2017 EDITION

AUTOGAS INCENTIVE POLICIES

A COUNTRY-BY-COUNTRY ANALYSIS OF WHY AND HOW GOVERNMENTS ENCOURAGE AUTOGAS AND WHAT WORKS

AEGPL EUROPE European LPG Association
LPG EXCEPTIONAL ENERGY
WLPGA

The World LPG Association

The World LPG Association (WLPGA) was established in 1987 in Dublin, Ireland, under the initial name of The World LPG Forum.

WLPGA unites the broad interests of the vast worldwide LPG industry in one organisation. It was granted Category II Consultative Status with the United Nations Economic and Social Council in 1989.

WLPGA exists to provide representation of LPG use through leadership of the industry worldwide.

The European LPG Association

The European LPG Association (AEGPL) is the sole representative of the LPG industry at European level, representing national LPG Associations as well as distributors and equipment manufacturers from across Europe.

Its mission is to engage with EU decision-makers and the wider policy community in order to optimise the contribution that LPG – as a clean and immediately available energy source – can make to meeting Europe's energy and environmental challenges.

Acknowledgements

This report was prepared by Trevor Morgan of Menecon Consulting. Acknowledgement also goes out to the many representatives of the LPG industry in the countries surveyed in the report, who provided invaluable assistance. Cécile Nourigat, Autogas Manager at WLPGA and AEGPL, was responsible for co-ordinating the project.

Copyright

Contents

Glossary

AEGPL	European LPG Association
AFV	Alternative fuel vehicle
CNG	Compressed natural gas
CO_2	Carbon dioxide
EV	Electric vehicle
HDV	Heavy-duty vehicle
LDV	Light-duty vehicle
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
NGV	Natural gas vehicle
NOx	Nitrogen oxides
OEM	Original equipment manufacturer
PM	Particulate matter
SCC	Social cost of carbon
UNECE	United Nations Economic Commission for Europe
VAT	Value-added tax
WLPGA	World LPG Association

Executive summary

Autogas – LPG used for transport – is the most common unblended alternative car fuel in use in the world today. Global consumption of Autogas has been rising steadily in recent years, reaching 26.7 million tonnes in 2016 – an increase of 283 000 tonnes, or 1.1%, over 2015 and 3.7 Mt, or 16%, up on 2000. There are now 26.8 million Autogas vehicles in use around the world. Yet Autogas use is still concentrated in a small number of countries: just five countries – Korea, Turkey, Russia, Poland and Italy – together accounted for just under half of global Autogas consumption in 2016; the 23 countries surveyed in this report accounted for 83%. The share of Autogas in total automotive-fuel consumption varies widely among those countries, ranging from a mere 0.1% in Spain and the United States to about 18% in Ukraine. Autogas makes up more than 10% of the automotive-fuel market in five other countries: Bulgaria, Korea, Poland, Serbia and Turkey. The enormous disparity in the success of Autogas in competing against the conventional automotive fuels, gasoline and diesel, is explained mainly by differences in government incentive policies.

The primary reason why governments in many countries actively encourage the use of Autogas and other alternative fuels is the environment. Autogas out-performs gasoline and, especially, diesel, as well as some other alternative fuels in the majority of studies comparing environmental performance that have been conducted around the world. Autogas emissions are especially low with respect to noxious pollutants. With respect to greenhouse-gas emissions, Autogas performs better than gasoline and, according to some studies, out-performs diesel, when emissions are measured on a full fuel-cycle basis and when the LPG is sourced mainly from natural gas processing plants. However, in practice, the strength of actual policies and measures deployed does not always fully reflect the true environmental benefits of switching to Autogas from conventional automotive fuels.

The most effective Autogas incentive policies are those that help to make the fuel more competitive against gasoline and diesel and give a strong financial incentive for an end user to switch to Autogas. In practice, the financial attractiveness of Autogas over other fuels depends essentially on two factors: the net cost of converting an existing gasoline vehicle (or the extra cost of buying a factory-built Autogas vehicle compared with an equivalent gasoline or diesel vehicle) and the pump price of Autogas relative to diesel and gasoline. In short, the vehicle owner needs to be compensated for the additional upfront cost through lower running costs, of which fuel is the most important. The time it takes for the savings in running costs to offset the capital cost – the payback period – depends on the usage of the vehicle, i.e. the average distance travelled monthly or annually. The payback period usually has to be less than two to three years to encourage

commercial vehicle owners to switch; private individuals often demand a quicker return on their investment.

The payback period – or breakeven distance – is very sensitive to the extent to which government incentives lower fuel costs relative to the other fuels and lower the upfront expenditure on the vehicle. Taxes on Autogas must be low enough relative to those on gasoline and diesel to compensate for the lower mileage of Autogas per litre (due to its lower energy-content-to-volume ratio) and to ensure that the pump price of Autogas is low enough to provide an incentive for motorists to switch fuels. In 12 of the 23 countries surveyed, Autogas pump prices per litre for private motorists were less than half those of gasoline in 2016. The price of Autogas as a proportion of that of gasoline ranged from 35% in Thailand to 115% in the United States, averaging 52% across all countries. Relative to diesel, the price of Autogas averaged 59%.

The wide variation in Autogas pump prices among the countries surveyed, both in absolute terms and relative to the prices of other fuels, mainly reflects differences in the way automotive fuels are taxed. Autogas taxes in 2016 were lower than those on gasoline on a per-litre basis in all the countries surveyed. Autogas is totally exempt from excise taxes in China, Mexico and Russia. The ratio of Autogas taxes to gasoline taxes was by far the highest in the United States (though most users were able to profit from a small tax credit up to the end of 2016); in all the other countries, excise taxes on Autogas were less than half of those on gasoline on a per-litre basis. The arithmetic average ratio across all the countries surveyed was 24%. For diesel, the ratio was 31%, because taxes on diesel were lower than on gasoline in all countries except Australia and the United Kingdom, where they were the same, as well as the United States.

Financial incentives aimed at the vehicle, in the form of grants or tax credits, can also be effective in offsetting part or all of the cost of conversion or the incremental cost of buying an Autogas vehicle. The cost of conversion and installing dual-fuel systems has increased with the growing sophistication of fuel-injection engine technology. Vehicle incentives are particularly important where fuel taxes generally are low, limiting the scope for savings on running costs. Yet the prevalence such incentives has diminished in recent years, partly because of government budget constraints; the central government or some local authorities subsidised conversions or OEM purchases in 2016 in just five countries of the countries surveyed here – Italy, Japan, Korea (old diesel trucks only), the United Kingdom (taxis) and the United States (some states). In some cases, subsidies effectively covered the entire cost of conversion or the additional OEM cost. Other countries, including Australia and France, have run similar schemes within the last five years.

The market penetration of Autogas is strongly correlated with the competitiveness of Autogas *vis-à-vis* gasoline and diesel. We have estimated, for each country, the distance at which an Autogas light-duty vehicle becomes competitive against gasoline and diesel in each country,

based on 2016 data on pump prices and vehicle costs. The results show that Autogas use and rates of market growth are generally highest in countries where the breakeven distance is lowest, especially against gasoline. In two-thirds of the countries surveyed, the breakeven distance against gasoline is under 50 000 km – or about three years of driving. Autogas is most competitive in Bulgaria, where it meets about 13% of the country's road-fuel needs and where a converted vehicle breaks even with gasoline at just 13 000 km – less than one year of driving for a private motorist. Autogas is also highly competitive in Lithuania, Poland, Thailand, Turkey and Ukraine, all of which have a breakeven distance of less than 25 000 km for a converted car and where the market penetration of Autogas is high. At the other extreme, Autogas is never competitive with either gasoline or diesel in the United States.

The competitiveness of Autogas is the most important factor in explaining the actual market penetration of Autogas and recent rates of market growth. But it is not the only factor: for example, the breakeven distance for Autogas against gasoline in Greece is lower than that in Ukraine, yet the penetration of Autogas in Greece is much lower – even though Autogas is always competitive against diesel. This is in part due to lags in the market response to changes over time in inter-fuel competition. But several other factors explain these divergences:

- *Government policy commitment:* The Autogas market has tended to develop more quickly where the government has shown a strong, long-term policy commitment in favour of Autogas.

- *Non-financial policies and measures:* In some cases, the use of non-financial incentives or other measures have either helped to boost or to hinder Autogas use. Public awareness and education campaigns to promote Autogas have certainly made a significant contribution to market growth in several countries, including the United States. Mandates and public transport fleet conversion programmes have also been very successful in several countries, notably in China, India and the United States. By contrast, traffic or parking restrictions discourage Autogas use in some countries.

- *Restrictions on diesel vehicles:* Local and central government environmental restrictions on the use of diesel vehicles have been an important factor behind the success of Autogas in Korea and Japan. These restrictions are likely to increase with growing concerns about the health effects of soot emissions from diesel vehicles, potentially boosting demand for Autogas.

- *Availability of equipment and fuel:* In some countries, Autogas has struggled to penetrate the fuel market where carmakers have been reluctant to market OEM models or where there is a limited number of refuelling sites selling Autogas.

- *Public attitudes:* Misconceptions about the safety and reliability of Autogas have clearly affected demand in several countries. This appears to be one reason why Autogas demand remains weak in France, despite highly favourable taxation policies.

In countries where Autogas remains small, the role of the government in giving an initial strong impetus to kick-start the simultaneous development of demand and supply infrastructure is vital. Even where strong financial incentives exist, Autogas use will not necessarily take off until critical market mass is achieved. The market needs to be large enough to demonstrate to potential Autogas users and fuel providers that the fuel is safe, reliable, easy to use and a cost-effective alternative to conventional fuels. Autogas must be widely available. And the market must be big enough to support a viable network or properly-trained mechanics to convert and maintain Autogas vehicles and ensure the availability of spare parts and equipment. Achieving critical mass requires a concerted effort on the part of all stakeholders – vehicle manufacturers and converters, Autogas suppliers and the government – to promote the development of the market.

National circumstances affect the best approach to designing and implementing Autogas incentive policies. These include budgetary considerations, which might limit available funds for subsidies, the seriousness of local pollution problems, fuel-supply and cost issues, the stage of development of the Autogas market and the prevailing barriers to fuel switching, including restrictive regulations and the local cost of vehicle conversions. Whatever the circumstances, however, experience in the countries surveyed in this study has clearly shown that the single most important measure – and a necessary condition – for making Autogas an attractive fuel to vehicle owners is favourable fuel-tax treatment *vis-à-vis* conventional fuels.

Policy stability and a strong, long-term commitment by the government to achieving environmental-policy objectives are also of crucial importance to efforts to promote the development of alternative-fuel markets. Stakeholders need to be given clear advance warning of any major shift in policy. Without policy stability, coherence and consistency, neither fuel suppliers, nor equipment manufacturers, nor consumers can be confident that they will be able to make a reasonable return on the investments required to switch fuels.

Introduction

Objectives of the study

Sales of Autogas – the most popular alternative to conventional automotive fuels for cars – have been growing quickly in some countries, thanks to government policies to encourage the use of alternative fuels on account of its inherent environmental, practical and cost advantages over other such fuels. But in some countries, the development of the Autogas market has been held back by ineffective or poorly-designed policies, such as unfavourable or contradictory tax rates and regulations that fail to account fully for the social and environmental benefits of switching to Autogas.

This study seeks to explain why governments encourage switching to Autogas and how they go about doing so based on an in-depth survey of some of the world's largest Autogas markets. It assesses what types of policies are most effective and why.

Approach and scope

The study involved a detailed survey of Autogas taxation and other incentive programmes covering 23 of the world's largest Autogas markets: Australia, Bulgaria, China, Czech Republic, France, Germany, Greece, India, Italy, Japan, Korea, Lithuania, Mexico, Netherlands, Poland, Russia, Serbia, Spain, Thailand, Turkey, Ukraine, the United Kingdom and the United States. All of these countries, with the exception of the Czech Republic, France, Spain and the United Kingdom, have annual sales of more than 100 000 tonnes; collectively, they made up over 83% of the global Autogas market in 2016.

We compiled historical data on pump prices, excise duties and sales taxes for Autogas and the conventional fuels, gasoline and diesel. Where available, data on compressed natural gas (CNG) and other relevant alternative fuels was also collected. In addition, we collated data on road-fuel consumption and vehicles fleets, as well as information on current tax and non-tax policies with regard to conventional and other alternative fuels. The market data cover the period 2000 to 2016, while the price and tax data cover 2011-2016.

The data on Autogas prices and taxes were used to analyse quantitatively the competitiveness of Autogas *vis-à-vis* gasoline and diesel in all 23 national Autogas markets. This analysis takes account of fuel prices at the pump, differences in mileage per litre (due to differences in energy content per litre and vehicle-engine technology among the three fuels) and the relative costs of acquiring each type of vehicle and converting conventionally fuelled vehicles to Autogas. It also takes into account local market conditions and regulations. The results were then compared to the current penetration of Autogas in the overall automotive-fuel market and recent rates of growth in the use of Autogas.

Structure of this report

Part A of this report presents the main findings of the study:

- Section 1 provides an overview of current global Autogas market trends, the rationale for promoting the fuel and the main drivers of demand.
- Section 2 sets out the principles of government policies and the different approaches available to policy makers to promote alternative fuels generally.
- Section 3 summarises and compares current Autogas incentive policies across the countries surveyed in the study, focusing on differences in taxes and subsidies.
- Section 4 analyses the impact of differences in policies on the competitiveness of Autogas compared with conventional fuels and the penetration of Autogas in the overall market for automotive fuels.
- Section 5 assesses the implications of this analysis and the lessons that can be drawn for policymaking.

Part B presents the detailed results of the survey and analysis of Autogas competitiveness by country. Detailed global Autogas market data, references and a note on data sources are included in the annexes.

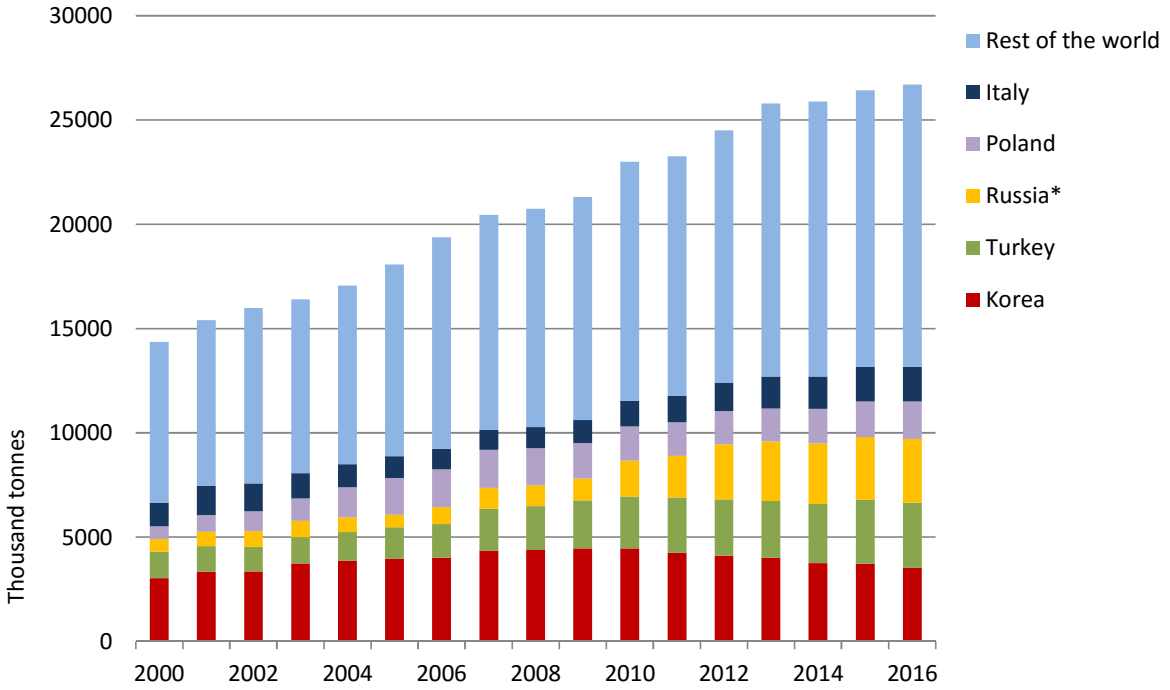
PART A: MAIN FINDINGS

1 The global Autogas market

1.2 Market trends

Autogas is the most widely used non-blended alternative to the conventional oil-based transport fuels, gasoline and diesel, in terms of the size of its fleet. A number of countries have well-developed Autogas markets. Global consumption of Autogas has increased steadily in recent years, reaching 26.7 million tonnes in 2016 – an increase of 283 000 tonnes, or 1.1%, over 2015 and 3.7 Mt, or 16%, up on 2000; the market has expanded by 85% since 2000 (Figure A1.1). Market growth, which has come from both established and emerging markets, has slowed a little in recent years, partly because of improvements in fuel economy. Trends differ markedly by country: several major markets contracted in 2016, while others grew strongly.

Figure A1.1: World Autogas consumption, 2000-2016



* The data shows a large increase in consumption in 2010, which is thought to be due largely to a re-categorisation of LPG demand in the residential sector.
Source: WLPGA/Argus (2017).

Demand remains highly concentrated in a small number of markets: the five largest countries – Korea, Turkey, Russia, Poland and Italy – accounted for 49% of world consumption in 2016 and the top ten for 69% (Table A1.1). The 23 countries surveyed in this report together accounted for 83% of world Autogas use. Two of the three largest consumers – Turkey and Russia – saw the biggest increases in Autogas consumption in absolute terms over the ten years to 2016, while the biggest falls occurred in Mexico, Australia, Japan and

Korea – still the world's largest Autogas consumer. Worldwide, Autogas currently accounts for 1.2% of total road-transport-fuel consumption.

Table A1.1: Top ten Autogas markets, 2016

Country	Consumption (thousand tonnes)	Vehicles (thousands)	Refuelling sites
Korea	3 515	2 185	2 031
Turkey	3 142	4 440	10 426
Russia	3 050	3 000	4 900
Italy	1 659	2 211	3 940
Poland	1 790	2 977	5 390
Thailand	1 466	920	950
Ukraine	1 385	2 250	3 500
Japan	1 002	221	1 440
China	990	165	550
Australia	532	360	2 500
Rest of the World	8 173	8 077	40 465
World	**26 704**	**26 806**	**76 092**

Source: WLPGA/Argus (2017).

There are close to 27 million Autogas vehicles in use around the world and over 76 000 refuelling sites. Autogas accounted for 9% of global consumption of LPG in 2016, though this share varies considerably across countries. Among the countries surveyed, the share is highest in Ukraine, where it is 85%, and is lowest in the United States at just 1.5%. Data on consumption, numbers of vehicles and refuelling sites for all 23 countries surveyed can be found in Annex 1.

Box A1.1: Autogas characteristics

Autogas is the abridged name for automotive liquefied petroleum gas (LPG) – that is, LPG used as an automotive transport fuel. LPG is the generic name for mixtures of hydrocarbons that change from a gaseous to liquid state when compressed at moderate pressure or chilled. The chemical composition of LPG can vary, but is usually made up of predominantly propane and butane (normal butane and iso-butane). Autogas generally ranges from a 30% to 99% propane mix. In some countries, the mix varies according to the season as the physical characteristics of the two gases differ slightly according to ambient temperatures.

LPG is obtained either as a product from crude-oil refining or from natural-gas or oil production. At present, more than 60% of global LPG supply comes from natural gas processing plants, but the share varies markedly among regions and countries. With both processes, LPG must be separated out from the oil-product or natural-gas streams. LPG is generally refrigerated for large-scale bulk storage and seaborne transportation as a liquid, but it is transported and stored locally in pressurised tanks or bottles (cylinders).

LPG has high energy content per tonne compared with most other oil products and burns readily in the presence of air. These characteristics have made LPG a popular fuel for domestic heating and cooking, for commercial use, for agricultural and industrial processes, including as a feedstock in the petrochemical industry, and increasingly as an alternative automotive fuel.

The make-up of the Autogas vehicle fleet by vehicle-type differs by country. In the two largest Asian markets, Korea and Japan, taxis and other fleet light-duty vehicles (LDVs) account for a large share of Autogas consumption. In both countries, the overwhelming majority of taxis run on Autogas as a result of a combination of incentives and government mandates requiring the use of alternative fuels. In Europe, private cars comprise the main market. In the United States, commercial fleet vehicles and school buses account for the bulk of Autogas vehicles.

In most countries, the majority of vehicles that run on Autogas are gasoline-powered vehicles that have been converted to use either Autogas or gasoline by installing a separate fuel system that allows the vehicle to switch between both fuels. Korea and Japan, where almost all vehicles are mono-fuel Original Equipment Manufacturer (OEM) vehicles, i.e. factory-fitted, are the main exceptions. For mainly technical reasons, most LDV conversions involve gasoline-powered spark-ignition engines, which are particularly well-suited to run on Autogas.

Autogas fuel systems are a proven and mature technology. Specialist companies have developed and market standardised Autogas conversion kits, including a parallel fuel system and tank, with specialist garages carrying out the installations. The market is fairly fragmented, with a large number of firms selling conversion kits, though consolidation is occurring in Europe and the United States; many of them serve just the national markets (for example, in China), but a growing number of them now export to other countries.

Sales of OEM Autogas vehicles, incorporating conversion kits at the point of manufacture, have been growing in many established markets in recent years. Most of the leading car manufacturers have introduced Autogas versions of at least one of their models, while others offer conversions at the time of sale, such that they are covered by their warranty (aftermarket conversions can invalidate the vehicle warranty). Worldwide, 15 carmakers in total currently market around 100 Autogas models. As Autogas has become more widely available, some OEM vehicle manufacturers have become involved in the development, design and manufacture of Autogas systems. They now produce and market dedicated Autogas vehicles with under-floor fuel tanks.

At present, there are relatively few heavy-duty vehicles that run on Autogas, since converting a diesel engine in an existing vehicle is technically more complex and expensive than converting a gasoline engine. In recent years, however, a number of heavy-duty Autogas spark-ignition engines (mostly adaptations of their diesel counterparts) have been commercialised by several of the larger engine manufacturers. These engines are used mainly in buses and mid-sized trucks, notably in the United States, Korea and China.

1.2 Drivers of Autogas use

The emergence of Autogas as a leading alternative to gasoline and diesel is, in most cases, the direct result of government policies to address energy-security and/or environmental concerns.

1.2.1 Alternative automotive fuel policies

The oil-price shocks of the 1970s provided the initial impetus for the development of alternative automotive fuels, as countries sought to reduce their dependence on imports of crude oil and refined products. Environmental concerns have since overtaken energy security as the principal driver of government policies to promote such fuels, as they are generally less polluting.

Research and development of alternative automotive-fuel technology in recent years has focused on fuels based on oil and natural gas, biofuels derived from vegetable matter such as ethanol or biodiesel, electric vehicles (EVs) and hydrogen-based fuel cells. Plug-in EVs and pure battery EVs are now starting to be commercialised, but their rate of uptake remains constrained by their high cost and limited mileage. The supply of ethanol and bio-diesel has risen sharply in recent years, but both fuels are usually blended with conventional gasoline and diesel for sale to end users. The scope for further increases in biofuel production using conventional technology is likely to be limited by competition for land to grow food crops.

The main non-blended alternative fuels in use in the world today are Autogas, compressed or liquefied natural gas (CNG/LNG), methanol and electricity (for plug-in hybrids or pure battery EVs). Autogas has established itself in many countries as by far the most important of these fuels, because of its favourable mix of inherent practical and cost advantages and environmental benefits. From an energy-security perspective too, Autogas has advantages over conventional fuels. There is an abundant supply of LPG from many sources around the world. In addition to proven reserves in oil and gas fields, the flexibility of modern refining processes offers considerable potential for expanding supply to meet demand from the transport sector. LPG supply is expected to rise briskly in the next few years with growing natural gas production and associated liquids extraction – already the primary source of LPG worldwide. And field and refinery supplies will also increase as wasteful flaring and venting practices, which are still common in many parts of the world, are eradicated. In addition, there is considerable scope for diverting supplies from relatively low-value petrochemical uses, where LPG can easily be replaced by other feedstock such as naphtha, ethane and distillate.

Autogas use has generally responded much better to government policies to promote alternative fuels than CNG/LNG or methanol. Despite some environmental advantages over conventional fuels, the development of CNG has been slow because of cost and practical considerations associated with the fuelling infrastructure. Methanol also has appealing environmental attributes, especially if produced from renewable biomass, but its use as a

motor fuel remains limited in most parts of the world, largely because of cost and the large infrastructure investments needed. In contrast, the technology for installing Autogas systems in vehicles or converting existing vehicles is proven (see below), greatly reducing the financial risks to investors. The costs of establishing the distribution infrastructure and converting vehicles to run on Autogas are generally much less than for other alternative fuels.

Alternative fuel policies are now beginning to focus on EVs, as the cost of manufacturing them has come down and their performance, particularly with respect to driving distance between recharges, has improved. Many countries have introduced financial incentives for purchasing EVs. There were close to 2 million EVs on the road worldwide at the end of 2016, compared with just 1.3 million a year earlier; that number could rise to between 9 and 20 million by 2020 and between 40 and 70 million by 2025, according to estimates based on recent statement from carmakers (IEA, 2017a). Depending on the way the electricity that is used to fuel EVs is produced, their well-to-wheel emissions can be lower than those of Autogas. But EVs continue to struggle to compete with established alternative fuel technologies, such as Autogas, in the mainstream car market because of the still high purchase price of the vehicle, the relatively low distance between recharges, the time required to fully recharge the battery and as yet limited recharging infrastructure. As a result, large subsidies to reduce the cost of purchasing or owning an EV remain necessary to stimulate their uptake.

1.2.2 Environmental benefits of Autogas

The main rationale for government support for Autogas and other alternative fuels is the environment. Road-transport vehicles are an important cause of air pollution and contributor to global warming. There is clear evidence of the harmful impact on human health of exposure to vehicle pollutants. As a result, local air quality has become a major policy issue in almost all countries. Government are also stepping up efforts to curb emissions of greenhouse gases from road transport.

Most industrialised countries have made substantial progress in reducing pollution caused by cars and trucks through improvements in fuel economy, fuel quality and the installation of emission-control equipment in vehicles. Increasingly, these improvements have been driven by a combination of emission and fuel-efficiency standards. However, rising road traffic has offset at least part of the improvements in vehicle-emissions performance in most countries. Less progress has been made in developing countries, where local pollution in many major cities and towns has reached catastrophic proportions. In particular, concerns about the health impact of particulate emissions from diesel vehicles have been growing in recent years, as more evidence of their impact in health comes to light. The decision by the World Health Organisation in 2012 to classify diesel as carcinogenic, as well as revelations about fraudulent emissions testing of diesel cars by the German carmaker, Volkswagen, have added to the pressure on policymakers to restrict the movement of diesel vehicles and phase out use of the fuel in the longer term.

The European Union and the United States have been the main driving forces behind vehicle-emissions standards. Every developed country and most developing countries have progressively introduced EU, US or similar standards for new vehicles. The international nature of vehicle manufacturing and trade has prompted increasing harmonisation of standards and regulation. The most broadly implemented standards, generally referred to as Euro regulations, are those developed by the United Nations Economic Commission for Europe (UNECE), which are uniformly applied across the European Union and in many other parts of the world. These standards have been tightened periodically, typically every four to five years, since they were first introduced in 1992. Euro 6 regulations came into force in September 2014 for passenger cars and commercial LDVs, covering emissions of nitrogen oxides (NOx), total hydrocarbon, non-methane hydrocarbons, carbon monoxide and particulate matter (PM), and in December 2013 for HDVs (also covering smoke).

Governments are also looking increasingly at ways of encouraging a shift in fuel use to alternative fuels that can yield a reduction in emissions of greenhouse-gases at least cost. Globally, road transport has become the second-largest source of emissions of carbon dioxide (CO_2) – the leading greenhouse gas – after power generation, accounting for well over one-fifth of total emissions. The United States was the first country to introduced fuel-efficiency standards in the 1970s.The European Union and several countries, including China and Japan, have also introduced and tightened CO2 emission or fuel-efficiency standards in recent years. Ultimately, low-carbon transport will require a wholesale move away from conventional fuels in the long term. In recognition of this, at least ten countries, including France, India and the United Kingdom, have already announced long-term goals of banning the sale of both diesel and gasoline cars, and other countries are posed to follow suit.

Autogas out-performs gasoline and diesel and most alternative fuels in the majority of studies comparing the environmental performance of conventional and alternative fuels that have been conducted around the world in recent years.[1] Autogas emissions are especially low with respect to noxious pollutants, while emissions of regulated and unregulated toxic gases from Autogas use are among the lowest of all the automotive fuels commercially available today. With regard to greenhouse-gas emissions, Autogas performs better than gasoline and, according to some studies, out-performs diesel, when emissions are measured on a full fuel-cycle, or well-to-wheels, basis and when the LPG is sourced mainly from natural gas processing plants.

The results of these studies vary to some degree, according to the types of vehicles selected, the quality of the fuel, the types of emissions measured and the conditions under which they were carried out vary: actual vehicle emissions are highly dependent on vehicle technology and driving behaviour. For both noxious and CO2 emissions, Autogas vehicles perform particularly

[1] Recent studies of the comparative environmental performance of Autogas can be found on the WLPGA website, www.wlpga.org, and www.auto-gas.net.

well when a direct fuel injection system, which improves the anti-knock behaviour of the fuel and boosts fuel economy, is deployed.

In the future, bio-LPG (also known as biopropane) used as Autogas could help reduce CO_2 emissions from road transport. Bio-LPG is LPG derived from production processes that use biomass as the feedstock, usually as a co-product. The molecular structure of pure biopropane is identical to that of conventional pure propane produced from hydrocarbons, so can be blended into conventional LPG or sold in a pure form. At present, the bigger project for commercial supplies of bio-LPG is a plant in Rotterdam operated by the Finnish company, Neste, but a number of other companies and organisations around the world are conducting research into other advanced biofuels production processes, some of which involve the production of bio-LPG as a co-product or the principal output.

1.2.3 Practical considerations

The performance and operational characteristics of Autogas vehicles compare favourably with other fuels. Autogas has a higher octane rating than gasoline, so converted gasoline-powered spark-ignition engines tend to run more smoothly. This reduces engine wear and maintenance requirements, including less frequent spark plug and oil changes.. The higher octane of Autogas also allows higher compression ratios, which can deliver increased engine-power output and better thermal efficiency, reducing fuel consumption and emissions. Acceleration and top speed using the latest generation of Autogas-fuel systems are comparable to gasoline or diesel. Autogas has a lower energy density than gasoline and diesel, which means that a larger volume of fuel and a bigger tank are required to achieve the same overall driving range, though this has no effect on engine performance.

In practice, however, converting a vehicle to be able to run on Autogas involves some operational inconveniences, the most significant of which is the loss of boot/trunk space to accommodate the additional fuel tank. The development of new technologies, including ring-tanks and lightweight composite tanks, has helped to alleviate this problem. Misconceptions about the safety of handling the fuel and the reliability of Autogas tanks may also be a barrier to conversion in some cases. Yet many years of operation worldwide have amply demonstrated the integrity and safety of Autogas dispensers, as well as on-board vehicle tanks. In fact, the safety record of Autogas use in practice is at least as good as, if not better than, gasoline or diesel. Autogas is fully contained under pressure in solid tanks, which limits the danger of leakage. Being stored in liquid form, gasoline is prone to leaks or vapour escapes. Nonetheless, widely-publicised accidents resulting from poor installation, the absence of a safety valve on the fuel-tank or the illegal use of cylinder gas, have undermined the safety image of Autogas in a few countries (see the country survey in Part B).

1.2.4 Cost factors

The cost of Autogas supply and infrastructure is generally lower than for other non-blended alternative fuels. On an energy-content basis, the cost of

bulk LPG delivered to service stations is usually lower than for gasoline (Section 3.1.2). Rising demand for Autogas is not expected to raise significantly the cost of LPG on the international spot market relative to gasoline given the abundance of supplies.

The costs incurred in establishing or expanding an Autogas distribution network essentially relate to investments in service-station storage and dispensing facilities. The plants and equipment that already exist to handle the importation, production, storage and bulk distribution of LPG for traditional uses are exactly the same as for Autogas, although some additional investment may be needed to cope with higher bulk throughput. Since Autogas generally makes use of the existing service-station infrastructure for distribution of conventional fuels, additional costs for Autogas dispensing are low relative to some other alternative fuels. For example, the cost of installing a standard tank, pump and metering equipment for Autogas alongside existing gasoline and diesel facilities is typically around a third that of installing dispensing facilities for CNG with the same capacity. This is because of the added cost of dedicated supply pipelines, high-pressure compression, storage cylinders and special dispensers for CNG.

Vehicle-conversion costs vary considerably from one country to another, depending on the sophistication and quality of the equipment installed and local labour costs. On average, the cost of conversions and the cost installation of dual-fuel systems in OEM vehicles has risen in recent years as fuel-injection engine technology has become more sophisticated, Worldwide, cost of converting an LDV varies from about $500 in developing countries to $4 000 in the United States. The premium for a dual-fuelled OEM vehicle also varies considerably: it used to be at least $1 000 in most countries and sometimes a lot more. But the premium has fallen sharply in some countries in the last few years, as some carmakers have cut the prices of their Autogas models. In India, for example, OEM Autogas cars on average cost only about $400 more than equivalent mono-fuelled gasoline models. It is also a commercial strategy from certain OEMs to propose LPG versions at the same price than gasoline versions (e.g. France, the Netherlands).

Among the various alternative fuels available today, CNG is probably the main alternative to Autogas on cost grounds.[1] Both fuels have pros and cons, but Autogas is generally more cost-competitive for LDVs (if both fuels are taxed equally on an energy-content basis), whereas CNG in many cases may be a more viable option for heavy-duty vehicles (HDVs) (Table A1.2). The cost of installing refuelling infrastructure and converting LDVs is significantly lower for Autogas, in large part because of the extra cost of CNG tanks (which need to be bigger and stronger because of their higher operating pressures).

Table A1.2: Competitiveness of Autogas against compressed natural gas (CNG)

[1] The main exception is biofuels in places where production costs are particularly low, such as Brazil, thanks to a favourable climate and fertile soil.

	Autogas	CNG
End-user price of fuel	Driven by the international LPG price (which follows other oil prices) but is generally lower than those of gasoline and diesel	Driven by bulk cost of delivered natural gas to major demand centres (low now in United States, but high in importing regions where the price is linked to that of oil)
Cost of refuelling infrastructure	Comparable to conventional fuels	Generally higher than for conventional fuels and Autogas as higher compression is needed; home refuelling costs are typically in excess of $10 000
Cost of vehicle conversion (LDV)	Ranges from around $500 to $4 000 depending on the type of car, type of conversion and local market conditions	Generally more expensive, partly because a bigger tank is needed (in the United States, the cost ranges from $12 000 to $18 000 due to licensing requirements)
Ease of refuelling	Refuelling is rather quick and the fuel is generally widely available as it is easy to transport by road	Refuelling usually takes longer; the fuel is not always available in all areas as it must be piped

Source: Menecon Consulting analysis.

Many analysts believe that EV will become the leading alternative-fuel technology in the medium term and the dominant automotive-fuel technology in the long term. But the rate of take-up of EVs hinges on further reductions in the price of the vehicles, better performance, expanded recharging infrastructure and generous subsidies. For many countries, Autogas is set to remain an important bridging fuel to a truly sustainable transport system.

Despite the favourable environmental attributes of Autogas compared with other alternative fuels, the rate of switching to Autogas and overall consumption is highly dependent on the financial benefits to end users. A publicly-owned bus company may take account of the local environmental benefits as well as relative costs of different fuel options in deciding whether to switch to Autogas. But for most private fleet operators, truckers and individual motorists, the sole factor is cost. As a result, private vehicle owners must be given an adequate financial incentive to switch to Autogas.

2 Government policies to promote alternative fuels

2.1 Principles of alternative-fuel policies

Reducing the environmental impact of transport activities is the main justification for governments to promote the use of Autogas and other alternative fuels. Pollution and global warming caused by rising concentrations of greenhouse gases in the atmosphere are prime examples of *market failure*, since the market fails to put a financial value or penalty on the cost of emissions generated by individuals or organisations. Air quality and the climate are, in economists' parlance, public goods, from which everyone benefits. Damage done to the environment is known as an external cost or externality. Governments have a responsibility to correct these failures, to discourage activities that emit noxious or greenhouse gases and to make sure that each polluter pays for the harm he causes to public goods.

Levying charges on polluting activities is effectively a way of internalising these environmental externalities, although placing an exact financial value on them is extremely difficult and inevitably involves a large degree of judgment. A large number of studies have attempted to assess the health and economic costs of different types of emissions, including greenhouse gases. The social cost of carbon (SCC), for example, is the marginal cost of emitting one extra tonne of carbon (as CO_2) at any point in time. Estimates vary widely according to the assumptions made and methodological approaches used. For example, the SCC currently used by the US Environmental Protection Agency to analyse the CO_2 impacts of various rulemakings rises from $36/tonne in 2015 to $69 in 2050 at an average 3% social discount rate.[1]

In principle, the most economically efficient approach to internalising external costs is one that relies mainly on financial incentives, i.e. a market-based approach. In other words, the effective market price of the activity that gives rise to an environmental externality should be adjusted through the application of a tax and/or subsidy large enough to reflect the value or cost of that externality. Once an appropriate fiscal framework is in place, consumers and producers are free to make informed economic choices according to their own preferences. In the case of road transport, that involves taxing or subsidising transportation in such a way that the financial costs to end users of the different fuel and vehicle options reflect their associated environmental costs.

In practice, developing effective transport and energy policies that take account of environmental externalities is extremely difficult – even if reliable quantitative estimates of external costs can be obtained. It is complex to apply taxes and subsidies exactly according to actual vehicle usage and the

[1] https://19january2017snapshot.epa.gov/climatechange/social-cost-carbon_.html.

actual emissions produced during use, though technological developments may make this a practical solution in the future. And emission-trading schemes are similarly impractical for fuel use in the transport sector given the large number of users. Financial incentives have, thus, generally focused on fuel-based taxes, as they are simpler and politically less sensitive than measures that impact vehicle use directly, such as road pricing, even though evidence suggests that pricing vehicle use can be very effective. The earliest widespread experience of differential taxation to support environmental goals was the introduction of unleaded gasoline, where lower taxes relative to leaded fuel were extremely effective in accelerating its uptake. More recently, similar incentives have been focused on encouraging the use of low-sulphur diesel and alternative fuels. The case for differential fuel taxes for to achieve environmental objectives is well established, though effective tax rates are rarely consistent with stated policy goals (OECD, 2013). In principle, economic efficiency demands that the excise taxes levied on any given fuel should be applied at the same rate to all users, commercial and non-commercial.

Most governments deploy other complementary approaches that target vehicle use, modal choices and emissions performance rather than just the prices of transport fuels, as such broader approaches tend to be more effective in practice in reducing emissions – especially of greenhouse gases – from road vehicles. Such approaches seek to internalise implicitly the external environmental costs of road transportation. They may be aimed specifically at encouraging the use of clean fuels, including Autogas and other alternative fuels, or discouraging the use of more polluting fuels.

2.2 Typology of policies to promote alternative fuels

In practice, there is wide range of options at the disposal of policy makers within the normal policy-toolbox to promote the supply and use of alternative fuels, including Autogas. These measures complement broader measures to reduce emissions from road vehicles, including emission standards. The main approaches that governments could or do deploy are financial incentives and regulatory measures. Other measures include support for technology development and public awareness programmes. These are summarised in Table A2.1 and are discussed below.

2.2.1 Financial incentives

Financial incentives can be directed at the fuels themselves or vehicles that are able to use them. Fuel incentives – the main measure that the countries surveyed in this report use to promote Autogas – can take the form of a lower rate of excise duty (and/or sales tax) or its complete exemption. In some cases, commercial vehicles may enjoy a rebate on fuel taxes. These measures directly reduce the cost of running an alternative fuel vehicle (AFV) *vis-à-vis* gasoline and diesel vehicles, and shorten the payback period on converting or acquiring the AFV. Since differences in excise duty show up in prices at the pump, the measure is also highly visible, raising public awareness of the potential cost savings from using alternative fuels. The lower the rates of

duty and tax relative to other fuels, the bigger the financial incentive to switch.

Table A2.1: Typology of government policies and measures to promote alternative fuels

Fiscal/financial	Regulatory	Other
Excise-duty exemption or rebate Road/registration-tax exemption or rebate Vehicle sales-tax exemption or income/profit tax credit (purchasers and OEMs) Tax credits for investment in distribution infrastructure and R&D Grants/tax credits for AFV conversion/acquisition. Rapid depreciation for commercial purchasers of Autogas vehicles and owners of distribution infrastructure Exemption from parking/road-use charges	Mandatory sales/purchase requirements for public and/or private fleets (with enforcement) Standards to harmonise refuelling facilities Vehicle-conversion standards Coherent and appropriate health and safety regulations Exemptions from city-driving restrictions	Government own-use of AFVs Information dissemination and public awareness campaigns Voluntary agreements with OEMs to develop and market AFV technologies Direct funding for research, development, demonstration and deployment of AFVs

Source: Based on WLPGA (2001).

The main way of providing incentives for AFV themselves is to subsidise the higher cost of buying an OEM vehicle or the cost of converting an existing conventional fuel vehicle. Subsidies are most easily provided through grants or tax credits. Eligibility can be made dependent on the emission performance of the vehicle being converted. Governments can also encourage AFV purchases or conversions directly through partial or complete sales or consumption-tax exemptions. Favourable rates or exemptions from vehicle registration and/or annual road taxes are another approach. Such incentives may be restricted to a pre-determined number of years to limit the loss of tax revenue and the free-rider problem (where the financial benefit to some end users from the tax incentive is greater than is necessary for them to switch to using an alternative fuel).

The measures described above are demand-side fiscal incentive measures aimed directly at reducing the cost to the end user of switching to an alternative fuel. Supply-side fiscal measures that reduce the tax liability of fuel providers and/or AFV manufacturers can also help to lower these costs in an indirect way. For example, profit-tax credits can be used to encourage OEMs to develop and market dedicated AFVs, or to encourage fuel providers to invest in distribution infrastructure.

2.2.2 Regulatory policies and measures

Governments can strongly influence how quickly alternative fuels and technologies are adopted through the design of the regulatory framework. There is a wide range of policies and measures that governments currently employ to promote the use of alternative fuels.

The most direct form of regulatory measure involves the use of legal mandates on public or private organisations to purchase a fixed number of AFVs. Traffic-control regulations can also be used to favour such vehicles. For example, AFVs may be granted exemptions from city or highway-driving restrictions, such as those imposed during periods of severe pollution. They may also be exempt from on-street parking charges and road-pricing schemes. Government can also facilitate the development of coherent standards, in partnership with industry, covering vehicle conversions, refuelling facilities and health and safety aspects of alternative fuel supply and use.

2.2.3 Other measures

Governments can support the research, development, demonstration and deployment of alternative-fuel technology either through voluntary agreements with OEMs and fuel providers or through direct funding of such activities. Voluntary agreements or collaborative partnerships with industry are usually seen as an alternative to stringent, mandatory regulations and punitive fiscal measures.

