CREG

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Study

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Study on the cost-effectiveness of natural gas (CNG or *compressed natural gas*) used as fuel in cars

Article 15/14, §2, subparagraph 2, 2° indent, of Law of 12 April 1965 on the transport of gas products and others by pipelines

Non-confidential

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EXECUTIVE SUMMARY

CNG (*compressed natural gas*) is an alternative fuel which is more environmentally-friendly and more economical than petroleum-based fuels.

Environmentally, for CNG, a reduction in fine particles and nitrogen oxides of approximately 75% to 90% is observed compared to diesel and petrol. A lower rate of CO_2 in the order of 7% to 16% is also noted, together with a 50% quieter engine. Bio-CNG, which is still relatively undeveloped in Belgium, can further reduce overall CO_2 emissions.

Economically, there are two key factors in play, the fuel cost and the purchase price of the vehicle.

In terms of fuel cost, in all cases analysed, CNG is less expensive than competing fuels. The difference is in the range of 35% to 75% compared to diesel and petrol, approximately 20% compared to electric and around 60% compared to the petrol-electric hybrid.

With regards purchase price, a CNG vehicle costs on average €200 more than a diesel vehicle and €2,400 more than a petrol vehicle. For the only model available in all fuel types (VW Golf), the electric and hybrid models cost €15,000 more than the CNG model, although admittedly with specific features (finish and power).

Potential obstacles to the widespread use of this fuel could be attributed to the still limited number of CNG vehicles offered by manufacturers and the still small, although growing, number of CNG service stations. This, coupled with the fact that the autonomy of such vehicles (between 300 km and 800 km for the CNG fuel tank alone and between 600 km and 1,360 km including the petrol tank) is less than that of petrol and diesel models.

However, the service station infrastructure is still relatively new. There are currently 91 CNG service stations in Belgium, of which 76 are in Flanders, 14 in Wallonia and 1 in the Brussels-Capital Region. 36 projects are planned (20 in Flanders, 14 in Wallonia and 2 in Brussels) which aim to cover every province, including the east and south-east of the country which are not yet covered.

There were approximately 10,000 CNG vehicles in use in March 2018, most of them registered in Flanders. Seven car manufacturers offer such vehicles across all categories. The great majority of CNG vehicles are production vehicles. However, converting an existing petrol vehicle into a CNG vehicle is possible.

The European DAFI (*Deployment of Alternative Fuels Infrastructure*) directive imposes objectives on Member States to be achieved within the framework of alternative mobility. Based on the number of CNG stations and vehicles in the National Plan coordinated by the Ministry for Economy (FPS Economy), Belgium is largely on track to achieve the objectives outlined in terms of CNG.

By 2030, the objectives set by the NGVA Europe association show a market share of 12% for natural gas cars (CNG) and 20% to 30% for lorries and buses (CNG and LNG). No issue is expected in terms of impact on the gas network due to the size of existing gas networks and the expected fall in heating volumes thanks to more efficient boilers and better insulation measures. This study shows that, from an economic and ecological perspective, CNG is an appropriate choice for both passenger and leased vehicles. That said, unlike electromobility, CNG is still relatively unknown by the general public, the media and the political sphere. The approach of gas and automotive sectors in promoting CNG seems, until now, relatively modest and would strongly benefit from increased visibility.

INTRODUCTION

Article 15/14, §2, subparagraph 2, 2° indent, of Law of 12 April 1965 on the transport of gas products and others by pipeline (hereafter, the Gas Law) states that CREG may, on its own initiative or at the request of the Minister, conduct research and studies relating to the natural gas market. The natural gas market is divided into three main segments: power stations (transmission network), industrial customers (transmission network) and distribution. On the distribution segment, natural gas is mainly used for applications related to heating and, to a smaller extent, for industrial processes on this network. Application as a fuel (CNG or compressed natural gas) is a relatively new market for natural gas. CREG considered it useful to examine the potential and characteristics of this new market and write a detailed study on this subject.

For this study, CREG questioned the sector's main economic actors, particularly CNG service station operators, vehicle importers, professional associations for the gas and automotive sectors and natural gas transmission and distribution network operators, for the most comprehensive view on the subject. This allows to present a relatively in-depth study about the CNG market.

The study as such comprises of six chapters. The first investigates the principal characteristics of CNG and therefore natural gas in its environmental, physical and technical aspects. The second chapter focuses on the Belgian objectives regarding CNG under the European DAFI (*Deployment of Alternative Fuels Infrastructure*) directive. The third chapter looks at regional support measures for the CNG market. The fourth chapter addresses the issue of CNG stations in particular their location, the breakdown of prices at the pump and the potential impact of these stations on the transmission and distribution networks. The fifth chapter sets a cost-benefit analysis between natural gas vehicles (CNG) and other fuel types, for both passenger and leased vehicles. The conclusion forms the sixth chapter.

The Board of Directors approved this study during its meeting on 29th March 2018.

1. CHARACTERISTICS

1.1. AVAILABILITY

1. CNG (*compressed natural gas*) is the compressed variant of natural gas. It is the same natural gas as that used for heating.

2. One characteristic of natural gas is that it is readily available worldwide. Natural gas reserves are larger than oil reserves and improved extraction techniques and potential unconventional gas discoveries could further increase this difference in the future.

3. According to the *World Energy Outlook* 2017 published by the International Energy Agency (IEA), proven[1] natural gas reserves are 215 trillion m³ (TCM) which represents 60 years of consumption. Recoverable reserves, comprised of proven reserves and probable[2] and possible[3] reserves, are estimated to be 796 TCM which represents 222 years of consumption. Still according to the same source, proven oil reserves stand at 1,695 billion barrels which is 50 years of consumption. Recoverable reserves are estimated to be 6,146 billion barrels which represents 181 years of consumption.

4. For the European supply of natural gas, the principal producing countries and natural gas exporters are Russia, Norway and the Netherlands. This supply is provided mainly by pipes. There is also a supply via LNG terminals which are used to import natural liquefied gas from Qatar, Algeria, Nigeria and even Russia.

5. Belgium is at a European crossroads in terms of the supply options for natural gas since the country is crossed by major pipelines and has an LNG terminal in Zeebrugge. The phasing out of the Dutch natural gas fields in Slochteren (the Netherlands) scheduled for 2029, will not pose any supply problems since there are enough other sources worldwide to transport natural gas and by extension CNG.

1.2. USES AND NAMES

6. CNG (compressed natural gas) can be used in cars, vans, buses, lorries and even tractors.

7. This name can vary between countries. In France, the term GNV (gaz naturel véhicules) which stands for NGV (natural gas for vehicles) is commonly used to describe natural gas mobility, a term which encompasses CNG (compressed natural gas) and LNG (liquefied natural gas). In Germany, Austria and the Grand Duchy of Luxembourg, the term "*Erdgas*" is used for CNG. In Italy, it is the term "*Metano*".

[1] i.e. reasonably certain of being produced using current techniques.
[2] with a more than 50% probability of being economically exploitable.
[3] with a more than 10 % probability of being economically exploitable.

1.3. ENVIRONMENT AND PHYSICS

8. CNG is stored in tanks at a maximum pressure of 200 bar, which allows a volume reduction of approximately 180 times compared with the volume at ambient pressure. Safety is ensured since the tank can withstand a maximum pressure of 600 bar.

9. Natural gas is lighter than air. In the event of a leak, it dissipates into the atmosphere. In terms of combustion, CNG only ignites at a temperature of 580°C, while petrol and diesel ignite at 220°C and 250°C respectively. So, there are fewer fire risks in the event of a fuel leak.

10. Environmentally, in comparison to EURO6 diesel vehicles, CNG vehicles have the following characteristics[4] under actual driving conditions:

- 7% to 16% less CO_2;
- 77% fewer fine particles;
- 90% less nitrogen oxides (NOx)
- 50% quieter.

1.4. CNG VS LPG & LNG

11. A common error is to confuse CNG with LPG, or even LNG. Let us briefly look at the differences.

12. CNG (compressed natural gas) is a fuel obtained by compressing natural gas and injecting it at a pressure of approximately 200 bar into the vehicle's fuel tank.

13. LPG (liquefied petroleum gas) is a by-product of petroleum that is a blend of propane and butane compressed between 5 and 7 bar. LPG is heavier than air and vehicles equipped with LPG are generally not allowed access to underground car parks (unlike CNG vehicles, which can since CNG is lighter than air). The different names for LPG are GPL in France and Autogas in Germany, Austria and the Grand Duchy of Luxembourg.

14. LNG (liquefied natural gas) is also natural gas like CNG but in liquid form. LNG is a natural gas liquefied at -162°C, used in lorries (international transport) and for river or maritime navigation. The energy density of LNG is approximately 2.5 times higher than CNG[5]. However, there are only three LNG stations[6] in Belgium compared with over 90 CNG stations, see chapter 4. Note that it is possible to produce CNG from LNG. This is notably already the case in some stations, called LCNG.

[4] See https://www.energuide.be/en/questions-answers/are-natural-gas-cars-a-real-alternative/198/

[5] See the last table on https://en.wikipedia.org/wiki/Energy_density

[6] These three Belgian LNG stations are located in Kallo (Total), Veurne (Mattheeuws-Fluxys) and Lokeren (Tankterminal). There are around ten LNG projects planned in Belgium for 2018 and 2019. Furthermore, the *LNG Blue Corridor* project, started by the European Commission, aims to establish LNG stations to form four corridors across Europe. This involves setting up LNG stations every 400 km along major roads. Lorries running on LNG are either fitted with a monovalent LNG tank or bivalent CNG and LNG tanks.

1.5. FOSSIL OR BIO

15. CNG can come from two sources. It is either a natural gas of *fossil* origin or a natural gas of *biological* origin (bio-CNG, also called biomethane) or even a mix of the two. Bio-CNG is a 100% renewable energy, resulting from the purification of biogas from the fermentation of organic matter (sewerage from treatment plants, effluents from agrifood industries, etc.).

16. In Belgium, CNG was until now of fossil origin only[7], unlike neighbouring countries like the Netherlands and Germany where bio-CNG accounts for between 20% and 50% of CNG. France has also started many biomethane projects, some of which are used for bio-CNG.

17. When an engine is fuelled by bio-CNG where the CNG is comprised of 20% bio-CNG[8] the reduction in CO_2 emissions compared to diesel is 23% on average, this rises to an average of 77% if the CNG is 100% bio-CNG.

1.6. L-GAS AND H-GAS VS OTHER FUELS

18. The price of CNG is quoted in €/kg. In Belgium, there are two qualities of CNG, just as there are two qualities of natural gas, namely high-calorific gas (called H-gas) and low-calorific gas (called L-gas). The quality of gas influences the price at the pump. Vehicles running on CNG take both H-gas and L-gas. High-calorific H-gas consumed in Belgium comes from LNG producing countries (notably Qatar) and from fields in the North Sea (Norway) and Russia. The H network supplies the provinces of East and West Flanders, the province of Luxembourg, most of the provinces of Hainaut, Namur and Liège and a great part of the province of Limburg. Belgium's supply of low-calorific L-gas comes from the Dutch Slochteren field in the Groningen region in the Netherlands, which is why it is known as "Slochteren gas". The L network supplies the provinces of Antwerp and Brabant as well as parts of the provinces of Limburg, Liège (west) and Hainaut.

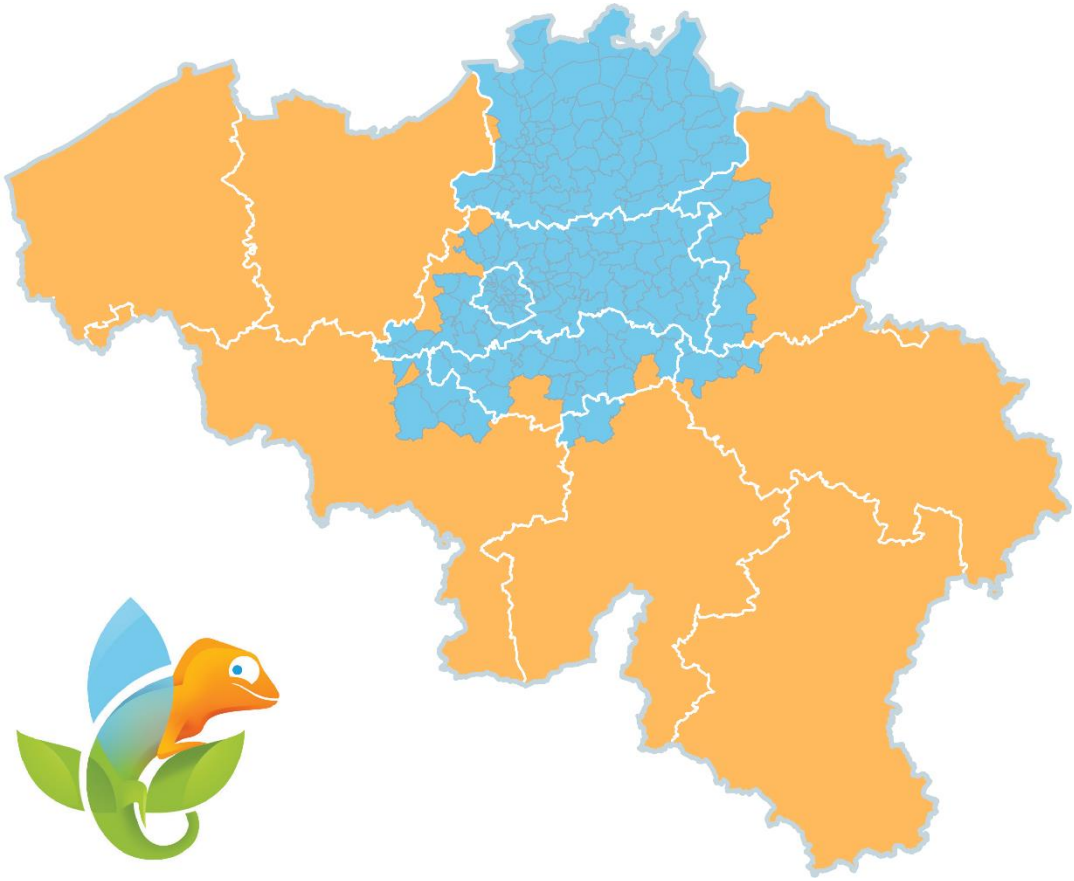
Natural gas is composed mainly of methane (CH4), generally between 85% and 97%. Other elements present in variable quantities such as nitrogen, carbon dioxide, water vapour, dust and sulfurated hydrogen affect the quality and calorific value of gas. This calorific value of gas is significantly lower for L-gas than H-gas, see appendix II at the end of the document.

The following figure shows the two zones, the L-gas zones in blue and the H-gas zones in orange. Following the planned phasing out of natural gas imports from the Netherlands, the entire network will switch to H-gas over the 2018-2029 years. Appendix III contains the detailed schedule for conversion by year.

[7] A bio-CNG station is however planned in Geer http://www.valbiomag.labiomasseenwallonie.be/news/entretien-biogaz-du-haut-geer-une-unite-en-plein-deploiement

[8] This is notably the case in Germany where 20% of the CNG distributed is bio-CNG. Source http://www.gaz-mobilite.fr/actus/allemagne-avantages-fiscaux-gnv-2026-1507.html

Figure 1: H-gas zones (orange) and L-gas zones (blue) in Belgium



Source: Synergrid

19. For the purpose of this study, the data relating to H-gas in terms of both price and autonomy will be used. This is mainly justified by the fact that H-gas is used almost everywhere in Europe[9], and secondarily by the fact that the entire country will be fuelled solely by H-gas within a decade.

20. The price of CNG-H is currently €1.02/kg. The energy content (net calorific value or NCV) by kg of CNG-H is approximately 13.3 kWh.

21. The price of CNG-L is currently in €0.92/kg. The energy content (NCV) by kg of CNG-L is approximately 11.3 kWh. The average difference in energy content between CNG-H and CNG-L is therefore about 18%[10] (13.3/11.3 - 1).

22. The prices stated are those applied by Dats24 (Colruyt group) the main CNG station operator in Belgium. However, prices are relatively similar across the different operators in Belgium including Dats24, Pitpoint or Enora[11].

23. A kilo of CNG (H) has an energy content of approximately 13.3 kWh, a litre of diesel approximately 9.9 kWh and a litre of petrol approximately 8.6 kWh. The energy value of a kilo of CNG

[9] In Europe, L-gas is only used in certain areas in Belgium, France and Germany. By 2029, H-gas will be the only type of gas in Europe.

[10] This 18% difference results from two elements, a difference in terms of kWh/m³ in the region of 11% and a difference in density (kg/m³) of around 6%, see appendix II at the end of the document.

[11] Exact prices and the locations of CNG stations can be viewed at http://www.gibgas.de/Tankstellen and http://www.metanoauto.com/modules.php?name=Distributori

(H) is therefore equivalent to 1.3 litres of diesel or 1.5 litres of petrol[12]. This is valid all things being equal. Given that CNG vehicles are bivalent, i.e. they have two fuel tanks, one for CNG and one for petrol, they are slightly heavier than monovalent petrol or diesel vehicles. For the purpose of this study, the cost-effectiveness analysis (chapter 5) is based not on these theoretical figures, but on the actual consumption measured for the vehicles analysed.

