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AUTOGAS INCENTIVE POLICIES

A country-by-country analysis of
why and how governments encourage
Autogas and what works

2022 UPDATE



The World LPG Association (WLPGA)

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The WLPGA promotes the use of LPG to foster a safer, cleaner, healthier and more prosperous world.

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Glossary

AFV	Alternative fuel vehicle
CNG	Compressed natural gas
CO ₂	Carbon dioxide
EV	Electric vehicle
HDV	Heavy-duty vehicle
LDV	Light-duty vehicle
LGE	Liquid Gas Europe
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 vehicle fuel in use in the world today. Global consumption of Autogas increased steadily over the first two decades of the current century, reaching a new high of 27.1 million tonnes in 2019, but fell by 10% in 2020 alongside declines in the use of other transport fuels due the economic disruption caused by the COVID-19 pandemic. Demand recovered by just over 3% to 25.1 Mt in 2021 as driving patterns and economic activity started to return to normal. The Autogas fleet continues to grow unabated: there are now 28.3 million Autogas vehicles in use around the world and close 82,000 refuelling stations selling the fuel.

Autogas use is still concentrated in a small number of markets. The five largest – Russia, Turkey, Korea, Poland and Ukraine – together accounted for almost exactly half of world consumption in 2021, while the 25 countries surveyed in this report accounted for 80%. The share of Autogas in total automotive-fuel consumption varies widely among those countries, ranging from a mere 0.04% in the United States to almost 28% in Ukraine. 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 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 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 an even 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 eight of the 25 countries surveyed, Autogas pump prices per litre for private motorists were less than half those of gasoline in 2021. The price of Autogas as a proportion of that of gasoline ranged from 28% in Thailand to 87% in the United States, averaging 56% across all countries. Relative to diesel, the price of Autogas averaged 60%.

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 2021 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, India, Mexico and Russia, and was effectively nullified by subsidies in 2021 in Thailand. The ratio of Autogas taxes to gasoline taxes was by far the highest in the United States, at 73%; in all the other countries, excise taxes on Autogas were less than 40% of those on gasoline on a per-litre basis. The arithmetic average ratio across all the countries surveyed was 22%. For diesel, the ratio was higher, at 25%, as taxes on diesel were lower than on gasoline in all countries except Australia and the United Kingdom, where they are the same, and Serbia and 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 installing dual-fuel systems has increased in modern vehicles 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 of such incentives has diminished in recent years, partly because of government budget constraints. The central government or local authorities subsidised conversions or OEM purchases in 2021 in eight of the countries surveyed here – Canada, France, Italy, Japan, Korea, Spain, the United Kingdom and the United States (some states) – for certain types of vehicle. In some cases, subsidies effectively covered the entire cost of conversion or the additional OEM cost.

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 the other two fuels in each country, based on 2021 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. The breakeven distance is less than 100 000 km in all countries except Canada, Turkey and the United States, where it is never competitive, and Japan, where it is around 110,000 km. In 17 of the 25 countries surveyed, the breakeven distance is under 50,000 km. Autogas is most competitive in India, where a converted vehicle breaks even with gasoline at just 11 000 km – less than one year of driving for a private motorist. Autogas is also highly competitive in Bulgaria, Greece, Lithuania, Poland and Thailand, all of which have a breakeven distance of less than 20,000 km for a converted car and where the market penetration of Autogas is high.

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 India is lower than that of Ukraine, yet the penetration of Autogas in India is much lower – even though Autogas is always competitive against diesel. This is in part due to lags in the market response to changes in inter-fuel competition over time. 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.
- ▶ *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 becoming more widespread 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 some countries, despite highly favourable taxation policies.

In countries where the Autogas market 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 safely 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 in 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 – has been growing in many countries in recent years, thanks to government policies to encourage the use of alternative fuels and the inherent environmental, practical and cost advantages of Autogas over other alternatives. 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 can and often do encourage switching to Autogas, and how they go about doing so based on an in-depth survey of many 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 25 of the world's largest Autogas markets: Australia, Bulgaria, Canada, China, Czech Republic, France, Germany, Greece, India, Italy, Japan, Korea,¹ Lithuania, Mexico, Netherlands, Poland, Portugal, 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, Lithuania, Portugal, Serbia, Spain and the United Kingdom, have annual sales of more than 100,000 tonnes. Collectively, the 25 countries made up 80% of the global Autogas market in 2021.

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 vehicle 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 2021, while the price and tax data cover 2016-2021.

The data on Autogas prices and taxes were used to analyse quantitatively the competitiveness of Autogas vis-à-vis gasoline and diesel in all 25 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 with the current penetration of

¹ In this report, Korea refers to the Republic of Korea.

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 policy making.

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.

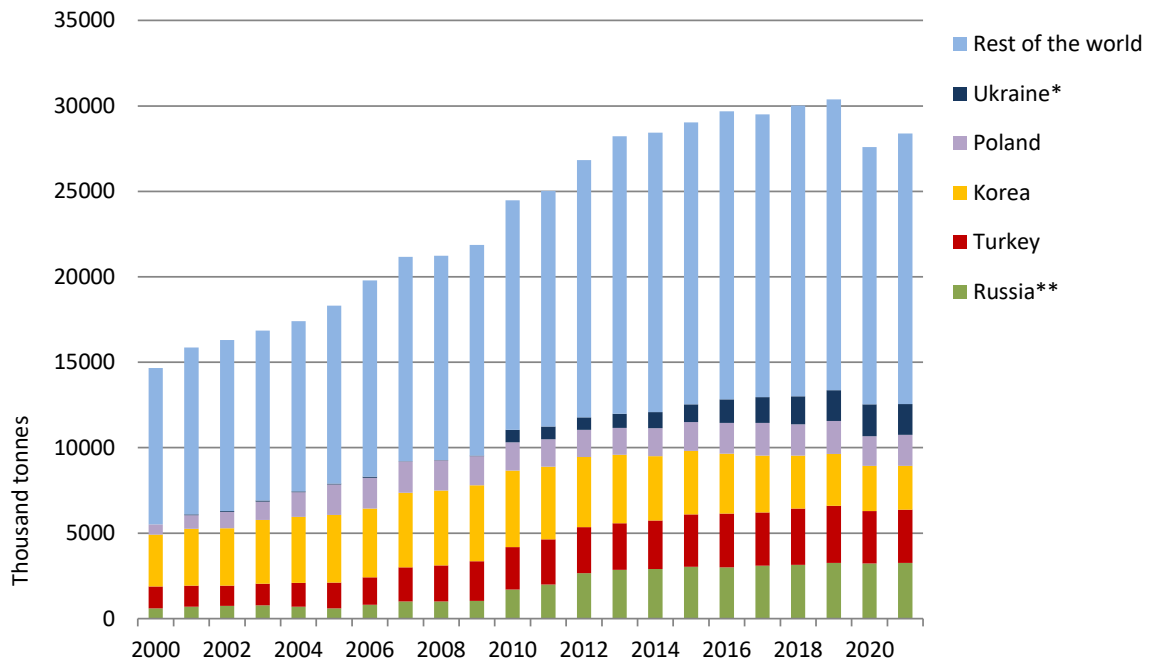
PART A: MAIN FINDINGS

1 The global Autogas market

1.1 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 increased steadily over the first two decades of the current century, reaching a new high of 27.1 million tonnes in 2019, but fell by 10% in 2020 alongside declines in the use of other transport fuels due the economic disruption caused by the COVID-19 pandemic (Figure A1.1). Demand recovered by just over 3% to 25.1 Mt in 2021 as driving patterns and economic activity started to return to normal. The upheavals of the last two years mask some marked differences in underlying trends, with improved fuel economy and a contraction of the Autogas fleet driving down consumption in some major markets, while some other markets are continuing to expand thanks to government measures to make the fuel competitive.

Figure A1.1: World Autogas consumption, 2000-2021



* The jump in 2010 is due to a break in the series. **The large increase in 2010 is thought to be due largely to a re-categorisation of LPG demand previously allocated to the residential sector. Source: WLPGA/Argus (2022); IEA databases.

Demand remains highly concentrated in a small number of markets: the five largest countries – Russia, Turkey, Korea, Poland and Ukraine – together accounted for almost exactly half of world consumption in 2021, while the

top ten accounted for 71% (Table A1.1). The 25 countries surveyed in this report together accounted for 80% of world Autogas use. The biggest increases in demand in absolute terms over the ten years to 2021 occurred in Russia, Ukraine and Turkey, while the biggest falls occurred in Korea, Australia and Japan. Worldwide, Autogas currently accounts for 1.2% of total consumption of road-transport fuels. The share of Autogas in total, automotive-fuel consumption varies widely among the countries surveyed, from a mere 0.04% in the United States to almost 28% in Ukraine. Autogas makes up more than 10% of the automotive-fuel market in two other countries: Turkey and Bulgaria. 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 (see below).

Table A1.1: Top ten Autogas markets, 2021

Country	Consumption (thousand tonnes)	Vehicles (thousands)	Refuelling sites
Russia	3,250	3,000	4,900
Turkey	3,117	4,923	10,950
Korea	2,563	1,961	1,992
Poland	1,815	3,394	7,450
Ukraine	1,810	2,660	5,500
Italy	1,407	2,847	4,450
Mexico	1,390	407	2,080
China	1,163	192	580
Thailand	668	708	1,570
Japan	552	137	1,212
<i>Rest of the World</i>	7,401	8,121	40,864
World	25,136	28,349	81,548

Source: WLPGA/Argus (2022).

There are 28.3 million Autogas vehicles in use around the world and over 81,500 refuelling sites. Both have been growing steadily in recent years, bar a small dip in 2020 due to the health crisis. Autogas accounted for 7.6% of global consumption of LPG in 2021, though this share varies considerably across countries. Among the countries surveyed, the share is highest in Ukraine, where it is 92%, and is lowest in the United States at just 0.4%. Data on consumption, numbers of vehicles and refuelling sites for all 25 countries surveyed can be found in Annex 1.

The make-up of the Autogas fleet by vehicle-type differs by country. In the largest market, Korea, and some others, including Japan, taxis and other light-duty vehicles (LDVs) account for a large share of Autogas consumption. In both these countries, most 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 Western Europe, Original Equipment Manufacturer (OEM) vehicles, i.e. with factory-fitted dual-fuel systems, represent the majority of new Autogas vehicles. The situation is similar in India, where OEM vehicles (including two- and three-wheelers) make up two-thirds of new LPG vehicles. In Korea and Japan, almost all vehicles are mono-fuel OEM vehicles. In the rest of the world, the majority of vehicles that run on Autogas are gasoline-powered vehicles that have been converted to be able to use either Autogas or gasoline by installing a separate dual-fuel system that allows the vehicle to switch between both fuels. For mainly technical reasons, most LDV conversions involve gasoline-powered spark-ignition engines, which are particularly well-suited to run on Autogas.

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 (WLPGA/Argus, 2022), 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.

Autogas fuel systems are not new. They have been used for over 70 years and 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 sometimes invalidate the vehicle warranty). Worldwide, around 20 brands currently market around 140 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 generally emit fewer emissions of air pollutants and greenhouse gases, including carbon dioxide (CO₂).

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 and pure battery EVs are now widely commercialised, but their rate of uptake remains constrained by their high cost and limited mileage (see below). The supply of ethanol and biodiesel 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, as well as concerns about methane leakages. 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 increasingly focusing 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 EV's. There were around 16.5 million EVs on the road worldwide at the end of 2021, compared with just two million five years earlier, with EVs now accounting for 9% of global car sales – four times the share in 2019 (IEA, 2022). 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. EV sales are still driven by large subsidies to make them competitive, as the cost of manufacturing them remains significantly higher than that of both conventional and alternative fuel vehicles, including Autogas-fuelled ones, though the gap is narrowing.

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. Governments are also stepping up efforts to curb emissions of greenhouse gases from road transport under the Paris Agreement on climate change.

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 emissions and fuel-efficiency standards. However, rising demand for mobility 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 on health comes to light. The decision by the World Health Organisation in 2012 to classify diesel as a group one carcinogen to humans, as well as revelations about fraudulent emissions testing of diesel cars by carmakers have added to the pressure on policy makers 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 heavy-duty vehicles (HDVs) (also covering smoke). Work has begun on Euro 7/VII regulations for future vehicles.

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 CO₂ – 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, more than a dozen 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. In June 2022, the European Parliament voted to phase out the sale of new internal combustion engine vehicles in all EU countries by 2035.

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, outperforms 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: actual vehicle emissions are highly dependent on vehicle technology and driving behaviour. For both noxious and CO₂ emissions, Autogas vehicles perform particularly 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, renewable LPG, or rLPG (also known as bioLPG or biopropane), used as Autogas could also help reduce CO₂ emissions from road transport by up to 80% compared to conventional LPG (WLPGA, 2022). RLPG is LPG derived from production processes that use biomass as the feedstock, usually as a co-product. The molecular structure of pure rLPG is identical to that of conventional pure LPG produced from hydrocarbons, so can be blended into conventional fuel or sold in a pure form, and can be used with existing infrastructure. RLPG can, in principle, be produced in many different ways, using different types of thermal and chemical processes, but only one of these technologies – HVO – is in full commercial use today. The HVO process involves the hydrogenation of vegetable oil or animal fat to produce renewable diesel or jet kerosene, yielding small volumes of rLPG – typically 5-7% by weight of the renewable diesel. Some plants separate out and commercialise the rLPG as a premium product. Output of rLPG from HVO plants, which amounts to around 450 000 tonnes per year at present, is set to continue to grow in the near term. New production pathways being developed today will be needed to expand supply substantially in the longer term given limitations on sustainable supplies of vegetable oil and animal fat feedstocks.

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

¹ Recent studies of the comparative environmental performance of Autogas can be found on the WLPGA and Liquid Gas Europe websites: www.wlpga.org and www.auto-gas.net. A quantitative assessment of the potential emissions savings from faster growth in Autogas use worldwide can be found in WLPGA (2019).

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 or doughnut-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 decades 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 in pressurised tanks, which limits the danger of leakage. 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 supply (WLPGA, 2019).

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 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 and high-pressure compression, storage cylinders and 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 of installing dual-fuel systems in modern OEM vehicles has risen in recent years as fuel-injection engine technology has become more sophisticated.

