized as minimum as possible, but to a certain extent A-category still exists on the maps. In other words, existence of suitable links between gas grids are big enough to map out these 50 new locations for new stations. Thus if there will be enough consumption of CBM then it can't be excluded that some fuelling station will be constructed onto the A-category gas grid (as a backup solution for CBM).

Launching 3% of biomethane to Estonian transport it is needed to establish 21 or 27 new fuelling stations according to ENMAK scenarios.

ENMAK Knowledge economy scenario for quantifying the 3% goal - this would correspond in 0,9 PJ using 27,5 million Nm³ (19,1 million kg) biomethane in Estonian transport in 2020.

ENMAK BAU scenario for quantifying the 3% goal - this would correspond in 1,2 PJ using 35,9 million Nm³ (24,9 million kg) biomethane in Estonian transport in 2020.

It should be also emphasized that the vision and number of methane fuel based fuelling stations could be ideally more far-seeing and greater than just covering the 3% target. Therefore it is been selected in total up to 50 new fuelling station locations in Estonia.

Meaning of icons that are depicted on the zoomed regions maps:

EE – already existing CNG fuelling station (Eesti Gaas AS); **SC** – Soon to be constructed CNG/CBM or L-CNG fuelling station (Alexela Group); **NEW** – new public possible CNG/CBM/L-CNG fuelling station; **NEW PR**. – new private possible CNG/CBM/L-CNG fuelling station, mainly *slow-fill* stations (near to bus depot); **OFF** – new public possible off-grid CBM/L-CNG station

- Harjumaa – 6 new stations (rastermap picture)
- Tartumaa – 3 new stations (rastermap picture)
- Ida-Virumaa – (rastermap picture)
- Tallinn - 15 new stations (rastermap picture)
- Tartu – 6 new stations (rastermap picture)
- Narva – 2 new stations (rastermap picture)
- Pärnu – 2 new stations (rastermap picture)
- Rakvere – 1 new station (rastermap picture)
- Kohtla-Järve linnastu – 3 new stations (rastermap picture)
- Viljandi – 1 new station (rastermap picture)
- Off-grid locations – 11 new stations (rastermap picture)

Rastermap pictures should be viewed in parallel with interactive map link of fuelling stations.

The final choice of possible location of new fuelling station in some certain area (where are highest density of regular fuelling stations near to gas grid, for example: *3 regular fuelling station within a radius of 200 m)* is rather indicative and does not necessarily mean particular site for a new fuelling station if there are many different regular fuelling stations close to each other.

The most reasonable is to build additional new fuelling stations to these properties which belongs to current fuelling station operators but it requires definately specific separate study whether these chosen regular fuelling stations have enough space for CNG/CBM/L-CNG refuelling equipment, is there enough customers market, enough electrical power supply and operators interest uptaking CNG/CBM/L-CNG as a new type of fuel to its fuelling station network and which terms and conditions is it possible.

In order to obtain more information about the specific properties, it is strongly suggested to work in parallel with Land Board cadastral map, e-land register database and interactive map link of fuelling stations.

Experiences abroad and possible variants

Swedish experience is that expanding a current (strategically located) petrol/diesel station with (bio)CNG as a new fuels, will be much more effective than building a new “gas only” station. The "gas only" solution is the case that Eesti Gaas AS has implemented so far with their 5 CNG stations. That could be also the reason why CNG consumption in Estonia have been much less than expected. "Analysis of the biomethane resources deployment of Estonia" analyzed 23 EU member states average statistics about vehicles per regular fuelling station and this number is 2500 vehicles per station. In Estonia this number is 1614 vehicles per station, thus it is 65% less compared EU average number. Considering Estonia's relatively low population the establishment of new "gas only" service stations is absolutely unjustified because the number of existing fuelling stations is already too high in comparison with other EU countries and in Estonia the availability of CNG/CBM must be ensured via existing fuelling stations network.

Risk Mitigation

Providing 3% of biomethane to Estonian transport it is needed to construct 21 or 27 new fuelling stations according to ENMAK scenarios. Current support measure by EIC could cover 17 – 21 new station construction, thus additional funding for approx. 30 new fuelling stations is needed if Estonia consider to follow greater scenario, up to 50 new stations. The main risk is that there is lack of enough funding sources by state for constructing these additional 30 stations. If there is not enough funding then there is a risk that there will be no interested operators/investors (stakeholders). On the other hand, some of the current petrol/gasoline fuelling stations operators are ready to invest in CNG/CBM/L-CNG fuelling station construction without any financial support only if there will exist enough demand for this fuel. Creation of consumption and demand of CNG/CBM/L-CNG is important.

Another risk can be shortage of land to install CNG/CBM/L-CNG fuelling facilities to existing fuelling stations. The mitigation measure can be providing state or municipal land, if there is available such land, to CNG/CBM station builder either with market price or reduced price or to agree on long term land leasing contract.

Impact

Effect on biomethane uptake

Based on ENMAK scenarios:

- 21 fuelling stations could supply 0,9 PJ - 27,5 million Nm³ (19,1 million kg) of biomethane
- 27 fuelling stations could supply 1,2 PJ - 35,9 million Nm³ (24,9 million kg) of biomethane

More far-seeing and greater scenario:

- 40 fuelling stations could supply 1,78 PJ - 52,5 million Nm³ (36,5 million kg) of biomethane
- 50 fuelling stations could supply 2,23 PJ - 65,6 million Nm³ (45,6 million kg) of biomethane

Anyhow, any development concerning infrastructure of methane fuels contributes in a positive way to biomethane sector.

Implementation

Design principles

Rather complicated to evaluate the implementation process of new fuelling stations, but it could be estimated as following:

- 2017 I q – 3 new stations (Alexela Group);
- 2017 II q – 2017 IV q – 10 new stations;
- 2018 I q – 2018 IV q – 10 new stations;
- 2019 I q – 2019 IV q – 10 new stations;
- 2020 I q – 2020 IV q – 10 new stations.

Means for this are following:

- Disclose CNG annual volume sales
- Organizing a roundtable (part of National platform)
- Interest mapping (MS Excel tool) download link
- Organizing series of (NGV) events for CNG/CBM/L-CNG market current and future stakeholders (part of National platform)
- Finding additional finances (joint proposal with chosen stakeholders)
- Number of new fuelling stations is continuously rising

Needs

- Disclose CNG annual volume sales

Currently there is a lack of information about CNG volume sales in Estonia. Statistical numbers of CNG should be available as petrol, diesel and LPG annual sales of volume[8]. This minor change could be a one indirect incentive for market development. CNG annual volume sales should be available for stakeholders to see the market development. In the future it should contain CBM volume sales as well. This could be done with no costs. Elering or MoEAC should simply notice Statistics Estonia to collect annual volume sales of CNG by EestiGaas AS and from other stakeholders (i.e Alexela Group) that are going to be shortly CNG seller in the market as well.

- Organizing a roundtable (part of National platform)

Better transparent approach should be applied. The process of notification and disclosing financial measures by EIC and MoEAC should be much better concerning the upcoming second application round for construction of CNG/CBM/L-CNG fuelling stations. Very important is to organize roundtable meeting to current leading fuelling station operators where will be held detailed discussion of second round support measure for CNG/CBM/L-CNG fuelling station construction and where will be introduced State long-term vision and strategy of CNG/CBM/L-CNG uptake. The approach to stakeholders must include more quality and personalized communication than previously have been done.

- Interest mapping (MS Excel tool)

After roundtable the next step is to map most possible interested stakeholders and t arget groups (current filling station operators/local a uthorities/gas associations) about methane fuel station construction. Therefore a MS Excel tool for mapping interest of building CNG/CBM/L-CNG stations to specific areas was created. Tool should be forwarded to targetgro ups. Tool should be uploaded parallel also to EIC website in the appropriate webpage section.

- Organizing series of (NGV) events for CNG/CBM/L-CNG market current and

[8] https://www.stat.ee/34173

future stakeholders (part of National platform)

NGV market equipment demonstrational and presentational series of events should be organizedas well during creation of national platform connecting all stakeholders. Quite a big problem for final customer/consumer of CNG/CBM/L-CNG is availability of vehicles – the variety of CNG vehicles choice in Estonia is very poor. Very big issue is how to involve car-dealers/importers and CNG/CBM/L-CNG market equipment providers and fuelling station operators in this process. Market demonstration events for vehicle dealers/importers and equipment providers to increase the willingness to sale NGVs would be great outcome and solution. The objective of series of events is to offer additional opportunities for industry players, political decision makers and stakeholders to cross-link, in order to advance the market development of methane gas as a fuel in Europe.

For example: Applicant (Elering) applies via EIC Environmental program a subsidy coverage for a set of info-days in 10 cities in Estonia. Preparing and compiling application takes 5-6 months. Cooperation with Estonian Biogas Association (EBA) should be considered at this point because EBA has already started (few years ago) application to EIC Environmental program via https://kikas.kik.ee/ web platform.

- Finding additional finances (joint proposal with chosen stakeholders)

Either way Estonia needs more funding for construc tion of additional fuelling stations to launch 3% of bi omethane considering the predetermined amount o f finances that is intended by EIC (3 million €). Ther efore it would be an issue to consider making a joint proposal with selected stakeholders to TEN-T Horizon 2020, a two staged call under *Smart, green and integrated transport* pilar (*MG- 7- 2 – Optimisation of transport infrastructure including terminals*. Stakeholders interest for making a joint proposal should be discussed at roundtable and there is also a question-box in the interest mapping MS Excel Tool, where stakeholder can show their interest to be a partner (contributing financially/non-financially) of joint project proposal.

- Number of new fuelling stations is continuously rising

Construction of new fuelling stations is proceeding as planned

Stakeholders

All:

- Regular fuelling stations operators;
- Municipalities/local authorities;
- Public transportation service operators;
- Car dealers/car importers;
- Natural gas operators;
- Gas associations;
- Biogas/biomethane producers.

Timing

There essentially six phases/groups in the timing of solutions (see chart on the first page of this key solution):

- Disclose CNG annual volume sales – *IV quarter 2016*
- Organizing a roundtable (part of National platform) – *IV quarter 2016*
- Interest mapping (MS Excel tool) – IV quarter 2016 (part of roundtable event)
- Organizing series of (NGV) events for CNG/CBM/L-CNG market current and future stakeholders (part of National platform) – *II quarter 2017 – IV quarter 2018*
- Finding co-partners for additional funding project (joint proposal with chosen stakeholders) – IV quarter 2016 (introducing the idea at roundtable, interest mapping tool gives also feedback of this idea by stakeholders) – II quarter 2017
- Construction of new stations – ongoing process and continuously rising since IV quarter 2016 - IV quarter 2020 (minimum 21 new fuelling stations, maximum 50 fuelling stations), depends will joint-proposal application (Key Solution 3.5) gets funding or not and how ambitious is the joint-application

References

[1] Web: http://www.arengufond.ee/wp-content/uploads/2015/10/Eesti_biometaani_ressursside_kasutuselev%C3%B5tu_anal%C3%BC%C3%BCs.pdf

[2] Jüri Viirmaa, gas technology specialist at Elering AS

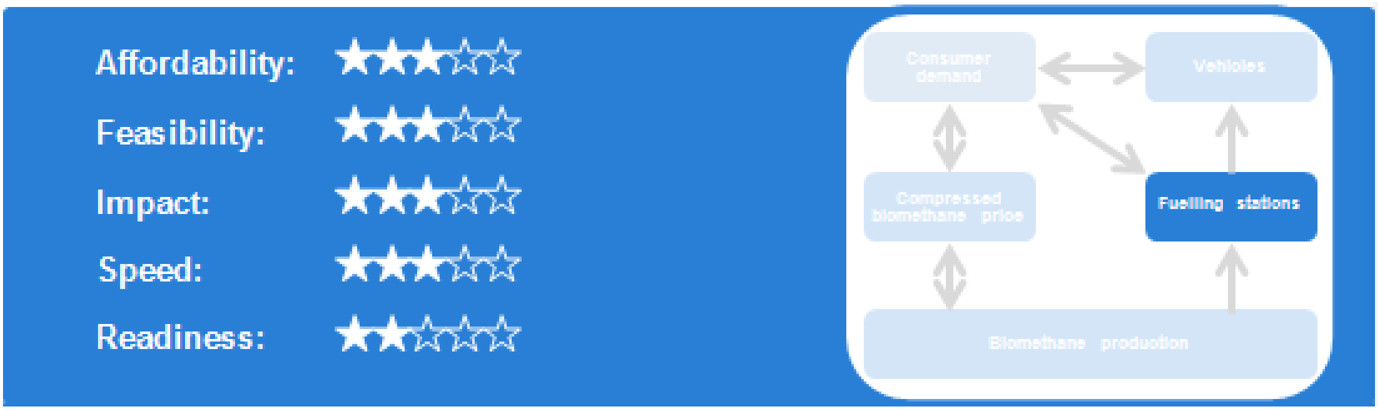
[3] Web: https://www.stat.ee/34173

3.5 Supporting roll-out fuelling stations

Solution summary

No matter what, Estonia needs more funding for construction of additional fuelling stations to launch 3% of biomethane considering the predetermined amount of money that is intended by EIC (3 million €). There are two options for additional funding – compile a joint proposal application to EU Framework Programme with local stakeholders or make a joint cross-border proposal to EU Horizon 2020 or CEF Transport creating crossborder CNG/CBM/L-CNG fuelling station network in Baltic states via TEN-T core roads.

Risk matrix



Solution timing by quarter

Elements	Stakeholders		2017				2018				2019				2020			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Roundtable (part of National platform)	All local stakeholders	■																
Interest mapping (MS Excel tool)	All local stakeholders	■																
Start communication with Latvia and Lithuania natural gas transmission service providers (Elering) and Ministries (MoEAC)	JSC Latvijas Gāze, Ministry of Transport, NeoZeo AB, AB Amber Grid, SG Dujos, Ministry of Transport and Communications	■	■															
*Under the premise that in both cases (local or cross-border case) there are positive results and attitude by stakeholders then start to prepare proposal to submit an application	Chosen stakeholders who shows an interest of (joint)project proposal to EU Framework Programme			■														
*Submit application	Chosen stakeholders				■													

Understanding

Mechanism

Local approach

<u>Taking into account:</u>

- ENMAK scenario;
- Maximum level of financial support (35% of eligible CAPEX costs);
- Investment costs per current methane fuel stations;

Experiences abroad and possible variants

There have been two very good experiences under EU's TEN-T Programme contributing in CNG fuelling stations infrastructure. One was lauched on the on the northern Sweden's main road network (Härnösand and Umeå). Other was called GREAT (Green Region for Electrification and Alternative fuels for Transport) during which three LNG/CNG stations, over more than 900 km of the Scandinavian-Mediterranean Corridor and the core road network (in Germany, Sweden and Denmark) were established.

Risk Mitigation

The main risk is that there will be no co-partners (stakeholders) from local market and from Latvia and Lithuania as well.

Impact

Effect on biomethane uptake

In Estonia, it is quite realistic and possible to provide by 2020 approx. 0,9 PJ – 1,2 PJ (27,5 million Nm^3 - 35,9 million Nm^3) of biomethane to the local market through cooperation between State and different stakeholders.

Costs

For local market it is needed 700 000 – 1 750 000 € additional funding, if application and its budgetary scheme for new fuelling stations construction proposal to EU Framework Programme is based on the maximum level of support of 35% of eligible CAPEX costs and current Investment costs per methane fuel stations in Estonia.

Implementation

Design principles

For both cases (local or cross-border) there will be available financial support by EU, specifically a two staged call under *Smart, green and integrated transport* pillar called *"MG-7-2-Optimisation of transport infrastructure including terminals"*.

Needs

- Organizing a roundtable (part of National platform)
- Interest mapping (MS Excel tool)

- Start communication with Latvia and Lithuania natural gas transmission service providers (Elering) and Ministries (MoEAC).

Stakeholders

In case of local approach

All local stakeholders who show interest during roundtable, and the interest mapping (National platform events, kick-off meeting)

In case of cross-border approach

- Elering (ESTONIA)
- JSC Latvijas Gāze (LATVIA); rather small but very important stakeholder – Neo Zeo AB
- Ministry of Transport (LATVIA)
- AB Amber Grid (LITHUANIA); rather small but very important stakeholder – SG Dujos
- Ministry of Transport and Communications (LITHUANIA).

Timing

There are essentially five phases/groups in the timing of solutions (see chart on the first page of this key solution):

- Organizing a roundtable (part of National platform) – *IV quarter 2016*
- Interest mapping – IV quarter 2016 (part of roundtable event)
- Start communication with Latvia and Lithuania natural gas transmission service providers (Elering) and Ministries (MoEAC) – *IV quarter 2016 – I quarter 2017.*

*Under the premise that in both cases (local or cross-border case) there are positive results and attitude expressed by enough stakeholders, then start to prepare a proposal to submit an application to the second deadline call *(19 October 2017) of MG-7-2-Optimisation of transport infrastructure including terminals".* – start to compile project application II quarter 2017. As mentioned before contacting with Estonian Research Council should be considered at this point because this institution has great experience with different EU Framework Programme projects.

*Submit application – *III quarter 2017*

If it seems there is not sufficient preparation time to meet the first deadline, then it should be considered to prepare a proposal anyway and submit this application in later future calls under Horizon 2020 or CEF Transport.

References

[1] Web: https://www.riigiteataja.ee/akt/125112015009

[2] Web: http://ec.europa.eu/transport/sites/transport/-files/themes/infrastructure/ten-t-guidelines/doc/ten-t-country-fiches/et_en.pdf

[3] Web: http://ec.europa.eu/transport/themes/-infrastructure/ten-t-guidelines/doc/ten-t-country-fiches/lv_en.pdf

[4] Web: .http://ec.europa.eu/transport/themes/-infrastructure/ten-t-guidelines/doc/ten-t-country-fiches/lt_en.pdf

[5] Interview with Kristine Rugele (NeoZeo AB), on 9.09.2016.

[6] Interview with Vidas Korsakas (SG Dujos), on 21.09.2016.

[7] Web: http://cngeurope.com/eus-ten-t-programme-will-co-finance-with-over-e2-million-cng-fuelling-stations-in-sweden/

[8] Web: https://ec.europa.eu/inea/en/connecting-europe-facility/cef-transport/projects-by-country/multi-country/2014-eu-tm-0477-s.

3.6 Support mechanism grid connection

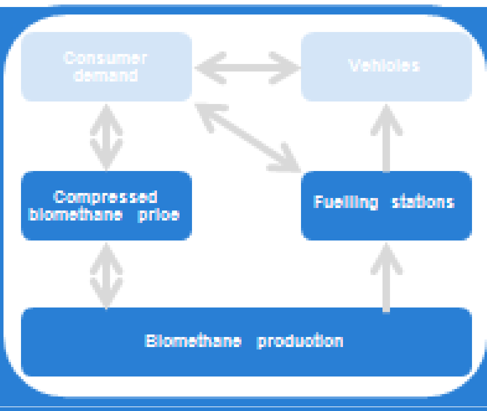
Affordability: ★★☆☆☆

Feasibility: ★★★☆☆

Impact: ★★★★☆

Speed: ★★★☆☆

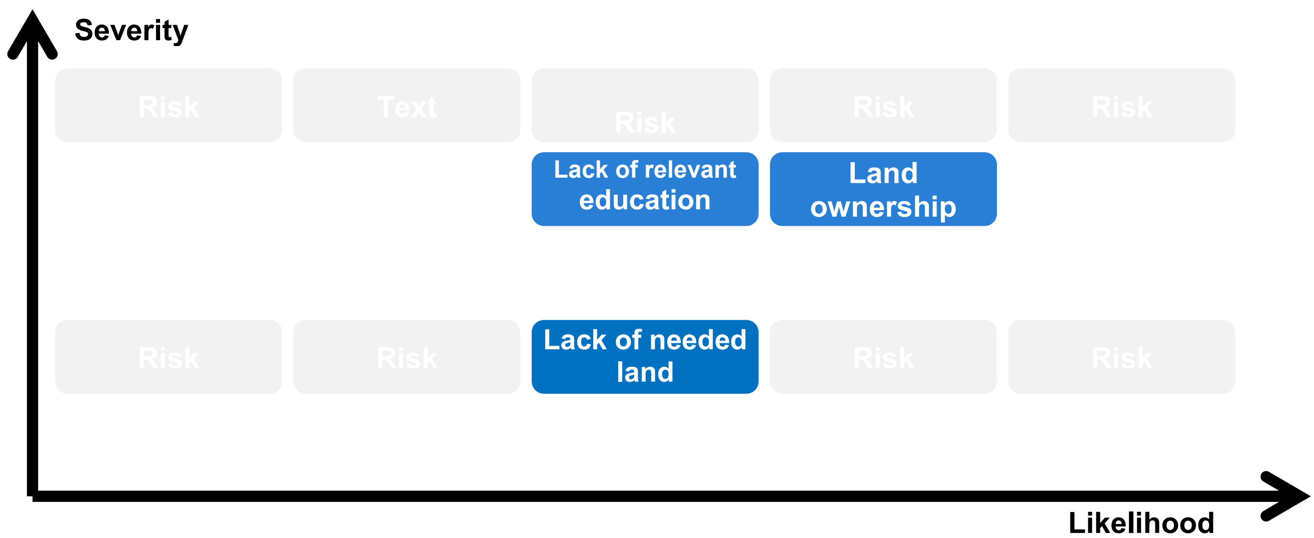
Readiness: ★★☆☆☆



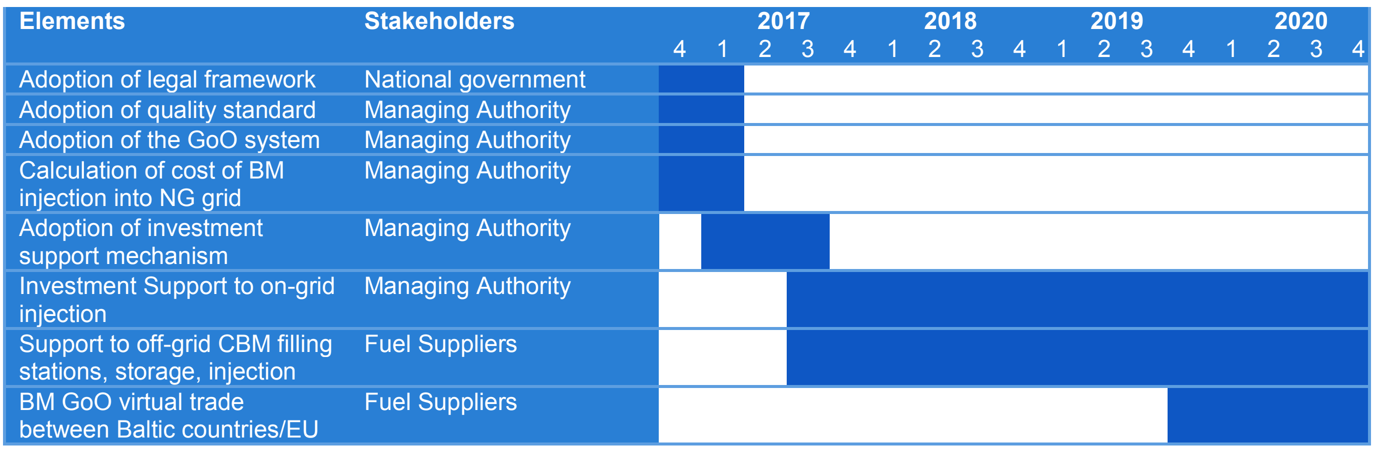
Solution summary

This key solution proposes to adopt legal regulation for biomethane quality standards, to develop technical and financial procedures for biomethane injection into the natural gas grid (incl. establishment of financial support schemes for grid injection, enforcement of Guarantee of Origin scheme for virtual trading) as well as procedures for quality control (Wobbe index, odorization, etc). The financial support is targeted towards the first 15-20 biomethane injection facilities.