24. Most car manufacturers quote the consumption of a CNG vehicle in kg/100 km in their technical specifications. However, some manufacturers express this consumption in m³/100 km[13]. This does not seem relevant since CNG prices at the pump are expressed in €/kg and not in €/m³. A kg of CNG-H is equivalent to about 1.3 m³ of natural gas. For example, a consumption of 5 kg/100 km would be equivalent to a consumption of 6.5 m³/100 km.

25. Eventually, it would seem appropriate to be able to express the prices of all fuels in €/kWh, which would allow a more objective comparison of the price at the pump between diesel, petrol, CNG (L or H) and electricity. That said, as we will see later, this method has limitations since the number of kWh per 100 km also depends on the engine specification.

1.7. AUTONOMY

26. The autonomy of alternative fuel types such as CNG is lower than that of diesel or petrol vehicles. The liquid form is still the one which provides the greatest autonomy in relation to a given volume. Thus, for the same energy, the fuel tank volume needed is 3.7 times greater for CNG compared to petrol and 4 times greater compared to diesel[14].

27. For some drivers, this lower autonomy could be a barrier to purchasing such a vehicle. That said, the autonomy of CNG vehicles is generally greater than that of electric vehicles and depending on the model, and reaches between 300 km and 800 km for a single tank of CNG (according to the NEDC standard). In addition, all CNG vehicles have a secondary petrol tank. The cumulative CNG and petrol autonomy is therefore between 600 km and 1,360 km depending on the model. This autonomy of 1,360 km (420 km CNG and 940 km petrol) is also that of one of the models (VW Golf) that will be used in the cost-effectiveness calculation in chapter 5. The figures given in this paragraph are those established in accordance with the NEDC standard, which will gradually be replaced by the WLTP standard – more representative of actual driving conditions[15].

28. A trend in CNG models is to develop vehicles that are always CNG-petrol bivalent, but with a larger CNG tank and a smaller petrol tank[16]. This trend will certainly reduce the global autonomy but will allow to drive longer while using a full tank of CNG, the objective being to use petrol only in the event of dire necessity due to environmental and economic reasons. This development is made possible by the growing number of CNG stations in Belgium, but also in Europe. Another, more recent trend consists of a hybrid system combining a natural gas engine with a small electric engine[17].

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[12] https://www.erdgas.info/erdgas-mobil/erdgas-fahren-rechnet-sich/

[13] The relevant manufacturers have been contacted to draw their attention to this issue.

[14] Presentation by Pierre Duysinx (LTAS, Automotive Engineering Research Group, ULiège) at the transport forum of the 2018 motor show, see page 11 of https://orbi.uliege.be/bitstream/2268/221603/1/BrusselsMotorShow2018_Duysinx_V2.pdf

[15] The current NEDC (New European Driving Cycle) methodology has been applied since the 1980s. The WLTP (Worldwide harmonised Light vehicle Test Procedure) methodology came into effect in September 2017 for new types of vehicles and will apply to all new registrations from September 2018, except for end-of-series vehicles, for which the effective date of the new method will be September 2019. See http://wltpfacts.eu/from-nedc-to-wltp-change/

[16] This will be the case with the new Skoda Octavia Combi G-Tec (new fuel tanks: 19 kg of CNG and 10.5 litres of petrol compared with 15 kg of CNG and 50 litres of petrol currently).

[17] www.moniteurautomobile.be/actu-auto/nouveautes-premieres-gimsswiss-2018/gimsswiss-koda-vision-x-hybride-cng.html

29. On the other hand, the move from L-gas to H-gas planned for the entire region will have a positive impact on mobility using natural gas given that CNG-H has an autonomy approximately 18% bigger than CNG-L.

2. OBJECTIVES

30. On 28 October 2014, Directive 2014/94 EU - the DAFI (*Directive Alternative Fuels Infrastructure*)[18] Directive included in the *Clean Power for Transport* package - was adopted. Its objective is to establish a common framework of measures to be deployed throughout the EU for infrastructures for alternative fuels in order to minimise transport dependency on oil and mitigate its environmental impact. The Directive sets minimum requirements for introducing such infrastructures, including recharging points for electric vehicles as well as natural gas (both LNG and CNG) and hydrogen refuelling points which must be implemented via the National policy framework defined by each Member States.

31. With regards CNG, this Directive forces Member States to guarantee a sufficient number of publicly-accessible CNG stations in their country by 2025. The aim is for CNG vehicles to be able to circulate freely in urban/suburban areas by 2020 and throughout the road network by 2025. The maximum indicative distance between CNG stations should be approximately 150 kilometres according to this Directive.

32. Under this Directive, Member States were to adopt a national policy framework for alternative fuels and to notify the Commission of it by 18 November 2016.

2.1. BELGIAN OBJECTIVES

33. In Belgium, such a national framework was developed by the FPS Economy together with the regions (Flanders, Wallonia, Brussels). The Belgian national policy framework was finalised on 16 November 2016. The document was adapted for the Walloon Region on 1st February 2017 and submitted to the Commission on 6 February 2017. This document[19] sets out specific objectives in terms of alternative mobility. With regards CNG, the following tables contain the objectives by Region in numbers of stations and cars.

[18] See http://eur-lex.europa.eu/eli/dir/2014/94/oj particularly paragraph 41 "*Member States should ensure, by means of their national policy frameworks, that an appropriate number of refuelling points accessible to the public for the supply of CNG or compressed biomethane to motor vehicles is built up*".

[19] See www.benelux.int/files/6514/9302/1820/BELGIUM-NPF_alternative_fuels_infrastructure_2017_02_01_002.pdf

Table 1: Number of CNG stations, current situation and 2020 prospects

	Flanders	Wallonia	Brussels	Total
Objective 2020	300	30	3	**333**
Situation 01/2018	76	14	1	**91**

Source: FPS Economy and Gas.be

Table 2: Number of CNG cars[20], current situation and 2020 prospects

	Flanders	Wallonia	Brussels	Total
Objective 2020	41.000	1.344	200	**42.544**
Situation 12/2016	3.727	258	176	**4.161**
Situation 12/2017	6.218	412	358	**6.988**

Source: FPS Economy and Febiac

34. Regarding these two objectives, a quarter of the objective has already been achieved with regard to the infrastructure and a sixth of the objective with regard to the number of vehicles. The 2020 objectives in terms of infrastructure (333 stations) will probably not be achieved due to the time needed to build new CNG stations. However, the objectives for CNG cars (42,544) for 2020 does seem achievable in view of the latest registration figures (662) and the number of orders (over 2,500) recorded over the first two months of 2018.

35. For 2018, the Belgian association for natural gas, Gas.be expects registrations of between 8,000 to 10,000 CNG vehicles, which would mean approx.. 3 times that of 2017 where 3,157 new CNG vehicles were registered (2,497 cars and 662 vans) out of a total of 630,355 registrations.

2.2. OBJECTIVES ABROAD

36. The forecasts by manufacturers, associations, gas operators and/or network operators in Europe are as follows:

- Germany: A consortium created around the Volkswagen group has set the objective of one million vehicles for 2025 (compared with 100,000 currently) and 2,000 stations (compared with 900 currently)[21]. The number of CNG vehicles registered in Germany in January (+371%) and February (+414%) 2018 has also increased dramatically over a year[22].
- Spain: Seat plans to sell 10% of CNG vehicles by 2020 (compared with 1% currently) and the number of CNG stations should be as high as 300 in 2020 (compared with 55 currently)[23].
- France: GRDF and GRTgaz are forecasting a total consumption of fuel gas in 2035, representing between 20 and 50 TWh which is around 10% of global gas demand. In 2035, the fleet of CNG vehicles could vary between 300,000 and over a million vehicles[24].

[20] Taking into account the number of vehicles (cars and vans), the total number was approximately 5,400 at the end of 2016 and approximately 9,000 at the end of 2017.
[21] www.firmenauto.de/erdgas-mehr-tankstellen-mehr-modelle-9179959.html
[22] www.kba.de/DE/Statistik/Fahrzeuge/Neuzulassungen/MonatlicheNeuzulassungen/monatl_neuzulassungen_node.html
[23] www.efemotor.com/ventas-seat-2020-gnc/
[24] www.gaz-mobilite.fr/actus/gnv-france-perspectives-developpement-horizon-2035-1777.html

- Italy: Fiat, Iveco and SNAM are aiming for 3 million CNG vehicles (compared with 950,000 currently) and 2,000 operational CNG stations by 2025 (against 1,200 currently)[25].
- Europe: The NGVA Europe Roadmap 2030 sets an objective for the European market of 12.5 million natural gas vehicles by 2030 including:
    - 450,000 lorries (20% market share)
    - 75,000 buses ([26]30% market share)
    - 12,000,000 cars and vans (12% market share)

37. However, there are major differences between the national policy frameworks submitted by Member States (MS) and the aims/forecasts of the industry, especially in France[27]. The European Commission has pointed out the lack of ambition in these NPF, lamenting that they are not up to the challenges set. If alternative fuels are to play a greater role in European mobility, the European Commission believes that MS must do more to develop the infrastructure[28].

3. SUPPORT MEASURES

3.1. FLEMISH MEASURES

38. In Flanders, alternative fuel vehicles (electric, hydrogen, CNG and *plug-in* hybrid)[29] are exempted from the tax levied for the first use of a car on the road (TMC) and annual road tax (TC). This exemption is valid until 2020 and only relates to vehicles that are not on leasing contracts.

39. From 1st July 2017, there is an additional condition regarding CNG vehicles in relation to fiscal horsepower. From this date, only vehicles with a fiscal horsepower under 12 are exempted from TC and TMC. CNG vehicles with a fiscal horsepower of 12 and above pay the annual road tax but benefit from a lump-sum discount of €4,000 on the TMC.

40. Since 2017, SMEs and large organisations have benefited from additional green subsidies for companies[30]. There is a particular support mechanism for CNG utility vehicles (max 3.5 tonnes), CNG lorries, LNG lorries and station infrastructures (CNG and LNG). This green subsidy consists of an intervention from Flanders for companies that make environmentally-friendly investments. The objective is to encourage companies to make their processes more environmentally-friendly and energy efficient. Flanders bears the cost of some of the additional expenses generated by such an investment. The intervention amount is between 15% and 55% depending on the technology and whether it relates to an SME or a large organisation.

[25] www.reuters.com/article/snam-fiat-gas/snam-signs-natural-gas-pump-deal-with-fiat-chrysler-iveco-idUSL5N1CB4NX

[26] For buses, which are aiming for a 30% market share across Europe, it is strange to note that the Belgian public transport companies (STIB, TEC, De Lijn) have not invested in a CNG infrastructure (green and bus stations) and do not apparently have any projects in this area, while many public transport companies in Europe already have such buses in their fleet. This is particularly the case in France, the Netherlands, Sweden, Spain and the United Kingdom.

[27] www.gaz-mobilite.fr/actus/carburants-alternatifs-cadre-action-national-canca-gnv-hydrogene-electrique-1495.html

[28] http://europa.eu/rapid/press-release_MEMO-17-4243_fr.htm

[29] https://belastingen.vlaanderen.be/vrijstelling-voor-bepaalde-brandstoftypes-vanaf-aanslagjaar-2016

[30] https://www.vlaanderen.be/nl/ondernemen/groen-en-duurzaam-ondernemen/ecologiepremie-plus-voor-ondernemingen

3.2. WALLOON MEASURES

41. In Wallonia, a grant of €500 is awarded by the distribution system operators (DSO) - Ores and Resa - for any individual living in Wallonia and ordering a CNG vehicle between 1st January and 30 June 2018[31].

42. A a support mechanism for local authorities (municipalities, Public Social Assistance Centres, provinces and autonomous municipal undertakings) in Wallonia[32] has also been set to help with the acquisition of less polluting vehicles.

- for vehicles under 3.5 tonnes, the subsidy amount sets at 20% of the purchase price including VAT of a non-polluting vehicle (CNG or non-hybrid electric), excluding optional extras, up to a maximum of €6,000;
- for vehicles over 3.5 tonnes, the subsidy amount sets at 15% of the purchase price including VAT of a vehicle with a minimum EURO 5 coefficient, excluding optional extras, up to a maximum of €22,500.

43. Finally, in order to promote the development of the infrastructure for CNG stations, the Walloon Commission for Energy (CWAPE), together with the distribution system operators Ores and Resa, has set up a (one-off) connection charge, establishing that the first 500 metres of network extension is free of charge and/or limits the connection costs to a maximum amount of €100,000. This investment is recovered over the long-term by a specific recurring tariff for CNG stations at T3 level. This tariff is provisional and runs until the end of 2018. In the absence of a pricing methodology for 2017-2018, it was not possible to create a new specific tariff. This is why it is presented as being at "T3 level"[33]. The 2019-2023 pricing methodology[34] provides for the creation of a specific tariff in its Article 78:

> *7° CNG: pricing category to which service stations that sell compressed natural gas (CNG) from a distribution network are assigned, regardless of the volumes they take from the distribution network.*

And sets out the following principle (Article 84):

> *"The tariffs applicable to the CNG pricing category are uniform across the Walloon Region. The natural gas distribution system operators set the levels for the recurring tariffs for the CNG pricing category in relation to the benefit given for the connection of these service stations to the natural gas distribution network."*

[31] https://www.gaznaturel.be/fr/demande-de-prime-cng
[32] pouvoirslocaux.wallonie.be/jahia/webdav/site/dgpl/shared/homepageMarilyn/2016_08_COP%2021%20Aide_achats.pdf
[33] See https://www.cwape.be/?dir=7&news=575
[34] See https://www.cwape.be/?dir=7.7.2

3.3. MEASURES IN BRUSSELS

44. There are currently no practical measures in the Brussels region, except very indirectly, via the "*low emission zones*" (LEZ) measure[35]. This latter is more favourable to CNG and petrol vehicles than diesel vehicles. Diesel vehicles are more targeted because they emit more pollutants affecting air quality and therefore health. For example, EURO5 diesel vehicles will be prohibited in the Brussels LEZ from 2025 onwards, while for CNG and petrol, only EURO2 vehicles will be prohibited from this same date.

45. A study on developing an infrastructure network of publicly accessible CNG refuelling points in the Brussels-Capital Region was however released on 8 September 2017 by the Brussels regulator, Brugel[36]. This study analyses a series of measures related to the regional competences likely to encourage the deployment of CNG in the Brussels Region.

46. It should also be noted that the Parliament of the Brussels-Capital Region adopted a resolution on 25 November 2016 in order to encourage a "fuel shift" and the development of a network of compressed natural gas (CNG) stations for passenger vehicles in the Brussels-Capital Region[37].

3.4. CROSS-BORDER MEASURES

47. Projects financed by the European Union's *Connecting Europe Facility* (CEF) programme to deploy the alternative fuel sector also exist. For our country, more specifically there is the Benefic[38] "*BrussEls NEtherlands Flanders Implementation of Clean power for transport*" project. This latter aims to support alternative fuel infrastructures in three well-defined areas: The Brussels-Capital Region, the Netherlands and Flanders. With regard to CNG, the "Benefic" call for projects relates solely to Belgium and is designed to deploy four stations; two CNG stations in the Brussels-Capital Region and two stations combining CNG and LNG in Flanders. The maximum amount of financial aid will depend on the type of station installed and is limited to 20% of eligible costs,. A maximum amount is set at €60,000 for a CNG station and €240,000 for an LNG station. The winners of the call will be appointed in June and July 2018.

3.5. OTHER MEASURES

48. Some occasional joint actions between operators and car manufacturers are identified such as offering the first 10,000 kilometres of CNG free of charge.

49. A recent notable step has been taken by VW in offering its compact CNG models (Up, Polo, Golf) at the same price as its petrol models. In doing so, the competitive advantage of these CNG models is noticeable at the first kilometre.

50. However, the gas and automotive sectors seem relatively inactive when promoting this new fuel in terms of communication. The radio and social networking campaigns during the 2018 Brussels Motor Show were certainly a priceworthy initiative, but communication must significantly be strengthened in view of the number of people who are still ignorant of the existence of CNG. More efforts in this area could be done to reach a critical mass of users of this fuel.

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[35] See www.lez.brussels/

[36] See www.brugel.brussels/publication/document/etudes/2017/fr/Etude_initiative_23_FR_CNG.pdf

[37] See www.weblex.irisnet.be/data/crb/doc/2016-17/130791/images.pdf

[38] See http://www.benefic.eu/en/home

4. CNG STATIONS AND CARS

4.1. CNG STATIONS IN BELGIUM

51. In Belgium, 91 CNG stations are open to the public to date. There are 76 CNG stations in Flanders (40 H-gas and 36 L-gas), 14 in Wallonia (12 H-gas and 2 L-gas) and 1 in the Brussels-Capital Region (L-gas). Around thirty new station projects are planned for 2018. Various internet applications for locating these CNG stations exist. A list of stations is also available on some websites[39]. Vehicles can use both CNG-H and CNG-L.