Worldwide, the cost of converting an LDV varies from about \$500 in developing countries to \$4,000 in the United States (in real 2021 dollars). 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. In some cases, OEMs propose LPG versions at the same price than gasoline versions for commercial reasons.

Among the various alternative fuels available today, CNG is probably the main alternative to Autogas on cost grounds (except where EVs are heavily subsidised).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 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)

	Autogas	CNG
<i>End-user price of fuel</i>	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)
<i>Cost of refuelling infrastructure</i>	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
<i>Cost of vehicle conversion (LDV)</i>	Ranges from around \$400 to \$4,000 (in 2021 dollars) depending on the type of car, type of conversion and local market conditions	Generally much 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)
<i>Ease of refuelling</i>	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. Refuelling is also noisier with CNG than Autogas

Source: Menecon Consulting analysis.

Most analysts believe that EVs 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 (IEA, 2022). EVs remain significantly more expensive than both conventional and Autogas vehicles without subsidies, though the cost gap is expected to continue to narrow in

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.

the coming years. For many countries, Autogas based on conventional LPG is set to remain an important bridging fuel to a sustainable transport system (WLPGA, 2019). In the long term, large-scale production of rLPG holds the promise of a continuing role for Autogas in meeting road transport energy needs alongside electricity and hydrogen (WLPGA, 2022).

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.

Other barriers to the uptake of alternative fuels like Autogas provide additional justification for policy intervention. They include awareness and capacity barriers, such as a lack of sufficient information and knowledge about renewable fuels and their performance; financial barriers, including a lack of adequate funding opportunities; administrative barriers, such as a lack of effective institutions and complicated licensing procedures and planning restrictions; market barriers, such as inconsistent pricing structures that disadvantage alternative fuels; and public acceptance, such as misconceptions about the safety of Autogas.

Levying charges on polluting activities is effectively a way of internalising environmental externalities and addressing market barriers. 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 explicit account of environmental externalities and other barriers 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 actual emissions produced during use, though technological developments may make this a practical solution in the future.

Deploying emission-trading schemes for fuel use in the transport sector is also complex 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 price of transport fuels, as such broader approaches tend to be more effective in practice in reducing emissions – especially of greenhouse gases – from road vehicles. 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, such as diesel.

2.2 Typology of policies to promote alternative fuels

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

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 emissions 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 – an increasingly common measure around the world. 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 expand the market for alternative fuels and set an example to other end users through public procurement of AFVs. This can be a powerful tool to build critical market mass for increasing their deployment more generally. They can also 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.

Other measures include the use of voluntary agreements and programmes between government and fuel providers and fleet operators. Voluntary agreements or collaborative partnerships with industry are usually seen as an alternative to stringent, mandatory regulations and punitive fiscal measures. 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.

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, newsletters or social media, to inform the public of market and technology developments and to indicate how to apply for subsidies if available. Such programmes can be carried out in partnership with industry associations.

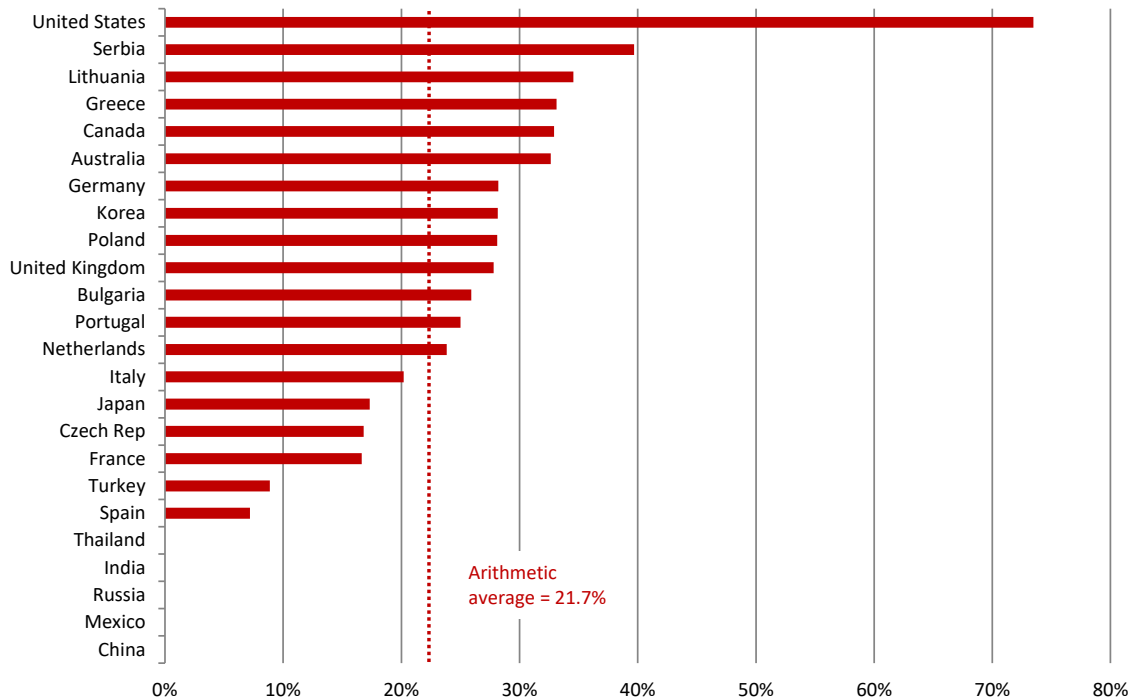
3 International comparison of Autogas incentive policies

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 the countries surveyed, 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 Canada and some US states to 24% in Greece. The rules governing the recovery of VAT, consumption and sales tax by commercial users also differ. 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, 2021



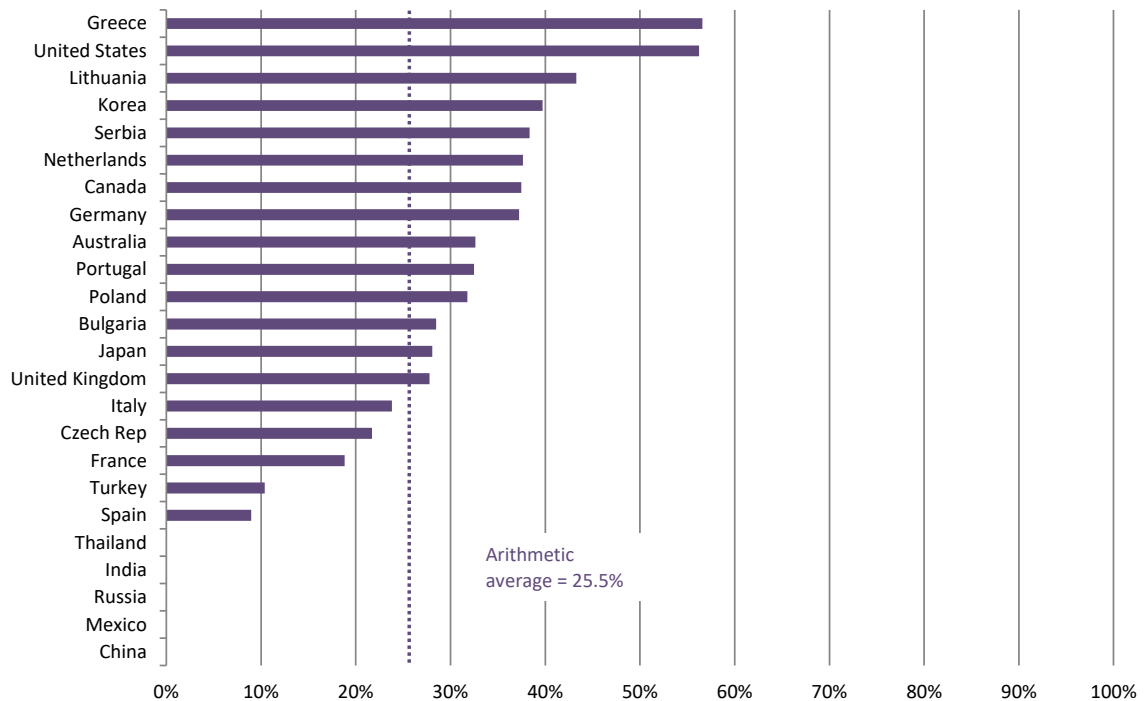
Note: Ukraine is not included as data on excise duties are not available.

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,

India, Mexico and Russia, and was effectively nullified by subsidies in 2021 in Thailand (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). As in previous years, the rate of tax on Autogas relative to that on gasoline was by far the highest in the United States in 2021, at 73% (though most users were able to profit from a small tax credit applied retroactively in 2021); in all the other countries, excise taxes on Autogas were less than 40% of those on gasoline on a per-litre basis. The arithmetic average ratio across all the countries surveyed was 22%. The ranking of countries according to the taxation of Autogas *vis-à-vis* gasoline shifted markedly in 2021 as a result of major tax reductions in some countries in response to higher international prices.

Excise taxes on diesel are lower than on gasoline in all countries except Australia and the United Kingdom, where they are the same, and Serbia and the United States. As a result, Autogas generally enjoys a slightly smaller tax advantage over diesel than gasoline, averaging 25% in 2021. The ratio of excise-tax rates on Autogas to diesel was highest in Greece, at 57%. In all but three countries, the share was below 40% (Figure A3.2).

Figure A3.2: Autogas excise taxes as % of taxes on diesel per litre, 2021



Note: Ukraine is not included as data on excise duties are not available.

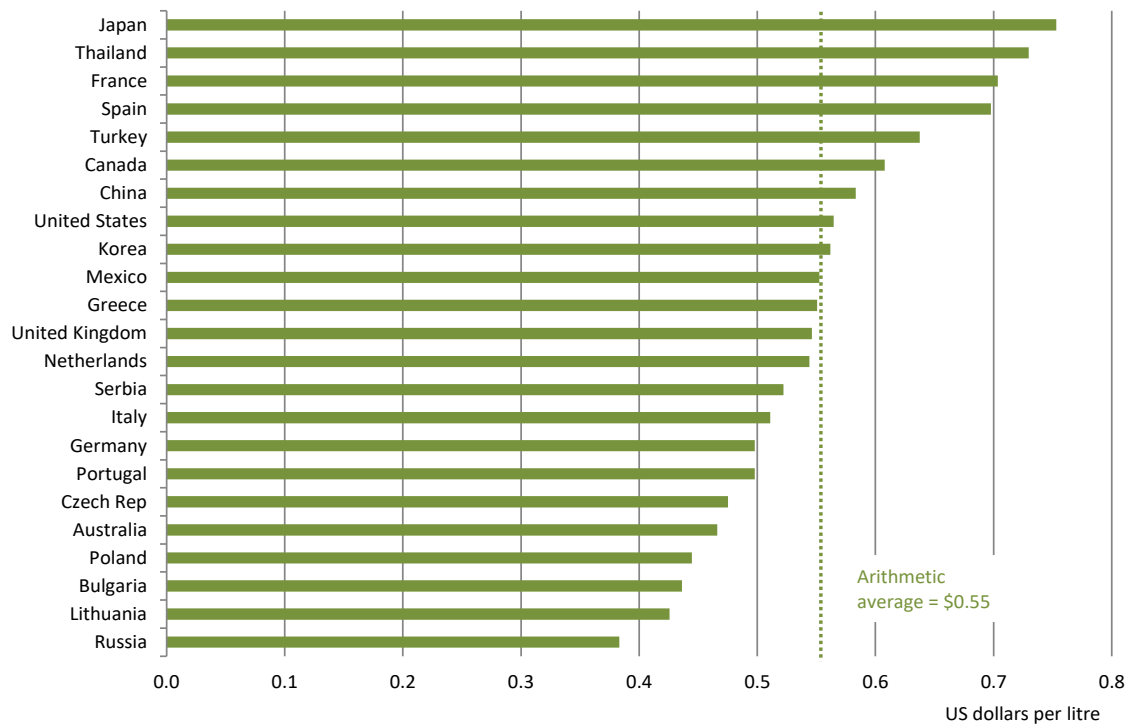
Because the calorific value of each fuel varies, the tax advantage of Autogas is in reality smaller – especially over diesel, which has the highest calorific value per litre. If all three fuels were taxed equally on an energy-content basis, taxes *per litre* on Autogas would on average be 20% lower than on gasoline and 38% lower than on diesel. Nonetheless, the effective rate of tax

on Autogas is lower than that on diesel or gasoline in all the countries surveyed here. 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 over 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, Mexico, Thailand and, to some degree, 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, 2021



Note: Prices are converted to US dollars at average 2021 exchange rates. Pre-tax prices are not available for India and Ukraine.

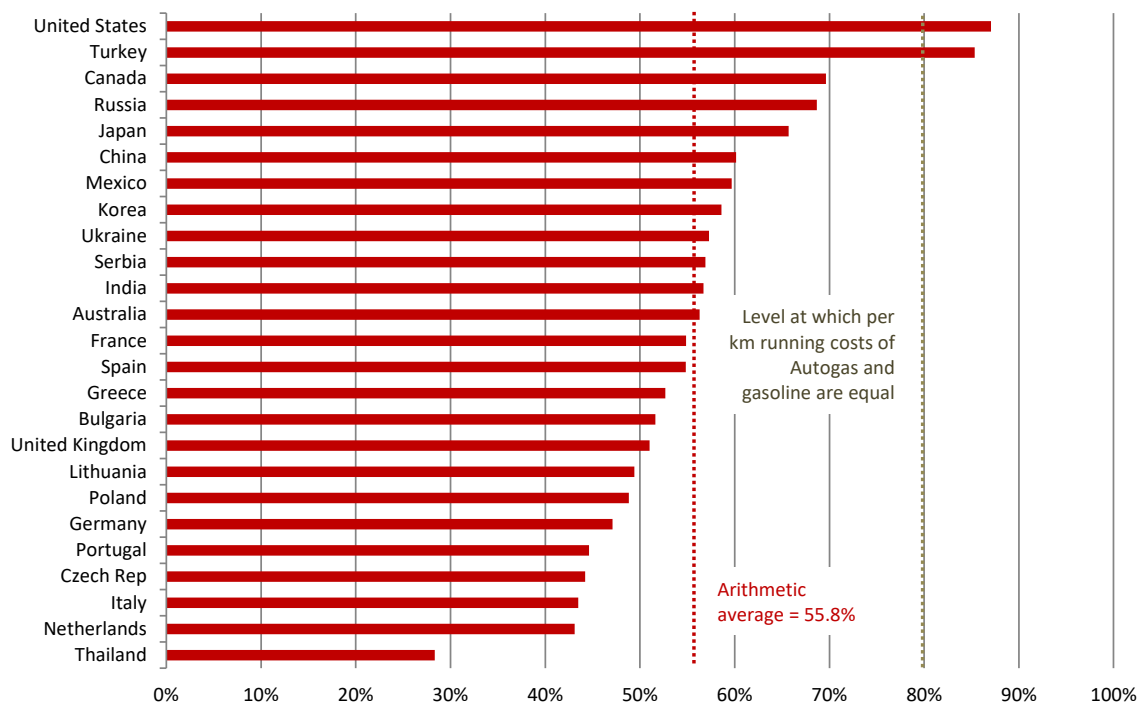
Pre-tax pump prices of Autogas for non-commercial end users in per-litre terms converted to US dollars were on average highest in Japan and lowest in Russia in 2021 (Figure A3.3, above). They were lower than both diesel and gasoline prices in all countries except France, Turkey and Thailand. Pre-tax prices change over time in line with fluctuations in international-market prices (Box A3.1). International butane and propane prices have generally 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. Cold winter weather in the northern hemisphere can impact prices in countries where LPG is used as a heating fuel. LPG prices can also be affected by petrochemical and refinery demand (for gasoline blending). 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.