Other measures include the use of voluntary agreements and programmes between government and fuel providers and fleet operators. The aim is to advance public understanding and awareness of the benefits of switching away from conventional fuels and of the various incentives available to them. The deployment of AFVs by the government itself can also expand the market for alternative fuels and set an example to other end users.

Information dissemination and education can also form a key element of government-incentive programmes for alternative fuels. They may take the form of regular communications, such as websites or newsletters, to inform the public of market and technology developments and to indicate how to apply for subsidies if available.

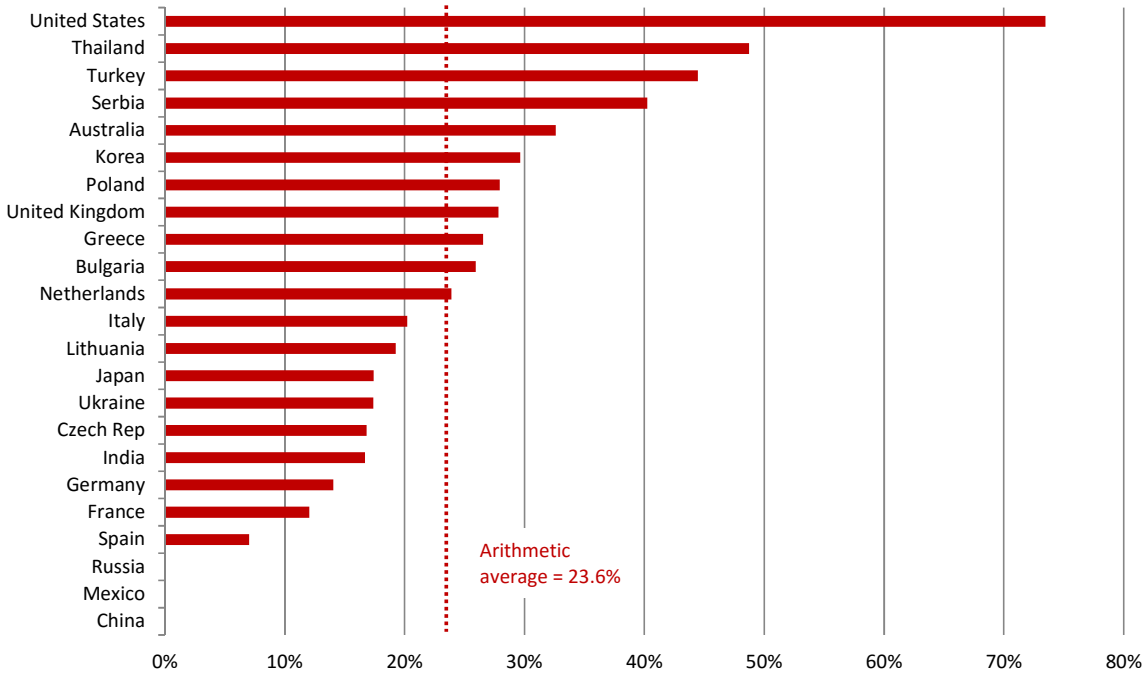
3 International comparison of Autogas incentive policies

3.1 Fuel taxation and pricing

3.1.1 Comparative taxation of Autogas

Rates of excise taxes and duties on road-transport fuels vary markedly across countries, both in nominal terms and relative to each other. In no country among those surveyed in this report is the same rate of excise duty applied uniformly across all fuels, either on a mass or volume basis. Rates of value-added tax (VAT) or sales taxes – which differ sometimes by fuel – also vary substantially; the rate levied on Autogas ranges from 5% in Japan and some US states to 23.4% in Greece. The rules governing the recovery of VAT, consumption and sales tax by commercial users also vary. In practice, the absolute level of tax on Autogas matters less than the how high it is in absolute terms relative to conventional fuels, as that is what helps determine the size of the financial saving that can be made from switching to Autogas .

Figure A3.1: Autogas excise taxes as % of taxes on gasoline per litre, 2016

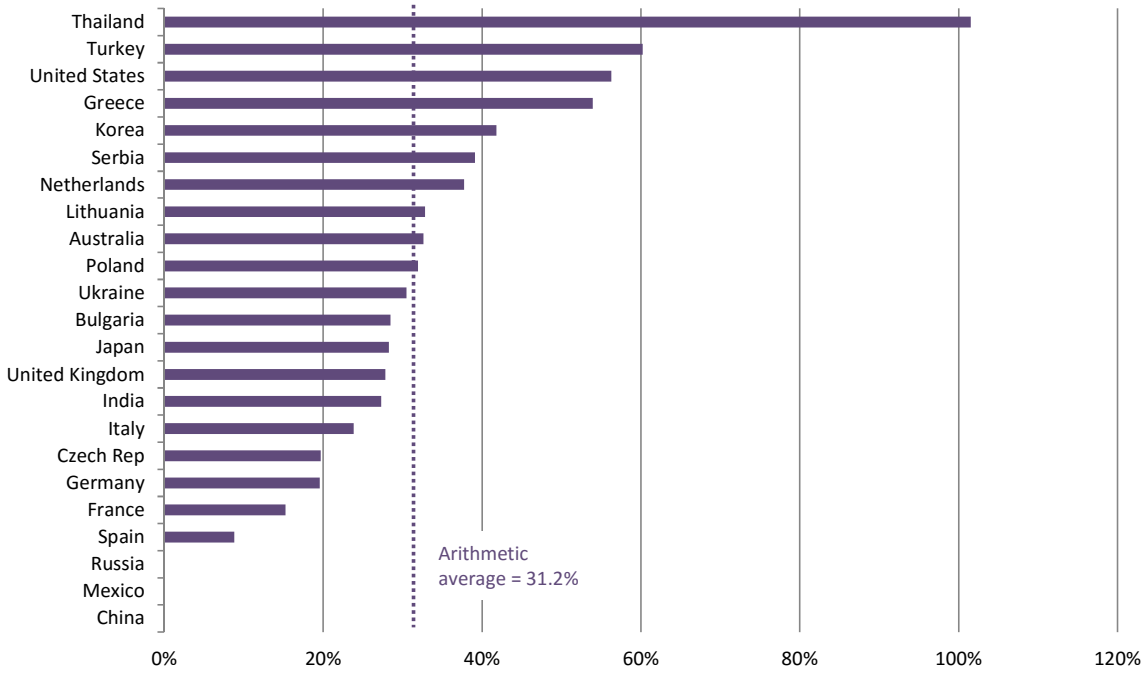


On a per-litre basis, Autogas taxes are almost always lower than for both diesel and gasoline, but the extent of the tax advantage varies significantly. Autogas taxes are lower than those on gasoline on a per-litre basis in all the countries surveyed. Autogas is totally exempt from excise taxes in China, Mexico and Russia (Figure A3.1, above). In the European Union, Member states are permitted to exempt Autogas from excise duties or charge a lower

rate than on gasoline and diesel (see below). The ratio of Autogas taxes to gasoline taxes is by far the highest in the United States (though most users were able to profit from a small tax credit up to the end of 2016); in all the other countries, excise taxes on Autogas are less than half of those on gasoline on a per-litre basis. The arithmetic average ratio across all the countries surveyed is 24%.

Excise taxes on diesel are lower than on gasoline in all countries except Australia and the United Kingdom, where they are the same, and the United States. As a result, Autogas generally enjoys a smaller tax advantage over diesel than gasoline. The ratio of excise-tax rates on Autogas to diesel is highest in Thailand, at just over 100%, though the rates on both fuels are very low (Figure A3.2). Autogas taxes as a proportion of diesel taxes average 31% for all 23 countries, though the average is distorted by the high figure for Thailand: in 12 countries, the share is below 30%.

Figure A3.2: Autogas excise taxes as % of taxes on diesel per litre, 2016



Because the calorific value of each fuel varies, the tax advantage of Autogas is in reality smaller – especially over diesel, which has the highest calorific value per litre. If all three fuels were taxed equally on an energy-content basis, taxes *per litre* on Autogas would on average be 22% lower than on gasoline and 29% lower than on diesel. Among the countries surveyed here, the effective rate of tax on Autogas is higher than that on diesel only in Thailand, while it is lower than that on gasoline in all countries.

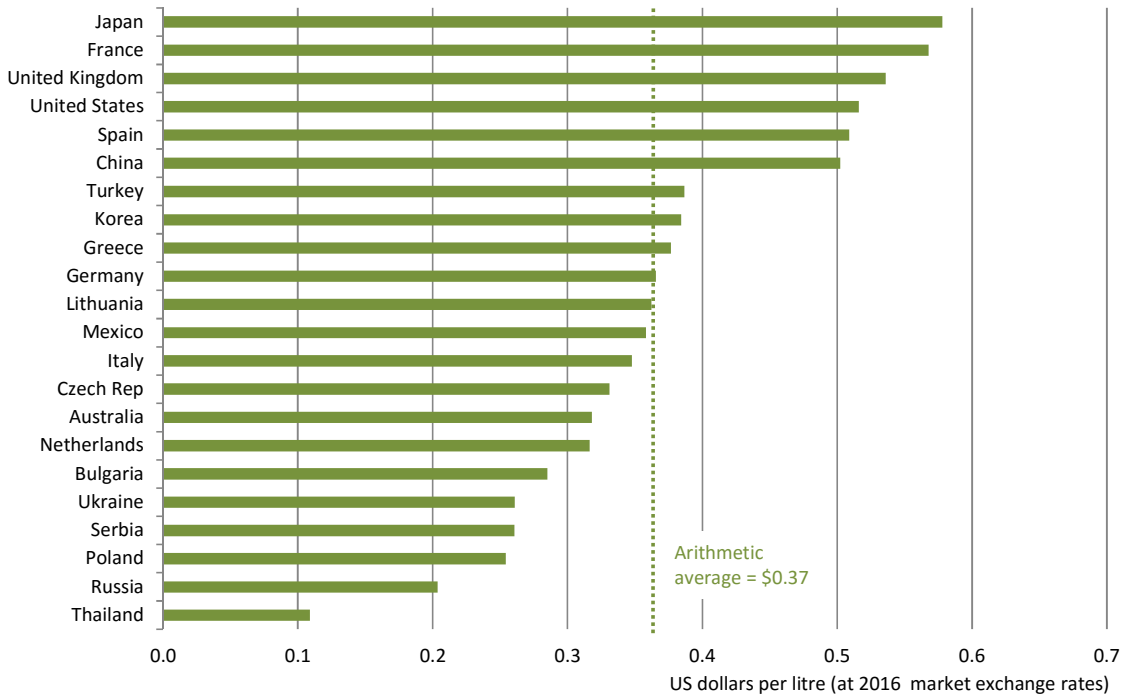
There is no environmental justification for taxing diesel less than gasoline – even less Autogas – either on a volume or energy-content basis (see Section A3). The favourable treatment usually given to diesel *vis-à-vis* gasoline

reflects lobbying by road hauliers and industry generally to minimise commercial fuel costs, especially in countries where trucks can easily refuel in a neighbouring country where duties and therefore pump prices are lower. Many European countries come into this category. It is impractical as well as economically inefficient to levy different rates of duty on different categories of end users. No country currently reimburses excise duties on diesel to commercial users.

3.1.2 Comparative pricing of Autogas

Retail or pump prices of Autogas also vary considerably across the countries surveyed both in absolute terms and relative to the prices of other fuels. This is largely because of differences in the way automotive fuels are taxed. But differences in the bulk price (import, ex-refinery or ex-processing plant) of LPG and the distribution and retail mark-up (including costs and profit margins) also contribute to price differences at the pump. Unsurprisingly, wholesale pre-tax prices are generally lowest in countries that export LPG. Margins differ among countries and regions according to the degree of competition between distributors and, in some cases, government margin or price controls. Autogas prices are controlled in China, India, Mexico, Thailand and, to some degree, in Turkey. In all the other countries surveyed, the government is no longer directly involved in setting wholesale or retail prices.

Figure A3.3: Pre-tax pump price of Autogas, 2016 (US$/litre)



Note: Prices are converted to US dollars at average 2016 exchange rates. Pre-tax prices are not available for India.

Pre-tax pump prices of Autogas for non-commercial end users in per-litre terms converted to US dollars were on average highest in Japan and, thanks to large subsidies, lowest in Thailand in 2016 (Figure A3.3, above). They were

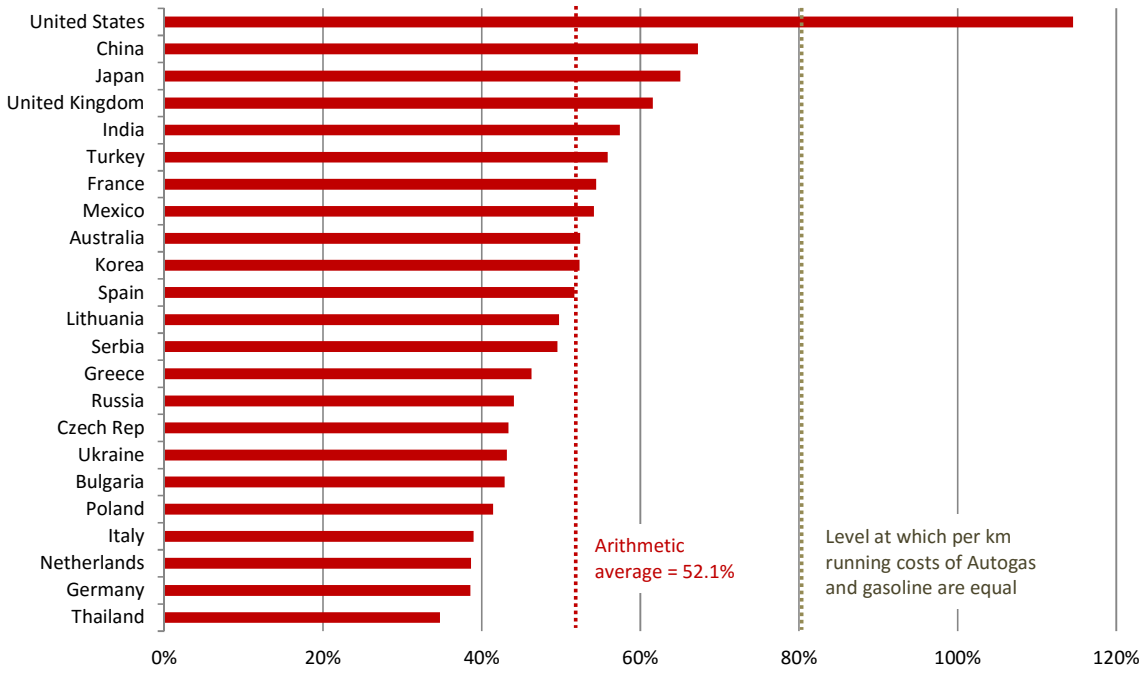
lower than for both diesel and gasoline in all countries except China, France, Japan and the United Kingdom, where Autogas is the most expensive of the three fuels. Pre-tax prices change over time in line with fluctuations in international-market prices (Box A3.1); international butane and propane prices have fallen relative to gasoline and diesel prices in recent years due to strong growth in supply with rising natural gas and associated liquids production, notably in the United States.

Box A3.1: International LPG pricing

Propane and butane are traded internationally and within the large North American market on a spot basis (cargo by cargo) and under term contracts that cover a specified number of cargoes over a specified period. Contract prices are typically indexed to published spot-price quotations for LPG and other oil products. Spot prices and the base prices in term contracts are determined by market conditions at the time the deal is struck. The primary determinants of propane and butane prices are crude oil, natural gas and naphtha prices, the local supply and demand balance, the proximity of the market to supply sources and the types of uses to which LPG are put.

Because of the large share of petrochemical demand in total world LPG demand and because of the volatility of demand from this sector, LPG prices tend to fluctuate more sharply in the short term than those of oil or natural gas. In particular, LPG prices tend to increase in the summer in the northern hemisphere, when petrochemical and refinery demand is highest because of increased demand for gasoline. Propane and butane replace naphtha as feedstock in ethylene plants, as larger volumes of naphtha are diverted to gasoline production in refineries. However, over the longer term, the bulk prices of LPG, crude oil and naphtha tend to move closely in line with each other. Propane and butane prices are usually very close and also tend to move in parallel.

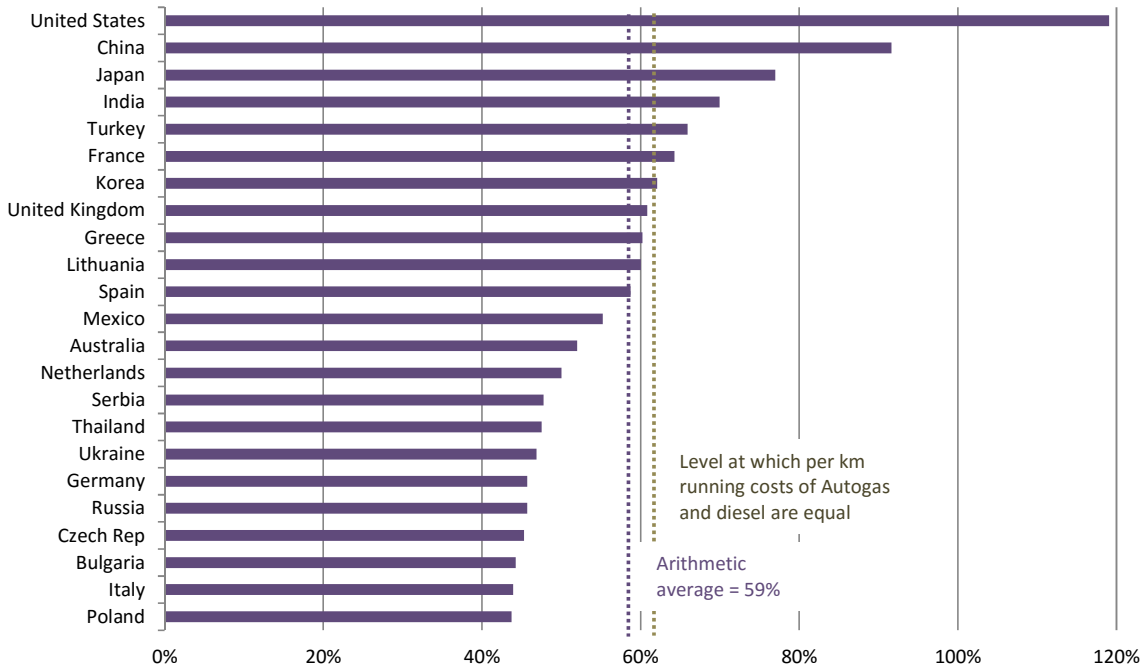
Figure A3.4: Autogas pump price including all taxes as % of gasoline price per litre, 2016



At the pump, the per-litre price of Autogas for non-commercial users (including all taxes) was on average lower than that of both conventional fuels in all countries except the United States in 2016. In 12 of the 23 countries surveyed, Autogas pump prices per litre were less than half those of gasoline (Figure A3.4). The price of Autogas as a proportion of that of gasoline ranged from 35% in Thailand to 115% in the United States, averaging 52% across all countries.

Because diesel is taxed less than gasoline everywhere except in Australia, the United Kingdom and the United States, the pump-price differential between Autogas and diesel is generally lower than that between Autogas and gasoline. The per-litre price of Autogas was on average 59% that of diesel in 2016. As for gasoline, the ratio was highest in the United States and lowest in Thailand (Figure A3.5). The share of total taxes in the per-litre pump price of each fuel and the ratio of Autogas pump prices including all taxes to those of diesel and gasoline are detailed in Table A3.1.

Figure A3.5: Autogas pump price including all taxes as % of diesel price per litre, 2016



Effective pump prices can also differ between commercial and non-commercial users. In most countries, commercial (business) users are able to recover part or all of the VAT on fuel purchases but usually not excise duties. In most cases, the rules governing VAT refunds are the same for all fuels and all types of vehicles.[1] Where this is the case, the relative competitiveness of the different fuels is not affected, although the absolute savings on running

[1] France is an exception: 100% of VAT can be recovered in the case of Autogas and 80% for diesel (100% for vans and trucks); 10% can be recovered for gasoline in 2017 (zero previously) rising to 80% in 2022 (the same rate as for diesel).

costs from switching to cheaper fuel/vehicle options differ between commercial and non-commercial users.

Table A3.1: Automotive-fuel taxes and prices, 2016

	Share of total taxes in price			Autogas pump price as % of prices of other fuels (including tax)	
	Autogas	Diesel	Gasoline	Diesel	Gasoline
Australia	30.1%	42.7%	42.9%	52.0%	52.4%
Bulgaria	39.0%	51.3%	53.6%	44.3%	42.9%
China	11.5%	43.7%	41.6%	91.6%	67.3%
Czech Republic	34.8%	57.3%	62.3%	45.3%	43.4%
France	27.6%	62.9%	66.4%	64.3%	54.4%
Germany	34.3%	58.7%	66.2%	45.7%	38.6%
Greece	46.8%	50.0%	67.4%	60.2%	46.3%
India	n.a.	n.a.	n.a.	69.9%	57.4%
Italy	44.2%	66.2%	68.5%	43.9%	39.0%
Japan	19.9%	39.1%	54.1%	77.0%	65.1%
Korea	39.2%	53.8%	62.3%	62.1%	52.3%
Lithuania	31.4%	43.1%	53.7%	60.0%	49.8%
Mexico	13.8%	13.8%	13.8%	55.2%	54.1%
Netherlands	49.9%	60.5%	70.0%	50.1%	38.7%
Poland	44.5%	54.0%	57.0%	43.7%	41.5%
Russia	15.3%	28.0%	36.0%	45.7%	44.1%
Serbia	51.8%	59.5%	59.9%	47.8%	49.5%
Spain	22.7%	53.6%	57.5%	58.7%	51.7%
Thailand	65.2%	34.0%	48.4%	47.5%	34.8%
Turkey	54.1%	57.8%	64.0%	65.9%	55.9%
Ukraine	25.0%	29.6%	37.5%	46.9%	43.2%
United Kingdom	40.7%	69.3%	69.9%	60.8%	61.6%
United States	21.3%	24.6%	22.6%	119.1%	114.6%
Average	**34.7%**	**47.9%**	**53.4%**	**59.0%**	**52.1%**

Note: Percentages are calculated on a volume basis. n.a. is not available. Averages are unweighted.

3.2 Autogas vehicle subsidies

The most effective measure other than favourable fuel taxation in encouraging switching to Autogas is subsidies to the vehicle itself. They usually take the form of grants or tax credits for converting gasoline vehicles to run on Autogas or for purchasing OEM Autogas vehicles. Among the countries surveyed, the central government and/or some local authorities subsidised conversions or OEM purchases in 2016 in Italy, Japan, Korea (old diesel trucks only), the United Kingdom (taxis) and the United States (some states). In some cases, subsidies effectively covered the entire cost of conversion or the additional OEM cost. Other countries, including Australia and France, ran similar schemes within the last five years.

Discounts on annual road taxes and initial vehicle registration taxes compared with those levied on gasoline or diesel vehicles are less common.

In 2016, France, Italy (some municipalities), the Netherlands and Thailand used this approach (though annual road taxes in the Netherlands are higher for Autogas vehicles than for diesel- or gasoline-powered ones).

3.3 Other incentives

Supply-side fiscal or subsidy measures that reduce the tax liability, investment cost or running costs of fuel providers are currently in place only in the United States. The federal Alternative Fuel Infrastructure Tax Credit covers up to 30% of the cost of installing refuelling facilities for alternative fuels, including Autogas, up to a limit of $30 000. In addition, some states have also introduced tax credits for part of the construction cost of refuelling stations or improvements to existing stations so they can provide Autogas or other alternative fuels. A Japanese government programme to promote Autogas distribution through grants covering 50% of both the cost of building and the cost of running Autogas refuelling stations up to a fixed ceiling ended in March 2012. As part of broader policy framework to reduce emissions from road transport, the European Union adopted a directive in 2014 to foster the development of alternative fuels, which include Autogas (Box A3.2).

Fleet-vehicle purchase mandates or Autogas-fuelled public transport programmes are used in three of the countries surveyed countries: India, China and the United States. Mandates for AFVs, including those using Autogas, have been widely used in the United States for many years. Under the Energy Policy Act of 1992, 75% of new LDVs acquired by certain federal fleets must be AFVs. A minimum share of certain state government and alternative fuel-provider fleet vehicle purchases must also be AFVs. Additional requirements for federal fleets were included in the Energy Independence and Security Act of 2007, including requirements to acquire low-emitting vehicles.

Autogas vehicles – along with other with other clean AFVs – enjoy exemptions from city or highway-driving restrictions imposed on peak-pollution days in several European cities, including Rome (in Italy) and Paris (in France). In some US cities, Autogas vehicles are given access to dedicated lanes. Most industrialised countries directly fund and manage transportation and automotive fuel research and development (R&D) programmes, which sometimes benefit Autogas.

Other measures that have been or are being used by governments to promote Autogas use include the use of voluntary agreements and programmes between governments and fuel providers and fleet operators. For example, the US Clean Cities Program, run by the Federal Department of Energy, helps city authorities seek voluntary commitments from fuel providers to expand the distribution network and fleet operators to increase their purchases of AFVs. The deployment of Autogas vehicles by the government itself is also used to expand the market for Autogas and set an example to other end users. Information dissemination and education programmes for Autogas and other alternative fuels are or have been used in several other countries.

Box A3.2: EU policy framework for Autogas

Under the treaty establishing the European Union, national governments retain competence in certain fields such as taxation, education and social welfare. But the Union plays a leading role in policy making on energy, climate change and other environmental concerns, with direct implications for Autogas. Roughly two-thirds of national legislation across all 28 member states now involves the transposition of EU directives or regulations. All EU members are required to comply with the legal acts proposed by the European Commission, and adopted by the European Parliament and the EU Council.

The European Union has set ambitious targets for reducing emissions of greenhouse gases (GHG) and various air pollutants. The 2030 Climate and Energy Framework, adopted in 2014, sets a 40% GHG emissions reduction target for 2030 compared with 1990 levels. For 2050, the European Commission proposed a reduction target of 80% in its 2011 roadmap for moving towards a competitive low-carbon economy (EC, 2011). In addition, the National Emission Ceilings Directive, which came into force in 2016, sets reduction targets for 2030 compared with 2005 covering a number of air pollutants, including 63% for NOx and 49% for fine PM. A number of policies are being developed to achieve these targets, many of which focus on road transport, which is responsible for one-fifth of total EU CO_2 emissions and is the main source of NOx and PM emissions.

The European Union has adopted several pieces of legislation to reduce progressively the emissions of new road vehicles, notably Euro standards on pollutant emissions (currently Euro 6) and CO_2 standards (a ceiling of 95 grammes of CO_2/kilometre by 2021 averaged across the fleet for each carmaker). More recently, it has started to promote a shift to alternative fuels, including Autogas. In 2014, it adopted Directive 2014/94/EU on the deployment of alternative fuels infrastructure, which sets national targets for minimum amounts of refuelling infrastructure. No specific target was considered necessary for Autogas infrastructure, though the directive clearly establishes the legal status of Autogas as an alternative fuel and deserving of public support. Such support can come in several forms, some of which are enshrined in other pieces of EU legislation, including:

- The Energy Taxation Directive 2003/96/EC, which sets minimum excise duty rates for all fuels, allows Member States to totally or partially exempt Autogas from excise duties because of its low-carbon content.
- The EU Fuel Quality Directive 2009/30/EC, among other provisions, sets a 6% decarbonisation target for transport fuels by 2020. This target is implemented in such a way that fuel distributors need to achieve a certain reduction in the overall lifecycle carbon intensity of the fuels that they sell. To implement this provision, the Directive has referenced well-to-wheel carbon intensity values for all transport fuels, which were originally defined by the EU Joint Research Centre and which show that LPG has 23% less well-to-wheel GHG emissions than diesel and 21% less than gasoline. Fuel distributors can increase the share of Autogas in their fuel-supply portfolio in order to meet the target.
- Regulations 443/2009/EC and subsequently 333/2014 set CO_2 emission-performance standards for new passenger cars; car manufacturers must achieve in 2021 an average performance of 95 g/km across their fleet. For LPG bi-fuelled cars, emissions must be measured in LPG mode. Introducing LPG models into their portfolio is therefore one solution for car manufacturers to achieve their target.

Table A3.2 summarises the principal measures deployed in the countries surveyed in this report. The most common measure to support Autogas, used in all countries bar the United States, is a tax exemption or large rebate relative to conventional fuels.

Table A3.2: Summary of Autogas incentive policies in countries surveyed, 2016

	Fuel tax exemption or large rebate[1]	Vehicle tax exemption or rebate[2]	Grants/tax credits for conversions or OEM purchases[3]	Autogas fleet vehicle purchase mandates[3]
Australia	✓			
Bulgaria	✓			
China	✓			✓
Czech Republic	✓			
France	✓	✓		
Germany	✓			
Greece	✓			
India	✓			✓
Italy	✓	✓	✓	
Japan	✓		✓[4]	
Korea	✓		✓[5]	
Lithuania	✓			
Mexico	✓			
Netherlands	✓	✓		
Poland	✓			
Russia	✓			
Serbia	✓			
Spain	✓		✓[6]	
Thailand	✓	✓		
Turkey	✓			
Ukraine	✓			
United Kingdom	✓		✓	
United States			✓	✓

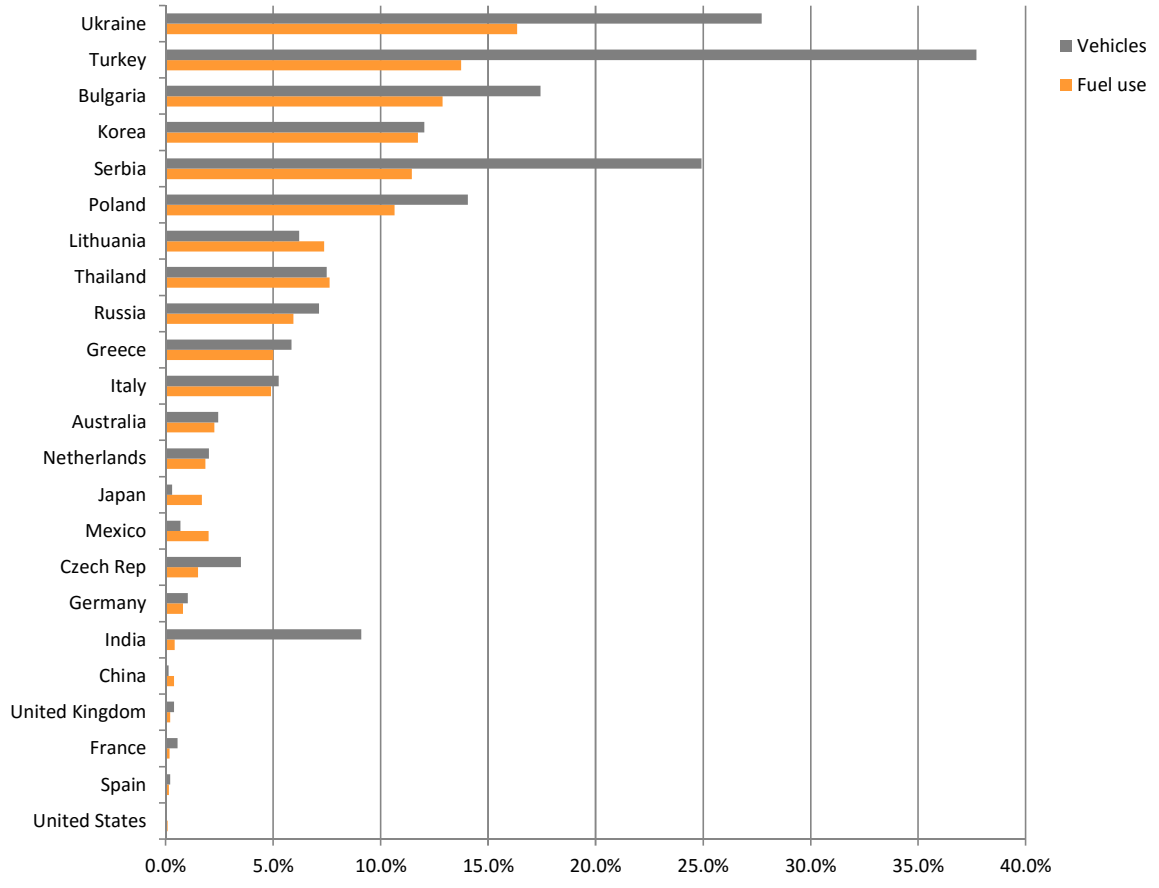
[1] Excise duty less than half that levied on diesel and gasoline, calculated on a per-litre equivalent basis. [2] Compared with gasoline. Includes taxes on vehicle conversion/acqusition, initial vehcile registration charges and annual road/registration charges. [3] Mandates for AFVs, including Autogas. Central and state governments. Includes public transport. [4] Ended in 2017. [5]Conversions of old diesel trucks only. [6] In Madrid, from 2017.

4 Effectiveness of Autogas incentive policies

4.1 Autogas share of the automotive-fuel market

The effectiveness of Autogas incentive policies varies considerably among the countries surveyed in this report. The share of Autogas in total automotive-fuel consumption ranged from a mere 0.1% in Spain and the United States to about 18% in Ukraine in 2015 – the latest year for which data on total automotive fuel consumption and the LDV fleet are available for all countries (Figure A4.1). Autogas accounted for more than 10% of the fuel market in five countries other than Ukraine: Turkey, Bulgaria, Korea, Serbia and Poland.

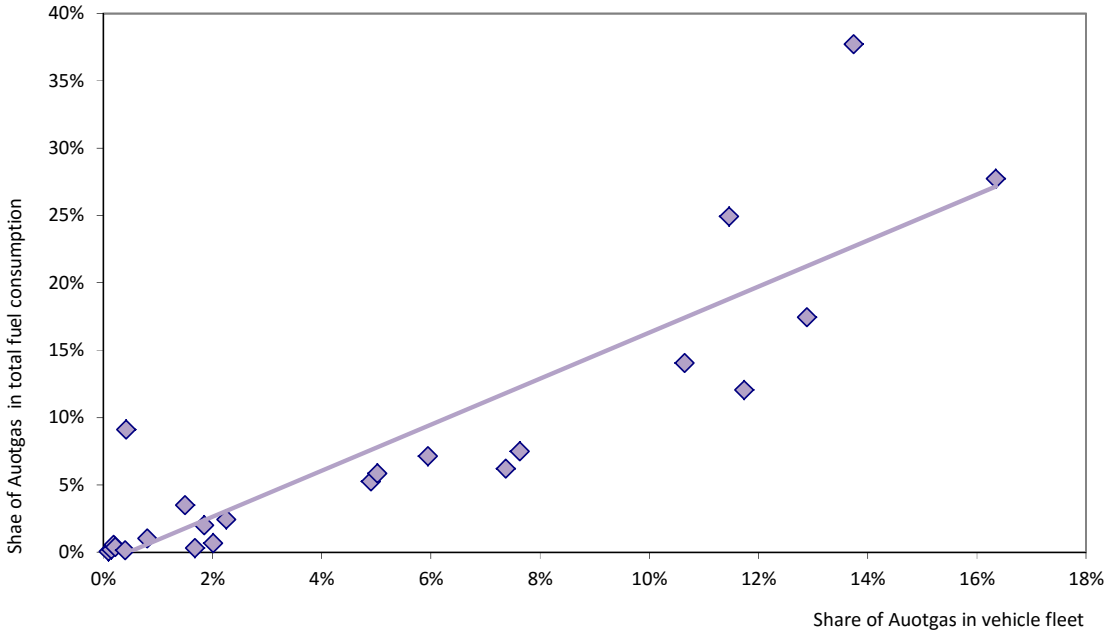
Figure A4.1: Share of Autogas in total automotive-fuel consumption and LDV fleet, 2015



The share of Autogas vehicles in the total number of passenger vehicles is, unsurprisingly, closely correlated with the share of Autogas in total automotive-fuel consumption (Figure A4.2). Fuel use is particularly high relative to the penetration of Autogas in the vehicle fleet in China, Japan and Mexico, largely because taxis and other commercial vehicles account for the bulk of Autogas consumption. The share of Autogas in the vehicle fleet is

very high relative to its share in total fuel use in India because three-wheelers, which consume less fuel, account for a large share of the Autogas vehicle fleet.

Figure A4.2: Share of Autogas in total automotive-fuel consumption versus vehicle fleet, 2015



4.2 Comparative competitiveness of Autogas

The market penetration of Autogas depends largely on how competitive the fuel is against gasoline and diesel – in other words, how financially attractive it is for an end user to switch to Autogas. This largely depends on the cost of converting the vehicle (or the cost of a dedicated OEM vehicle compared with a gasoline or diesel vehicle) and the pump price of Autogas relative to diesel and gasoline.

Since converting a vehicle to run on Autogas involves upfront capital expenditure, the owner needs to be compensated through lower running costs, of which fuel is the most important. The time it takes for the savings in running costs to offset the capital cost – the payback period – depends on the usage of the vehicle, i.e. the average distance travelled monthly or annually. The extent to which government incentives lower the initial expenditure (through subsidies) and fuel costs (through favourable taxation) is critical to the payback period. In practice, the payback period generally has to be less than two to three years to encourage commercial vehicle owners to switch; private individuals often demand an even quicker return on their investment.

We have estimated, for all the countries surveyed, the distances over which a typical non-commercial LDV of recent vintage would need to travel before it becomes competitive with similar gasoline and diesel vehicles. The methodology and assumptions used for this analysis are described in Box

4A.1. The results are summarised in Table A4.1 (the detailed results by country can be found in Part B).

Box A4.1: Methodology for calculating the comparative competitiveness of Autogas

In order to analyse the role inter-fuel competition plays in Autogas demand, we have calculated indicative breakeven distances for non-commercial Autogas-fuelled LDVs compared with both gasoline and diesel vehicles for all 23 countries surveyed. This involved compiling information on current pump prices and effective differences in actual vehicle conversion and acquisition costs for Autogas and diesel relative to gasoline vehicles, taking account of any grants or tax rebates currently available (including any differences in vehicle registration and annual road taxes). The cost of running a gasoline vehicle is the baseline against which the cost of running Autogas and diesel vehicles is compared.

To allow cross-country comparisons, uniform assumptions about fuel and vehicle types were adopted. For all countries, a typical passenger car of recent vintage was assumed (a five-door saloon or hatchback) with the same power rating for each fuel. For Autogas vehicles, a vapour-injection system was assumed (unless indicated otherwise). Mileage differences due to the lower per-litre energy content of Autogas and engine performance were also taken into account. The diesel vehicle was assumed to consume 22% less fuel per kilometre on a volume basis than the gasoline vehicle, while the Autogas vehicle was assumed to consume 25% more per kilometre than the gasoline vehicle. No differences in fuel specifications and operating characteristics between countries were taken into account, because of the difficulty in obtaining reliable information for each country (notably the propane-butane mix of Autogas, which varies in practice across seasons and countries).

There is considerable variation in the competitiveness of Autogas against each of the other fuels among the countries surveyed. Converted vehicles eventually break even with gasoline vehicles in all countries except the United States (Figure A4.3). The breakeven distance is around 150 000 km in Japan and 109 000 km in Australia; in all other countries, it is less than 90 000 km. Autogas is most competitive in Bulgaria, where a converted vehicle breaks even with gasoline at just 13 000 km – less than one year of driving for a private motorist. Autogas is also highly competitive in Greece, India, Lithuania, Poland, Thailand, Turkey and Ukraine, all of which have a breakeven distance of less than 25 000 km for a converted car. In 15 of the 23 countries surveyed, the breakeven distance is under 50 000 km – or less than three years of driving. The equivalent breakeven distance for OEM Autogas vehicles is generally higher, because it is more expensive to buy an OEM than convert a gasoline car in most cases. In Korea, certain categories of motorist are able to buy a mono-fuelled Autogas car at the same price as the gasoline version; as result, Autogas is always more competitive than gasoline as the pump price is much lower.

Table A4.1: Breakeven distance for a non-commercial Autogas LDV, 2016 (thousand km)

	Autogas conversion against		Autogas OEM against	
	Diesel	Gasoline	Diesel	Gasoline
Australia	0	109	NA	NA
Bulgaria	0	13	0	43
China	NC	64	NC	120
Czech Republic	0	29	0	29
France	0	53	0	38
Germany	0	38	0	34
Greece	0	15	0	22
India	0-150	18	0-150	18
Italy	0	22	0	17
Japan	0-101	150	0-76	200
Korea	NC	83	0	0
Lithuania	0	23	0	28
Mexico	0	38	NA	NA
Netherlands	0	58	0	14
Poland	0	17	0	21
Russia	0	37	0	46
Serbia	0	37	0	37
Spain	0	39	0	47
Thailand	0	21	NA	NA
Turkey	0	20	0	53
Ukraine	0	24	0	30
United Kingdom	0	75	NA	NA
United States	NC	NC	NC	NC

Note: Zero indicates that Autogas is always competitive. A range indicates the distances over which Autogas is competitve before the competing fuel becomes more economic. NC indicates that Autogas is never competitive. NA is not available.

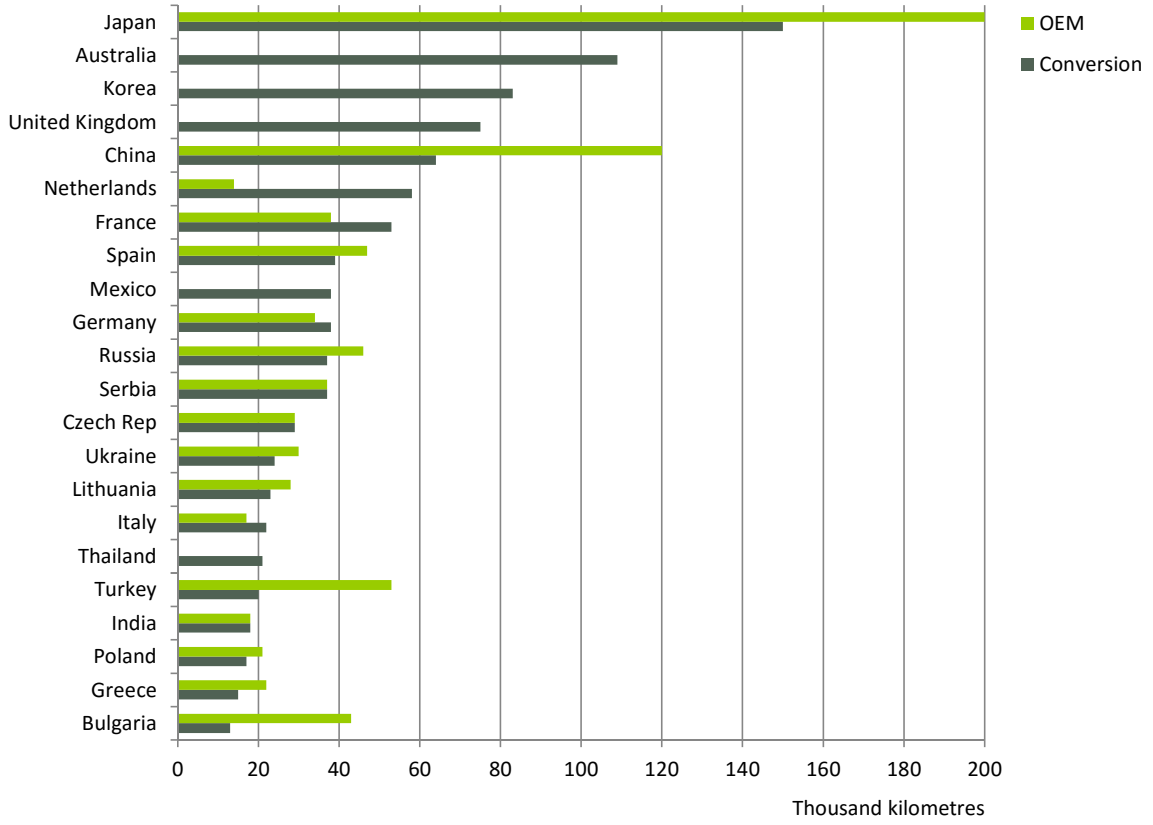
The picture is less straightforward when Autogas is compared with diesel. Converted Autogas vehicles are always competitive against diesel regardless of distance in all but five of the countries surveyed here as Autogas-conversion costs are less than the additional cost of buying a diesel vehicle. In India and Japan, a converted Autogas car is initially competitive with diesel, but the latter eventually becomes cheaper (at over 100 000 km in both cases). In China, Korea and the United States, the upfront additional cost of buying a diesel car is no more than that of a converted Autogas car, while the running costs of diesel are lower than for Autogas, so diesel is always the most competitive option whatever the distance travelled.