52. In Flanders, the 76 stations are located as follows: 22 stations in the Province of Antwerp, 17 in West Flanders, 14 in East Flanders, 14 in Flemish Brabant and 9 in Limburg. For 2018, there are 20 projects for new stations in Flanders (6 in West Flanders, 7 in East Flanders, 3 in Flemish Brabant, 2 in the Province of Antwerp and 2 in Limburg).

53. In Wallonia, the 14 stations are located as follows: 10 stations in Hainaut, 2 in Walloon Brabant, 2 in the Province of Namur and none in the Provinces of Liège and Luxembourg. For 2018, there are 14 projects for new stations (5 in Hainaut, 2 in Walloon Brabant, 4 in the Province of Liège and 3 in the Province of Luxembourg).

54. In the Brussels-Capital Region, there is 1 station in Anderlecht. For 2018, there are two projects for new stations (1 additional station in Anderlecht and 1 in Auderghem).

55. With the current projects in progress, all Belgian provinces should therefore have CNG service stations by the end of 2018.

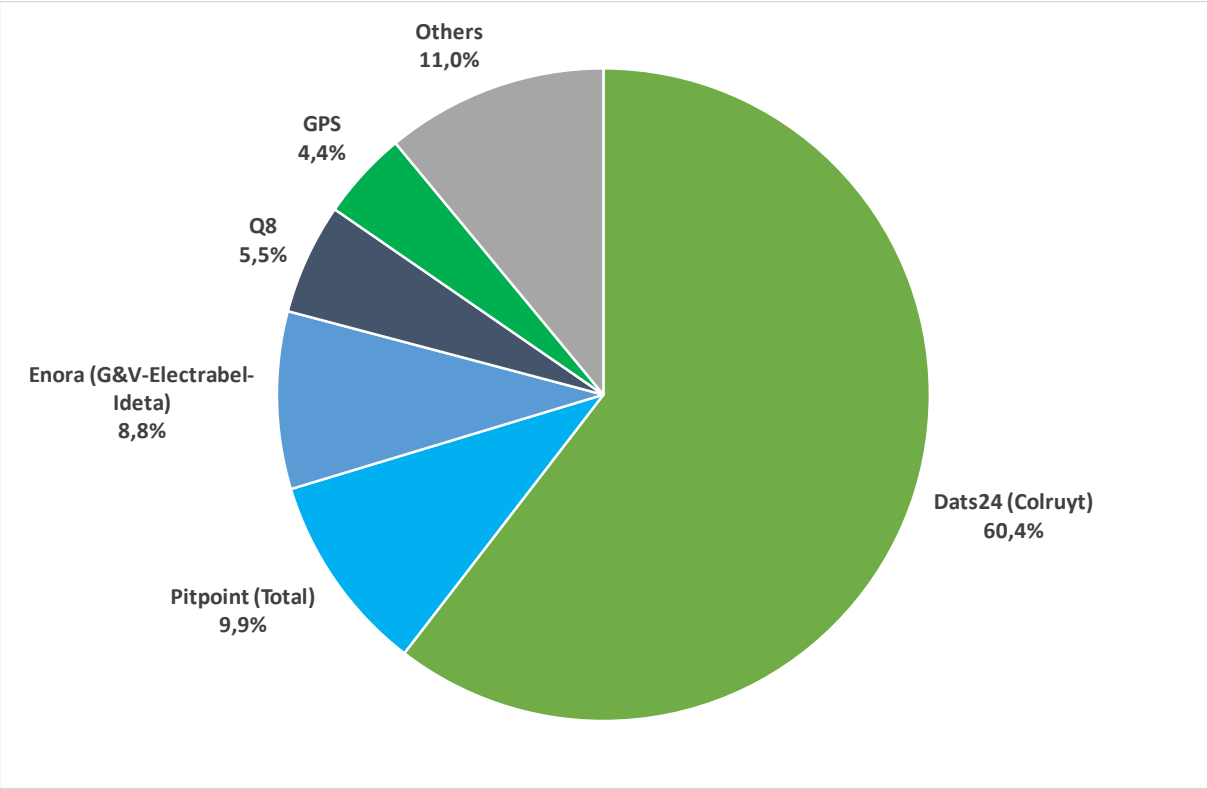
56. The main station operator in Belgium is Dats24 (Colruyt) followed in order by Pitpoint (Total[40]), Enora[41] (association bringing together G&V, Electrabel and Ideta), Q8 and GreenPoint Supplies (GPS). Dats24 detains 55 of the 91 stations open to the public. The following map shows the market share of the different operators of CNG stations.

[39] See http://www.ngva.be/fr/cherche and http://www.metanoauto.com/modules.php?name=Distributori&p=6

[40] Total took over Pitpoint in April 2017.

[41] G&V, the operator of the stations that acquired the Esso and Shell brands for Belgium, has joined forces with Engie Electrabel and the Ideta development agency to develop these stations which are mainly present in the western part of the country, mostly in Hainaut.

Figure 2: Market share of CNG station operators in Belgium (03/2018) based on number of stations



Source: Gas.be

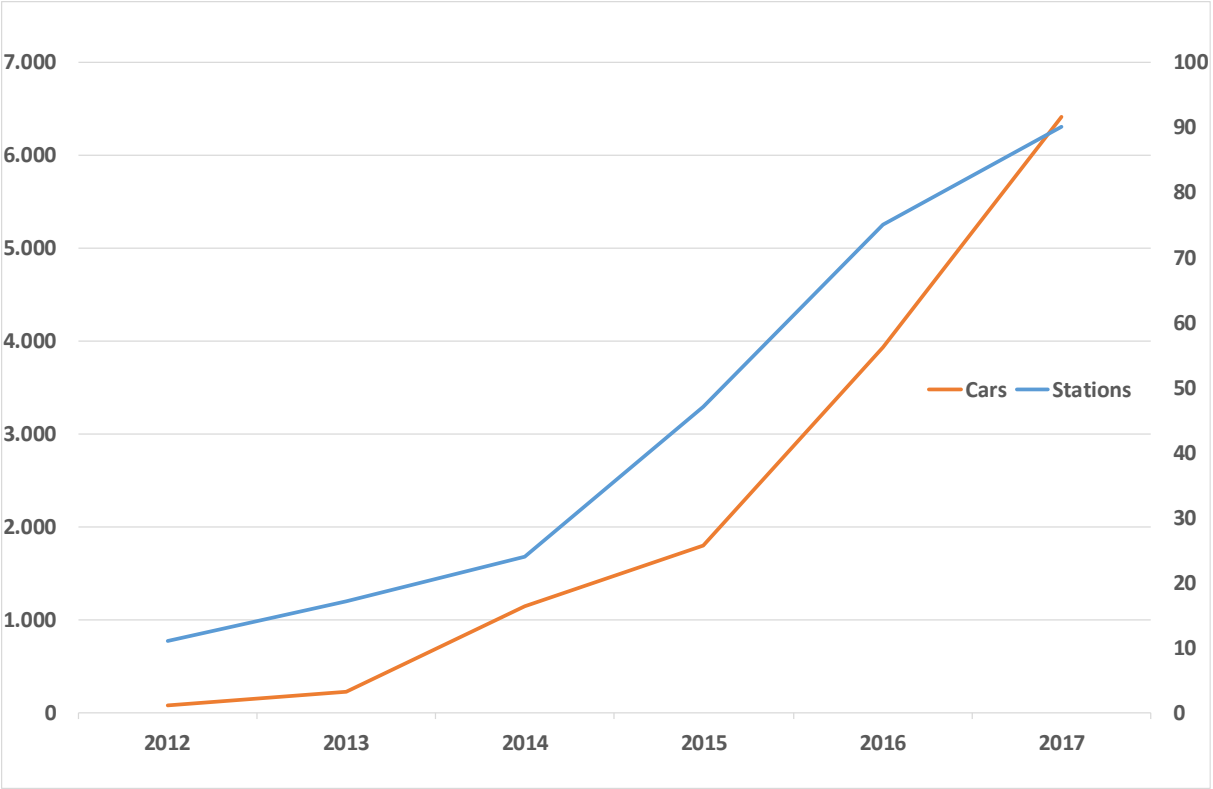
57. Unlike diesel or petrol, CNG is not supplied by lorries but by pipes. The only exceptions relate to the Kallo and Verne stations which are supplied by LNG lorries (some of the LNG is regasified on site to provide CNG) and the station at Hoboken supplied by CNG lorry from the Kallo LCNG station.

58. The fact that pipes supply CNG stations has the benefit of reducing the number of tankers on the roads. Another potential advantage is the security of the supply, since there is no need to worry about shortages of CNG in contrary to what could be the case for petroleum-based fuels in the event of blockages at oil refineries.

59. Another benefit of CNG as fuel is that it is as quick to fill the tank as with a petrol or diesel tank, and without odours or possible stains because it is a gaseous fuel.

60. The following graph shows the development in the number of stations (right scale) and cars (left scale) from 2012 to 2017.

Figure 3: Development in the number of CNG stations and cars 2012-2017.



Source: Febiac and Gas.be

61. Based on current CNG prices at the pump on the one hand and the various components of the price of natural gas on the other, it is estimated that nearly 50% of the sales price excluding VAT at the pump is used to cover direct costs related to the supply of natural gas -the molecule - the network costs and taxes. The remaining 50% is used to cover investment expenses including connection (CAPEX), operating expenses (OPEX) and the operator's profit margin.

62. The price at the pump considered is €1.02/kg inc. VAT for CNG-H. The ex-VAT price is 1.02/1.21=€0.843/kg. The NCV (net calorific value) for natural H-gas is on average 13.3 kWh/kg. This therefore gives €0.0634/kWh or €63.4/MWh ex. VAT.

63. The price components of natural gas for a station operator are as follows:

- Energy (molecule) *mark-up* included: €20.0/MWh
- Transmission: €1.5/MWh
- Distribution (T3)[42]: €7.0/MWh
- Surcharges: €1.6/MWh

This gives a subtotal of €30.10/MWh.

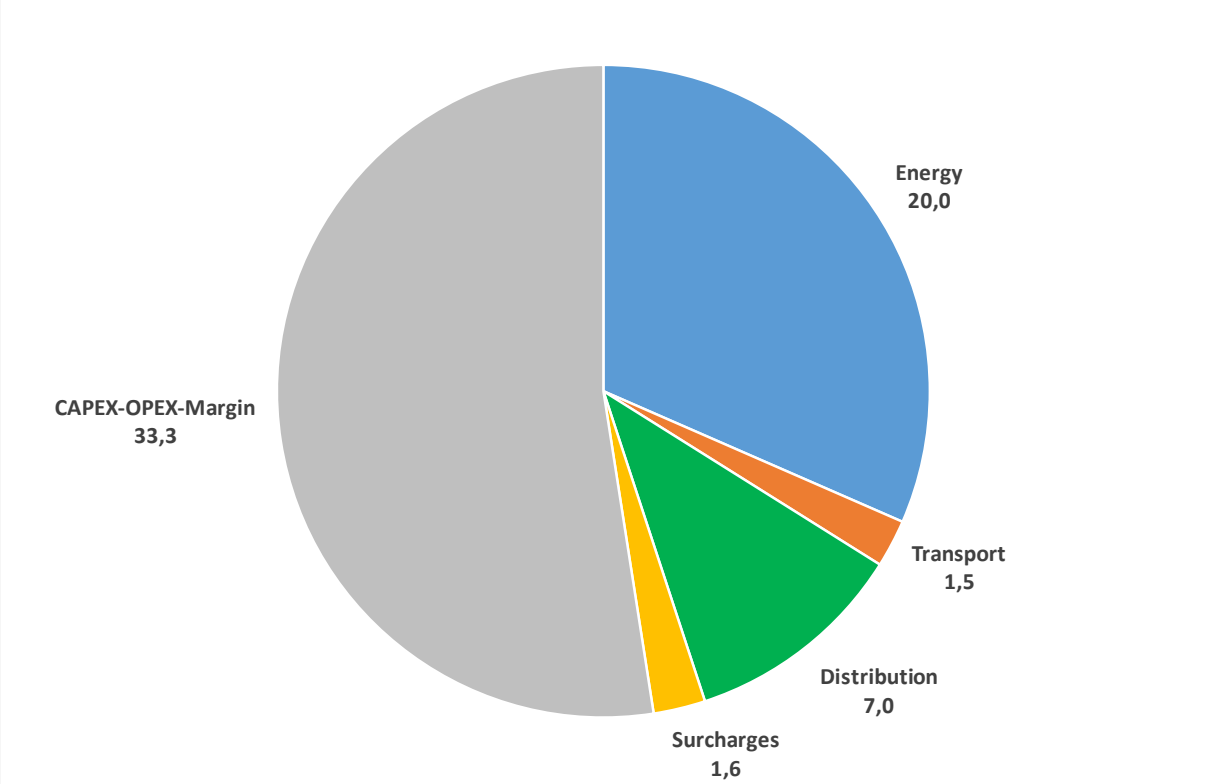
[42] The distribution tariffs for a type T3 distribution customer vary from €3.70/MWh (Imea zone) to €16.30/MWh (Ores Hainaut zone). The natural gas distribution tariffs for such a customer are on average twice as high in Wallonia as in Flanders (€6.40/MWh in Flanders compared with €12.80/MWh in Wallonia). The lower network density and bearing the costs for the first 500 metres of network for the connection of CNG stations in Wallonia partly explain the higher Walloon tariffs compared with those practised in Flanders. The selected figure of €7/MWh for distribution is an average based on the distribution of the number of CNG stations across Belgium. It should also be noted that some stations will be assigned to a higher category (T4 or T5) or to a specific category (Wallonia, see point 3.2.)

64. The difference between the price of H-CNG at the pump converted into €/MWh (63.4) and the subtotal of the price components of natural gas (30.1) is of €33.30/MWh. This means that most of the price at the pump comes from elements that cannot be directly assigned to the price components of natural gas, but as well as which results from infrastructure expenses (CAPEX) and to a lesser extent, maintenance expenses (OPEX) and the operators' profit margin.

65. CREG does not have an accurate view of the infrastructure expenses, maintenance expenses and gross profit margin of operators since this is an unregulated activity. Given the still restricted number of CNG vehicles compared to the total number of vehicles[43], it seems conceivable that these costs still account for more than half of the price at the pump.

66. However, for the infrastructure (CAPEX), the price of a CNG station is generally estimated at approximately €400,000. Based on an average volume of 100,000 kg per year and per station and depreciation over 10 years, this would give €0.40/kg excl. VAT (corresponding to €30/MWh). Operating expenses (OPEX), mainly comprised of maintenance and electricity costs and the gross sales margin, make up the balance.

Figure 4: Breakdown of the price charged at pump for CNG in Belgium expressed in €/MWh ex. VAT



67. The level of CAPEX-OPEX to be covered by the tariff is in the future the variable that is most likely to decrease. A significant rise in the number of CNG vehicles circulating would allow this component to be reduced substantially. Currently, a CNG pump[44] receives on average 16 vehicles per day for an average volume of some 17 kg per vehicle. Technically, it is possible to reach an estimated number in the region of 100 vehicles per day per pump.

[43] 0.5% of new registrations in 2017 (2,500 out of a total of 545,000) and 0.1% of the total cars in circulation (7,000 out of a total of 5.7 million).
[44] There are generally several CNG pumps per station.

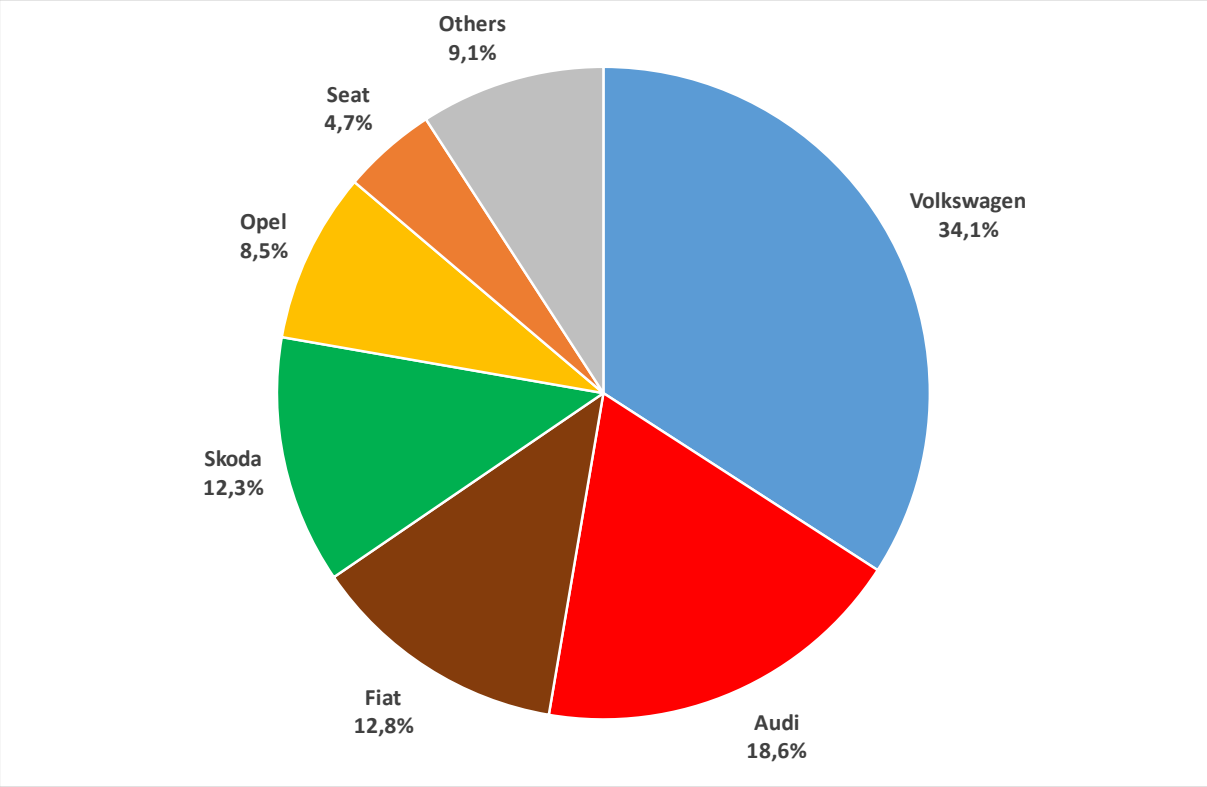
68. This could help to ease the fears of some consumers who argue that the State could be taxing tax this fuel more once it has achieved a large market share. Any additional taxation should in fact be offset by a significantly lower level of CAPEX and OPEX as long as the operators pass this reduction onto the consumer. It also seems unlikely that the State will reduce the tax difference between the price of CNG and that of petroleum-based fuels given the environmental qualities of CNG compared with such fuels. With a view to public health, it would even seem appropriate to increase this difference.