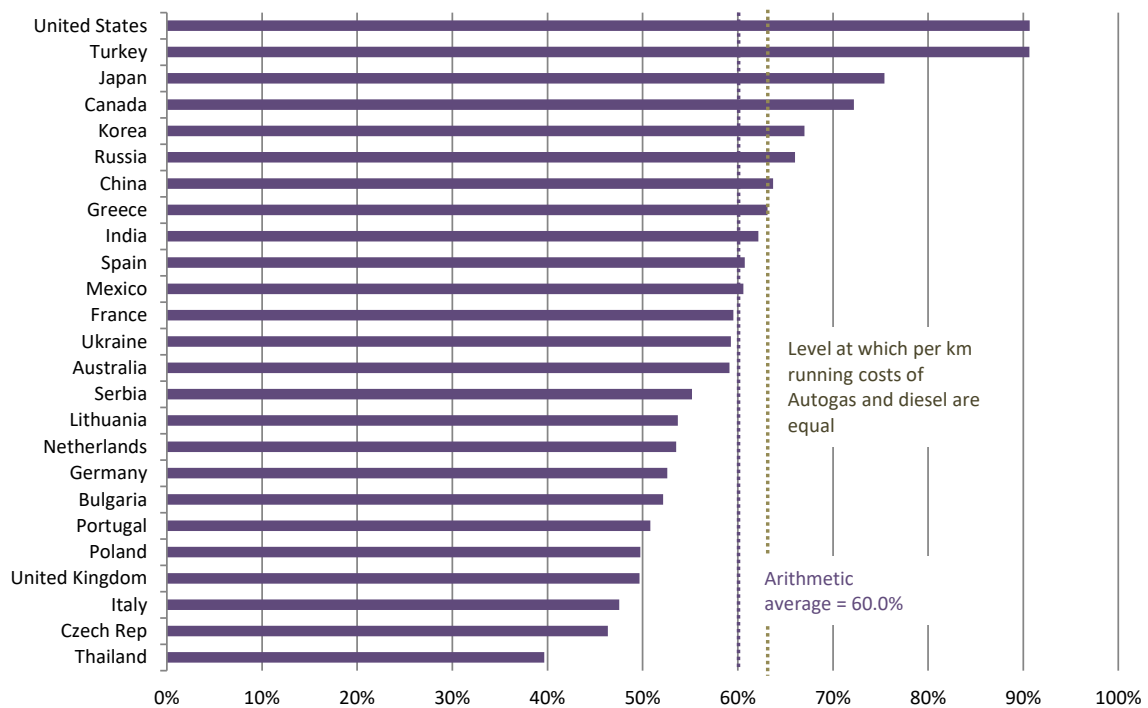
Figure A3.4: Autogas pump price including all taxes as % of gasoline price per litre, 2021



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 in 2021. In eight of the 25 countries surveyed, Autogas pump prices per litre were less than half those of gasoline (Figure A3.4, above). The price of Autogas as a proportion of that of gasoline ranged from 28% in Thailand to 87% in the United States, averaging 56% across all countries (up from 52% in 2019).

Because diesel is taxed less than gasoline everywhere except in Australia, Serbia, the United Kingdom and the United States, the pump-price differential between Autogas and diesel is generally lower than that between Autogas and gasoline, though it has narrowed in recent years. The per-litre price of Autogas was on average 60% that of diesel in 2021. 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, 2021



Effective pump prices can also differ between commercial and non-commercial users. In most countries, commercial (business) users can 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 costs

¹ France is an exception: 100% of VAT can be recovered in the case of Autogas and 80% for diesel and gasoline (100% for vans and trucks).

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

Table A3.1: Automotive-fuel taxes and prices, 2021

	Share of total taxes in price			Autogas pump price as % of prices of other fuels (including tax)	
	Autogas	Diesel	Gasoline	Diesel	Gasoline
Australia	25.8%	39.5%	38.0%	59.1%	56.3%
Bulgaria	33.6%	47.7%	50.4%	52.2%	51.6%
Canada	18.8%	32.0%	34.7%	72.2%	69.6%
China	8.3%	30.1%	33.8%	63.7%	60.2%
Czech Republic	29.0%	49.2%	56.5%	46.4%	44.2%
France	30.2%	59.4%	61.2%	59.5%	54.9%
Germany	43.0%	54.2%	61.2%	52.6%	47.1%
Greece	46.2%	49.3%	62.0%	63.1%	52.7%
India	n.a.	n.a.	n.a.	62.2%	56.7%
Italy	38.9%	59.6%	62.9%	47.5%	43.5%
Japan	18.7%	32.8%	45.6%	75.4%	65.7%
Korea	31.0%	46.1%	54.7%	67.0%	58.6%
Lithuania	42.9%	49.0%	53.9%	53.7%	49.4%
Mexico	13.8%	13.8%	13.8%	60.6%	59.7%
Netherlands	41.2%	51.1%	60.4%	53.5%	43.1%
Poland	36.2%	46.1%	49.1%	49.8%	48.8%
Portugal	41.7%	54.7%	59.7%	50.8%	44.6%
Russia	16.7%	n.a.	n.a.	66.0%	68.7%
Serbia	42.1%	53.2%	53.1%	55.2%	56.9%
Spain	21.9%	47.9%	51.7%	60.7%	54.8%
Thailand	n.c.	31.8%	45.0%	39.6%	28.4%
Turkey	16.6%	27.2%	28.4%	90.6%	85.3%
Ukraine	n.a.	n.a.	n.a.	59.3%	57.3%
United Kingdom	40.7%	59.6%	60.8%	49.7%	51.0%
United States	15.3%	18.8%	16.9%	90.7%	87.1%
Average	29.7%	43.3%	47.9%	60.0%	55.8%

Note: Percentages are calculated on a volume basis. n.a. is not available. N.c. is not calculable. Averages are unweighted. The share of taxes excludes those countries for which data are not available or calculable.

3.2 Autogas vehicle subsidies

The most effective measure, other than favourable fuel taxation, in encouraging switching to Autogas is subsidies directed at 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 2021 in Canada, France, Italy, Japan, Korea, Spain, the United Kingdom and the United States (some states) for certain types of vehicle. In some cases, subsidies effectively covered the entire cost of conversion or the additional OEM cost.

Discounts on annual road taxes and initial vehicle registration taxes compared with those levied on gasoline or diesel vehicles are less common. In 2021, France, Italy (some municipalities), Mexico and the United Kingdom used this approach. In the Netherlands, the initial registration tax for Autogas vehicles is lower than for diesel- or gasoline-powered ones, but the annual road tax is higher.

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. 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 four of the countries surveyed countries: Canada, China, Korea 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 a growing number of cities, notably in Europe. In some US cities, Autogas vehicles are given access to dedicated lanes for high-occupancy vehicles. 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 27 member states now involves the transposition of EU directives or regulations. All EU members are required to comply with the legal acts 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 NO_x 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 CO₂ emissions and the main source of NO_x and PM emissions. In December 2019, the European Council adopted the European Green Deal – a set of policy initiatives by the European Commission aimed at making Europe climate neutral in 2050. In September 2020, the European Commission proposed raising the GHG emissions reduction target for 2030 to 55% compared with 1990 levels.

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 CO₂ standards (a ceiling of 95 grammes of CO₂/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 CO₂ 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, 2021

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

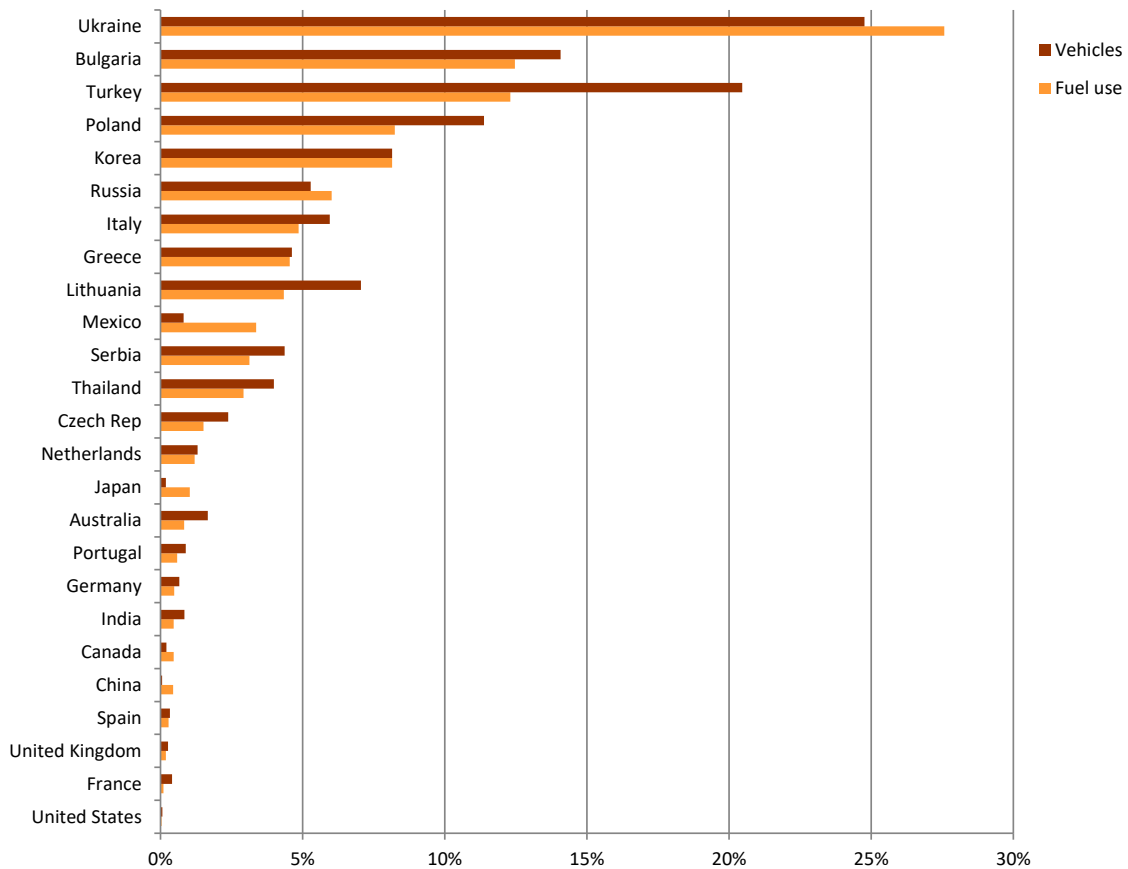
¹ Excise duty less than half that levied on both diesel and gasoline, calculated on a per-litre equivalent basis. ² Compared with gasoline. Includes taxes on vehicle conversion/acquisition, initial vehicle registration charges and annual road/registration charges. ³ Mandates for AFVs, including Autogas (central and state governments); includes public transport. ⁴ For purchases of Universal Design Taxi Cabs that use electric or hybrid motors, including Autogas. ⁵ For conversions of old diesel trucks.

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 just 0.04% in the United States to almost 28% in Ukraine in 2020 – the latest year for which data on total automotive fuel consumption are available for all countries (Figure A4.1). Autogas accounted for more than 10% of the fuel market in two countries other than Ukraine: Turkey and Bulgaria, where the share is 12%.

Figure A4.1: Share of Autogas in total automotive-fuel consumption and LDV fleet, 2020

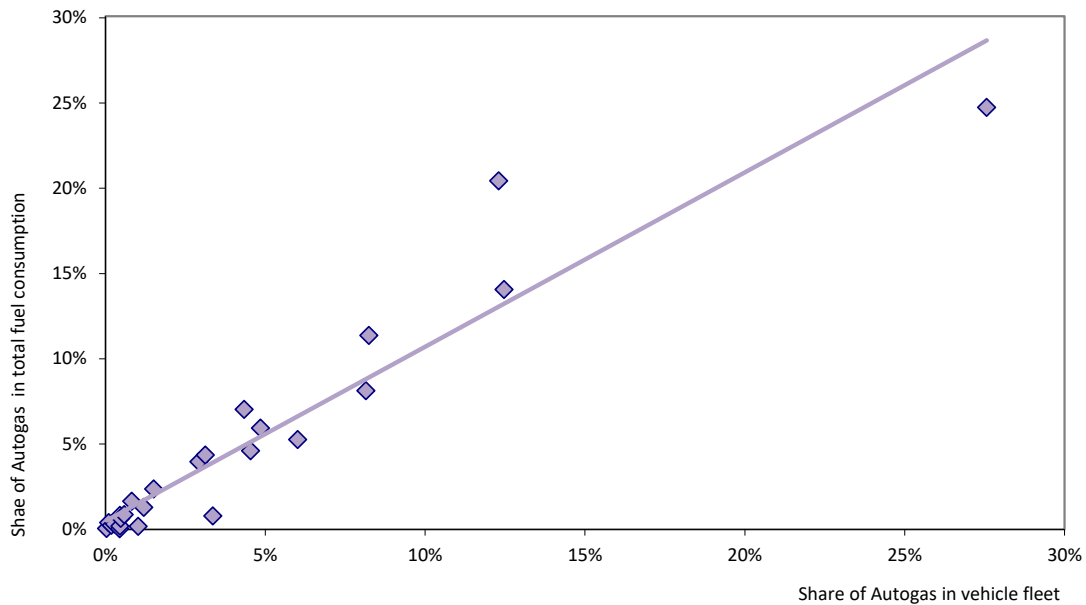


Note: Share of automotive-fuel consumption for Russia is for 2018 – the latest year for which data are available.