Risk matrix



Solution timing by quarter



Mechanism

Biomethane injection into the natural gas (NG) grid is preconditional for achieving the target of 3% biomethane in transport. It's impossible to achieve this goal only with off grid supply of biomethane in off-grid filling stations. The biomethane injection into NG grid should take place at the closest suitable and feasible injection point to the biomethane producer to keep transport costs as low as possible.

The problem relays in fact, that for projects with low biomethane production volumes the grid injection costs can become an important market barrier (in some cases these costs can add up to a several € 100.000).

Aim of the support scheme is to lower the injection costs of biomethane. The grid injection points could be positioned in such a way, that at a later stage they can be used by other biomethane producers as well. Support could be aimed to companies which will build and manage the injection points. Preferable these companies are gas sector companies, which deal with gas equipment on daily basis rather than biomethane producers, which usually don't have such competences.

In Germany the cost of a biomethane injection facility is € 250 000. The first price estimation for grid injection in Estonia was € 195 000[9] provided by Elering AS. The biomethane must meet existing gas quality standards[10], set by Elering. The grid operator should monitor the gas quality injected into grid from biomethane facilities.

Quality standards and procedures for grid injection should address:

- Measuring gas quality and flow (amount injected) with calibrated instruments.
- Adjusting the heating value e.g. by adding propane, butane other appropriate gases.
- Compressing biomethane to the required pressure level.
- To ensure a safe and smooth operation of the gas grid and connected gas utilisation equipment.
- Biomethane has to meet gas quality standards and comply with different procedures to inject either to the transmission network or to the distribution network.
- Setting biomethane quality standards for off-grid local (autonomous) biomethane grid networks (where methane content can be lower than in natural gas grid).
- Biomethane injection / storage/ use in on-grid and off-grid CNG/CBM filling stations.
- Relevant training to gas grid operators, biomethane producers, service providers.
- Rules that establish a fair pricing method for leaseholding or purchasing land, which is needed for installing pipes and grid connections facilities.

Both for on-grid and off-grid injection of biomethane to natural gas grid or to CNG/CBM filling station the procedure of biomethane Guarantee of Origin (GoO) system and trading possibility should be established using the Elering Data Storage Database of Natural Gas (*maagaasi andmeladu*). The feasibility pro and cons of virtual trading of biomethane Guarantee of Origins with other Baltic countries and with European customers (via Biomethane Registers of GoO) should be analyzed.

Needs

- Need to adopt legal, technical and financial procedures to ensure standardized biomethane grid injection to different grid options (B, C or D grid) or use of compressed biomethane in CNG/CBM filling stations;
- Need to analyze the impact of allowing Elering to socialize[11] the costs of biomethane Injection facilities to overcome market barrier.[12]
- Need to decide, who will cover investment and operational costs of biomethane injection into natural gas grid or to CNG/CBM filling station;
- If CAPEX and OPEX for biomethane injection appear to be a substantial market barrier in the value chain, than there is a need to adopt a support scheme;
- Need to implement relevant training for: gas grid operators, biomethane producers, service providers under national platform scheme;
- Need to work out fair rules that establish a location-related fair price for leaseholding land.

Stakeholders are: biomethane producers, grid operators, grid connection service providers, training institutions, Technical Supervisory Body

9 Source: e-mail from Vreni Veskimägi, 2.11.2016

10 http://gaas.elering.ee/kasulikku/vorgugaasi-kvaliteedinouded/

11 "Socializing of costs" means that grid operators are allowed to charge the users of their grid in order to earn back their investment costs

12 This is one option. There could also be a subsidy for producers to process their gas and feed it into the grid.

(*Tehnilise Järelvalve Amet)*, filling stations, and in addition transport companies in case off-grid biomethane is transported by trucks to a BM injection facility.

3.7 Green public procurement

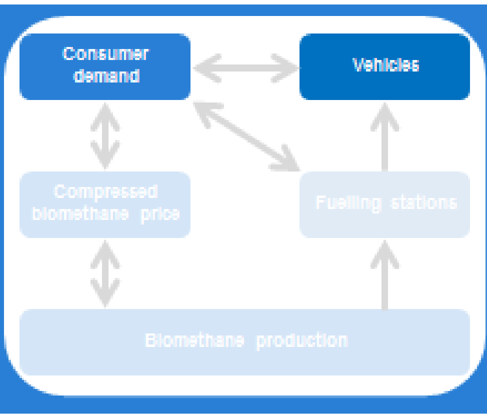
Affordability: ★★★☆☆

Feasibility: ★★★☆☆

Impact: ★★★★☆

Speed: ★★★☆☆

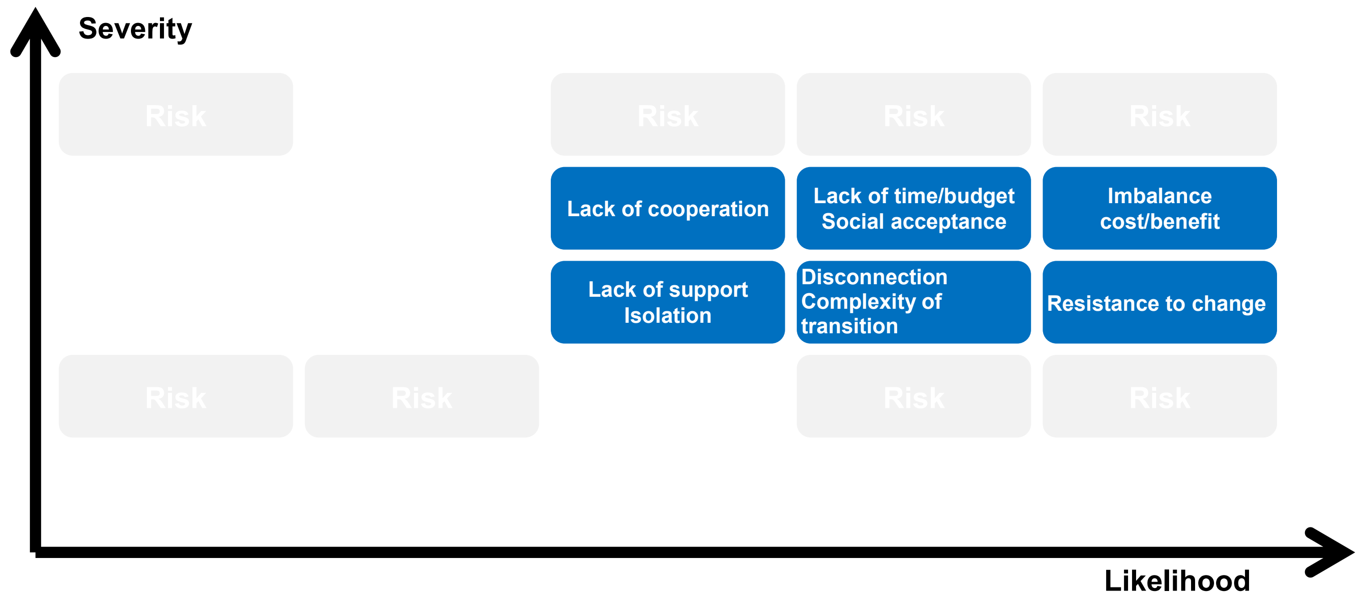
Readiness: ★★☆☆☆



Solution summary

Introducing public procurement rules that favour the use of alternative fuels. By using a dedicated system dynamics model and an advanced process management approach public transport concessions can be switched to biomethane without substantial additional expenditure. Apart from that it's also important to make the concession part of a bigger goal like trying to establish a local circular economy.

Risk matrix



Solution timing by quarter

Elements	Stakeholders		2017				2018				2019				2020			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Initiate	Local government	■	■															
Identify	Local government, project team, users, suppliers			■														
Specify	Project team				■													
Plan	Project team					■	■											
Approach	Project team							■										
Negotiate	Project team								■									
Manage	Managing Authority									■	■	■	■	■	■	■	■	■

Understanding

Mechanism

This solution provides a template for a green public procurement, it is based on the approach taken by the city region Arnhem Nijmegen in the Netherlands. Their case study of 'greening' in public transport provides a solution to calculate the costs / benefits of greening while tendering public transport concessions. The solution consists of a ‘system dynamics’ financial model and a programme management description.

In the 'sandwich' between policy and interests every public transport authority ought to ask a series of questions when tendering public transport services:

What (environmental) requirements do we set for busses and rolling stock? How will technology develop over a ten-year period? What are the consequences of transition scenarios? How reliable is a solution? Can we afford to pay this?

They have developed a system dynamics model consisting of a financial model and a programme management approach to help answer these questions. The implementation of the whole process can be achieved within four months as an integral part of a tender procedure. Two months preparation, one month modelling and one month for a 2nd opinion and decision making.

The technical model works with inputs consisting of characteristics of a concession like the Frequency of service, composition of the fleet and cost entries such as fuel, personnel, quantity of fine particles, tank-to-wheel and well-to-wheel costs;

In several transition paths the costs of the scenarios according to system dynamics are modelled in time. The output consists of costs per scenario. Contract variations are compared with the current reference costs. Emissions of harmful substances are calculated into societal costs and benefits.

By using a system dynamics model and implementing an advanced process management approach the city region has been able to ‘green’ its concession without any additional expenditure. After comparing all technologies in multiple scenarios and transitions the city region has chosen for a regional chain of locally produced green gas that drives 225 green gas busses. Through independent comparison and calculations they have identified all possible risks and mitigated them into the public transport franchise. All stakeholders were involved in composing the terms of reference and thus became part of the solution.

The city region also developed a financial model that is technology neutral. It can be applied to any concession and for every kind of tendering type: Public European, private allocation or competition-oriented dialogue. Every public transport authority can have the model expanded and adapted according to its own situations and wishes.

Anyone familiar with simulation software Vensim and system dynamics (SD) can inspect it and use it. The model consists of:

- Model, spread sheet with data and reader;
- Administrative decision-making with all underlying documents (according to Dutch law);
- Terms of reference;
- Stakeholder consultation.

Joint government procurement in Estonia

The Estonian National Support Centre is preparing the joint procurement of passenger cars. This joint procurement is for all state institutions and foundations aiming to procure new passenger cars in 2017 and 2018. Vehicle procurement documents have been prepared under the leadership of the Ministry of Finance. For all desired categories except SUV’s are biomethane powered vehicles available. Unfortunately the requirements used in the procurement documents are very unfavourable for biomethane vehicles. The required engine power is chosen at such a level that biomethane vehicles often are just below the lower limits. On the other hand the required CO_2 performance is not very ambitious, it could be reached by any standard vehicle. The required CO_2 performance level is almost at 150% of what is should have been to really favour only the cleanest fossil vehicles together with biomethane powered vehicles.

Experiences abroad and possible variants

This approach has been successfully demonstrated by the city region of Arnhem-Nijmegen in the Netherlands who have chosen for locally produced green gas that drives 225 biomethane buses. The city region used independent comparison and calculations to identify all possible risks and applied mitigation actions for the local public transport franchise.

Risk Mitigation

Imbalance costs/benefits. One of the most important questions to surface when public transport is put out for tender is: What (environmental) requirements do we set for the equipment? Stricter requirements cost more to satisfy, which means that there is less money available for the actual service and the network. To overcome this, the Arnhem Nijmegen City Region has developed and used a system dynamic model for putting a new concession out to tender (see above). The city region would like to share its positive experiences in using the model with other parties. The model is accessible on the internet[1].

Lack of support. To be successful a green public procurement project should be supported by the entire organisation. High level government officials should work closely together with the independent public procurement project manager. Ideally they should strive to connect a problem with air quality and the concession with an inspiring vision of circular economy and independence in terms of energy supply. This will lead to a thoroughly substantiated proposal that could be easily be adapted by the local politicians.

Lack of cooperation. Governments, businesses and research institutions should work closely together on solutions for the entire value chain. This calls for participation of the right parties with the right resources and the right direction from the government. All should keep an open mind to unconventional actions and for new partners.

Both board and official organization should have the ambition to be innovative. The project manager is responsible for the translation of the administrative and bureaucratic ambitions in an economically viable business case for the market.

Lack of time/budget. Often the cost of preparing a public procurement process seems high, but not if viewed in relation to the tender amount. Investment in preparation will deliver substantial cost savings. The rule of thumb is: A 1 billion turnover contract (e.g. a concession of a large metropolitan area for 10 years) will require 0.1% of preparation costs each year. A public transport concession this large may take up to three years of preparation. This would result in preparation costs of about €3 million.

Resistance to change. Change never comes easy. One should establish a setting in which people feel free to experiment with new roles and new instruments. Allowing them to work horizontally rather than hierarchically makes them:

- Problem- and opportunity- focused;
- Aware of issues outside their own organisation;
- Fulfil a more relational role;
- Facilitators instead of monitors.

Embracing opposition is better than ignoring or giving a veto. It's crucial to invite all stakeholders early in the process to put their concerns on the table. All complaints should be taken seriously and included in the final recommendation.

Disconnection. Don't ring fence the project, the procurement officials should operate outside as well as inside the procurement organization. Their modus operandi should be part of everyday practice. This way successes are not limited to this project alone, but working on a climate-neutral region and a circular economy will become self-evident.

Isolation. The ambition for the procurement should match those of the region and this should in turn match with provincial and (inter)national agendas. This sometimes gives friction. Parties should therefore work close together.

Complexity of transition. The transition to a more climate-neutral public transport concession is complex and the danger is getting stuck in unrealistic views. Public transport concession and logistics experiments in urban distribution are stepping stones towards a sustainable future and should be taken step by step.

A government has public knowledge and should invest in private expertise. This will lead to cooperation between governments, market parties and knowledge institutes where each party has its own recognized strength and momentum.

Going for the cheapest option will only result in short-term solutions. Allowing sufficient return on investment creates space for sustainable ambitions and will most likely result in more profitable solutions in the long term. Concession requirements should be aimed at the entire concession period and not only at the time of tendering and contracting. This prevents additional payments for extra ambitions during the operation period.

Social acceptance. 'The bus in the region is driving on my organic waste' is a message that sells well to the citizens. This story must be told in many variations. In addition, the government must not lose sight of the bigger picture and the final vision (Earth, circular economy). The public transport concession has been a means to initiate the transition to a bio-based economy and CO_2-neutral transport. Green public transport concession is not the end result, but a means to achieve that goal.

Impact

Effect on biomethane uptake

The most fuel intensive sectors resorting under a possible public procurement tender add up to a biomethane uptake of 88 million Nm³ biomethane. This is 247% of the ambition of 3% biomethane in 2020[1]. Obviously it's not realistic that they all use 100% biomethane in 2020.

For example: even if all the public transport procurements from now on would be on biomethane it still would add up to no more than 21% of all buses in Estonia. Realistically the uptake could only be 27%. Below is mentioned the 126% that the entire bus fleet would be able to contribute.

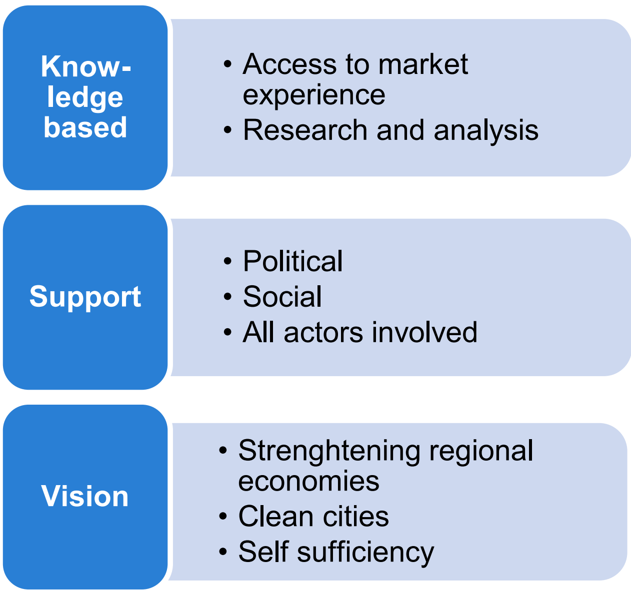
Domain	Use	Uptake
Public transport	Buses	126%
Governmental	State Forest Management	3%
Governmental	Postal	5%
Public transport	Trains	93%
Governmental	(Border) police	7%
Governmental	Armed forces	10%
Governmental	Fire and rescue department	3%
Total		247%

Costs

Costs will be around 0,3% of the total contract value.

Implementation

Design principles



The public procurement process should be designed as shown in Figure 16

Needs

Decisions should be based on the right information. A lot of time will be spent collecting and analysing all available knowledge.

Political, social and stakeholder support. Choosing something new will encounter opposition. As Machiavelli stated centuries ago"…And let it be noted that there is no more delicate matter to take in hand, nor more dangerous to conduct, nor more doubtful in its success, than to set up as a leader in the introduction of changes. For he who innovates will have for his enemies all those who are well off under the existing order of things, and only the lukewarm supporters in those who might be better off under the new…"

A vision, preferably one that goes beyond the public procurement alone. Like a vision on a local circular economy, self-sufficiency and or clean cities.

A drive to change. At the moment the Estonian government is developing the joint procurement of passenger cars. It needs some minor adjustments to allow for biomethane vehicles to compete with diesel and gasoline vehicles.

A dedicated project team that can start in time and has sufficient budget.

Stakeholders

See Figure 16.

Timing

Initiate Project. Identify key internal and external stakeholder groups. Appoint individuals to the project team and a project team leader. Clarify the background and key objectives for the procurement. Establish high-level budget estimate for the procurement and associated process costs.

Identify needs & analyse the market. Identify stakeholders needs. Review previous procurements. Supply positioning (operating environment, policy considerations, sustainability opportunities/issues). Market Analysis (together with market and supply stakeholders). Solutions identification and options appraisal. Approach to market options.

Specify requirements. Prepare specification of requirements (mandatory and non-mandatory requirements, timeline and key deliverable dates, sustainability requirements or preferences). Quality & Standards. Rules of Procurement or any other government or agency procurement policy requirements.

Plan approach to market and evaluation. Approach market (Request for Information, supplier briefings/workshops/one-on-one meetings). Evaluation methodology. Evaluation criteria. Due Diligence. Contract (Type of contract, legal risks, terms and conditions). Process plan and timetable

Approach market and select supplier. Inform market (Publish Request for proposal, Supplier briefings, Respond to supplier questions) Form & instruct evaluation panel, evaluate offers. Prepare evaluation panel minutes and recommendation. Identify preferred supplier. Undertake due diligence. Write to the preferred supplier indicating points for negotiation.

Negotiate and award contract. Prepare a negotiation plan. Negotiate terms & conditions of contract. Prepare contract document. Award contract and execute contract document. Debrief successful and unsuccessful suppliers. Prepare contract management plan.

Manage contract and relationships. Implement contract management plan. Performance management. Financial management.

Review

- Have the anticipated benefits been received?
- Does the initiative represent value for money?
- Opportunities for further improvements?
- Lessons learned?

References

[1] Groene Hub, September 2012, Green cockpit: TCO model for public procurement. http://degroenehub.nl/projecten/schoon-ov/tco-de-groene-cockpit/.