4.3 Impact of Autogas competitiveness on automotive-fuel market penetration

There is a strong correlation between how competitive Autogas is against other fuels and how successful Autogas has been in penetrating the automotive-fuel market. Autogas use is generally higher in countries where the break-even distance against gasoline is low (Figure A4.4). For example,

Bulgaria has the lowest breakeven distance and one of the highest rates of market penetration for Autogas. At the other extreme, Autogas accounts for the second-smallest share of total automotive-fuel consumption in the United States, where Autogas is most uncompetitive. The correlation for diesel is weaker, largely because Autogas is always competitive against that fuel in almost half of the countries.

Figure A4.3: Autogas breakeven distance against gasoline, 2016

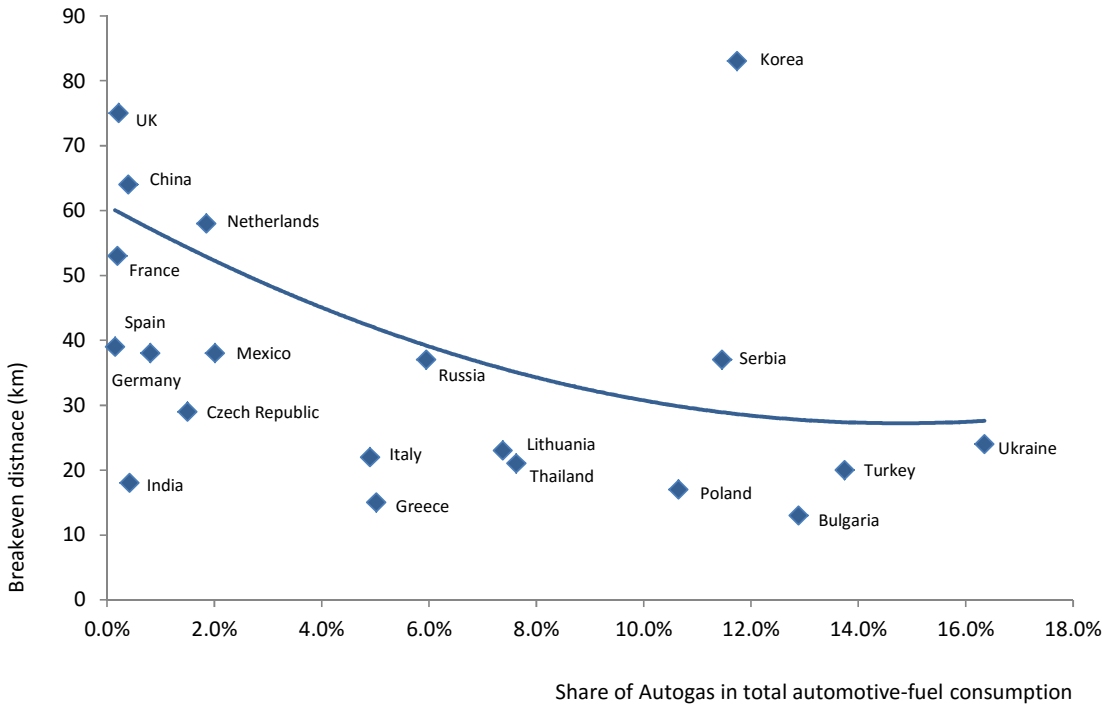


Note: The United States are not shown, as Autogas is never competitive against gasoline. In Korea, an OEM is competitive against gasoline at 0 km; no OEMs are available in Australia, Mexico, Thailand or the United Kingdom.

4.4 Impact of non-financial incentives

The competitiveness of Autogas is the most important factor in explaining the actual market penetration of Autogas and recent rates of market growth. But it is not the only factor: for example, the breakeven distance for Autogas against gasoline in Greece is lower than that of Ukraine, yet the penetration of Autogas in Greece is much lower – even though Autogas is always competitive against diesel. This is in part due to lags in the market response to changes over time in inter-fuel competition: for example, the low market penetration of Autogas in Bulgaria reflects the fact that Autogas has only recently become highly competitive with gasoline and diesel. Several other factors also explain these divergences:

Figure A4.4: Autogas share of automotive-fuel consumption and breakeven distance against gasoline



Note: The breakeven distances shown are the lowest for each country (a converted or OEM vehicle). The United States is not shown as Autogas is never competitive against gasoline. Australia and Japan are not shown as their breakeven distances are off the scale at 109 000 km and 150 000 km respectively. Breakeven distances are based on 2016 data and market shares on 2015 data.

- *Government policy commitment:* The Autogas market has tended to develop more quickly where the government has shown a strong, long-term policy commitment in favour Autogas. Frequent changes of policy, including shifts in taxation, deter end users, equipment manufacturers and fuel providers from investing in Autogas. For example, in Australia, the introduction of an excise duty on Autogas in 2011 and annual increases each year since have resulted in a collapse in conversions and the withdrawal of OEM Autogas cars from the market, leading to a slump in fuel sales. In contrast, the long-term commitment by the German government in 2006 to keeping Autogas taxes low was an important factor in the take-off of Autogas demand there.

- *Non-financial policies and measures:* In some cases, the use of non-financial incentives or other measures have helped either to boost or hinder Autogas use. Public awareness and education campaigns to promote Autogas have certainly made a significant contribution to market growth in several countries, including the United States. Mandates and public transport fleet conversion programmes have also been successful in several countries, notably China, India and the United States. In other cases, regulations restricting Autogas

use, including bans on underground parking (although currently, it is formally banned in only two European countries), have been a barrier to market development.

- *Restrictions on diesel vehicles:* Local and central government environmental restrictions on the use of diesel vehicles have been an important factor behind the success of Autogas in Korea and Japan.

- *Availability of equipment and fuel:* In some countries, Autogas has struggled to penetrate the fuel market where carmakers have been reluctant to market OEM models or where there is a limited number of refuelling sites selling Autogas. A lack of OEM vehicle availability has been a major barrier to market development in the United States.

- *Public attitudes:* Worries about the safety and reliability of Autogas have clearly affected demand in several countries. This appears to be the main reason why Autogas demand remains weak in France, despite highly favourable taxation policies. Misperceptions about the convenience of using Autogas also deter interest in using the fuel in some cases.

5 Lessons for policy makers

5.1 The rationale for promoting Autogas

For environmental and economic reasons, Autogas remains a particularly attractive alternative automotive fuel. In many parts of the world, urban air pollution is worsening and emissions of greenhouse gases from road vehicles rising as demand for mobility – whether for transporting people or goods – grows inexorably with increasing economic activity and prosperity. Urgent action is needed in many places, especially in Asia. Draconian measures to curb mobility are politically and socially unacceptable. Breakthrough technologies under development today, notably EVs, hold out the prospect of much lower or even zero emissions, but their widespread commercialisation is still several years away. Biofuels can bring significant reductions in greenhouse-gas emissions, but are often very expensive to produce, requiring large subsidies to make them financially viable.

The most practical approach in the short-term to reducing emissions is by encouraging people and businesses to switch to cleaner-burning fuels that are already commercially available. Autogas is the obvious option. It outperforms conventional fuels and most other alternative automotive fuels for local and regional environmental benefits. It can also play an important role in mitigating greenhouse-gas emissions until such time as ultra-low or zero-emission vehicle technologies are commercialised on a large scale. In this sense, Autogas can be regarded as a "bridging fuel" in the transition to a o-emission energy system.

Autogas makes economic as well as environmental sense because its raw material costs are competitive and installing the distribution infrastructure costs less than for other alternative fuels. Most gasoline-powered LDVs, including commercial vans and taxis, are highly amenable to conversion to Autogas. OEM Autogas buses have operated for many years in a number of cities around the world, and improved Autogas-fuelled engines for buses and trucks are now available. Yet there are obstacles to market take-off and development. In practice, Autogas can only be successful if there is a concerted effort on the part of all stakeholders – vehicle manufacturers and converters, Autogas suppliers and governments – to make switching attractive to end users.

The loss of revenue from lower taxation of Autogas fuels or vehicle sales may be used by the government as an excuse for not providing fiscal incentives – especially in countries where fuel-tax revenues make up a large share of the overall government budget. In practice, however, any reduction in taxes from automotive-fuel sales can be easily offset by marginal increases in taxes on gasoline and diesel.

5.2 Critical success factors for Autogas market development

In designing Autogas incentives, policy makers need to take account of the critical success factors behind the development of a sustainable Autogas market. The analysis of the preceding two chapters demonstrates clearly that the most important factors are the financial attraction of switching to potential Autogas-vehicle owners, i.e. the speed of payback on the initial investment, and the achievement of critical market mass.

Fuel taxes and vehicle grants are the primary determinants of the financial benefit to vehicle owners of switching to Autogas. In practice, the crucial variable to vehicle owners and operators in their choice of fuel is the speed of payback on the initial additional cost of converting a gasoline vehicle to run on Autogas or the higher price of an OEM vehicle relative that of a new gasoline or diesel vehicle. The payback period has to be sufficiently short to justify the investment and to compensate for the inconvenience associated with Autogas.

Even where reasonably strong financial incentives exist, Autogas use will not necessarily take off until critical market mass is achieved:

- The market needs to be large enough to demonstrate to potential Autogas users and fuel providers that the fuel is safe, reliable and cost-effective alternative to conventional fuels. The more Autogas vehicles there are on the road, the more confidence other vehicle owners will have to switch fuels.

- Autogas must be widely available and this needs to be known to the public. Lack of refuelling stations is a major impediment to persuading vehicle owners to switch to Autogas, even where there is a strong financial incentive.

- The Autogas market must be big enough to support a viable network or properly-trained mechanics to convert and maintain Autogas vehicles and ensure the availability of spare parts and equipment.

The role of the government in giving an initial strong impetus to the simultaneous development of demand and supply infrastructure in collaboration with all stakeholders is vital. Favourable taxation of Autogas relative to gasoline and diesel is a necessary but not always a sufficient condition for establishing and sustaining an Autogas market. Other government incentives may be necessary where the market has not yet reached critical mass. Government grants for vehicle conversions for private individuals and fleets have been particularly successful in kick-starting Autogas markets in some instances. Road and vehicle registration and purchases taxes that favour Autogas vehicles can also be an effective policy, with relatively low implementation costs and few negative side-effects. Conversion of public vehicle fleets to Autogas is also an effective way of demonstrating the benefits of Autogas and driving the development of distribution infrastructure.

Technical and safety standards are another important area of responsibility for governments in partnership with LPG suppliers, vehicle converters and OEMs. It is essential for the authorities to lay down and enforce harmonised operating standards for aspects of both Autogas distribution and vehicle equipment, including installation. Poor-quality conversions can undermine engine and emission performance and jeopardise sustainable development of the market. The European Union, for example, addressed this concern with the adoption of ECE Regulation 67.01.

Safety should be an overriding concern for policymakers everywhere. Fuel providers and end users need to be reassured that the transportation, handling and storage of Autogas pose no safety risks. But the drafting and implementation of safety regulations specific to Autogas need to be based on an objective assessment of risk. In certain countries, regulations still limit unnecessarily access and parking of Autogas vehicles, the siting of refuelling stations and the on-site location of dispensers. Studies have shown that many of these restrictions are unjustified. For example, some countries do not allow the positioning of Autogas dispensers next to gasoline and diesel pumps. This raises the station's capital and operating costs and undermines the customers' confidence in the safety of Autogas refuelling. Experience in countries where this is permitted, such as France and the Netherlands, shows that there is no risk if good equipment and appropriate procedures are in place.

In most cases, there is no need for policy makers to draw up technical and safety standards and regulations from scratch, since several countries have developed effective frameworks based on many years of experience of Autogas use. For example, the European Standards Organisation, CEN, has drawn up detailed minimum safety requirements for Autogas vehicles, fuel and storage systems and installation procedures as well as fuel distribution.

5.3 Formulating an effective Autogas strategy

There is no single model or approach to formulating and implementing a government programme of incentives to promote the development of a sustainable Autogas market. The appropriate strategy for each country depends on specific national circumstances. These include budgetary considerations, which might limit available funds for subsidies, the seriousness of local pollution problems, fuel-supply and cost issues, the stage of development of the Autogas market and the prevailing barriers to fuel switching, including restrictive regulations and the local cost of vehicle conversions.

Whatever the circumstances, however, experience in the countries surveyed in this study has clearly shown that the single most important measure to making Autogas an attractive fuel to vehicle owners is favourable fuel-tax treatment compared with conventional fuels. At a minimum, taxes should take account of the environmental benefits of encouraging switching to Autogas. But this is not always sufficient. Complementary policy initiatives, including grants and tax credits to lower the cost of vehicle conversions, and regulatory measures may also be needed – especially during the early stages

of market development. Vehicle incentives are particularly important where fuel taxes generally are low, limiting the scope for savings on running costs.

Policy stability and a strong, long-term commitment by the government to achieving environmental-policy objectives are crucial to success in promoting the development of alternative-fuel markets. Stakeholders need to be given clear advance warning of any major shift in policy. Without policy stability, coherence and consistency, neither fuel suppliers, nor OEMs nor consumers will be confident that they will be able to make a reasonable return on the investments required to switch fuels.

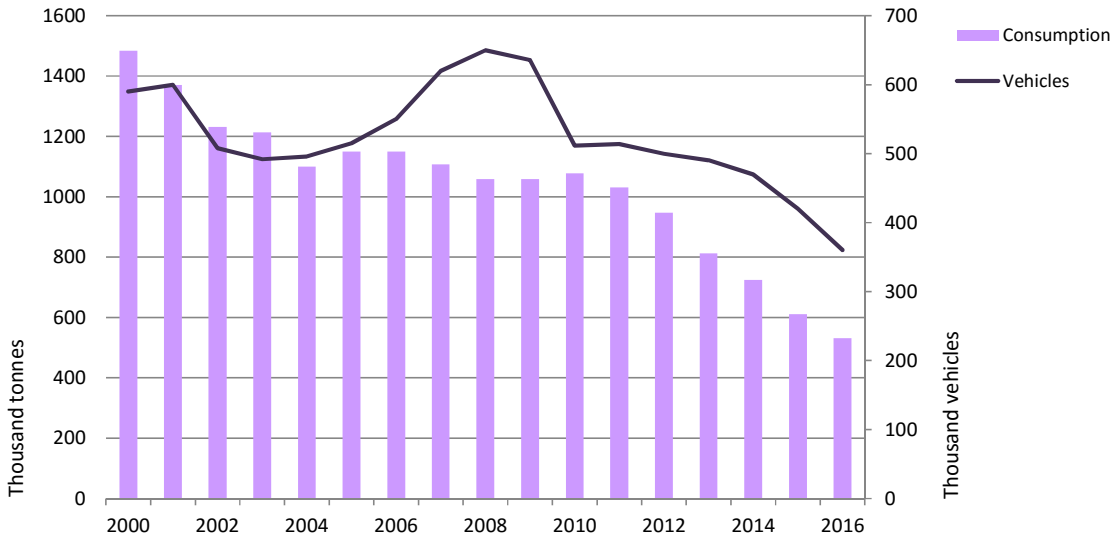
PART B: COUNTRY SURVEYS

1 Australia

1.1 Autogas market trends

Australia has a comparatively long history of Autogas use. The federal government started to encourage the use of Autogas use in 1981 for reasons of energy security – the country is a large producer and exporter of LPG, derived mainly from natural-gas processing – and air quality. The market took off in the 1990s thanks to a combination of a zero excise tax on Autogas and generous vehicle-conversion grants. Autogas consumption fluctuated around 1.1 Mt per year between 2004 and 2010 (Figure B1.1).

Figure B1.1: Autogas consumption and vehicle fleet – Australia



But the market started to contract in 2011 as a result of the introduction of and progressive increase in an excise tax on Autogas, improved fuel economy and consumers shunning large six-cylinder vehicles, which have been the mainstay of the Australian Autogas market, in favour of smaller four-cylinder vehicles, diesels and hybrids. In particular, there has been a shift in demand from fleet operators away from Autogas to diesel vehicles (ABMARC, 2016). The phase-out of grants for converting or buying Autogas vehicles also contributed (see below). Sales dropped to just 532 000 tonnes in 2016 – less than half the level of 2010 and barely one-third of the level of 2000, when they hit an all-time peak of almost 1.5 million tonnes. Autogas use was equal to less than 2% of total road-fuel consumption in 2016 compared with 4.8% ten years earlier.

The state of Victoria has the largest Autogas market in Australia. Nationwide, Autogas use is particularly high among taxis, about half of which

run on the fuel. Autogas accounts for around one third of the country's LPG consumption.

The prospects for Autogas use in Australia have been further undermined by the recent closure of the Ford and General Motors (Holden) car factories in the country, where OEM Autogas models were produced. Local production of LPG has also fallen with the recent closure of three refineries, though this has been offset to some extent by rising output from natural gas processing plants. The number of aftermarket conversions has also fallen, with most conversions involving kits produced by Prins, Landi Renzo, Sprint Gas and IMPCO. Autogas has also come under pressure from the dieselisation of the new vehicle fleet, with some models now only being made available with a diesel engine, limiting the scope for aftermarket conversions.

Australia still has an extensive nationwide retail-distribution network, with 2500 refuelling sites throughout the country serving an estimated 360 000 vehicles at end-2016 (around 2% of the total car fleet). About 40% of all service stations in Australia sell Autogas.

1.2 Government Autogas incentive policies

Government policies on transport fuels have shifted in recent years, with a growing emphasis on promoting low- and zero-emission vehicles. The federal government has traditionally supported the development of the Autogas market primarily through favourable taxation. Up to 2011, Autogas and other alternative fuels (ethanol, LNG and CNG) benefitted from a complete exemption from excise taxes. A tax was introduced on Autogas (as well as CNG and LNG) on 1 December 2011 at 2.5 cents/litre and was scheduled to rise each year on 1 July by 2.5 cents to 12.5 cents in 2015 – still well below the rates applied to gasoline and diesel. In May 2014, the government announced a proposal to index excise-duty rates for most road fuels to inflation every six months. The excise tax on Autogas averaged 12.9 cents/litre in 2016. The taxes on gasoline and diesel are still considerably higher – 39.6 cents for both fuels – but the gap with Autogas has narrowed.

The pump price of Autogas, including the 10% general sales tax (GST), is currently 52% that of both gasoline and diesel (Table B1.1). Despite the introduction of and steady increase in the excise tax on Autogas, the differences in price between Autogas and the two other fuels have barely changed since 2011, because pre-tax Autogas prices have fallen relative to those of gasoline and diesel prices as a result of international price movements. Nonetheless, the price of Autogas increased in 2016, while that of gasoline and diesel fell.

Table B1.1: Automotive-fuel prices and taxes per litre – Australia

	Australian dollars						US dollars
	2011	2012	2013	2014	2015	2016	2016
Pump prices							
Autogas	0.704	0.717	0.721	0.785	0.590	0.613	0.455
Diesel	1.484	1.497	1.523	1.551	1.289	1.178	0.875
Gasoline*	1.430	1.432	1.454	1.468	1.283	1.169	0.869
Total taxes							
Autogas	0.064	0.103	0.128	0.159	0.169	0.185	0.137
Diesel	0.516	0.517	0.519	0.523	0.508	0.503	0.373
Gasoline	0.511	0.511	0.513	0.516	0.507	0.502	0.373
Excise taxes							
Autogas	0.000	0.038	0.063	0.088	0.115	0.129	0.096
Diesel	0.381	0.381	0.381	0.382	0.391	0.396	0.294
Gasoline	0.381	0.381	0.381	0.382	0.391	0.396	0.294
Pre-tax prices							
Autogas	0.640	0.614	0.593	0.626	0.422	0.428	0.318
Diesel	0.968	0.980	1.003	1.028	0.782	0.675	0.502
Gasoline	0.919	0.921	0.941	0.952	0.775	0.667	0.496

* Regular unleaded.

The federal government no longer makes available grants for the conversion of existing vehicles or purchase of an OEM Autogas vehicle. The LPG Vehicle Scheme, introduced in 2006, provided grants to private motorists for the conversion of existing LDVs of less than 3.5 tonnes or the purchase of an OEM Autogas LDV. The scheme was capped at 25 000 claims per year in 2011 and was closed at the end of June 2014. State and local governments have also reduced incentives to promote Autogas. For example, the Western Australian government used to provide a subsidy of A$1 000 for Autogas conversions, but the scheme was halted in 2009.

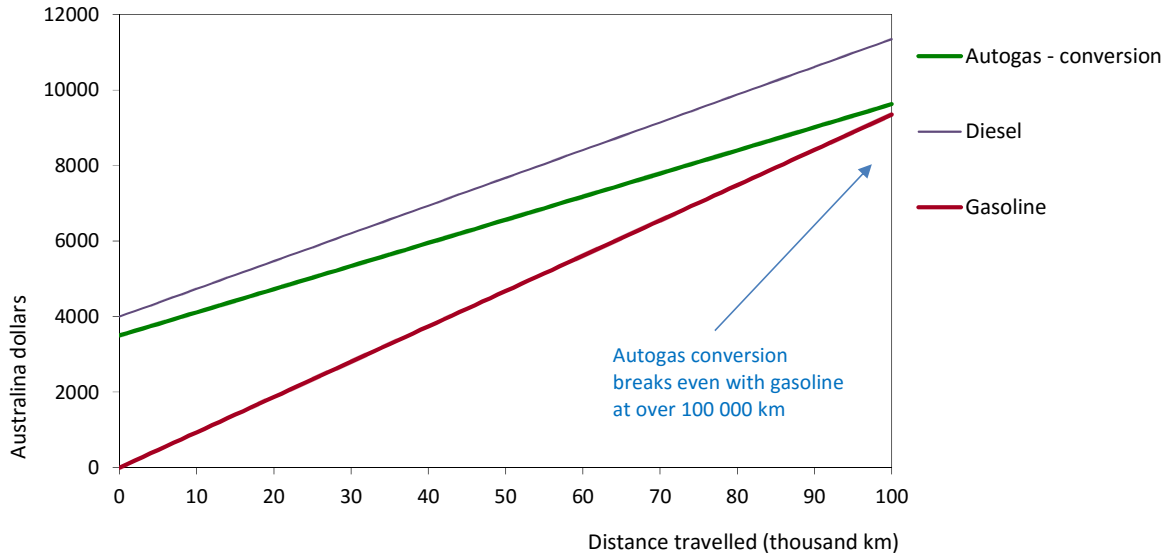
Current government fleet policies focus on fuel efficiency, which favours smaller vehicles and those using hybrid or diesel technology. Some Autogas vehicles can benefit from federal and state government programmes to support low-emission vehicles. For example, the federal government launched in 2015 a low-interest loan scheme for private and public sector vehicle fleets. The biggest incentives are offered to electric and hydrogen fuel-cell vehicles.

1.3 Competitiveness of Autogas against other fuels

Assuming an average conversion cost of A$3 500 (including GST), a converted Autogas-powered light-duty vehicle (LDV) breaks even with a conventional (non-hybrid) gasoline equivalent at 109 000 km – despite the favourable rate of excise duty and lower pump price of Autogas (Figure B1.2). The breakeven distance has increased markedly in recent years as a result of the removal of conversion subsidies and, since 2016, an increase in the price of Autogas relative to that of gasoline. Diesel breaks even with gasoline at

close to 200 000 km, effectively making it uncompetitive for all but the highest-mileage users, and is never competitive with Autogas.

Figure B1.2: Running costs of a non-commercial LDV, 2016 – Australia

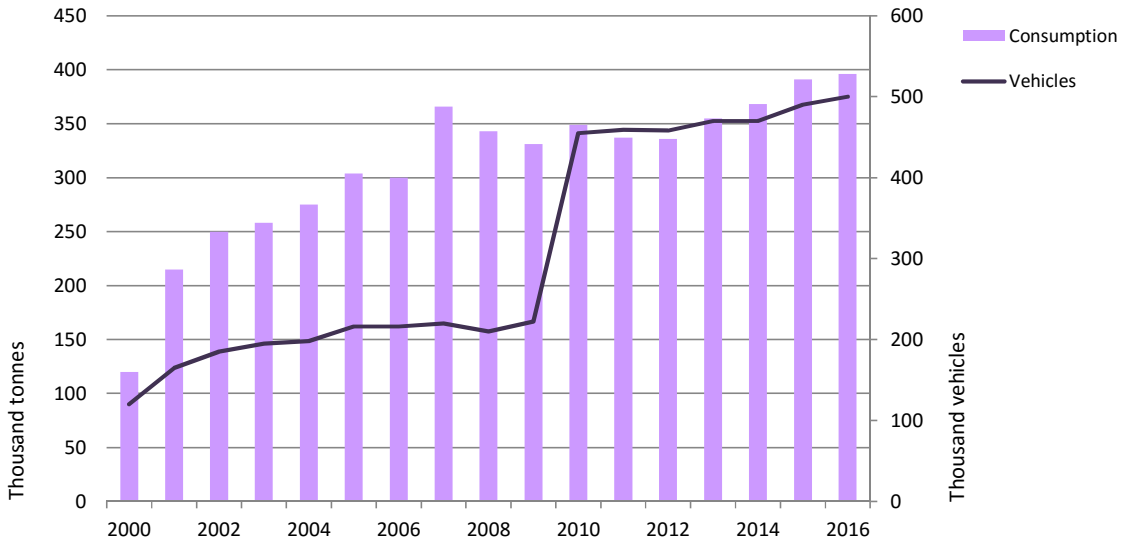


2 Bulgaria

2.1 Autogas market trends

The Bulgarian Autogas market took off in the 1990s and continued to grow steadily through most the 2000s, with demand stalling in 2008 in response to the financial and economic crisis. After a period of stagnation, demand is once again on the rise, reaching almost 400 000 tonnes in 2016 – about 13% of total road-fuel use (Figure B2.1). The market has been driven solely by favourable taxation of the fuel *vis-à-vis* gasoline and diesel and the relatively low cost of conversions, which account for most of the Autogas vehicles in use today. Autogas accounts for about 90% of all LPG consumed in Bulgaria.

Figure B2.1: Autogas consumption and vehicle fleet – Bulgaria



Note: The jump in vehicle numbers in 2010 is due to a break in the series.

The Autogas vehicle fleet has grown rapidly in recent years as private motorist, taxis and other commercial vehicles have switched from diesel and gasoline usually by installing conversion kits in existing vehicles. The number of Autogas vehicles has more than doubled since the end of the 1990s to around 500 000 in 2016. There are several marketers of conversion kits, including Sofgas, AGU-serviz and Lovato, and a certification scheme for conversions has been introduced. Some carmakers now market OEM models in Bulgaria, notably Dacia. The number of refuelling stations selling Autogas has also expanded quickly to an estimated 2 900 in 2016.

2.2 Government Autogas incentive policies

The principal policy incentive for Autogas is a low rate of excise tax relative to other fuels. The rate has been constant at 0.184 lev/litre for several years, compared with 0.646 Lev on diesel and 0.71 on gasoline (unchanged since

2013) (Table B2.1). Combined with a very low wholesale price of Autogas, this tax advantage translates into a highly competitive price of the fuel at the pump. In 2016, the average pump price of Autogas was equal to just 43% of the price of gasoline and 44% of that of diesel. These ratios are among the lowest of all the countries surveyed in the report.

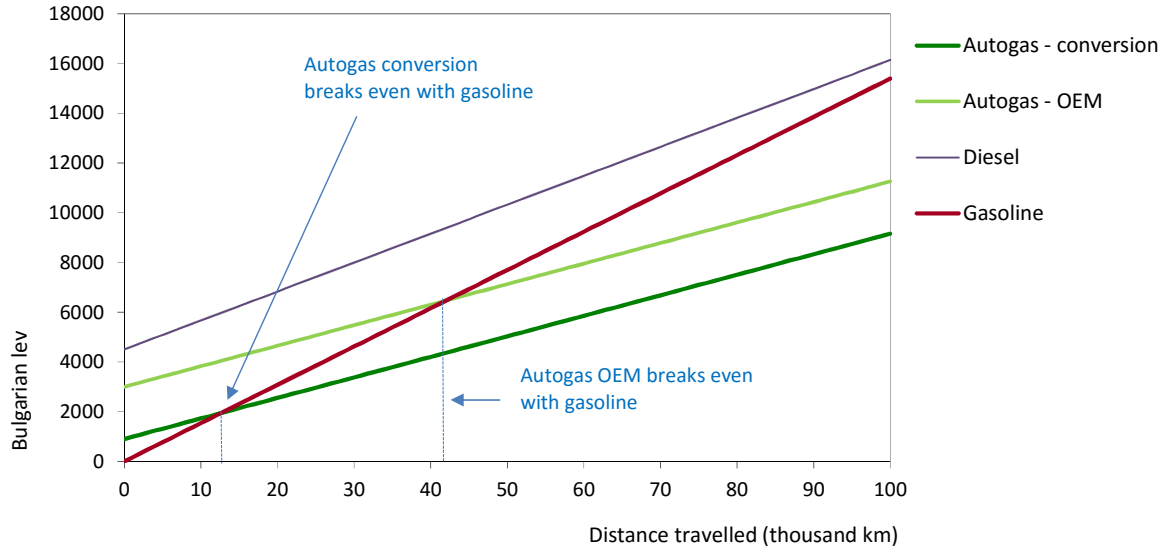
Table B2.1: Automotive-fuel prices and taxes per litre – Bulgaria

	Lev						US dollars
	2011	2012	2013	2014	2015	2016	2016
Pump prices							
Autogas	1.172	1.179	1.266	1.242	0.969	0.826	0.467
Diesel	2.297	2.490	2.611	2.550	2.203	1.865	1.055
Gasoline	2.285	2.500	2.576	2.497	2.157	1.924	1.088
Total taxes							
Autogas	0.379	0.380	0.395	0.391	0.345	0.322	0.182
Diesel	0.998	1.045	1.081	1.071	1.013	0.957	0.541
Gasoline	1.091	1.127	1.139	1.126	1.070	1.031	0.583
Excise taxes							
Autogas	0.184	0.184	0.184	0.184	0.184	0.184	0.104
Diesel	0.615	0.630	0.646	0.646	0.646	0.646	0.365
Gasoline	0.710	0.710	0.710	0.710	0.710	0.710	0.402
Pre-tax prices							
Autogas	0.792	0.798	0.871	0.851	0.623	0.504	0.285
Diesel	1.299	1.445	1.529	1.479	1.190	0.908	0.514
Gasoline	1.194	1.373	1.437	1.371	1.088	0.893	0.505

2.3 Competitiveness of Autogas against other fuels

The very low price of Autogas at the pump makes the fuel by far the cheapest fuel option at present in Bulgaria. The financial incentive to convert an existing gasoline LDV to run on Autogas is particularly strong because of the very low cost of conversion – around 800-1 000 lev, or roughly €400-500 (Figure B2.2). Based on average 2016 fuel prices, the breakeven distance against gasoline is only 13 000 km – less than one year of driving for a private motorist. An OEM Autogas car breaks even at about 43 00 km assuming an average price premium over a standard gasoline car of 3 000 lev (€1 500). The high price of diesel and the higher purchase price of a diesel car mean that the fuel is never competitive against Autogas and breaks even with gasoline only at above 120 000 km.

Figure B2.2: Running costs of a non-commercial LDV, 2016 – Bulgaria

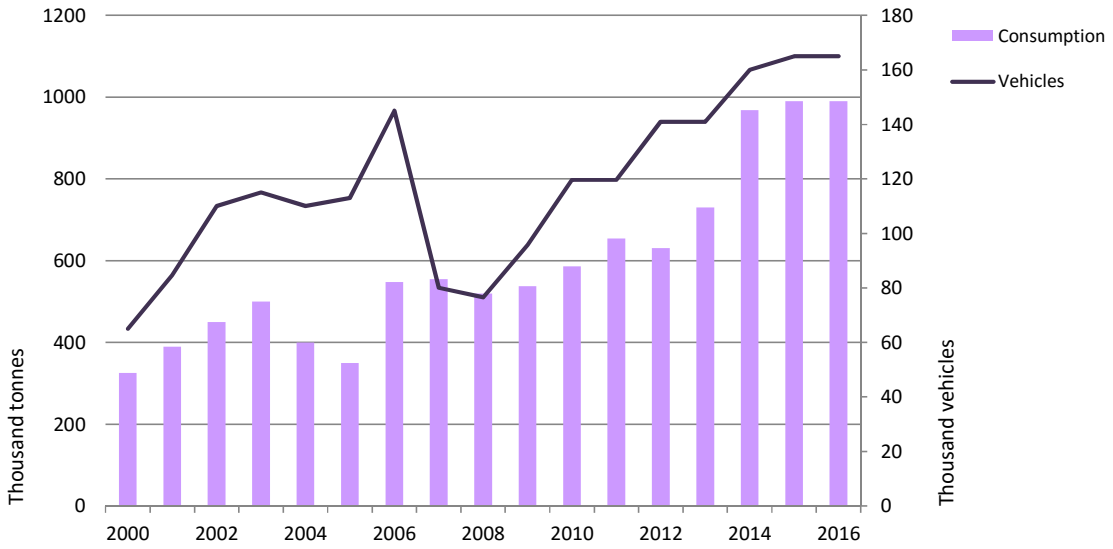


3 China

3.1 Autogas market trends

Autogas use in China has grown rapidly though in a rather uneven fashion since the 2000s, in line with rapidly rising use of LPG generally. Nationwide, consumption amounted to 990 000 tonnes in 2016 (including Hong Kong) – almost twice the level of 2008 and three times the level of 2000 (Figure B3.1). Consumption has grown particularly strongly since 2014. Just two cities – Guangzhou and Hong Kong – account for the bulk of the Chinese market. The overwhelming bulk of Autogas use is in taxis and buses. Hyundai, Sanatan, Kia, Zhonghua, Englon and Nissan market OEM taxis and GAC Group, Zhengzhou Yutong Bus Company, King Long, Ankai and Wuzhoulong Motors market Autogas buses. There are about 30 conversion centres in Guangzhou. Despite the surge in Autogas use, it still accounts for just 0.4% of total automotive-fuel use in China. At end-2016, there were an estimated 165 000 Autogas vehicles and 550 refuelling sites. Autogas accounted for just 2% of total Chinese LPG consumption in 2016, 27% of which was imported.

Figure B3.1: Autogas consumption and vehicle fleet – China



3.2 Government Autogas incentive policies

The Autogas market in China developed largely as a result of local programmes to promote alternative fuels, motivated by the need to tackle the worsening problem of urban air pollution. Autogas schemes, which were initially developed in Hong Kong and Guangzhou City, have now been introduced in more than 25 other cities. In Guangzhou, virtually all of the city's 19 000 taxis and 90% of its 8 000 buses had switched to the fuel by 2010, with most of the remainder running on CNG or LNG, though a recent change in policy is promoting LNG and electric vehicles (Box B3.1). In Hong

Kong, all the city's 20 000 taxis run on Autogas, as a result of a conversion programme launched in 1997, which involved grants over the period 2000-2003. Diesel taxis were banned in 2006 because of their high particulate emissions. More than 30% of public buses in Hong Kong also use Autogas. Several other cities, including Shanghai, have also mandated the conversion of public taxis to alternative fuels.

Box B3.1: Guangzhou takes the lead in pushing Autogas

The city of Guangzhou began to investigate the feasibility of Autogas in the mid-1990s based on experience in other Asia-Pacific countries, with some taxis and buses switching to the fuel after 1997. In July 2003, the Leadership Group of Clean Energy of Guangzhou municipal transportation committee was established with the initial goal of converting 100 buses and 480 taxies. Worsening air pollution led to a decision to convert the bulk of the bus and taxi fleet to the Autogas; by 2010, all but 5% of public vehicles were using the fuel. There are currently 42 refuelling stations installed around the city, the majority of them run by private and foreign companies. Initially, subsidies were made available for converting vehicles to use Autogas (but not for OEM vehicle purchases).

The policy towards Autogas changed in 2012, when a new plan covering the period 2013-2020 was adopted by the Guangzhou Development and Reform Committee, under which new buses can only use LNG. In 2016, the Guangdong authorities announced new regulations requiring 90% of all new buses to use electric battery technology and the other 10% alternative fuels including Autogas. For taxis, the share was 70%, rising to 75% in 2017 and by another five percentage points each year thereafter. The Guangzhou government also obliges 10% of the 120 000 number plates for medium and small vehicles issued every year to run on alternative fuels. Other than pricing and mandates, there are no financial incentives for CNG or biofuels, but subsidies are available for EV purchases. As a result of the change in public policy, Autogas consumption in Guangzhou has fallen from a peak of around 400 000 tonnes at the end of the 2000s to under 300 000 in 2016.

Table B3.1: Automotive-fuel prices and taxes per litre – China

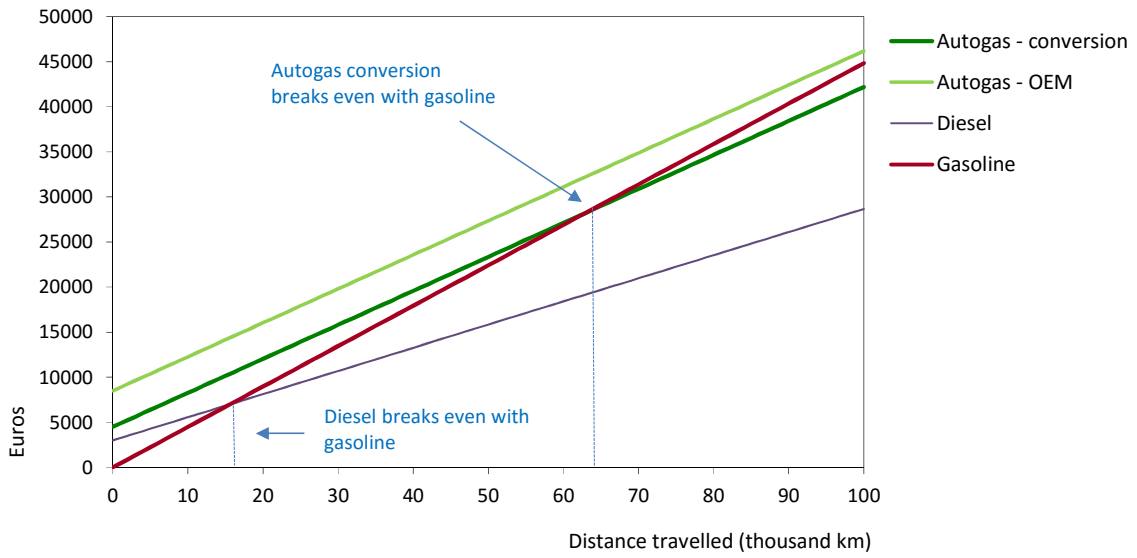
	Yuan						US dollars
	2011	2012	2013	2014	2015	2016	2016
Pump prices							
Autogas	4.546	4.802	4.899	4.693	3.895	3.770	0.567
Diesel	6.100	6.279	6.160	5.950	4.532	4.114	0.619
Gasoline	7.710	7.920	7.781	7.547	6.067	5.605	0.844
Total taxes							
Autogas	0.523	0.552	0.564	0.540	0.448	0.434	0.065
Diesel	1.686	1.712	1.695	1.701	1.859	1.798	0.271
Gasoline	2.120	2.151	2.131	2.142	2.401	2.334	0.351
Excise taxes							
Autogas	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel	0.800	0.800	0.800	0.837	1.200	1.200	0.181
Gasoline	1.000	1.000	1.000	1.045	1.520	1.520	0.229
Pre-tax prices							
Autogas	4.023	4.249	4.336	4.153	3.447	3.336	0.502
Diesel	4.414	4.567	4.465	4.248	2.674	2.316	0.349
Gasoline	5.590	5.769	5.651	5.405	3.665	3.271	0.492

The central government also promotes the use of Autogas through favourable pricing and tax policies. No consumption (excise) tax is levied on Autogas, while the tax on gasoline and diesel was raised substantially at the end of 2014 and early 2015. In addition, a lower VAT rate of 13% is levied on Autogas, compared with 17% on gasoline and diesel. Wholesale and retail prices of all oil products, including transport fuels, are controlled by the National Development and Reform Commission, though there is some flexibility for retailers to adjust prices. Under a new mechanisms introduced in 2013, it adjusts prices periodically according to changes in crude oil prices on the international market and domestic economic conditions. In 2016, the resulting pump price of Autogas was 67% of that of gasoline and 92% of that of diesel (Table B3.1, above).

3.3 Competitiveness of Autogas against other fuels

Based on average 2016 fuel prices, a converted non-commercial Autogas LDV breaks even with gasoline at 64 000 km, based on an conversion cost of around 4 500 yuan (approximately $700). For an OEM vehicle, the break-even distance is close to 120 000 km, assuming it costs 8 500 yuan ($1 300) more than a mono-fuel gasoline vehicle. Autogas is never competitive with diesel, which breaks even with gasoline at just 16 000 km (Figure B3.2). Where diesel is not permitted for high-mileage public vehicles for environmental reasons, Autogas can be the most economic fuel option depending on the price of CNG/LNG. It should be noted that automotive fuel prices and, therefore, the relative competitiveness of Autogas can vary markedly across cities where the fuel is available. Regulations concerning fuel use, notably for public vehicles, also vary.