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 Canada, 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, 2020



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 must 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 25 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 Canada, Turkey and the United States based on 2021 data (Figure A4.3). The breakeven distance is less than 100,000 km in all countries except Japan, where it is around 120,000 km. In 17 of the 25 countries surveyed, the breakeven distance is under 50,000 km. Autogas is most competitive in India, where a converted vehicle breaks even with gasoline at just 11,000 km – less than one year of driving for a private motorist. Autogas is also highly competitive in Bulgaria, Greece, Lithuania, Poland and Thailand, all of which have a breakeven distance of less than 20 000 km for a converted car.

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 and India, a mono-fuelled Autogas car is generally priced the same as the gasoline version.

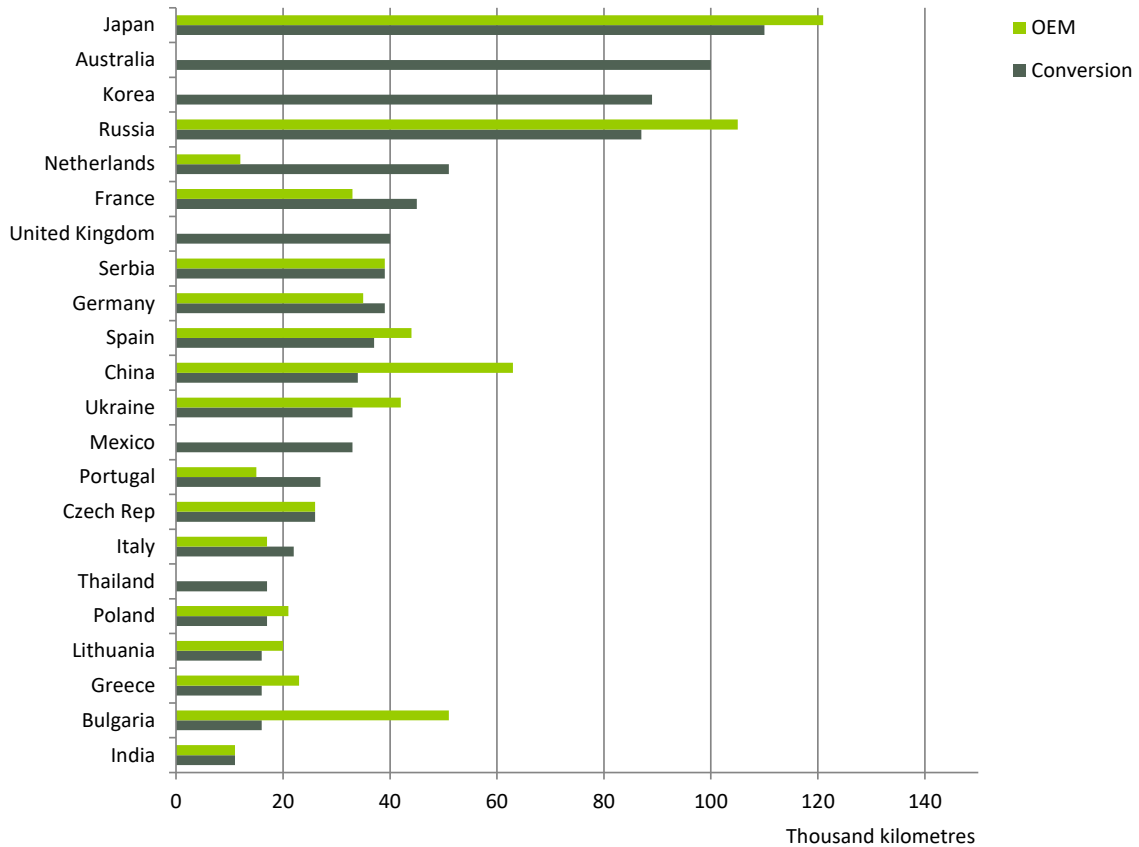
Table A4.1: Breakeven distance for a non-commercial Autogas LDV, 2021 (thousand km)

	Autogas conversion against		Autogas OEM against	
	Diesel	Gasoline	Diesel	Gasoline
Australia	0	100	NA	NA
Bulgaria	0	16	0	51
Canada	NC	NC	NA	NA
China	NC	34	NC	63
Czech Republic	0	26	0	26
France	0	45	0	33
Germany	0	39	0	35
Greece	0	16	0	23
India	0	11	0	11
Italy	0	22	0	17
Japan	0-85	110	0-64	121
Korea	NC	89	0	0
Lithuania	0	16	0	20
Mexico	0	33	NA	NA
Netherlands	0	51	0	12
Poland	0	17	0	21
Portugal	0	27	0	15
Russia	0	87	0	105
Serbia	0	39	0	39
Spain	0	37	0	44
Thailand	0	17	NA	NA
Turkey	0-55	NC	0-39	NC
Ukraine	0	33	0	42
United Kingdom	0	40	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 competitive 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 six of the countries surveyed here as Autogas-conversion costs are less than the additional cost of buying a diesel vehicle and Autogas running costs are lower. In Japan, a converted Autogas car is initially competitive with diesel, but the latter eventually becomes cheaper (at around 85 000 km). The same is the case in Turkey, where diesel breaks even with Autogas at 55,000 km. In Canada, 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.

Figure A4.3: Autogas breakeven distance against gasoline, 2021

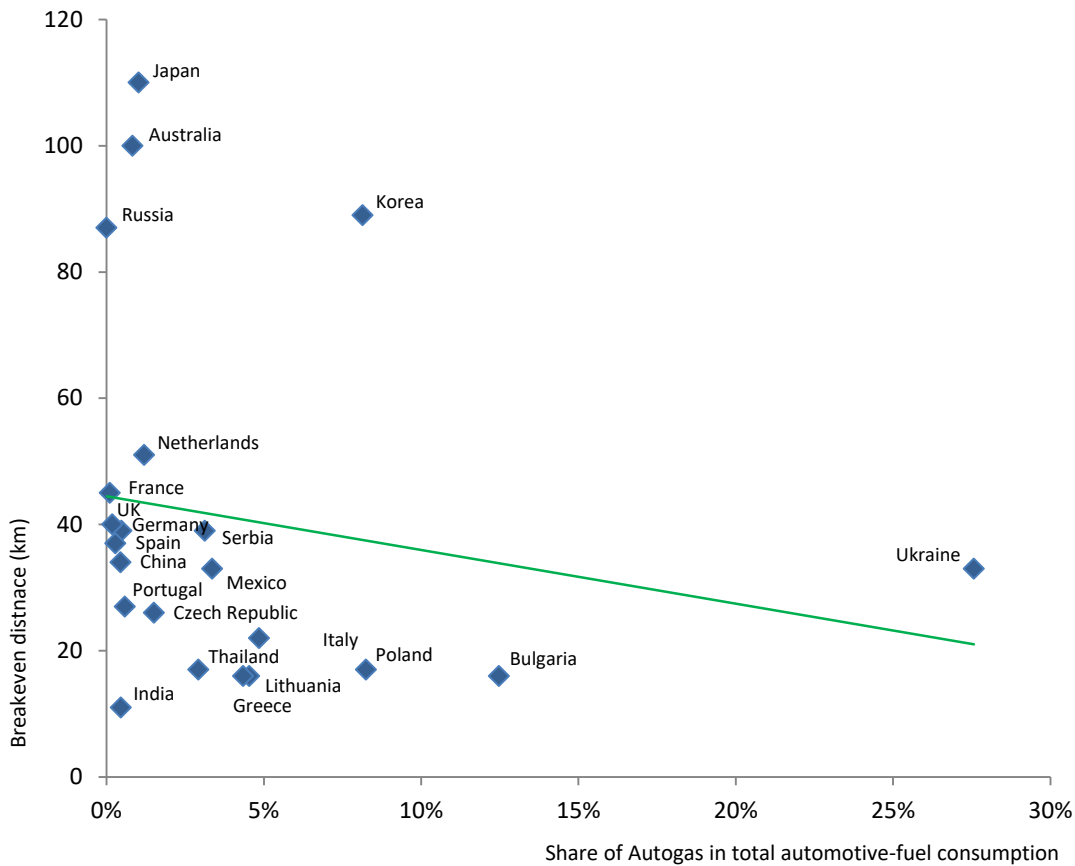


Note: Canada, Turkey and the United States are not shown, as Autogas is never competitive against gasoline. In Korea, an OEM is competitive against gasoline at 0 km; no OEMs were available in Australia, Mexico, Thailand or the United Kingdom.

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

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). Canada, Turkey and the United States are not shown as Autogas is never competitive against gasoline. Breakeven distances are based on 2021 data and market shares on 2020 data.

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 India is lower than that of Ukraine, yet the penetration of Autogas in India 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 India reflects the fact that Autogas has only recently become highly competitive with gasoline and diesel (thanks to tax reform). In many cases, the market has been growing in countries below the trend line in Figure A4.4 and stagnating in those above the line.

Several other factors also 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 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 in the past. Increasing restrictions in many other countries could provide a major boost to Autogas demand in the medium term.
- ▶ *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 traditionally 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. EVs hold out the prospect of zero emissions at the tailpipe, but their widespread commercialisation still hinges critically on expensive subsidies and the well-to-wheel emissions reductions they can achieve depend on the fuel mix in power generation. 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 and economical 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 zero-emission energy system, but also as a long-term solution to the extent that conventional supplies of LPG can be replaced with rLPG.

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, and would, in any case, be more than compensated by

positive externalities in terms of better air quality and health, and the reduction in damage to buildings from sulphuric emissions.

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 sustainable Autogas markets. 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 must 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 of 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, long-term 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. The use of Autogas in ambulances and school buses in the US sends a powerful message that the fuel is safe.

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 No. 67 on the approval of LPG equipment and vehicles and Regulation No. 115 on LPG and CNG retrofit systems.

Safety must 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. This would address 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. The starting point should be to set out a detailed roadmap for Autogas.

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 enough. 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.

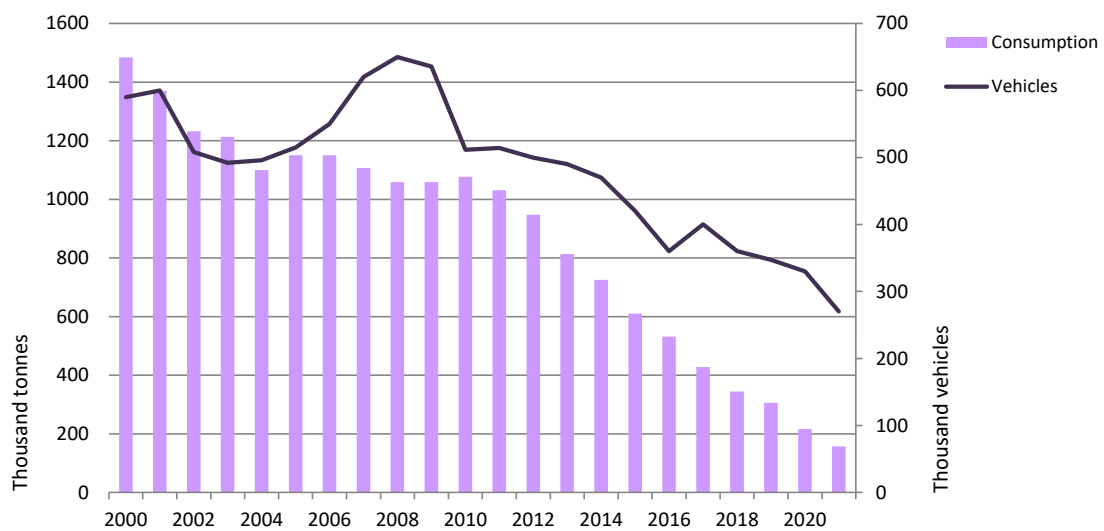
PART B: COUNTRY SURVEYS

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 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 at around 1.1 Mt per year between 2004 and 2010 (Figure B1.1).

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



Source: WLPGA/Argus (2022).

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 federal and state government grants for converting or buying Autogas vehicles also contributed (see below). Sales slumped to just 157,000 tonnes in 2021 – 50% down in 2019 and barely a tenth of the level of 2000, when they peaked at almost 1.5 million tonnes. The sharp decline in 2020 was accentuated by the effects of the COVID-19 pandemic. Autogas use was equal to less than 0.8% of total road-fuel consumption in 2020 compared with a peak of 6.6% in 2000.

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 16% of the country's LPG consumption.

The Autogas market in Australia was further undermined by the closure in 2017 of the Ford and General Motors (Holden) car factories in the country, where dedicated 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 Prins¹, 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 2,400 refuelling sites throughout the country serving an estimated 270,000 vehicles at end-2021 (around 1.7% of the total car fleet). Both the number of stations and vehicles has been declining steadily in recent years.

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, notably EVs. The federal government 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 1st December 2011 at 2.5 cents/litre and was scheduled to rise each year on 1st 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 14 cents/litre in 2021. The taxes on gasoline and diesel are still considerably higher – 42.9 cents for both fuels – but the gap with Autogas has narrowed over the last decade.

The pump price of Autogas, including the 10% general sales tax (GST), is currently 56% that of gasoline and 59% of that of diesel (Table B1.1). The price of Autogas fell sharply relative to those of the two other fuels in 2019, thanks to a sharper fall in pre-tax prices as a result of international price movements, but has since rebounded to record levels relative to both fuels.

¹ Prins recently launched a new Autogas fuel system for the Toyota Kluger, a popular SUV in Australia, which is expected to lead to more taxi conversions (<https://autogas.net/mediaroom/autogas-toyota-kluger-now-available-for-australian-taxi-fleets/>).