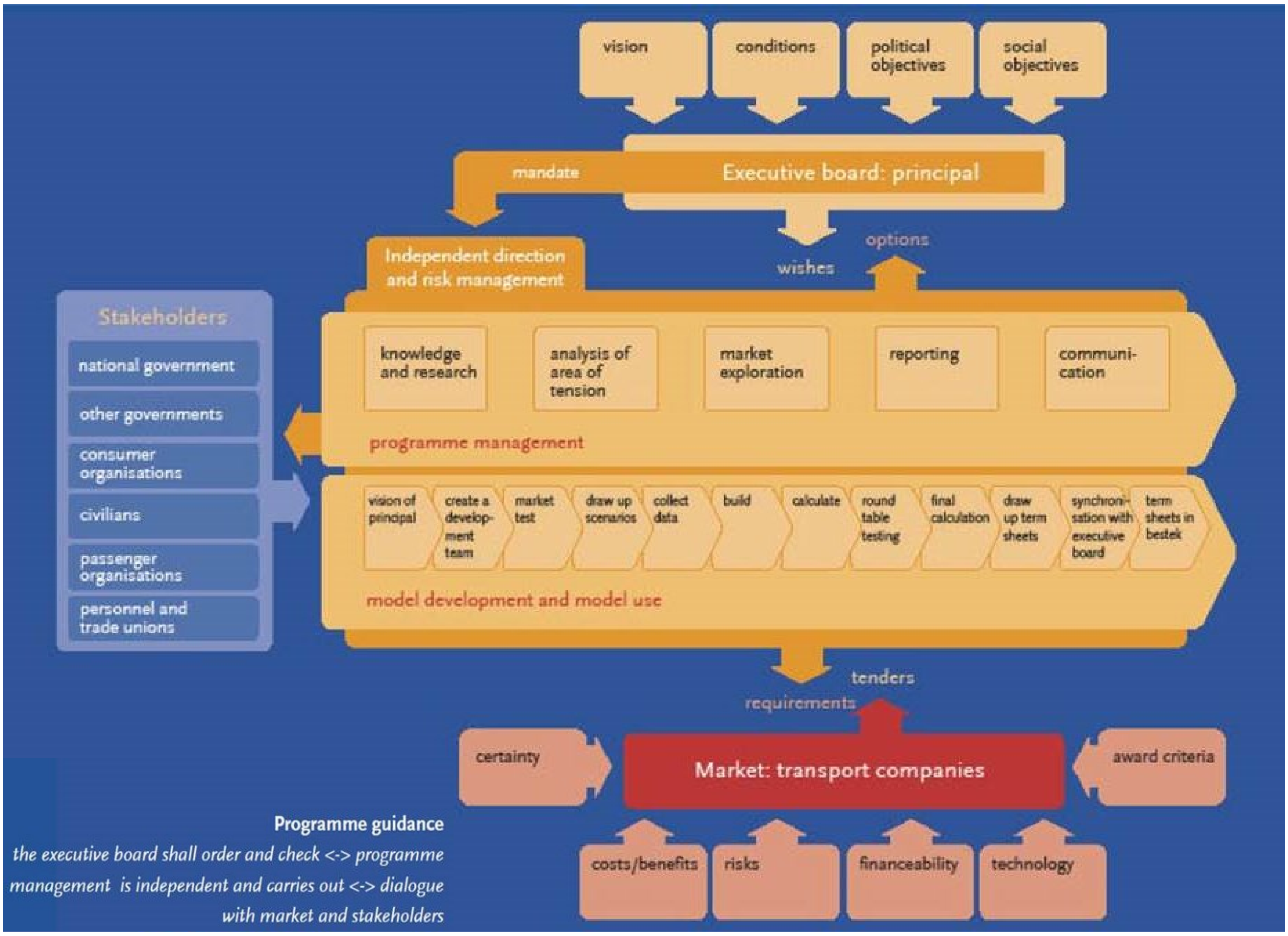


Figure 16: Stakeholders Green Public Procurement

3.8 Privileges for CBM vehicles

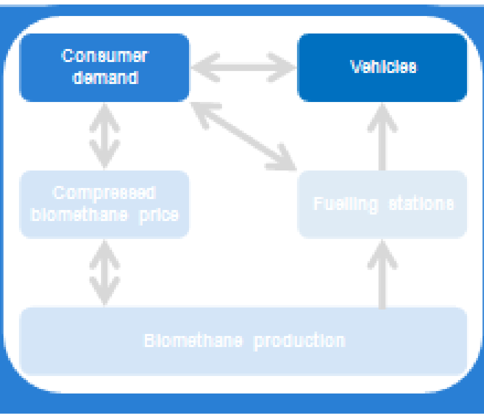
Affordability: ★★☆☆☆

Feasibility: ★★★☆☆

Impact: ★★★☆☆

Speed: ★★★☆☆

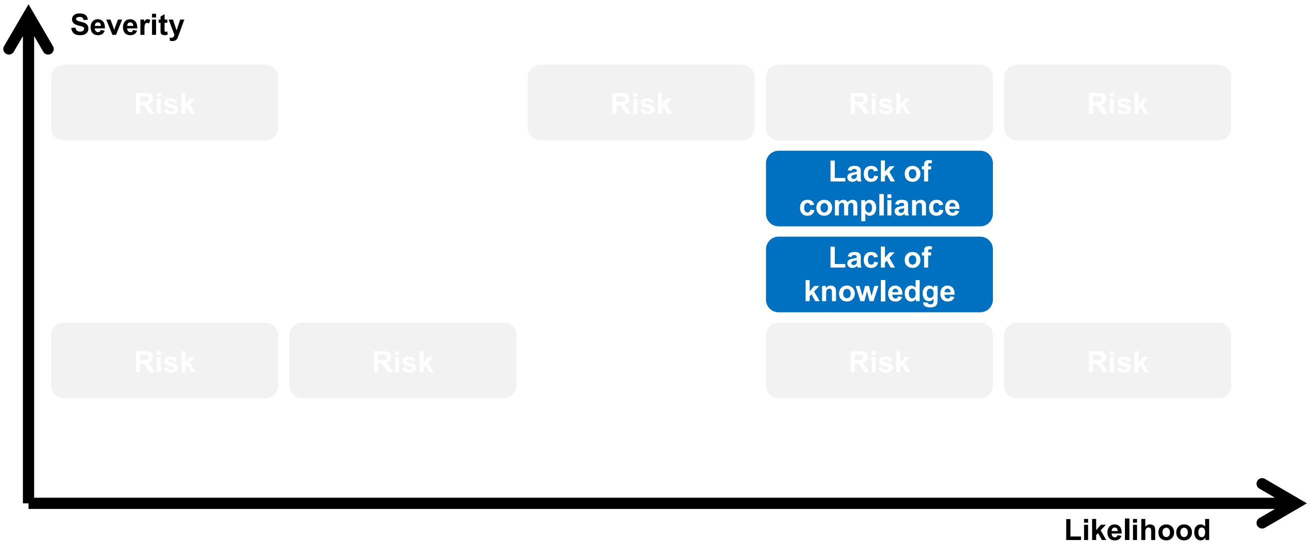
Readiness: ★★☆☆☆



Solution summary

The attractiveness of using biomethane can be improved by introducing privileges for biomethane-powered vehicles. For delivery trucks, one can think of allowing them inside city centers at very early hours because they are more silent than diesel-powered trucks. Allowing biomethane cars the use of priority or bus lanes and free parking will also contribute to their attractiveness..

Risk matrix



Solution timing by quarter

Elements	Stakeholders		2017				2018				2019				2020			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Appoint a programme manager	National government	X																
National programme on clean cities / sustainable regions	National, regional and city governments	X	X															
Standards for noise emission	National government		X	X														
National Policy on Environmental zones	National government		X	X														
Information campaign	Programme manager			X	X	X	X	X	X	X								
Develop and test solutions	Programme manager, user groups				X	X												
Implement solutions	Regional/city government					X	X	X	X	X								

Understanding environmental zones & restricted access

Mechanism

Environmental zones are zones where older heavy diesel trucks are banned, either permanently or during certain times. Banned vehicles can obtain permission to operate within the environmental zone if they install additional exhaust control equipment. The motivation for this is to reduce pollution and noise.

Delivery trucks preferably enter urban centres before rush hour starts. These diesel-powered delivery trucks are responsible for a significant decrease of air quality and produce a lot of noise. Biomethane vehicles can contribute to air quality and noise levels targets in urban centres. They emit no particles, very little NO_x, and their noise emissions are half those of a diesel-powered vehicle (about 4 decibels). They also have about 24% less tailpipe CO_2 emissions [1]. The reason for the reduction in noise level is that combustion of natural gas fuel is slower than that of other hydrocarbons, which in turn means a significant reduction in vibrations.

Experiences abroad and possible variants

Heavy diesel trucks and buses older than eight years are banned in almost the entire inner city of Stockholm. One issue was that compliance was low. This was remedied by an improved cooperation between the city and the police department. As a consequence, this accelerated the renewal of the heavy vehicle fleet. The environmental zone in Stockholm was introduced in 1996 and covers almost the entire inner city, with the exception of some transit routes.

In 1998, the Dutch Government set out standards for noise emission during loading and unloading in retail trade and craft businesses. This resulted in a project called PIEK and, in 2004, in the PIEK [2] certification scheme vehicles and equipment must operate under 60dB(A) . This makes them suitable for use in night time deliveries without causing noise disturbance. This measure resulted in an increase of approximately 300 LNG trucks for city distribution trucks in the Netherlands in 5 years' time.

Understanding free parking for biomethane vehicles

Mechanism

Studies [3] have indicated that reduced parking fees can be an incentive for using clean vehicles. As part of this solution private persons driving a clean vehicle should be able to apply for a free (or discounted) parking permits or space use.

This system can include biogas, ethanol, electric and electric hybrid vehicles. Private companies that use cars extensively within the city centre should also be able to apply.

Experiences abroad and possible variants

Stockholm has strict parking rules with high parking fees in the inner city zones during business hours. The realisation of this parking regulation was heavily delayed due to a lack of political agreement. The free parking scheme for clean vehicles was introduced in May 2005. When the decision was taken, the city started to advertise about the new incentive for clean vehicles and media covered the news very well. The interest for the free parking is big. From May until August 440 private and 390 company permits was issued.

In Graz (Austria), low-emission vehicles get a 30 percent reduction on parking fees. During the introduction in spring 2004, the interest of the general public was quite high. However, only 41 drivers of low-polluting vehicles were approved by the parking department in the first year. The main reason is that only very few cars fulfilled the set criteria. This was mostly because they lacked particle filters. Cars that fulfilled the criteria were not promoted actively by producers and retailers. At the moment more cars fulfilling the criteria are available and a promotion campaign was carried out together with the car retailers. Nowadays there are a over 400 cars using this reduced parking option.

Understanding using priority / bus lanes

Mechanism

The aim of this solution is to allow vehicles that meet a pre-determined clean vehicle standard to use transport priority lanes. Vehicles using the lanes would have to operate on (locally produced) biomethane

Experiences abroad and possible variants

Norwich (UK) decided to allow only clean heavy goods vehicles to use bus lanes for their operations. Drivers were given training on how and when to drive in the bus lane. The vehicles had distinctive markings to identify them as being permitted to use the bus lanes. The width of the existing bus lanes was a barrier to implementing the measure. The number of heavy goods vehicles using the bus lanes was about one per day. There was some stakeholder opposition to the measure. Monitoring showed a peak-time journey saving of two to four minutes per trip for an overall average journey of 25 minutes. This equates to small savings in emissions and fuel consumption. There was little benefit from using the bus lane at off-peak times.

Risk Mitigation

Lack of compliance. Compliance can be increased by having occasional police raids where vehicles with no permission are fined. On top of that it's also possible to let these vehicles pay to be towed away out of the zone (since they are not allowed to drive there). In Stockholm these efforts from the police have been very effective and increased compliance with 6% from (90% to 96%.)

The renewal of the heavy vehicle fleet has also been speeded up. The measure has created a more attractive city centre with lower emissions and energy consumption, reduced noise levels and increased acceptance for cleaner vehicles.

Lack of knowledge. Information campaigns are essential to make environmental zones accepted and thus also respected. Other informative actions are road signs indicating restricted access and physical barriers. Automatic plate recognition systems could play a role in supervising traffic in restricted areas as well.

Impact

Effect on biomethane uptake

These solutions are targeted at private car owners, business car owners and delivery trucks.

For the first two categories this solution by itself will not have a significant impact on the biomethane uptake. Together with other solutions it might just tip the scale for a vehicle owner.

If this solution leads to the switching of 100 delivery trucks to biomethane, the effect will contribute approximately 2% of the 3% biomethane goal for 2020.

Costs

The budget should cover internal staff costs as well as durable investments such as traffic signs. Together they might amount to about € 100 000 [3] for a large city.

Implementation

Design principles

Start with identifying user needs. What do the vehicle drivers need to be able to act in line with these solutions. Do research, analyse data, talk to users and try not to make assumptions. Have empathy for users, and remember that what they ask for isn't always what they need. It's recommendable to design this solution in close cooperation with the distribution companies in order to give them enough time to prepare in case of a total restriction.

Government should only do what only government can do. Make rules, check compliance and set examples. If something works, make it reusable and shareable, the Civitas website has a lot of information on this subject [3]. This means build platforms and registers others can build upon, provide resources that others can use, and link to the work of others.

Let data drive decision-making, not hunches or guesswork. Keep doing that after implementing these measures. Develop methods of measurement for peak noise during loading and unloading [4].

Making something look simple is easy. Making something simple to use is much harder but that's what we should be doing. Working with permits and automatic plate recognition systems could work very well. Getting feedback from users is very important in this stage.

The best way to build good solutions is to start small and iterate a lot. Release minimal solutions early and test them with actual users. Delete things that don't work and make refinements based on feedback. Iteration reduces risk. It makes big failures unlikely and turns small failures into lessons.

Consider the needs of the range of people that you want to reach with your solution to make sure you are not excluding people. Make sure traffic signs can be understood also if you're not Estonian.

A solution should be something that helps people to do something not something that restricts them of doing something. This should be taken into account when we start communicating about the project. We don't want to ban vehicles from inner cities, we want to improve the quality of living in inner cities. We don't want to forbid the use of diesel and gasoline but we want to stimulate the regional economy by switching to biomethane.

For this kind of solution the cooperation of local governments is essential. Since more than 55% of Estonians are living in one of their 12 historical cities it could be interesting to develop a joint approach. This way the historical city centres will be preserved and become more attractive for both tourists to visit an inhabitants to live in.

Needs

National Policy on standards for noise emission during loading and unloading in retail trade and craft businesses.

A National Policy on Environmental zones.

A programmatic approach where multiple cities work together to save costs and increase impact. Preferably the solutions described here should only be a small part of a bigger programme on increasing quality of live in inner cities and strengthening regional sustainable economies.

An information campaign helping focus on increasing the quality of life in inner cities and on strengthening regional sustainable economies. This campaign should also include traffic signs.

Stakeholders

The main stakeholders for these solutions are:

- National, Regional and City governments should work closely together in a programmatic approach.
- Dedicated user groups to test and discuss the different measurements: distribution companies, private care owners and business car owners.
- Vehicle dealers to inform potential buyers on the benefits of biomethane vehicles.

Timing

The government should start with appointing a programme manager. The programme manager is responsible for developing a National programme on clean cities and sustainable regional economies together with the other stakeholders. He also has to establish a programme organisation.

The National programme on clean cities / sustainable regions should be adopted by the different levels of government.

The National Government should develop and adopt standards for noise emission during loading and unloading as well as a National policy on Environmental zones. This policy should also be adopted by regional and city governments.

The programme manager is also responsible for developing an information campaign. They should develop and test solutions together with user groups.

Regional and city governments should implement the solutions.

References

[1] RVO, 2015, List of energy carriers and emission factors https://www.rvo.nl/sites/default/files/2015/12/Nederlandse%20energiedragerlijst%20versie%20april_2015_def_0.pdf (CNG, LNG and NG are identical, as the form does not matter for this)

[2] http://www.piek-international.com/english/

[3] http://www.civitas.eu

[4] http://www.piek-international.com/include/downloadFile.asp?id=195

3.9 Renewable Fuel Units (RFUs)

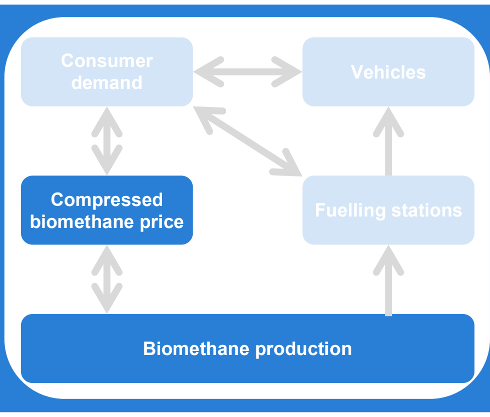
Affordability: ★★★★★

Feasibility: ★★★★☆

Impact: ★★★★☆

Speed: ★★★☆☆

Readiness: ★★★☆☆



Solution summary

This key solution consists of establishing a registry for Renewable Fuel Units (RFUs) that can be traded for biofuels blending obligations. This allows CBM suppliers to leverage the blending obligation of liquid fuel suppliers, and potentially close the financial gap with CNG. We find that they can obtain about €7.15/GJ, which is based on estimated production costs. allows 0.41 PJ of CBM (34% of the target) to compete with CNG.

Risk matrix

Solution timing by quarter

Elements	Stakeholders		2017				2018				2019				2020			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Laws and funding for management authority	National government	■	■															
Setup website for registry	Managing Authority			■	■	■												
Establish registration rules	Managing Authority			■	■	■												
Workshops and communication	Managing Authority			■	■	■		■				■				■		
Run and maintain registry	Managing Authority	■	■				■	■	■	■	■	■	■	■	■	■	■	■
Helpdesk	Managing Authority						■	■	■	■	■	■	■	■	■	■	■	■
Register RFUs	Fuel Suppliers						■	■	■	■	■	■	■	■	■	■	■	■
Trade RFUs	Fuel Suppliers						■	■	■	■	■	■	■	■	■	■	■	■
Verify registration	Verifiers										■				■			
Control entries	Managing Authority											■				■		

Understanding

Mechanism

Using a Renewable Fuel Units (RFUs) system would help some CBM suppliers to close the financial gap between CBM and CNG. It would do so by leveraging the blending obligation for suppliers of liquid fuels.

To understand how RFUs work, we first need to look at it from the point of view of the suppliers of liquid transportation fuels (gasoline and diesel). These suppliers have an obligation to blend in a certain amount of biofuels into their retailed products. This obligation is typically a few percent (so that the Renewable Energy Directive's target of 10% renewable energy in transport can be achieved).

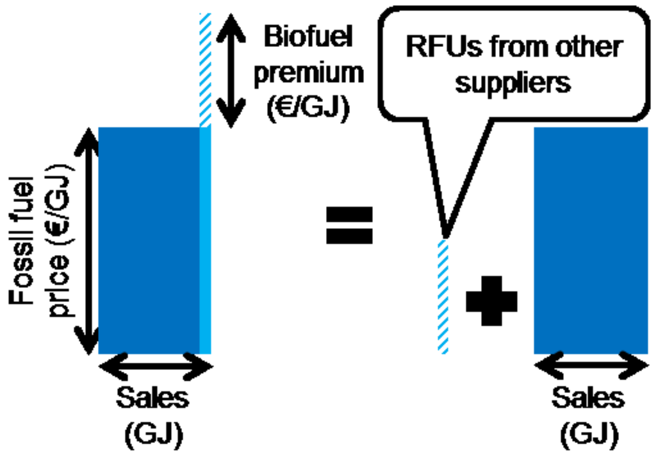


Figure 17: RFUs for fossil fuel suppliers

This obligation can be achieved in two ways, as shown in Figure 17: Suppliers can either purchase biofuels for physical blending in their retailed products. Alternatively, they can buy a Renewable Fuel Unit (RFU) that another supplier has beyond their own obligations. That other supplier would be able to offer these extra RFUs by supplying more biofuels to the market than they are obligated to. This can happen if the supplier delivers higher blends to the market, such as delivering a pure biodiesel to the market (either for cars that can accommodate it or by delivering a fuel, such as HVO, that has identical properties to its fossil fuel counterpart). This can also occur if a supplier that has no blending obligation (such as a CNG supplier, or a supplier of electricity for transport) uses a renewable supply, such as biomass.

The price of these RFUs will be determined by the cheapest available option, since other suppliers will buy the cheapest RFUs they can acquire. They will also only buy them if they are cheaper than doing the actual physical blending.

The other side of the coin is the point of view of the CBM/CNG suppliers. In order for them to sell CBM alongside (or instead of) CNG, CBM needs to have a lower or similar price than CNG. This is necessary for suppliers to keep the price they are currently proposing to customers. It is also sufficient to help uptake of CBM on a financial basis, since we assume that CNG is competitive with diesel on a cost basis, at least for enough users to ensure uptake at the volumes we are considering.

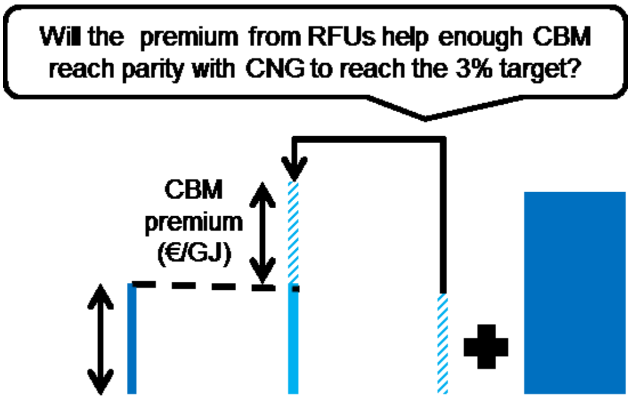


Figure 18: RFUs for CBM suppliers

Figure 18illustrates this support: If CBM/CNG suppliers can get enough money through RFUs to close the financial gap/compensate for the CBM premium, they will be able to sell CBM alongside (or instead of) CNG at the same price as CNG now. We will be looking at the maximal expected price CBM could fetch from the market. This price will be determined by the market price without CBM.