4.2. CNG VEHICLES IN BELGIUM

69. Several car manufacturers have developed CNG engines for cars and utility vehicles[45]. Admittedly, not all the models by these manufacturers are available in a CNG version, but all types of vehicle are possible: city, sedan, estate, compact, MPV, vans, SUV. Appendix I on the second to last page of this document gives the different types of cars and small vans available in CNG versions, with the price for the CNG version and the price of the equivalent power diesel and petrol versions. The differences in purchase price between CNG models and diesel and petrol models are relatively small.

70. The following graph shows the market share of the different car manufacturers operating on the Belgian CNG market, according to the number of vehicles sold. This number was 3,159 in 2017, made up of 2,497 cars and 662 utility vehicles.

Figure 5: Market share based on number of CNG vehicles sold in 2017 in Belgium



Source: Febiac

[45] The lists of cars available in CNG versions can be found on the websites https://www.gaznaturel.be/fr/offre-des-voitures-disponibles-au-cng and http://www.gaz-mobilite.fr/voiture-gnv/

71. Volkswagen is the leading brand for CNG in Belgium with 34% market share. If the different brands belonging to the Volkswagen AG group (Audi, Seat, Skoda, VW) are taken into account, the total market share for Volkswagen AG group is of 70%, ahead of Fiat whose market share is of 13% and Opel ofw 8.5%.

72. In 2017, approximately 97% of CNG vehicles were production vehicles. 3% of CNG vehicles (78 in total) were *retrofit* vehicles, that is existing petrol vehicles to which a CNG fuel tank was added. In the future, the share of *retrofit* vehicles should decrease due to the growing number of CNG production models. The cost of a *retrofit* installation is +/- €5,000 which is significantly higher than the extra cost for a CNG production model compared to its petrol equivalent.

73. With regards the breakdown by region, 89% of CNG vehicles registered have been registered in Flanders, 5% in Brussels and 6% in Wallonia. In terms of the breakdown of CNG vehicles by customer category, this was approximately 30% for personal customers and 70% for companies (own fleet or leasing).

4.3. CNG IN EUROPE

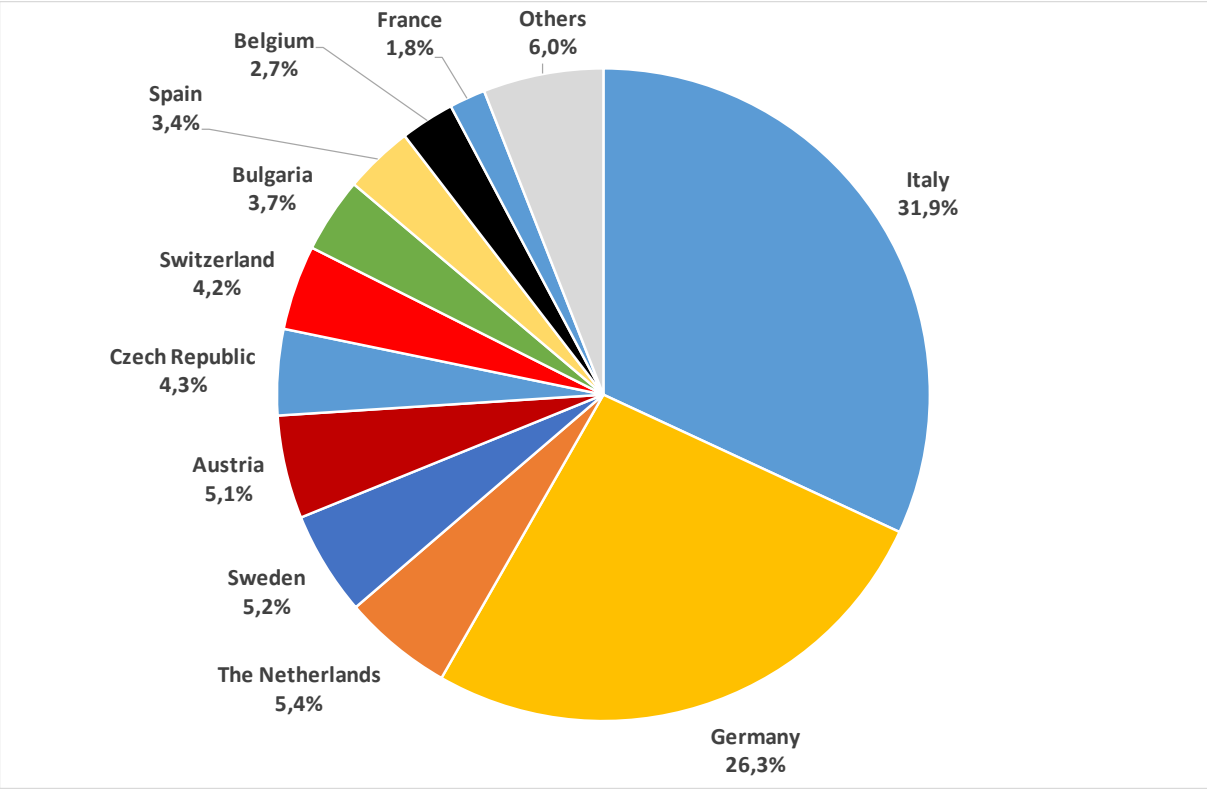
4.3.1. CNG stations in Europe

74. The number of CNG stations has also grown in other European countries. According to NGVA Europe, some 3,400[46] operational CNG stations exist on the continent (EU28 + Switzerland, Norway and Iceland) out of a total of some 120,000[47] stations for petroleum-based fuels. Figure 6 shows the percentage share in various countries. Besides, in Belgium's neighbouring countries, the number of CNG stations open and freely accessible to the public is currently as follows:

- Germany[48]: 900;
- The Netherlands[49]: 160;
- France[50]: 54 (+24 planned for 2018 and target by 2022 of 460[51]);
- Grand Duchy of Luxembourg[52]: 6.

[46] See page 6 of https://www.ngva.eu/downloads/NGVA_Europe_Statistical_Report-2017.pdf
[47] See https://www.fuelseurope.eu/wp-content/uploads/2015/06/Graphs_FUELS_EUROPE-_2017_-52.pdf
[48] See https://www.erdgas.info/erdgas-mobil/erdgas-tankstellen/tankstellenfinder/
[49] See https://groengas.nl/rijden-op-groengas/tanklocaties-kaart/
[50] See https://gnv-grtgaz.opendatasoft.com/explore/dataset/stations-gnv-publiques-en-france/
[51] See http://www.gaz-mobilite.fr/actus/assises-mobilite-filiere-ambitionne-2000-stations-gnv-2030-1802.html
[52] See http://www.erdgas.lu/mmp/online/website/content/car/41/index_DE.html

Figure 6: Breakdown of CNG stations in Europe (3,408 public and private stations)



Source: NGVA Europe

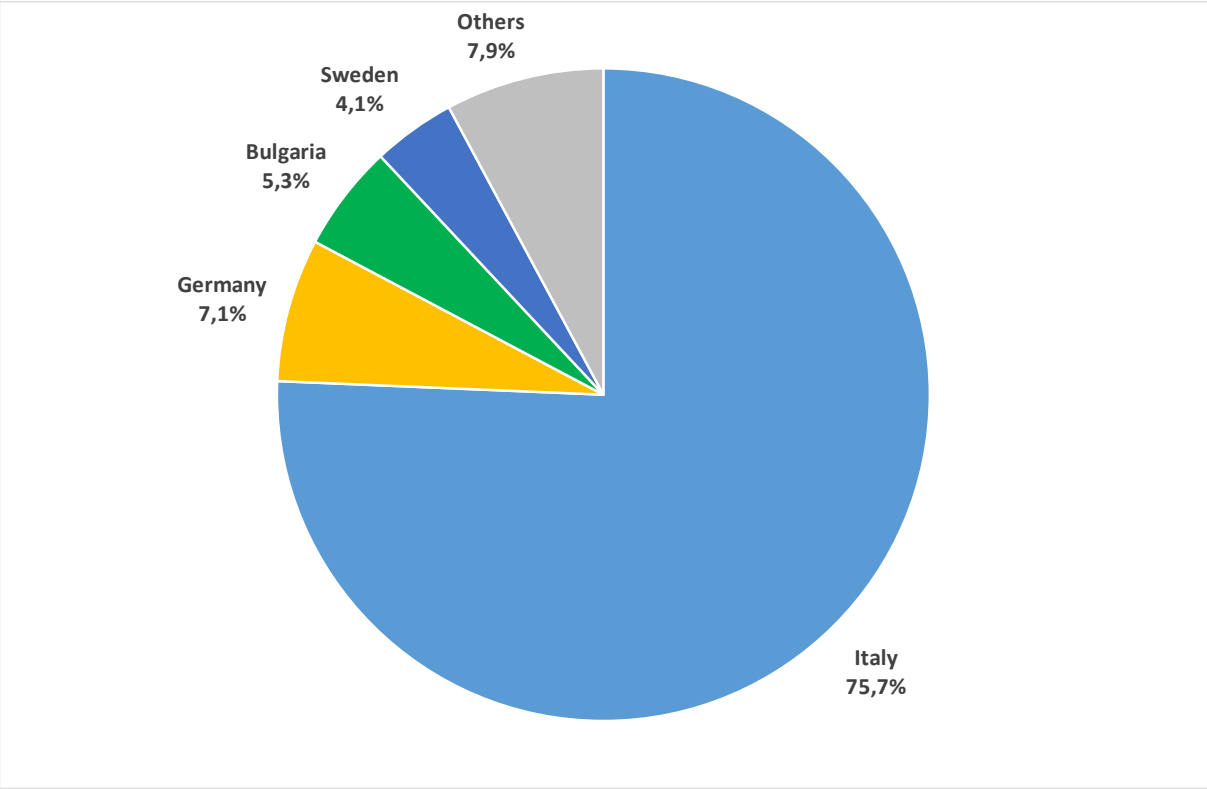
75. There are various applications and websites for finding the location and exact addresses of CNG stations in the different European countries[53]. It is also possible to plan a route and/or find a CNG station within a defined area in Europe[54].

4.3.2. CNG vehicles in Europe

76. The data relating to Europe (EU28 + Switzerland, Norway and Iceland) reports some 1.3 million CNG vehicles. The following graph shows the share of various European countries in terms of CNG vehicles circulating. With some 9,000 CNG vehicles (7,000 cars and 2,000 vans) at the end of 2017, Belgium represents 0.7% of the European total. Italy alone represents over three quarters of CNG vehicles registered in Europe.

[53] See http://www.metanoauto.com/modules.php?name=Distributori et https://www.pitpoint.be/fr/stations-service/
[54] See https://www.ngva.eu/get-directions

Figure 7: Breakdown of CNG vehicles in Europe (1.3 million)



Source: NGVA Europe

4.3.3. Average number of cars per station

77. The average number of cars per CNG station depends on the country. The average number of CNG cars per station in Belgium was of nearly 80 cars[55] (7,000 cars/90 service stations) at the end of 2017. The European average was of nearly 400 cars per station. In Italy, the most advanced country in terms of CNG, it was of 930 cars per station, see figure below.

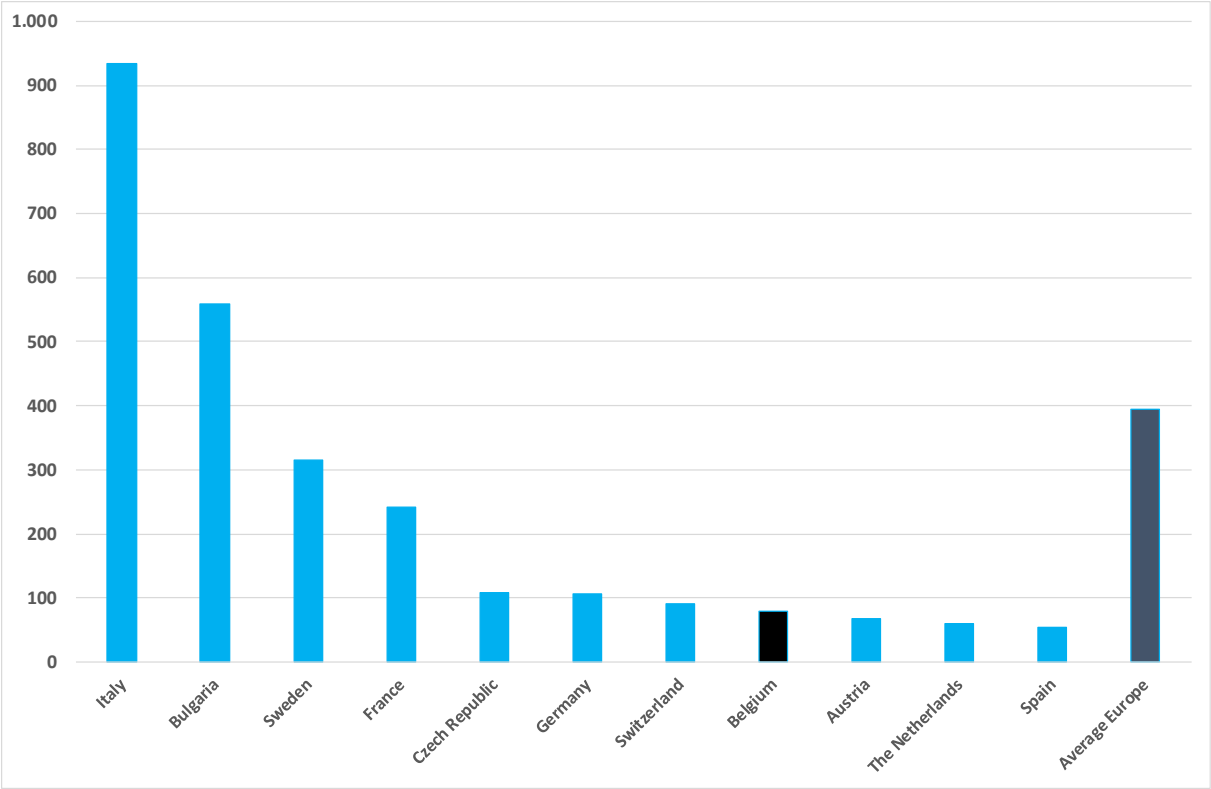
78. As a comparison, the average for cars using petroleum-based fuels (diesel and petrol) per station in Belgium was nearly 1,700 cars (5.6 million cars/3,350 service stations)[56].

79. All things being equal, one can conclude that the current (91) and future (26 planned in 2018) CNG stations in Belgium can accommodate a much higher number of vehicles. Filling a tank with natural gas takes approximately the same amount of time as filling it with petrol or diesel.

[55] This average is approximately 100 vehicles per station when vans are also taken into consideration (7,000 cars and 2,000 vans).