Figure B3.2: Running costs of a non-commercial LDV, 2016 – China



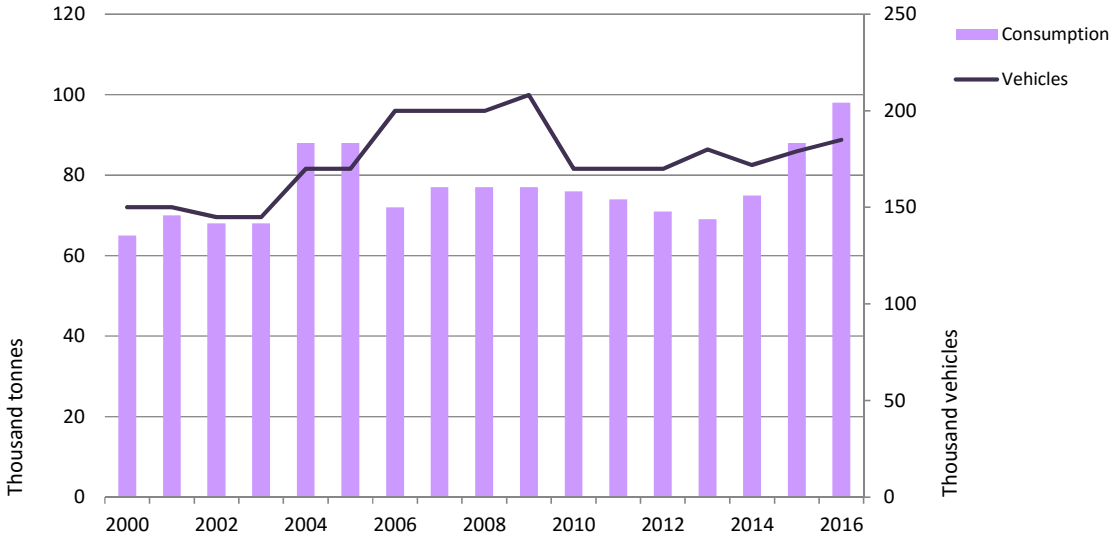
Note: Based on vehicle costs and Autogas prices in Guangzhou.

4 Czech Republic

4.1 Autogas market trends

After several years of stagnation, the Czech Autogas market is showing signs of taking off once again. Consumption reached 98 000 tonnes in 2016, a rise of 11% on the previous year and 42% since 2013; for most of the previous decade, it had hovered at around 70 000 to 80 000 tonnes per year (Figure B4.1). Recent market growth has been driven by an increase in the number of high-mileage Autogas vehicles, mainly taxis and commercial fleet LDVs, seeking to take advantage of a highly favourable taxation policy and relatively low prices at the pump. Autogas now accounts for around 1.7% of the country's road-fuel needs and 40% of total LPG use.

Figure B4.1: Autogas consumption and vehicle fleet – Czech Republic



Most Autogas vehicles are converted gasoline cars, but sales of OEM vehicles are growing with several models on offer from six carmakers: Kia (Venga model), Opel (Adam, Mokka, Meriva and Zafira), Mitsubishi (Outlander), Hyundai (i10 and ix20), Dacia (Logan, Sandero, Lodgy, Duster and Dokker), and Fiat (Panda, Punto, 500L and Tipo). The number of vehicles that can run on Autogas has grown over the last two years to 185 000, but the fleet is still smaller than it was in the late 2000s. The CNG fleet has also been growing, but remains far smaller with around 14 000 vehicles in operation in 2016, including buses and light-duty trucks. There are an estimated 1 250 filling stations that sell Autogas across the country – about one-fifth of the total. Only around 120 stations were selling CNG in mid-2016, though the number has been increasing rapidly.[1]

[1] http://www.timeforgas.com/downloads/pdf/78/cng_78_p8.pdf

4.2 Government Autogas incentive policies

The sole government policy to support Autogas is a very low excise duty of the fuel compared with gasoline and diesel. The tax has been constant at 3.93 crowns per kilogramme (2.16 crowns per litre) since 2004. The tax on gasoline and diesel, which last increased in 2010, amounts to 12.84 crowns and 10.95 crowns respectively (Table B4.1). This resulted in an Autogas price at the pump in 2016 that was just 43% of the gasoline price and 45% of the diesel price. In contrast to electricity chargers and CNG infrastructure, the government provides no financial incentives or support for Autogas distribution infrastructure.[1]

Table B4.1: Automotive-fuel prices and taxes per litre – Czech Republic

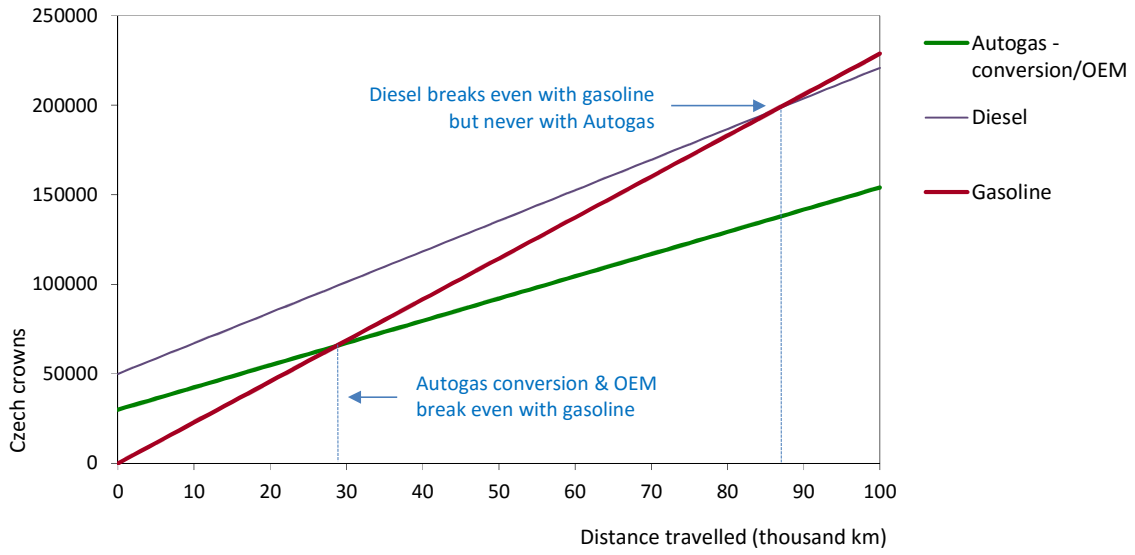
	Crowns						US dollars
	2011	2012	2013	2014	2015	2016	2016
Pump prices							
Autogas	17.15	17.76	17.39	17.52	14.66	12.41	0.508
Diesel	34.27	36.46	36.14	36.28	31.20	27.38	1.120
Gasoline	34.60	36.70	36.18	36.13	31.35	28.60	1.170
Total taxes							
Autogas	5.02	5.12	5.18	5.20	4.70	4.31	0.176
Diesel	16.66	17.03	17.22	17.25	16.36	15.70	0.642
Gasoline	18.61	18.96	19.12	19.11	18.28	17.80	0.728
Excise taxes							
Autogas	2.16	2.16	2.16	2.16	2.16	2.16	0.088
Diesel	10.95	10.95	10.95	10.95	10.95	10.95	0.448
Gasoline	12.84	12.84	12.84	12.84	12.84	12.84	0.525
Pre-tax prices							
Autogas	12.13	12.64	12.21	12.32	9.95	8.09	0.331
Diesel	17.61	19.43	18.92	19.04	14.83	11.68	0.478
Gasoline	16.00	17.74	17.06	17.02	13.07	10.79	0.442

4.3 Competitiveness of Autogas against other fuels

The low price of Autogas makes it by far the cheapest fuel in terms of cost per kilometre among the three leading fuels. Based on an average cost of conversion of 30 000 crowns (around $1 200) and a similar amount for the price premium of an OEM Autogas car over a gasoline-powered model, the break-even distance is just 29 000 km, or a year-and-a-half of driving for the typical private motorist (Figure B4.2). The fuel-cost savings after 100 000 km amount to about 75 000 crowns ($3 000). Diesel breaks even with gasoline at 87 000 km (based on a price premium of 50 000 crowns, or $2 000), but is never competitive with Autogas.

[1] Incentives are also available for the purchase of public buses, communal cars and passenger cars for local government fleets that run on CNG, but not Autogas.

Figure B4.2: Running costs of a non-commercial LDV, 2016 – Czech Republic

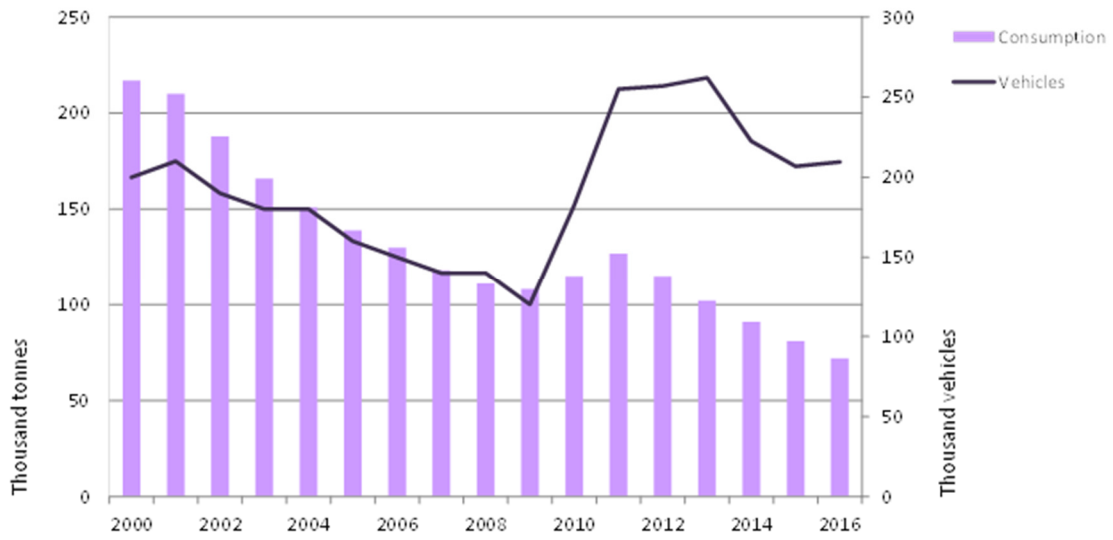


5 France

5.1 Autogas market trends

The Autogas market in France has been in constant decline since 2000, with the exception of a brief recovery in the early part of the current decade, despite persistently attractive fuel prices. The market first took off in the mid-1990s following the introduction of a strong fiscal incentive. Initially, consumption grew rapidly to around 220 000 tonnes in 2000, driven by LDV conversions, but then began to decline, to around 100 000 tonnes at the end of the decade (Figure B5.1). This was largely the result of shifts in policy, as well as a highly publicised accident involving an Autogas vehicle, which undermined public confidence in their safety. Fuel sales recovered a little in 2010-2011, apparently due to a temporary surge in OEM vehicle sales in 2010 in response to an increase in the price advantage of Autogas over gasoline at the pump and the announcement by the government that the tax credit for Autogas vehicles would be scrapped at the end of the year (see below). But fuel use resumed its downward trend in 2012, reaching just 72 000 tonnes in 2016. Autogas now accounts for only around 0.2% of total automotive-fuel use.

Figure B5.1: Autogas consumption and vehicle fleet – France



Note: The fuel consumption data shown here are from Argus/WLPGA with the exception of the period 2010-2013, which are from the International Energy Agency; Argus/WLPGA data for that period alone are much higher, apparently because they include off-road use in fork-lift trucks.The jump in vehicle numbers in 2010 and 2011 was due to a surge in sale of OEM Autogas vehicles to households, with lower average mileage than commercial fleet vehicles and taxis.

The number of Autogas vehicles declined progressively through the 2000s, but jumped to over 260 000 by 2013 (0.7% of the total car and truck fleet) as a result of a surge in new conversions and record OEM vehicle sales of over

75 500 in 2010. However, both conversions and OEM sales have since almost dried up: sales totalled just 325 and conversions 551 in 2016. A few carmakers, including Citroën, Dacia, Fiat, Opel and Piaggio, still market OEM Autogas vehicles in France. In an effort to stimulate sales, Fiat recently cut the price of the Autogas version of its Tipo model to the same as that of the gasoline version.[1] Dacia just made available Euro 6 LPG versions for its entire vehicle portfolio (six models). The total number of Autogas vehicles on the road in France dwindled to 185 000 at end-2016, or about 0.5% of the total car fleet. There were still 1 670 refuelling stations across the country – barely fewer than in the early 2000s – with every metropolitan region well-served.

5.2 Government Autogas incentive policies

Government incentives for Autogas date back to 1996, when a policy was adopted of encouraging the use of Autogas (and CNG) through a sharp reduction in the excise duty on the fuel and the introduction of a range of other fiscal and regulatory measures. The duty was held constant between 1999 and 2014 at 6 euro cents/litre, but was then raised to 7.2 cents in 2015 and 7.8 cents in 2016 (Table B5.1). The duties on gasoline and diesel, already much higher, increased steadily over the same period. The duty on diesel, in particular, has increased significantly since 2012. [2] The average excise-duty differential with Autogas in 2016 stood at 43.3 cents/litre for diesel – the leading road-transport fuel in France – and 57 cents/litre for gasoline. In addition, the government introduced a small carbon tax in 2015, further increasing the price differential between Autogas and the other two fuels.[3] As a result of the lower excise and carbon taxes on Autogas, its price at the pump was well over a third lower than that of diesel and 46% lower than that of gasoline in 2016.

There are a number of other public policy measures in place to encourage the use of Autogas. Until the end of 2010, the principal measure was a tax credit of €2 000 for the purchase of an OEM Autogas vehicle with CO_2 emissions of less than 136 grammes per kilometre or the conversion of gasoline-fuelled vehicles with emissions of less than 155 g/km. This incentive, which had been in place for several years, was abolished for budgetary reasons in 2011. In its place, the government introduced a system of ecological bonuses and penalties based on vehicle emissions; any new vehicle with low emissions, including one fuelled by Autogas, qualified for a bonus (a cash grant) at the time of purchase. The threshold has been lowered progressively in recent years and now only applies to electric cars or hybrids (including LPG hybrids but excluding diesel hybrids) that emit less than 110 g/km. The bonus for hybrids emitting 61g-110 g/km is €750; the grant rises to €1,000 for emissions of between 21 and 60 g/km, and to €6,300 for emissions of less than 21 g/km (up to a maximum of 27% of the vehicle price). At present, there are no OEM Autogas vehicle on the market that qualify for the bonus, but Autogas cars

[1] http://auto-gas.net/newsroom/fiat-offers-lpg-powered-car-price-gasoline-one/
[2] The government has announced its intention to progressively eliminate the excise-tax differential between diesel and gasoline.
[3] The tax is due to rise in a progressive manner over 2015-2030. In 2017, the tax amounted to 4.7 cents/litre (excluding VAT) for Autogas, 7 cents for gasoline and 8.1 cents for diesel.

benefit from lower penalties that apply to cars with above-average emissions. The bonus for EVs currently amounts to 27% of the total purchase price (up to a maximum of €6 000, or €10 000 if it replaces a scrapped old vehicle), but is still insufficient in most cases to offset the higher initial price of the models currently on the market relative to conventional and Autogas vehicles.

Table B5.1: Automotive-fuel prices and taxes per litre – France

	Euros						US dollars
	2011	2012	2013	2014	2015	2016	2016
Pump prices							
Autogas	0.853	0.882	0.873	0.857	0.787	0.709	0.784
Diesel	1.336	1.396	1.350	1.288	1.151	1.104	1.221
Gasoline	1.500	1.567	1.538	1.486	1.353	1.303	1.442
Total taxes							
Autogas	0.200	0.204	0.203	0.203	0.204	0.196	0.217
Diesel	0.656	0.659	0.660	0.656	0.674	0.695	0.768
Gasoline	0.857	0.861	0.865	0.861	0.857	0.865	0.957
Excise taxes							
Autogas	0.060	0.060	0.060	0.060	0.072	0.078	0.086
Diesel	0.437	0.430	0.439	0.441	0.482	0.511	0.565
Gasoline	0.611	0.604	0.613	0.613	0.631	0.648	0.717
Pre-tax prices							
Autogas	0.654	0.678	0.670	0.654	0.583	0.513	0.568
Diesel	0.680	0.737	0.690	0.633	0.477	0.409	0.452
Gasoline	0.643	0.706	0.673	0.626	0.496	0.438	0.484

Note: Excise taxes exclude a carbon tax introduced in 2015 (reflected in pre-tax prices). Corsica and Poitou-Charentes apply a slightly lower excise tax on diesel, not reflected in the data shown in the table.

The other main tax measure is a partial or complete exemption of the initial vehicle-registration tax for commercial and non-commercial Autogas vehicles in 10 out of the 11 metropolitan regions (the rebate is also applied to CNG, battery EVs and cars that can run on E85 ethanol). Businesses can also recover all of the VAT on Autogas fuel purchases for LDVs, compared with 80% of the tax for diesel and 10% for gasoline.[1] In addition, the 2017 finance law introduced a two-year exemption from the business tax on Autogas cars that emit less than 110 grammes of CO_2/km.

In 2016, the French government revised its system of vehicle classification according to their pollutant emissions. Autogas vehicles are now including in the second least polluting category (the first one, or category 0, covering only EVs and hydrogen-powered cars) regardless of their registration date. This classification is intended to be used by local authorities in implementing measures affecting parking and driving in certain areas during periods of severe air pollution periods to encourage the use of less polluting fuels. Paris

[1] For vans and trucks, 100% of the VAT on diesel and gasoline can be recovered. Up to 2017, none of the VAT could be recovered on gasoline used by commercial LDVs; the rate is set to rise in stages to 80% in 2022 (the same rate as for diesel).

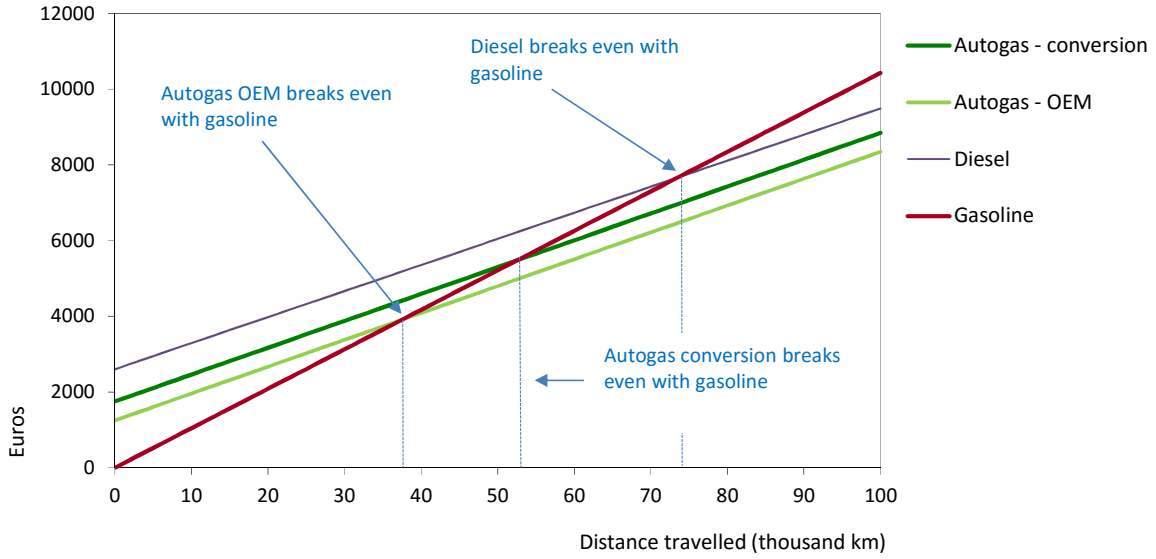
and Grenoble are the first cities to introduce a requirement to purchase a "Crit'Air" sticker based on the new classification system.

Autogas is also promoted through other local regulatory measures. Autogas vehicles can benefit from free or reduced car-parking fees in some cities. At present, several cities offer free parking for two hours for Autogas and other clean vehicles and other cities are considering doing likewise.[1] The Environment Agency and the National Association of Green Vehicles signed a partnership agreement in March 2016 to develop this type of incentive.

5.3 Competitiveness of Autogas against other fuels

Until 2010, the large tax credit on Autogas conversions for private individuals, which typically covered the entire cost, ensured that Autogas broke even with gasoline at very low distances and was always competitive with diesel. The removal of that subsidy reduced the competitiveness of Autogas, but it still remains the cheapest fuel option in most cases. An OEM Autogas vehicle, based on a typical cost premium of €1 500 compared with a gasoline-powered car, now breaks even with gasoline at just 38 000 km and a converted vehicle at 53 000 km (Figure B5.2).

Figure B5.2: Running costs of a non-commercial LDV, 2016 – France



Note: Assumes an average car-registration tax rebate of 250 euros.

Both an OEM Autogas vehicle and a converted Autogas vehicle, based on a typical conversion cost of €1 500, are always competitive against diesel, regardless of distance. The running costs per kilometre of Autogas and diesel are very similar so it is the difference in the price of each type of vehicle that determines which is the cheapest option in the long run. At present, most new diesel cars cost more than either an OEM Autogas car or a new gasoline car immediately converted to run on Autogas. The prospect of tighter

[1] http://www.voiture-electrique-populaire.fr/actualites/tarif-preferentiel-stationnement-peage-212

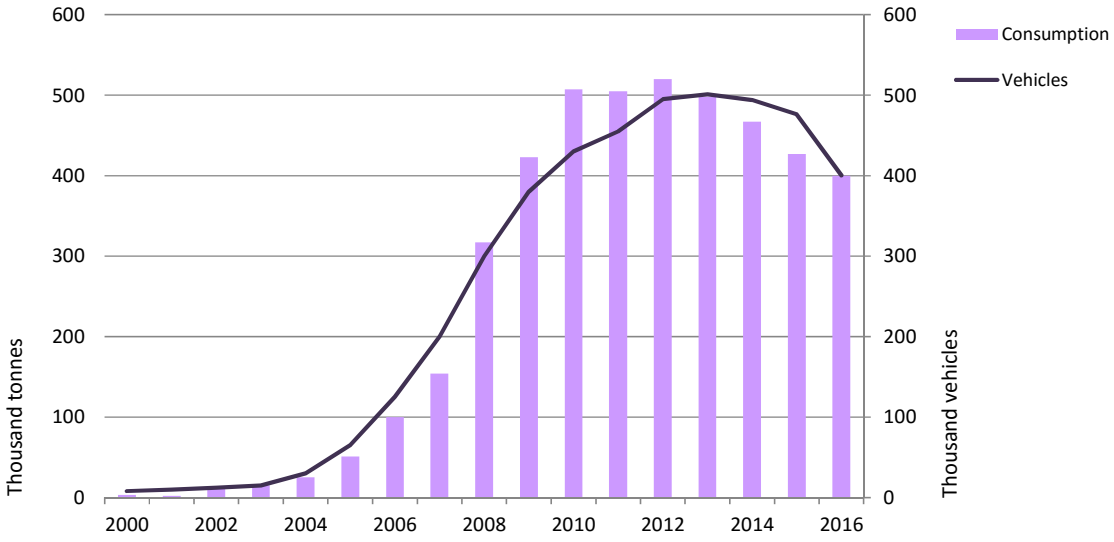
environmental restrictions on diesel vehicles and higher fuel taxes should add to the attractiveness of Autogas. CNG remains generally uncompetitive, because the relatively low fuel price is insufficient to compensate for the high cost of conversion, the inconvenience it engenders and the poor availability of the fuel. EVs also remain unattractive in most cases for now, despite vehicle-purchase subsidies.

6 Germany

6.1 Autogas market trends

The Autogas market in Germany took off in the early 2000s and grew rapidly through to 2010 as a result of highly favourable fuel taxation. After falling back slightly in 2011, demand reached a peak of 520 000 tonnes in 2012, but then fell steadily to around 400 000 tonnes in 2016 (Figure B6.1). One reason is an improvement in fuel economy, which has slowed the growth of consumption of road fuels generally. The share of Autogas in total automotive-fuel use has fallen only marginally, from a peak of 1.1% in the early 2010s to about 0.8% today.

Figure B6.1: Autogas consumption and vehicle fleet – Germany



There are an estimated 400 000 Autogas-powered vehicles on the road in Germany, most of them converted gasoline cars, accounting for about 1% of all vehicles. The fleet of Autogas vehicles is far bigger than that of any other alternative fuel technology, including hybrids (of which there were 130 365 in use at the start of 2016), CNG/LNG (80 300), and EVs (25 502).[1] The number of Autogas vehicles continued to grow up to 2013, but uncertainty about the government's Autogas policy has discouraged switching to Autogas to some degree and depressed sales of new OEMs. Just 2 990 Autogas cars were registered in 2016, down 37% on 2015 and less than half the level of 2014.[2] Kia, Lada, Opel and Hyundai are the carmakers offering Autogas models. Sales of EVs (including plug-in hybrids), in contrast, jumped 43% in 2016 and

[1] http://auto-gas.net/newsroom/autogas-the-most-popular-alternative-fuel-in-2015-in-germany/. Consumption of CNG/LNG in Germany is about one-third the level of Autogas.
[2] Argus LPG World, 14 February 2017.

24% in 2015, though the actual number of vehicles in use is still small at less than 70 000 at end-2016. Autogas is widely available throughout the country, with a record 7 034 filling stations selling the fuel in 2016 – almost one in every two stations.

6.2 Government Autogas incentive policies

The federal German government supports the use of Autogas largely through fuel-tax incentives. Since the completion in 2003 of a major reform of energy taxation aimed at introducing ecological taxes, the rates of excise tax on Autogas, gasoline and diesel have been constant. The rate of tax on Autogas is 9.2 euro cents per litre – well below the rate of 47 cents levied on diesel and 65.5 cents on gasoline (Table B6.1). In absolute terms, the price differentials per litre between Autogas and gasoline, as well as between Autogas and diesel, are among the biggest of the countries surveyed for this report. As a result, the price of Autogas at the pump is relatively very low, at only 39% that of gasoline and 46% that of diesel. The price advantage in favour of Autogas has increased in recent years, as pre-tax prices of Autogas have generally risen less than those of the other fuels.

Table B6.1: Automotive-fuel prices and taxes per litre – Germany

	Euros						US dollars
	2011	2012	2013	2014	2015	2016	2016
Pump prices							
Autogas	0.736	0.780	0.738	0.692	0.571	0.503	0.556
Diesel	1.425	1.490	1.429	1.363	1.189	1.099	1.216
Gasoline	1.560	1.651	1.598	1.536	1.401	1.303	1.441
Total taxes							
Autogas	0.210	0.217	0.210	0.203	0.183	0.172	0.191
Diesel	0.698	0.708	0.699	0.688	0.660	0.646	0.714
Gasoline	0.904	0.918	0.910	0.900	0.878	0.862	0.954
Excise taxes							
Autogas	0.092	0.092	0.092	0.092	0.092	0.092	0.102
Diesel	0.470	0.470	0.470	0.470	0.470	0.470	0.520
Gasoline	0.655	0.655	0.655	0.655	0.655	0.655	0.724
Pre-tax prices							
Autogas	0.527	0.563	0.528	0.490	0.388	0.330	0.365
Diesel	0.727	0.782	0.731	0.675	0.528	0.454	0.502
Gasoline	0.656	0.733	0.688	0.636	0.523	0.440	0.487

The prospects for the German Autogas market took a positive turn in June 2017, when the Finance Committee of the German Bundestag (parliament) agreed on an extension of the commitment, originally adopted in 2006, to keep the excise-tax rate on Autogas well below that on the other fuels until the end of 2022, in order to provide certainty to investors in Autogas distribution and refuelling infrastructure and motorists looking to switch to Autogas. Nonetheless, the tax will increase each year by 20% starting in

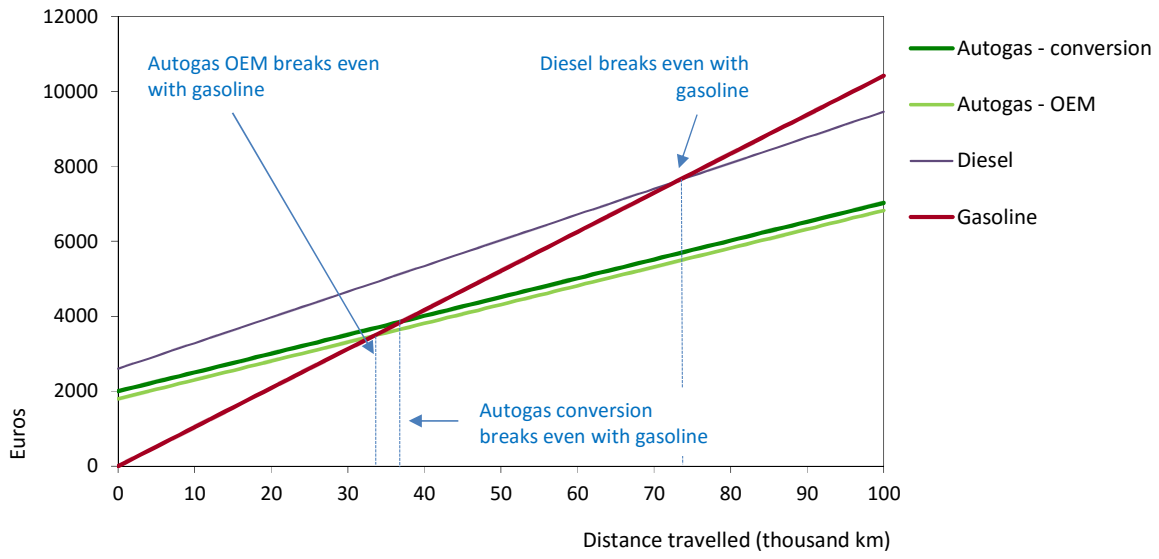
2019, reaching €409/tonne in 2023 (20.9 cents/litre), though this rate is still well below that levied on diesel and gasoline.

There are no vehicle-related incentives for Autogas in Germany, as the government considers that the fuel-tax advantage is sufficient. In 1993, the federal government issued a non-binding ordinance lifting all restrictions on parking by gas-fuelled vehicles in underground garages and multi-storey car parks. Only the states (Länder) of Bremen and the Saarland require some minor technical requirements to be fulfilled. EVs are now the focus of the German Government's efforts to decarbonise the transport sector, with subsidies of €3 000 for plug-in hybrids and €4 000 for battery EVs currently on offer for new car purchases. Nonetheless, a recent ordinance, which adopts into national law EU guidelines on vehicle emissions, formally recognises the lower emissions from Autogas vehicles and bio-LPG as a renewable source of energy.[1] Measures to limit the sale and use of diesel cars are under discussion.

6.3 Competitiveness of Autogas against other fuels

The very low rate of excise tax on Autogas relative to the taxes on gasoline and diesel means that an Autogas OEM LDV (which is assumed to cost about €1 800 more than a gasoline-fuelled equivalent and €800 less than a diesel vehicle) is always cheaper to run than an equivalent diesel vehicle and breaks even with a gasoline vehicle at about 34 000 km (Figure B6.2). For an Autogas conversion, which is estimated to cost around €2 000 on average, the breakeven distance is slightly higher, at 38 000 km. Thus, a typical motorist can pay back the upfront additional cost of an Autogas vehicle within about two years.

Figure B6.2: Running costs of a non-commercial LDV, 2016 – Germany



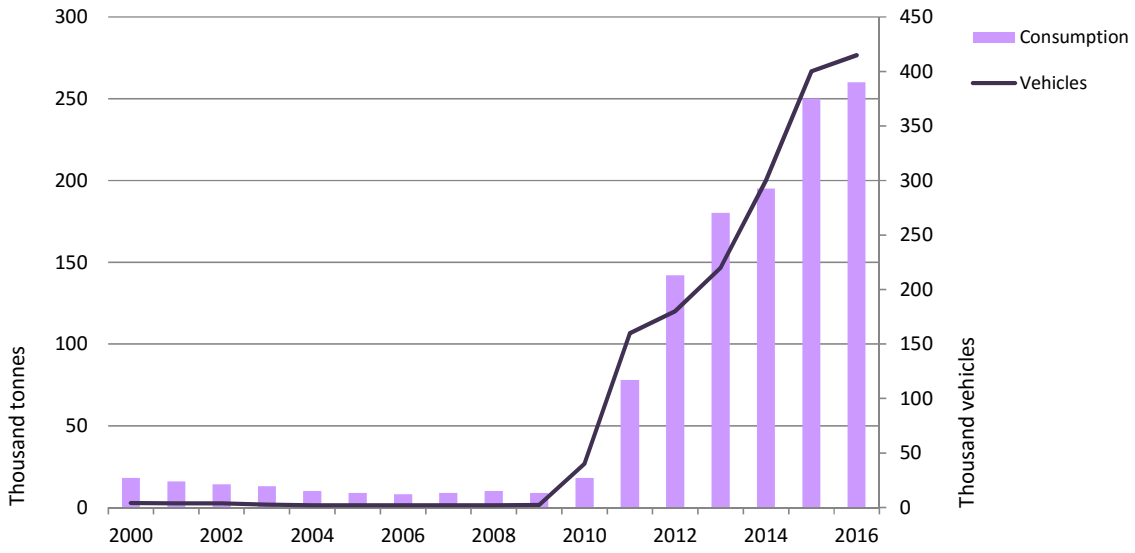
[1] http://auto-gas.net/newsroom/german-regulation-underlines-sustainable-contribution-autogas/.

7 Greece

7.1 Autogas market trends

The Greek Autogas market has seen spectacular growth since 2010, though there are signs that demand may now be starting to decelerate. Consumption reached 260 000 tonnes in 2016, up from 250 000 in 2015 and just 9 000 tonnes in 2009 (Figure B7.1).[1] Autogas was introduced in Greece in the 1980s, but its use was initially limited to taxis – most of which used the fuel. In the mid-1990s, the authorities opted to replace the existing Autogas taxi fleet with diesel cars, causing Autogas use to decline. The government made it legal for all vehicles to use the fuel in 1999, but there was little interest in the fuel for the first decade as there were few refuelling stations and the financial incentive to switch to Autogas was minimal. This changed with a sharp rise in excise duties on gasoline and diesel in 2010 – bigger than that imposed on Autogas – as the government sought to raise additional tax revenue in the wake of the financial and economic crisis, making Autogas the cheapest fuel option for Greek motorists. Autogas now accounts for about 5% of total road-fuel use in Greece and half of total LPG consumption.

Figure B7.1: Autogas consumption and vehicle fleet – Greece



The recent growth in the number of vehicles able to run on Autogas has been phenomenal. In 2016, their number reached an estimated 415 000, compared with just 2 000 in 2009. Autogas vehicles now make up about 6% of the total vehicle fleet. Most of these vehicles are aftermarket conversions. A number of companies sell conversion kits, notably Icom, BRC, Landi Renzo and

[1] Some industry sources suggest that actual consumption may as much as 30 000 tonnes higher than reported volumes due to reporting issues

Zavoli. A few OEM Autogas vehicle models (with bi-fuel capability) are available on the Greek market: Opel Zafira & Meriva, Fiat Punto & Panda, Chevrolet Spark and Ssang Yong Tivoli and XLV (a new after-sale conversion covered by the vehicle warranty).

The Autogas distribution network has expanded rapidly in recent years to accommodate the boom in demand, with the number of refuelling stations reaching 860 in 2016. The majority of Autogas sales are made by two companies, Hellenic Petroleum and Motor Oil, and the rest by around 30 small retailers.

7.2 Government Autogas incentive policies

The excise tax on Autogas remains considerably lower than that on gasoline and diesel, despite an increase in 2012 from 125 to 330/tonne (6.8 to 17.8 cents/litre) (Table B7.1). The tax on diesel was reduced slightly in 2012 and 2013, while that on gasoline was unchanged between 2011 and 2016. The wholesale price of Autogas is also significantly lower than that of the other two fuels. As a result, the pump price of Autogas stood at just 46% that of gasoline and 60% that of diesel in 2016. The tax on all three fuels increased on 1 January 2017, but the increase for Autogas to 430euros/tonne (23 cents/litre) was the largest in absolute terms, which has narrowed the difference in prices at the pump slightly. In mid-June 2017, the price difference stood at roughly 63% vis-à-vis diesel and 52% compared with gasoline.

Table B7.1: Automotive-fuel prices and taxes per litre – Greece

	Euros						US dollars
	2011	2012	2013	2014	2015	2016	2016
Pump prices							
Autogas	n.a.	n.a.	n.a.	0.781	0.701	0.640	0.708
Diesel	1.457	1.510	1.376	1.327	1.159	1.062	1.175
Gasoline	1.652	1.731	1.676	1.631	1.461	1.383	1.530
Total taxes							
Autogas	n.a.	n.a.	n.a.	0.324	0.309	0.299	0.331
Diesel	0.684	0.674	0.587	0.578	0.547	0.532	0.588
Gasoline	0.979	0.994	0.983	0.975	0.943	0.932	1.031
Excise taxes							
Autogas	0.068	0.178	0.178	0.178	0.178	0.178	0.197
Diesel	0.412	0.392	0.330	0.330	0.330	0.330	0.365
Gasoline	0.670	0.670	0.670	0.670	0.670	0.670	0.741
Pre-tax prices							
Autogas	n.a.	n.a.	n.a.	0.457	0.392	0.341	0.377
Diesel	0.773	0.836	0.789	0.749	0.612	0.531	0.587
Gasoline	0.673	0.737	0.693	0.656	0.518	0.450	0.498

Government policies in recent years have tended to favour diesel – the main competitor to Autogas in Greece. In addition to the cut in the excise tax earlier in the decade, a new law in 2011 lifted the ban on diesel vehicles in

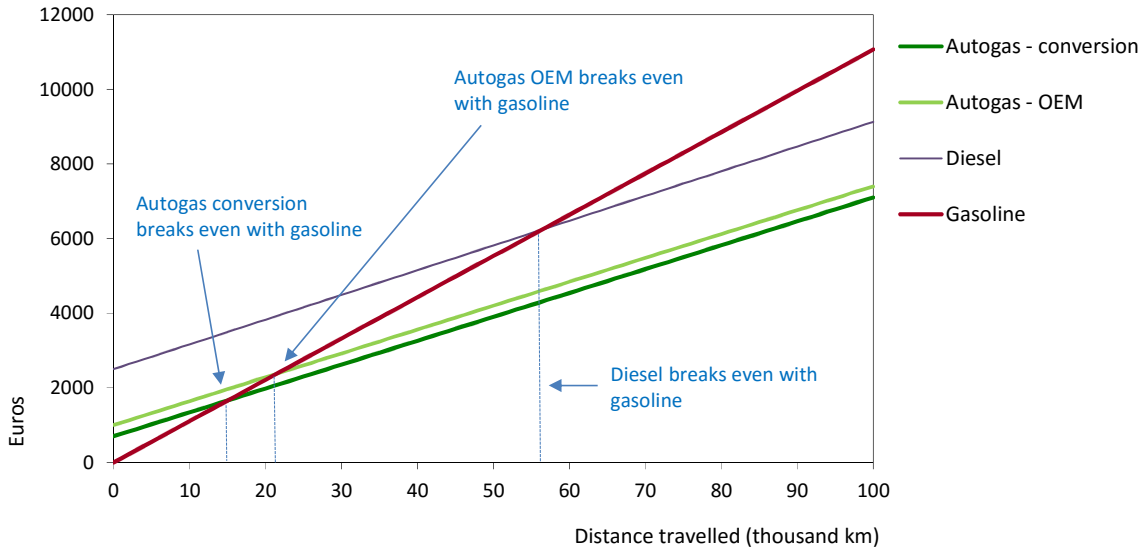
Athens and Thessaloniki on condition they meet Euro 5 or 6 standards. The result of these measures has been to boost sales of diesel cars and limit the potential for more conversions to Autogas. The recent rise in the tax on diesel may signal a change in policy.

Other than taxation, there are no other government incentives to encourage Autogas. However, the authorities recently modified the regulations relating to refuelling stations, reducing the minimum distance between Autogas pumps and LPG tanks to two metres. This should make it easier for refuelling stations to install Autogas dispending facilities where they do not already exist.

7.3 Competitiveness of Autogas against other fuels

The cost of converting a gasoline-powered car to Autogas ranges from just €550 to €1,300 for standard kits, averaging around €700 (kits for direct-injection systems are more expensive). As a result, in 2016, Autogas broke even against gasoline at just 15 000 km – less than a year for an average private motorist (Figure B7.2). For a bi-fuelled OEM Autogas car, which typically costs €1 000 more than a gasoline model, the breakeven distance was only slightly higher, at around 22 000 km. Autogas was always competitive against diesel, as the price premium for a diesel car over a gasoline car was considerably higher (€2 500 on average). With the tax changes that took effect at the start of 2017, Autogas is still the most competitive option, though the breakeven distances have increased.

Figure B7.2: Running costs of a non-commercial LDV, 2016 – Greece



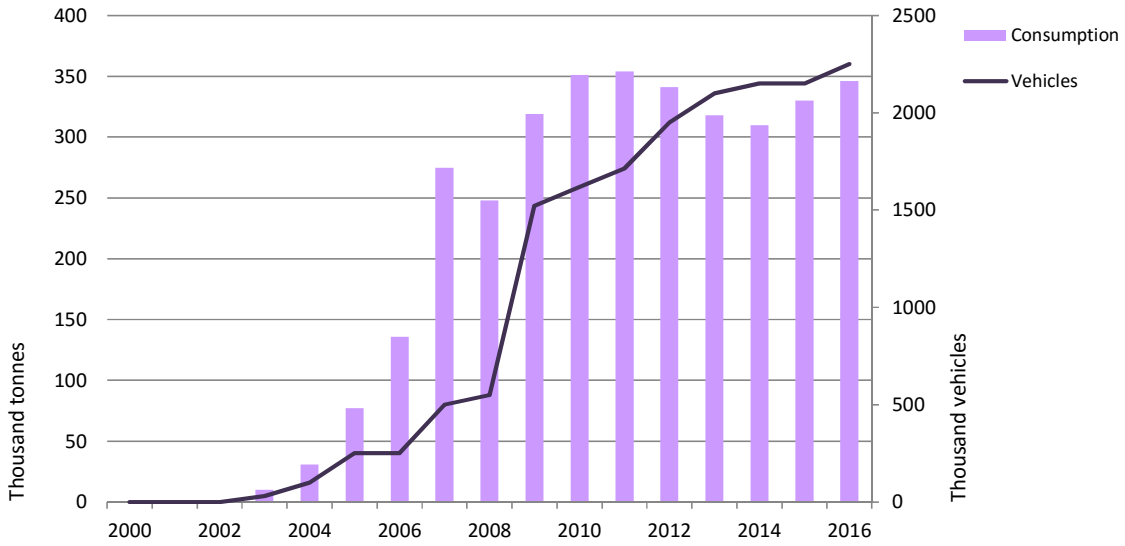
No other alternative fuel is competitive with gasoline or diesel: a CNG vehicle is much more expensive to convert (more than €2 000) and the fuel is not widely available, while an EV is still more than twice as expensive as a gasoline car.

8 India

8.1 Autogas market trends

The Indian Autogas market is once again expanding after a three-year contraction that began in 2012. The market took off in the early 2000s following the legalisation of the fuel in 2000 and grew rapidly to just over 350 000 tonnes in 2011 in response to favourable government pricing policies; by 2014, demand had dropped to 310 000, but has been rising since, reaching 346 000 tonnes in 2016 (Figure B8.1). Still, Autogas use is tiny in comparison with the rest of the automotive-fuel market, accounting for a mere 0.4% of total fuel sales. CNG consumption, which has been heavily promoted in some cities, is around eight times higher.