In principle, the entry of CBM would influence the market price, but the effect is likely to be small in the initial phases. The first reason for this is that CBM would have small, supply constrained volumes at first, which means that their influence on the much larger market price would be small. The second reason is that CBM would also benefit from its novelty and local production: Information about its actual production costs would not be as available or reliable as for products that have been available for a long time and traded globally, such as biogasoline and biodiesel. This means that CBM suppliers could fetch biodiesel or biogasoline RFU prices, even if their own costs are lower.

Experiences abroad and possible variants

Some small variants of an RFUs scheme would include the possibility of banking credits, i.e. the possibility to buy RFUs at a point in in time and use them at another point in time. Another variant is to require a minimum amount of actual physical blending, and only allow RFUs for part of the blending obligation. The former option would increase the demand for RFUs (thereby increasing the market price), whereas the latter would have a reducing effect on the total demand for RFUs (thereby reducing the market price, depending on the blending obligation level).

We can also extend the approach in this key solution to cases where CBM suppliers have customers willing to pay a premium (for image, environment, or local production reasons). It can also be extended to cases where they need to be even cheaper than CNG, in order to attract customers that do not gain enough from switching to CNG. Such extensions are relatively straightforward.

In another variant, the dedicated parts of the blending obligation could be allotted for a particular subset of biofuels, e.g. domestically produced ones, such as biomethane. This is done in some other countries, e.g. in the US and in Italy. The Renewable Volume Obligation of USA, in force since 2008, have a small blending obligation for cellulosic biofuels, in addition to two other categories (conventional renewable fuel and advanced biofuels. Categorisation is based on GHG reduction performance). The originally intended suppliers, cellulosic ethanol producers, have failed to deliver, so the quota has been reduced significantly, and is now in essence fulfilled by a quickly growing biomethane market. Biomethane is also an eligible biofuel in the advanced biofuel category, but there it can't compete with the other fuels, such as sugar cane ethanol. The price level of RFUs[13] are market based, the one of the cellulosic RFU is similar to the one of the advanced RFU, thus corresponding to the price floor of the cellulosic RFU. The price ceiling is set by addition of the price of the Cellulosic Waiver Credit (CWC), which price is calculated yearly by the EPA. The CWC is the last resort of the liquid fuel suppliers to fulfil their cellulosic biofuel obligation. The cheaper petrol prices has led to increased CWC prices[14], leading to increased interest in biomethane based RFUs from fuel suppliers.

In the US system, the RFU is created and registered by the biofuel producer

Renewable energy units in the Netherlands

The Netherlands have an RFUs system in place. It is managed by the Dutch Emissions Authority (NEa, in Dutch) and has been in place, in its current form, since January 1st, 2015. The RFUs are called HBEs in Dutch and are equal to 1 GJ. Prior to 2015, a similar system using "biotickets" was in place. The NEa has an administrative, support, and verification role, but is not involved in contracts and financial transactions related to RFUs. The NEa also issues periodic reports about the system that shows the amount and types of fuels registered in the system.

Only Dutch companies, supplying fuels that are used in the Netherlands, are eligible to book HBEs in the registry maintained by the NEa. HBEs are booked at the moment[15] the fuel is delivered to the market, not when it is blended (as was the case in the previous system). Suppliers can bank up to 10% of their RFUs (with a maximum of 2000) for the next year.

For the supply of biomethane, suppliers have to be a registered gas supplier and have a metered connection to the network that is dedicated exclusively to transport. The latter is ensured by having the station operators as the entities that can register RFUs[16]. All forms of transport (road, rail, water, air) are eligible. Suppliers have to satisfy the sustainability criteria in force at the moment of booking. This can be done through, in principle, guarantees of origin. Note that there is a two-actor limit to ensure that the sustainability of a fuel can be controlled. This two-actor-limit means that the producer has either to deliver CBM to consumers directly or that the entity that sells CBM to consumer has to buy the biomethane from the biomethane producer directly. There is no brokerage or allowed.

[13] The corresponding designation of RFUs in the US is Renewable Identification Number, RIN. Each RIN corresponds to one gallon of ethanol.

[14] CWC price is set by the highest of two values (corrected for inflation):
0,25 <-> 3 – average gasoline price [USD/gallon]
Low gasoline prices means a high CWC price, which is the case of 2016, 1,33 USD/gallon.

[15] The actual booking can take place between the month of January where the fuel has been delivered to the month of February of the following year.

[16] For electricity, it's the charging point operator.

The biomethane cannot receive both production subsidies (such as the one described in Key Solution 3.10) and RFUs. It can however get the right to a production subsidy first (a grant) and then opt to relinquish the grant to get an RFU (before it is paid out). Double-counting (see double-counting text box) is also allowed, if the delivered biomethane satisfies the required criteria. Note that double-counting is actually done through a multiplier (2 at the moment) that can be changed by a ministerial regulation, so that it can follow developments at the European level (such as a stop on double-counting, which would bring the factor to 1).

The RFU bookings have to be verified in the following year by an accredited verifier. The verification includes a verification of the system and of the data made during a site visit. The NEa also performs controls that can result in a change of the amount of RFUs booked and in the case of substantial discrepancies, also issuing of fines.

Similar provisions apply to suppliers of liquid biofuels or renewable electricity for transport (with some variations). [NEa].

Risk mitigation

The three main risks for the RFU market are the lack of blending obligation, the influx of cheap liquid biofuels and the (fear of) fraud.

If there is **no blending obligation**, either because the introduction of blending legislation fails, or because there is no follow-up to the 2020 targets in the Renewable energy Directive (RED), there would be no more demand for RFUs and the market would collapse. The following actions would reduce the likelihood of this risk occurring or reduce its impact:

1. **Ensure legislative certainty:** To reduce the likelihood of this risk occurring, legislators can ensure that the current proposed blending obligation is passed and that it integrates provisions for years beyond 2020. This could be coupled to efforts at the European level to ensure that there are provisions for years after 2020 at the European level. This should include high enough blending obligations to create enough RFU demand.
2. **Provide alternatives:** Having the possibility to switch to a subsidy system would reduce the impact, since producers would have a guaranteed source of income even in the case the market would collapse. (see below and Key Solution 3.10).

If **cheap liquid biofuels** (that is considerably cheaper than now) entered the market, then they would set a new, much lower price for RFUs, which would mean that CBM might not be able to compete with CNG anymore. In other words, this risk has the potential to kill the RFU market. It is however quite unlikely that very cheap biofuels would enter the market in the short term, as there are no indications of much cheaper biofuels appearing in the short term. Nevertheless, there is a number of mitigation measures that either reduce the likelihood of this risk, or reduce its impact:

1. **Having a parallel subsidy system:** CBM suppliers can either get an RFU for their CBM, or producers can get a subsidy for the production of that RFU (if they are two separate entities, then the subsidy will be passed through). This creates a de facto floor for the RFU market price, as CBM suppliers will at least have the possibility of getting the subsidy, even if the market collapses. Pushing the choice to a later stage, such as in the Dutch case (see above) reinforces the effect of this price floor even further, as suppliers can wait longer before making a decision. This reduces the impact of the risk.
2. **Having sustainability requirements:** These requirements would reduce the pool of available biofuels. As such, they could exclude some cheap biofuels from the market. This reduces the likelihood of the risk.

The other main risk is the **(fear of) fraud**. The fear would keep liquid fuels suppliers from participating in the market, while actual fraud would reduce the actual adoption of CBM. The impact would be relatively mild, as it would be related to the level of (perceived) fraud. The focus for risk mitigation should focus on reducing the likelihood of fraud, as reducing its impact would involve trying to correct the market. This would be highly uncertain, for something that has a relatively low severity. Reducing the likelihood of fraud essentially boils down to controlling the various elements of the value chain. This can be decomposed into the following three elements (see the Dutch example above for more details):

1. **Suppliers:** The managing authority can restrict access to trustworthy and

established parties, or at least force parties to follow strict rules such as the ones applying to participants in the gas network. The managing authority can also ensure that the produced biomethane is actually used in transport by requiring that the supplier must use a gas connection (which can be a split from an existing line, if it has its own meter) that will be used for transport exclusively, at a filling station. This obligation is in place in the Netherlands, for example (see above).
2. **Fuels:** The managing authority can set qualification criteria for biomethane, such as requiring guarantees of origin to be acquired and registered in the system at the same time as the RFU registration itself. The managing authority can also set special rules, such as a two-actor limit (equivalent to banning brokering) in order to facilitate the monitoring of the value chain.
3. **Processes:** The managing authority can require yearly verification of each supplier's entries by an accredited verifier, and it can also perform random and periodic controls.

Impact

Effect on biomethane uptake

How much are RFUs worth?

The first step into determining the effect of RFUs on biomethane uptake is to determine the value of RFUs.

Fuel	Fossil price (€/GJ)	Bio price (€/GJ)	Difference (€/GJ)
Gasoline	12.85	20.00	**7.15**
Diesel	11.66	24.00	12.34

Table 3: Price of liquid fuels (fossil and bio) excluding taxes from Text Box 4.1 and [IEA]

To do that, we start with the prices of liquid fossil fuels (gasoline and diesel) in Estonia, excluding taxes (see Text Box 4.1) and compare them to their bio counterparts. This is shown in Table 3. The €20/GJ for biogasoline (in this case bioethanol) and €24/GJ for diesel are our estimates, based on numbers from the IEA [IEA] and checked against spot market prices [OSPI]. In this check, our biogasoline (in this case bioethanol) number was very close to the spot price market, while our biodiesel price was a bit above (but in line with the IEA). This small discrepancy for biodiesel might come from temporary fluctuations. In any case, it does not matter much, as we are only interested in the biofuel that has the lowest premium, as it will determine the price of RFUs. The reason for this is that suppliers purchasing RFUs will buy the cheapest available option. Our estimate for this is then given by the biogasoline (in this case bioethanol) production premium, which is **€7.15/GJ**.

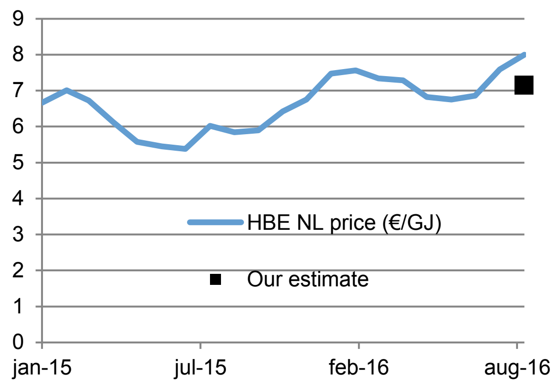


Figure 19: RFUs (HBE) price in the Netherlands (€/GJ) [STX] and our model estimate

Note that this estimate is most likely an upper boundary, as diesel and gasoline suppliers will want to have a slightly RFU lower price than their current alternatives. The risks explained above also have a depressing effect on the price of RFUs.

It can be useful to perform a check on this value, based on actual values in existing markets. This is done in Figure 19, which shows the prices of the Dutch HBE scheme (see above) between January 2015 and September 2016. Our estimate appears to fit quite well within the range of prices in the Dutch market. This fact that our estimate matches the Dutch market so well is partly coincidental (a slightly larger difference would not have invalidated our estimate), but also due to the fact that fossil fuels and biofuels are globally traded commodities.

How much of the CBM target can RFUs help achieve?

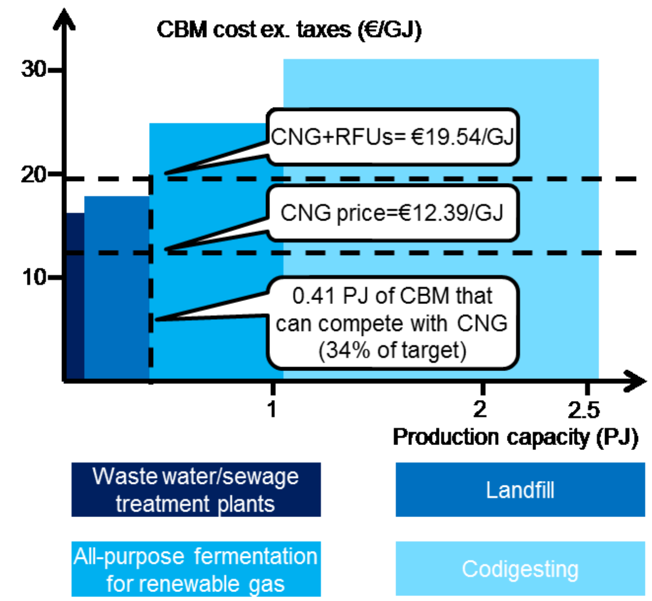


Figure 20: The first 2.5 PJ of the CBM merit order and RFUs

Now that we have a price for the RFUs, we can add that to the price of CNG (€12.39/GJ, see Text Box 4.1), leading to a CBM target price (excluding taxes) of €19.54/GJ (see Figure 20). At this price, CBM suppliers will be able to propose the same pump price as CNG suppliers, if they can sell RFUs.

The question of figuring out how much suppliers can deliver at that price is answered in Figure 20, which is based on the merit order data determined in the Text Box 4.2. This merit order data arranges the various methods of producing CBM according to their production costs (shown on the vertical axis). It also shows the available annual production capacity (on the horizontal axis). Figure 20 shows the merit order, going up to a production of 2.5 PJ. Only two methods (waste water treatment plants and landfill) are below the CBM target price. Together, their production capacity is 0.41 PJ, or 31% of the 1.22 PJ target. If we multiply these 0.41 PJ (or 410'000 GJ) by the RFU price of €7.15/GJ, we get a transfer of €2.93 million per year from liquid fuels suppliers to CBM suppliers. The next section will look at costs and look at how efficient this transfer mechanism would be.

Costs

RFUs have no (net) costs to the suppliers, since they leverage an existing blending obligation. Suppliers might have some personnel costs to manage the selling and/or purchasing of RFUs, but they would only engage in such costs if they were outweighed by the benefits (a source of income or a cost reduction, depending if they are selling or buying RFUs). The government would incur some low costs in setting up and administering the system, but these can be absorbed by a small fee on RFUs, if needed.

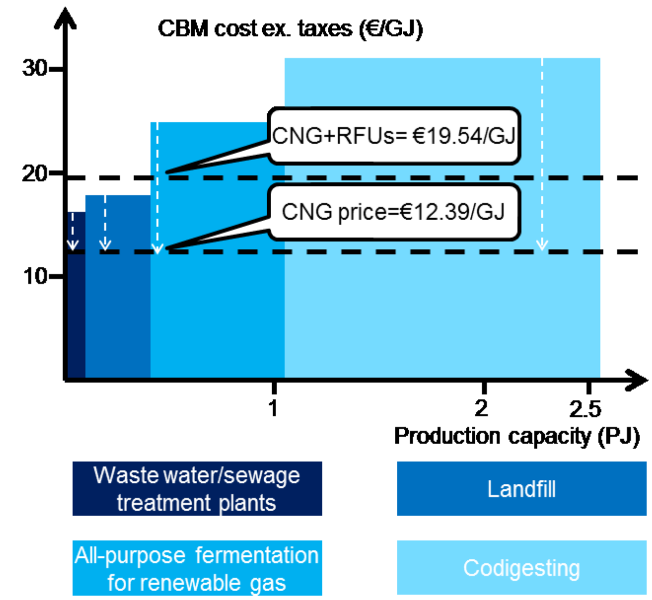


Figure 21: Subsidising only the financial gap

This does not mean, however, that the RFUs system is optimal at redistributing money: Some CBM suppliers will receive more than what they need to cover their financial gap. This is due to the fact that all suppliers will get the same amount per GJ from RFUs but won't have the same financial gap. Figure 21 shows the financial gap for various types of CBM production methods already shown in the previous section. In Figure 21, two methods (waste water treatment plans and landfill) have a financial gap that is lower than the value of RFUs, while the other two (organic waste and industrial residues, and codigesting) have a financial gap that is larger than the value of RFUs. As discussed in the previous section, only the methods that have a financial gap smaller than the value of the RFUs will actually come to the market (in the absence of other mechanisms). These methods will get more money than they actually need to cover their financial gap with CNG.

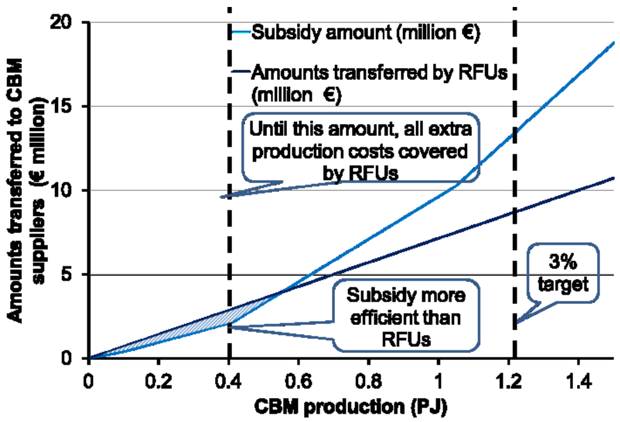


Figure 22: Transferred costs of subsidy and RFUs

Figure 22 illustrates this inefficiency in covering the financial gap by comparing the RFUs scheme, where all suppliers get the same amount of money per GJ, to a targeted subsidy scheme where only the actual financial gap is covered (see Key Solution 3.10). In this figure, we can see that a targeted subsidy would transfer less money towards the production of CBM, up to a given production volume (0.56 PJ in this case). After this, more expensive methods outweigh the cheaper ones, and a targeted subsidy would transfer more money than a "blind" scheme such as the RFUs system. Note that the uptake of CBM in the RFUs system is capped at 0.41 PJ because methods available above this production level would not recoup all their financial gap with CNG (see above), whereas the targeted subsidy scheme would continue to increase uptake at higher volumes. As such, the efficiency comparisons only makes sense up to the value where RFUs close the financial gap of CBM (in our case, 0.41 PJ).Note also that the targeted subsidy scheme would incur costs (through an increased excise tax on liquid fuels, for example), in contrast to the RFUs system (see above). This could however be tempered by reducing the blending obligation of liquid fuels suppliers in exchange for an increase in the excise tax (see above and in Key Solution 3.10).

In other words, a targeted subsidy system would transfer less money for a given amount of CBM production, or would lead to more CBM production for the same amount of transferred money (or a combination of the two). This is valid up to a production volume, given by the amount until which RFUs close the CBM financial gap with CNG, which is 0.41 PJ in our case. Note that extending the RFU curve leads to another value where the transferred costs of the two schemes are equal, but that value is not real, as RFUs would not be used above 0.41 PJ. The transferred costs can be quantified for the merit order we used and for the RFUs price we estimated. The production of 0.41 PJ of CBM (or the amount that RFUs would generate, as explained above) would transfer €2.93 million per year towards CBM suppliers in the RFUs system (see above), while a targeted subsidy system would transfer €2.15 million per year. Conversely, transferring €2.93 million per year would lead to a production of 0.41 PJ in the RFUs scheme, while the targeted subsidy scheme would generate 0.47 PJ. These numbers would change for a different context, but this relation would remain: Figure 22 will have a similar shape, as targeted subsidies will always transfer less money if we are below the production threshold of RFUs, since all production methods up to that point have by definition lower financial gaps than the price of RFUs.

Implementation

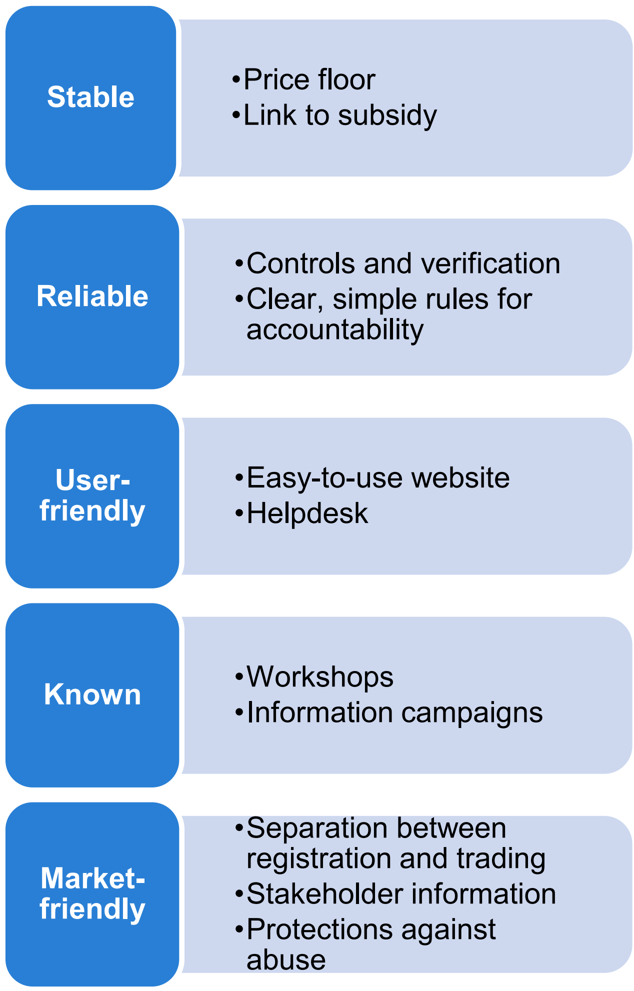


Figure 23: Design principles and needs of the RFU system

Figure 23 lists the recommended design principles, as well as the corresponding needs. Both are based on the existing Dutch system (see above and [NEa]).