[56] www.petrolfed.be/fr/lindustrie-p%C3%A9troli%C3%A8re/economie/l%C3%A9volution-du-nombre-de-stations-service

Figure 8: Average number of CNG vehicles per station in various countries in Europe



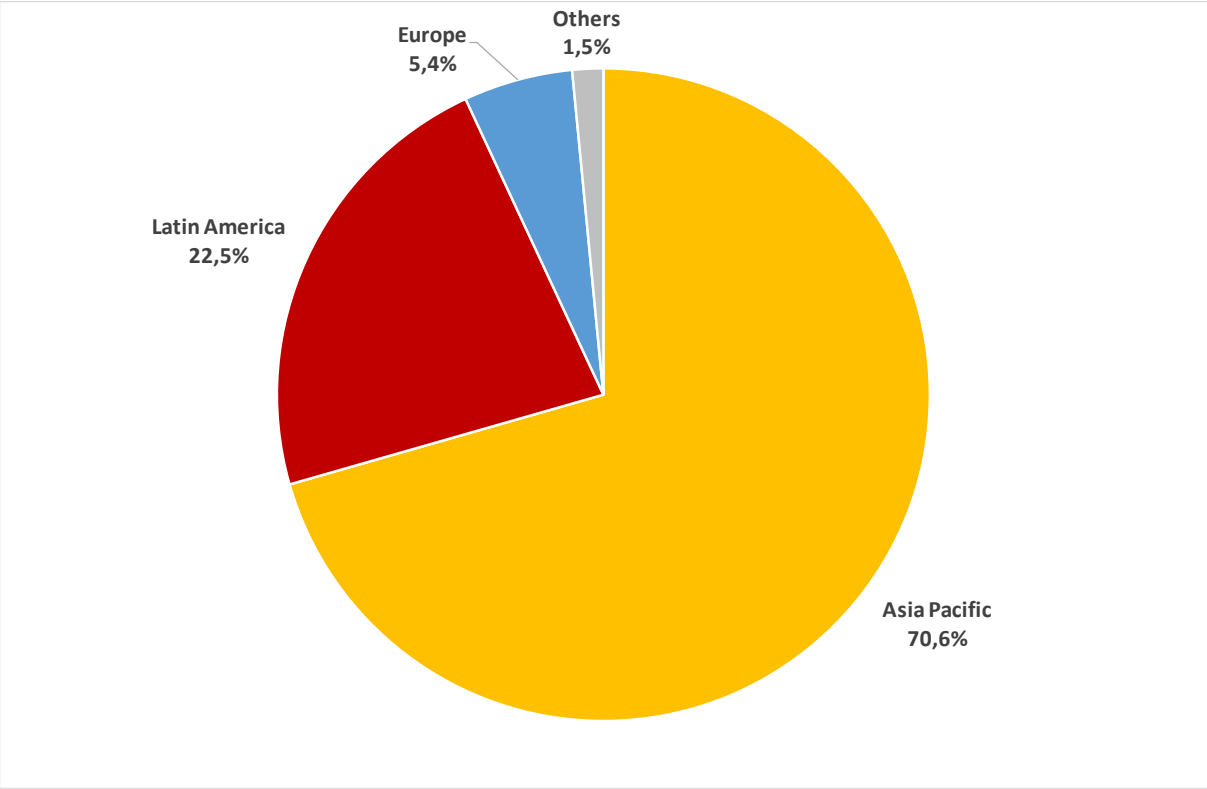
Source: NGVA Europe

4.4. CNG WORLDWIDE

80. The number of natural gas vehicles worldwide is estimated at approximately 24.5 million according to the NGV Global association[57]. The largest share is in Asia. Europe's share (EU28 + Switzerland, Norway and Iceland) represents 5.5% of this market. The following figure shows the market share of the various continents.

[57] See http://www.iangv.org/current-ngv-stats/

Figure 9: Market share of CNG according to continent in 2017 (24.5 million vehicles)



Source: NGV Global

The countries with the largest fleet of CNG vehicles are China (5.3 million), Iran (4 million), India (3 million), Pakistan (3 million), Argentina (2.3 million), Brazil (1.8 million) and Italy (1 million).

The penetration of CNG engines when compared to other engine types is highest in the following countries; Armenia (56%), Pakistan (33%), Bolivia (30%), Uzbekistan (22%), Iran (15%), Bangladesh (11%) and Argentina (10%). As a comparison, the market share of CNG in Italy - the most advanced country on this subject in Europe - is 4%.

4.5. POTENTIAL IMPACT ON NETWORKS IN BELGIUM

81. In terms of distribution and transmission, the gas network is configured to carry volumes of natural gas uninterrupted up to an external temperature of 11° Celsius. The network therefore seems robust enough to be able to cover even a substantial increase in volume resulting from CNG. Underused for most of the year, the gas network appears more able to absorb the increase in demand due to mobility than the electricity network, which suffers from greater congestion. Apart from investments for connections and potential network extensions relating to certain connections, no major strengthening investment appears necessary to support the deployment of CNG stations across the distribution network, except for some rare areas that are not as well networked. Faced with the fall in demand for natural gas linked to energy efficiency, other uses for natural gas such as CNG can optimise the use of the network. Such development could, *ceteris paribus*, generate a fall in the distribution tariff and to a lesser extent in the transmission tariff, or at least avoid an increase in these tariffs. Indeed, the DSOs eventually expect volumes to decrease by around 10% on the residential heating market due to improvements in the energy efficiency of boilers in buildings. The additional CNG volumes would help to offset the decline in heating volumes. Under the regulated activity of network operators, the tariff is obtained by dividing the costs (numerator) by the volumes (denominator). CNG could therefore have a downward effect on these tariffs and a positive effect on

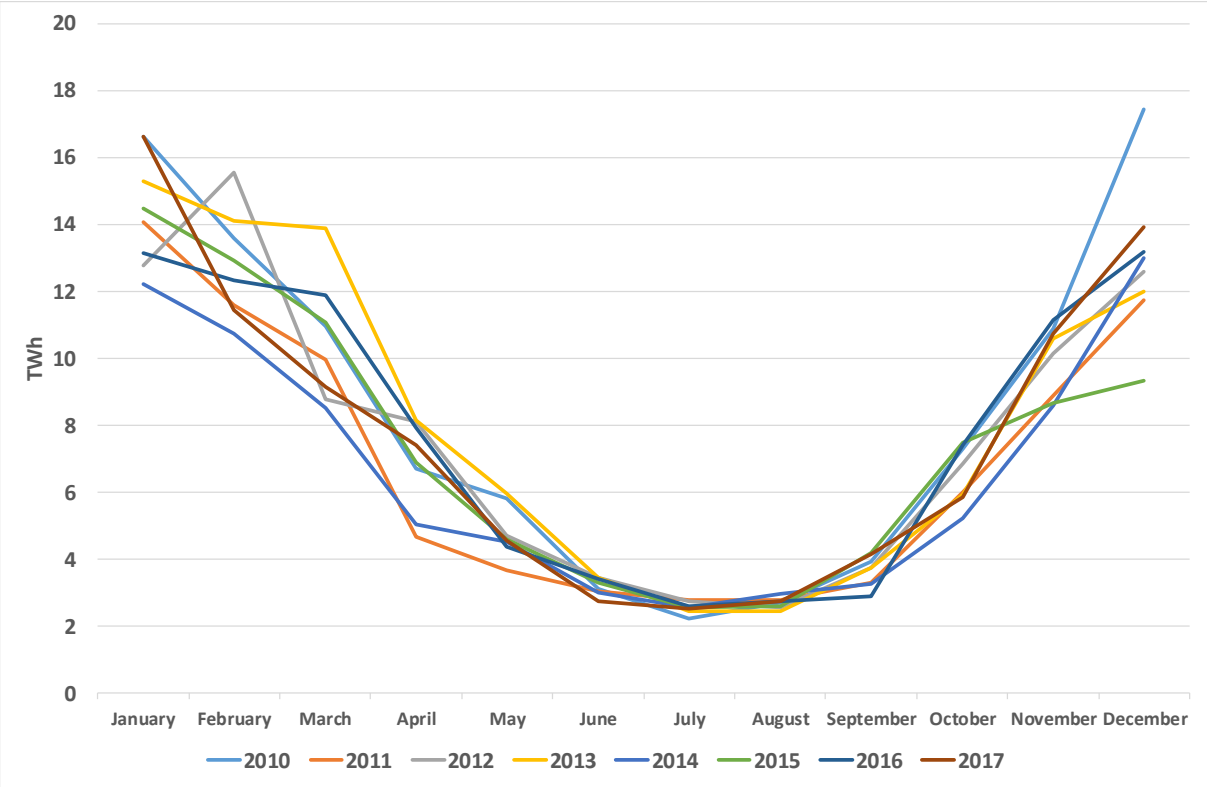
network loads due to the withdrawal profile which is independent of the external temperature. In a previous study[58] conducted in 2012, the Walloon regulator (CWAPE) arrived at very similar conclusions regarding the positive impact of CNG on the distribution networks.

82. The annual volume for the CNG market in Belgium is currently estimated at 7,500,000 kg (10,000 vehicles * 15,000 km/year * 5 kg/100), which is approximately 0.1 TWh.

83. By taking the assumption of a large market share for CNG of approximately 20% for Belgium[59] (+/- 1,000,000 vehicles), this would mean a volume of 750,000,000 kg (1,000,000 * 15,000 km/year * 5 kg/100 km), which represents approximately 10 TWh per year[60], or 0.83 TWh/month. This additional volume is relatively steady throughout the year and across the day, unlike the heating profile that experiences a peak in winter. On an annual basis, the additional volume of 10 TWh represents 11% of the consumption of natural gas for public distribution (PD) which is approximately 90 TWh in Belgium and 5.5% of the total consumption of natural gas that is approximately 183 TWh. On a monthly basis, the additional volume of 0.83 TWh represents 6% of the consumption of natural gas for public distribution (PD) over a winter month, which is on average 13.5 TWh and 3.5% of the total consumption of natural gas in a winter month, which on average is of 23 TWh.

84. By way of comparison, the very cold year in 2010 found consumption to be set at 101 TWh on the distribution network with a monthly consumption figure of 17.5 TWh in December 2010, compared with a usual volume of 13.5 TWh during a normal winter month. This level of 4 TWh xtra over a month did not generate any supply issues.

Figure 10: Monthly consumption of gas on Belgian distribution networks 2010-2017



[58] https://www.cwape.be/?dir=0.2&docid=779

[59] The NGVA Europe assumption is 12% for the European market for cars and 20% to 30% for lorries and buses.

[60] 750,000,000 kg * 13.3 kWh/kg = 9,975,000,000 kWh rounded up to 10 TWh.

85. The transmission and distribution network operators reached about this subject positively welcome the development of CNG and point out that the resulting investments (connection and possible extension) would remain limited. Unlike what would be the case for the electricity network with the development of electric vehicles and especially fast charging points, no strengthening of the gas network seems to be required for the development of CNG. According to the DSOs, costs to develop the network infrastructure required for CNG are, in any case, less than those to develop the necessary infrastructure for electro-mobility.

5. COST-BENEFIT ANALYSIS

86. On 26 March 2018, the price excl. VAT of CNG and competing fuels was as follows [61]:

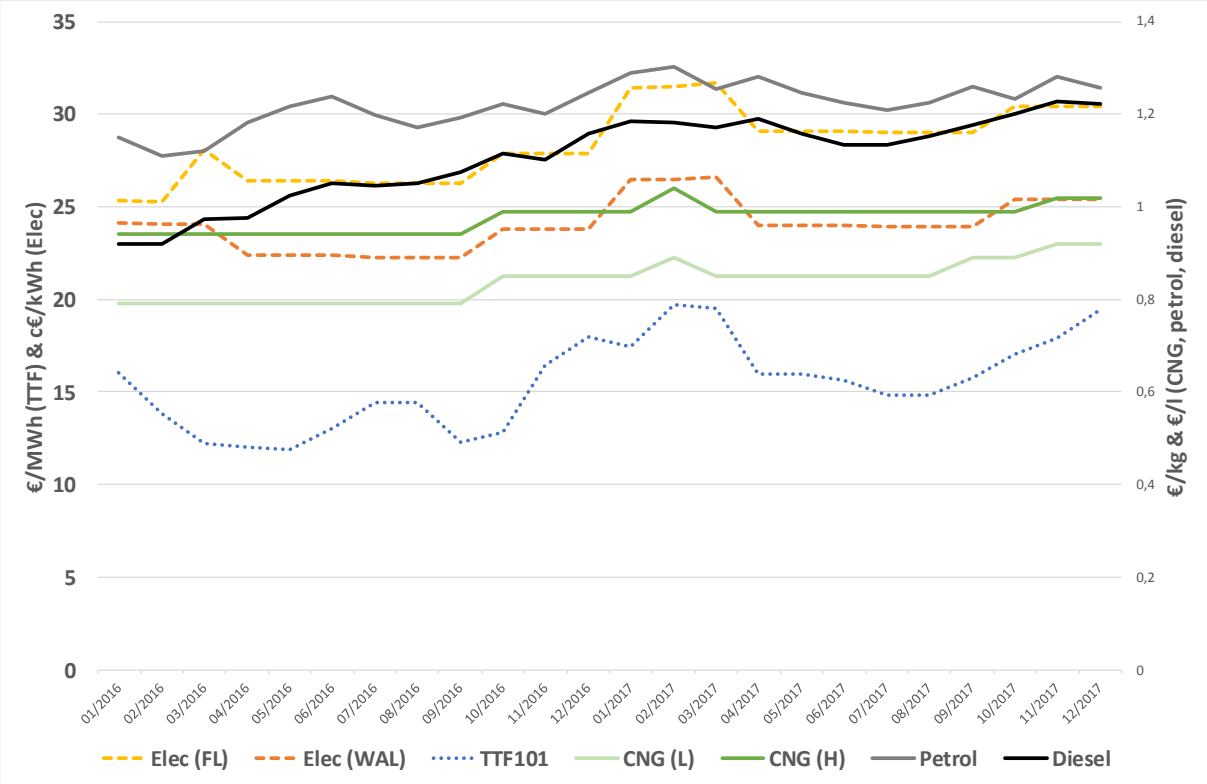
- CNG (type H): €1.020/kg;
- Diesel (10S): €1.272/l;
- Petrol (95 RON): €1.272/l;
- Electricity[62]: €0.25/kWh

87. With regards the fuel cost, the methodology used is based on the last known prices and not on prices for the last 12 or 24 months. For information, the following graph shows the average monthly prices charged in recent years.

[61] For the robustness of the comparison, the maximum prices are not taken into account. We consider the real prices at pumps offering discounts in the order of €0.15/l for diesel and petrol compared with the maximum prices set by FPS Economy. For CNG, there is no maximum price, the price selected is the price practiced by Dats24.

[62] Based on a consumption of 3,000 kWh/year (equivalent to 15,000 km with a consumption of 20 kWh/100 km), 2/3 at off-peak times and 1/3 at peak times with the default supplier Engie Electrabel (Easy indexed tariff) in the Imewo and Ores Hainaut DNO zones based on the VREG V-test https://vtest.vreg.be (€789/year) and based on the CWAPE simulator http://www.compacwape.be (€752/year). The price obtained is €0.25/kWh in the Ores Hainaut zone and €0.263/kWh in the Imewo zone. The price of €0.25/kWh was selected for this comparison. The aforementioned price does not include any photovoltaic production.

Figure 11: Trend in fuel prices[63] at the pump, for electricity and natural gas



Sources: Dats24, CREG and FPS Economy (max price petrol and diesel less €0.15/l).

88. Diesel - which was, *ceteris paribus*, at the same level as CNG in early 2016 - became 20% more expensive by the end of 2017 and reached the same level as petrol. However, the difference between CNG and petrol has remained relatively constant over the period.

89. The price of a CNG vehicle is relatively similar to the price of an equivalent-power diesel vehicle. The average price difference is around €200 as shown in appendix 1. The price differences between CNG and diesel vehicles vary between -€1,140 and +€2,353 depending on the brand and model of the vehicle. Out of the 26 car models currently available in CNG versions, 8 models have a CNG version where the price is lower than the equivalent diesel version. Given an average purchase price difference of about €200 between CNG and diesel vehicles and a fuel cost 33% more expensive for diesel, this extra cost is recovered after just 20,000 km to 25,000 km (or even directly if the benefits offered in Flanders and Wallonia are taken into account).

90. The price of a CNG vehicle is on average €2,400 higher than the price of an equivalent-powered petrol vehicle. The price differences between CNG and petrol vehicles vary between €0[64] and +€5,283 depending on the brand and model of the vehicle. Given this average purchase price difference between CNG and petrol vehicles and a fuel cost some 80% more expensive for petrol[65], this extra cost is recovered after 70,000 km (or even less if the benefits offered in Flanders and Wallonia are taken into account).

[63] Idem footnote 61.

[64] VW has applied the same price to the petrol and CNG versions of the Up, Polo, Golf and Golf estate since February 2018.

[65] Even if the price of petrol and diesel was more or less identical, the price difference between CNG and petrol is greater than that between CNG and diesel, because the petrol engine consumes more than the diesel engine.

91. In order to allow an objective comparison, it is important to choose a vehicle available in different fuel types. The engines selected are solely production cars[66]. The choice for this comparison therefore focused on the Volkswagen Golf, which is available in CNG, diesel, petrol, electric, and hybrid petrol/electric[67] models and on the Opel Zafira, which has CNG, diesel and petrol versions.

92. In order to make this comparison more relevant, manufacturers' values are not taken into account. These are often too optimistic compared with actual consumption. The average values calculated by the ADAC (*Allgemeiner Deutscher Automobil-Club*), the largest European automobile club with 20.2 million members were therefore used. This independent body has developed an Ecotest which is used to provide a realistic measurement of vehicle consumption[68].