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

	Australian dollars						US dollars
	2016	2017	2018	2019	2020	2021	2021
<i>Pump prices</i>							
Autogas	0.613	0.719	0.794	0.729	0.716	0.836	0.628
Diesel	1.178	1.295	1.497	1.465	1.250	1.414	1.061
Gasoline*	1.169	1.286	1.432	1.421	1.236	1.485	1.115
<i>Total taxes</i>							
Autogas	0.185	0.197	0.206	0.203	0.203	0.216	0.162
Diesel	0.503	0.520	0.547	0.550	0.536	0.558	0.419
Gasoline*	0.502	0.519	0.541	0.546	0.535	0.564	0.423
<i>Excise taxes</i>							
Autogas	0.129	0.132	0.134	0.137	0.138	0.140	0.105
Diesel	0.396	0.402	0.411	0.417	0.423	0.429	0.322
Gasoline*	0.396	0.402	0.411	0.417	0.423	0.429	0.322
<i>Pre-tax prices</i>							
Autogas	0.428	0.522	0.589	0.526	0.513	0.621	0.466
Diesel	0.675	0.775	0.950	0.915	0.713	0.856	0.643
Gasoline*	0.667	0.767	0.891	0.875	0.701	0.921	0.691

* Regular unleaded.

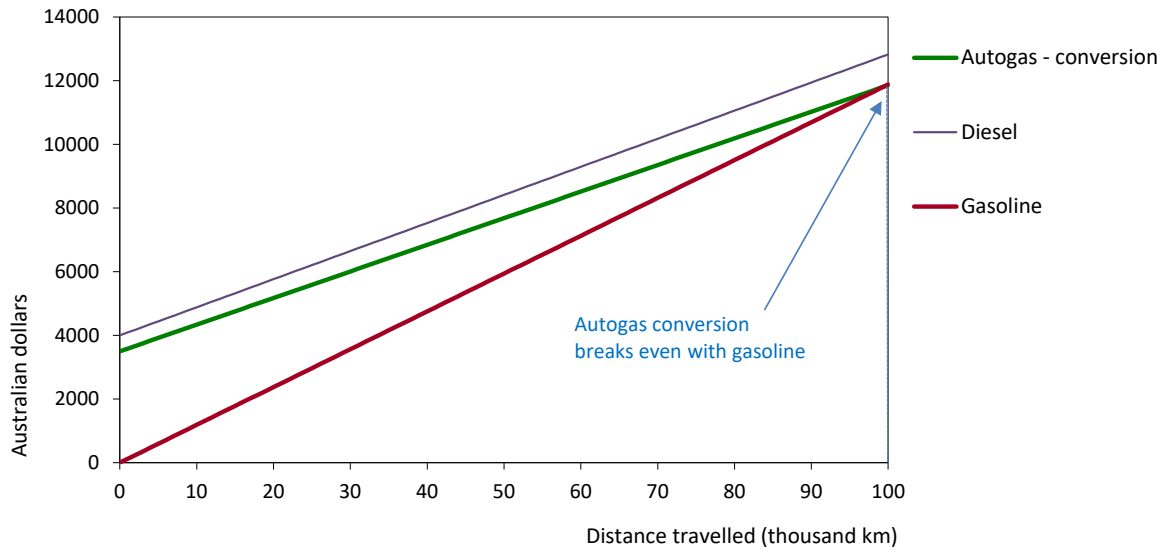
The federal and state governments no longer make available grants for the conversion of existing vehicles or purchase of an OEM Autogas vehicle. The LPG Vehicle Scheme, introduced in 2006, provided grants to private motorists for the conversion of existing LDVs of less than 3.5 tonnes or the purchase of an OEM Autogas LDV. The scheme was closed at the end of June 2014. State governments have also stopped 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, and EVs. 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 EVs 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 around 100,000 km (Figure B1.2). The breakeven distance has increased markedly over the last decade or so 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 over 120,000 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, 2021 – Australia

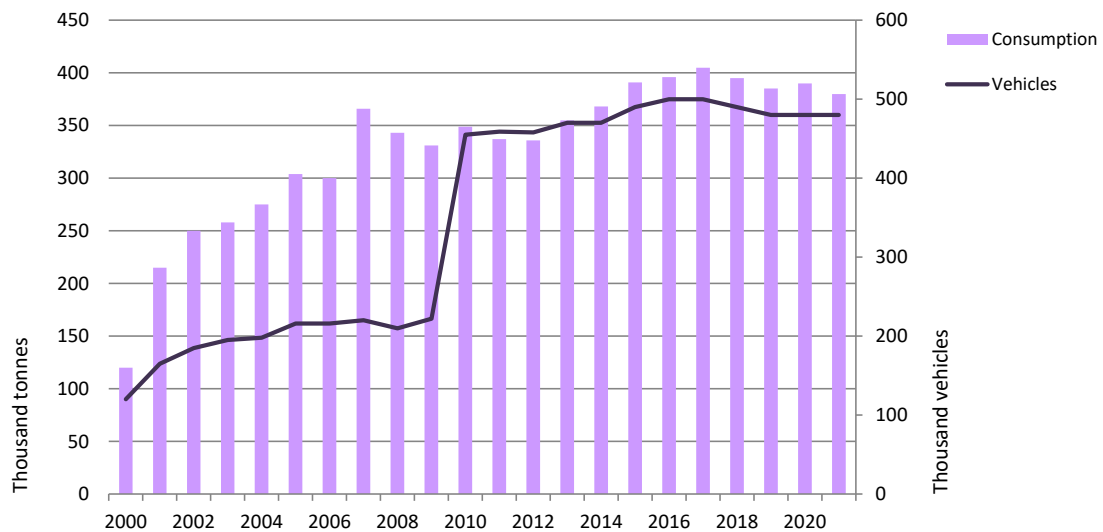


2 Bulgaria

2.1 Autogas market trends

The Bulgarian Autogas market took off in the 1990s and continued to grow steadily through most of the 2000s, with demand stalling in 2008 following the financial and economic crisis. After a period of stagnation, demand rebounded, reaching a peak of 405,000 tonnes in 2017, before falling back marginally to 380,000 tonnes in 2021 – 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 88% of all the 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.
 Source: WLPGA/Argus (2022).

The Autogas vehicle fleet grew steadily through the 2010s as private motorists, taxis and other commercial vehicles have switched from diesel and gasoline usually by installing conversion kits in existing vehicles. The number of Autogas vehicles peaked at around 500,000 in 2017, though it has since fallen back to an estimated 480,000 in 2019 and remaining at the same level through to 2021 – about 14% of the total vehicle fleet. 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 also expanded quickly to 2013, though it has since fallen to an estimated 2,400 in 2021.

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/litre on diesel and 0.71 lev/litre on gasoline (unchanged since 2013) (Table B2.1). Combined with a relatively low wholesale price of Autogas, this tax advantage translates into a competitive price of the fuel at the pump. In 2021, the average pump price of Autogas was equal to 51% of the price of gasoline and 52% of that of diesel. The price advantage of Autogas over both the other fuels has nonetheless fallen significantly since 2019.

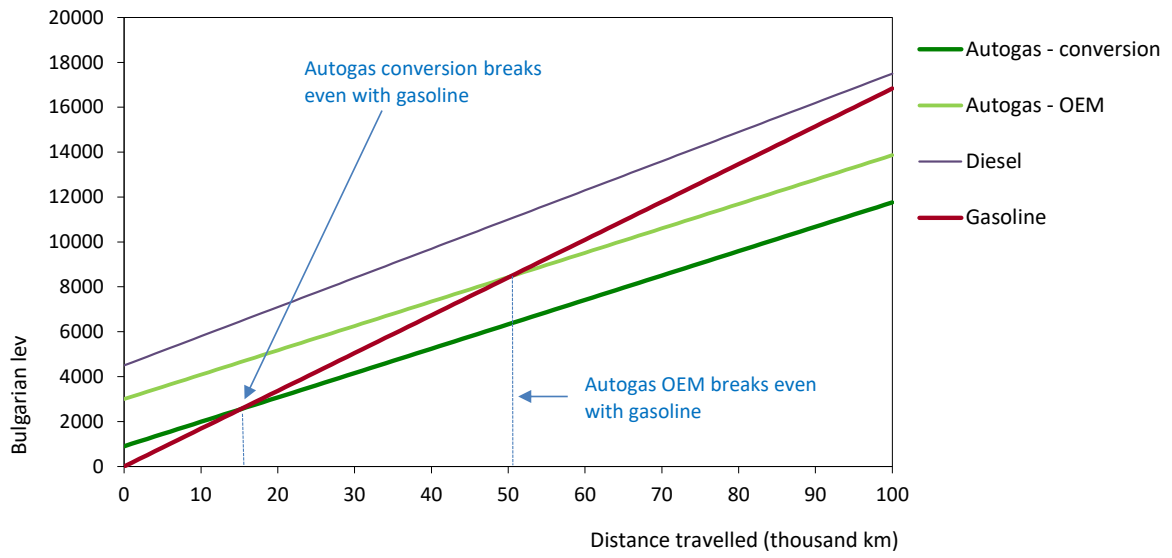
Table B2.1: Automotive-fuel prices and taxes per litre – Bulgaria

	Lev						US dollars
	2016	2017	2018	2019	2020	2021	2021
<i>Pump prices</i>							
Autogas	0.826	0.941	1.011	0.912	0.846	1.086	0.657
Diesel	1.865	1.980	2.163	2.173	1.803	2.083	1.259
Gasoline	1.924	2.007	2.148	2.121	1.821	2.104	1.272
<i>Total taxes</i>							
Autogas	0.322	0.341	0.353	0.336	0.325	0.365	0.221
Diesel	0.957	0.976	1.007	1.008	0.947	0.993	0.600
Gasoline	1.031	1.044	1.068	1.063	1.014	1.061	0.641
<i>Excise taxes</i>							
Autogas	0.184	0.184	0.184	0.184	0.184	0.184	0.111
Diesel	0.646	0.646	0.646	0.646	0.646	0.646	0.391
Gasoline	0.710	0.710	0.710	0.710	0.710	0.710	0.429
<i>Pre-tax prices</i>							
Autogas	0.504	0.600	0.659	0.576	0.522	0.721	0.436
Diesel	0.908	1.004	1.157	1.165	0.857	1.090	0.659
Gasoline	0.893	0.962	1.080	1.057	0.808	1.044	0.631

2.3 Competitiveness of Autogas against other fuels

The 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 in real 2021 prices (Figure B2.2). Based on average 2021 fuel prices, the breakeven distance against gasoline is only 16,000 km – little more than one year of driving for a private motorist. An OEM Autogas car breaks even at 51,000 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 with Autogas and breaks even with gasoline only at above 110,000 km.

Figure B2.2: Running costs of a non-commercial LDV, 2021 – Bulgaria

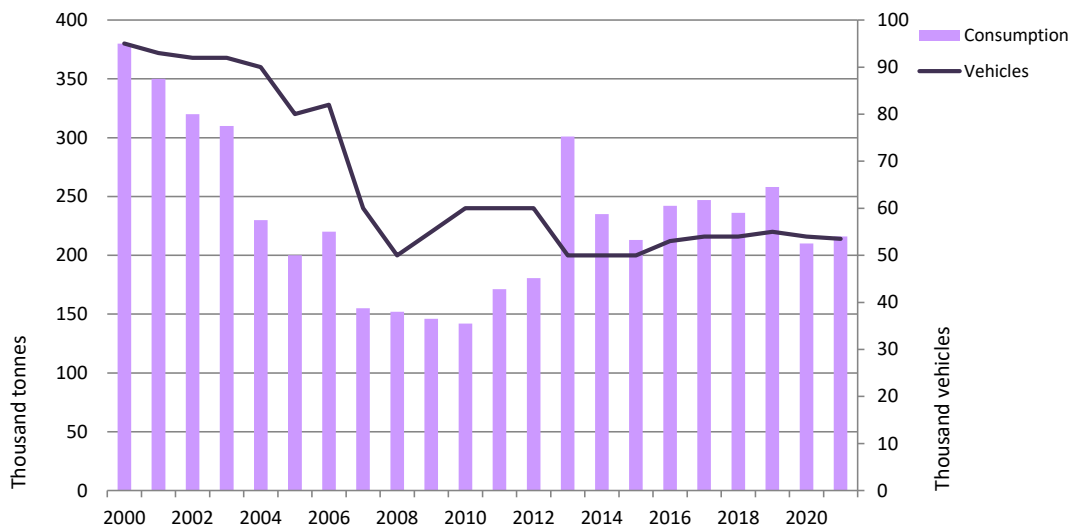


3 Canada

3.1 Autogas market trends

The Canadian Autogas market went into decline in the early 1990s after a decade of growth. Autogas use peaked in 1992 at around 700,000 tonnes and then fell to less than 150,000 tonnes in 2010. The market has since picked up strongly, reaching 258 000 tonnes in 2019, falling back to 216 000 tonnes in 2021, largely as a result of the effects of the health crisis (Figure B3.1). Autogas accounts for just 0.5% of total automotive-fuel use – a share that has barely changed in recent years. The initial slump in Autogas use was a direct result of the declining number of Autogas conversions in fleets, primarily due to increased conversion equipment costs and the removal of federal conversion grants. The subsequent rebound in demand was largely due to a fall in the price of Autogas relative to that of gasoline and diesel (at least until 2017) and federal incentives (see below).

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



Source: WLPGA/Argus (2022).

The majority of the estimated 54,000 Autogas vehicles in use in Canada today are high-mileage public fleet vehicles, mainly converted vans and school buses. At present, no OEM Autogas vehicles are marketed in Canada. Alberta, Ontario and British Columbia have the largest Autogas markets. Autogas is available at 2,230 filling stations across Canada – a very high number relative to the number of vehicles in use. Refuelling infrastructure is larger than that of any other alternative fuel (excluding public EV recharging facilities) in Canada.¹

¹ <https://auto-gas.net/mediaroom/growing-network-of-autogas-refuelling-locations-in-canada/>

In January 2021, the national government and that of Ontario announced funding of more than CA\$ 3.5 million for two projects as part of the Public Transit Infrastructure Stream (PTIS) of the Investing in Canada plan, one of which involves the replacement of existing specialised transit buses with 69 new Autogas buses.¹ The new buses, with side-mounted lift, will provide accessible transit in Brampton, Mississauga, and Caledon, and are capable of carrying as many as six wheelchair passengers.