Design principles

The design principles are that the system should be:

I. **Stable:** Producers would make long-term investment decisions. As such, they will want a stable, predictable RFU price. The most essential part of this stability would be that the price does not collapse. As such, mechanisms that create a price floor are very important. Offering links to a subsidy system (see above and Key Solution 3.10) is a possibility of doing so.

II. **Reliable:** In order for suppliers to participate in the market (both as purchasers and sellers of RFUs), they need to trust the system. There is also a need to demonstrate that biomethane supplied 1) satisfies sustainability criteria, 2) will be used in transport and 3) will contribute to the target for renewable energy in transport.

III. **User-friendly:** Another key point to increase supplier participation is to make the system easy to use. This is particularly important for the registry website, which should not require too much effort from CBM suppliers.

IV. **Known:** A third element increasing supplier participation is how much it is known. Its benefits and the way it works should be well communicated to potential users.

V. **Market-friendly:** Finally, the system should be setup in a market-efficient way, since it is based on a market (see the Mechanism section above).

Note that the registration system for RFUs can in principle largely be based on existing systems, such as a Guarantee of Origin (GoO) system, with additional information/data fields. The main additional information necessary is the certification that CBM is used for transport (see above and next paragraph for principles to ensure this).

Needs

The following elements can help realise these design principles:

XI. **Reliable:** Confidence in the system can be supported by two types of measures:
   a. **Controls and verification:** This includes a requirement for suppliers to get an annual verification of their entries by an accredited verifier, as well as periodic and random controls supported by a sanctions system (reducing the amount of RFUs booked, financial fines, bans from participation, etc.).
   b. **Clear, simple rules for traceability:** In order to ensure that both the origin and destination of biomethane, the managing authority can require guarantees of origin and set sustainability criteria for the biomethane, set a two-actor limit on the value chain/ban brokerage of biomethane, and require a dedicated connection to the gas for transport by allowing only station operators to register RFUs.

XII. **User-friendly:** The focus on making the system user-friendly is essentially aimed at the registry system.
   a. **Easy-to-use registry website:** The main element of the registry system is the website suppliers use to register their RFUs. It should be simple to use, require only necessary information, and it should reuse existing systems as much as possible. For example, it could reuse (parts of) the natural gas system and use current national and international tracking/guarantee of origin systems.
   b. **Helpdesk:** In parallel, the managing authority should open a helpdesk to help suppliers with their use of the website and any general questions about the system.

XIII. **Known:** The managing authority should promote the system among suppliers of renewable energy in transport and liquid fuels suppliers (who have a blending obligation and could be interested in buying RFUs).
   a. **Workshops:** The managing authority should organise workshops focussed on practical questions and helping (potential) users with the data registration process.
   b. **Information campaigns:** In parallel, the managing authority

should conduct an information campaign (advertisements, events at trade shows, etc.) aimed at all stakeholders, in order to get them to buy into the system.

XIV. **Market-friendly:** There are essentially three types of actions the managing authority can take to ensure that the market works well.

a. **Provide quality information:** The authority can ensure that market participants have quality information by informing about the system (see point III), by making the registration of RFUs reliable and trusted (see point I above), and by publishing statistics about the system (number of RFUs available). This information will make the market more efficient.
b. **Let suppliers organise the market:** By having suppliers decide on the price of RFUs and the forms of the contracts, the market will have maximal flexibility. This will make the market more efficient and more attractive for suppliers.
c. **Protections against abuse:** This includes the risk mitigation measures mentioned above: Controls and required verifications, guarantees of origin on fuels, requirements for suppliers, and the possibility to choose between subsidies and RFU registration. The latter creates a de facto floor, protecting suppliers from a market collapse (see Risk section above).

Stakeholders

The main stakeholders involved in the RFU market are:

I. **The Managing Authority:** Sets up rules for registering RFUs. It creates, maintains, and manages the registry. It also supports and informs (potential) users of the registry. It also sets up a control and verification systems, and sanctions suppliers that don't follow the rules.

II. **CBM suppliers**: Report their activities following the rules established by the manging authority. Sell the CBM to consumers and ensure that this happens through a dedicated connection to the grid. Sell RFUs to liquid fuels suppliers and establish contracts for these sales.

III. **Liquid fuels suppliers**: Purchase RFUs from CBM suppliers and establish contracts for these purchases. Note that they can also register and sell liquid biofuel RFUs.

IV. **Biomethane suppliers**: Supply biomethane to CBM suppliers and provide them with guarantees of origin and proof of adherence to sustainability regulations (if they are a different entity).

V. **Verifiers:** Check if the CBM suppliers follow the rules established by the Managing Authority.

VI. **The National Government:** Establishes the Managing Authority, and gives it its powers and financing (which can come through fees for using the system).

Timing

There essentially three phases/groups in the timing of solutions (see chart on the first page of this key solution):

IV. **Preparation (until Q4, 2017):** In this phase, the National Government ensures that the Managing Authority has the required support (legislative and funding). The Managing Authority sets up the registry website, establishes registration rules, and organises workshops and communications about the registry and RFUs. The Managing Authority also allows fuel suppliers to open test accounts to get familiar with the system.

V. **Execution (starting in Q1, 2018):** The Managing Authority runs and maintains the registry website, while suppliers register their RFUs and trade them.

VI. **Control and support (yearly, starting in 2018):** Verifiers check the entries made by suppliers, and the Managing Authority checks these entries. The Managing Authority also runs a helpdesk and organises workshops and communications about the registry and RFUs.

Note that this schedule is indicative and should be adapted as developments unfold.

Sources

[NEa]
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https://zoek.officielebekendmakingen.nl/stb-2014-460.html

[STX] Data by STX services in September 2016

[IEA] Biofuels for Transport Roadmap, IEA, 2011
https://www.iea.org/publications/freepublications/publication/Biofuels_foldout.pdf page 3, 2010 numbers

[OSPI]
http://www.opisnet.com/images/productsamples/EBISnewsletter-sample.pdf

For July 8th, 2016 to July 14th, 2016, Weekly average Gulf Coast (Retrieved September 29th, 2016): €19.7/GJ (ethanol) and €21.2/GJ (biodiesel)

3.10 Targeted Subsidies on Biomethane

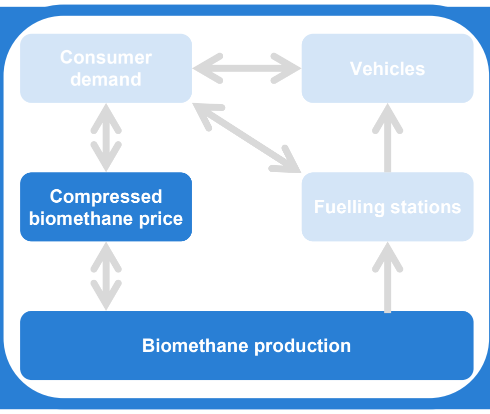
Affordability: ★☆☆☆☆

Feasibility: ★★★★★

Impact: ★★★★★

Speed: ★★★☆☆

Readiness: ★★☆☆☆



Solution summary

This key solution proposes to introduce a targeted subsidy system that closes the (estimated) financial gap between CBM and CNG. Achieving this for the 1.22 PJ target would cost about €13.47 million, which could be financed by a small increase in excise taxes. The crucial element of this key solution is to have a proper cost evaluation process in place.

Risk matrix

Solution timing by quarter

Elements	Stakeholders	2016	2017				2018				2019				2020			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Laws and funding	National government	■																
Select evaluator	Management agency	■																
Setup website for applications	Management agency			■														
Establish application rules	Management agency			■	■	■												
Get EC approval				■	■	■												
Workshops/communication	Management agency			■	■	■		■				■				■		
Select applications and fund	Management agency						■	■	■	■	■	■	■	■	■	■	■	■
Conduct interviews	Evaluator		■	■			■	■			■	■			■	■		
Produce subsidy advice	Evaluator				■	■			■	■			■	■			■	■
Submit applications	Biomethane producers						■	■	■	■	■	■	■	■	■	■	■	■
Verify registration	Controllers										■				■			

Understanding

Mechanism

Figure 24:What the subsidised financial gap is

This key solution consists of offering a subsidy to biomethane producers (who can pass that through to CBM suppliers so that CBM can be sold at the same price as CNG). This can be part of a more general scheme to subsidise the production of renewable energy (including other sectors than transport).

The crucial point is that this subsidy covers the actual financial gap between the production costs of renewable energy and the market price of the corresponding fossil alternative, as shown in Figure 24.

This requires that the entity providing the subsidy (generally a government agency) knows what the actual production costs of renewable energy are, and what the proper reference price is. This knowledge is provided by an evaluating entity (or evaluator).

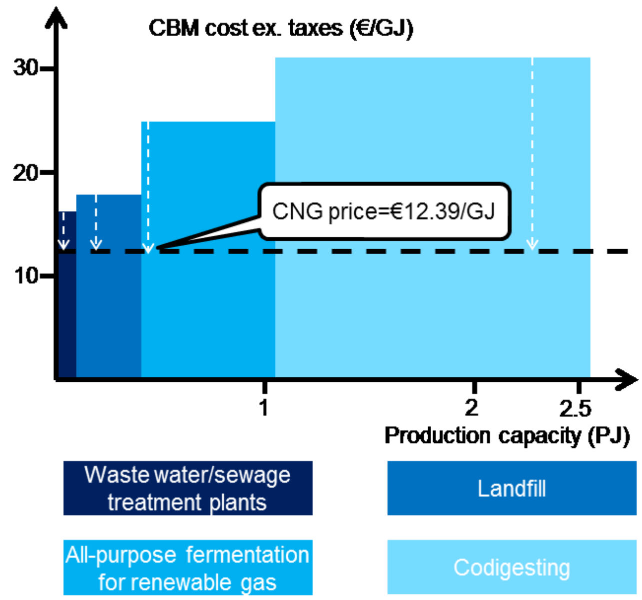


Figure 25:Subsidising only the financial gap

Figure 25 shows these elements for the case of CBM in Estonia. This figure shows the first 2.5 PJ of the merit order for the production of CBM, with the price of the fossil alternative (CNG) shown as a reference (see Text Box 4.2). The dashed white arrows show how big the financial gap is. Note that the CBM cost estimates are based on Dutch cost data for biomethane production. As such, the numbers quoted in this key solution are indicative only and should not be treated in the same manner as advice for the amount of subsidy to be given. That kind of advice requires a thorough and long process described below.

Experiences abroad and possible variants

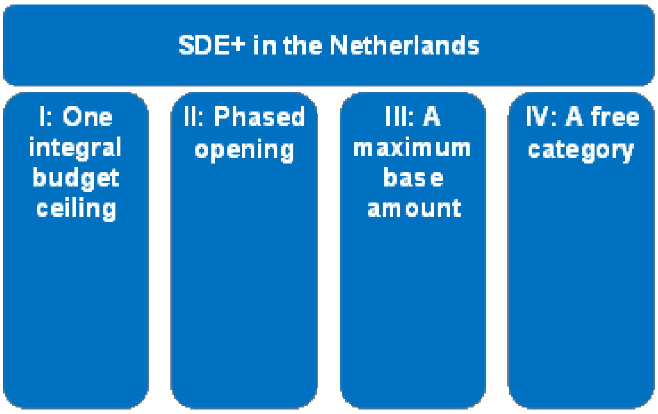


Figure 26: The four pillars of the SDE+ in the Netherlands

This section describes the Dutch SDE+ subsidy system. This key solution is an operating (feed-in-tariff) subsidy. Producers receive a subsidy for the production of renewable energy, and not for acquiring production installations such as with investment subsidies. It covers a wide range of technologies, for a wide range of uses. New categories are added (and removed) every year. The SDE+ subsidy compensates the financial gap of the production of renewable energy over a period of 5,8,12, or 15 years, depending on the technology. The subsidy is organised around four pillars, as illustrated in Figure 26:

I. **One integral budget ceiling:** The authority fixes a ceiling (€3.5 billion in 2015) for the subsidy scheme, and applications are processed on a first come, first serve basis. If two applicants apply on the day this amount is exhausted, the application with the lowest requested subsidy wins (there is a drawing of lots if the requested amounts are equal).
II. **Phased opening:** The subsidy is allocated in phases (9 in 2015), with increasing subsidy amounts per produced energy. For example, the first phase in 2015 was

€10.80/GJ for biomethane, going up to €18.72/GJ in phase 9 for co-fermentation of manure to produce biomethane. [RVO, 2015]

III. **A maximum base account:** The subsidised financial gap has a cap (which is the limit of the last phase from the point above). Technologies will only receive this amount or less per produced amount of energy.

IV. **A free category:** Technologies for which the required subsidy is higher than the maximum amount (that depends on the phase, as seen above) can still apply for a subsidy by using the free category. They would then get that maximum amount. The reason for them to do so could be that their actual costs are lower than the costs determined by the subsidy scheme, which would be the case for an operator more efficient or innovative than others, Another possibility for this application would be the case where an operator requires a lower (or even negative) return than is assumed in the base case. Operators might do so as an investment or for image reasons.

Subsidy applications are made through a dedicated website that uses general-purpose identifiers similar to the Estonian e-citizenship system. The application must include a feasibility study comprising, at minimum, an operation calculation, a financial plan and an elaborated time frame regarding the commissioning of the production installation. In order to actually receive a subsidy, applicants must also register with a certifying authority and set up a measurement protocol with a network operator. Banking (carrying forward to the following year) is allowed for production above or below an set amount, with a cap of 25%. [RVO, 2015]

The subsidy amounts discussed above (and the reference market prices) are determined by an independent evaluator (ECN Policy Studies[17]). This evaluator conducts confidential interviews with producers. These interviews collect production financial breakdowns and serve as input to a techno-economic evaluation that also includes an assumed required return on investment and time horizons. This is complemented by literature research and expert judgement. The key selling point is that it is in the best interest of producers to share that information (the confidentiality assures that their competitors do not get that information).

[17] Two of the authors of this report are ECN Policy Studies Employees but are not involved in the SDE+ evaluation process

Risk mitigation

The four main risks for this scheme are a rejection by the European Commission, a lack of trust in the evaluator, a (fear of) fraud, and project failures.

The reason for a **rejection by the European Commission** is that such a scheme could be viewed as an illegal state aid. Such aids are in principle forbidden, but the European Commission has laid out a series of exceptions. One of these exceptions is investment and operating aid to energy from renewable sources. One of the conditions for this aid is that only the actual extra costs (that is, the financial gap) are paid out, with yearly updates on the cost data. [European Commission, 2014] While this is relatively unlikely to occur, since there are justifiable reasons to introduce it and since other countries, such as the Netherlands have introduced it, this risk would have fatal consequences for the scheme, as it would not be allowed to happen. To overcome this risk, the Estonian government will have to submit extensive and detailed documentation and justification about the solidity of the scheme and show that it is justified, most notably by showing that only actual costs (the financial gap) are subsidised and that a proper evaluation place with annual updates is in place. This is a process that could take up to six months. The Dutch experience shows that the European Commission will look at the cost breakdown of subsidies to ensure that only the actual additional costs of producing renewable energy are subsidised. As such, it will be crucial to have solid data and procedures on the matter.

A **lack of trust in the evaluator** would cause some potential operators not to enter the scheme, but it is not likely to be universal, making this risk both relatively unlikely and relatively low-impact. Nevertheless, this should be overcome by selecting a trusted evaluator, through its (perceived) independence and competence. Clearly communicating the design principles of the process (see design principles below) would also help increase the trust in the evaluator.

A **(fear of) fraud** would the impact of the system, as subsidy would be paid to operators that do not provide the performance they are supposed to provide instead of providers that provide the performance, but at a higher cost. Similarly to the Renewable Fuels Unit (see Key Solution 3.9), this risk can be overcome by setting up a strong control system and only allowing trusted parties to participate in the system, such as is the case in the Netherlands (see above).

Project failures would result in wasted money and unrealised production of CBM. This is a risk that has a medium likelihood and a medium severity. Mitigation possibilities consist of ensuring that only reliable parties with a proven track record are eligible and by setting requirements on the stages of project realisation (i.e., stopping the subsidies if the project is too far behind schedule).

Impact

Effect on biomethane uptake

In principle, this scheme can close the financial gap for any amount of CBM, if enough money is made available for this scheme. The next section will look at how much money would be needed to achieve the target. This will be limited to CBM in transport and is only intended as an indication rather than an actual evaluation (which would require a long and thorough evaluation, similar to the one described in the previous section for the Netherlands). Such a scheme could also apply to other sectors, which would increase the costs. It is unclear if restricting the subsidies to the use in transport (through similar mechanisms as in Key Solution 3.9) would be allowed by the European Commission (see above).

Costs

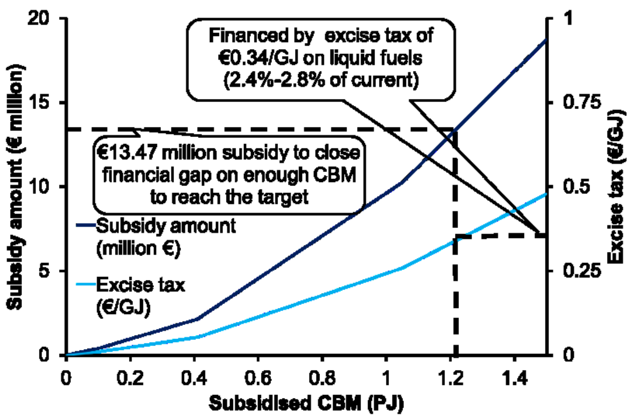


Figure 27: Targeted subsidy costs and corresponding excise tax

Figure 27, which is based on the merit order curve shown in Figure 25, shows how much subsidy would be required to close the gap for a given amount of CBM. For the 3%/1.22 PJ target, this amount would be €13.47 million (again, this is an indicative amount, based on production costs for the Netherlands). Figure 27 also shows by how much the excise tax would need to be increased to finance this subsidy amount. This is only one possibility to finance the subsidy scheme and is primarily shown here to give an idea of the impact. As such, this is not meant as an advice on how to finance the subsidy but to illustrate the scales at hand. This is computed by dividing the subsidy amount by the amount of gasoline and diesel. This tax amount increases as more CBM enters the system and replaces gasoline and diesel. The €13.47 million needed to close the financial gap for 1.22 PJ of CBM would require an excise tax increase of €0.36/GJ. This would correspond to an increase of 2.4%/€1.1 ct/litre (if compared to gasoline, without VAT) to 2.8%/€1.4 ct/litre (if compared to diesel, without VAT).

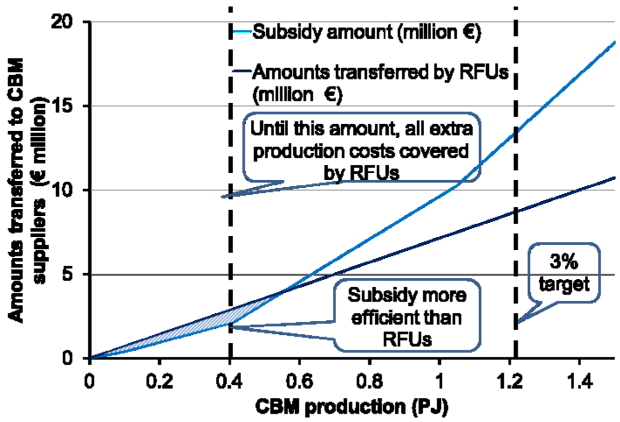


Figure 28: Transferred costs of subsidy and RFUs

Figure 28 compares the computed transferred amounts from liquid fuels suppliers through the Renewable Fuel Units (RFUs) scheme discussed in Key Solution 3.9 to the amount of subsidies required by a targeted subsidy scheme. Note that the RFU curve is only valid until the first threshold amount of 0.41 PJ shown in Figure 28. This amount is the amount of CBM that a RFU system makes cost-competitive with CNG. After that, it would not lead to an increased uptake, since CBM manufacturers would have a remaining financial gap with CNG (see Key Solution 3.9).

Figure 28 shows that the RFU scheme would transfer €2.93 million to get 0.41 PJ of CBM (above this, the RFU scheme does not make CBM competitive with CNG anymore). A targeted subsidy would transfer only €2.15 million. Another way to look at this is that a subsidy of €2.93 million would close the gap for 0.47 PJ of CBM. This means that the targeted subsidy scheme we are looking at is a more efficient way of transferring money/ can achieve more with the same amount of transferred money than the RFU scheme in Key Solution 3.9. The reason for this is that more information is available to the party paying the money: Subsidies correspond to estimated production costs. These can different from actual costs of a given producer, so it is not entirely efficient. Nevertheless, this is more information than in the case of RFUs, where the amount of money transferred is based on the price difference between gasoline and biogasoline, which is due to the fact that liquid fuels suppliers have a blending obligation and the fact that biogasoline has a lower premium over gasoline than biodiesel over diesel (see Key Solution 3.9). This does not take into account the dynamic nature of the RFU scheme, which would make an actual comparison more complex.