The following two sections contain in order, the catalogue price, performance data, consumption data (manufacturer/ADAC) and CO_2 data (manufacturer/ADAC) for the different fuel types of the Volkswagen Golf Comfortline[69] and the Opel Zafira Edition. The performance data for the petrol, diesel and CNG engines is relatively similar. The performance data for the e-Golf and the *plug-in* hybrid is higher, which partly explains the significantly higher price of these versions.

5.1. VW GOLF BASIC DATA

Table 3: Price data (purchase and consumption) for the VW Golf Comfortline[70]

			(in l or kg or kWh)/100 km			
VW Golf (Comfortline) 5 doors	**purchase price VAT incl. €**	**kW / hp**	**Consumption manufacturer (NEDC)**	**Consumption ADAC**	**CO_2 manufacturer (NEDC TTW)**	**CO_2 ADAC (WTW)**
Petrol (TSI)	23.925	85 / 115	4,8	**5,1**	109	141
Diesel (TDI)	25.680	81 / 110	3,2	**3,8**	106	120
CNG (TGI)	23.925	81 / 110	3,5	**3,6**	96	98
e-golf	39.010	100 / 136	12,7	**17,3**	0	100
GTE (plug-in hybrid)	40.060	150 (110 & 75) / 204 (150 & 102)	1,6 l & 11,4 kWh	**3,3 l & 7 kWh**	36	131

[66] In Belgium, there are no LPG production vehicles which is why this alternative is not considered in this study.

[67] The VW Golf hybrid petrol/electric model (GTE) has sold out in Belgium (dedicated volume per country) pending the 2019 version, which is not a new model but an *update*.

[68] See https://www.adac.de/infotestrat/tests/eco-test/default.aspx. The values used to recalculate the CO_2 emissions of electric and hybrid vehicles are based on the German energy mix. For Belgium, there is also Ecoscore (www.ecoscore.be) which gives an indication of a vehicle's overall environmental character and which also uses a *well-to-wheel* procedure, but which does not recalculate consumption based on tests as the ADAC does.

[69] The Comfortline model is available in diesel (TDI), petrol (TSI) and CNG (TGI) versions. The electric (e-Golf) and plug-in hybrid (GTE) models have a specific finish.

[70] The ADAC Ecotest procedure for vehicles was modified in late 2016. The values given for the e-Golf were obtained using the new procedure. According to the old procedure, ADAC consumption was 18.7 kWh instead of 17.3 kWh. The values for the other fuel types (TSI, TDI, TGI, GTE) were obtained using this old procedure.

93. There is a difference between the consumption reported by VW and the consumption as shown by the ADAC tests. For CNG, the ADAC consumptions are very slightly higher than the value reported by VW. For the electric and hybrid models, the difference in CO_2 between the manufacturer's values and the ADAC values[71] are due to the fact that the ADAC values take account of the *well-to-wheel* (WTW) cycle while the manufacturer's values only take into account the *tank-to-wheel* (TTW).

Table 4: Price of fuel (based on ADAC consumption) for the VW Golf Comfortline

VW Golf (Comfortline) 5 doors	price (€/l or kg or kWh)	Consumption / 100 km (l or kg or kWh)	Price / 100 km (€)	price / 15.000 km (€)	price / 75.000 km (€)
Petrol (TSI)	1,272	5,1	6,49	973	4.865
Diesel (TDI)	1,272	3,8	4,83	725	3.625
CNG (TGI)	1,020	3,6	3,67	551	2.754
e-golf	0,250	17,3	4,33	649	3.244
GTE (plug-in hybrid)			5,95	892	4.461
GTE (plug-in hybrid) petrol	1,272	3,3	4,20	**630**	**3.148**
GTE (plug-in hybrid) elec	0,250	7	1,75	**263**	**1.313**

94. For an average consumption of 15,000 km/year (average annual mileage in Belgium), on the assumption that fuel prices remain stable over the period, the CNG model is the most cost-effective in terms of fuel costs, ahead of the electric model[72], the diesel, the hybrid (where applicable) and finally the petrol. In the case of the VW Golf, the table above shows that the price in euro for the same distance travelled compared with the CNG model, is 18% higher for electric[73], 32% higher for diesel, 62% higher for the hybrid and 77% higher for petrol.

95. It could initially seem interesting to convert everything into a price expressed in €/kWh, including for combustion fuels, but this would only give a partial view since consumption in kWh/100 km differs depending on the fuel type[74]. A combustion engine (primary energy) has a kWh/100 km consumption approximately 2 to 2.5 times higher than an electric engine (secondary energy[75]).

[71] These ADAC CO_2 values are calculated using the German energy mix.

[72] The calculation does not take into account any photovoltaic production, nor loss in battery performance.

[73] Calculation based on a breakdown of electricity consumption for 2/3 off-peak times and 1/3 peak times. Based on the tariff for off-peak times alone, the cost of the electricity fuel is still 8% more expensive compared to the CNG.

[74] As stated previously, 1 kg of natural H-gas = 13.3 kWh, 1 litre of diesel = 9.9 kWh and 1 litre of petrol = 8.6 kWh. This gives a consumption of between 38 and 48 kWh/100 km.

[75] Electricity is not a primary energy source. The theoretical average of a steam/gas turbine plant is assumed to have an efficiency of 50% (see http://www.creg.be/sites/default/files/assets/Publications/Studies/F1628FR.pdf) and must also take into account losses on the electricity transmission network. It is therefore important to put the lower kWh/100 km consumption for electric cars into perspective.

Table 5: Price of fuel for the VW Golf Comfortline (data converted into €/kWh)

VW Golf	consumption / 100 km (l or kg or	energy content (kWh/kg or kWh/l)	consumption / 100 km (kWh)	price / 100 km (€)	price (€/kWh)
Petrol (TSI)	5,1	8,6	43,9	6,49	0,148
Diesel (TDI)	3,8	9,9	37,6	4,83	0,128
CNG (TGI)	3,6	13,3	47,9	3,67	0,077
e-golf	17,3	1	17,3	4,33	0,250

5.2. OPEL ZAFIRA BASIC DATA

Table 6: Price data (purchase and consumption) for the Opel Zafira Edition[76]

			(in l or kg or kWh)/100 km			
Opel Zafira Edition	**purchase price VAT incl. €**	**kW / ch**	**consumption manufacturer (NEDC)**	**consumption ADAC**	**CO2 manufacturer (NEDC TTW)**	**CO_2 ADAC (WTW)**
Petrol (Ecotec)	25.050	103 / 140	6,4	**7,2**	148	192
Diesel (CDTI)	27.300	99 / 134	4,5	**5,7**	119	183
CNG (Ecotec)	27.800	110 / 150	4,7	**4,9**	129	131

96. There is here also a difference between the consumption reported by Opel and the consumption as shown by the ADAC tests. For CNG, the ADAC consumptions are once again very slightly higher than the value reported by the manufacturer.

Table 7: Price of fuel (based on ADAC consumption) for the Opel Zafira Edition

Opel Zafira Edition	price (€/l or kg or kWh)	consumption / 100 km (l or kg or kWh)	price / 100 km (€)	price / 15.000 km (€)	price / 75.000 km (€)
Petrol (Ecotec)	1,272	7,2	9,16	1.374	6.869
Diesel (CDTI)	1,272	5,7	7,25	1.088	5.438
CNG (Ecotec)	1,020	4,9	5,00	750	3.749

97. For an average consumption of 15,000 km/year (average annual mileage in Belgium), with the assumption that fuel prices remain stable over the period, for the Opel Zafira too, the CNG model is the most economical in terms of fuel costs, ahead of the diesel and petrol versions. In the case of the Opel Zafira, the table above shows that the price in euro for the same distance travelled is 45% higher for diesel and 83% higher for petrol.

98. For information only, the consumption expressed in kWh/100 km is also provided.

[76] All the values for the Opel Zafira have been established based on ADAC's new Ecotest procedure. In the absence of an ADAC Ecotest for the Zafira Petrol 103 kW model, the ADAC values for the Ecotec petrol engine had to be obtained by approximation with two comparable petrol models from the same brand (Zafira 88 kW and Mokka 103 kW) which each led to an increase in fuel of about 12% (and a rise in CO2 of around 30%). This approximation can therefore be considered as relatively reliable. A second comment concerns the diesel model which is 100 kW in Germany but 99 kW in Belgium.

Table 8: Price of fuel for the Opel Zafira Edition (data converted into €/kWh)

Opel Zafira Edition	consumption / 100 km (l or kg or kWh)	energy content (kWh/kg or kWh/l)	consumption / 100 km (kWh)	price / 100 km (€)	price (€/kWh)
Petrol (TSI)	7,2	8,6	61,9	9,158	0,148
Diesel (TDI)	5,7	9,9	56,4	7,250	0,128
CNG (TGI)	4,9	13,3	65,2	4,998	0,077

5.3. BASIC DATA FOR OTHER VEHICLES

99. Further internal simulations were performed for other models available in a CNG version, particularly for the Fiat 500 L, Skoda Octavia Combi, Seat Leon and Audi A4 Avant. All these simulations gave the same result, that is, a lower fuel cost for CNG compared with diesel (this latter being in average 33% more expensive) and petrol (on average 77% more expensive).

100. For practical reasons, the cost-effective analyses in points 5.4 and following are limited to the two cases represented by the VW Golf (compact model) and the Opel Zafira (MPV).

5.4. COST-EFFECTIVE ANALYSIS FOR INDIVIDUALS

VW Golf calculation

101. Based on the graph below, the CNG vehicle is most cost-effective from the first kilometre at VW. Diesel is never the most cost-effective solution. Based on current prices, diesel is in second position just ahead of petrol after 100,000 km but is always behind CNG. The difference between CNG and the two petroleum-based fuels increases over the kilometres in favour of CNG.

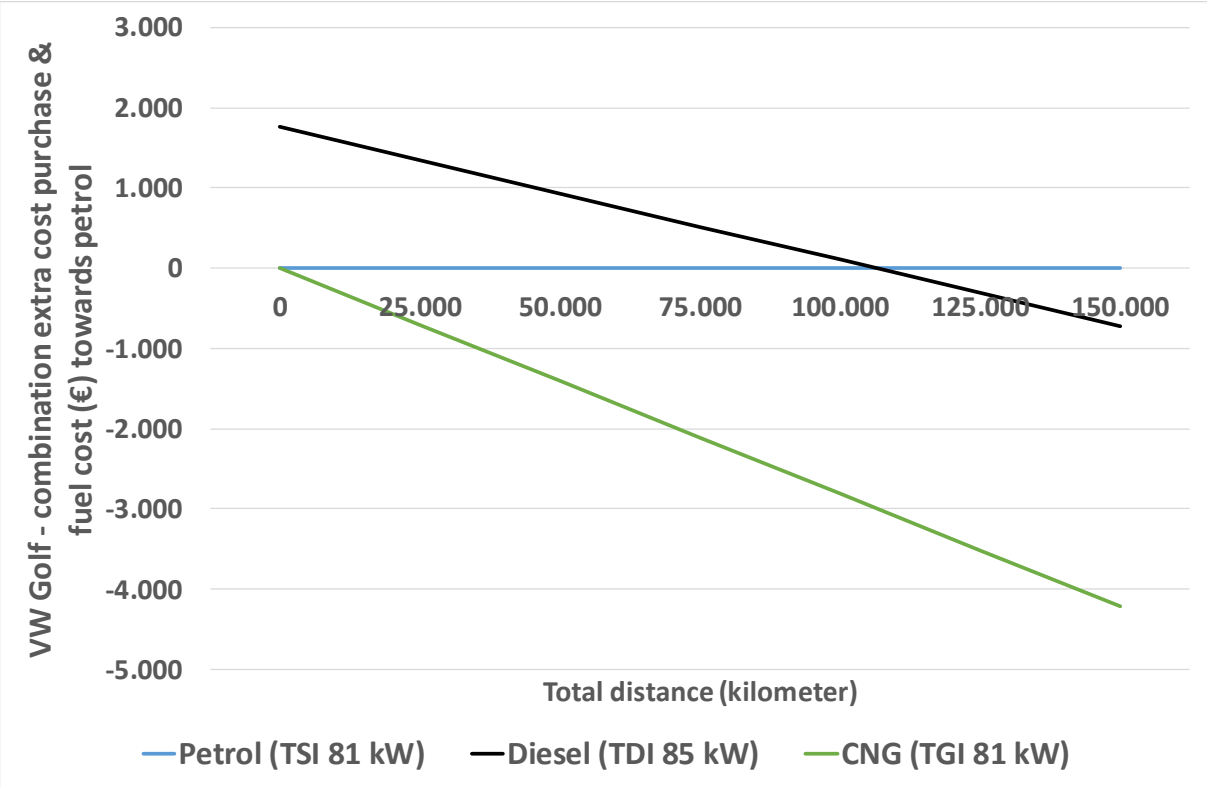
102. This calculation only takes into account any extra purchase cost[77] for diesel and CNG versions compared with the petrol model of the Volkswagen Golf Comfortline and the fuel cost (based on current prices and ADAC consumption). Other costs (insurance, annual road taxes, TMC tax for the first use of a car on the road, etc.) have not been included in this calculation, nor have the different subsidies[78] and tax exemptions[79]. Neither is the residual value taken into account. The situation taking account of all these elements would have been even more favourable to CNG compared with petrol and diesel. The electric (e-Golf) and hybrid (GTE) models, which are significantly more expensive (€15,000 more on purchase), are not shown on the following figure for presentation reasons.

[77] VW is the first manufacturer to have aligned the price of its CNG engines with those of its petrol engines (for the Up, Polo, Golf and Golf estate models).

[78] A €500 subsidy is granted by the DNOs Ores and Resa for the purchase of a CNG vehicle in Wallonia.

[79] CNG vehicles are exempt from annual road tax and TMC tax in Flanders until 2020.

Figure 12: Cost comparison (purchase and fuel) for the petrol, diesel and CNG versions of the VW Golf Comfortline



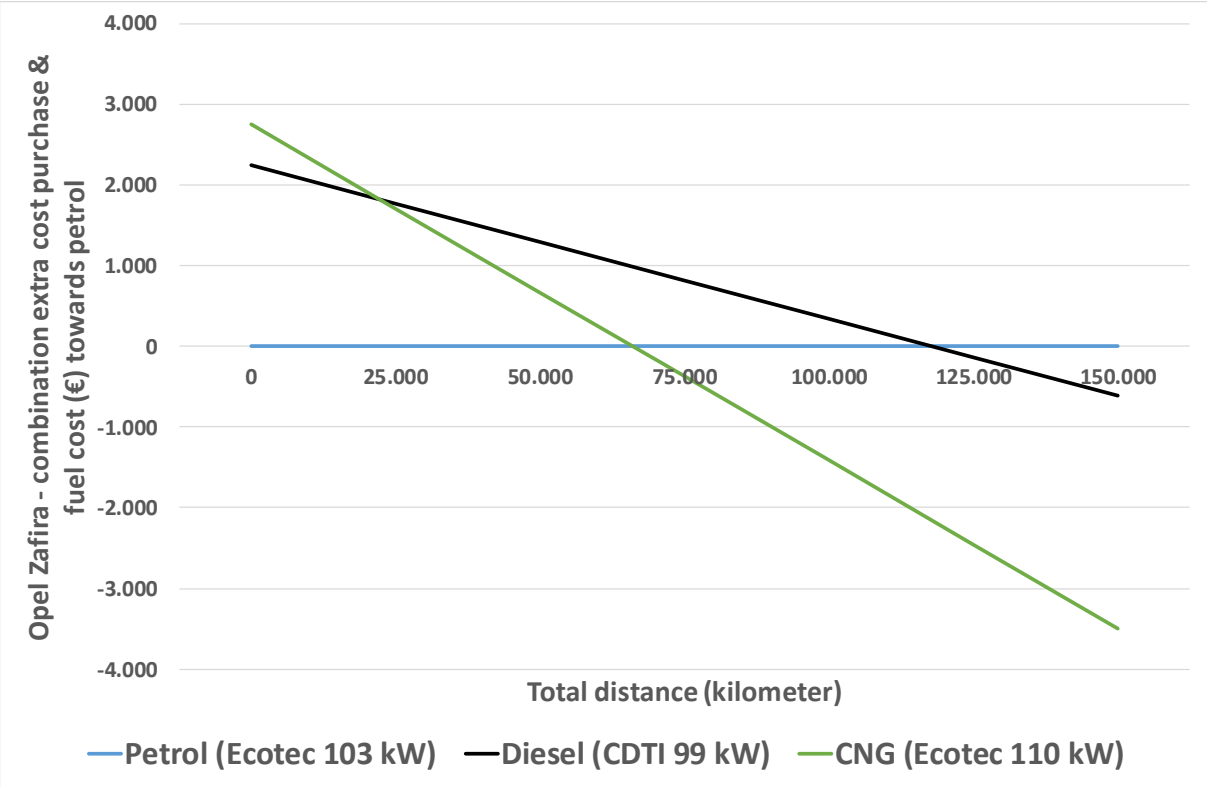
NB: calculation excluding subsidy (WAL) and tax benefits (VL)

Opel Zafira calculation

103. Based on the graph below, it appears that the petrol vehicle remains more cost-effective until approximately 70,000 km. After this mileage, the CNG vehicle becomes more attractive. Diesel is never the most cost-effective solution. Based on current prices, diesel becomes more attractive than petrol after 120,000 km but is always far behind CNG. The difference between CNG and the two petroleum-based fuels increases over kilometres in favour of CNG.