Figure B8.1: Autogas consumption and vehicle fleet – India



Note: Fuel consumption is official sales only. Vehicles include three-wheelers.

There are now an estimated 2.25 million vehicles capable of running on Autogas in India, the majority of which are three-wheelers (which is one reason why average consumption per vehicle is only around 300 litres per year). Roughly 9% of all the vehicles on the road in India (excluding two-wheelers) run on Autogas. Most of those vehicles are converted, though most of the main vehicle manufacturers now offer factory-fitted Autogas models. There are around a dozen OEM Autogas models currently on sale in India, including those made by Bajaj Auto, Maruti Suzuki, Tata Motors, General Motors and Hyundai. Interest among carmakers in marketing more models is growing with the recent fall in Autogas prices relative to gasoline and diesel (see below). In many cities, a large share of three-wheeler rickshaws – an important means of public transport in India – has been converted to run on Autogas.

There are 1 250 filling stations selling Autogas across the country, spread over more than 500 cities (mainly in Andhra Pradesh, Gujarat, Karnataka, Kerala, Maharashtra and Tamil Nadu).[1] Three state-owned companies – Indian Oil, Bharat Petroleum and Hindustan Petroleum – own close to 700 (about 55%) of these stations, with the rest owned by a number of private companies, notably Reliance, Total, SHV, Aegis Logistics and IPPL.

8.2 Government Autogas incentive policies

The main public policy incentive for Autogas in India is a very low excise tax and generally lower rates of state sales tax, which vary by state and fuel, compared with diesel and gasoline. The Indian government has deregulated retail prices of Autogas, gasoline and diesel: oil marketing companies are now free to revise their Autogas prices every month in line with international prices, though they have to seek permission from the Ministry of Oil if they want to revise their gasoline prices. Excise duties on gasoline and diesel vary according to the type of fuel: high rates are charged on premium, or "branded", gasoline and diesel – a practice that has all but wiped out sales of these fuels, even though they provide better engine performances and longevity. Other sales taxes are also applied at the national and state levels, including VAT, the rate of which varies according to the fuel and state; it currently averages around 14.5% for Autogas, 18% for diesel and 27% for gasoline.

Table B8.1: Automotive-fuel prices and taxes per litre – India

	Rupees						US dollars
	2011	2012	2013	2014	2015	2016	2016
Pump prices							
Autogas	40.01	46.27	47.74	59.63	39.91	37.24	0.554
Diesel	43.54	46.36	53.90	59.50	50.82	53.23	0.792
Gasoline	67.24	73.22	73.18	74.29	65.67	64.84	0.965
Total taxes							
Autogas	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Diesel	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Gasoline	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Excise taxes							
Autogas	0.00	0.00	0.00	0.00	0.00	3.23	0.048
Diesel	n.a.	n.a.	n.a.	n.a.	n.a.	11.83	0.176
Gasoline	n.a.	n.a.	n.a.	n.a.	n.a.	19.36	0.288
Pre-tax prices							
Autogas	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Diesel	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Gasoline	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Note: Price and taxes are averages across Delhi, Kolkata, Mumbai and Chennai (state tax rates vary). Excise duties, which include basic and special duties, for 2016 correspond to June.

[1] http://www.iac.org.in/alds-stations.

In 2016, total taxes on unbranded Autogas were estimated to average 12-15% of the final price, a somewhat lower rate than for gasoline and diesel, ensuring that Autogas was the cheapest of the three fuels at the pump. Autogas prices averaged 37 rupees per litre – equal to around 70% of the unbranded gasoline price and 57% of the diesel price (Table B8.1, above). The price ratios fell significantly in October 2016 as the leading Autogas marketers sought to boost sales.

The price of CNG – the other main alternative fuel in India – has generally increased more rapidly than that of Autogas in recent years, undermining its potential as a competitor to Autogas. CNG is not widely available across India. In some cities, including Delhi, rickshaws and commercial vehicles are forced to use the fuel for environmental reasons, just like Autogas.

The taxation of all transport fuels changed substantially with the introduction of a goods and services tax (GST) on 1 July 2017, a move that is likely to favour Autogas. GST is an indirect tax applied across India to replace a host of excise and sales taxes levied by the central and state governments. It represents the biggest tax reform in India since the country's independence. The government has announced that LPG will be taxed at a single rate across all sectors and has indicated that it will apply a low rate to LPG so as not to increase the cost of the fuel to households for cooking. At present, taxes on domestic LPG are negligible. This move is expected to make Autogas almost 60% cheaper than gasoline and possibly cheaper than CNG in most parts of the country, which should provide a huge boost to Autogas demand in India. It will also discourage the diversion of domestic bottled LPG to use as Autogas – a highly dangerous and illegal practice.[1]

There are no credits or tax incentives available from the federal government, though several Indian cities, including Ahmedabad, Bangalore, Chennai, Hyderabad and Kolkata, make use of fiscal measures to encourage Autogas and other AFVs to address air pollution. Some states, such as Kartanaka and West Bengal, on occasion offer grants for converting cars or three-wheeler rickshaws to Autogas. Several Indian cities, including Ahmedabad, Bangalore, Chennai, Hyderabad and Kolkata, have introduced measures to encourage or mandate the use of Autogas and other alternative fuels for certain types of vehicle for reasons of local air quality.

Bangalore has been at the forefront of efforts to promote alternative fuels. It initially focused on three-wheelers, which are now obliged to run on Autogas. To facilitate switching, the city government offered a subsidy of around 2 000 rupees (around $35) to three-wheeler owners to help cover the cost of conversion. Nearly 75 000 auto rickshaws have already converted to Autogas and about 40 filling stations have been established. Kolkata and Chandigarh have also launched initiative to replace polluting vehicles with Autogas and other AFVs. All public vehicles more than 15 years old had to be scrapped by end-July 2010.[2] Many of the 32 000 auto-rickshaws in Kolkata and its suburbs

[1] Actual Autogas consumption, including the illegal use of domestic cylinders, is thought to be much higher than official figures show.
[2] http://www.iac.org.in/auto-lpg-in-india:.

have so far been converted to Autogas. The Union Territory of Chandigarh also allows only Autogas-fuelled three-wheelers to operate on its roads. Chennai and Pune have also encouraged the introduction of Autogas; over 10 000 auto-rickshaws now run on Autogas in Pune. In Delhi and National Capital Region (NCR) region, nearly 10 000 gasoline and diesel cars more than 15 years old were banned from April 2016, unless they converted to Autogas or another clean fuel.[1]

The central government is increasing its support for EVs, with the budget for the financial year 2017/18 increasing by 42% to 1.75 billion rupees ($26 million).[2] The current plan, adopted in 2014, aims to subsidise up to 150 000 cars and 30 000 two-wheelers, with an overall goal of 7 million EVs on the road by 2020. Most subsidies go to hybrids. Some state governments and cities also provide their own subsidies. For example, Delhi, Rajasthan, Uttarakhand, Lakshadweep, Chandigarh, Madhya Pradesh, Kerala, Gujarat and West Bengal offer a partial or total rebate on VAT. Delhi also provides a 15% subsidy of the list price of certain EVs and exempts such cars from road tax and registration fees.

8.3 Competitiveness of Autogas against other fuels

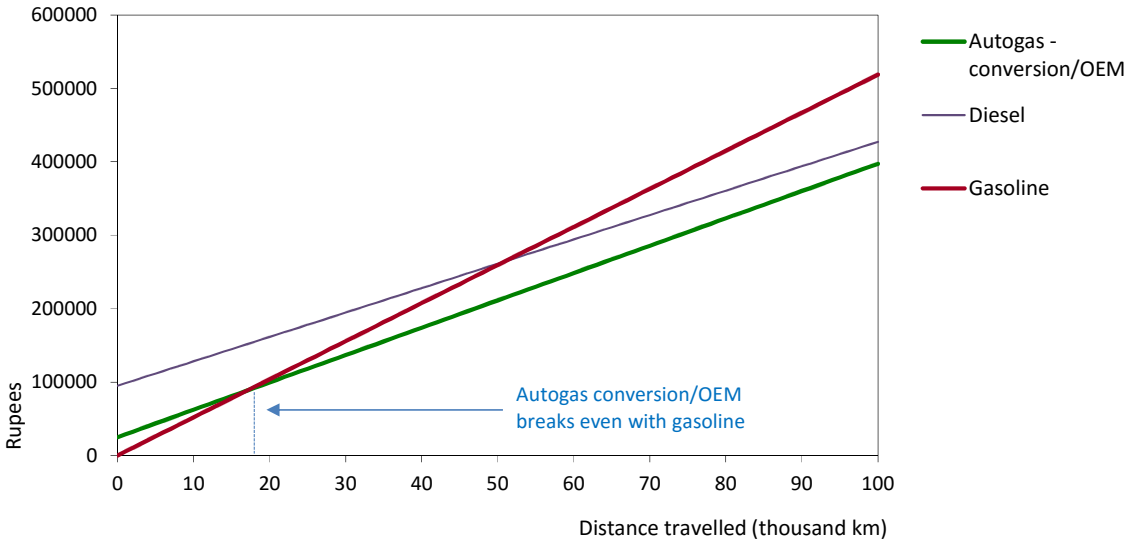
Low taxes and, therefore, low pump prices, mean that converting a gasoline-powered vehicle to run on Autogas – or buying an OEM model – both pay back the upfront additional cost on average after just 18 000 km (Figure B8.2). The conversion costs is estimated at 25 000 rupees (about €400) – the same as the cost premium for an OEM car. These costs are very low by international standards because of low labour costs and the type of conversion kits that are installed.

Diesel cars are a lot more expensive – on average, around 95 000 rupees more than a standard gasoline model – such that, although fuel costs per km are marginally lower for diesel than for Autogas, the breakeven distance is more than 150 000. With the widening of price differentials in favour of Autogas in the second half of 2017, Autogas will become even more attractive. Although CNG prices, adjusted for mileage, are believed to be comparable to Autogas in most cities where the fuel is available, the upfront cost of converting or buying a vehicle is considerably higher than for Autogas.

[1] http://auto-gas.net/newsroom/nearly-10000-cars-encouraged-to-switch-to-clean-fuels-in-northern-india/.

[2] http://economictimes.indiatimes.com/industry/auto/news/passenger-vehicle/cars/budget-2017-govt-extends-subsidy-for-electric-vehicles-to-fy-18-with-42-higher-allocation/articleshow/56940069.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst.

Figure B8.2: Running costs of a non-commercial LDV, 2016 – India

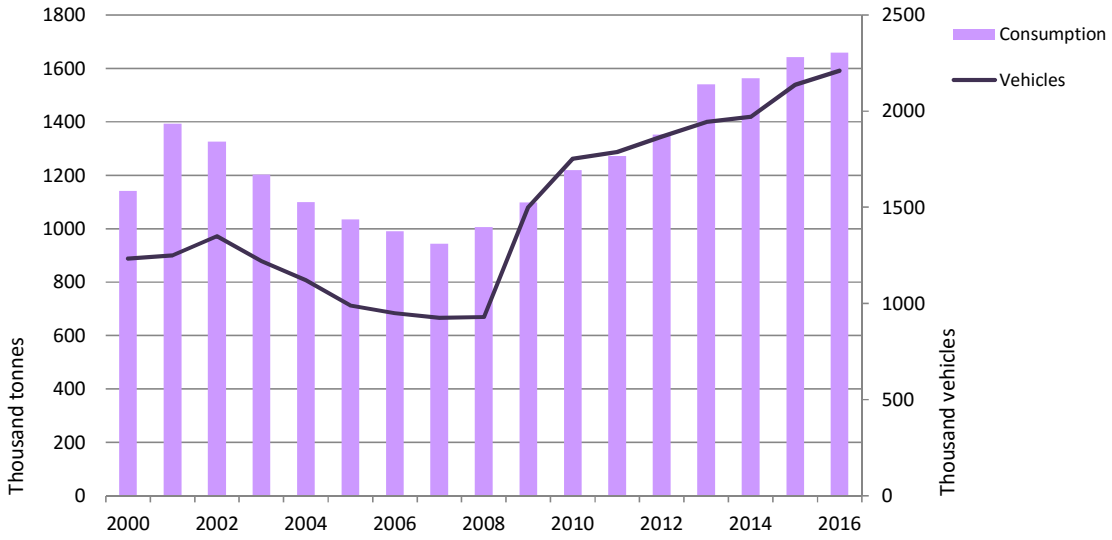


9 Italy

9.1 Autogas market trends

Italy has the second-largest Autogas market in the European Union after Poland and the fifth-largest in the world. It was one of the first countries to introduce the fuel, in the 1950s. Consumption originally peaked at 1.4 million tonnes in 2001, declining steadily to below 1 Mt in 2007; it has since rebounded, hitting a new all-time high of 1.66 Mt in 2016, thanks to favourable taxation, vehicle acquisition and conversion incentives, and local measures to encourage clean vehicles (Figure B9.1). Autogas accounts for 47% of total LPG consumption in Italy and roughly 5% of total automotive-fuel demand.

Figure B9.1: Autogas consumption and vehicle fleet – Italy



The number of Autogas vehicles in use has surged in recent years, reaching almost 2.2 million at end-2016 – over 5% of all cars and trucks in Italy – three times the number just eight years earlier. Historically most Autogas vehicles were converted gasoline-fuelled vehicles, but sales of OEM vehicles have now overtaken conversions. The introduction of a generous subsidy led to a jump in OEM purchases in 2009-2010: about 600 000 new Autogas cars were sold in just those two years. Sales have since dropped to around 100 000-150 000 per year. Autogas-vehicle sales have held up best among younger people, who tend to be more ecologically minded and more cost-conscious.[1] At present, nine carmakers market a total of 23 Autogas models in Italy. Italy remains home to several Autogas engine and conversion-kit manufacturers, with a well-established network of installers. The number of refuelling sites

[1] *Argus LPG World*, 15 March 2016.

continues to grow, reaching 3 940 at end-2016 – about one-fifth of all service stations in Italy.

9.2 Government Autogas incentive policies

Italy has traditionally promoted the use of Autogas, initially to provide an outlet for surplus volumes of LPG from the large domestic refining industry, though the country has since become a net importer. In recent years, environmental concerns have been the main driving force behind Autogas policies.

The central government and local authorities encourage Autogas use through a mixture of policies, including favourable fuel taxes, incentives for clean vehicles and traffic regulations. Autogas currently enjoys a substantial excise-tax advantage of 58 cents/litre over gasoline and 47 cents/litre over diesel (Table B9.1). There has been no significant change in tax rates since 2013. As a result, the pump price of Autogas in 2016 was equal to just 39% that of gasoline in 2016 (compared with 50% in 2006) and 44% that of diesel (57%). The increase in the price-competitiveness of Autogas is the primary reason for the recent rebound in Autogas fuel sales.

Table B9.1: Automotive-fuel prices and taxes per litre – Italy

	Euros						US dollars
	2011	2012	2013	2014	2015	2016	2016
Pump prices							
Autogas	0.755	0.823	0.806	0.770	0.613	0.563	0.623
Diesel	1.448	1.706	1.658	1.610	1.406	1.282	1.419
Gasoline	1.555	1.787	1.749	1.712	1.538	1.444	1.597
Total taxes							
Autogas	0.253	0.290	0.288	0.286	0.258	0.249	0.275
Diesel	0.703	0.902	0.908	0.910	0.871	0.849	0.939
Gasoline	0.860	1.027	1.035	1.039	1.006	0.989	1.094
Excise taxes							
Autogas	0.125	0.147	0.147	0.147	0.147	0.147	0.163
Diesel	0.459	0.606	0.617	0.619	0.617	0.617	0.683
Gasoline	0.598	0.717	0.728	0.730	0.728	0.728	0.806
Pre-tax prices							
Autogas	0.502	0.533	0.517	0.484	0.355	0.314	0.348
Diesel	0.745	0.804	0.750	0.700	0.535	0.434	0.480
Gasoline	0.696	0.760	0.714	0.673	0.532	0.455	0.503

The Italian government also encourages Autogas and other clean fuels through vehicle incentives. Grant schemes for the conversion of an existing vehicle or the purchase of an OEM Autogas vehicle have been used periodically. In May 2014, grants were reintroduced for the purchase of Autogas and other alternative fuel vehicles on condition their CO_2 emissions do not exceed 120 grammes per km for businesses and 95 g/km for private motorists (though the grants were conditional on scrapping an existing

vehicle more than 10 years old for businesses). The grant was limited to 20% of the total cost of the vehicle (before tax) up to a maximum of €4 000 for cars with emissions of between 51 and 95 g/km and€2 000 for those purchased by companies with emissions of between 96 and 120 g/km. In 2014, the total budget for the scheme amounted to €64 million, including unspent funds from the previous year. The scheme has since been modified and slimmed down significantly. For 2016, the budget was cut to just €1.8 million euros and the scope of the incentives, which now vary from €500 to €750 per car, restricted to certain types of vehicle and to the 674 municipalities that have joined the Low Impact Fuel Initiative (ICBI).

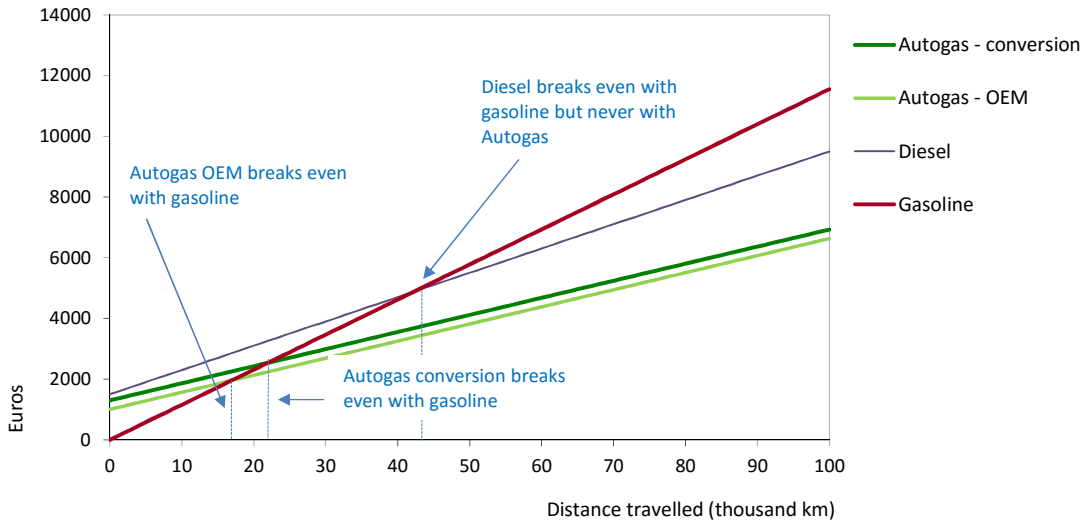
Some local initiatives to promote cleaner transport also benefit Autogas. For example, the region of Emilia-Romagna, in northern Italy, is offering grants of up to €2 500 to small and medium-sized businesses to purchase fleet vehicles that run on alternative fuels, including Autogas.[1] The aim of the "ecobonus" is to replace light commercial diesel vehicles up to 3.5 tonnes that meet only the Euro-3 standard with bi-fuel Euro-6 vehicles. In many parts of Italy, Autogas vehicles also benefit from a lower annual vehicle road tax, which depends on engine power and CO_2 emissions. For example, exemptions are granted for new vehicles or conversions in Lombardia, Toscana, Piemonte, Puglia and Trentino Alto Adige. In addition, a number of cities have adopted "soft measures", such as traffic regulations that exempt Autogas vehicles from driving restrictions imposed on gasoline and diesel vehicles during periods of acute pollution, provide free access to congestion-charging zones or grant free parking for Autogas vehicles. It is also reported that licences for refuelling stations to offer lucrative on-site side-business, such as cafes, can be made conditional on supplying Autogas. [2]

9.3 Competitiveness of Autogas against other fuels

The large fuel-tax advantage over gasoline and diesel makes Autogas the cheapest fuel option, regardless of eligibility for the conversion grants that are still on offer. Assuming a typical price premium of €1 000, an OEM Autogas car breaks even with gasoline at just 17 000 km – barely one year of driving for a private motorist – based on average 2016 fuel prices (Figure B9.2). Assuming an average cost of 1 300 for installing a conversion kit, a converted Autogas car breaks even at 22 000 km (assuming it is not eligible for a grant). Diesel breaks even with gasoline at 43 000 km, but is never competitive with Autogas (assuming a diesel LDV costs €1 500 more than an equivalent gasoline vehicle).

[1] http://auto-gas.net/newsroom/emilia-romagna-offers-ecobonus-replace-diesel-powered-commercial-fleets/
[2] *Argus LPG World*, 6 December 2016.

Figure B9.2: Running costs of a non-commercial LDV, 2016 – Italy

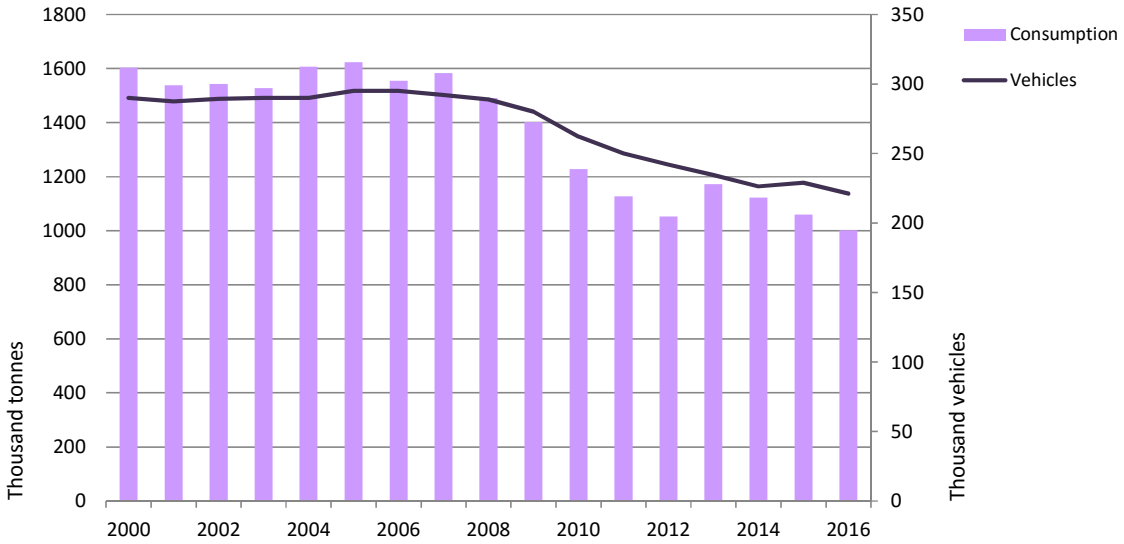


10 Japan

10.1 Autogas market trends

Japan has a long history of Autogas use stretching back to the 1960s. Consumption amounted to a fraction over 1 million tonnes[1] in 2016, equal to an estimated 1.6% of total road-transport fuel consumption (Figure B10.1). Consumption was flat at around 1.5-1.6 Mt between 2000 and 2007, but then began to decline steadily, mainly because of a gradual fall in the number of Autogas vehicles and a significant improvement in the fuel economy of the vehicle fleet (the average fuel consumption of Autogas vehicles in Japan fell by 15% between 2010 and 2016 according to official data). Autogas now accounts for only about 6% of total Japanese LPG consumption.

Figure B10.1: Autogas consumption and vehicle fleet – Japan



The size of the Autogas fleet contracted from a peak of just under 300 000 vehicles in 2006 to 221 064 in 2016 (just 0.3% of all motor vehicles in Japan).Taxis, 90% of which run on Autogas, account for the bulk of the Autogas fleet. Commercial fleet LDVs, HDVs and minibuses account for almost all the rest. A contraction in the overall size of the taxi fleet (taxi mileage dropped by a third between 2004 and 2014 according to the most recent official data) and the growing penetration of diesel cars are the principal reasons for the decline in the overall number of Autogas vehicles.

Most Autogas taxis are dedicated mono-fuel vehicles. The two largest OEMs are Nissan and Toyota. Both carmakers sell taxi cabs that meet government criteria for the so-called Universal Design Taxi Cab (UDTC), which can

[1] Butane accounts for three-quarters of this consumption (Argus LPG World, 19 July 2016).

accommodate passengers in a wheelchair together with other passengers in the same cabin. Toyota recently introduced a van-type hybrid vehicle fuelled by Autogas, which qualifies as a UDTC.[1] There are 1 440 refuelling station selling Autogas in Japan.

10.2 Government Autogas incentive policies

The Japanese government has maintained lower excise duties on Autogas than on diesel and gasoline for many years, though the size of the differentials has generally been large enough to incentivise the use of Autogas only in high-mileage vehicles. Excise duties have not changed for more than a decade. The duty on Autogas is about one-third the level of that on diesel and less than a fifth of that on gasoline (Table B10.1). In addition, import duties and a carbon tax – both of which are relatively small – are levied on imports at a lower rate on Autogas than on gasoline and diesel (these charges are reflected in pre-tax retail prices). The pump price of Autogas is currently 77% of that of diesel and 65% of that of gasoline in per-litre terms. Price differentials narrowed in 2016, as the pre-tax retail price of Autogas fell less than that of both other fuels due to divergent trends in international prices.

Table B10.1: Automotive-fuel prices and taxes per litre – Japan

	Yen						US dollars
	2011	2012	2013	2014	2015	2016	2016
Pump prices							
Autogas	89.21	93.81	96.23	102.60	87.25	78.48	0.722
Diesel	126.03	127.24	135.20	141.92	117.03	101.95	0.937
Gasoline	145.78	146.89	155.98	162.92	137.63	120.63	1.109
Total taxes							
Autogas	14.05	14.27	14.38	16.74	16.28	15.61	0.144
Diesel	38.61	38.73	39.30	42.01	40.93	39.81	0.366
Gasoline	62.78	62.90	63.52	67.30	66.53	65.28	0.600
Excise taxes							
Autogas	9.80	9.80	9.80	9.80	9.80	9.80	0.090
Diesel	34.14	34.20	34.39	34.58	34.64	34.64	0.318
Gasoline	55.84	55.90	56.09	56.28	56.34	56.34	0.518
Pre-tax prices							
Autogas	75.16	79.54	81.85	85.86	71.22	62.86	0.578
Diesel	87.41	88.51	95.90	99.92	76.09	62.14	0.571
Gasoline	83.00	84.00	92.46	95.62	71.09	55.35	0.509

Note: Pre-tax prices include duties and a carbon tax levied on imports of crude oil and petroleum products (1.0 Yen/litre on LPG and 2.8 Yen/Litre on gasoline and diesel in 2016).

A scheme that provided grants for Autogas vehicles was ended in March 2017. It covered up to 50% of the additional cost of buying an OEM Autogas

[1] http://www.auto-gas.net/newsroom/40/47/Autogas-market-developments-in-Japan#.U_NqNMscRaQ

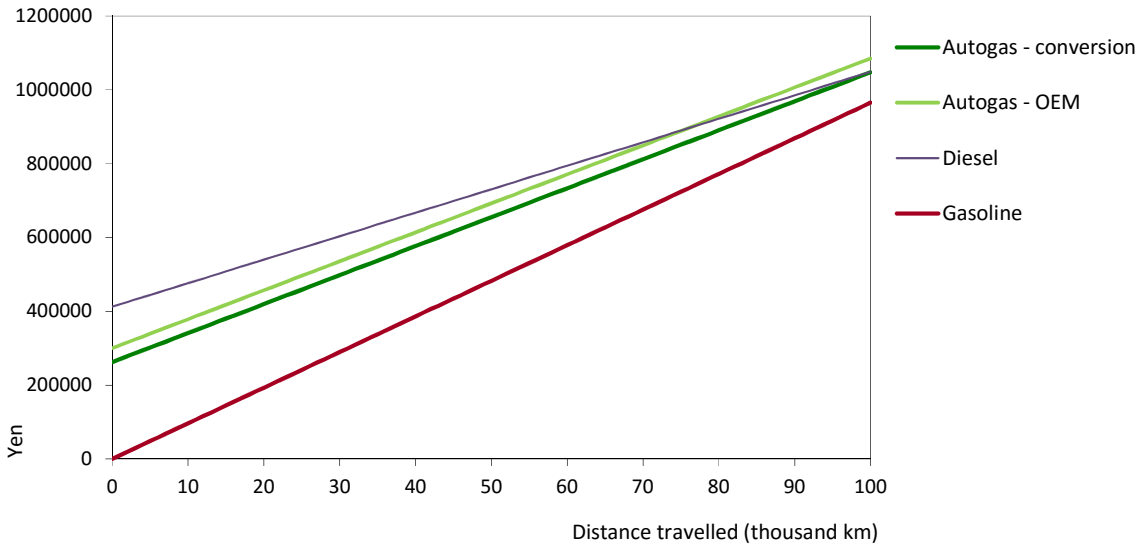
vehicle of converting an existing vehicle up to a maximum of 250 000 yen (¥). (around $2 500). A total of ¥91 million ($900 000) was budgeted for the scheme, the same as in 2015. Taxis did not qualify for the grant. To compensate for this change, the government has added Autogas vehicles to the category of "eco-car", which qualifies for a reduction in the purchase tax for two years from April 2017. In addition, the Tokyo Metropolitan Government is offering grants of up to ¥600 000 (roughly $6 000) for UDTCs that use electric or hybrid motors, including Autogas. The Japanese government has also scrapped grants of up to ¥150 000 ($1 500) previously offered to the buyers of those diesel-powered vehicles categorised as "clean".

The government's new Basic Energy Plan, announced in April 2014, sets an objective of increasing the role of Autogas, though it does not set any targets.

10.3 Competitiveness of Autogas against other fuels

In 2016, when subsidies on Autogas vehicles were still available, a converted Autogas LDV broke even with gasoline at around 150 000 km and an OEM at close to 200 000 km. However, the running costs of a diesel car – even without a purchase subsidy – were lower than those of a converted Autogas car at above 76 000 km (Figure B10.2). However, with the removal of Autogas subsidies in March 2017, diesel is now always more competitive than Autogas as both fuel costs per km and the vehicle purchase price are lower. This analysis demonstrates why the Autogas market is contracting. Restrictions on the use of diesel by taxis on environmental grounds and/or the reintroduction of incentives to use Autogas will be needed to reverse this trend.

Figure B10.2: Running costs of a non-commercial LDV, 2016 – Japan

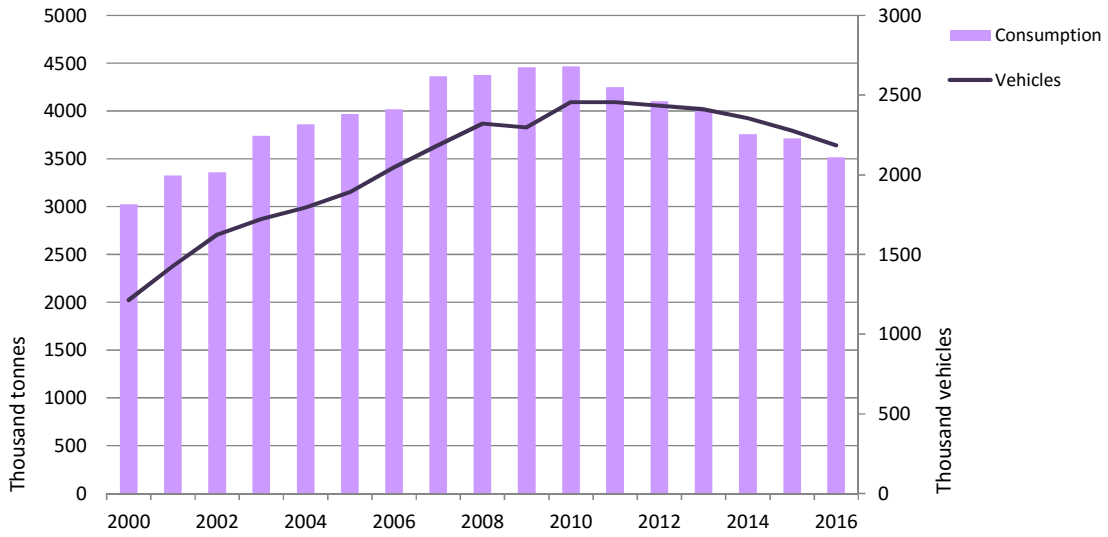


11 Korea

11.1 Autogas market trends

The Republic of Korea was one of the first countries to promote the widespread use of Autogas and, for many years, has had by far the largest Autogas market in the world. Demand took off in the 1970s as taxis started to adopt the fuel and surged in the 1990s in response to strong government support for the fuel's use in taxis, other fleet vehicles and public buses, mainly through a large fuel-tax advantage. Environmental restrictions on diesel vehicles also helped encourage Autogas use by high-mileage vehicles. By 2010, consumption of Autogas had reached close to 4.5 million tonnes with almost 2.5 million vehicles running on the fuel – despite a ban on the use of Autogas in private passenger cars (Figure B11.1).

Figure B11.1: Autogas consumption and vehicle fleet – Korea



The Autogas market began to contract in 2011, with sales falling every year since to just 3.515 million tonnes in 2016 – more than one-fifth below their 2010 peak. The main reason for this reversal was a gradual change in government policy towards Autogas use that began in the 2000s, motivated by the perceived improvement in emissions performance of new diesel and gasoline vehicles relative to Autogas vehicles, and the objective of boosting revenues from automotive-fuel taxes. Excise duties on Autogas were raised in step-wise fashion in order to reduce the pump-price advantage of Autogas over diesel and gasoline (see below). By the end of the 2000s, the attractiveness of Autogas to high-mileage commercial vehicle-owners had been greatly diminished, leading to a shift in demand for new commercial LDVs away from Autogas. The increased fuel-efficiency of the Autogas

vehicle fleet also contributed to a drop in sales of the fuel. By 2016, Autogas accounted for an estimated 11% of total road-transport fuel consumption – down from over 16% at the end of the 2000s – and 37% of total LPG consumption in Korea.

The number of Autogas vehicles on the road in Korea has also fallen back since the turn of the decade, but at a slower rate than fuel use, reflecting the inherently slow rate of vehicle turnover and improving fuel efficiency. At the end of 2016, there were still 2.185 million Autogas cars in use, supported by a network of 2 031 refuelling stations. Around three-quarters of the current Autogas vehicle fleet are private LDVs (including taxis and rental cars) and the rest are sports utility vehicles, specially designed vehicles for disabled people, minibuses and commercial vans. Around 95% of the country's taxis still run on Autogas, as dedicated diesel taxis are not yet marketed in Korea (see below). Autogas vehicles make up about 10% of the country's total vehicle fleet. Most of these vehicles are locally manufactured mono-fuelled OEMs. At present, four companies – Hyundai, Kia, RSM and General Motors – market a total range of 16 dedicated Autogas vehicles.

11.2 Government Autogas incentive policies

The exceptional size of the Korean Autogas market today, despite the recent contraction in demand, is primarily the result of many years of highly supportive government policies, including favourable taxation of Autogas. Excise-tax differentials were reduced progressively over the five years to 2006 under a plan to restructure the taxation of all automotive fuels, but the tax on Autogas is still significantly lower than that on diesel and gasoline (Table B11.1).

Table B11.1: Automotive-fuel prices and taxes per litre – Korea

	Won						US dollars
	2011	2012	2013	2014	2015	2016	2016
Pump prices							
Autogas	1076.1	1101.9	1070.8	1051.2	806.4	734.0	0.632
Diesel	1745.7	1806.3	1729.6	1636.7	1299.6	1182.5	1.019
Gasoline	2136.2	2233.7	2216.2	2162.3	1876.1	1757.6	1.514
Total taxes							
Autogas	318.9	321.2	318.4	316.6	294.4	287.8	0.248
Diesel	676.9	693.0	686.0	677.5	646.9	636.3	0.548
Gasoline	976.1	985.0	983.4	978.5	952.5	941.7	0.811
Excise taxes							
Autogas	221.1	221.1	221.1	221.1	221.1	221.1	0.190
Diesel	518.2	528.8	528.8	528.8	528.8	528.8	0.455
Gasoline	781.9	781.9	781.9	781.9	781.9	781.9	0.674
Pre-tax prices							
Autogas	757.2	780.6	752.4	734.6	512.0	446.3	0.384
Diesel	1068.8	1113.4	1043.6	959.1	652.7	546.3	0.471
Gasoline	1160.1	1248.7	1232.8	1183.8	923.7	815.9	0.703

Since July 2007, government tax policy has aimed to keep pump prices of Autogas at roughly 50% of those of gasoline and diesel prices at 85% of gasoline prices. Since July 2008, the tax on Autogas has stood at 221 won/litre, compared with 746 won for gasoline and (since 2010) 518 won/litre for diesel. The pre-tax price of Autogas also remains markedly lower than that of both diesel and gasoline, partly because LPG imports are exempted from a small duty applied to the other fuels. As a result, the pump price of Autogas was equal to 52% that of gasoline and 62% that of diesel. Thus, the price of Autogas relative to gasoline is marginally higher than the official target, while that of diesel considerably lower.

The government continues to place restrictions on the ownership of Autogas vehicles, though they have recently been eased. Under regulations designed achieve a balanced fuel mix in the transport sector, new OEM Autogas vehicles can only be purchased by commercial operators such as taxis and car-rental companies. Private passenger cars are not allowed to be converted to Autogas. There are exemptions for disabled people, compact cars, vehicles that can carry more than seven people and hybrids. In addition, a change in the rules came into effect in January 2017 allowing anyone to own a used Autogas car once it has been registered for at least five years. This allows second-hand Autogas taxis and rental cars to be sold to private owners. These sales are expected to amount to about 30 000 vehicles a year.[1] Several car-rental companies have already launched leasing programmes, which include the option for customers to own Autogas cars after renting them for five years. Autogas vehicles owned for more than five years by handicapped people and citizens of national merit can also be sold to the general public. In July 2017, a parliamentary committee adopted a bill permitting the general public to purchase recreational vehicles powered by Autogas that can carry five people or less and some other types of passenger vehicle.[2]

Regulations concerning the use of diesel vehicles as taxis remain critical to the prospects for Autogas in Korea. At the end of 2013, the government decided to lift the ban on taxis using diesel vehicles from September 2015 for environmental reasons, on condition that they meet Euro-6 standards. However, the government has since tightened the regulations, due to concerns about the environmental and health risks associated with diesel emissions. Further changes are imminent; for example, the government plans to introduce extra NOx emission compliance tests during car inspections, which are thought to be very challenging for diesel vehicles. As a result of the uncertainty this has created, Korean car makers have delayed the launch of specially designed diesel taxis, which are not yet being sold on the Korean market.

The Korean government does not make available grants or any other form of financial incentive for OEM Autogas LDV purchases on the grounds that

[1] http://auto-gas.net/newsroom/korean-government-opens-autogas-use-wider-public/
[2] http://world.kbs.co.kr/english/news/news_Ec_detail.htm?No=128965

favourable taxation is sufficient to encourage the use of Autogas.[1] However, other measures promote Autogas. The government operates a programme to encourage the conversion of old diesel trucks to Autogas. Grants of 80-90% of the total conversion cost are available. This programme, which began in 2005, enabled the retrofit of 197 000 Autogas engines by the end of 2015. It is scheduled to continue to 2024. Clean vehicle mandates also boost Autogas sales, as some Autogas models have been classified as low-emission vehicles. The government mandates the purchase of minimum proportions, ranging from 20% to 30%, of clean vehicles in its own LDV fleets. Car manufacturers are also obliged to sell a certain portion of clean vehicles. In addition, in Seoul, designated low-emission vehicles are granted free or discounted access to fast-lanes to encourage their adoption. The government also funds a research and development programme for Autogas LDVs and HDVs (Box 11.1).This led to the commercialisation of Autogas hybrid LDVs. More recently, the government has supported a research programme to develop direct injection Autogas engines.

Box B11.1: A new Autogas truck under development for the Korean market

The government is funding the development of a new 1-tonne Autogas truck, in cooperation with Hyundai Motors, the Automotive Technology Institute and universities. The new truck, which will use advanced liquid propane direct injection technology, is designed to meet strict new emission standards that are due to be introduced in September 2017. At present, 1-tonne diesel trucks – led by the Kia Bongo and Hyundai Porter – are the most popular trucks in use in the commercial sector, because of their attractive prices and compact size. But their prices are set to rise with the modifications that will be necessary to meet the new emission standards. As a result, the new Autogas truck that is being developed is expected to provide an attractive alternative. It is due to be commercialised from 2020.

In early 2017, it was reported that the government is planning to draw up legislation that would pave the way for the installation across the country of 200 new refuelling stations dedicated to selling alternative fuels, including Autogas, hydrogen and electric vehicles.[2] The stations are due to be completed by 2025. The plan would involve licensing the stations to private operators over 30 years. It is expected that any revenue generated by the businesses would be reinvested in government-led fuel cell research projects.

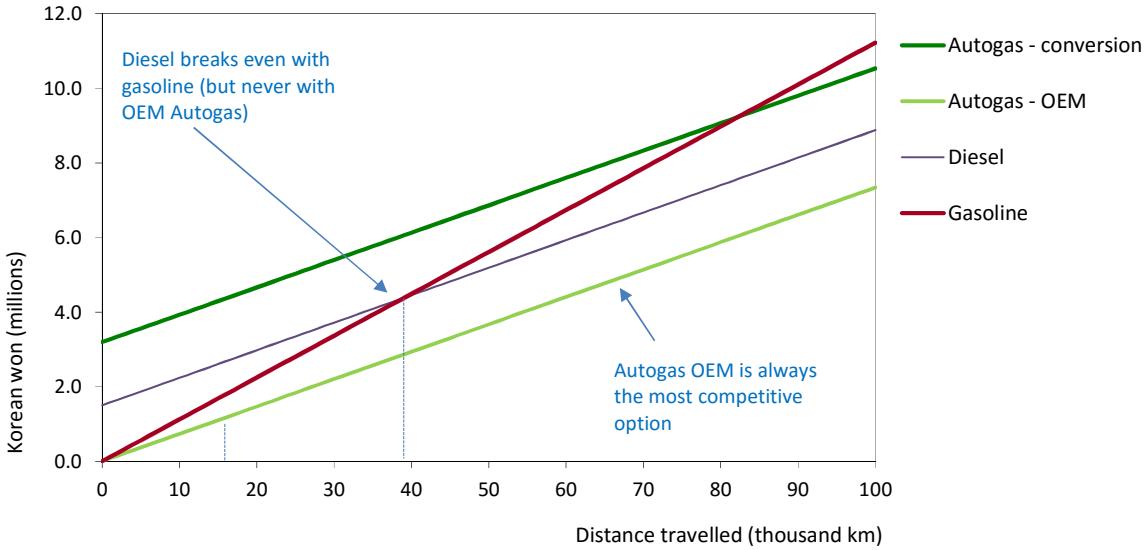
11.3 Competitiveness of Autogas against other fuels

Autogas remains highly competitive with both gasoline and diesel for OEM LDVs. As a dedicated OEM vehicle in Korea costs no more than an equivalent gasoline model, the cumulative running costs are always lower (Figure B11.2). After 100 000 km of operation, the total savings on fuel amount to an impressive 3.9 million won ($3 340) based on 2016 prices. The payback period for a converted Autogas vehicle, which is rare in Korea, is 83 000 km, or little more than a year for most commercial users. A diesel vehicle breaks even with a gasoline one at just under 40 000 km, but is never competitive with an

[1] Grants are available for CNG, fuel-cell and electric vehicles, including hybrids.
[2] http://auto-gas.net/newsroom/government-korea-plans-install-200-alternative-fuel-stations-2025/

OEM Autogas one, based on a price premium for a diesel car of about 1.5 million won over a gasoline car. This analysis clearly demonstrates the continuing appeal of Autogas vehicles in Korea.