This does not however mean that a targeted subsidy scheme is cheaper than an RFU system. The opposite actually holds, as the RFU scheme does not create extra costs to suppliers, but an increased excise tax would (the money could also come from elsewhere). A potential way to combine the efficiency of a targeted subsidy scheme and of the low (or zero) financial impact of the RFU scheme would be to reduce the blending obligation of liquid fuels suppliers, in exchange for an increase in the excise tax. That excise tax could then in turn finance the financial gap of CBM. This would however require a careful, complex evaluation of the required blending obligations and levels of excise tax. This evaluation would also need to be adjusted regularly.

Implementation

Design principles

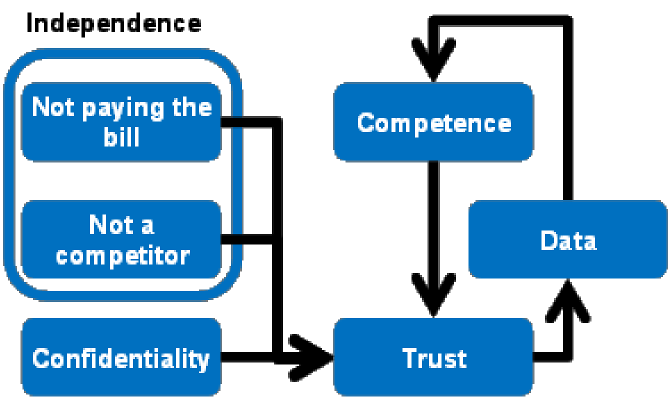


Figure 29: How to build up a trusted and competent production costs evaluation system

The key element in a successful targeted subsidy system is the evaluation process that estimates the production costs of renewable energy (CBM, in this case). This will help producers buy into the system and avoid risks concerning fraud and lack of trust in the evaluator. It will also reinforce the case towards external parties, such as the European Commission, thereby avoiding a potential veto on the scheme (see Risks above). Figure 29 shows how a proper evaluation system helps build trust into the system.

I. The first element of a proper evaluation system is the choice of the evaluator. It should be doubly independent. The first form of independence is that the evaluator and the managing agency that hands out payments are separate. This will ensure that there is no pressure to underestimate the costs. This independence can be ensured if the evaluator is a private, external party. It can also be ensured if the evaluator is a governmental agency that is fully independent (by law) from the managing entity that hands out payments. The second form of independence is that the evaluator should not be receiving any of the money, which would ensure that there is no pressure to overestimate the costs, or to favour technologies from the evaluator (or related entities).
II. The second element of a proper evaluation system is the confidentiality of the shared data. This will ensure that interviewed producers share meaningful data, as they would not fear that their competitors would access that data. It is crucial to communicate that confidentiality and explain which mechanisms are in place, as well as to explain the whole system in general so that producers see that it is in their best interest to share meaningful data (such as detailed financial breakdowns and decision-making criteria). The confidentiality can be assured by strong non-disclosure agreements and by a strong and transparent system to anonymize and aggregate the data. The latter will ensure that no input data can be reconstructed or attributed to a specific party.
III. The third element of a proper evaluation system is that the evaluation process is an ongoing, repeated process. Independence and confidentiality build trust in the evaluator, which gives them access to meaningful data. This access helps them build competence, which in turns reinforces the trust. This reinforced trust means that

the next round of interviews will yield meaningful data, and so on and so forth.

Needs

In addition to the strong evaluation system explained in the previous paragraph, a successful targeted subsidy system needs:

a) **A strong verification system:** Producers need to submit data for verification, including on-site metering to avoid any risk of fraud and ensure that the subsidies have an actual impact.
b) **Clear, well known rules**: The rules for application (process, amounts available, deadlines for various phases, deciding criteria) should be clearly established, known in advance, and properly communicated. This will ensure both that producers buy into the system and trust from producers and external parties.
c) **Broad and sustained communication**: Potential participants should be aware of the system. This needs to happen well in advance and needs to be regularly sustained.
d) **Link to RFUs (optional):** Having a Renewable Fuel Unit (RFU) system in parallel to a targeted subsidy scheme could help reduce the subsidy amount, as (some) producers would choose the RFUs, if they are more valuable to them. This also works as a floor for the RFU market, protecting participants from a market collapse (see Key Solution 3.9 and Costs Section above)

Stakeholders

The main stakeholders involved in a targeted subsidy scheme are:

I. **Biomethane producers:** Produce biomethane, apply for and receive subsidies. They also need to share detailed financial breakdowns with the evaluator on a regular basis and submit their production data to the controller.
II. **The Evaluator:** Gathers financial data from biomethane producers, processes the data, maintains confidentiality, and produces advice of the subsidy amounts (difference between production costs and fossil market alternative price).
III. **The Controller:** Verifies the integrity of the production data submitted by producers.
IV. **National Government Management Agency:** Manages the submission system, makes final decisions on subsidy levels (including setting caps for each phase), sanctions fraud, and communicates about the system (support and outreach).
V. **The National Government:** Empowers the Management Agency and funds it (running costs and subsidies to producers).

Timing

The timing shown in the chart at the first page of this key solution can be divided into two parts:

I. **Preparation:** In this phase (until end of 2017), the involved parties set the system up, with the following main action points, sorted by actor
    a. **The National government** : Passes the laws that empower and fund the management agency (running costs and subsidies)
    b. **The Management Agency**: Selects the evaluator, sets up the website for applications, establishes application rules, and gets approval from the European Commission. It also conducts workshops and informs potential applicants about the system.
    c. **The Evaluator**: Conducts interviews and produces subsidy advice reports.
II. **Running:** The programme itself can start in 2018, under the condition of being approved by the European Commission. The main action points, sorted by actor, are:
    a. **The Management Agency**: Selects which applications to fund (this also includes deciding what the actual subsidy levels are and the timing of each phase).It also conducts workshops and informs potential applicants about the system.
    b. **The Evaluator**: Conducts interviews and produces subsidy advice reports.
    c. **Biomethane producers:** Submit applications and activity data.

d. **Controller:** Verifies data submitted by producers.

Sources

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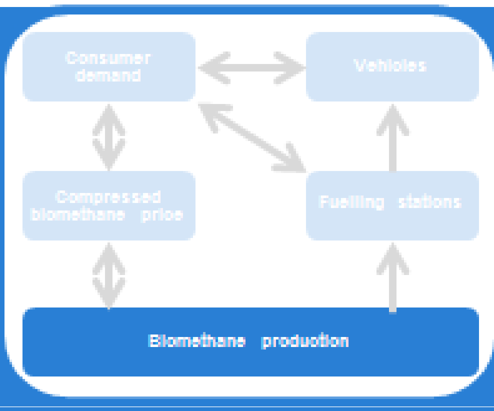
3.11 Increasing digestion of organic waste

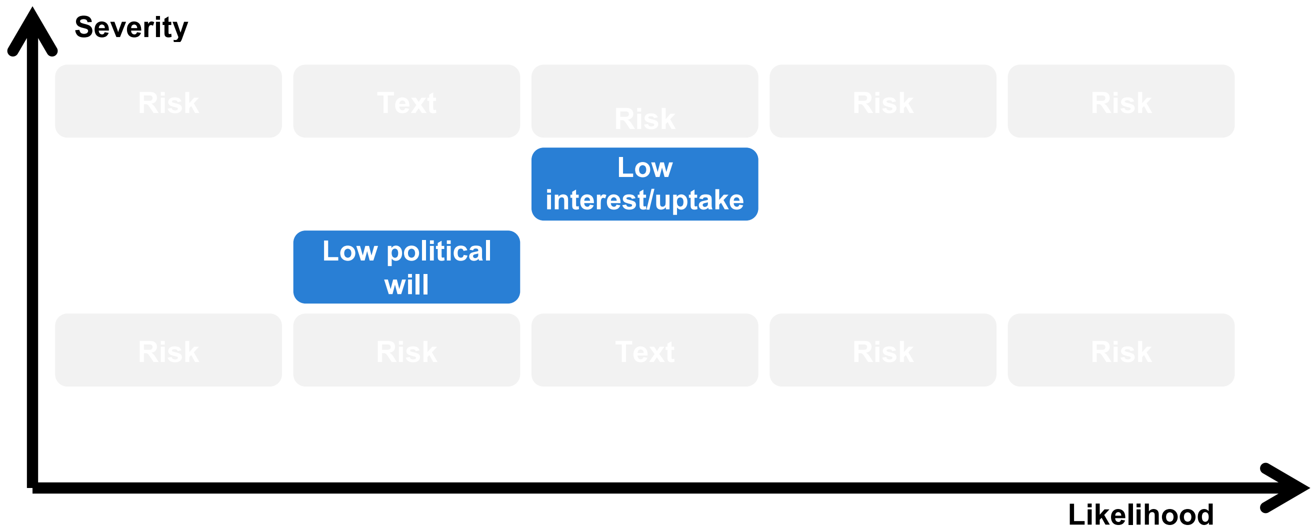
Affordability: ★★☆☆☆
Feasibility: ★★★☆☆
Impact: ★★★★☆
Speed: ★★★☆☆
Readiness: ★★★☆☆



Solution summary

This solution will increase the digestion of organic waste and related biomethane production by: (1) obliging the separation of biowaste at the source; (2) collecting biowaste separately from municipal and other waste generators; (3) adjusting the gate fees for landfilling and incineration; (4) adopting a ban on landfilling and incinerating of biowaste; and (5 supporting regional biowaste anaerobic digestion platforms.

Risk matrix



Solution timing by quarter

Elements	Stakeholders		2017				2018				2019				2020			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1.1 Set clear policy targets	National government	■	■	■	■													
1.2 Ban biowaste landfilling.	National government		■	■	■	■												
2.1 unpackaging feasibility study and investment support	Managing Authority, experts		■	■	■	■	■	■	■	■	■	■	■	■				
2.2 review existing subsidy schemes for biowaste projects	Managing Authority, experts	■	■	■	■													
2.3 To differentiate gate fees	Managing Authority			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
2.4. To select AD technology for organic residues of MBT	R&D						■	■	■	■	■	■	■	■	■	■	■	■
2.5 To work out selection criteria for high priority	Managing Authority, experts		■	■	■	■												
3.1 Support and training of municipalities, stakeholders	Training institutions			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

Understanding

Mechanism

Biodegradable waste (organic fraction of municipal solid waste, organic industrial waste, garden waste nature and landscape conservation waste etc.) could serve as valuable raw material for biomethane production. It also doesn't compete with food production and usually has lower cost compared with using silage. In Estonia biowaste is not digested to biomethane. Key problems and issues are:

(1) Biowaste is currently almost not separated at source; (2) Waste (organic fraction) is not collected separately 3) biowaste is mostly burned or composted: a missed opportunity to produce biomethane and biofertilizers.

This key solution identifies the reasons for this situation and provides actions and measures to improve the situation.

In 2015 a new regulation[18] obliges that biodegradable kitchen and canteen waste has to be sorted at spot. The gap is in enforcement of this regulation. The reasons for this are not yet analyzed. [MOE 2016]

Estonia has set a goal that from 2020 onwards, all separately collected waste from households and municipal waste from other sources should be recycled for at least 50 %. However, only few municipalities have enforced separated biowaste collection..

Annually 12'000 tonnes of food products are left unsold and written off at Estonian food stores. Until now this separately collected biowaste is composted or landfilled rather than being used for biomethane production. Barriers for doing this are:

- unfavourable price of biomethane compared to the price of natural gas;
- low demand;
- no differentiated gate fees
- not fully enforced legislation;
- *additional cost of un-packaging facility.*

[18] The Minister of the Environment signed an amendment to the regulation on sorting and classifying municipal waste, specifying the requirements for the collection and sorting of waste in May 2015.

After 2020 Estonia is allowed to landfill no more than 20% of their municipal biowaste. The remaining 80% has to be recycled.

Producing biomethane from biowaste is cheaper than from green biomass. Anaerobic digestion is a very cost effective and nature friendly waste management option, even compared with composting of biowaste.

The majority of food waste is created in households, catering companies and supermarkets. Approximately 40% out of 92.6 thousand tonnes of food waste annually produced can be easily used for anaerobic digestion [Moora, H. 2016].[19]

To support biowaste source separation, the separate collection of biowaste, the use of biowaste for biomethane production and to get digestate valued and sold on market with proper price needs a lot of cooperation, training, awareness raising, joint marketing via regional whole-value-chain-covered platforms (long-term cooperation business models).

Experiences abroad and possible variants

Norway- from food waste to bus fuel and biofertiliser

The Norwegian capital's new biogas plant supplies nutrient-rich biofertiliser for agriculture. The plant processes 50'000 tonnes of food waste annually, converting it to environment-friendly fuel for 135 municipal buses as well as enough biofertiliser for roughly 100 medium-sized local farms. [Aarvig, S & Lie, E 2012]. More details about Norwegian experiences are in separate annex on biowaste.

Biowaste to biofertilizer in Finland

The Finnish MSW strategy is based on source separation of biowaste[20]) and incineration of the residual waste. The biowaste treatment is mainly

[19] In the case 1 tonne of biowaste creates 100 Nm3 biomethane (97% CH4) the total biomethane potential is 9.26 million Nm3 (0.33 PJ) and 40% of it makes 0.13 PJ).

20 Biowaste is intended to be collected and treated separately from other waste fractions in Finland. According to the Waste Tax Act (495/96) at the moment a tax of 70 euro/tonne tax for the waste landfilled. In order to support the progress of biological treatment of separately collected biowastes and sludges from municipal waste water treatment plants, the treatment is not subjected to taxation.

based on composting. In addition there are five anaerobic digestion plants in Finland, which usually treat biowaste together with sewage sludge. The new waste legislation prohibits landfilling of waste with more than 10 % organics from 01.01.2016.

The intensity of separate biowaste collection depends mainly on the view the municipal waste management companies have on the advantages of incineration or biological treatment. Also in Finland the awareness for the need of nutrient recycling by anaerobic digestion is rising. [Gareis, C. 2016]

Risk Mitigation

Risk 1. Low political will to set national targets to get majority of biowaste separated and digested by 2020

Mitigation: LCA, feasibility study and awareness campaigns on positive economic and environmental effects should indicate the win-win character of the measure. Also positive European/Nordic working examples should be encouraging. Study visits to one or two of these countries like Finland, Norway, Sweden, Denmark, Netherlands, Germany, UK, might enhance political will to use biowaste for biomethane production.

Risk 2. Low interest/uptake from companies to invest to un-packaging and pre-treatment facilities

Mitigation: the investment for un-packaging technology for food waste recycling from supermarkets should be economically feasible for companies (either via biomethane price, CAPEX support or differentiated gate fees).

Impact

Effect on biomethane uptake

The supposed actions are expected to have a significant impact to the uptake of biomethane because they rank as attractive cost-effective. Their total potential is 0.74 PJ (22 million Nm3/year, divided between the different feedstocks as shown below:`

Feedstock	Energy (PJ)	Biomethane volume (million Nm^3)
Organic fraction of MSW	0.06	1.7
Waste water treatment	0.10	3.0
Industrial waste and food industry	0.58	17.1
Total	0.74	21.8

Costs

Composing and implementing a legal framework and setting national priorities will not cause substantial additional costs.

The costs for installation and operation of the first 10 food-waste unpackaging facilities is yet uncertain and needs to be defined[21]. In addition options need to be identified for setting differentiated gate fees, in such a way that it discourages landfilling and incentives the digestion of waste streams that are most suitable to convert into biogas. This would imply setting higher gate fees for composting/MBT or setting lower gate fees for biowaste, if used for digestion (the collected higher gate fee for composted biowaste can be used to support the bio-waste unpackaging / pre-treatment projects in long term).

Implementation

Design principles

<u>1. Improving legal environment</u>

At first all laws concerning separate collection of biowaste already approved need to be enforced.

<u>2. Economic incentives to promote biowaste digesting</u>

The second group of actions should lower the market barriers for separate collection of biowaste and subsequent biomethane production.

[21] Relevant background studies, situation analyses, investment support relevance for the first 10 food-waste un-packaging facilities or pre-treatment installations, assessment of existing subsidy schemes needed to be implemented. The cost will depend on the terms of references and there is a knowledge gap to estimate the costs at this stage.

3. Awareness, knowledge and experience sharing

The third group of actions are targeted to raise awareness and knowledge of all stakeholders to ensure common understanding of national priorities in using biowaste for biomethane production. These actions can be implemented under national platform key solution.

Needs

1. Improving legal environment

To improve and enforce legal environment following actions are designed:

1.1 to set clear policy targets and to agree on "biowaste to biomethane" as national priority in next national waste management plan;

1.2 by 2030 biowaste landfilling should be banned fully.

2. Economic incentives to get biowaste digested and biofertilizer produced

2.1 to implement feasibility study to find out if the additional cost of unpackaging facility are covered by differentiated gate fees or that they need additional incentives.;

2.2 Review if existing subsidy schemes for biowaste still provide the proper incentives;

2.3 To differentiate gate fees (to find out most appropriate method to interfere market based gate fee strucuture) according to selected biowaste treatment method (e.g biomethanization, composting, MBT, incineration, landfilling).

2.4. To work out selection criteria for supporting high priority biowaste to biofertlizer regional platforms-projects.

2.5 to cover the knowledge gap on how regulated gate fee for different use of biowaste will effect the waste price and subsequently biomethane price.

Stakeholders

Governmental authorities, local municipalities, waste management companies, landfill operators, biomethane producers, biofertilizer cluster-joint marketing, biomethane platforms.

Timing

First of all existing legislation should be enforced. New legal acts should be implemented next. Economic incentives should be worked out and implemented from 2017 onwards. The awareness raising campaign has to begin in 2017.

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3.12 Certification and legislation of digestate

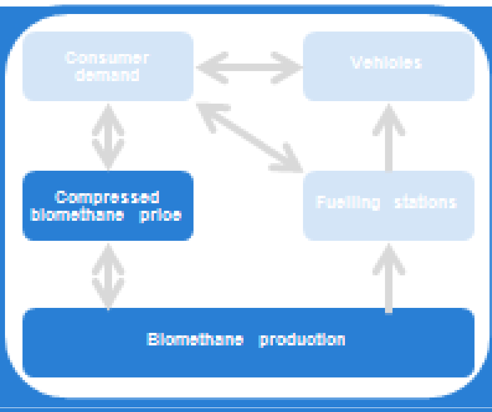
Affordability: ★★☆☆☆

Feasibility: ★★★☆☆

Impact: ★★★★☆

Speed: ★★★☆☆

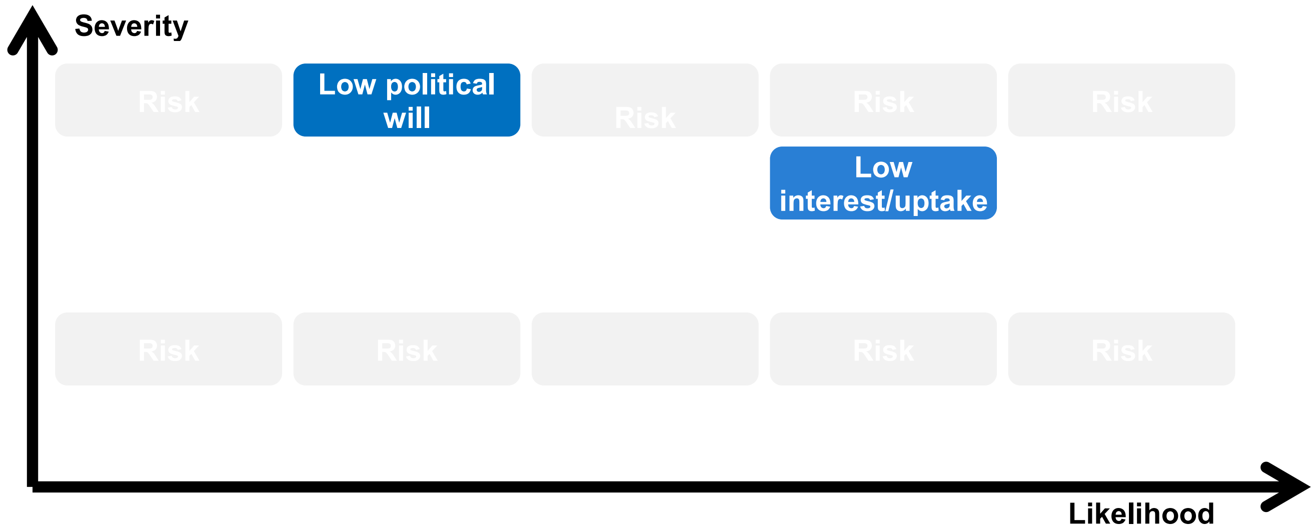
Readiness: ★★★☆☆



Solution summary

This solution helps toimprove the business case for biomethane production by enhancing the value and market price of digestate (also from biowaste) in various ways: (1) certifying the process of digestate useage as biofertilizer; (2) enforcing related norms and standards and requireing a legal framework; and (3) implementing trainings and raising awareness.. In addition the solution analyses the feasibility and support for regional whole-value-chain-covered platforms (long-term cooperation business models) for joint marketing biofertilizer in export markets.

Risk matrix



Solution timing by quarter

Elements	Stakeholders		2017				2018				2019				2020			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1.1 to set clear policy targets	National government	■	■	■	■													
1.2 To establish BM digestate certification body	Managing Authority		■	■	■													
2.1 feasibility studies (5-6) of regional biowaste AD plants	Waste sector, experts, biomethane producers		■	■	■	■												
2.2. Joint marketing support	Regional platforms			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
3.1 Support and training of municipalities, stakeholders	Training institutions			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

Understanding

Mechanism

Digestate from biomethane production could be a valuable biofertilizer with similar nutrient value as artificial fertilizers[22]. Although most of the legal acts for using digestate as fertilizer already exist in Estonia, the market does not start. Until now no exportable biofertilizer is produced from digestate. This key solution identifies the reasons to this situation and provides actions and measures for solution.