104. This calculation only takes into account the extra purchase cost for diesel and CNG versions compared with the petrol version of the Opel Zafira Edition and the fuel cost (based on current prices and ADAC consumption). Other costs (insurance, annual road taxes, TMC tax for the first use of a car on the road have not been included in this calculation, nor have the different subsidies and tax exemptions (see previous page)). Neither is the residual value taken into account. The situation taking account of all these elements would have been even more favourable to CNG compared with petrol and diesel.

Figure 13: Cost comparison (purchase and fuel) for the petrol, diesel and CNG versions of the Opel Zafira Edition



NB: calculation excluding subsidy (WAL) and tax benefits (VL)

105. The previous calculations were made for the Volkswagen Golf and the Opel Zafira. However, broadly similar conclusions can be drawn for the various brands that have CNG vehicles. The list of different models is provided in appendix 1. Generally, petrol versions are cost-effective up to an average mileage of 70,000 km (between 0 and 200,000 km for the extremes). Beyond that, the CNG versions are most cost-effective. Diesel is never the most cost-effective solution; at best it is in second position beyond 100,000 to 150,000 km, although it is always beaten by CNG.

5.5. COST-EFFECTIVE ANALYSIS FOR COMPANIES

5.5.1. Tax allowances

106. For companies, the current tables for vehicle tax allowances are as follows:

	CO_2 (NEDC) in g/km		
Deductibility	**Diesel**	**CNG & Petrol**	**Electric**
120%			0
100%	< 60	< 60	
90%	61 - 105	61 - 105	
80%	106 - 115	106 - 125	
75%	116 - 145	126 - 155	
70%	146 - 170	156 - 180	
60%	171 - 195	181 - 205	
50%	> 195	> 205	

107. From 2020 onwards, allowances will be calculated using the following formula for vehicles as defined by Law of 25 December 2017 on the corporate tax reform[80]:

120% - (0.5% * fuel factor * $C0_2$/km)

The factor varies depending on the fuel type:

- diesel and hybrid diesel vehicles: 1;
- vehicles equipped with another engine (petrol, hybrid petrol, LPG, etc.): 0.95;
- CNG vehicles; 0.9[81] (if the number of tax horsepower is higher than or equal to 12, the coefficient rises to 0.95).

108. From the same date, electric vehicles will see their tax allowances change to 100% instead of 120%.

109. For a plug-in hybrid vehicle fitted with an electric battery with an energy capacity of less than 0.5 kWh per 100 kg of vehicle weight or emitting over 50 grams of CO_2 per km, the emission of grams of CO_2 to be taken into consideration is equal to that of the corresponding combustion vehicle. If there is no corresponding combustion vehicle, the value of the emission is multiplied by 2.5.

110. For the models analysed, this gives the following tax allowance rates (2018 and 2020):

VW Golf calculation

Golf (comfortline)	**CO_2 (NEDC)**	**2018**	**2020**
Petrol (TSI) 81 kW	109	80%	68%
Diesel (TDI) 85 kW	106	80%	67%
CNG (TGI) 81 kW	96	90%	77%
e-golf 100 kW	0	120%	100%
GTE (plug-in hybrid) 150 kW	36	100%	100%

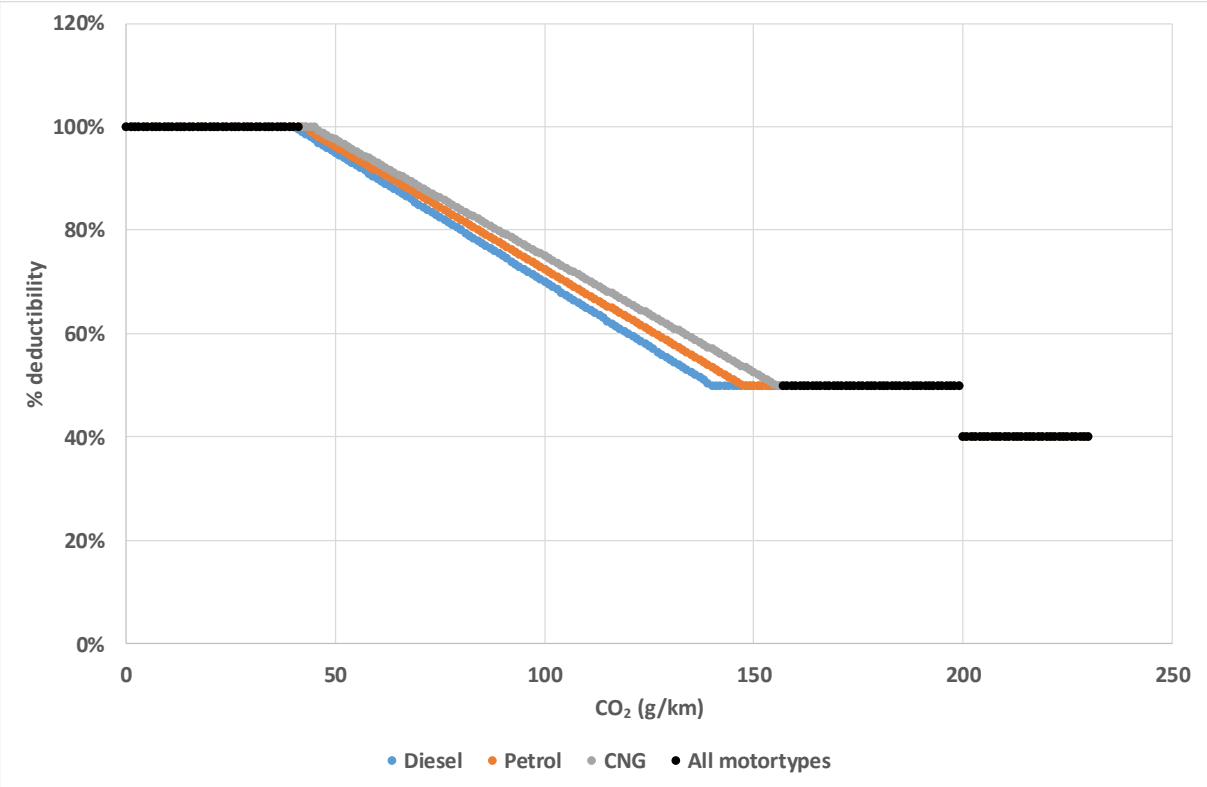
Opel Zafira calculation

Opel Zafira Edition	**CO_2 (NEDC)**	**2018**	**2020**
Petrol (TSI) 103 kW	143	75%	52%
Diesel (TDI) 99 kW	119	75%	61%
CNG (TGI) 110 kW	129	75%	62%

[80] See Art 11 of the Law of 25 December 2017 on the corporate tax reform http://www.etaamb.be/fr/loi-du-25-decembre-2017_n2017014414.html. See also https://www.sd.be/ellawebsite/fr/legalnews/8e57d466-8220-4355-a74a-9ab505859799 and https://www.moniteurautomobile.be/conseils-auto/la-deductibilite/deduction-des-frais-automobiles-a-partir-de-2020.html

[81] By Royal Decree deliberated in the Council of Ministers, the King can reduce the coefficient applicable to vehicles fitted with a natural gas engine with a fiscal power under 12 tax horsepower, to a minimum of 0.75 (see Article 11, 2°, last paragraph of the aforementioned law).

Figure 14: Tax allowances for car and fuel expenses from 2020



Sources: Febiac and CREG

111. In terms of tax allowances, CNG cars are therefore more cost-effective than petrol cars and this benefit should generally increase from 2020 as shown clearly with the two examples and the figure above.

112. The tax allowance rate is admittedly less favourable than for electric cars and conventional hybrids, both now and from 2020. However, the cost of electric and hybrid vehicles remains significantly higher than that of CNG vehicles. For example, the extra purchase cost incl. VAT is approximately €15,000 for the VW Golf.

113. Furthermore, the extent to which the Government will take account of the new CO_2 values resulting from the WLTP standard, which is more restrictive than the NEDC standard still remains to be seen.

5.5.2. Leasing cost

114. The cost for the employer in the case of operational leasing was also analysed for both models previously examined, the VW Golf Comfortline and the Opel Zafira Edition.

115. CREG called on the two main leasing companies in Belgium to obtain price simulations based on the following assumptions: 60 months and 125,000 km (25,000 km/year[82]). Based on the data from FPS Mobility and Transport[83], the annual mileage of a company car (28,937 km) is significantly higher than a passenger car (14,999 km).

[82] Leasing mileage is limited to 20,000 km/year for the electric model.
[83] https://mobilit.belgium.be/sites/default/files/kilometers_2016_fr.pdf

116. For reasons of confidentiality and commercial secrecy, the results on this issue do not appear in € but in base 100.

117. For the VW Golf[84], the cost of such a lease (rental + fuel[85]) amounts to

- 100 for the TGI 81 kW Comfortline model (CNG);
- 115 for the TSI 81 kW Comfortline model (Petrol);
- 115 for the TDI 85 kW Comfortline model (Diesel);
- 143 for the e-Golf 100 kW model (electric);

118. For the Opel Zafira Edition, the cost of such a lease (rental + fuel) amounts to

- 100 for the 110 kW CNG model;
- 104 for the 99 kW TDI model;
- 109 for the 103 kW Petrol model;

119. It is mainly the lower cost of CNG fuel that tips the scales in favour of CNG models. The cost of the lease excluding fuel is in fact slightly higher for CNG models due to their usually higher purchase price. Other elements (maintenance/repairs, insurance, roadside assistance, etc.) are generally similar regardless of the vehicle's fuel type.

120. Other taxation elements are also taken into account, such as whether the company is subject to VAT or not, whether it is an SME or a large organisation or an administration. The aim here is not to go into detail about taxation but to give an overview of the cost of CNG compared with other fuel types in a leasing deal. For both models analysed, this comparison clearly favours CNG.

121. The data given above relates to operational leasing where a company leases the vehicle from a leasing company. Another possibility for a company is to purchase the vehicle, the total cost of which will then be depreciated. The main difference in this case in terms of cost will relate to annual road tax and tax levied for the first use of a car on the road (TMC) which will then depend on the region in which the company is based. Within the framework of an operational leasing, vehicles in the name of an approved leasing company are always subject to TMC and federal road tax as they are still applied in Brussels and Wallonia regardless of the location in which the leasing company is based.

5.6. COST-EFFECTIVE ANALYSIS FOR EMPLOYEES

122. Since 1 January 2012, the benefit in kind for the provision of a free company car has been calculated based on the vehicle's catalogue value and CO_2 emissions using the following formula: vehicle's catalogue value x CO_2 percentage x 6/7.

123. In order to determine the CO_2 percentage, a vehicle's CO_2 emission rate is compared to a reference CO_2 emission rate. The reference CO_2 emission rates are set annually by Royal Decree. Following the publication in the Belgian Official Journal[86] of the Royal Decree of 13 December 2017 amending benefits in kind (RD/ITC 92) arising from the personal use of a vehicle provided free of charge, the calculation formulae for the taxable benefit for company cars for 2018 are as follows:

[84] The current GTE (hybrid) model is no longer available.

[85] The electric fuel package was taken as irrelevant in the simulation sent by the leasing company. For an objective comparison, this cost was set to the level of the CNG* 1.18, see previous calculation (table 4 and paragraph 94).

[86] http://www.etaamb.be/fr/arrete-royal-du-13-decembre-2017_n2017040954.html

- petrol, LPG and CNG vehicles:

  catalogue value x [5.5 + ((CO_2 emission rate - 105) x 0.1]% x 6/7

- diesel vehicles:

  catalogue value x [5.5 + ((CO_2 emission rate - 86) x 0.1]% x 6/7

- electric vehicles:

  catalogue value x 4% x 6/7

124. In the case of the two previously analysed vehicles, this gives the following benefit in kind

VW Golf calculation

Golf (comfortline)	Price VAT incl.	CO_2 (NEDC)	formule benefit in kind (BIK)	minimum BIK	applicable BIK
Petrol (TSI)	23.925	109	1.209,92	1.310,00	1.310,00
Diesel (TDI)	25.680	106	1.650,86	1.310,00	1.650,86
CNG (TGI)	23.925	96	943,33	1.310,00	1.310,00
e-golf	39.010	0	1.337,49	1.310,00	1.337,49
GTE (plug-in hybrid)	40.060	36	1.373,49	1.310,00	1.373,49

Opel Zafira calculation

Opel Zafira Edition	Price VAT incl.	CO_2 (NEDC)	formule benefit in kind (BIK)	minimum BIK	applicable BIK
Petrol (TSI)	25.050	143	1.996,84	1.310,00	1.996,84
Diesel (TDI)	27.300	119	2.059,20	1.310,00	2.059,20
CNG (TGI)	27.800	129	1.882,46	1.310,00	1.882,46

125. In both cases analysed here, the benefit in kind is the lowest for CNG cars. This is due to the fact that the CO_2 rates of such vehicles are lower (for equivalent power) than those of their diesel and petrol counterparts and their purchase price is lower than that of electric and hybrid vehicles[87].

6. CONCLUSION

126. CNG (*compressed natural gas*) is an alternative fuel which is more environmental-friendly and more economical than petroleum-based fuels. The number of years of availability of natural gas (and therefore CNG) currently estimated (222) is higher than that of oil (181) even without taking the renewable variant made up of biomethane into account.

[87] From 2020, the Government has decided to increase the benefit in kind on *plug-in* hybrid electric vehicles (PHEV), where the battery energy capacity (in kWh)/ vehicle weight (in kg) *ratio* is less than 0.5. In the case of an energy ratio below this threshold, the CO_2 of the "traditional" (non-PHEV) version will have to be taken into account. If there is no PHEV version, the CO_2 of the PHEV will be multiplied by 2.5.

127. Environmentally, compared to the EURO6 version of diesel and petrol engines, a substantial reduction (approximately 80 to 90%) in fine particles and nitrogen oxides is observed for CNG engines. A lower rate of CO_2 is also noted, in a range of 7% to 16% as well as a 50% quieter engine. It is mainly concerns related to air quality that make it appropriate to use natural gas as a fuel. Bio-CNG, which is admittedly still relatively undeveloped in Belgium - unlike in its neighbouring countries- can further reduce overall CO_2 emissions.

128. Economically, the price at the pump for CNG, quoted in €/kg is 25% cheaper than the price of petrol and diesel expressed in €/litre. The difference in terms of fuel costs per km is however high. It is around 33% in favour of CNG compared to diesel and about 77% in favour of CNG compared to petrol. This is due to the fact that a kg of CNG contains more energy than a litre of diesel, which itself contains more energy than a litre of petrol.

129. Currently, half of the price of CNG at the pump is composed of the components of the price of natural gas (energy, transmission, distribution, surcharges) and half accounts for infrastructure expenses for service stations (CAPEX) and operating expenses (OPEX). This is due to the fact that the infrastructure is still relatively new and the number of CNG vehicles circulating in Belgium is still limited (approximately 10,000 vehicles to date). Eventually, the share of CAPEX and OPEX in the end price should decrease with the growth in the number of vehicles.

130. A CNG vehicle costs on average €200 more than a diesel vehicle and €2,400 more than a petrol vehicle.

131. Compared to diesel, given the small difference in the purchase price further reduced by the grant of €500 for the purchase of a CNG vehicle in the Walloon Region (valid until 30 June 2018) or the exemption from tax levied for first use of a vehicle and annual road tax in Flanders (valid until 2020), CNG models are on average cost-effective from the first kilometre.

132. Compared to petrol, given the generally higher purchase price, CNG models are on average cost-effective after 70,000 km, or even less when the aforementioned grants and tax exemptions are taken into account.

133. Compared to electric and hybrid vehicles, based on the only model (VW Golf) available on the market in these different versions and in CNG, the CNG model proves to be cost-effective from the first kilometre, considering the higher fuel cost for electricity on the one hand and the €15,000 higher purchase price for electric and hybrid models on the other. However, here, neither photovoltaic production by the owner to recharge the battery nor the loss of performance of this battery over time are taken into account. In addition, the electric and hybrid models referred to have a specific finish and a more powerful engine, which does not allow a comprehensive comparison.

134. The different fuel types were also compared within the framework of operational leasing. Once again, the different simulations proved favourable to CNG.

135. In terms of infrastructure, the Belgian network of CNG service stations had 91 publicly-accessible stations as of March 2018 - 76 in Flanders, 14 in Wallonia and 1 in Brussels. In late 2018, there were 36 new projects (20 in Flanders, 14 in Wallonia and 2 in Brussels) designed to provide coverage in each province, which would overcome the current absence of stations in the east and south-east of the country. Wallonia is gradually beginning to make up ground in this area and this can partially be imputable to the incentive policy in terms of connections set by CWAPE to promote the installation of CNG stations.