3.2 Government Autogas incentive policies

Autogas enjoys a significant per-litre tax advantage over gasoline and diesel, thanks to lower provincial taxes and no federal excise tax on Autogas. However, because fuel taxes across the board are relatively low in Canada, the differences in prices at the pump in absolute terms are not very large. The Autogas tax differential (including sales taxes) is currently just 29 Canadian cents/litre compared with diesel and 24 cents/litre compared with gasoline (Table B3.1). Tax rates on all three fuels have increased steadily in recent years, but the differentials have barely changed. The average pump price of Autogas in 2019 was 28% lower than that of gasoline and 30% less than that of diesel. Adjusted for differences in energy content per litre (and, therefore, mileage), Autogas is only slightly cheaper than gasoline, but more expensive than diesel.

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

	Canadian dollars						US dollars
	2016	2017	2018	2019	2020	2021	2021
<i>Pump prices</i>							
Autogas	0.576	0.716	0.875	0.895	0.892	0.940	0.750
Diesel	0.977	1.102	1.288	1.231	1.038	1.302	1.038
Gasoline	1.029	1.146	1.288	1.209	1.031	1.350	1.077
<i>Total taxes</i>							
Autogas	0.102	0.120	0.140	0.154	0.163	0.177	0.141
Diesel	0.310	0.333	0.356	0.366	0.371	0.417	0.333
Gasoline	0.381	0.399	0.416	0.421	0.420	0.468	0.373
<i>Excise taxes</i>							
Autogas	0.075	0.086	0.098	0.111	0.120	0.133	0.106
Diesel	0.263	0.281	0.295	0.307	0.322	0.355	0.283
Gasoline	0.332	0.345	0.354	0.364	0.371	0.404	0.322
<i>Pre-tax prices</i>							
Autogas	0.473	0.596	0.735	0.741	0.730	0.762	0.608
Diesel	0.667	0.769	0.931	0.865	0.667	0.886	0.707
Gasoline	0.648	0.747	0.873	0.787	0.610	0.882	0.703

Autogas receives limited policy support in Canada. The Alternative Fuels Act 1995 requires that three-quarters of all vehicles purchased by the federal government be capable of operating on one of a range of alternative fuels,

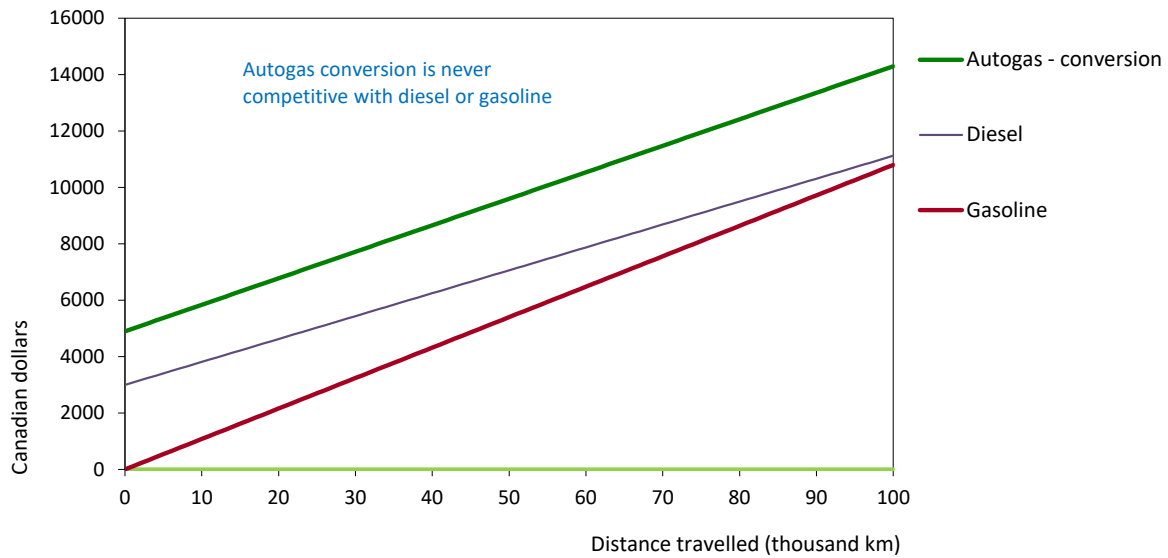
¹ <https://www.canada.ca/en/office-infrastructure/news/2021/01/canada-and-ontario-invest-in-accessible-public-transit-infrastructure-for-residents-of-peel-region.html>

including Autogas, where it is cost-effective and operationally feasible. However, in practice, most of the AFVs purchased are gasoline-fuelled vehicles capable of running on blends of gasoline and ethanol with content of the latter of up to 85%.

3.3 Competitiveness of Autogas against other fuels

At present, the Autogas market – as in the United States – is driven entirely by federal fleet mandates: the fuel is not a financially-attractive alternative to either diesel or gasoline in Canada because of unfavourable taxation policies and a lack of incentives to convert or buy OEM Autogas vehicles. Conversion costs, at around CA\$4,900 (\$3 700) in 2021 prices for a typical 4-cylinder gasoline-fuelled vehicle are also relatively high in Canada, further undermining the competitiveness of Autogas. Autogas is never competitive with either diesel or gasoline. By contrast, diesel becomes competitive with gasoline at just over 100 000 km (Figure B3.2).

Figure B3.2: Running costs of a non-commercial LDV, 2021 – Canada

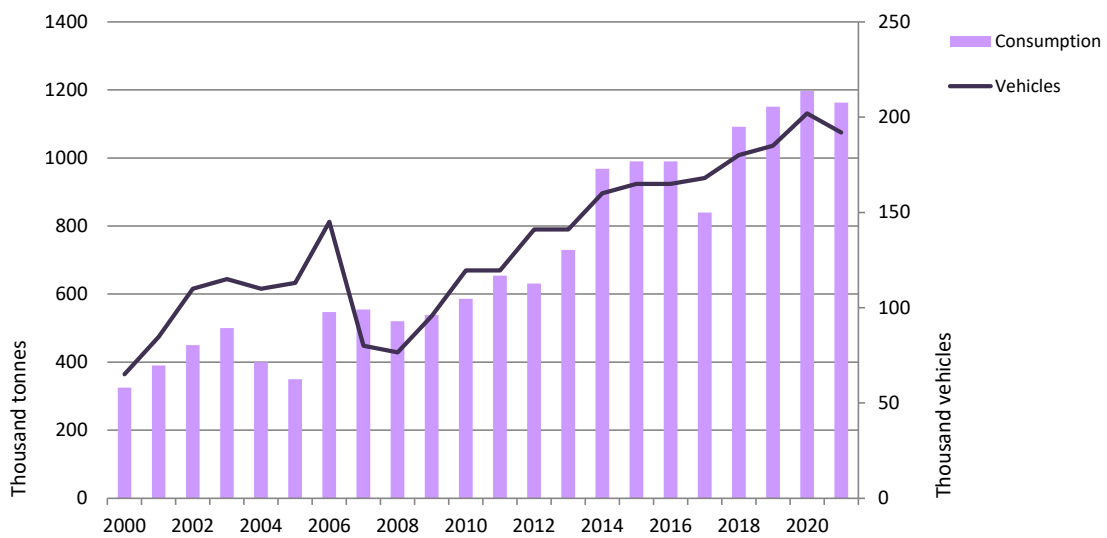


4 China

4.1 Autogas market trends

Autogas use in China has grown in a rather uneven fashion over the last two decades, reaching a peak of 1.2 Mt in 2019 before falling back to 1.16 Mt in 2021 in the wake of the COVID-19 crisis – still almost twice the level of 2010 (Figure B4.1). Just two cities – Guangzhou and Hong Kong – account for the bulk of the Chinese market.

Figure B4.1: Autogas consumption and vehicle fleet – China



Source: WLPGA/Argus (2022).

The overwhelming bulk of Autogas use is in taxis and buses. Hyundai, Toyota, 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. No OEM Autogas cars are available for the general public, though it is a network of conversion centres (of which around 30 are in Guangzhou). Autogas accounts for just 0.4% of total automotive-fuel use in China. At the end of 2021, there were an estimated 192,000 Autogas vehicles (down slightly on the peak of 202,000 in 2020) and 580 refuelling sites. Autogas made up just 1.6% of total Chinese LPG consumption in 2019.

4.2 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 EVs (Box B3.1). In Hong Kong, almost all the city's 20,000 taxis and 30% of the public buses run on Autogas, as a result of a conversion programme launched in 1997, which involved grants over the period 2000-2003. New diesel taxis were banned in 2006 because of their high particulate emissions and existing ones were phased out. The Toyota Comfort makes up the majority of Hong Kong's Autogas taxi fleet, though most new taxis are Toyota JPNs (production of the Comfort model was discontinued in 2018).

Box B4.1: Guangzhou's Autogas policy goes into reverse

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 taxis. 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 been falling steadily from a peak of around 400 000 tonnes at the end of the 2000s.

Several other cities, including Shanghai, have also mandated the conversion of public taxis to alternative fuels. Beijing is planning to do the same, with the city's 67,000 conventionally fuelled taxis due to be converted to either Autogas or electricity.¹ The central government has announced plans to introduce stricter emissions standards for new vehicles, with local authorities encouraged to adopt them earlier than schedule, which is expected to favour Autogas over diesel and may give a boost to demand for the former fuel.²

The central government promotes the use of Autogas mainly 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 (they have been stable since). In addition, a lower VAT rate of 9% is levied on Autogas (down from 11% up to the end of March 2019 and from 13% up to 2016), compared with 13% on gasoline and diesel (down from 16% up to the end of March 2019). Wholesale and retail prices of

¹ <https://auto-gas.net/mediaroom/beijing-plans-to-replace-all-its-taxis-with-alternative-fuel-vehicles/>

² <https://auto-gas.net/mediaroom/china-encourages-alternative-fuel-adoption-to-cut-emissions/>

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 mechanism introduced in 2013, it adjusts prices periodically according to changes in crude oil prices on the international market and domestic economic conditions. In 2021, the resulting pump price of Autogas was on average 60% of that of gasoline and 64% of that of diesel (Table B4.1).

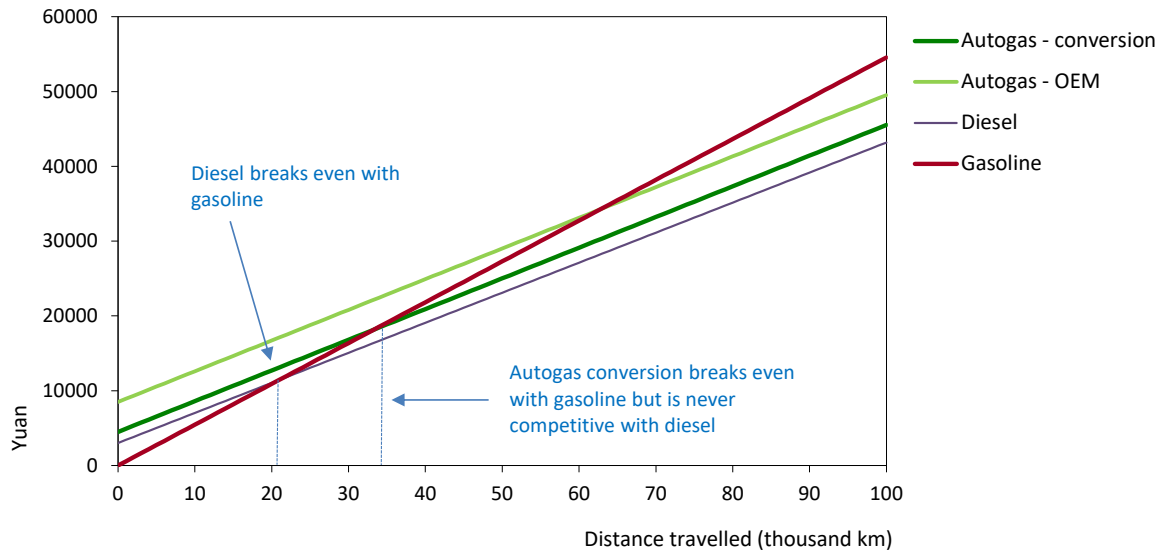
Table B4.1: Automotive-fuel prices and taxes per litre – China

	Yuan						US dollars
	2016	2017	2018	2019	2020	2021	2021
<i>Pump prices</i>							
Autogas	3.77	3.84	4.22	3.41	3.26	4.10	0.636
Diesel	5.34	5.96	6.83	6.44	5.62	6.44	0.998
Gasoline	5.77	6.38	7.20	6.81	6.38	6.82	1.057
<i>Total taxes</i>							
Autogas	0.43	0.41	0.39	0.29	0.27	0.34	0.053
Diesel	1.98	2.07	2.16	1.98	1.85	1.94	0.301
Gasoline	2.36	2.45	2.53	2.34	2.25	2.30	0.357
<i>Excise taxes</i>							
Autogas	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Diesel	1.20	1.20	1.20	1.20	1.20	1.20	0.186
Gasoline	1.52	1.52	1.52	1.52	1.52	1.52	0.236
<i>Pre-tax prices</i>							
Autogas	3.34	3.43	3.82	3.12	2.99	3.76	0.583
Diesel	3.36	3.89	4.67	4.46	3.77	4.50	0.697
Gasoline	3.41	3.93	4.67	4.47	4.13	4.52	0.700

4.3 Competitiveness of Autogas against other fuels

Based on average 2021 prices, a converted non-commercial Autogas LDV breaks even with gasoline at 34,000 km, based on a conversion cost of around 4,500 yuan (approximately \$650). For an OEM vehicle, the break-even distance is 63,000 km, assuming it costs 8,500 yuan (\$1,200) more than a mono-fuel gasoline vehicle. Autogas is never competitive with diesel, which breaks even with gasoline at just over 20,000 km (Figure B4.2). 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 B4.2: Running costs of a non-commercial LDV, 2021 – China