Instead of using biowaste for biomethane production it is currently composted according to the Degree no 7 of Ministry of Environment [Compost Reg. 2013], which sets the legal framework for certification of the compost as fertilizer. The certification body is Estonian Union of Waste Management Organizations (*Eesti Jäätmekäitlejate Liit)* and the certified compost can be sold as fertilizer. According to this Compost regulation and certification scheme the biggest compost producer, Tallinn Recycling Centre, sells the compost from biowaste at a price of 4.8 €/tonne (including VAT and loading cost); transport service is not provided; the minimum amount is 20 kg.

The digestate from biomethane production (also from biowaste) could be a valuable biofertilizer. If biomethane is produced from biowaste, the process and end product – biofertilizer – has to be certified. In this way it won't be qualified as waste, but as a new product. The Ministry of Environment adopted the Regulation nr 12 on biogas digestate quality and process requirements in May 2016 [Digestate Reg, 2016]. However, the practical enforcement of this Regulation requires the establishment of Certification Body, which yet needs to be defined.

To get digestate valued and sold on the market for a proper price needs a lot of cooperation, training, awareness rising, and joint marketing via regional whole-value-chain-covered platforms (long-term cooperation business models).

[22] Digestate has similar nutrient value as manure, but it will depend from used raw materials in AD plant. The objective of biofertilizer as product development should target to turn digestate into a product with very stable nutrient content and needed balance between N, P and K, using e.g biochar, pelletizing biofertlizer for transport purposes (not for burning), etc.

Risk Mitigation

The key risk is low interest/uptake by agriculture to use digestate as fertilizer. The risk is higher for biofertilizer, which is made from biowaste. Even it is certified, it has no demand/market yet in Estonia, because manure and digestate from agricultural plants have satisfied the domestic demand already. If the demand in domestic market is low, biofertilizer has to be exported. Without implementing solutions there is a high risk that the current situation won't improve. This will have a severe impact, because if the biofertilizer is not sold based, the feasibility of biomethane production from biowaste is much lower.

Mitigation: provide seed capital for regional platforms on biowaste anaerobic digestion. Set up joint marketing of these regional platforms to sell certified biofertilizer jointly, in Estonia an/or elsewhere where demand exists. Increasing volume by ointly marketing of all Estonian (5-7) regional platforms is crucial in selling biofertilizer in export markets.

Impact

Effect on biomethane uptake

Planned actions have direct impact to the uptake of biomethane because if the digestate can be sold for a decent price it will have a significant impact on the cost of biomethane. The solution will impact biomethane production form organic biodegradable municipal, kitchen, canteen etc waste, waste water treatment plants sludge and industrial organic waste.

Costs

The costs an appropriate financial support for the above listed economic incentives for biowaste digestion to biofertilizer, still needs to be defined. Similarly costs have not yet been defined for establishing and training a digestate certification body, as well as for implementing relevant background studies and situation analyses. RResources needed, yet to be defined.

Implemention of feasibility study(ies) on economic incentives to get biowaste digested to biofertilizer in regional plants.

via regional platforms and joint-marketing support to regional biowaste AD platforms to export

Support and training of municipalities and stakeholders, which will establish joint cooperation digestate platforms will be implemented within framework of national platforms.

The support particularly involves seed capaital for regional biowaste anaerobic digestion platforms (e.g. for establishing and OPEX during the 1st year, until export market channels are properly working). Such support would increase the feasibility of biomethane production. Assuming that 5-6 biowaste platforms will be established, at an average support need per platform of 0.2-0.4 million €, the overall costs would amount € 1 -2,4 million.

Implementation

1. To establish digestate certification body and to enforce the digestate certification system to get biofertilizer from biowaste recognized as valuable side-product of biomethane production.

2. feasibility study(ies) on economic incentives to get biowaste digested to biofertilizer in regional biowaste co-digestion plants (e.g. Pärnu). According to the promoter of Pärnu regional biowaste to biomethane plant around 5-6 such regional biowaste-to-biomethane plants are feasible in Estonia. Feasibility studies will give answer to this assumption. [Pitk, P. 2016].

3. Joint marketing support to regional platforms. This will assist the cooperation between regional platforms, which helps to overcome the market barrier, where single biomethane (and biofertilizer) producers alone are not able to find additional export market channels and segments for biofertilizer.

Regional platforms on biowaste to biofertilizer projects have the first preference with higher priority, because they have lower GHG emissions and lower negative environmental impact according to the Life Cycle Analyses (LCA) or similar assessment methods. The appropriate support need (and amount) will be assessed at later stages, when legal environment and other preparatory activities are implemented.

Stakeholders

Governmental authorities, local municipalities, waste management companies, landfill operators, biomethane producers, biofertilizer cluster-joint marketing, biomethane platforms.

References

[Compost Reg. 2013] Keskkonnaministeeriumi määrus / Regulation of Ministry of Environment 08.04.2013, Biolagunevatest jäätmetest komposti tootmise nõuded, (Requirements for compost from biowaste) no 7, https://www.riigiteataja.ee/akt/110042013001

[Digestate Reg, 2016] Keskkonnaministeeriumi määrus nr 12 / Regulation of Ministry of Environment, Nõuded biolagunevatest jäätmetest biogaasi tootmisel tekkiva kääritusjäägi kohta (Requirements for digestate from biogas production from biowaste) adopted on 10.05.2016, https://www.riigiteataja.ee/akt/119052016009#

[Pitk, P. 2016]. Interview with Mr. Peep Pitk 23.08.2016, Tallinn.

4 Text boxes

This chapter provides six ‘Text Boxes’ containing additional information. These ‘Text Boxes’ have been selected in support of some of the Key Solutions, as well as on the basis of their relevance and added value for the topic in general.

4.1 Fuel properties and costs

Introduction/Goal

This document puts together the properties, costs, and taxes of (fossil) fuels in Estonia, namely gasoline, diesel, CNG, and natural gas.

Physical properties

Fuel	Unit	Energy content (GJ/unit)	Source
Gasoline	Litre	0.03315	[IEA, 2004]
Diesel	Litre	0.03661	[IEA, 2004]
CNG	Kilogram	0.04905	[Elering, 2016]
Natural gas	Cubic metre	0.03407	[Elering, 2016]

Table 4: Physical properties of fossil fuels

Prices

Pump prices of liquid fuels per sold unit

Fuel	Unit	Pump price with taxes (€/unit)	Source
Gasoline	Litre	1.069	[European Commission,2016]
Diesel	Litre	1.050	[European Commission,2016]
CNG	Kilogram	0.729	[Eesti Gas, 2016]

Table 5: Pump prices of liquid fuels per sold unit (with taxes)

Fuel	Unit	Pump price excluding VAT (€/unit)	Pump price excluding taxes (€/unit)
Gasoline	Litre	0.891	0.426
Diesel	Litre	0.875	0.427
CNG	Kilogram	0.608	0.608

Table 6:Pump prices of liquid fuels per sold unit (without taxes)

Pump prices of liquid fuels per energy unit (GJ)

Fuel	Pump price with taxes (€/GJ)	Pump price excluding VAT (€/GJ)	Pump price excluding taxes (€/GJ)
Gasoline	32.251	26.876	12.847
Diesel	28.682	23.902	11.664
CNG	14.862	12.385	12.385

Table 7:Pump prices of liquid fuels per GJ

CNG pump price components

CNG pump price= €14.862/GJ (€0.729/kg)

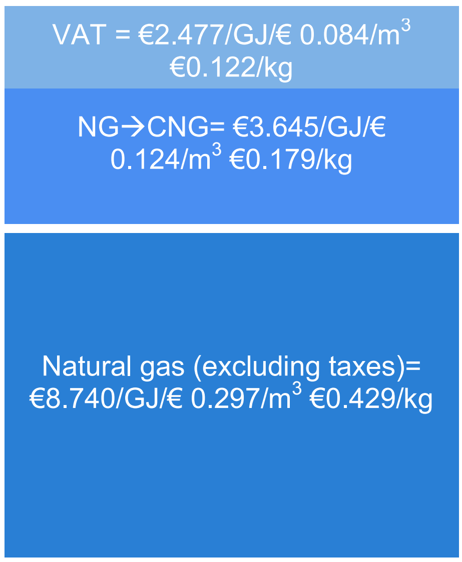


Figure 30: Elements of the pump price of CNG

The price of natural gas (for industrial customers, excluding taxes, see source for details) is €8.74/GJ [Eurostat, 2016] (or €0.297/m^3, or €0.429/kg). This means that the **price to transform NG into CNG** (compression and distribution) is €12.385/GJ-€8.740/GJ**=€3.645/GJ** (or €0.124/m^3, or €0.179/kg). Note that this is based on market prices and includes vendor margin. It is expected that station owners would aim at treating CBM in the same way as CNG, namely they would apply the same margins.

Taxes

VAT rate=20% [Ministry of Finance of the Republic of Estonia, 2016a]

Fuel	Unit	Excise tax (€/unit)	Excise tax (€/GJ)
Gasoline	Litre	0.465	14.029
Diesel	Litre	0.448	12.238
CNG	Kilogram	0	0

Table 8:Excise tax

Source = [Ministry of Finance of the Republic of Estonia, 2016b] . Note that the table above does not include the VAT, which is applied to the price including the excise tax (thereby increasing it by 20%).

Note that there is a proposal to set an excise tax on CNG, of €0.035/kg (€0.714/GJ) in 2017 and €0.077/kg (€1.570/GJ) in 2018. These plans include an exemption for CBM.

Sources

[Elering, 2016] Elering, 2016, Maagaasi kvaliteedi tuunistus august 2016 http://gaas.elering.ee/wp-content/uploads/2016/09/Maagaasi-kvaliteeditunnistus-august-2016.pdf , density= 0,6946 kg/m³, consistent with http://www.gaas.ee/en/compressed-natural-gas/cng-as-car-fuel/ with 34 MJ/m3, density of 0.56 that of air (1.225 kg/m3, 1atm, 15C)=49.56 MJ/kg

[IEA, 2004] IEA, 2004, Energy Statistics Manual IEA/OECD/Eurostat 2004

http://ec.europa.eu/eurostat/documents/3859598/5885369/NRG-2004-EN.PDF/b3c4b86f-8e88-4ca6-9188-b95320900b3f

44.75 GJ/tonne net calorific value, 740.7 kg/m^3 density (gasoline)

43.38 GJ/tonne net calorific value, 843.9 kg/m^3 density (gasoline)

[European Commission, 2016] European Commission, 2016, Weekly Oil Bulletin, https://ec.europa.eu/energy/en/data-analysis/weekly-oil-bulletin Retrieved on September 28th, 2016

[Eesti Gas, 2016] Eesti Gas, 2016 http://www.gaas.ee/en/compressed-natural-gas/cng-price/ Retrieved on September 28th, 2016

[Ministry of Finance of the Republic of Estonia, 2016a] http://www.fin.ee/value-added-tax

[Ministry of Finance of the Republic of Estonia, 2016b] Ministry of Finance of the Republic of Estonia, 2016 http://www.fin.ee/excise-duties

[Eurostat, 2016] Eurostat, 2016

Gas prices for industrial consumers - bi-annual data (from 2007 onwards), excluding taxes and levies, band I4 (100'000 GJ<Consumption<1'000'000 GJ).

http://appsso.eurostat.ec.europa.eu/nui/show.do?query=BOOKMARK_DS-052778_QID_19DCD425_UID_-3F171EB0&layout=TIME,C,X,0;GEO,L,Y,0;PRODUCT,L,Z,0;CONSOM,L,Z,1;UNIT,L,Z,2;TAX,L,Z,3;CURRENCY,L,Z,4;INDICATORS,C,Z,5;&zSelection=DS-052778PRODUCT,4100;DS-052778TAX,X_TAX;DS-052778CONSOM,4142904;DS-052778INDICATORS,OBS_FLAG;DS-052778UNIT,GJ_GCV;DS-052778CURRENCY,EUR;&rankName1=TAX_1_2_-1_2&rankName2=UNIT_1_2_-1_2&rankName3=CURRENCY_1_2_-1_2&rankName4=CONSOM_1_2_-1_2&rankName5=INDICATORS_1_2_-1_2&rankName6=PRODUCT_1_2_-1_2&rankName7=TIME_1_0_0_0&rankName8=GEO_1_2_0_1&sortC=ASC_-1_FIRST&rStp=&cStp=&rDCh=&cDCh=&rDM=true&cDM=true&footnes=false&empty=false&wai=false&time_mode=NONE&time_most_recent=false&lang=EN&cfo=%23%23%23%2C%23%23%23.%23%23%23

4.2 Merit order CBM production

Introduction/Goal

This document contains merit order data for the production of CBM with different feedstocks (and corresponding methods).

Merit order

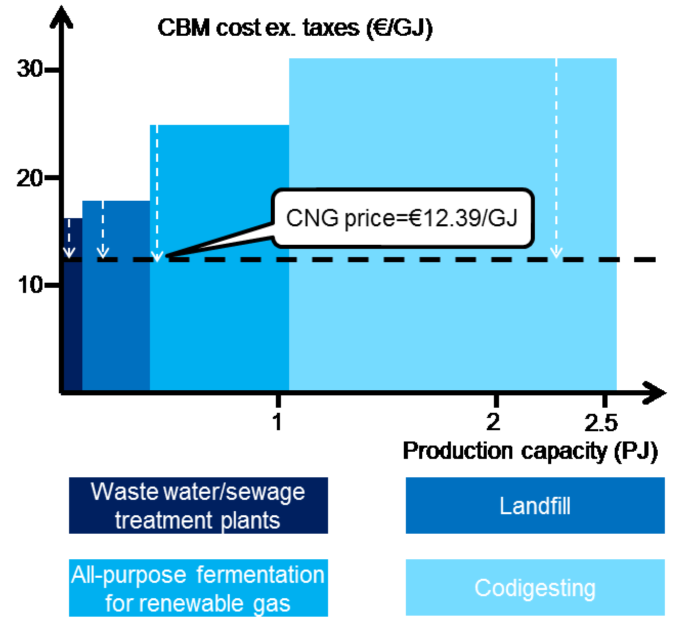


Figure 31:The first 2.5 PJ of the CBM merit order

Each method of producing CBM will have a different production cost and production capacity. Putting these together, we get a merit order graph, shown in Figure 31 for the first 2.5 PJ of production (the 3% target is 1.22 PJ).

Pump prices

Method	CBM pump price (€/GJ) excluding taxes Production	Transport	Bio-methane to CBM	Total
Waste water/sewage treatment plants	9.88	2.90	3.65	16.43
Landfill	11.47	2.90	3.65	18.02
All-purpose fermentation for renewable gas	18.52	2.90	3.65	25.07
Codigesting	24.69	2.90	3.65	31.24

Table 9: CBM pump price for different methods

The first element to create the merit order is the pump price of CBM, which includes the production biomethane, its transport, and its transform into CBM. This is given in Table 9.

Biomethane production costs

Method	Biomethane production costs in the Netherlands, excluding taxes €/kWh (Gross/HHV)	€/kWh (Net/LHV)	€/GJ (net/LHV)
Waste water/sewage treatment plants	0.032	0.036	9.88
Landfill	0.037	0.041	11.47
All-purpose fermentation for renewable gas	0.060	0.067	18.52
Codigesting	0.080	0.089	24.69

Table 10: Biomethane production costs in the Netherlands

The production cost data is based on values for the Netherlands. As such, they are indicative only and would need to be recalculated in a thorough manner if they were used for actually attributing subsidies, for example. These costs and are shown in Table 10.

This is based on the final advice for 2016 [ECN, 2015], which gives figures based on a gross calorific value (or Higher Heating Value), which we then convert to a net calorific value (or Lower Heating Value), to be consistent with the rest of the work. The conversion factor is given by the ratio of these values for Dutch natural gas (35.17 MJ/Nm^3 gross [RVO, 2015a] and 31.65 MJ/Nm^3 net [RVO, 2015b]). This data is also available in English [RVO,2016], with some slight differences (prices are capped off at the free/maximal price category, and the biomass prices for codigesting differ slightly).

Transport and transformation prices

The transport data is based on Swedish data (average grid and road based distribution 2013 [SGC, 2014) . The transformation costs are based on the price difference between CNG and natural gas, as explained before.

Production potential

Source	Production potential		Corresponding method(s)
	Million m3	PJ	
Cattle slurry	37.6	1.28	Codigesting
Pig slurry	4.1	0.14	Codigesting
Other agricultural residues	2.4	0.08	Codigesting
Biodegradable food industry	9.2	0.31	All-purpose fermentation for renewable gas
Separately collected biodegradable kitchen and canteen waste	1.7	0.06	All-purpose fermentation for renewable gas
Sludge	3.0	0.10	Waste water/sewage treatment plants
Industrial waste	7.9	0.27	All-purpose fermentation for renewable gas
Landfills	9.1	0.31	Landfill

Table 11: Production potential for different sources in Estonia and corresponding method(s)

The second element we need to produce the merit order is to know how much can be produced by method. Table 11 shows how much each source of biomethane produces.

The production potential is taken from [Oja, 2014], which gives the Estonian production potential for biomethane at the 2050 horizon, which gives an upper bound for an estimate of the current potential. The source also gives potentials for energy crops, but the elements listed in Table 11 are sufficient to reach the 2.5 PJ barrier we are looking at.

These results can be put together by method, to give the following potentials:

Method	Potential (PJ)
Waste water/sewage treatment plants	0.10
Landfill	0.31
All-purpose fermentation for renewable gas	0.64
Codigesting	1.50

Table 12: Potentials per method

Note that there is a particular challenge for landfills, as the resulting biogas would be of low quality. Upgrading it to biomethane might be challenging (both technically and in terms of costs). As such, this puts some uncertainty on our merit order.

Sources

[ECN, 2015] Eindadvies basisbedragen SDE+ 2016, ECN, October 9th, 2015, https://www.ecn.nl/publications/PdfFetch.aspx?nr=ECN-E--15-052 Tables 3 to 5

[European Council, 1999] European Council, April 26th 1999, Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31999L0031

[SGC, 2014] Vestman J, Liljemark S, Svensson M (2014): Kostnadsbild för produktion och distribution av fordonsgas (Cost benchmarking of the production and distribution of biomethane/CNG in Sweden), SGC Report 296

http://www.sgc.se/ckfinder/userfiles/files/SGC296_v2.pdf

[ECN, 2011] Basisbedragen in de SDE 2012, Conceptadvies ten behoeve van de marktconsultatie, ECN, 2011 https://www.ecn.nl/publications/PdfFetch.aspx?nr=ECN-E--11-046 Table S.1

[RVO, 2015a] RVO, April 2015,Nederlandse lijst van energiedragers en standaard CO2 emissiefactoren, versie april 2015, https://www.rvo.nl/sites/default/files/2015/12/Nederlandse%20energiedragerlijst%20versie%20april_2015_def_0.pdf

[RVO, 2015b] RVO, 2015, SDE+ 2015 Instructions on how to apply for a subsidy for the production of renewable energy, http://english.rvo.nl/sites/default/files/2016/03/Brochure%20SDE-plus%202015.pdf Page 4: 0.102359965 Nm3 natural gas equivalent = 0.0036 GJ of heat.

[RVO, 2016] RVO, 2016, Table base amounts SDE+ spring 2016http://english.rvo.nl/sites/default/files/2016/03/UK%20Tabel%20basisbedragen.pdf

[Oja, 2014] Ahto Oja, 2014, Estonian local transport fuel scenarios for ENMAK 2030. Kohalike transpordikütuste stsenaariumid, https://energiatalgud.ee/img_auth.php/0/08/ENMAK_2030_kohalike_transpordik%C3%BCtuste_stsenaariumid.pdf Table 1, page 11.

4.3 Differentiated tax levers

Introduction/Goal

This text box shows the tax levers other countries have to promote CNG/CBM vehicles, illustrated with the example of passenger cars in the Netherlands. In that example, the fuel tax is actually the smallest differentiator and is topped by both the road tax and the registration tax.

Comparison of tax levers

The only tax differentiating tool Estonia has to support CBM/CNG vehicles is its fuel (excise) tax (VAT cannot be differentiated for such purposes), but that is not the case for other countries. Such countries have essentially two other tax instruments to differentiate CNG/CBM from gasoline or diesel vehicles. The first is a registration tax that is due when registering a new vehicle in the country. The second is a road tax, which is due when using the vehicle (it can be a fixed sum per time period, or per kilometre driven).

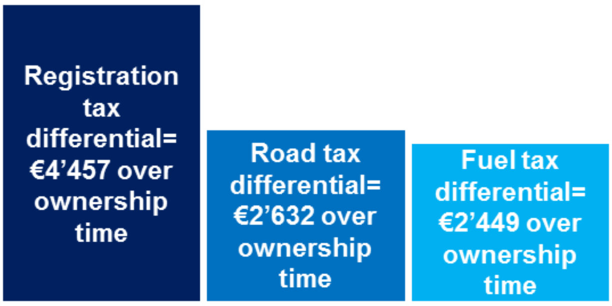


Figure 32: Tax advantage of a CNG car compared to a diesel one, in the Netherlands, over an ownership time of 7 years

Figure 32 shows how big the tax differential is between a CNG/CBM passenger car and a diesel one, in the Netherlands. All three elements are in favour of CNG/CBM.