Figure B11.2: Running costs of a non-commercial LDV, 2016 – Korea



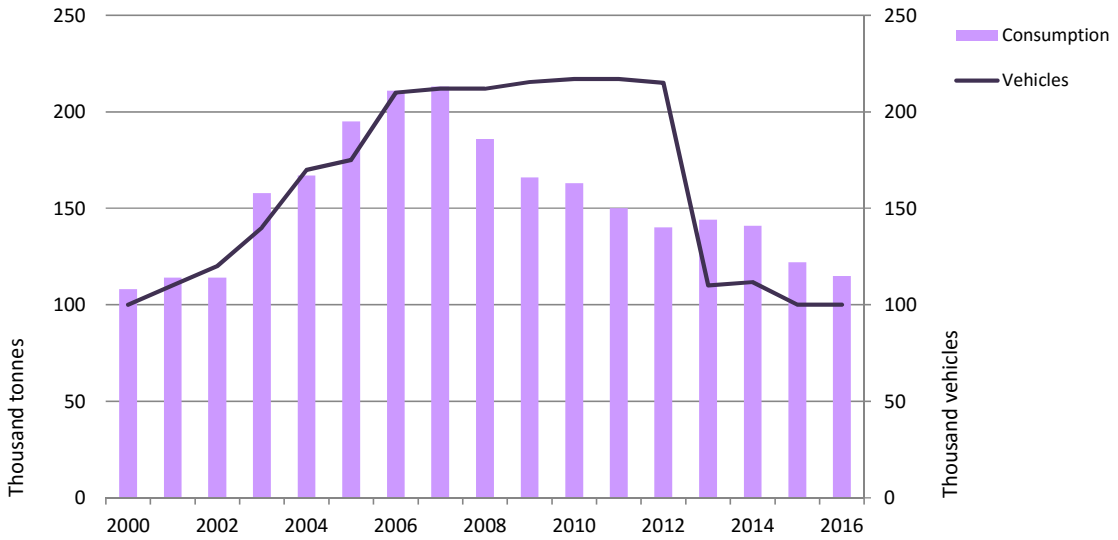
Note: The Autogas OEM vehicle is mono-fuelled. In most other countries, they are dual-fuelled, which usually makes them more expensive than equivalent gasoline-fuelled models.

12 Lithuania

12.1 Autogas market trends

Lithuania has a large Autogas market relative to the size of the country with a traditionally favourable fuel-tax policy, though it has contracted markedly in recent years. Consumption fell steadily from a peak of 213 000 tonnes in 2006 to just 115 000 tonnes in 2016 – its lowest level since 2002 (Figure B12.1). Autogas met roughly 7% of the country's total automotive-fuel needs and accounted for 73% of total LPG consumption in 2016.

Figure B12.1: Autogas consumption and vehicle fleet – Lithuania



Note: the drop in vehicle numbers is 2013 is due to a break in the series.

Despite falling fuel sales, the number of Autogas vehicles has been broadly constant in recent years, totalling 100 000 at end-2016. A similar range of factory-fitted OEM models as in neighbouring Poland are available, distributed mostly by Polish companies. Conversions of existing gasoline-powered cars are common. There are an estimated 690 refuelling sites throughout the country.

12.2 Government Autogas incentive policies

Autogas use is encouraged solely through a strong fuel-tax incentive. The excise duty on autogas, at 0.23 litas/litre, is less than a fifth of that on gasoline and under a third of that on diesel (Table B12.1). Excise duties on Autogas and gasoline have not changed since 2011, while the duty on diesel fell sharply in 2013. Combined with a relatively low pre-tax price, the pump of Autogas in 2016 was just under half that of gasoline and 40% that of diesel.

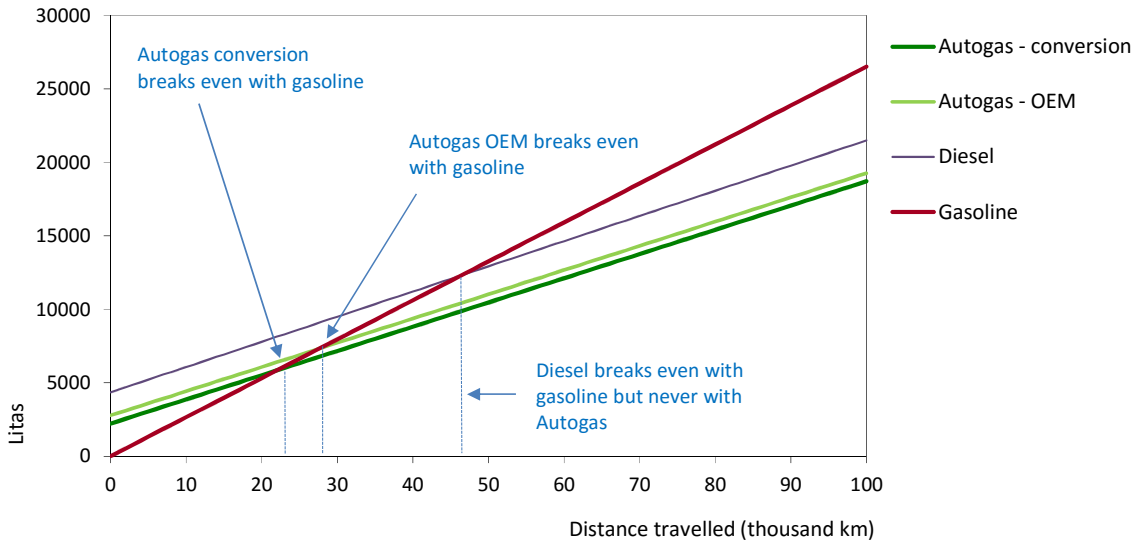
Table B12.1: Automotive-fuel prices and taxes per litre – Lithuania

	Litas						US dollars
	2011	2012	2013	2014	2015	2016	2016
Pump prices							
Autogas	2.301	2.339	2.271	2.257	1.869	1.649	0.528
Diesel	4.263	4.596	4.044	3.861	3.186	2.746	0.880
Gasoline	4.196	4.517	4.391	4.201	3.647	3.314	1.062
Total taxes							
Autogas	0.631	0.638	0.626	0.624	0.556	0.518	0.166
Diesel	1.783	1.841	1.409	1.377	1.260	1.184	0.379
Gasoline	1.932	1.988	1.966	1.933	1.837	1.779	0.570
Excise taxes							
Autogas	0.232	0.232	0.232	0.232	0.232	0.232	0.074
Diesel	1.043	1.043	0.707	0.707	0.707	0.707	0.226
Gasoline	1.204	1.204	1.204	1.204	1.204	1.204	0.386
Pre-tax prices							
Autogas	1.669	1.701	1.645	1.633	1.313	1.131	0.362
Diesel	2.480	2.755	2.635	2.484	1.926	1.563	0.501
Gasoline	2.264	2.529	2.425	2.268	1.810	1.535	0.492

12.3 Competitiveness of Autogas against other fuels

The break-even distance for Autogas against gasoline is estimated at around 23 000 km for a converted Autogas LDV and 28 000 for an OEM vehicle based on 2016 fuel prices and vehicle costs (Figure B13.2). This assumes an average conversion cost of about 2 200 litas ($700) and an average price premium over a new gasoline car of around 2 800 litas ($900).

Figure B12.2: Running costs of a non-commercial LDV, 2016 – Lithuania



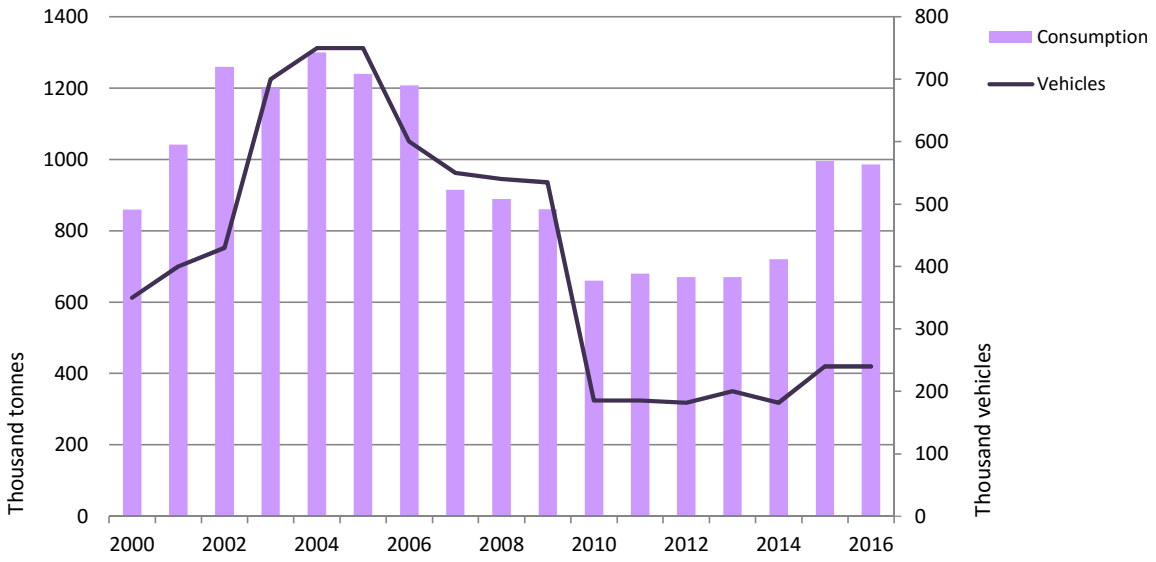
Autogas is always competitive against diesel, both because running costs are lower and because the conversion cost and OEM price premium are less than the higher vehicle-acquisition price of a diesel vehicle. The net financial savings to the owner of a converted Autogas vehicle for a distance of 100 000 km are over 7 800 litas ($2 500).

13 Mexico

13.1 Autogas market trends

Mexico's Autogas market is showing signs of revival after several years of decline. Demand rose strongly during the 1990s and early 2000s, reaching a peak of 1.3 million tonnes in 2004, but then slumped to just 660 000 tonnes in 2010; sales fluctuated around that level until 2013, but rebounded to 996 000 tonnes in 2015 with a widening of fuel-price differentials in favour of Autogas; sales fell back marginally to 986 000 tonnes in 2016 (Figure B13.1). Diesel is the main competing fuel, with several new diesel LDV models having been introduced onto the Mexican market. But environmental concerns and higher prices have held back diesel consumption in recent years and stimulated more interest in Autogas, which is once again competitively priced. The Mexican government forecasts continuing rapid growth in Autogas demand, totalling 61% between 2014 and 2029 (SENER, 2016). The use of CNG remains tiny and that of other alternative fuels negligible. Autogas accounts for about 2% of total automotive-fuel consumption, down from almost 4% in the early 2000s but up from only 1.3% in 2012.

Figure B13.1: Autogas consumption and vehicle fleet – Mexico



Note: The sharp fall in vehicle numbers in 2010 is due to a break in the series.

The number of Autogas vehicles has fluctuated in recent years, dipping to 182 000 at the end of 2012 and then recovering to 240 000 at end-2016 – about 0.7% of the total car and truck fleet. Most vehicles are old converted gasoline cars, most of them operating in the northern and central-western regions.[1] No OEM Autogas models are marketed in Mexico at present. However, an agreement was reached in early 2017 between the Mexican

[1] A special licence is required to convert a vehicle to run on Autogas in Mexico City.

Association of Liquefied Gas Distributors (Amexgas), the Association of Distributors of Liquefied Petroleum Gas (ADG), the Regional Chamber of Gas, and Alden Group, one of the main dealers of cars and trucks in the country, to allow buyers of new gasoline vehicles to convert them to Autogas and still keep the original warranty from the factory.[1] There is growing interest among fleet operators in switching to Autogas. Companies, including taxi operators, in Jalisco and Nayarit are in talks with the authorities to adopt Autogas in their vehicles as a way of improving air quality.[2] There are 2 150 refuelling sites selling Autogas around the country – a very large number relative to the size of the fleet. The network is set to expand further: in early 2017, the Mexican Energy Regulatory Commission (CRE) granted four new fuel dispensing permits.

13.2 Government Autogas incentive policies

The Mexican government launched a major reform of the energy sector in 2013. The oil sector, which has traditionally been dominated by the state monopoly, Pemex, is being opened up partially to competition. Since 2106, private companies are allowed to import oil and participate in downstream markets. However, the government retains direct control over wholesale and retail prices of all oil products sold in Mexico. It sets maximum retail prices on a monthly basis according to a formula that takes account of a distribution margin based on actual costs and value-added tax. When the benchmark international price is greater than the domestic price, the rate for the country's excise tax effectively becomes negative (though the tax is not explicit). Marketers obtain a compensatory tax credit equivalent to the price difference. In October 2016, the Mexican Congress approved the government's initiative included in the Federation Income Law 2017, which accelerates gasoline and diesel price liberalisation in those regions where the energy regulator CRE identifies a lack of competition. CRE is yet to publish the criteria and schedule for those purposes. In the regions where CRE determines that competition conditions are not yet met, prices will remain regulated (IEA, 2017b).

In the case of LPG (cylinder gas and Autogas), a price-cap policy was implemented in 2000, as international prices were substantially higher than domestic prices. Every month, the government sets the maximum national final price. In 2015 and 2016, prices increased only at the beginning of the year owing to inflation. The Ministry of Energy (SENER) continues to set final LPG final prices. However, according to the new Hydrocarbons Law, adopted in 2013, pricing will follow market conditions from the beginning of 2017.

A new tax on oil products, known as the Special Production Tax and Service (IEPS), was introduced at the start of 2014, which pushed the prices of transport fuels up by around 0.20 pesos per litre. A carbon tax was also introduced in 2014, payable by producers and importers; the tax was set at

[1] http://auto-gas.net/newsroom/mexico-supports-adoption-lpg-powered-vehicles/
[2] http://auto-gas.net/newsroom/new-licences-granted-set-autogas-stations-mexico/

6.60 US cents/litre for Autogas, compared with 10.38 cents for gasoline and 12.59 cents for diesel.[1] Value-added tax of 16% is applied to all fuels.

The pump prices of all transport fuels have risen steadily in recent years, but that of Autogas has increased slightly less rapidly than that of diesel and gasoline. In 2016, the pump price of Autogas was on average equal to only 54% of that of gasoline and 55% of the diesel price, providing a relatively strong financial incentive for motorists to use Autogas (Table B13.1). The price of Autogas relative to diesel has fallen significantly since the mid-2000s, when they were almost at parity.

Table B13.1: Automotive-fuel prices and taxes per litre – Mexico

	Pesos						US dollars
	2011	2012	2013	2014	2015	2016	2016
Pump prices							
Autogas	5.59	6.09	6.71	7.43	7.82	7.77	0.416
Diesel	9.49	10.52	11.74	13.21	14.12	14.06	0.752
Gasoline	10.30	10.89	12.00	13.37	14.10	14.35	0.768
Total taxes							
Autogas	0.77	0.84	0.92	1.02	1.08	1.07	0.057
Diesel	1.31	1.45	1.62	1.82	1.95	1.94	0.104
Gasoline	1.42	1.50	1.66	1.84	1.94	1.98	0.106
Excise taxes							
Autogas	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Diesel	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Gasoline	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Pre-tax prices							
Autogas	4.82	5.25	5.78	6.41	6.74	6.70	0.358
Diesel	8.18	9.07	10.12	11.39	12.17	12.12	0.648
Gasoline	8.88	9.38	10.34	11.53	12.15	12.37	0.662

There are no subsidies for vehicle owners to convert to Autogas or purchase OEM vehicles. However, Autogas vehicles are exempted from the annual road tax. In addition, some Autogas vehicles are exempted from local driving restrictions imposed for air quality reasons, For example, under the "Hoy No Circula" programme, which covers Mexico City and surrounding areas within the State of Mexico, conventionally fuelled vehicles are prohibited from the area one day a week based on their licence plate number. Autogas vehicles however can freely circulate any day of the week.

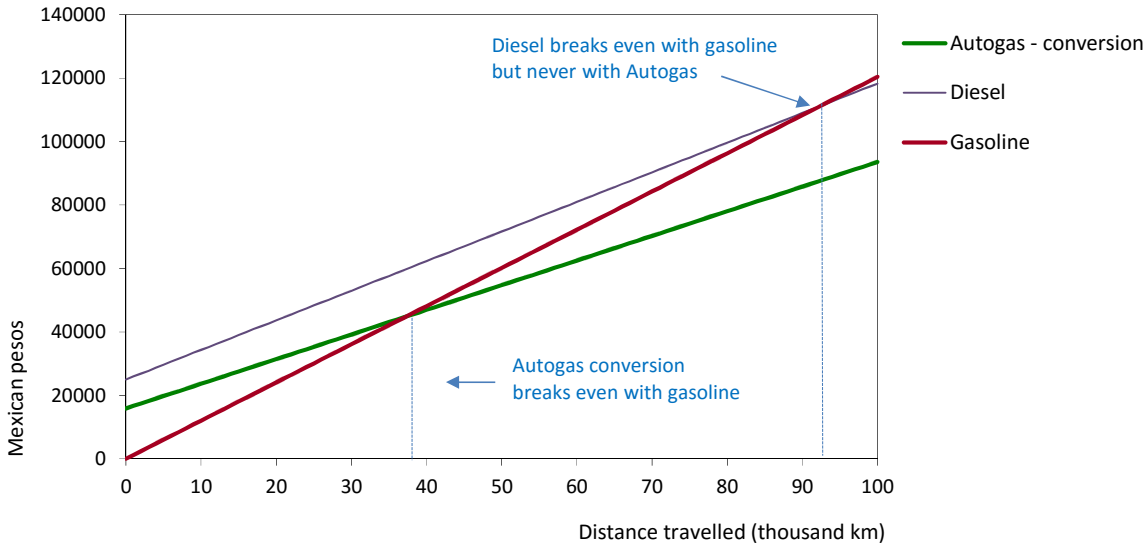
13.3 Competitiveness of Autogas against other fuels

Assuming an average conversion cost of about 15 900 pesos ($850), Autogas becomes competitive with gasoline at just 38 000 km based on 2016 fuel prices (Figure B13.2).[2] The costs savings after 100 000 km amount to about

[1] www.thepmr.org/system/files/documents/Carbon%20Tax%20in%20Mexico.pdf
[2] The conversion cost for vehicles using more sophisticated fuel systems is estimated at over 20 000 pesos and as much as 30 000 pesos for some vehicles.

27 000 pesos ($1 400). Autogas is always more competitive than diesel, which breaks even with gasoline only at more than 90 000 km. These calculations take account of the exemption from the annual road tax. The breakeven distance of Autogas against gasoline has dropped substantially in the last five years thanks to lower pump prices, which explains why Autogas sales have recovered. In 2006, Autogas broke even with gasoline at more than 100 000 km and was uncompetitive against diesel. The highly competitive price of Autogas points to continued market growth in the coming years.

Figure B13.2: Running costs of a non-commercial LDV, 2016 – Mexico



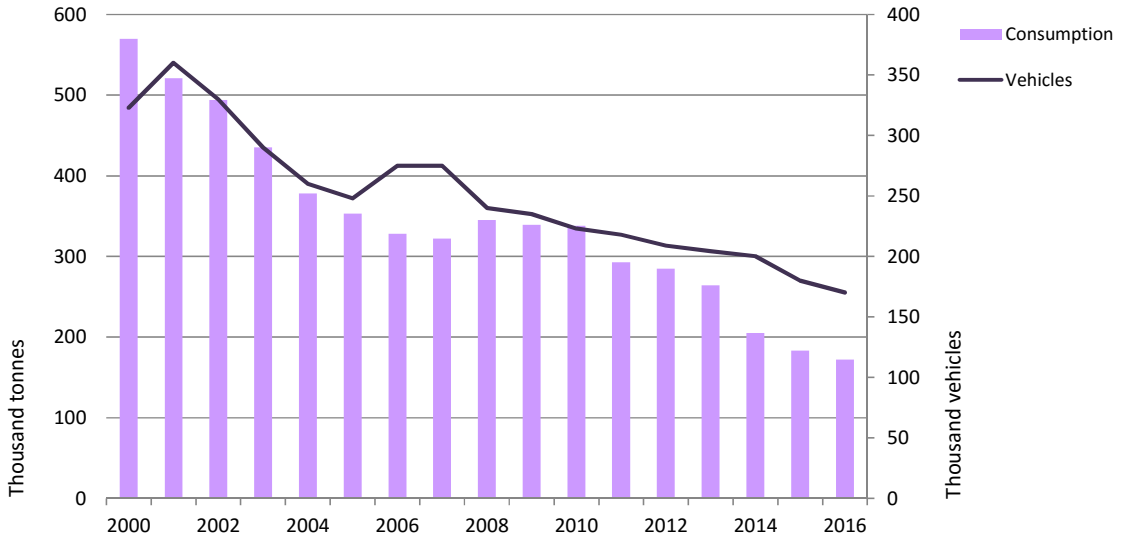
Note: Running costs here include the annual road tax, from which Autogas vehicles are exempt.The tax varies according to the size, type and age of the car. For the purposes of this analysis, it is assumed to amount to 1 000 pesos per year for both gasoline and diesel vehicles, which equals 55.5 pesos per thousand kilometres based on an assumed driving distance of 18 000 km per year.

14 Netherlands

14.1 Autogas market trends

Autogas use in the Netherlands has a long history. The Dutch Government has encouraged the use of autogas and LPG generally for many years because the country, with a large refining industry, used to be a major producer and exporter of the fuel. The country is now a net importer of LPG, so the rationale for encouraging Autogas now is purely environmental. But demand has been declining for many years, as policy support for the fuel has waned and as priority has shifted to encouraging natural gas (CNG and LNG) and EVs, even though Autogas remains highly competitive. Autogas consumption reached 172 000 tonnes in 2016, about 6% down on 2015 and 70% lower than in 2000 (Figure B14.1). Autogas now meets less than 2% of the country's total road-fuel demand.

Figure B14.1: Autogas consumption and vehicle fleet – Netherlands



Apart from a short-lived recovery in 2006, the Autogas vehicle fleet has been contracting steadily since the early 2000s. At end-2016, there were 170 000 Autogas vehicles in use – down from 360 000 in 2001. A hike in the excise tax on Autogas that took effect at the beginning of 2014 alongside much smaller increases in the tax on gasoline and diesel has driven down consumer interest in buying OEM Autogas cars or converting an existing car to run on the fuel. Only two carmakers – Dacia (with two models), and Opel (with four) – still offer Autogas versions, even though the prices are often not much more (and in some cases cheaper)[1] than those of gasoline-powered equivalents and are much cheaper than diesel cars thanks to lower purchase taxes (see below). There are 1 650 refuelling sites that sell Autogas across the country, close to half of the total.

[1] For example, the bi-fuelled versions of Dacia's Sandero and Stepway are currently cheaper.

The fleet of other types of alternative fuels is expanding. The number of EVs, including hybrids, on the road in the Netherlands has been growing very rapidly in the last few years, and the fleet is now thought to be larger than for Autogas. Growth in EV sales is now slowing with a reduction in subsidies for budgetary reasons. The CNG fleet has also been expanding, but in 2015 numbered just 6 900 – mostly heavy-duty vehicles and municipal fleet LDVs.

14.2 Government Autogas incentive policies

The Dutch government maintained a policy of encouraging the use of Autogas through fuel and vehicle tax incentives for many years. The excise tax on Autogas was raised almost every year between 2007 and 2013, but by less in absolute terms than the taxes on gasoline and diesel, widening the gap in final prices (Table B14.1). In 2014, the tax on Autogas was increased sharply, causing the price gap to narrow suddenly; it has risen very slowly and more-or-less at the same rate as those on gasoline and diesel since then. In 2016, the tax was 18.6 cents/litre, compared with 49.3 cents on diesel and 77.8 cents on gasoline. The pre-tax price of Autogas also remains much lower than that of the other two fuels in per-litre terms. As a result of this and the lower excise tax, the price of Autogas gas at the pump in 2016 was equal to just 39% of the price of gasoline and 50% of the price of diesel. In absolute terms, Autogas was 91 cents/litre cheaper than gasoline and 57 cents cheaper than diesel. These differences have narrowed slightly since 2013, mainly due to the bigger increase in the tax on Autogas.

Table B14.1: Automotive-fuel prices and taxes per litre – Netherlands

	Euros						US dollars
	2011	2012	2013	2014	2015	2016	2016
Pump prices							
Autogas	0.700	0.769	0.732	0.752	0.619	0.571	0.632
Diesel	1.348	1.444	1.421	1.406	1.231	1.141	1.262
Gasoline	1.640	1.759	1.736	1.705	1.558	1.477	1.633
Total taxes							
Autogas	0.199	0.219	0.228	0.309	0.292	0.285	0.315
Diesel	0.645	0.672	0.694	0.730	0.704	0.691	0.764
Gasoline	0.986	1.023	1.055	1.063	1.044	1.034	1.144
Excise taxes							
Autogas	0.087	0.094	0.101	0.178	0.185	0.186	0.206
Diesel	0.430	0.437	0.448	0.486	0.490	0.493	0.545
Gasoline	0.724	0.736	0.754	0.767	0.774	0.778	0.861
Pre-tax prices							
Autogas	0.502	0.549	0.504	0.444	0.327	0.286	0.316
Diesel	0.703	0.772	0.726	0.676	0.527	0.450	0.498
Gasoline	0.654	0.735	0.681	0.641	0.513	0.442	0.489

There are no grants or tax credits available for Autogas conversions or OEM purchases. However, the vehicle-purchase tax (known as the luxury tax) is

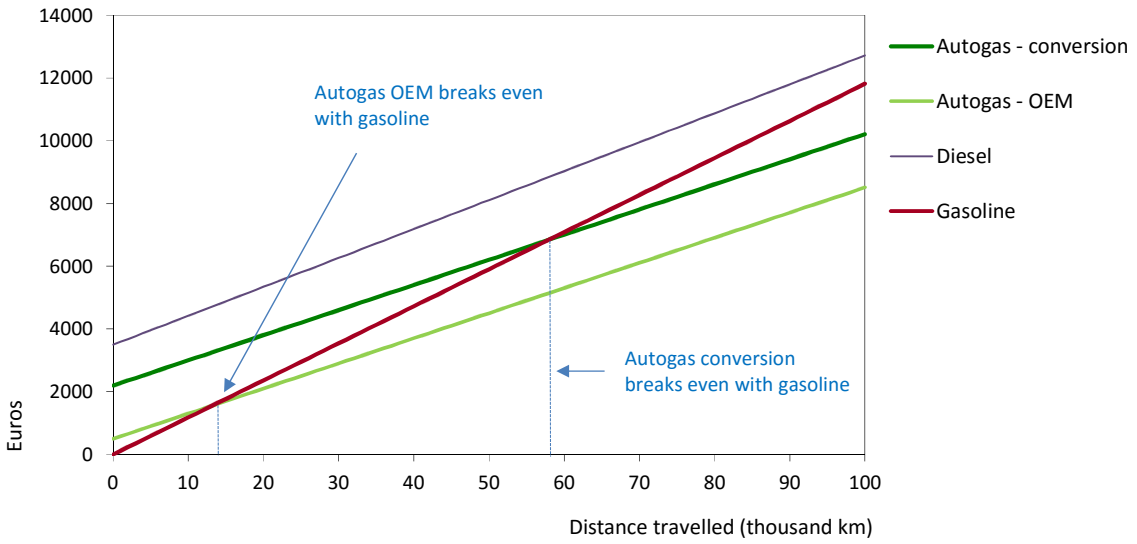
significantly lower than for diesel cars (and the same as for gasoline cars). [1] On the other hand, the annual vehicle (road) tax, known as the *holdership* tax, for Autogas vehicles is higher than for both gasoline and diesel vehicles (except for the lightest vehicles). For example, the tax rate for a car weighing one tonne is €304 per year for gasoline, €676 for diesel and €724 for Autogas. The rates of the luxury and holdership taxes have not changed for several years. On 1 January 2017, the benefit-in-kind tax for company cars was harmonised at 22% of the list price for all fuels, with the exception of EVs. Previously, Autogas cars incurred a higher rate. The tax on EVs is 4% up to €50 000 and 22% for the additional cost above that.

The Dutch LPG industry called for Autogas to be allowed to be sold on unmanned refuelling sites, which is currently not permitted. There are signs that this ban may be lifted, but it may require two years to take effect.

14.3 Competitiveness of Autogas against other fuels

The relatively low pump price of Autogas resulted in a breakeven distance for Autogas against gasoline of around 14 000 km for an OEM Autogas LDV (based on a typical price premium of just €500 over a gasoline car thanks in part to a favourable the luxury tax) and 58 000 km for converted vehicles (assuming an average cost of installing a conversion kit of €2 200) in 2016 (Figure B14.2). These calculations take account of the higher annual road tax on Autogas vehicles. Autogas is always more competitive than diesel (regardless of distance) as a diesel LDV costs much more than an equivalent gasoline model (3 500 euros on average) and per-km fuel costs are higher.

Figure B14.2: Running costs of a non-commercial LDV, 2016 – Netherlands



Note: The analysis takes into account differences in annual vehicle road taxes (assumed to be €23/1 000 km for Autogas and €21/1 000 for diesel based on 18 000 km distance per year).

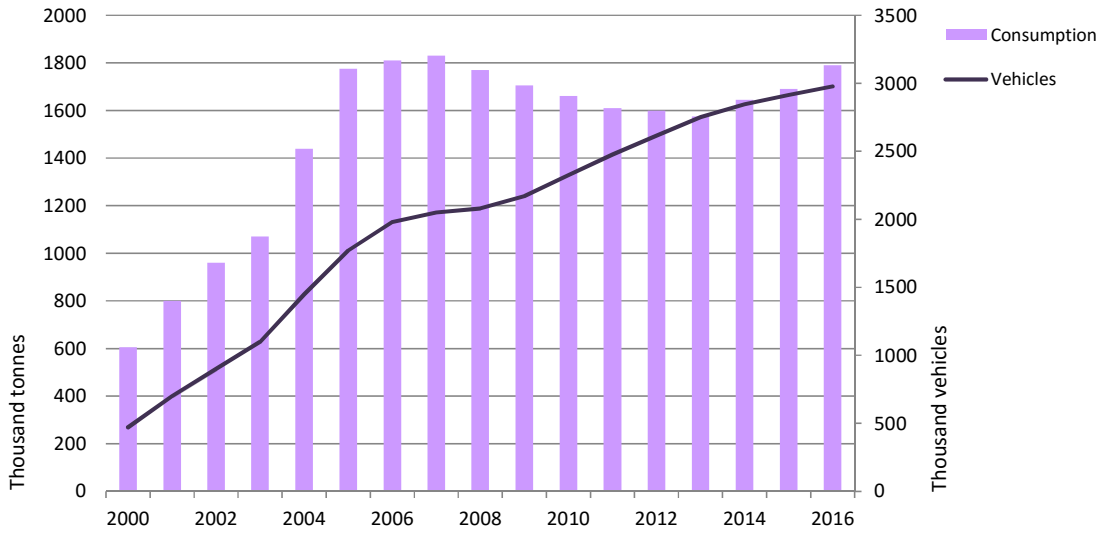
[1] The tax is 42.3% of the net catalogue price minus €1 442 on Autogas and gasoline cars, and plus €307 for diesel cars (http://www.cfe-eutax.org/taxation/road-tax/netherlands).

15 Poland

15.1 Autogas market trends

Poland has the largest Autogas market in the European Union and the fourth-largest in the world after Korea, Turkey and Russia. The market grew rapidly in the 1990s and the first half of the 2000s, but demand fell back temporarily between 2006 and 2013 due to a marked improvement in fuel economy as old cars were replaced with more fuel-efficient models. Demand has rebounded since, thanks to a steady widening of the tax advantage of the fuel, especially over diesel, and a corresponding increasingly attractive price at the pump. Autogas consumption reached just under 1.8 million tonnes in 2016 – 5.9% up on 2015 and close its historic peak of just over 1.8 million tonnes in 2007 (Figure B15.1). It now accounts for roughly 11% of total road-fuel use in Poland and around three-quarters of the country's total LPG consumption. Most of the country's LPG needs is imported, mainly from Russia, Kazakhstan and Belarus.

Figure B15.1: Autogas consumption and vehicle fleet – Poland



The fleet of vehicles that are able to run on Autogas has grown steadily since the 1990s, reaching almost 3 million by the end of 2016 – about 14% of all the vehicles in Poland. Most vehicles are LDVs for private and commercial use, but some Autogas-fuelled buses have also been brought into service. Most Autogas-powered LDVs are conversions. The number of conversions was boosted in 2004 by a surge in imported second-hand gasoline cars following Poland's entry into the European Union; around half of these cars, mostly imported from Germany, are thought to have been converted to Autogas. In 2016, around 110 000 conversion kits were installed in Poland (POGP, 2016). Conversion costs are low compared to Western European countries, mainly due to lower labour costs. There is a wide range of conversion kits on offer,

including the local brand, STAG, produced by ACSA. Sales of OEM Autogas vehicles have also been growing as the number of OEM models available on the Polish market has expanded. Dacia and Skoda are the market leaders, with Hyundai-Kia, Opel, Renault-Nissan and others also marketing Autogas cars (either factory-fitted or converted by the importer). Sales of OEM models reached around 10 000 cars in 2015 – around 2.5% of all new car registrations. [1]

At the end of 2016, there were 5 390 refuelling stations selling Autogas across the country – slightly fewer than a year before. Most of these stations are small, family-run businesses, though more large service stations are installing Autogas pumps in response to growing demand (POGP, 2017).

15.2 Government Autogas incentive policies

The success of Autogas in Poland is the result of a large excise-tax advantage over gasoline and diesel, which ensures a relatively low price of the fuel at the pump. The excise duty on Autogas has barely increased since 2005, while that on the other two fuels continued to rise until 2013, especially in the case of diesel (the rates on all three fuels have been constant since 2013). The tax on Autogas is now less than an a third of the amount charged on gasoline and diesel (Figure B15.1). Wholesale LPG prices are also much lower, helped since February 2015 by the removal of a small import duty. Consequently, the pump price of Autogas in 2016 was just 42% that of gasoline and 44% that of diesel.

Table B15.1: Automotive-fuel prices and taxes per litre – Poland

	Zlotys						US dollars
	2011	2012	2013	2014	2015	2016	2016
Pump prices							
Autogas	2.600	2.772	2.491	2.562	1.963	1.807	0.458
Diesel	5.037	5.664	5.474	5.206	4.477	4.133	1.047
Gasoline	5.122	5.696	5.477	5.273	4.629	4.358	1.104
Total taxes							
Autogas	0.945	0.981	0.931	0.945	0.833	0.804	0.204
Diesel	2.230	2.505	2.479	2.432	2.296	2.232	0.566
Gasoline	2.617	2.729	2.692	2.655	2.535	2.484	0.630
Excise taxes							
Autogas	0.459	0.462	0.465	0.466	0.466	0.466	0.118
Diesel	1.288	1.446	1.456	1.459	1.459	1.459	0.370
Gasoline	1.660	1.664	1.668	1.669	1.669	1.669	0.423
Pre-tax prices							
Autogas	1.655	1.791	1.560	1.617	1.130	1.003	0.254
Diesel	2.807	3.159	2.994	2.774	2.181	1.901	0.482
Gasoline	2.504	2.967	2.785	2.618	2.094	1.874	0.475

Note: Excise taxes do not include a fuel surcharge and a compulsory stock fee (which are reflected in pre-tax prices).

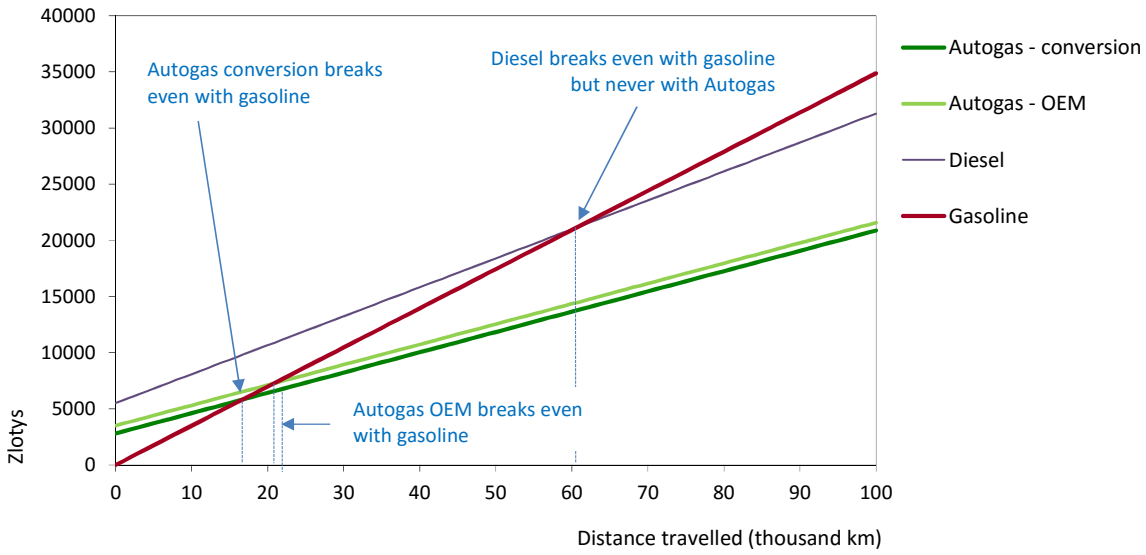
[1] *Argus LPG World*, 19 April 2016.

In contrast with some other Autogas markets that have seen rapid growth, there are no grants or other kinds of subsidy for vehicle conversions, nor the installation of distribution and refuelling infrastructure. Autogas may benefit from planned changes in legislation on clean transport, which is expected to include tighter controls on emissions, especially from diesel vehicles.

15.3 Competitiveness of Autogas against other fuels

The break-even distance for Autogas against gasoline vehicles is very low in Poland, both because of the big tax advantage on the fuel itself and the relatively low costs of vehicle conversions and OEM vehicles. The average cost of converting an old gasoline car is estimated at around 2 800 zlotys (about $700). This yields a break-even distance of just 17 000 km – about one year of driving for a private car owner and much less for a taxi or commercial operator based on average 2016 fuel prices (Figure B15.2). An OEM autogas vehicle breaks even with gasoline at a slightly greater distance of 21 000 km assuming an average premium of about 3 500 zlotys ($900), though the premium is a lot lower and even zero in some cases (which means that the running costs of an Autogas vehicle are always lower than those of a gasoline vehicle). Autogas is always cheaper than diesel regardless of distance as the cost of buying a diesel car and fuel costs are higher.

Figure B15.2: Running costs of a non-commercial LDV, 2016 – Poland

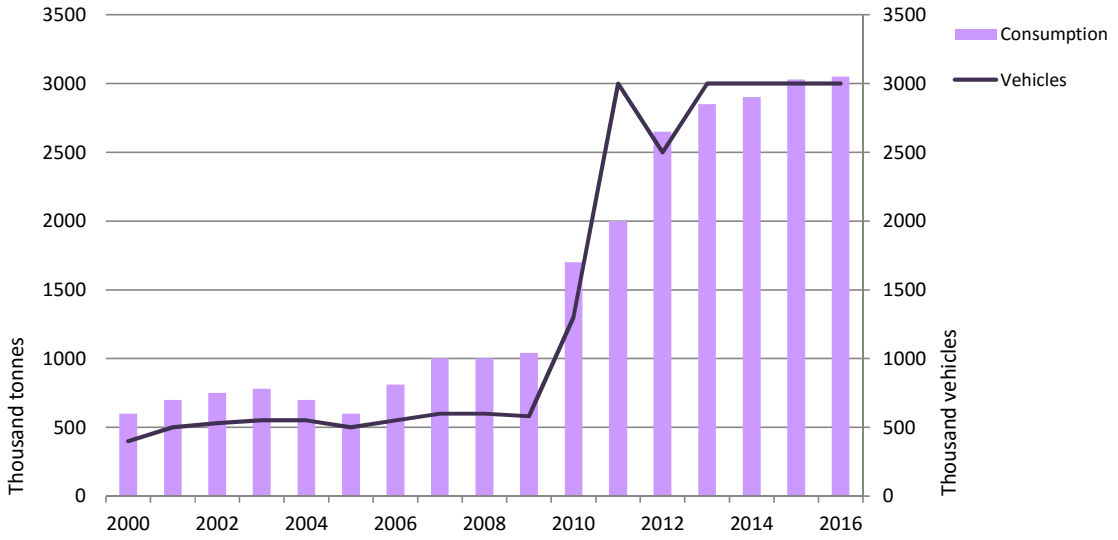


16 Russia

16.1 Autogas market trends

Russia has the world's third-largest Autogas market after Korea and Turkey. The market took off in the 2000s when the previous policy of diverting LPG to the domestic sector for social reasons, which had deprived the Autogas sector of fuel, changed. Demand has surged since the late 2000s as Autogas has become much cheaper than competing fuels. It reached 3.05 million tonnes in 2016 – three times the levels of 2009 and almost six times that of 2000 (Figure B16.1).[1] Autogas now accounts for about 6% of total road-fuel consumption (it was little more than 2% in 2009) and 30% of total LPG use.

Figure B16.1: Autogas consumption and vehicle fleet – Russia



At end-2016, there were an estimated 3 million vehicles in Russia capable of running on Autogas – most of them converted gasoline cars, though factory-fitted OEM vehicles are available. The majority of these vehicles are owned by commercial fleet operators. Most Autogas vehicles are thought to be more than ten years old.[2] There are an estimated 4 900 Autogas refuelling stations across Russia, the majority of which are owned by Gazprom and sell CNG alongside Autogas.

Autogas competes both with diesel and CNG in Russia. CNG use has been falling rapidly in recent years and is now a fraction of that of Autogas; in 2014, CNG consumption reached 49 000 tonnes of oil equivalent – less than

[1] There is some uncertainty about the accuracy of Autogas consumption data for Russia. The data shown here are from WLPGA/Argus (2017). Data from the IEA show much lower consumption levels (386 000 tonnes for 2016, or 13% of the level reported by WLPGA/Argus).This enormous discrepancy is thought to be due to misreporting of sales by retailers to the authorities.

[2] Presentation by A. Rodichev, *Russian LPG Market: Current Status and Trends* (Dusseldorf, June 2011).

half the level of 2009 (and 2% of Autogas use), mainly because of switching to diesel and Autogas by public buses. A recent change in government policy aims to boost the use of both CNG and Autogas.