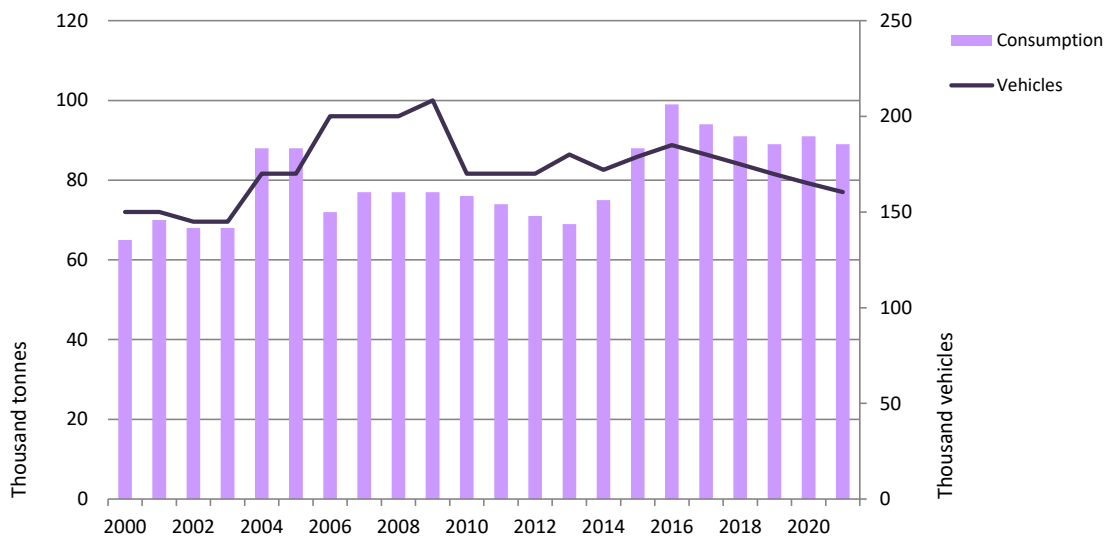


5 Czech Republic

5.1 Autogas market trends

After several years of stagnation, the Czech Autogas market rebounded strongly in 2014-2016, though it has since contracted once again. Consumption peaked at 99,000 tonnes in 2016 and then fell to 89,000 tonnes in 2019, remaining at that level in 2021 (Figure B5.1). The surge in the market up to 2016 was 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 1.5% of the country’s road-fuel needs and 21% of total LPG use.

Figure B5.1: Autogas consumption and vehicle fleet – Czech Republic



Source: WLPGA/Argus (2022).

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 hit a recent peak of 185,000 in 2016, but has since fallen back steadily to 161,000 in 2021 (2.4% of the total vehicle fleet). Sales of new OEM Autogas vehicles are nonetheless rising, hitting 1,021 units in the first quarter of 2022 – three times more than the same period in 2021.¹ In addition, the number of Autogas conversions has doubled, reaching 1,600 vehicles, according to the Czech LPG Association. In total, about 6,800 Autogas vehicles were added to the fleet in 2021, about one third of which were new

¹ <https://auto-gas.net/mediaroom/czech-republic-sales-of-new-lpg-cars-triple-during-the-first-quarter-of-2022/>

OEM cars. The CNG fleet has also been growing, but remains far smaller, made up mainly of buses and light-duty trucks.¹ There are 870 filling stations that sell Autogas across the country – less than one-fifth of the total.

5.2 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, which last increased in 2010, amounts to 12.84 crowns, while that of diesel was cut from 10.95 crowns to 9.95 crowns in 2021 as part of the government's economic stimulus programme in response to the COVID-19 crisis – the first change in 11 years (Table B5.1). This resulted in an Autogas price at the pump in 2021 that was just 44% of the price of gasoline and 46% of that of diesel. In contrast to electricity chargers and CNG infrastructure, the government provides no financial incentives or support for Autogas distribution infrastructure.²

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

	Crowns						US dollars
	2016	2017	2018	2019	2020	2021	2021
<i>Pump prices</i>							
Autogas	12.41	13.90	14.68	14.15	12.58	14.51	0.669
Diesel	27.38	29.50	31.56	31.68	27.97	31.29	1.443
Gasoline	28.60	30.31	32.06	31.34	28.18	32.80	1.513
<i>Total taxes</i>							
Autogas	4.31	4.57	4.71	4.62	4.34	4.20	0.194
Diesel	15.70	16.07	16.43	16.45	15.80	15.38	0.709
Gasoline	17.80	18.10	18.40	18.33	17.73	18.53	0.855
<i>Excise taxes</i>							
Autogas	2.16	2.16	2.16	2.16	2.16	2.16	0.100
Diesel	10.95	10.95	10.95	10.95	10.95	9.95	0.459
Gasoline	12.84	12.84	12.84	12.84	12.84	12.84	0.592
<i>Pre-tax prices</i>							
Autogas	8.09	9.33	9.97	9.53	8.24	10.31	0.475
Diesel	11.68	13.43	15.14	15.23	12.16	15.91	0.734
Gasoline	10.79	12.21	13.66	13.32	10.45	14.27	0.658

5.3 Competitiveness of Autogas against other fuels

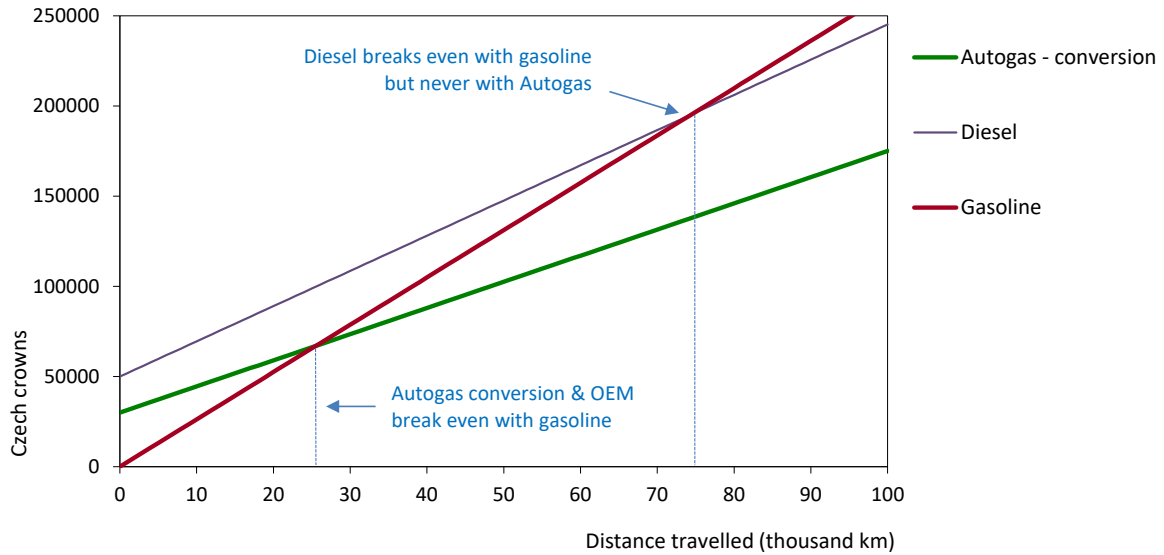
The low price of Autogas makes it by far the cheapest fuel in terms of cost per kilometre among the three leading fuels. Based on an average cost of conversion of 30 000 crowns (around \$1,200) and a similar amount for the price premium of an OEM Autogas car over a gasoline-powered model, the break-even distance is just 26,000 km, or about two years of driving for the

¹ <https://www.ngvglobal.com/blog/bonetts-cng-fuel-sales-czech-republic-highest-third-year-0216>.

² 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.

typical private motorist (Figure B5.2). This distance has changed little in recent years. The fuel-cost savings after 100,000 km amount to about 80,000 crowns (\$3,700). Diesel breaks even with gasoline at around 75,000 km (based on a vehicle price premium of 50,000 crowns, or \$2,200), but is never competitive with Autogas.

Figure B5.2: Running costs of a non-commercial LDV, 2021 – Czech Republic

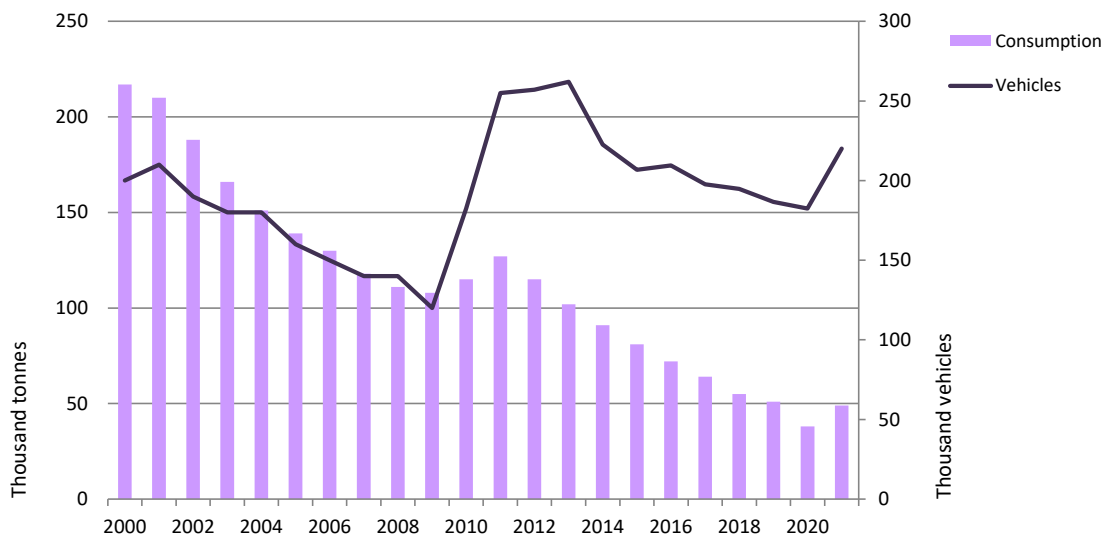


6 France

6.1 Autogas market trends

The Autogas market in France was in constant decline between 2000 and 2020, except for a brief recovery in the early part of the current decade, despite persistently attractive Autogas 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 B6.1). 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 the safety of the fuel. After a temporary rebound in 2020-2021, Autogas use resumed its downward trend in 2012, reaching just 38,000 tonnes in 2020 (accentuated by the COVID-19 crisis), but rebounded sharply to 49,000 tonnes in 2021 on the back of the economic recovery and a surge in vehicle sales due to higher gasoline and diesel prices. Autogas accounts for only around 0.1% of total automotive-fuel use and 1.6% of total LPG consumption in the country.

Figure B6.1: 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 sales of OEM Autogas vehicles to households, with lower average mileage than commercial fleet vehicles and taxis. Source: WLPGA/Argus (2022); IEA databases.

The number of Autogas vehicles on French roads, which had been in constant decline since the early 2010s, rebounded sharply in 2021, mainly due to renewed interest in profiting from the fuel cost savings on offer from

switching from the increasingly more expensive gasoline and diesel (sales of EVs and conversions to ethanol have also been rising strongly). New OEM Autogas car sales almost tripled in 2021 to 46,420, boosting the overall fleet to around 220 000 vehicles – about 0.5% of the total car fleet. New OEM sales make up most new LPG vehicle registrations. Dacia, which dominates the market, launched Euro 6 LPG versions for its entire vehicle portfolio (six models) in 2017, the prices of which are currently no higher than those of the gasoline-only versions. Renault's Clio and Captur models are now also available in Autogas versions at the same price as their gasoline-only equivalents.¹ There are 1,579 refuelling stations across the country – barely fewer than in the early 2000s – with every metropolitan region well-served.

6.2 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 has since been raised each year, reaching 11.5 cents in 2018 (Table B6.1). But the duties on gasoline and diesel, already much higher, also increased steadily, notably that on diesel since 2012.² Duties on Autogas and gasoline have not changed since 2018, while that diesel has increased marginally. The average excise-duty differential with Autogas stood at 49.6 cents/litre for diesel – the leading road-transport fuel in France – and 58 cents/litre for gasoline in 2021. 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 on average 40% lower than that of diesel and 45% lower than that of gasoline in 2021. Autogas qualifies for the 18 cents/litre transport fuel price discount introduced by the government in April 2022 as part of the policy to address the rising cost of living.⁴

There are a number of other public policy measures in place that have the effect of encouraging the use of Autogas and other clean vehicles. The principle measure is the system of bonus-malus (or penalty) for new vehicle registrations. The penalties for polluting cars and the threshold for penalties have been lowered progressively since the scheme was introduced in the early 2010s. The threshold since 1 January 2022 is 128 g/km (down from 133 g/km in 2021). Since 2020, the thresholds and penalties have been based on the more stringent world light-duty vehicles test procedure (WLTP), which yields higher emissions compared with the new European driving cycle

¹ <https://auto-gas.net/mediaroom/renault-unveils-new-autogas-engine-for-clio-and-captur-models/>; <https://www.renault.fr/gpl.html>

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.

⁴ <https://www.economie.gouv.fr/remise-carburant-fonctionnement>

(NEDC) used previously. Penalties rise to €40,000 for cars emitting 224 g/km or more (up from €30,000 in 2021 and just €10,500 in 2019). Since Autogas-fuelled cars emit less than the equivalent mono-fuelled gasoline car, penalties are lower. In addition, the bonuses (*bonus ecologiques*) for hybrid vehicles emitting less than 60 g/km were extended to Autogas/electric hybrids in 2021.

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

	Euros						US dollars
	2016	2017	2018	2019	2020	2021	2021
<i>Pump prices</i>							
Autogas	0.709	0.740	0.819	0.856	0.845	0.852	1.008
Diesel	1.102	1.230	1.437	1.439	1.260	1.431	1.692
Gasoline	1.301	1.375	1.507	1.505	1.357	1.553	1.837
<i>Total taxes</i>							
Autogas	0.196	0.215	0.251	0.258	0.256	0.257	0.304
Diesel	0.694	0.751	0.848	0.849	0.819	0.850	1.005
Gasoline	0.864	0.888	0.942	0.942	0.917	0.950	1.123
<i>Excise taxes</i>							
Autogas	0.078	0.092	0.115	0.115	0.115	0.115	0.136
Diesel	0.511	0.546	0.608	0.609	0.609	0.611	0.723
Gasoline	0.648	0.659	0.691	0.691	0.691	0.691	0.817
<i>Pre-tax prices</i>							
Autogas	0.513	0.525	0.568	0.598	0.589	0.595	0.704
Diesel	0.408	0.479	0.589	0.590	0.441	0.581	0.687
Gasoline	0.437	0.487	0.565	0.563	0.439	0.603	0.713

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 ten 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 gasoline.¹ There is also a three-year exemption from the business tax on Autogas cars that emit less than 100 g/km.