136. There were some 10,000 CNG vehicles circulating in March 2018, mostly registered in Flanders. Seven car manufacturers offer such vehicles for sale. Among 26 different models, all vehicle types are available including city, sedan, estate, compact, MPV, vans, SUV. Most (97%) CNG vehicles circulating are production vehicles, with only 3% being so-called *retro-fit* versions, i.e. petrol vehicles to which a CNG fuel tank has been added.

137. Based on the number of stations and vehicles, Belgium seems partially able to achieve its objectives set under the DAFI (*Deployment of Alternative Fuels Infrastructure*) Directive. The national plan developed in 2017 by the FPS Economy and the FPS Mobility and Transport in partnership with the Regions, provides for 333 CNG stations (300 in Flanders, 30 in Wallonia and 3 in Brussels) and 42,500 CNG vehicles (41,000 in Flanders, 1,300 in Wallonia and 300 in Brussels) by 2020. Given the development of the market, with a reserve on the number of stations in Flanders (and in Belgium) all these objectives seem achievable.

138. In terms of te autonomy of CNG vehicles in accordance with NEDC standards, depending on the model, the autonomy can be between 300 km and 800 km for a single tank of CNG. All CNG vehicles also have a secondary petrol tank. The cumulative CNG and petrol autonomy sets therefore between 600 km and 1,360 km depending on the model.

139. By 2030, the objectives defined by the NGVA Europe association show a market share of 12% for natural gas cars (CNG) and 20% to 30% for lorries and buses (CNG and LNG). In addition to Belgium, the major European nations also have ambitious intermediary objectives.

140. Based on this study, CNG appears to be a real alternative to traditional fuels and demonstrates its relevance both ecologically (sharp fall in fine particles and nitrogen oxides) and economically. In the context of the energy transition, it is important to remember the important contribution that natural gas could represent and encourage its use in the field of mobility. The gas and automotive sectors would also benefit from developing more communication campaigns on this subject.

For the Commission of Electricity and Gas Regulation:

Laurent JACQUET
Director

Marie-Pierre FAUCONNIER
President of the Management Committee

APPENDIX 1

Price inc. VAT of CNG, diesel and petrol cars

Starting price catalog VAT incl. 03/2018 - without option - CNG and equivalent model in diesel and petrol in terms of power							
		CNG	Diesel	Petrol	Delta CNG/Diesel	Delta CNG/Petrol	Vehicle type
Audi	A3 Sportback G-Tron	26.640,00	27.780,00	26.370,00	-1.140,00	270,00	Compact
Audi	A4 Avant G-Tron	38.443,13	36.090,00	33.160,00	2.353,13	5.283,13	Saloon / Estate
Audi	A5 Sportback G-Tron	40.400,00	38.560,00	37.050,00	1.840,00	3.350,00	Saloon / Estate
Fiat	500L Natural Power Popstar	21.000,00	19.800,00	17.900,00	1.200,00	3.100,00	MPV
Fiat	500L Wagon Natural Power Popstar	21.500,00	20.300,00	18.400,00	1.200,00	3.100,00	MPV
Fiat	Doblo Natural Power Street	19.775,00	19.175,00	16.175,00	600,00	3.600,00	MPV / Van
Fiat	Panda Natural Power Easy	14.140,00	13.540,00	11.940,00	600,00	2.200,00	City
Fiat	Punto Natural Power Easy	16.440,00	16.340,00	13.140,00	100,00	3.300,00	Compact
Fiat	Qubo Natural Power Easy	15.240,00	16.440,00	13.140,00	-1.200,00	2.100,00	Van
Opel	Astra 1.4 Turbo EcoTec CNG Edition	23.600,00	22.800,00	20.650,00	800,00	2.950,00	Compact
Opel	Astra ST 1.4 Turbo EcoTec CNG	24.475,00	23.675,00	21.525,00	800,00	2.950,00	Saloon / Estate
Opel	Zafira 1.6 Turbo CNG Edition	27.800,00	27.300,00	25.050,00	500,00	2.750,00	MPV
Opel	Combo Cargo 1.4 CNG L1H1 cua	20.945,10	19.904,50	18.585,60	1.040,60	2.359,50	Van
Seat	Leon Tgi Style	24.290,00	24.790,00	21.790,00	-500,00	2.500,00	Compact
Seat	Leon ST Tgi Style	25.190,00	25.690,00	22.690,00	-500,00	2.500,00	Saloon / Estate
Seat	Ibiza Tgi Style	18.410,00	19.190,00	17.000,00	-780,00	1.410,00	Compact
Seat	Mii Ecofuel	13.960,00		12.200,00		1.760,00	City
Škoda	Citigo G-TEC Ambition	13.355,00		11.275,00		2.080,00	City
Škoda	Octavia Combi G-TEC Ambition	27.545,00	26.550,00	23.825,00	995,00	3.720,00	Saloon / Estate
Volkswagen	Eco up! Move	12.720,00		12.720,00		0,00	City
Volkswagen	New Polo TGI Trendline	16.900,00	18.300,00	16.900,00	-1.400,00	0,00	Compact
Volkswagen	Golf TGI Trendline (5 doors)	22.685,00	24.450,00	22.685,00	-1.765,00	0,00	Compact
Volkswagen	Golf TGi Variant Trendline	23.600,00	26.290,00	23.600,00	-2.690,00	0,00	Saloon / Estate
Volkswagen	Caddy TGI Conceptline	20.520,00	19.370,00	16.650,00	1.150,00	3.870,00	MPV / Van
Volkswagen	Caddy TGI Conceptline Maxi	21.470,00	20.540,00	17.850,00	930,00	3.620,00	MPV / Van
Ssangyong	XLV	19.490,00	18.990,00	16.490,00	500,00	3.000,00	SUV
Average delta CNG-Diesel & CNG-Petrol					**201,00**	**2.376,00**	

Sources: websites of Belgian vehicle importers

NB: Most new CNG models sold will have a 15-litre petrol tank (instead of 50) but a larger CNG tank. This may lead to a temporary unavailability for some models.

APPENDIX 2

Quality of natural gas supplied in 2017 in Belgium

QUALITIES OF THE NATURAL GAS TYPES SUPPLIED IN BELGIUM								
ANNUAL AVERAGES 2017								
QUALITY Ref. 1	**SYMBOL**	**UNIT**	**SLOCHTEREN (10)**	**EYNATTEN 1 (18)**	**SEGEO (20)**	**LNG (29)**	**IZTF (34)**	**ZPT (91**
NATURAL GAS TYPE	Reference location		Poppel	Raeren	Gravenvoerer	Terminal	Zeebrugge	Ramskapelle
	Gas type		L – gas	H – gas	H – gas	H – gas	H – gas	H – gas
GAS COMPOSITION Ref.1								
Nitrogen	N_2	mol %	9,981	0,403	0,959	0,491	1,735	1,071
Carbon dioxide	CO_2	mol %	1,375	0,409	1,383	0,000	1,230	1,714
Methane	C1 (CH_4)	mol %	83,903	96,263	91,387	93,100	90,642	90,748
Ethane	C2 (C_2H_6)	mol %	3,718	2,694	5,142	6,244	4,787	4,739
Propane	C3 (C_3H_8)	mol %	0,646	0,138	0,757	0,139	1,111	1,123
Iso-butane	iC4	mol %	0,108	0,045	0,136	0,011	0,163	0,251
N-butane	nC4	mol %	0,119	0,023	0,118	0,014	0,175	0,174
Iso-pentane	iC5	mol %	0,030	0,005	0,031	0,000	0,041	0,056
N-pentane	nC5	mol %	0,026	0,003	0,022	0,000	0,034	0,036
Hexane and superior HC	C6+	mol %	0,057	0,005	0,042	0,000	0,046	0,075
Oxygen	O2	mol %	0,000	0,000	0,000	0,000	0,000	0,000
Helium	He	mol %	0,035	0,012	0,022	0,000	0,035	0,013
CALCULATED VALUES Ref. 2								
Gross Caloric Value	GCV	kJ /m^3 (n)	37.154	40.476	41.252	41.626	41.210	41.429
Net Caloric Value	NCV	kJ /m^3 (n)	33.544	36.508	37.253	37.578	37.221	37.423
Gross Caloric Value	GCV	kJ /m^3 (n) Min	35.027	40.284	38.471	37.676	39.765	41.022
Gross Caloric Value	GCV	kJ /m^3 (n) Max	37.443	41.329	41.948	42.847	42.300	42.266
Gross Caloric Value	GCV	kWh /m^3 (n)	10,321	11,243	11,459	11,563	11,447	11,508
Net Caloric Value	NCV	kWh /m^3 (n)	9,318	10,141	10,348	10,438	10,339	10,395
Wobbe index (GCV/√d)	W I	kJ /m^3 (n)	46.458	53.320	52.797	54.230	52.521	52.620
Wobbe index	W I	kJ /m^3 (n) Min	44.433	52.584	50.394	49.534	49.665	51.448
Wobbe index	W I	kJ /m^3 (n) Max	46.667	53.475	53.661	55.064	53.357	54.184
Density	RON	kg / m^3 (n)	0,8269	0,7451	0,7893	0,7618	0,7960	0,8015
Relative mass density	d	-	0,6396	0,5763	0,6105	0,5892	0,6156	0,6199
Gross Caloric Value	GCV	kJ / kg	44.932	54.326	52.263	54.644	51.774	51.693
Net Caloric Value	NCV	kJ / kg	40.565	48.999	47.196	49.329	46.762	46.694
Gross Caloric Value	GCV	kWh / kg	12,481	15,091	14,518	15,179	14,382	14,359
Net Caloric Value	NCV	kWh / kg	11,268	13,611	13,110	13,703	12,990	12,971
Ratio NCV / GCV	NCV / GCV	-	0,9028	0,9020	0,9030	0,9027	0,9032	0,9033
STOCHIOMETRIC COMBUSTION Ref. 3								
Stochiometric air requirement	a (moist air)	m^3 (n) air / m^3 (n) gas	8,95	9,75	9,93	10,03	9,92	9,97
Combustion prod. at stochiometric combustion (moist)	q st (moist air)	m^3 (n) comb.prod. / m^3 (n) gas	9,91	10,69	10,90	10,98	10,89	10,95
Combustion prod. at stochiometric combustion (dry)	q st (dry air)	m^3 (n) comb.prod. / m^3 (n) gas	8,11	8,71	8,90	8,96	8,90	8,95
Comb.prod. max.CO_2	% CO_2 max	% m^3 / m^3	9,66	9,58	9,77	9,62	9,77	9,82
Comb.prod. max.CO_2	% CO_2 max	# mol / mol	0,96	1,03	1,07	1,06	1,07	1,08
Comb.prod. max. H_2O	% H_2O max	% m^3 / m^3	17,90	18,24	18,03	18,11	18,00	17,98
Dry comb.prod. max.CO_2	% CO_2 max	% m^3 / m^3	11,81	11,75	11,95	11,79	11,95	12,01
ADDITIONAL DATA Ref. 3								
Molar mass	Mol. Mass	kg / kmol	18,488	16,657	17,642	17,028	17,790	17,912
Weight percentage C	C mass %	%	62,494	74,140	72,757	74,849	72,101	72,370
Weight percentage H	H mass %	%	20,001	24,397	23,210	24,343	22,954	22,893
Weight percentage N	N mass %	%	15,125	0,678	1,523	0,808	2,732	1,675
Weight percentage O	O mass %	%	2,380	0,785	2,509	0,000	2,213	3,061
Specific CO_2 emission	-	kg CO_2/GJ	56,445	55,439	56,483	55,596	56,490	56,787
Specific CO_2 emission	-	kg CO_2/MWh	203,201	199,580	203,339	200,145	203,366	204,432
H_2S Mean (ref. 1)	H_2S	mg/m^3 (n)	0,36	0,12	2,66	0,11	0,97	2,20
H_2S Max (ref.1)	H_2S	mg/m^3 (n)	1,51	2,53	4,06	1,26	4,08	4,00
Total Sulfur Mean (ref.1)	S	mg/m^3 (n)	0,35	0,14	2,43	0,09	1,04	1,72
Total Sulfur Max (ref.1)	S	mg/m^3 (n)	2,88	2,86	3,85	0,53	3,37	3,23
CH_4 rate (ref.4)	AVL	(+/- 2 units)	86,7	88,7	80,8	83,7	79,3	78,6
CH4 rate (ref.4)	ISO	(+/- 2 units)	(*)	90,4	83,7	84,7	81,6	82,5

The information above is given for information only.

Ref. [1] : Fluxys - Quality & Metrology

Ref. [2] : ISO 6976 - 1995 , reference temperature for the combustion enthalpy: 25 °C ; 1 m³ (n): at 0 °C and 1013.25 mbar

Ref. [3] : Reference temperature and pressure (0 °C and 1013.25 mbar) ; Fluxys

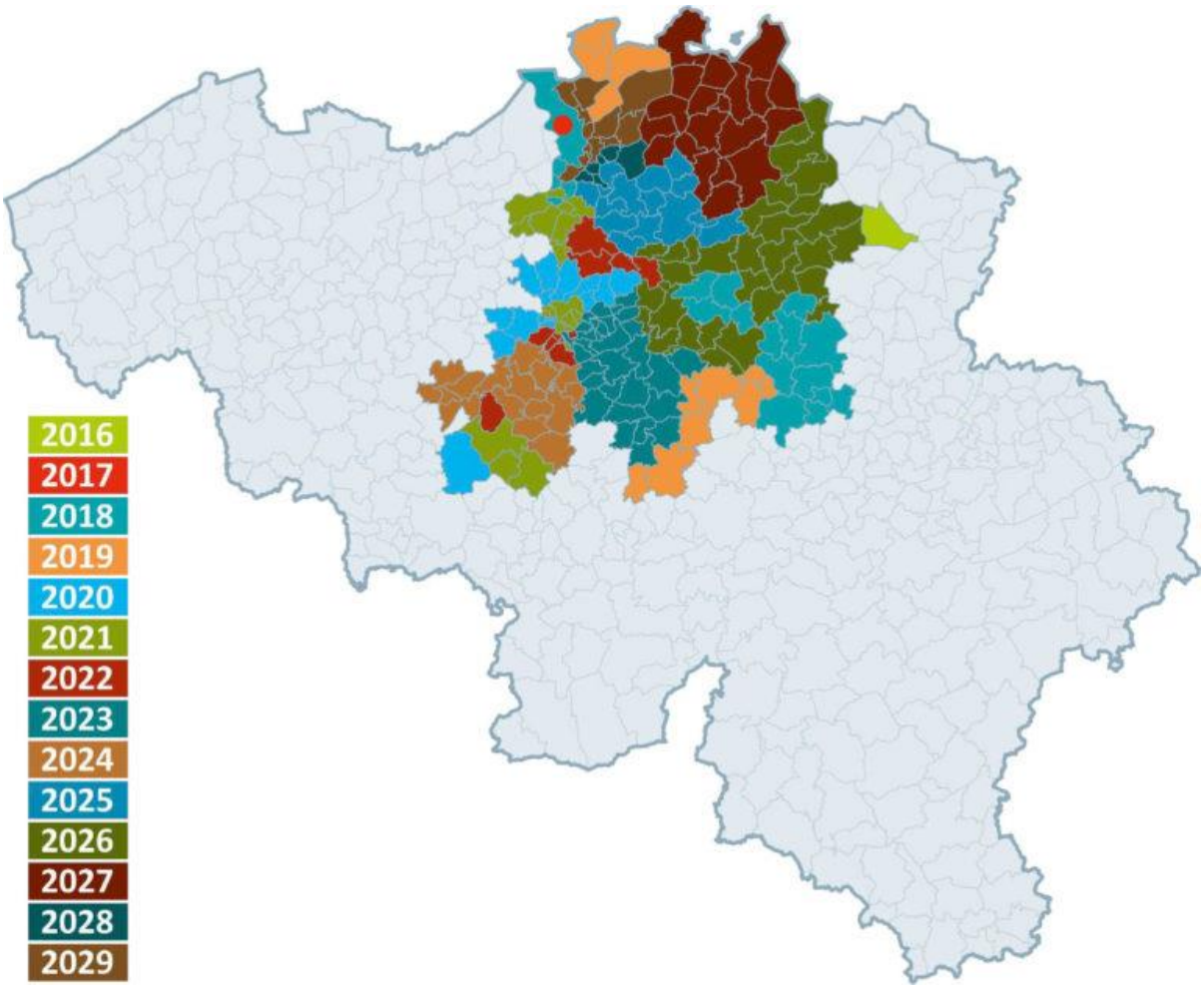
Ref. [4] : K. Christoph, W. Cartellieri en U. Pfeifer , "Die Bewertung der Klopffestigkeit von Kraftgasen mittels der Methanzahl und deren praktischen Anwendung bei Gasmotoren, MTZ, 33, no. 10 , 1972 , p. 391 - 40

(*) These values are not significant due to the high N_2 content in Slochteren gas.

Source: Fluxys

APPENDIX 3

Planned L-gas to H-gas conversion (2016-2029)



Source: Synergrid