16.2 Government Autogas incentive policies

A law adopted in 2012 sets out a goal of stimulating the use of Autogas and natural gas as alternative fuels, as well as EVs. The most significant policy incentive for Autogas is Russia is the absence of an excise tax on the fuel (gasoline and diesel both carry taxes). As Russia is a major producer and exporter of LPG (primarily from natural gas processing), domestic wholesale prices are relatively low (as they are determined by the netback value of exports, which carry a large transportation component). Retail fuel prices are deregulated. The pre-tax price of Autogas in 2016 was little more than half that of gasoline and diesel (Table B16.1). Adding VAT of 18%, the pump price of Autogas in 2016 was just 16.08 rubles per litre, compared with 36.48 rubles for gasoline (including an excise tax of 13.15) and 35.20 rubles for diesel (with a tax of 9.87 rubles). The rate of excise tax on gasoline has risen in recent years, while that on diesel has been broadly flat since 2012.[1] There are no other fiscal or regulatory incentives.

Table B16.1: Automotive-fuel prices and taxes per litre – Russia

	Rubles						US dollars
	2011	2012	2013	2014	2015	2016	2016
Pump prices							
Autogas	0.00	n.a.	15.00	n.a.	n.a.	16.08	0.24
Diesel	0.00	39.90	n.a.	37.74	34.62	35.20	0.53
Gasoline	0.00	39.50	n.a.	40.75	35.51	36.48	0.54
Total taxes							
Autogas	0.00	n.a.	2.29	n.a.	n.a.	2.45	0.04
Diesel	0.00	9.84	n.a.	10.21	9.78	9.87	0.15
Gasoline	0.00	10.38	n.a.	12.24	13.00	13.15	0.20
Excise taxes							
Autogas	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Diesel	0.00	3.75	4.05	4.46	4.50	4.50	0.07
Gasoline	0.00	4.36	4.60	6.02	7.58	7.58	0.11
Pre-tax prices							
Autogas	0.00	n.a.	12.71	n.a.	n.a.	13.63	0.20
Diesel	0.00	30.06	n.a.	27.52	24.84	25.33	0.38
Gasoline	0.00	29.12	n.a.	28.51	22.51	23.33	0.35

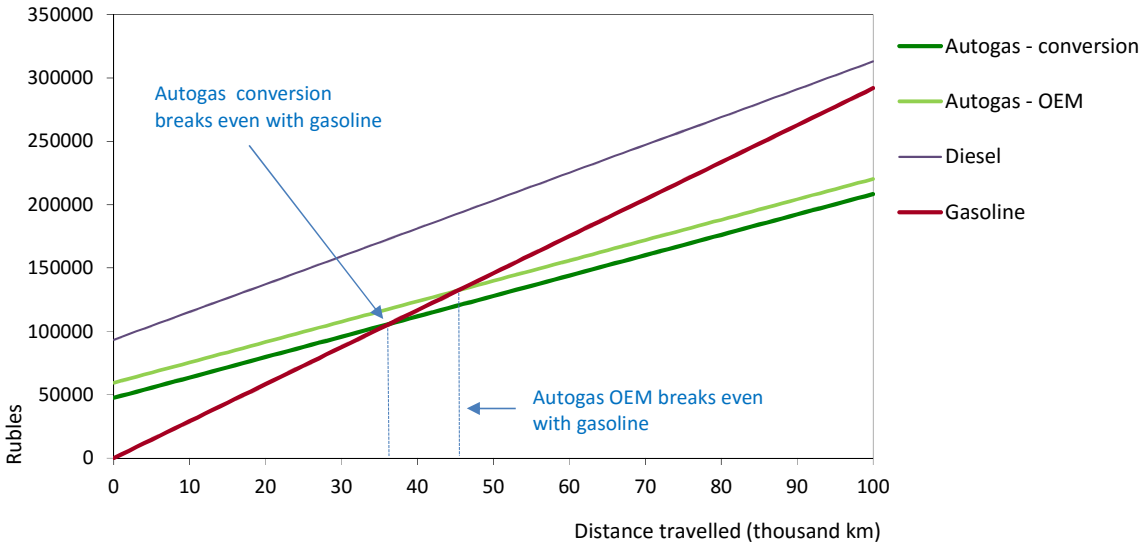
Note: Diesel prices and taxes are for Euro-5 grade.

[1] For Euro-5 grade diesel. In line with the Russian government's policy of encouraging the take-up of less polluting modern diesel vehicles, the government applies different rates of tax on diesel according to the grade of fuel, with higher rates being applied progressively to the lowest-quality grades.

16.3 Competitiveness of Autogas against other fuels

The relatively low price of Autogas at the pump renders it highly competitive with both gasoline and diesel. Assuming a conversion cost of 48 000 rubles (about $700), a converted Autogas car breaks even with a gasoline-fuelled equivalent at 37 000 km, or less than a year of driving for a commercial fleet vehicle, based on 2016 prices (Figure B16.2). For an OEM Autogas vehicle, the break-even distance is 46 000 km, assuming a price premium of 58 000 rubles ($900). Autogas is always competitive with diesel, regardless of distance. This analysis clearly demonstrates the continuing attraction of Autogas.

Figure B16.2: Running costs of a non-commercial LDV, 2016 – Russia

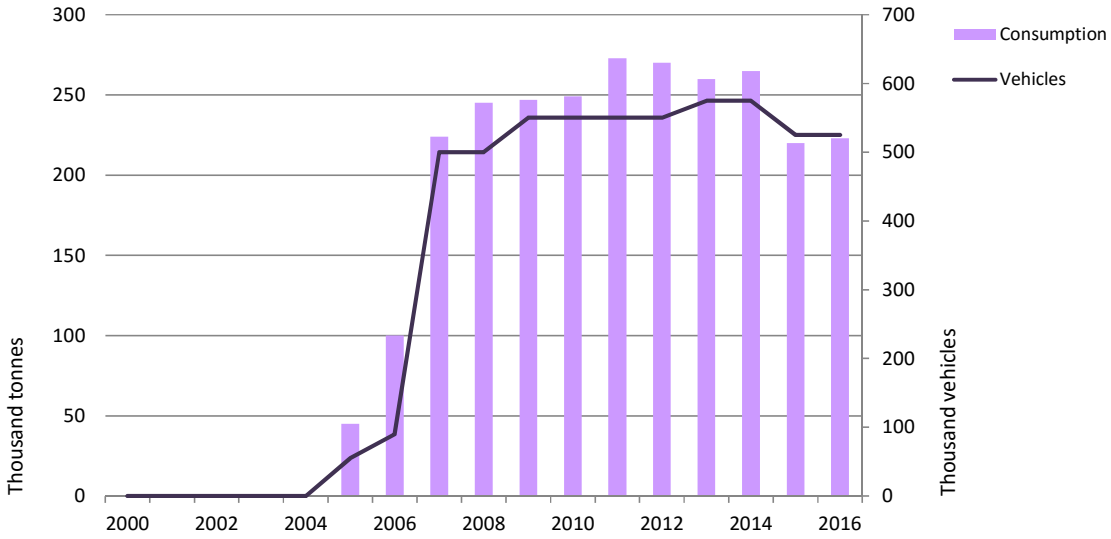


17 Serbia

17.1 Autogas market trends

Serbia has a well-developed Autogas market, with one of the highest shares of total automotive-fuel consumption in the world. Autogas sales took off in the mid-2000s in response to a strong fuel-tax incentive. From almost zero in 2004, they reached close to 280 000 tonnes in 2011; they have dropped back since then, reaching 223 000 in 2016 (Figure B17.1). Autogas now makes up about 12% of the road-fuel market and 71% of total LPG consumption in Serbia – most of which is imported. Autogas is the only alternative fuel used to any significant degree in the country.

Figure B17.1: Autogas consumption and vehicle fleet – Serbia



Autogas use has been driven by a rapid expansion in the size of the fleet of vehicles able to run on the fuel. Most of that increase took place in just five years up to 2009. Since then, it has continued to edge up, reaching a record 525 000 vehicles in 2016 – many of them old gasoline cars dating back to the 1980s and 1990s, which were easy and cheap to convert. These include locally made cars, such as Yugos, and imports from Western Europe. Most of the conversions kits that have been installed are from Italian companies, including Lovato and Tartarini. Autogas is widely available throughout the country in urban areas and along major routes. At end-2016, there were 700 filling stations selling Autogas, some of them entirely dedicated to the fuel.

17.2 Government Autogas incentive policies

The principal policy incentive for Autogas in Serbia is a low rate of excise duty relative to that on the gasoline and diesel. In 2016, the duty amounted to 21.12 dinars/litre (based on an official rate of 41 dinars/kilogramme), compared with 54 dinars for diesel and 53.50 dinars for gasoline (Table

B17.1). The resulted in a pump price of Autogas that was 48% that of diesel and exactly half that of gasoline. The price of Autogas has fallen slightly relative to the other fuels in the last few years due to a faster increase in the excise duty on diesel and a widening of the gap in wholesale prices. Most of the excise duty on all three fuels is refundable for commercial users, including taxis and road hauliers.[1]

Table B17.1: Automotive-fuel prices and taxes per litre – Serbia

	Dinars						US dollars
	2011	2012	2013	2014	2015	2016	2016
Pump prices							
Autogas	n.a.	n.a.	59.03	63.21	64.20	60.23	0.540
Diesel	n.a.	n.a.	114.30	115.08	125.22	126.03	1.130
Gasoline	n.a.	n.a.	114.30	109.85	120.98	121.57	1.090
Total taxes							
Autogas	n.a.	n.a.	25.30	28.58	31.32	31.17	0.279
Diesel	n.a.	n.a.	61.05	65.18	70.87	75.01	0.672
Gasoline	n.a.	n.a.	68.65	68.31	70.16	72.76	0.652
Excise taxes							
Autogas*	15.46	15.46	15.46	18.04	20.62	21.13	0.189
Diesel	n.a.	42.00	42.00	46.00	50.00	54.00	0.484
Gasoline	n.a.	49.60	49.60	50.00	50.00	52.50	0.471
Pre-tax prices							
Autogas	n.a.	n.a.	33.73	34.63	32.88	29.06	0.261
Diesel	n.a.	n.a.	53.25	49.90	54.35	51.03	0.458
Gasoline	n.a.	n.a.	45.65	41.54	50.81	48.81	0.438

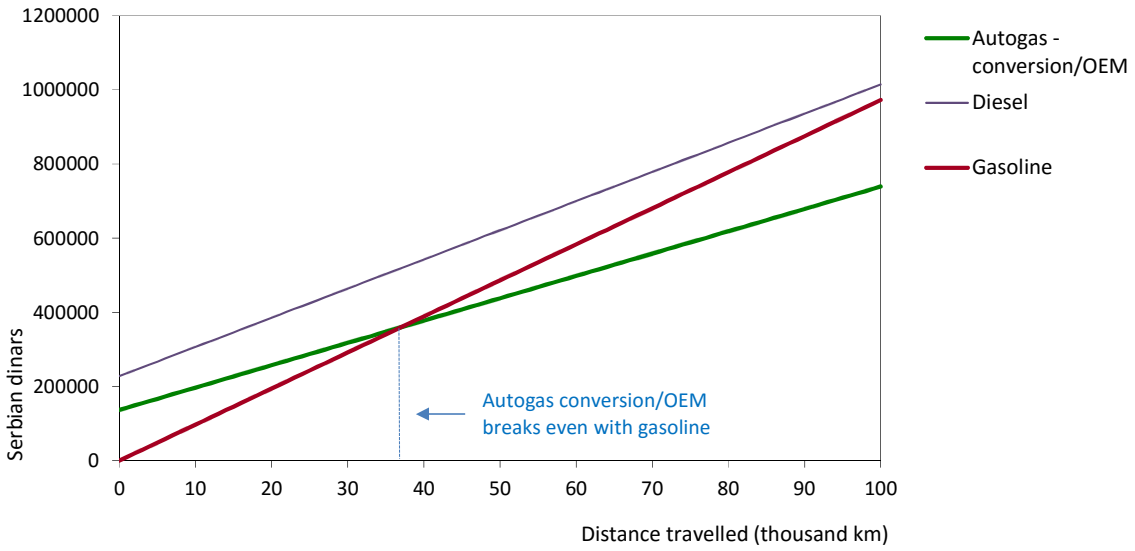
* Converted from the official rates in dinars/kg at 1.94 litres/kg. The tax rose from 30 dinars/kg in 2013 to 35 dinars in 2014, 40 dinars in 2015 and 41 dinars in 2016. The excise tax rates on diesel and gasoline are set in dinars/litre.

17.3 Competitiveness of Autogas against other fuels

The low rate of excise duty and correspondingly low price of Autogas at the pump makes the fuel highly competitive with other road-transport fuels. Assuming the cost of converting a gasoline car to run on Autogas is around 140 000 dinars (about $1 250), the breakeven distance is just 37 000 km – roughly two years of driving (Figure B17.2). After 100 000 km, the total cost saving is over 230 000 ($2 000). The price premium of an OEM LPG car over gasoline version is generally about the same as the cost of conversion, so the breakeven distance is similar. The high price of diesel, largely due to the large excise duty, means that the fuel is never competitive with Autogas and only breaks even with gasoline at well over 100 000 km.

[1] https://home.kpmg.com/content/dam/kpmg/pdf/2016/01/tnf-serbia-jan-19-2016excise.pdf

Figure B17.2: Running costs of a non-commercial LDV, 2016 – Serbia



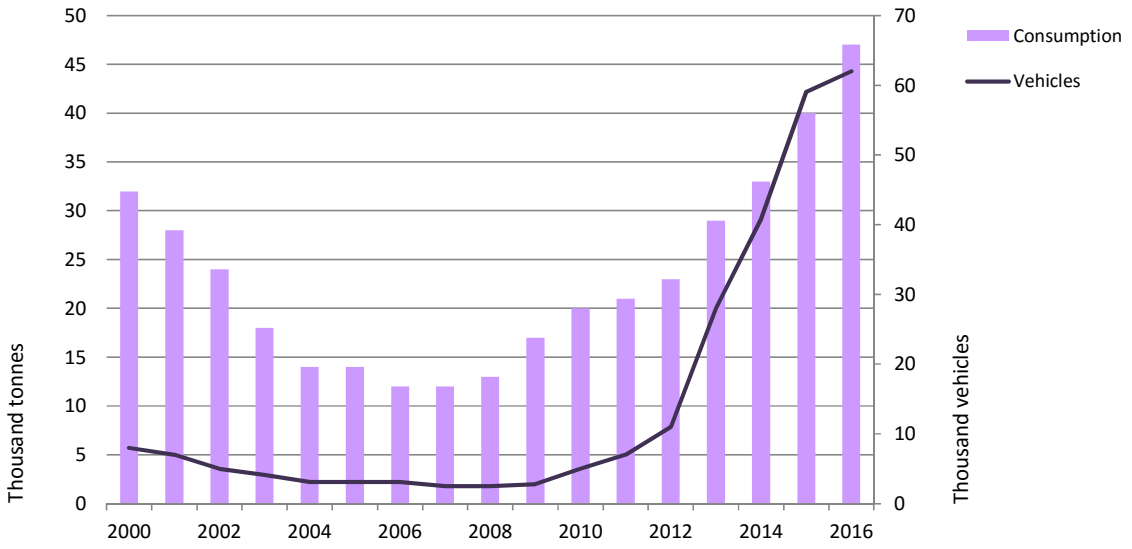
:

18 Spain

18.1 Autogas market trends

Spain has a very small Autogas market, but it is expanding rapidly in response to a substantial fiscal incentive and various national and local initiatives to promote the take-up of the fuel for environmental reasons. Consumption of the fuel has dwindled to little more than 10 000 tonnes by the mid-2000s, but has since risen steadily, reaching 47 000 tonnes in 2016 (Figure B18.1) – 0.2% of total use of automotive fuel in the country.

Figure B18.1: Autogas consumption and vehicle fleet – Spain



The rise in Autogas use has been driven by a jump in conversions and OEM vehicle sales. At the end of 2016, there were an estimated 62 000 Autogas vehicles on use, up from just 3 000 as recently as 2009. Until recently, most Autogas vehicles in use were aftermarket conversions. However, a growing number of carmakers now sell OEM Autogas models. At present, 14 carmakers – Alfa Romeo, Dacia, Fiat, Ford, Opel, Piaggio, Renault, Ssangyong, Subaru, Citroën, Peugeot, Suzuki, Mercedes and DFSK – market Autogas LDVs. In addition, there has been an increase in so-called "phase II" conversions or "delayed OEMs", whereby new vehicles are sent directly by the OEM (excluding Opel) to an associated workshop which handles the conversion and the paperwork. A number of different conversion kits are available, mostly from Italian-based companies, including Tartarini, Landi Renzo, BRC, Icom, GFI, Imega, Lovato, LiquidSi (Vialle) and Stefanelli. Conversions must be inspected before a Road Permit (Permiso de Circulación) can be issued.

The number of refuelling sites that sell Autogas is also on the rise, numbering 1 000 at the end of 2016. Repsol, which operates two-thirds of these sites, plans to expand the number of its stations selling Autogas to 1 000 by 2020.[1]

18.2 Government Autogas incentive policies

The principal form of policy support for Autogas, as in most other countries, is a relatively low excise tax on the fuel. Up to 2011, Autogas was exempt from excise tax. A tax of 3.2 cents/litre was introduced in 2012 and has not changed since (Table B18.1). In 2016, the same tax was 46.2 cents on gasoline and 36.8 cents on diesel. The tax on those fuels has increased by almost as much as the amount for Autogas, so the introduction of the tax on Autogas has not had any significant effect on the fuel's competitiveness. Combined with a lower wholesale price, the favourable excise tax results in a relatively low price of Autogas at the pump. In 2016, it averaged 59.5 cents/litre – 41% lower than the price of diesel and 48% lower than that of gasoline. In absolute terms, these price differentials have changed very little in recent years.

Table B18.1: Automotive-fuel prices and taxes per litre – Spain

	Euros						US dollars
	2011	2012	2013	2014	2015	2016	2016
Pump prices							
Autogas	0.696	0.747	0.765	0.744	0.626	0.595	0.658
Diesel	1.270	1.365	1.359	1.306	1.115	1.014	1.121
Gasoline	1.319	1.424	1.431	1.387	1.228	1.151	1.273
Total taxes							
Autogas	0.138	0.151	0.165	0.161	0.141	0.135	0.150
Diesel	0.540	0.579	0.606	0.598	0.562	0.544	0.601
Gasoline	0.644	0.684	0.713	0.706	0.675	0.662	0.732
Excise taxes							
Autogas	0.000	0.032	0.032	0.032	0.032	0.032	0.036
Diesel	0.346	0.361	0.370	0.371	0.368	0.368	0.407
Gasoline	0.443	0.457	0.465	0.465	0.462	0.462	0.511
Pre-tax prices							
Autogas	0.558	0.596	0.601	0.583	0.486	0.460	0.509
Diesel	0.730	0.786	0.753	0.709	0.554	0.470	0.520
Gasoline	0.675	0.740	0.718	0.681	0.553	0.489	0.541

To date, other central government measures aimed at encouraging Autogas have been largely limited to periodic incentives for clean transport generally. The Ministry of Economy, Industry and Competitiveness recently reaffirmed its support for Autogas and announced the approval of a new plan, called MOVEA, with a budget of €1.6-1.7 million.[2] Regions and provinces also have

[1] http://auto-gas.net/newsroom/spanish-energy-company-guarantees-1500-lpg-stations-2020/
[2] http://auto-gas.net/newsroom/spain-catalonia-commits-encourage-autogas-adoption/

programmes to support Autogas and other alternative fuels. For example, in 2017, the city of Madrid launched a scheme to encourage the conversion of 1 000 private cars that run on gasoline to Autogas, whereby a grant of €200 per vehicle is paid to the owner of the vehicle and another €200 to the workshop where the conversion is carried out. The Catalonia government is also preparing a decree that will mandate the purchase of clean vehicles for its public fleets, including Autogas vehicles.[1]

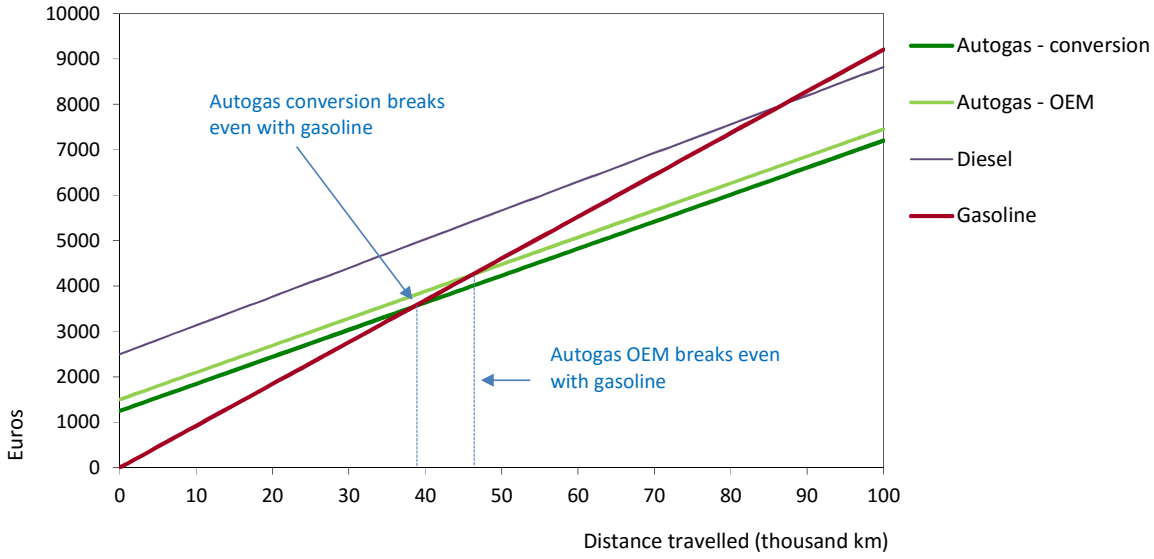
Another important measure that increasingly favours Autogas concerns traffic restrictions. In early 2017, the General Transit Authority (DGT) started to implement a vehicle-labelling system based on emissions, which (as in some other European countries) provides a legal basis for local traffic regulations related to air quality. Under the system, battery EVs are classified in "zero emissions" category; Autogas, hybrid and CNG/LNG vehicles are classified in the "ECO" category just below, and vehicles that meet Euro-6 standards to a "C" category. Some municipal authorities may restrict or prohibit the entry in densely populated areas of certain vehicles according to their emissions category. For example, the municipal authorities in Madrid, in the event of severe pollution, may ban all vehicles from entering the central area of the city other than "ECO" and "zero emissions" vehicles. Barcelona plans to do likewise from 2020, as well as offering a discount to Autogas vehicles that park in the city's central blue zone.[2]

18.3 Competitiveness of Autogas against other fuels

The current structure of fuel prices makes Autogas highly competitive in Spain. Based on average 2016 prices, Autogas breaks even against gasoline after just 39 000 km for converted vehicle (based on an average cost of around €1 250) and 47 000 km for an OEM vehicle (based on an average price premium of €1 500) (Figure B18.2). Diesel breaks even against gasoline after about 85 000 km, but is never competitive with Autogas because of higher fuel costs and a higher vehicle price (around €1 000 more than an OEM Autogas car on average).

[1] http://auto-gas.net/newsroom/spain-catalonia-boosts-alternative-vehicles-public-fleets/
[2] http://auto-gas.net/newsroom/barcelona-offers-parking-discounts-autogas-vehicles/

Figure B18.2: Running costs of a non-commercial LDV, 2016 – Spain

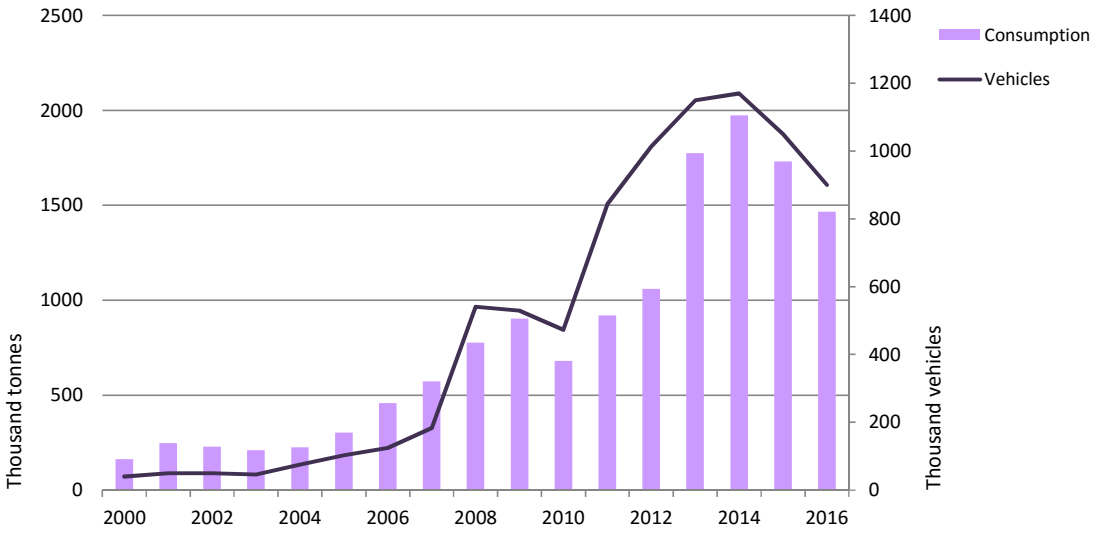


19 Thailand

19.1 Autogas market trends

Thailand's Autogas market has been on a roller-coaster ride over the last decade or so, with shifting policies and uncertainty over future policy direction. Sales were flat at around 200 000 per year over the first half of the 2000s, but then took off in 2005 in response to a sudden widening of the already favourable price gap between Autogas on the one hand and gasoline and diesel on the other – part of a new government strategy aimed at reducing pollution in major urban centres. Sales dropped sharply in 2010, but then rebounded to a peak of almost 2 million tonnes in 2014, rising by a remarkable 710 000, or two-thirds, in 2013 alone (Figure B19.1). They have since fallen heavily, to just 1.47 million tonnes in 2016 with higher prices. Autogas accounted for an estimated 6% of total road-transport fuel sales in 2016, down from over 9% in 2014. The rapid growth in Autogas demand has contributed to Thailand becoming a large net importer of LPG.

Figure B19.1: Autogas consumption and vehicle fleet – Thailand



Note: The fall in consumption and vehicle numbers in 2010 may be due to a break in the series.

The number of vehicles running on Autogas grew rapidly after 2003 to almost 1.2 million in 2014, but fell back to about 900 000 in 2016 – equal to roughly 6% of all the cars and trucks on the road in Thailand. The growth in the Autogas fleet was originally driven by taxis and motorised rickshaws, but private passenger cars accounted for a bigger share of vehicles that were added to the fleet in recent years. Virtually all the Autogas vehicles in use in Thailand are converted gasoline cars; no OEM Autogas models are marketed in Thailand. The contraction in the Autogas fleet is largely due to switching to ethanol (see below). At end-2016, there were an estimated 1 000 refuelling

stations selling Autogas (about 6% of the total), most of which are in or around Bangkok.

19.2 Government Autogas incentive policies

Thailand's oil market was largely deregulated in 1991, but the government still caps the wholesale and retail prices of LPG for social reasons, using an oil stabilisation fund to balance differences in the ex-refinery prices (which are deregulated) and wholesale prices. The retail price of Autogas, which used to be same as that of LPG sold in cylinders, remained unchanged between 2008 and 2011. Since then the price has risen, while those of gasoline and diesel have fallen due to a change in policy aimed at phasing out oil subsidies (LPG was more heavily subsidised than other transport fuels). The regime that came to power after the coup in 2014 has shifted most of the remaining subsidies from the oil fund away from LPG and towards two ethanol blends (Gasohol E20 and E85) produced locally. A small subsidy on LPG at the same rate for all sectors remains in place. Since January 2015, in order to better reflect the cost of supply, the government sets a uniform LPG wholesale price for all sectors based on a weighted average of market prices (IEA, 2017c). CNG prices were completely deregulated in 2016 and subsidies removed.

Table B19.1: Automotive-fuel prices and taxes per litre – Thailand*

	Baht						US dollars
	2011	2012	2013	2014	2015	2016	2016
Pump prices							
Autogas	9.79	11.21	11.55	11.77	12.63	11.06	0.313
Diesel	29.45	30.42	29.97	29.69	24.54	23.26	0.659
Gasoline	44.64	46.42	46.66	46.73	34.34	31.80	0.901
Total taxes							
Autogas	1.14	7.10	7.20	6.34	6.19	7.21	0.204
Diesel	3.13	2.49	3.23	0.21	6.48	7.91	0.224
Gasoline	16.02	16.35	20.74	11.24	15.66	15.40	0.436
*Excise taxes***							
Autogas	0.50	6.37	6.45	5.57	5.37	6.49	0.184
Diesel	1.21	0.50	1.27	-1.73	4.88	6.39	0.181
Gasoline	13.10	13.32	17.69	8.19	13.41	13.32	0.377
Pre-tax prices							
Autogas	8.65	4.10	4.34	5.43	6.44	3.84	0.109
Diesel	26.32	27.93	26.74	29.48	18.06	15.34	0.435
Gasoline	28.62	30.06	25.92	35.49	18.68	16.40	0.465

* In Bangkok. **Including oil fund levies and subsidies, and conservation levies.

The average pump price of Autogas in 2016 was only 35% of that of gasoline – the lowest rate of any of the countries surveyed in this report – and 47% of that of diesel (Table B19.1). All automotive fuels, including Autogas, are subject to an excise tax, a conservation fund tax and an oil stabilisation levy (or subsidy). Overall, these taxes are still lower for Autogas than the other

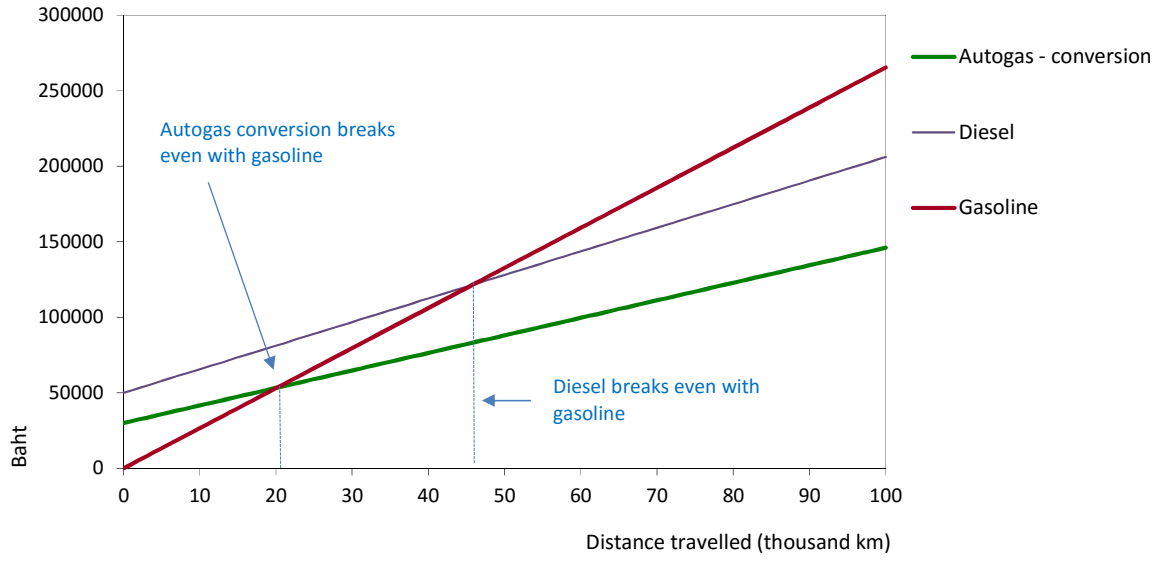
two main transport fuels, though the gaps have narrowed considerably in recent years. There are no subsidies for vehicle conversions.

The previous government had been encouraging motorists to switch to CNG rather than Autogas, partly as a way of reducing the overall cost of subsidies to LPG. This led to a rapid increase in CNG consumption alongside the expansion of the Autogas market: by 2014, CNG consumption exceeded slightly the use of Autogas in energy terms, accounting for 12% of the total automotive fuel market. Demand for CNG, like that for Autogas, has since fallen back (by 12% between 2014 and 2016) in response to a sharp increase in the pump price. The new government is promoting switching instead to ethanol blends, to support the large sugarcane sector in Thailand. Production and consumption of ethanol has been growing at double-digit rates in the last few years. The low prices of the subsidised ethanol blends (see below) is boosting demand for ethanol as a transport fuel: sales of gasohol increased 37% between 2014 and 2016. The government is also looking to promote EVs; several charging stations have been installed in Bangkok, though the number of plug-in and battery EVs remains very small as yet.

19.3 Competitiveness of Autogas against other fuels

Despite recent price increases, the pump price of Autogas remains low enough to make the fuel competitive with diesel and price results in a breakeven distance for a typical passenger car converted to run on Autogas against gasoline of around 21 000 km (Figure B19.2). This analysis assumes a conversion cost of 30 000 baht (roughly $850). Diesel breaks even with gasoline at a distance of more than 50 000 km (assuming a premium of 50 000 baht, or around $1 400, for a diesel car over a gasoline car), but as the running costs for Autogas cars are lower than those for diesel cars, Autogas is always more competitive.

Figure B19.2: Running costs of a non-commercial LDV, 2016 – Thailand



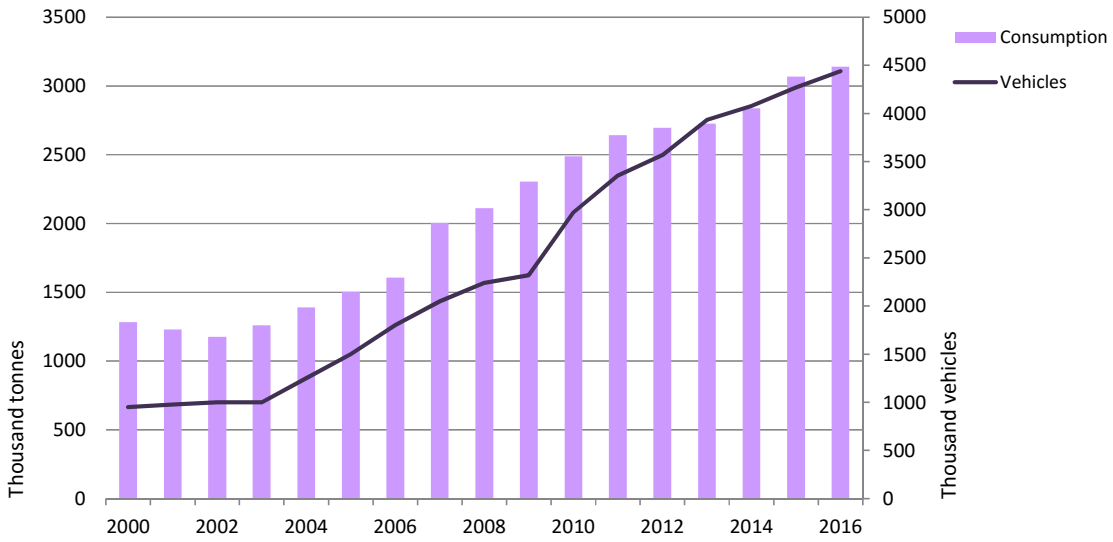
Although Autogas remains competitive with conventional fuels, it has lost ground to ethanol, the prices of which have fallen significantly compared with Autogas. In 2016, the price of E85 in Bangkok averaged 18.14 Baht/litre and that of E20 21.98 Baht. Adjusting for differences in mileage (which vary a lot depending on the vehicle and the conversion kit), the price of E85 in many cases is only slightly higher than that of Autogas. As the cost of installing an ethanol conversion kit to enable a gasoline car to run on all blends of ethanol and gasoline is even lower than that for Autogas (since there is no need to install a separate fuel tank), ethanol is now generally preferred to Autogas where available, which explains the recent slump in Autogas sales.

20 Turkey

20.1 Autogas market trends

Turkey today has the second-largest Autogas market in the world after Korea – the result of spectacular growth in consumption since the end of the 1990s, when a ban on Autogas vehicles was lifted, and especially since 2003. Consumption of Autogas overtook that of gasoline consumption in 2009, making Turkey the only country in the world where Autogas sales are bigger than those of gasoline. Autogas consumption has more than doubled since 2010, reaching 3.14 million tonnes in 2016 (Figure B20.1). Autogas meets an estimated 14% of the country's total demand for automotive fuels and accounts for three-quarters of Turkey's total LPG consumption, 77% of which is met by imports.

Figure B20.1: Autogas consumption and vehicle fleet – Turkey



The boom in Autogas use in Turkey is the result of a huge expansion in the number of vehicles able to run on the fuel. By the end of 2016, there were an estimated 4.44 million Autogas vehicles in use – close to 40% of the country's total fleet of passenger vehicles. No country has more Autogas vehicles on the road. The number of conversions has slowed over the last few years as the market approaches saturation: 167 000 conversions were carried out in 2016. Most vehicles that use Autogas are privately owned, converted gasoline-powered cars; taxis, which make up just 1.5% of the total Autogas fleet, account for 7% of Autogas fuel sales because of their high mileage. The share of taxis in the total Autogas vehicle fleet has fallen sharply in recent years as taxi-owners have tended to opt most often for diesel, but this trend is expected to reverse with growing concerns about pollution from diesel engines.

There are a limited number of OEM Autogas models on sale in Turkey, though carmakers are considering launching new models. Honda's Civic

Sedan, Fiat's Egea and Hyundai's i10 now account for the bulk of sales of new Autogas cars with an OEM warranty. But conversion-kit manufacturers now offer engine warranties to new cars, expanding enormously the range of cars that are converted after purchase. In addition, many car dealers have signed agreements with the conversion-kit manufacturers to enable them to offer the option of converting new cars to Autogas at the time of purchase, boosting consumer confidence. Turkey has a large network of service stations offering Autogas. In total, there were 10 426 refuelling sites at end-2016 – about two-thirds of all the filling stations in Turkey.

20.2 Government Autogas incentive policies

The take-off in Autogas use in Turkey came about more as a result of a social policy of low taxation of LPG as a household fuel than a deliberate policy of promoting alternative fuels. An unregulated conversion industry took root to allow motorists to take advantage of the low price of LPG and low taxes on Autogas. The Turkish LPG market was deregulated at the beginning of 2005, allowing wholesalers and retailers to set pre-tax prices freely, though the regulatory authority retains the right to set a temporary ceiling on prices if it considers that there is a lack of competition in the market. No non-fiscal incentives for Autogas are currently in place.

Table B20.1: Automotive-fuel prices and taxes per litre – Turkey

	Liras						US dollars
	2011	2012	2013	2014	2015	2016	2016
Pump prices							
Autogas	2.320	2.510	2.700	2.760	2.410	2.550	0.843
Diesel	3.679	4.018	4.350	4.369	3.880	3.867	1.278
Gasoline	4.196	4.502	4.786	4.828	4.510	4.563	1.508
Total taxes							
Autogas	1.070	1.270	1.300	1.300	1.250	1.380	0.456
Diesel	1.866	1.987	2.258	2.269	2.186	2.234	0.739
Gasoline	2.532	2.642	2.906	2.853	2.864	2.923	0.966
Excise taxes							
Autogas	0.720	0.880	0.880	0.880	0.880	0.990	0.327
Diesel	1.305	1.375	1.595	1.595	1.595	1.645	0.544
Gasoline	1.892	1.955	2.177	2.177	2.177	2.227	0.736
Pre-tax prices							
Autogas	1.250	1.250	1.410	1.450	1.160	1.170	0.387
Diesel	1.813	2.031	2.092	2.100	1.694	1.633	0.540
Gasoline	1.664	1.860	1.879	1.975	1.645	1.641	0.542

Tax policy changed several times during the early 2000s, as the government sought to control the growth of the market and prevent suppliers from illegally diverting LPG from the cylinder market to the Autogas market. Since the middle of the 2000s, taxation of Autogas has been more stable, though tax rates have risen. The same rate of VAT is now applied to Autogas as to gasoline and diesel (a higher rate had been applied in 2000-2002 to rein back demand) and excise taxes on Autogas have been held well below the level of

those on the other two fuels. From 2012 to 2016, the excise tax on Autogas was constant at 0.88 liras/litre, increasing to 0.99 liras in 2016; the tax on gasoline, which had been unchanged since 2013, also increased by 0.10 lira in 2016 to 2.28 liras, while that on diesel increased by half as much to 1.64 liras (Table B20.1).

As a result of favourable taxation and lower wholesale prices, the pump price of Autogas in Turkey remains significantly lower than that of the other two main fuels. In 2016, the average price of Autogas was 56% of that of gasoline and 66% of that of diesel in per-litre terms. The price gaps have changed only slightly since the start of the decade.

To improve technical performance and ensure safety, the government established stringent conversion standards and laws in 2005. All conversion centres must be licensed by the Turkish Standards Institute and all conversions must be approved by a qualified engineer; the converted vehicle must then be tested for leaks by an independent organisation every two years. As a result, the safety and reliability of conversions has increased. There are now around 1 800 accredited conversion centres offering a wide range of kits, some of which have been developed by Turkish firms. The European Autogas Quality Standard EN 589 became mandatory at the beginning of 2004, which has helped to reduce problems caused by poor fuel quality.

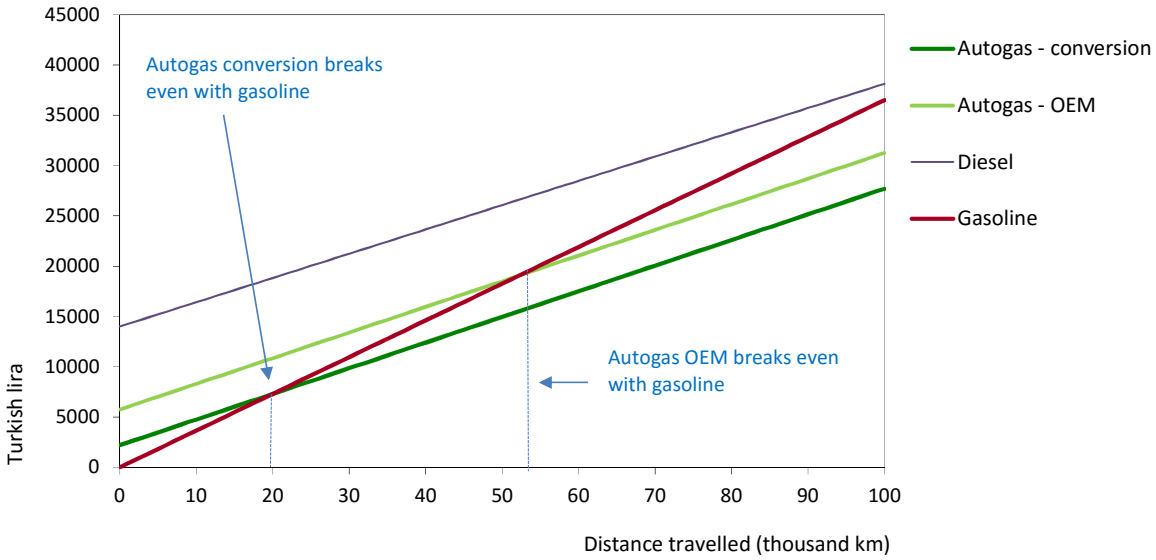
20.3 Competitiveness of Autogas against other fuels

The low cost of conversions in Turkey, due to low labour costs and economies of scale, and the competitive prices of OEM vehicles mean that Autogas breaks even with gasoline at relatively short distances. For a good-quality conversion, which is assumed to cost around 2 200 lira ($700),[1] the distance is only 20 000 km, or little more than one year's driving for a private motorist based on 2016 prices (Figure B20.2). An OEM vehicle, which currently costs on average 5 750 liras more than a gasoline equivalent, breaks even at 53 000 km.