Vehicle	Energy use (MJ/km)	TTW emissions (gCO_2e/km)
2010 DISI Gasoline	2.41	150
2010 DICI Diesel	1.96	120
2010 DISI CNG	2.47	121

Table 13: Typical passenger car characteristics from [JRC,2014]

We assumed a 7-year car ownership and a driven distance of 20’000 kilometres per year, and typical European vehicle characteristics (see Table 13). The largest difference is given by the registration tax (€4’457), which is due to the lower (tailpipe) emissions of a CNG (or CBM, since their tailpipe emissions are the same for this tax’s purposes) vehicle compared to a diesel one. The next element is the road tax differential (€2’632), while the fuel tax differential (€2’449) is actually the smallest of the three differences even though it is the only one that has VAT on top of its basic value.

For comparison, Estonia only has a fuel (excise) tax for such differentiation. At the moment, there is no excise tax in Estonia, so the differential between diesel and CNG amounts to €3’358 over the ownership time of the vehicle, which is bigger than for the Dutch case. Introducing an excise tax, as planned in Estonia, would bring the two countries to a similar situation, if the excise tax is similar. Note that the proposed excise tax in Estonia is €35/1’000 kg in 2017 and €77/1’000 kg in 2018, against a €160/1’000 kg in the Netherlands (see below).

Dutch vehicle tax components

Registration tax

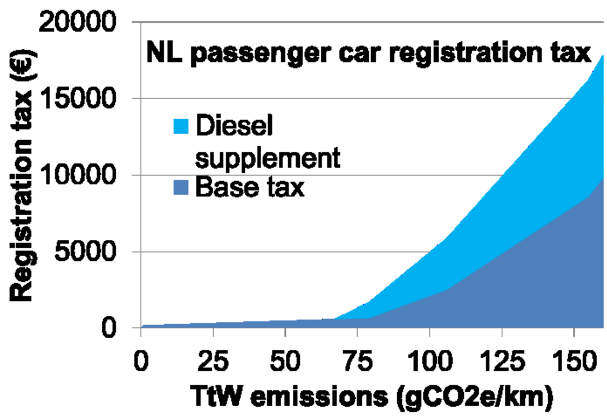


Figure 33: Dutch registration tax for passenger cars in the Netherlands, based on the tariffs in [Belastingdienst, 2016a]

Figure 33 shows the value of the registration tax for passenger cars in the Netherlands. This amount depends on the tailpipe (TtW) CO_2e emissions. Other vehicles have a tax that depends on their purchase price. The curve in Figure 33 is given various slopes for various emission thresholds. Registering a diesel vehicle adds a supplement proportional to the vehicle's emissions, if they are above 67 gCO_2e/km. [Belastingdienst, 2016a]. Taking the typical emissions profile assumed in Table 13, one gets a registration tax of €8'829 for diesel and €4'372 for CNG, leading to a differential of €4'457 over the assumed ownership time.

Road tax

The Dutch road tax is due in three-months increments and depends on the vehicle type, vehicle fuel, vehicle weight, and province of residence. For a passenger car between 1'351 and 1'450 kg in South Holland, the tax is €204 (gasoline), €385 diesel, €291 (CNG/CBM) per three months. Belastingdienst, 2016] For the 7-year ownership we assumed, this means a road tax of €10'780 for diesel and €8'148 for CNG, leading to a differential of €2'632 over the assumed ownership time.

Fuel tax

Fuel	Excise tax NL (€/GJ)	Excise tax EE (€/GJ)
Gasoline	23.62	14.03
Diesel	13.78	12.24
CNG/CBM	5.08	0

Table 14: Excise taxes of fuels, without VAT, for the Netherlands [Belastingdienst, 2016c] and Estonia [Ministry of Finance of Estonia, 2016], with numbers converted into €/GJ

Table 14 shows the value of excise tax in the Netherlands and Estonia. The Dutch value also includes a tax for security of supply.

Note that these tariffs do not include VAT (21% in the Netherlands, 20% in Estonia), which has to be added on top.

For the 7-year ownership and the 20'000 kilometres per year, as well as the typical energy uses we assumed in Table 13, we get a fuel tax of €4'575 for diesel and €2'126 for CNG, leading to a differential of €2'449 over the assumed ownership time.

References

[Belastingdienst, 2016a] Belastingdienst, 2016,

http://www.belastingdienst.nl/wps/wcm/connect/bldcontentnl/belastingdienst/prive/auto_en_vervoer/belastingen_op_auto_en_motor/bpm/bpm_berekenen_en_betalen/bpm_tarief/bpm_tarief_personenauto

[Belastingdienst, 2016b] Belastingdienst, 2016, **http://www.belastingdienst.nl/rekenhulpen/motorrijtuigenbelasting/**

Fuels: Gasoline=Benzine, Diesel=Diesel, CNG=Aardgas

[Belastingdienst, 2016c] Belastingdienst, 2016, http://download.belastingdienst.nl/douane/docs/tarievenlijst_accijns_acc0552z72fol.pdf

[JRC,2014] JRC, March 2014, WtW report v4.a, http://iet.jrc.ec.europa.eu/about-jec/sites/iet.jrc.ec.europa.eu.about-jec/files/documents/wtw_app_1_v4a_march_2014_final.pdf

[Ministry of Finance of Estonia, 2016] Ministry of Finance of Estonia, 2016, http://www.fin.ee/excise-duties

4.4 Double counting advanced biofuels

Introduction/Goal

This section explains what double counting is, what the advantages and disadvantages are and how it can help achieve the biomethane in transport target more easily.

Explanation of the mechanism

Legal basis

Double counting increases the value of certain biofuels and is made possible by Article 21 Sub 2. of the Renewable Energy Directive which states that “ *…contribution made by biofuels produced from wastes, residues, non-food cellulosic material, and ligno-cellulosic material shall be considered to be twice that made by other biofuels…*”

Blending obligation

In order to understand how it works one needs to understand how a blending obligation can add value to a biofuel. This is shown in Figure 1. If you blend more biofuel than is required you fulfil part of somebody else’s obligation. This part can be traded in the form of Renewable Fuel Units (RFU’s).

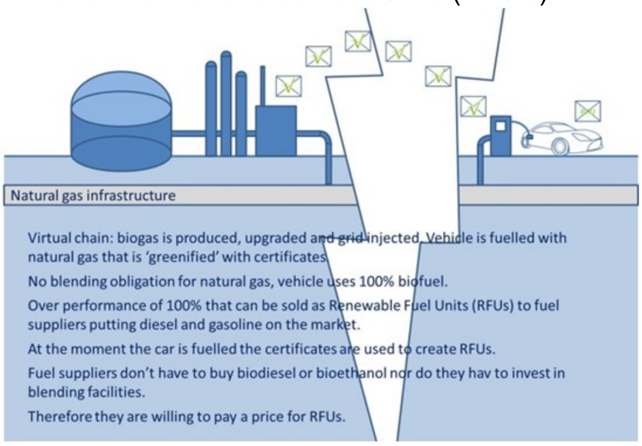


Figure 34: Blending, certificates & RFU’s

Value

Since the other party doesn’t have to buy biofuel and blend it himself the price they are willing to pay would be more or less equal to the costs they are avoiding. In these cases the price of these RFUs is predominantly determined by (and therefore dependent on) the price difference between diesel and biodiesel. The last two years the Dutch prices have moved between € 5,3/GJ (July 2015) & € 8,4/GJ (October 2016).

Double counting

Double counting biofuels (liquid as well as gaseous) counts double towards the obligation, therefore their RFUs have twice the value of an ordinary one. For example: Under a 10% obligation a fuel supplier supplying 100 GJ of fuel can choose to blend himself or buy 10 (rapeseed) biodiesel RFUs of 1 GJ each or choose to buy 5 biomethane (from landfill) RFUs.

Effect on volume

Double counting increases the value of a biofuel twofold but in absolute numbers the total volume of biofuel will decrease in comparison to a single counting mechanism. Therefore it leads to a difference between the on paper and actual amounts of renewable energy (with a factor 2).

Uncertainties

Double counting also creates some uncertainties since the price of a single RFU is already uncertain. Because the price is twice as high, the price uncertainty will be twice as high in absolute terms This uncertainty in RFU price is particularly a consideration for biofuel production technologies that have high upfront investment costs (much less for options with low fixed costs and high variable costs, think of biodiesel from waste oils and fats). Biogas routes probably have an intermediate position in this respect. Since RFUs are linked to the RED uncertainty is an issue anyway these days, since the post-2020 EU and national objectives for biofuels are still unclear.

Conclusion

Double counting proves to be sufficient for creating a market demand for developed and inexpensive technologies producing biofuels from wastes and residues. However, double counting is not effective in promoting ligno-cellulosic biofuels, which are in the development phase and are more expensive.[1]

Having double counting in place for a couple of years might help kick start the production of biomethane for transport but it’s not something producers can depend upon the entire lifespan of their operation.

References

[1] Working Group Renewable Energy Sources in transport and biofuels, Thorsten Wege, Dutch Ministry for Infrastructure and Environment & Madis Laaniste, Ministry of Economic Affairs and Communications, Estonia, august 2013.

4.5 Qualitative analysis of the effect of policy support schemes

Introduction/Goal

This section makes a qualitative analysis of the effect on market dynamics, based on experiences from other European countries, of policy support schemes. Knowing the characteristics of a policy driven, growing biomethane market will make it possible to avoid the worst pitfalls and inadequacies of earlier policies, in order to increase the probability of establishing a biomethane market resilient to change.

Introduction

What can be learnt from the implementation of policy systems for biomethane in Europe? Without going into details, this section makes an overview of the experiences of the market in different European countries, such as Sweden, Germany, the UK, Denmark and Italy. The focus of the analysis is on the production side.

Biogas market characteristics

The goal of all policy systems is to promote something, in our case increase the uptake of biomethane. In essence it provides economic feasibility for the emergence of a new market. However, there are a number of factors that are characteristic of the biogas and biomethane market that need to be understood before embarking on designing a policy system

Heterogeneity

Feedstocks for biogas are multifold, and they all have different characteristics. Waste based feedstocks are the lowest hanging fruit, free of charge or might even bring a fee for accepting them (gate fee). Some are very easy to mobilize, such as existing biogas production on wastewater treatment plants, which only needs installation of upgrading and injection to the grid to become available. Some need a bit of work on the handling side, such as food waste. Manure on the other hand is plentiful, but is dispersed over large areas and is in itself diluted with water, making treatment economics more challenging. In addition, the heterogeneity of feedstocks also brings a very complex and heterogenous pool of suppliers.

Capital intensity

The share of CAPEX is high in any biomethane project. Depreciation periods are always very long. If policies are weak, the profit margin is always slim in the biomethane industry, making it difficult for them to raise capital

Long lead-times

The process of establishing a new biogas production facility is very time consuming. There's a number of permits that need to be applied for, and the economics and handling of feedstocks and products (biomethane and digestate/bio-fertiliser) is because of the number of actors very complex and time consuming Establishing a new market for the products adds to the lead-time. In addition, the anaerobic digestion process in itself is complex, demanding a lot of experience, tests and planning to make a good fit between available feedstocks and the equipment chosen. Bad planning and short-term thinking will make the facility less resilient to changing market conditions. See also the next subsection "Public acceptance".

Public acceptance

All industrial facilities face the challenge of gaining public acceptance. To start with, it might not be a big issue, the public not knowing what to be fearful of, and the no. of facilities being low. However, experience show that if not attending to known problem areas, such as amount of road transports increasing, and odour management, there will be a grassroots protest movement cropping up with each permit application filed, relying on maybe just one example of bad management from another part of the country as basis for their claims.

Experiences from policy driven growing biomethane markets

Changes induced by policy implementation and market growth that has been experienced in other European countries. The source is power point presentations and discussions at several conferences.

Drastic changes in feedstock availability and pricing

With the growth of the market, the prices and availability of feedstocks changes. Waste streams bringing revenue in the form of gate fees will in time become an expense, when the waste owners realise the new market value. Well prepared biogas owners who signed long-term supply contracts survive, less organized ones perish, especially when benefits are degressed (e.g. in the UK). change. Germany illustrates the danger of becoming too reliant on one type of energy crop, which also was a fodder crop (fodder maize). Because of the extreme demand, but also world food and fodder market events, the market was ill-prepared for the degression of the policy scheme, and many operations have been disbanded. In response, the market is shifting to more abundant but technologically more demanding feedstocks, such as straw, but the technology development has taken a lot of time.

Overheating market and the risk of monopoly pricing

When the market grows very fast, it often happens that some part of the delivery chain becomes a narrow section, thus creating a risk of market becoming overheated so that prices inflate when the demand is larger than the supply. In some cases it might be a single actor providing a technology, in essence a monopoly situation.

Reinvestment degree higher than expected

The maintenance CAPEX of biogas plants have turned out to be higher than expected, making it more difficult for biogas plants to stay economically viable after the production support period is over. The wear and tear of equipment from handling difficult feedstocks and chemically aggressive reactor conditions were overlooked in the original calculus.

Waste of human resources when winding down support schemes

When Germany winded down their policy schemes, the domestic market stagnated. Biogas companies that survived adapted by transferring their business to abroad, in countries with new policy schemes, such as the UK, France and Denmark. However, the personnel in Germany, important when tutoring the new employees from other countries, found themselves dispensable when the companies reconstructed to survive. Of course, their knowledge is still accessible, but if Germany would rekindle their market, not all of them would return.

The risk of over-complicated policy regulations

Making policy is not easy, making a balanced set of requirement, so the funds are spent in the most climate mitigating manner possible. When covering several biofuels at the same time, the different characteristics and market conditions for the different fuels make it even more difficult. The worst example to date is the German blending obligation system, where the needs of the waste fat industries (e.g. cosmetics) has been met in such a way that food waste for biogas production is not allowed. The reason is that the regulation is interpreted in a way where even the possibility of discarded vegetable oil in foodwaste was enough to disqualify it as an eligible feedstock. The complicated regulations have been written with only liquid biofuels in mind, severely hampering the possibilities for biomethane producers to take part, and increasing their administrative costs to a point where many of them just give up.

Effects of the magnitude of the policy

How much money one provides the market with decides how quick the growth will be. The examples of Germany and the UK (feed-in tariffs for electricity, and then also for biomethane injected to the grid) demonstrate the great speed the market is capable of when provided with a generous profit margin. The German example show that a number of very strong technology providers have established themselves, which adapt to the less prolific German market by going abroad to other European countries, but also Asia. But is the domestic market resilient and adaptive enough to start growing again, without generous policies? In the other end of the spectrum is Sweden, where the progression of the market has been slow, but steady, driven by a general tax exemption, and several CAPEX support programmes with applications in competition, lately based on the calculated GHG mitigation capacity. Recently the market is in a slump here as well because of the uncertainties of the future framework conditions (definite stop for the tax exemption end of 2019, no new policy system in place yet) the low conventional fuel prices, and the larger challenges in the sector of public transport, the main Swedish biomethane market

Conclusion

The faster and more well-funded a policy scheme is, the more difficult it becomes for the market to respond in a true market fashion, with organic growth and implementation of the most cost-efficient solution, and with more attention to sustainable technical solutions. On the other hand, moving slower with lower benefit levels will risk that the growth in size and number of actors is too weak to accumulate a critical momentum.

Adaptive policy making is thus needed, changing in accordance to the growth of the market, and giving different benefits for different feedstocks, according to technical barriers and societal benefits in addition to the biomethane (see section 3.2 National vision biomethane). The Dutch example of SDE+ might be a good solution. Here applicants for a tender win based on bidding the lowest premium compared to natural gas market prices. Another good example might be the Swedish system with CAPEX co-funding applications being graded according to their specific GHG reduction cost.

4.6 Merit order demand side

Introduction/Goal

This section aims to show which vehicle categories are the most promising for switching to biomethane and how much they could contribute to the 3% biomethane in transport ambition for 2020.

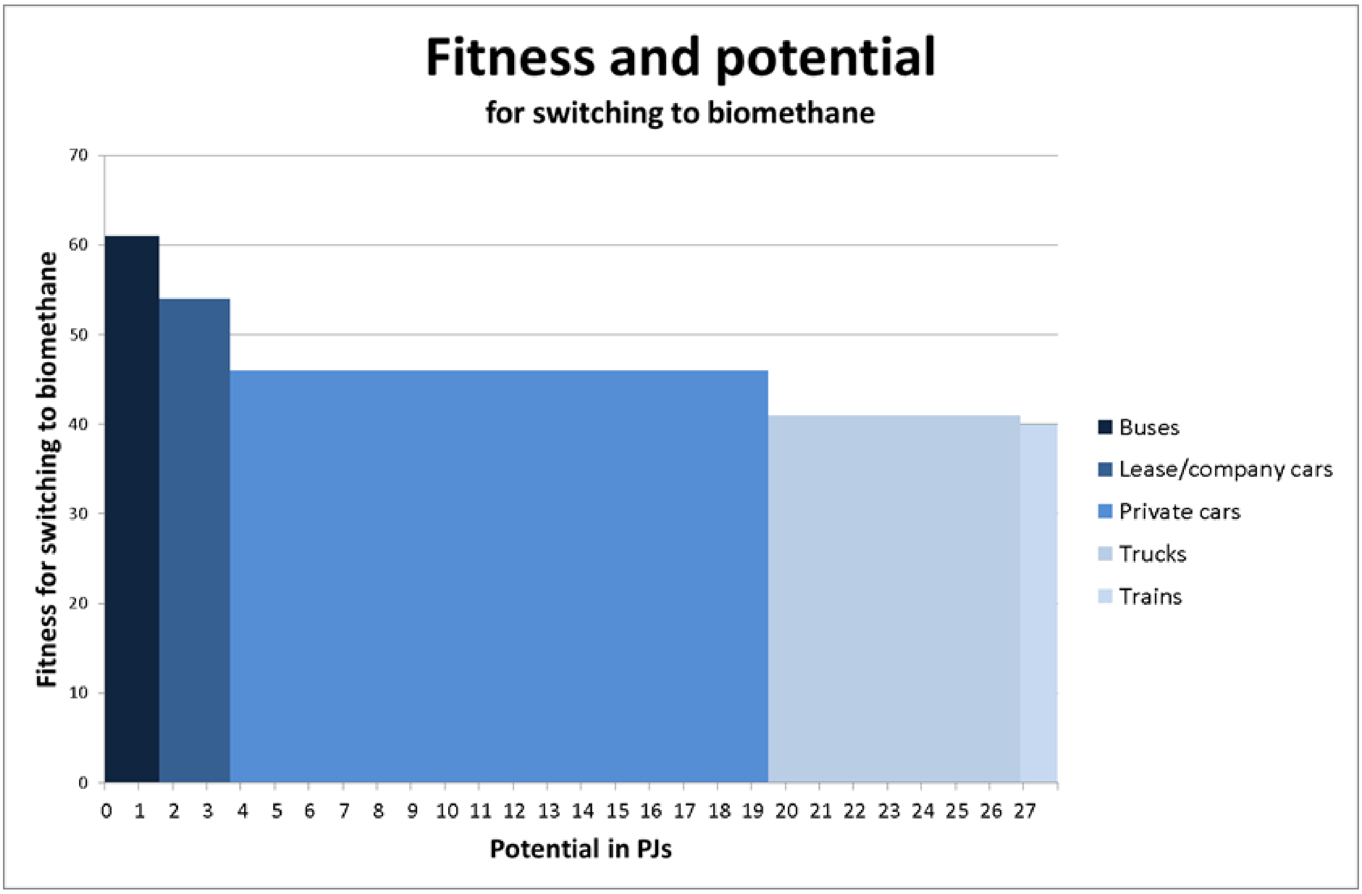


Figure 35: Demand side merit order

Explanation of the mechanism

Figure 35

This figure shows the demand-side merit order for biomethane. It divides the Estonian transport fleet into vehicle segments. The horizontal axis shows how big the consumption of each segment is. The vertical axis shows the fitness for switching to biomethane. A higher value means that the segment in question is more likely to switch to biomethane. This rating is decomposed into four criteria, each with a weight factor that shows how important the criterion is in the rating. The weight factors are (whole) numbers between 2 and 5. The value of each criterion is estimated through an expert judgement and is a (whole) number between 1 and 5. The rating is then the sum of these (weighted) evaluations. The lowest possible score is 14 and the highest possible score is 70.

Criteria

1. **Potential** (weight factor 5): This describes how large the contribution of the selected option could be to the 3% biomethane in transport goal. The rating of the potential is given in Table 15.

% CBM target	Points
0%-5%	1
5%-10%	2
10%-50%	3
50%-150%	4
>150%	5

Table 15: Point values for the potential criterion

2. **Influenceability** (weight factor 4): This considers how vehicle owners can be influenced. In other words, we need to consider how easily potential owners of a vehicle segment can be influenced. For example, fleet managers (for public tendering, for example) have both more power (as they decide on a large number of vehicles) and are more sensitive to Total Cost of Ownership (TCO) arguments than a private person buying a car for their own use

3. **Suitability** (weight factor 3): This considers the fact is that not all types of vehicles are currently suitable for biomethane use. The use of biomethane in planes for instance is at this moment still experimental, so the uptake of biomethane is expected to be minimal in the near future. This also considers the match between travel patterns and the network of filling stations: Vehicles that travel long distances in areas that are not well covered with biomethane filling stations would be less suitable than vehicles that travel shorter distances, in regions well covered by the biomethane filling station network.

4. **Timing** (weight factor 2): This considers the frequency of renewal of vehicles. If a vehicle type has a low frequency (meaning that vehicles are only replaced after a long time), the contribution of that type of vehicle to the 2020 target will be low. Conversely, if the renewal occurs every four years, then the whole fleet could switch to biomethane.

References

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[3] Vohu thesis