Allowing for the better mileage of a diesel vehicle compared with Autogas, the per-km running costs are marginally lower for the former. But the purchase price of a new diesel car is much higher than that of an OEM Autogas car. Assuming a price difference of about 8 000 liras, diesel never breaks even with Autogas and only breaks even with gasoline at well over 100 000 km. This analysis clearly demonstrates the continuing attractiveness of Autogas over both gasoline and diesel.

[1] The cost can be as low as 1 200 liras ($400).

Figure B20.2: Running costs of a non-commercial LDV, 2016 – Turkey

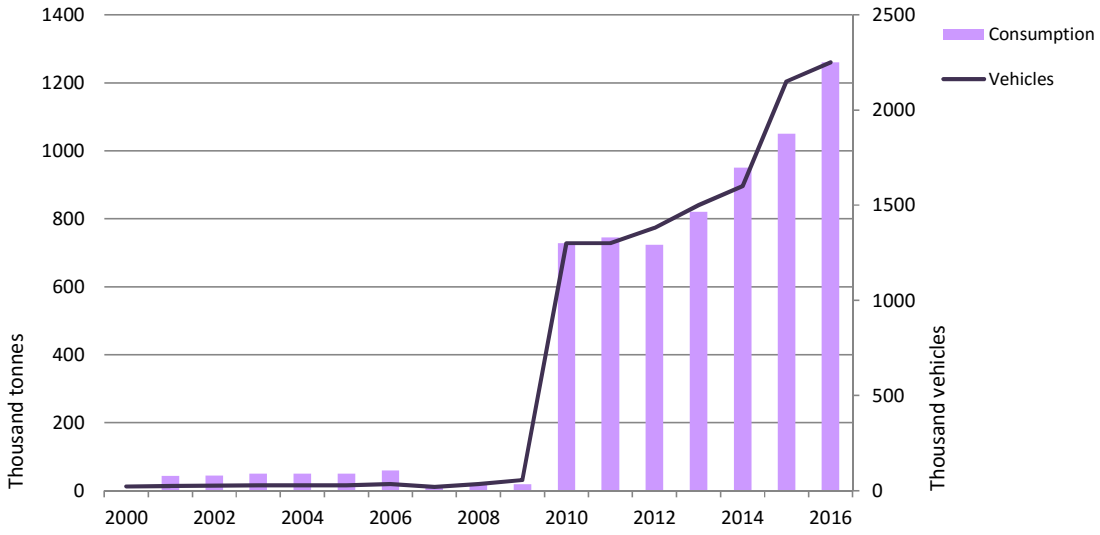


21 Ukraine

21.1 Autogas market trends

Autogas use in Ukraine has grown spectacularly in recent years in response to extremely favourable pump prices, helped by low taxes, and the low cost of converting gasoline cars to run on both fuels. Consumption reached an estimated 1.26 million tonnes in 2016 – a jump of 210 000 tonnes, or one-fifth, compared with 2015 and 73% higher than at the start of the decade (Figure B21.1). Official data show much lower consumption of 565 400 tonnes in the first 11 months of 2016, but not all suppliers file reports of retail sales and some include them in their wholesale figures to avoid paying excise tax.[1] Autogas accounts for approximately one-fifth of all road-fuel sales and 85% of total LPG use in Ukraine.

Figure B21.1: Autogas consumption and vehicle fleet – Ukraine



Note: The jump in concsumption and vehicle numbers in 2010 is due to a break in the series.

The Autogas fleet is expanding rapidly, driving higher consumption. By end-2016, there were an estimated 2.25 million Autogas-enabled cars in use in Ukraine – well over a quarter of all vehicles on the road. Most of them are converted gasoline-powered cars, including many from the 1980s and 1990s, both locally made, such as ZAZ, and imports from Western Europe. A few OEM Autogas cars are imported into Ukraine. Autogas is widely available at filling stations in cities and along major routes, as well as at a few dedicated Autogas stations. In total, there were 3 500 stations selling Autogas throughout the country at end-2016 – up from 3 000 two years earlier.

[1] *Argus LPG World*, 4 January 2017.

21.2 Government Autogas incentive policies

The only government measure in support of Autogas is a very low rate of excise duty compared with gasoline and diesel. In 2016, the tax averaged 0.74 hryvnia per litre, compared with 2.42 for diesel and 4.25 for gasoline (Table B21.1). Duties on all three fuels have been rising in recent years, but the tax on Autogas has remained much lower. The gaps narrowed a little at the beginning of 2017, when the duty on Autogas was raised by 68% while that on gasoline went up by just 24% and that on diesel by 47%. However, taking account of sales taxes, the price advantage of Autogas at the pump in absolute terms has barely changed. The low duty, together with low wholesale prices, result in a highly attractive price of Autogas at the pump: it averaged 8.81 hryvnia in 2016 – 57% lower than that of gasoline and 53% below that of diesel. The price advantage was less pronounced at times in 2016 in the eastern part of the country, due to problems with LPG supplies, which drove up wholesale and retail prices.[1]

Table B21.1: Automotive-fuel prices and taxes per litre – Ukraine

	Hryvnia						US dollars
	2011	2012	2013	2014	2015	2016	2016
Pump prices							
Autogas	n.a.	n.a.	n.a.	6.997	9.350	8.808	0.348
Diesel	n.a.	n.a.	n.a.	12.686	18.434	18.774	0.741
Gasoline	n.a.	n.a.	n.a.	13.298	19.852	20.390	0.805
Total taxes							
Autogas	n.a.	n.a.	n.a.	1.419	2.093	2.205	0.087
Diesel	n.a.	n.a.	n.a.	3.039	4.829	5.549	0.219
Gasoline	n.a.	n.a.	n.a.	3.840	6.392	7.643	0.302
Excise taxes							
Autogas	n.a.	n.a.	0.184	0.253	0.535	0.737	0.029
Diesel	n.a.	n.a.	0.674	0.924	1.756	2.420	0.096
Gasoline	n.a.	n.a.	1.184	1.623	3.083	4.245	0.168
Pre-tax prices	n.a.	n.a.	n.a.				
Autogas	n.a.	n.a.	n.a.	5.578	7.256	6.602	0.261
Diesel	n.a.	n.a.	n.a.	9.647	13.605	13.224	0.522
Gasoline	n.a.	n.a.	n.a.	9.458	13.460	12.747	0.503

Note: Diesel is Euro-4 and Euro-5 grade.

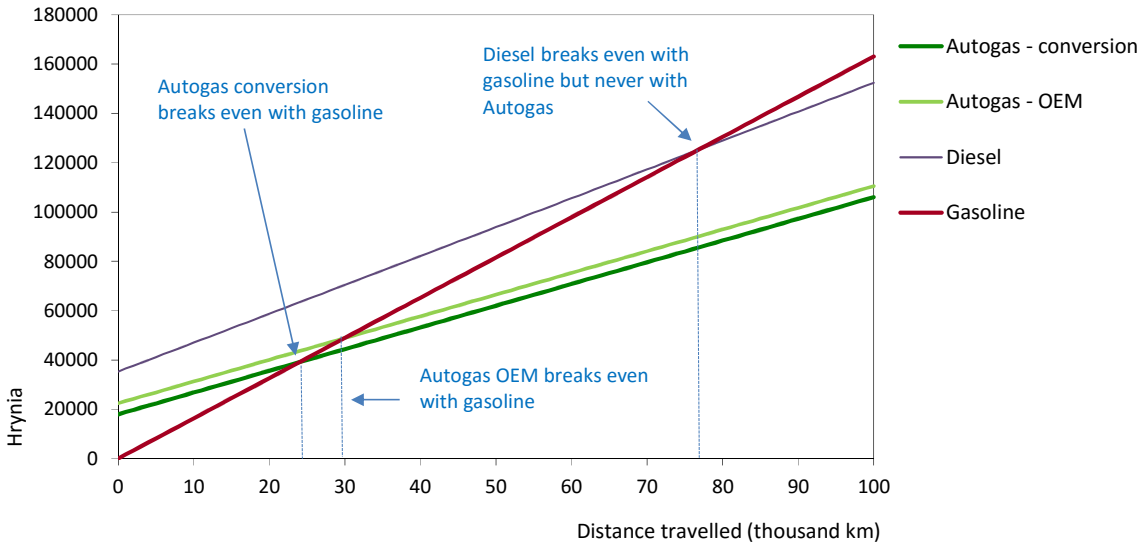
21.3 Competitiveness of Autogas against other fuels

Unsurprisingly, the relatively low price of Autogas *vis-à-vis* gasoline results in a very low break-even distance of just 24 000 km for a converted vehicle – little more than one year of driving for a private motorist – assuming a typical conversion cost of 18 000 hryvnia (about $700) (Figure 21.2). An OEM vehicle breaks even at 30 000 hryvnia assuming a price premium of 22 500 ($900). Autogas is always more competitive with diesel regardless of distance as per-km fuel costs are lower and the price premium for a diesel vehicle is generally

[1] *Argus LPG World*, 1 November 2016.

higher. This analysis demonstrates very clearly why Autogas demand is rising so strongly in Ukraine.

Figure B21.2: Running costs of a non-commercial LDV, 2016 – Ukraine

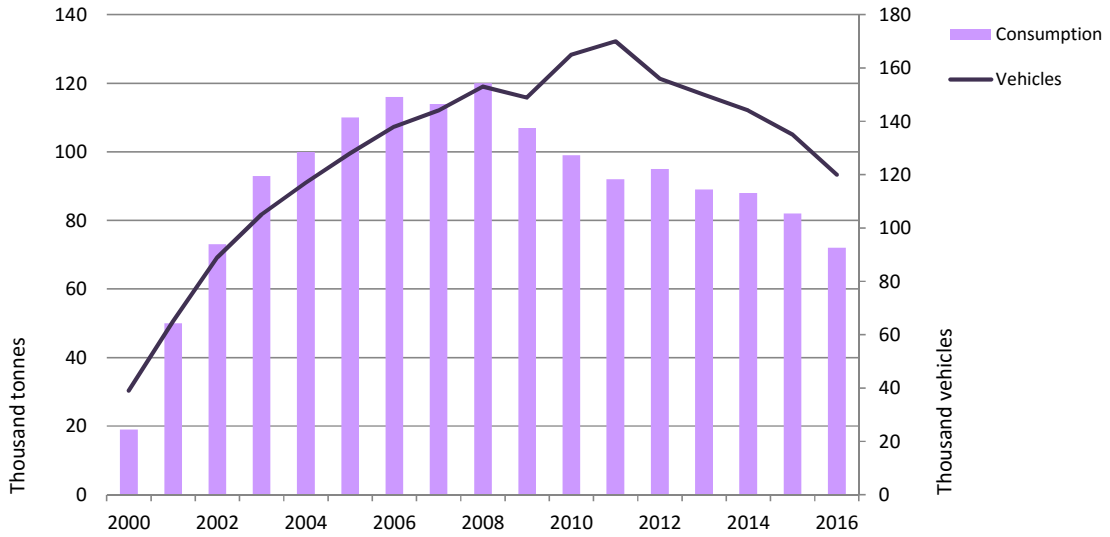


22 United Kingdom

22.1 Autogas market trends

The Autogas market in the United Kingdom emerged at the end of the 1990s and grew rapidly until the mid-2000s in response to a concerted policy push by the government and investment by Autogas suppliers, car manufacturers and technology providers. Vehicle manufacturers, including Vauxhall, Ford, Volvo, MG Rover, LDV and Mitsubishi, developed and brought to market LPG models. Autogas consumption peaked at 120 000 tonnes in 2008 (Figure B22.1). Following a rise in excise duty, which pushed up the price of the fuel at the pump substantially relative to gasoline and diesel, and a reduction in grants in for the purchase of OEM vehicles and aftermarket conversions, the market began to contract, with fuel sales falling to just 71 000 tonnes in 2016. Autogas now meets just 0.2% of the country's road-fuel needs. The consumption of other unblended alternative fuels is minimal, though sales of electric vehicles are starting to rise, in part thanks to fiscal incentives.

Figure B22.1: Autogas consumption and vehicle fleet – United Kingdom



There are a total of 120 000 vehicles in the United Kingdom that are able to run on Autogas, down from a peak of 170 000 in 2011. Sales of OEM Autogas vehicles have dried up completely as none of the major carmakers that market Autogas models import them any longer, but there are still several companies that install conversion kits.[1] A robust vehicle certification and tracking system has been introduced. Interest in Autogas and hybrid Autogas conversion technologies has picked up recently with rising concerns about

[1] At the end of 2016, there were 132 UKLPG Approved Autogas Installers at the end of 2016. UKLPG is the UK trade association for the LPG industry.

the adverse impact of diesel vehicles on urban air quality. There are 1 250 refuelling stations selling Autogas across the country.

22.2 Government Autogas incentive policies

The main form of support for Autogas from the central government is a reduced rate of excise duty. In his 2013 Autumn Statement, the Chancellor of the Exchequer announced a 10-year commitment that the difference between the duty on Autogas on the one hand and that on gasoline and diesel on the other will not be reduced by more than 1 pence per litre per year to assure consumers that the government continues to support the fuel and that their investment in converting to Autogas will not be lost. In fact, the differential has remained constant at 41.9 pence, with the duty on Autogas amounting to 16.1 pence since 2012 (Table B22.1). As a consequence, the pump price of Autogas in 2016 was just 62% of the price of gasoline and 61% that of diesel. The pump price of Autogas fell sharply in 2016, due to weak wholesale prices, widening the price gap with the other two fuels.

Table B22.1: Automotive-fuel prices and taxes per litre – United Kingdom

	Pounds						US dollars
	2011	2012	2013	2014	2015	2016	2016
Pump prices							
Autogas	0.756	0.754	0.874	0.861	0.822	0.670	0.904
Diesel	1.387	1.418	1.404	1.335	1.149	1.101	1.487
Gasoline	1.333	1.354	1.341	1.275	1.111	1.088	1.469
Total taxes							
Autogas	0.289	0.287	0.307	0.305	0.298	0.273	0.368
Diesel	0.813	0.816	0.814	0.802	0.771	0.763	1.030
Gasoline	0.804	0.805	0.803	0.792	0.765	0.761	1.027
Excise taxes							
Autogas	0.163	0.161	0.161	0.161	0.161	0.161	0.218
Diesel	0.582	0.580	0.580	0.580	0.580	0.580	0.782
Gasoline	0.582	0.580	0.580	0.580	0.580	0.580	0.782
Pre-tax prices							
Autogas	0.467	0.467	0.567	0.556	0.524	0.397	0.536
Diesel	0.574	0.602	0.591	0.533	0.378	0.338	0.457
Gasoline	0.529	0.549	0.538	0.483	0.347	0.328	0.442

The only other fiscal incentive for Autogas is a small discount of £10 or £25 (depending in vehicle size) on the annual road tax for Autogas vehicles converted by a UKLPG approved installer.

Other initiatives to encourage Autogas are in place at the local level. The Birmingham City Council recently offered grants for converting a maximum of 63 taxis. The scheme is now complete, but more funds are being sought. In London, the transport authority, Transport for London, has accepted to extend the life of a black cab by five years if it is converted to Autogas (and complies with Euro-6 standards) in order to operate within the ultra-low

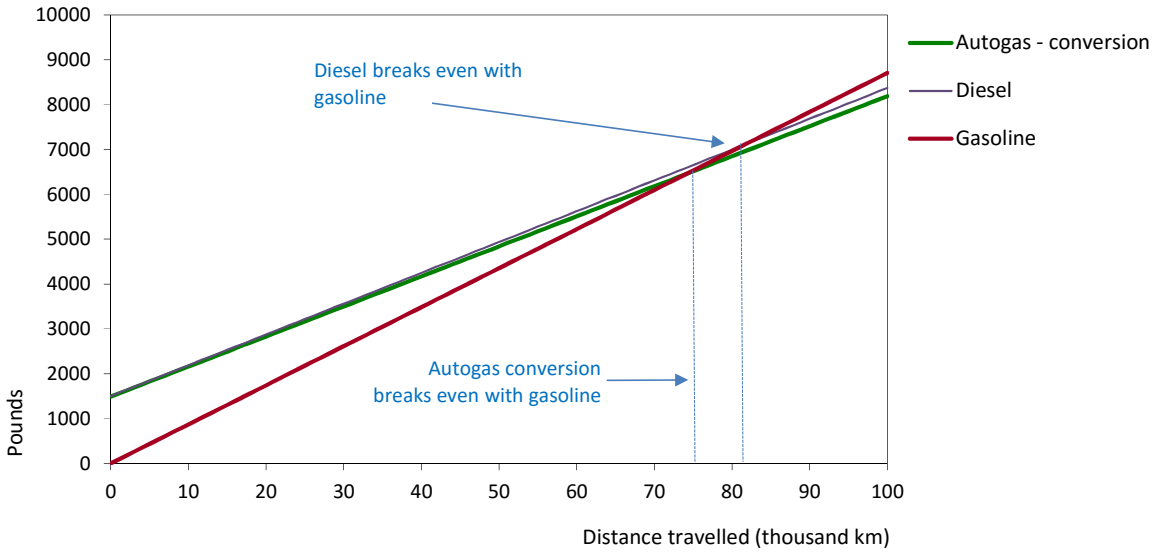
emission zone – an area of central London within which vehicles all vehicles will need to meet exhaust emission standards by 2020 or pay a daily charge to travel. From 2018, all newly licensed taxis and private hire vehicles will need to meet the new emission standards.[1] Clean Air Zones, affecting commercial vehicles only, are due to be introduced in five other UK cities – Birmingham, Leeds, Nottingham, Derby and Southampton – by 2020. In these zones, all Autogas vehicles that comply with Euro-6 standards will be exempt from any charges.

The UK Government published in July 2017 an Air Quality Plan, which is predominantly aimed at reducing NOx emissions in urban areas. The plan provides for funding for local authority initiatives, including retrofitting buses to run on alternative fuels, including Autogas. Fiscal incentives to promote the use of alternative fuels, possibly including Autogas, and discourage the take-up of diesel cars, are expected to be included in the autumn budget in November 2017.

22.3 Competitiveness of Autogas against other fuels

A converted Autogas LDV breaks even with an equivalent gasoline-powered vehicle at around 75 000 km – or about three-and-a-half years of driving for a typical private motorist – based on an average conversion costs of about £1 500 and average 2016 fuel prices (Figure B22.2). Diesel breaks even with gasoline at 82 000 km but is never competitive with Autogas, assuming that a new diesel vehicle costs £1 500 more than a gasoline one. This analysis suggests that Autogas is a more attractive option for high-mileage vehicle owners, such as fleet operators, than diesel, especially in view of the likelihood of new measures to discourage the purchase and use or diesel for air quality reasons.

Figure B22.2: Running costs of a non-commercial LDV, 2016 – United Kingdom



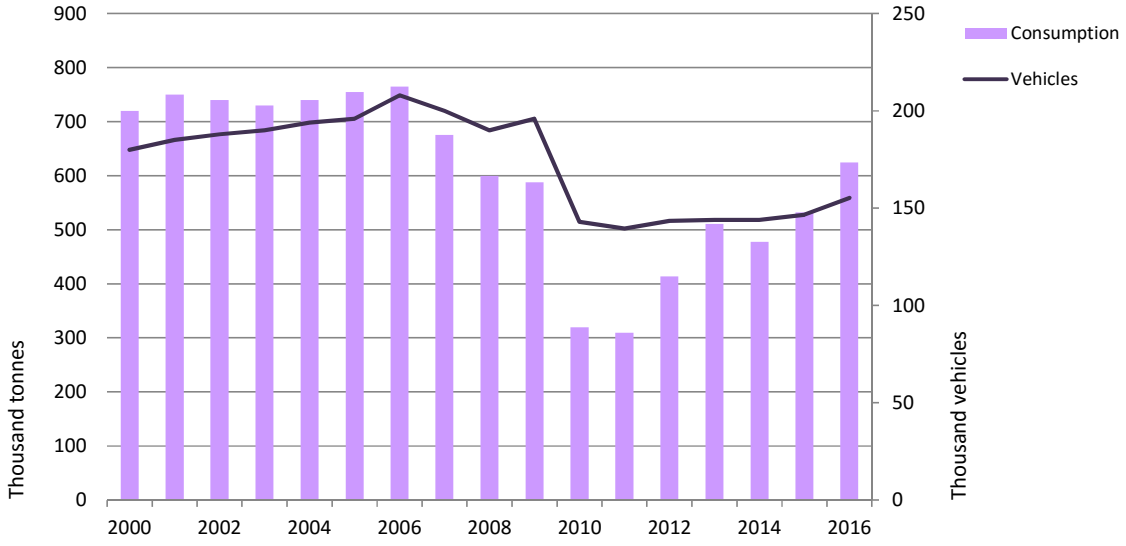
[1] https://tfl.gov.uk/modes/driving/ultra-low-emission-zone/taxi-and-private-hire-requirements?intcmp=35073

23 United States

23.1 Autogas market trends

Despite federal and state efforts to encourage vehicle conversions and refuelling stations, sales of Autogas (known as propane) in the United States remain extremely small compared to the rest of the automotive-fuel market. Autogas consumption amounted to 625 000 tonnes in 2016, equal to a mere 0.1% of total road-fuel sales (Figure B23.1). Sales have nonetheless been rising strongly in the last few years, more than doubling since 2011. High pump prices of Autogas relative to conventional fuels for non-commercial end users is the main reason for the low market penetration of Autogas, though tax credits are available in some states to lower the cost of fuel purchases and vehicle conversions or OEM purchases.

Figure B23.1: Autogas consumption and vehicle fleet – United States



Note: The sharp decline in fuel consumption and vehicle numbers in 2010 is due to breaks in the series (all the data before them include off-road forklift trucks).

There are currently around 155 000 road vehicles, mostly fleet vehicles, operating on Autogas across the United States – 0.1% of the total US car and truck fleet. The fleet expanded by 5% in 2016, with sales of new vehicles totalling 14 045 – one-third of which were OEMs and the rest aftermarket conversions. Sales have increased every year since 20102, when they totalled just 5 629.[1] Several OEM Autogas vehicles are available and several new vehicle platforms under development, including medium- and heavy-duty trucks and school buses.[2] Manufacturers include Alliance AutoGas, Blue Bird

[1] According to data provided by the Propane Education and Research Council (PERC).
[2] http://auto-gas.net/newsroom/12000-autogas-school-buses-operate-u-s-streets/.

Corp, CleanFuel USA, Collins Bus, Icom North America, Impco Technologies, Roush CleanTech and Freightliner. Market penetration is highest in the school-bus segment, with almost 3% of all such buses running on Autogas. Over 700 public and private operators in 47 states currently operate a total of 12 500 buses nationwide, 2 600 of them in Texas and 1 369 in California.[1] Most other Autogas vehicles are in commercial and public fleets.

There are very few private non-commercial Autogas vehicles, because of the relatively high cost of the fuel compared with gasoline, diesel and CNG, and the high cost of conversions. A tightening of regulations by the Environmental Protection Agency has led to a reduction in the number of conversion kits available on the market and an increase in the prices of OEM vehicles.[2] Installing a conversion kit typically costs at least $4 000, while OEM Autogas versions of pick-ups and vans cost around $6 000 to $10 000 more than a standard gasoline-powered vehicle (for example, the Ford F-150, Dodge Ram 2500 HD and Chevrolet Express 2500). At end-2016, there were 3 700 refuelling stations selling Autogas across the United States.

The relatively low price of natural gas that has resulted from the boom in shale gas production in recent years has boosted interest in CNG, though use of the fuel remains small compared with propane and other alternative fuels, especially by LDVs. The overall CNG fleet has grown to 150 000 and is projected to grow further if gas prices stay low. Sales of EVs are also rising quickly as the performance of new models improves and prices drop.

23.2 Government Autogas incentive policies

There are a number of federal, state and local government incentives to encourage the supply and use of Autogas. These are summarised below. More details can be found at the web site of the Alternative Fuels and Advanced Vehicles Data Center run by the US Department of Energy (DOE): www.afdc.energy.gov/fuels/laws/LPG/US.

23.2.1 Fuel-tax differentials

Rates of federal fuel taxes have not changed since 1993; the excise duty on Autogas, at 3.6 US cents/litre (13.5 cents per gallon), is lower than that on gasoline (4.9 cents/litre) and on diesel (6.4 cents/litre), though the differences are much smaller in energy-value terms. Alternative fuels, including Autogas, that are used for certain purposes, including farming, some types of local bus services, school buses, non-profit educational services and by state governments, are fully exempt from federal fuel taxes. States also levy taxes at varying rates on transport fuels. Pre-tax Autogas prices have fallen much less than those of gasoline and diesel since 2014, with a sharp drop in the supply of natural gas liquids in the United States as shale-gas production fell back in the wake of the collapse in international oil

[1] A list of all AFVs on sale in the United States can be found at https://www.afdc.energy.gov/uploads/publication/model-year-2017-vehicles.pdf.
[2] Details of the EPA certification and testing requirements can be found at https://www.epa.gov/vehicle-and-engine-certification/overview-certification-and-compliance-vehicles-and-engines.

prices. As a result, the average price of Autogas at the pump in 2016 (including state taxes) for non-commercial users was actually 15% *higher* than that of gasoline and 19% higher than that of diesel in per-litre terms (Table B23.1). In energy-content terms, the price gaps are even higher. The United States is the only country in this survey where per-litre Autogas prices are higher than those of the other two fuels.

Table B23.1: Automotive-fuel prices and taxes per litre – United States

	Dollars						Euros
	2011	2012	2013	2014	2015	2016	2016
Pump prices							
Autogas*	0.819	0.739	0.734	0.831	0.765	0.726	0.726
Diesel	1.016	1.049	1.036	1.011	0.716	0.609	0.609
Gasoline	0.963	0.994	0.968	0.937	0.697	0.633	0.633
*Total taxes***							
Autogas	0.102	0.091	0.093	0.111	0.148	0.155	0.155
Diesel	0.139	0.141	0.142	0.143	0.150	0.150	0.150
Gasoline	0.133	0.135	0.135	0.137	0.144	0.143	0.143
*Excise taxes****							
Autogas	0.036	0.036	0.036	0.036	0.036	0.036	0.036
Diesel	0.064	0.064	0.064	0.064	0.064	0.064	0.064
Gasoline	0.049	0.049	0.049	0.049	0.049	0.049	0.049
Pre-tax prices							
Autogas	0.717	0.649	0.641	0.721	0.618	0.571	0.571
Diesel	0.877	0.908	0.894	0.868	0.565	0.459	0.459
Gasoline	0.830	0.859	0.833	0.800	0.553	0.490	0.490

* Not including the federal Alternative Fuel Tax Credit. ** Average across states. In the absence of official data, state taxes on Autogas are assumed to be the same as those on gasoline.*** Federal excise duties only.

In practice, the prices paid by most end users may be considerably lower than those reported in Table B19.1, which are compiled from data published by the DOE Clean Cities Program – the only published source of data on retail Autogas prices in the United States.[1] There is evidence that these prices may overstate the actual prices paid by consumers, especially non-commercial Autogas users. A report prepared by ICF International on behalf of the National Propane Gas Association (NPGA), released in March 2012, found that the price of Autogas is actually significantly lower than that of gasoline (ICF, 2012). In addition, commercial and public fleets reportedly pay much lower prices as they are able to negotiate sizeable discounts. For example, Alliance AutoGas, a private organisation, reported that the price of Autogas in the West Coast region was just $1.52/gallon ($0.40/litre) in the last week of July 2017[2] compared with an average price of $3.04 ($0.80/litre) for gasoline and $2.91 ($0.77.litre) for diesel.

[1] These reports can be downloaded from http://www.afdc.energy.gov/afdc/price_report.html
[2] http://www.allianceautogas.com/services/autogas-vehicles/

In addition, effective Autogas prices were lower for most users up to the end of 2016 thanks to the Alternative Fuel Excise Tax Credit. The credit, which had been in place for several years, expired on 31 December 2014, but was reinstated in December 2015 and made retroactive to 1 January 2015. A new expiration date of 31 December 2016 was established. The credit, which effectively reduces the pump price by the same amount, stood at 50 cents/gallon (13.2 cents/litre) up to 2015, but was reduced to 36 cents (9.5 cents) in 2016. It was available for any alternative fuel, including Autogas, and for any entity retailing or using Autogas (a private citizen, bulk fuel retailer, company or state/local government) registered with the Internal Revenue Service. The US LPG industry has called for the credit to be reinstated and applied retroactively from the start of 2017.

23.2.2 Federal clean-fuel incentive and programmes

There are several federal programmes, regulations and incentives in place to encourage alternative fuels, including Autogas.[1] The main form of federal support for Autogas is alternative vehicle acquisition and fuel-use mandates. Under the Energy Policy Act of 1992, 75% of new LDVs acquired by certain federal fleets must be AFVs; Autogas was classified by the Act as an alternative fuel. Federal fleets are also required to use alternative fuels in dual-fuel vehicles unless the DOE determines an agency qualifies for a waiver; grounds for a waiver include the lack of alternative fuel availability and cost restrictions. The 1992 Act also requires certain state government and alternative fuel provider fleets to acquire AFVs. Additionally, Executive Order 13423, issued in January 2007, requires federal agencies with 20 vehicles or more in their US fleet to reduce petroleum consumption by 2% per year, relative to their Fiscal Year (FY) 2005 baseline, through to FY 2015. Agencies must also continue to increase their alternative fuel use by 10% per year, relative to the previous year.

Executive Order 13514, issued in October 2009, and the Energy Independence and Security Act of 2007, introduced additional requirements for federal fleets to acquire vehicles with low greenhouse-gas emissions, favouring Autogas and other AFVs. Executive Order 13693, issued in March 2015, also requires federal agencies with 20 vehicles or more to improve fleet and vehicle efficiency through the elimination of non-essential vehicles and achieve a 30% reduction of fleet-wide GHGs relative to FY 2014 emissions baseline by FY 2025.

The federal government also runs a number of programmes that encourage the use of alternative fuels. One of the most important is the Clean Cities Program, which supports local public/private initiatives to promote the deployment of AFVs and reduce conventional fuel consumption in urban areas.[2] In 2011, President Obama announced the creation of a National Clean Fleets Partnership, run by the DOE, under which more than 20 000 advanced

[1] A full list of current programmes and incentives can be found at https://www.afdc.energy.gov/fuels/laws/LPG/US.
[2] For more information, go to https://cleancities.energy.gov/.

technology vehicles, including Autogas vehicles, are to be deployed.[1] Clean School Bus USA provides funding for projects designed to retrofit and/or replace older diesel school buses with AFVs; Autogas accounts for a large number of the buses that have been converted under this programme. [2] The Propane Education and Research (PERC), set up under a 1996 law and funded by the LPG industry, helps coordinate efforts to promote the use of propane as an alternative fuel. The Propane Education and Research Enhancement Act of 2014 expanded PERC's duties by tasking the council with developing training programs to reduce the effects of future Autogas price spikes for distributors and consumers.

In December 2015, Congress extended the Alternative Fuel Infrastructure Tax Credit until the end of 2017. The credit covers up to 30% of the cost of installing refuelling facilities for alternative fuels, including Autogas, up to a limit of $30 000. Federal grants are no longer available for Autogas vehicle purchases or conversions.

23.2.3 State programmes

Most US states make available additional fiscal and other incentives to support the use of Autogas and other alternative fuels, including grants and loans for vehicle conversions and purchases, as well as refuelling infrastructure. For example, Louisiana offers an income tax credit of 36% of the cost of converting a vehicle to operate on an alternative fuel, the incremental cost of purchasing an original equipment manufacturer AFV, and the cost of alternative fuelling equipment.[3] Alternatively, a taxpayer may take a tax credit of 7.2% of the cost of the vehicle, up to $1,500. In Texas, a grant of up to $7 500 per vehicle is available to private, non-profit, local government, state, and school fleets to cover the incremental cost of switching to Autogas, limited to $30 000 per fleet.[4]

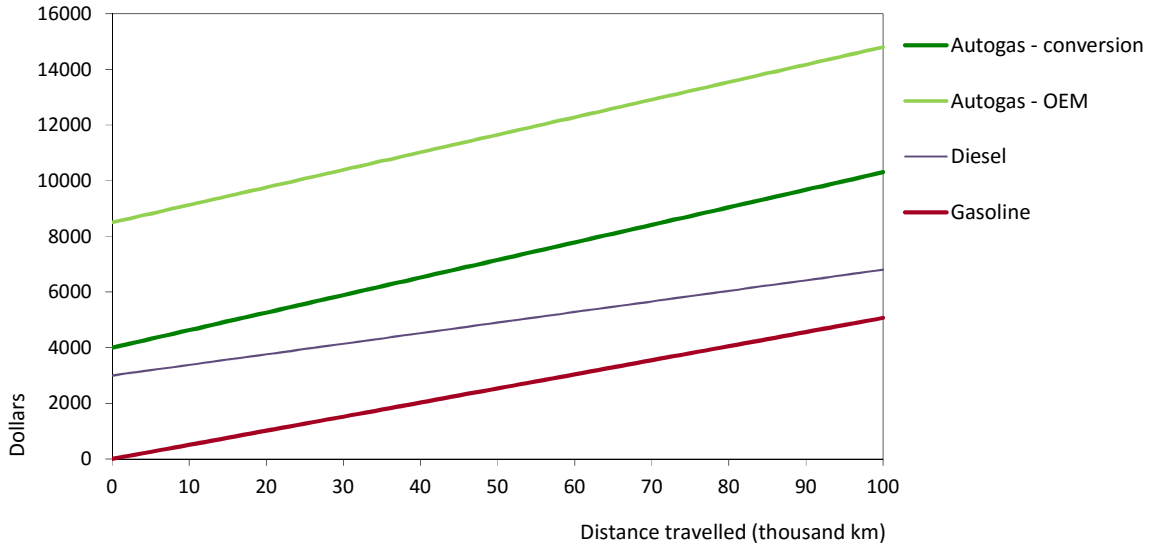
Some states also have AFV purchase mandates in addition to those under federal laws. In some states, tax rebates and exemptions are also applied to Autogas. For example, in California, Autogas is exempt from the state excise tax of 6 cents per gallon when the vehicle owner pays a flat-rate sticker tax ($36 per year for a LDV weighing less than 4 000 lbs).[5] The Alternative and Renewable Fuel and Vehicle Technology Program, administered by the California Energy Commission, provides financial incentives for developing and deploying alternative and renewable fuels.6 Some states grant exemptions from parking restrictions, discounts on parking fees and access to high-occupancy vehicle lanes for AFVs.

[1] For more information, go to http://www.afdc.energy.gov/uploads/publication/60619.pdf
[2] For more information, go to https://www.epa.gov/cleandiesel/clean-school-bus
[3] https://www.afdc.energy.gov/laws/6603.
[4] https://www.afdc.energy.gov/laws/11500.InJanuary 2017, the programme was expanded to public vehicles to include school district, municipal, county, and state fleets (http://auto-gas.net/newsroom/texas-offers-incentives-support-adoption-lpg-vehicle-fleets/).
[5] https://www.afdc.energy.gov/laws/4246
[6] https://www.afdc.energy.gov/laws/6307

23.3 Competitiveness of Autogas against other fuels

At reported 2016 prices for non-commercial end users, Autogas struggled to compete with either gasoline or diesel regardless of distance travelled, even allowing for the federal Alternative Fuel Tax Credit that was applicable then and any vehicle-related grants. This was essentially because of low federal and state taxes on all automotive fuels and the relatively high wholesale price of propane; Autogas could not compete even if there were no excise taxes on the fuel (Figure B23.2). Nonetheless, Autogas may be competitive in states where pump prices are lower and vehicle incentives are available. Diesel is generally a more competitive alternative to gasoline, though its breakeven distance is very high, at around 150 000 km (which explains why diesel is not a very popular alternative to gasoline in the United States).

Figure B23.2: Running costs of a non-commercial LDV, 2016 – United States



Note: An Autogas conversion is assumed to cost $4 000 and the additional price of an OEM Autogas vehcile $8 500. These costs can, in practice, be considerably higher. The analysis takes account of the alterntive fuels tax credit of 9.5 cents/litre, but not any state financial incentives that might be available.

Autogas appears to be much more competitive for commercial and public fleets, such as school buses. For example, based on reported prices on the West Coast for the last week of July 2017, Autogas would break even with gasoline at around 120 000 km in the case of an aftermarket conversion costing $4 000; a vehicle subsidy of $2 000 would lower the distance to 60 000 km, making it an attractive option for high-mileage vehicles.

This analysis demonstrates very clearly why Autogas has failed to make inroads into the non-commercial road-fuel market in the United States and the crucial role that mandates will need to play in encouraging switching to the fuel in the absence of fuel-tax and vehicle incentives. The price of natural gas and investments in refuelling infrastructure for CNG will also have an important impact on how well Autogas is able to compete against that fuel.

At present, CNG is the cheapest of all the available fuels in the Unites States for non-commercial end users on an energy-equivalent basis (Table B23.2).

Figure B23.2: Pump prices of road-transport fuels per gasoline gallon equivalent (GGE) for non-commercial users – United States

	2010	2011	2012	2013	2014	2015	2016
Autogas*	4.02	4.28	3.86	3.83	4.34	4.00	3.79
Gasoline	2.75	3.48	3.65	3.50	3.51	2.47	2.13
Ethanol (E85)	3.37	4.38	4.70	4.50	4.44	2.95	2.48
CNG	1.90	2.04	2.10	2.11	2.14	2.10	2.06
Diesel	2.67	3.42	3.56	3.54	3.49	2.56	2.07
Biodiesel (B20)	2.80	3.53	3.68	3.67	3.60	2.64	2.17
Biodiesel (B99/B100)	3.63	4.13	4.36	4.21	4.18	3.62	3.00
Electricity*	1.15	1.17	1.18	1.20	1.17	n.a.	n.a.

* The price of Autogas does not take account of the Alterntive Fuel Tax Credit of 9.5 cents/litre. ** Electricity prices are reduced by a factor of 3.4 because electric motors are 3.4 times as efficient (on a BTU basis) as internal combustion engines. Efficiency adjustments were not made for other fuels because they are much smaller and vary by type of vehicle.

Source: US Department of Energy, *Clean Citites Alternative Fuels Price Report* (various issues). (https://www.afdc.energy.gov/publications/search/category/)

Annex 1: Autogas market data

Autogas consumption, vehicle fleet and retail sites in surveyed countries

	Consumption (thousand tonnes)		Vehicle fleet (thousands)		Retail sites	
	2015	2016	2015	2016	2015	2016
Australia	610	532	420	360	3 200	2 500
Bulgaria	391	396	490	500	2 900	2 900
China	990	990	165	165	550	550
Czech Republic	88	98	179	190	1 100	1 250
France	81	72	207	210	1 750	1 670
Germany	427	400	476	400	7 000	7 034
Greece	250	260	400	415	780	860
India	330	346	2 150	2 250	1 200	1 250
Italy	1 648	1 659	2 137	2 211	3 600	3 940
Japan	1 060	1 002	229	221	1 459	1 440
Korea	3 715	3 515	2 276	2 185	2 015	2 031
Lithuania	122	115	100	100	690	690
Mexico	996	986	240	240	2 150	2 150
Netherlands	183	172	180	170	1 750	1 650
Poland	1 690	1 790	2 914	2 977	5 420	5 390
Russia	3 030	3 050	3 000	3 000	4 900	4 900
Serbia	220	223	525	525	700	700
Spain	40	47	59	62	807	1 000
Thailand	1 731	1 466	1 050	920	1 150	950
Turkey	3 069	3 142	4 272	4 440	9 961	10 426
Ukraine	1 032	1 385	2 150	2 250	3 500	3 500
United Kingdom	82	71	135	120	1 400	1 250
United States	532	625	147	155	3 594	3 700
Rest of the world	***4 104***	***4 362***	***2 528***	***2 735***	***13 749***	***14 311***
Total World	**26 421**	**26 704**	**26 430**	**26 803**	**75 325**	**76 092**

Source: WLPGA/Argus Media (2017).

Annex 2: References

ABMARC (2016), *Autogas Vehicle Demand Study*, May 2016, Boronia, Australia.

European Commission (EC) (2011), *The Energy Roadmap 2050*, Brussels.

ICF International (2012), *The Price of Propane for Fleet Vehicle Use*, March 2012, NPGA, Washington D.C.

IEA (2017a), *Global EV Outlook*, Paris.

- (2017b), *Energy Policies Beyond IEA Countries – Mexico*, Paris.
- (2017c), *Tracking fossil fuel subsidies in APEC economies: toward a sustained subsidy reform*, Paris.

OECD (Organisation for Economic Co-operation and Development) (2013), *Taxing Energy Use: A Graphical Analysis*, OECD, Paris.

Petroleum Argus, *LPG World* (twice-monthly newsletter, various issues).

Polska Organizacja Gazu Plynnego (POGP) (2017), *Annual Report 2016*, Warsaw.

Secretaríat de Energía (SENER) (2016) *Prospectiva Gas Natural y Gas LP*, Mexico City.

World LPG Association (2001), *Developing a Sustainable Autogas Market: Guidelines for Policymakers*, WLPGA, Paris.

World LPG Association (2009), *LP Gas: Healthy Energy for a Changing World*, WLPGA, Paris.

World LPG Association/Argus Media (2014), *Statistical Review of Global LPG 2016,* WLPGA/Argus Media, Paris/London.

World LPG Association/Menecon Consulting (2005), *Autogas Incentive Policies*, WLPGA/ Menecon Consulting, Paris.

Annex 3: Note on data sources

Data on automotive-fuel prices and taxes were compiled from a range of sources. For many countries, *Energy Prices and Taxes*, a quarterly report published by the International Energy Agency (IEA), was the source for historical price and tax data for Autogas, diesel and gasoline. For some European countries, the weekly *Oil Bulletin*, published by the European Commission, was the primary source. For others, national sources, including national LPG associations, government agencies, fuel providers and consumer groups, were used.

Estimates of Autogas vehicle conversion costs and the incremental cost of OEM vehicles and diesel vehicles were compiled from industry sources in each country, including national associations, Autogas retailers, car and equipment manufacturers, and conversion-kit installers. Where reliable country-specific information was not available, generic cost estimates were used.

Most data on Autogas consumption, vehicles and refuelling sites are from the WLPGA/Argus annual publication, *Statistical Review of Global LPG,* except where otherwise stated. Data on total road-vehicle fleets were compiled from national sources. Data on total automotive fuel consumption are from the IEA's annual publication, *World Energy Balances*.

European LPG Association
15-17 rue Belliard
B-1040 Brussels, Belgium

aegpl@aegpl.be
www.aegpl.eu

WLPGA
182 avenue Charles de Gaulle
92200 Neuilly-sur-Seine, France

association@wlpga.org
www.wlpga.org