In 2016, the French government revised its system of vehicle classification according to their pollutant emissions, known as “Crit’Air”. Autogas vehicles are now included in the second least polluting category (the first one, or category 0, covers 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 (air quality protection zones) during periods of severe air pollution

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 rose in stages to 80% in 2022 (the same rate as for diesel).

periods to encourage the use of less polluting fuels. Paris and Grenoble were the first cities to introduce a requirement to purchase a Crit'Air sticker based on the new classification system and several other cities have followed suit or are planning to do so. Under the 2021 Climate and Resilience Act (*loi climat et resilience*), all agglomerations with more than 150 000 inhabitants will be obliged to introduce clean air zones by 31 December 2024. For ten metropolitan areas that regularly exceed air quality limit values, traffic bans will be standardised to prohibit vehicle circulation: Crit'air 5 in 2023, Crit'air 4 in 2024 and Crit'Air 3 in 2025. As they are classified as Crit'Air 1, these restrictions will not apply to Autogas vehicles. Some cities, including Toulouse, have introduced grants schemes to help household and business owners of old polluting vehicles to buy clean ones.¹

In January 2018, the government launched a new incentive scheme to encourage owners of private and commercial cars, vans and trucks to scrap an old polluting vehicle (older than 1996 from a gasoline vehicle and 2001 for a diesel) and replace it with a new or used "clean" cars emitting less than 130g CO₂/km and with a Crit'Air rating of 1 or 2 (including all Autogas vehicles). The incentive amounted to €1,000 (€2,000 for low income families, up from €1,000 in 2017). The rules for qualification for the bonus were tightened in 2019 and the emissions threshold lowered to 122 g/km in January and 117 g/km in August (based on NEDC testing), though the size of the bonus was increased to a maximum of €3,000 (€5,000 for EVs or hybrids).

As part of the emergency plan to boost the economy in the wake of the Covid-19 crisis, President Macron announced in May 2020 a new car-scraping scheme with the same bonuses, but with different conditions, from the second half of 2020 (the bonuses can be combined with the *bonus ecologiques* under the bonus-malus scheme described above). The scheme applies to gasoline cars older than 2006 and diesel cars older than 2011. It includes a €3,000 grant for the purchase of any new or second-hand Autogas vehicle that emits less than 127 g/km (WLTP) for a car less than 6 months old and 137 g/km for older cars (subject to household income).²

Autogas is also promoted through other local regulatory measures. For example, the departmental council of Mayenne announced in 2018 its intention to acquire 40 new AFVs.³ 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.⁴

¹ <https://auto-gas.net/mediaroom/france-toulouse-announces-aid-to-replace-old-polluting-cars/>

² <https://www.cfbp.fr/wp-content/uploads/2020/06/CFBPPRIMECONVERSIONGPLDEF.pdf>

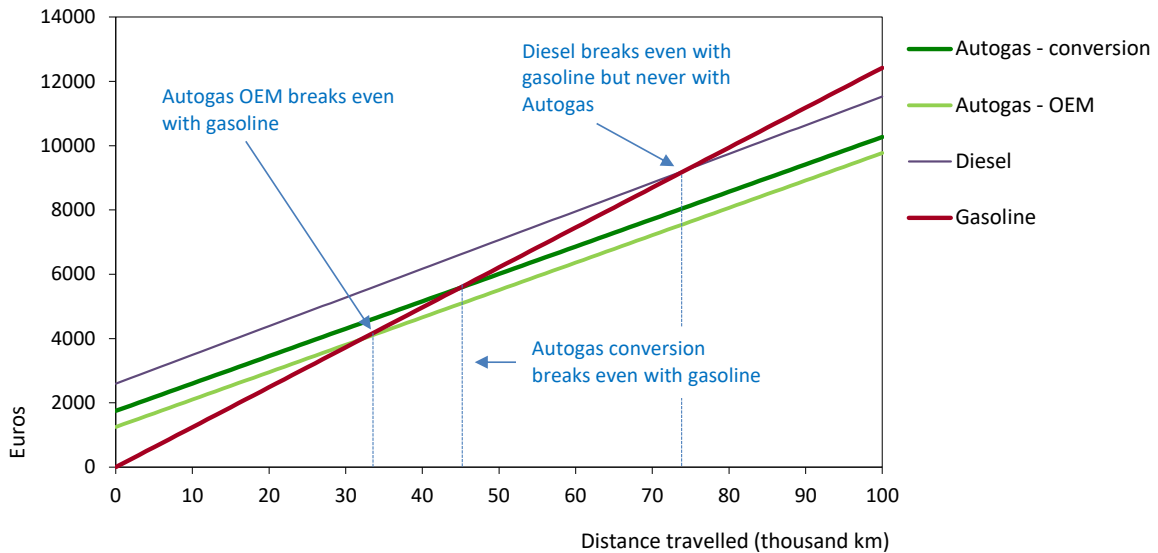
³ <https://auto-gas.net/mediaroom/northern-french-territory-plans-to-renew-fleet-with-alternative-fuel-vehicles/>

⁴ <http://www.voiture-electrique-populaire.fr/actualites/tarif-preferentiel-stationnement-peage-212>

6.3 Competitiveness of Autogas against other fuels

Autogas remains the cheapest fuel option in most cases, even where the vehicle scrapping incentive and *bonus écologique* are not applicable. 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 33,000 km – or about two years of driving for a typical motorist – and a converted vehicle at 45 000 km (Figure B6.2).

Figure B6.2: Running costs of a non-commercial LDV, 2021 – France



Note: Assumes an average car-registration tax rebate of €250. Does not take account of the vehicle-scrapping incentive.

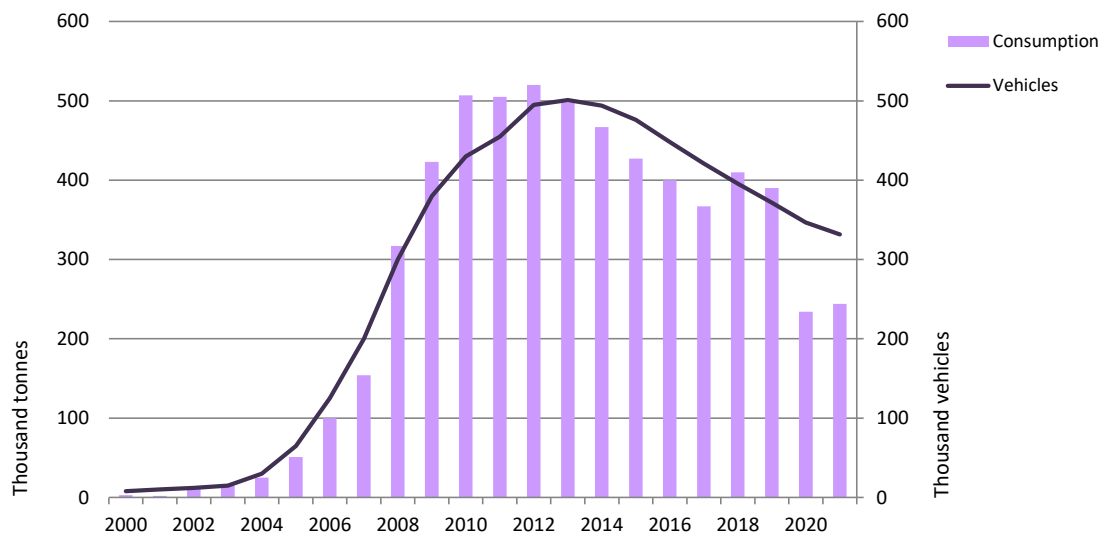
Both an OEM Autogas vehicle and a converted Autogas vehicle, based on a typical conversion cost of €2,000, are always competitive against diesel, regardless of distance. The running costs per kilometre of Autogas and diesel are very similar, so it is the difference in the price of each type of vehicle 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 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 are also still less attractive financially in most cases, despite lower running costs and vehicle-purchase subsidies, as they remain significantly more expensive to buy and usually offer much less autonomy.

7 Germany

7.1 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 367,000 tonnes in 2017. It rebounded to 410,000 tonnes in 2018 but then fell back to 390,000 tonnes in 2019 and to a new low of 234 000 tonnes in 2020, recovering slightly to 244 000 tonnes in 2021 as the economy rebounded from the health crisis (Figure B7.1). An initial reason for the decline in Autogas use since 2013 over 2013-2017 was an improvement in fuel economy, which slowed the growth of consumption of road fuels generally, but growing demand for EVs is now playing a major role. The share of Autogas in total automotive-fuel use has fallen from a peak of 1.0% in the early 2010s to about 0.8% today.

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



Source: WLPGA/Argus (2022).

There are an estimated 331,000 Autogas-powered vehicles on the road in Germany, most of them converted gasoline cars, accounting for 0.7% of all vehicles. The fleet of Autogas vehicles has been contracting steadily since 2014 but is still bigger than that of any other alternative fuel technology other than EVs. The number of Autogas vehicles continued to grow up to 2013, but uncertainty about the government’s Autogas policy and, more recently, a switch in emphasis towards EVs has discouraged switching to Autogas. The government announcement in 2017 of an extension of incentives to 2022 led to a revival in interest in Autogas: vehicle registrations

rose by 56% in 2019,¹ though sales of new vehicles and conversions were still not enough to offset the scrapping of old vehicles. Sales of OEMs and after-market conversions have since fallen back. The only carmakers that offered Autogas models in Germany in 2021 were Dacia (Duster and Sandero models), Fiat (500 model) and Renault (Clio and Captur).² Autogas is widely available throughout the country, with just over 6,000 filling stations selling the fuel in 2021 – almost one in every two stations.

In contrast to Autogas, sales of EVs (including plug-in hybrids), are booming in response to large subsidies (see below), reaching 680,000 in 2021, accounting for around a quarter of all cars sold in 2021 and a third over the last two months of the year (IEA, 2022).³ Over half were battery EVs.

7.2 Government Autogas incentive policies

The federal German government supports the use of Autogas largely through fuel-tax incentives. In June 2017, 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 gasoline and diesel 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. Following a major reform of energy taxation in 2003, the rates of excise tax on Autogas, gasoline and diesel remained constant through to mid-2019. The duty has increased each year since 2019 for Autogas and was raised for both gasoline and diesel in 2021. The rate of tax on Autogas in 2021 was 20 euro cents per litre – more the double its level in 2019 – but it remains well below the rate of 70.9 cents levied on gasoline and 53.7 cents on diesel (Table B7.1).

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 47% that of gasoline and 53% that of diesel. The price advantage in favour of Autogas has nonetheless diminished since 2018 due to a narrowing of the tax differentials.

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 €6 000 for plug-in hybrids and €4,500 for battery EVs currently on offer for new car purchases priced at less than €40,000 (subsidies are lower for more expensive cars). Nonetheless, a recent ordinance, which

¹ <https://auto-gas.net/mediaroom/germany-autogas-offers-superior-service-station-density/>

² <https://en.greengear.de/list-market-overview-comparison/autogas-liquefied-petroleum-gas-lpg-cars-vehicles/>

³ <https://insideevs.com/news/560910/germany-plugin-car-sales-2021/>

adopts into national law EU guidelines on vehicle emissions, formally recognises the lower emissions from Autogas vehicles and bioLPG as a renewable source of energy.¹

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

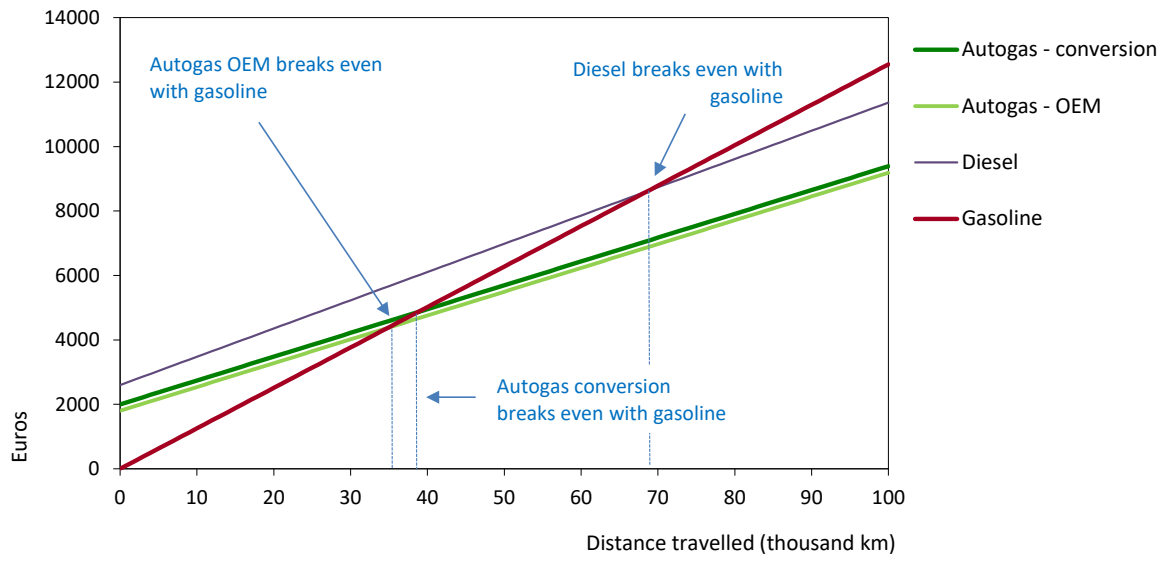
	Euros						US dollars
	2016	2017	2018	2019	2020	2021	2021
<i>Pump prices</i>							
Autogas	0.503	0.551	0.599	0.606	0.581	0.739	0.874
Diesel	1.099	1.180	1.316	1.294	1.135	1.405	1.662
Gasoline	1.303	1.372	1.464	1.438	1.297	1.569	1.855
<i>Total taxes</i>							
Autogas	0.172	0.180	0.188	0.212	0.226	0.318	0.376
Diesel	0.646	0.659	0.680	0.677	0.640	0.761	0.900
Gasoline	0.862	0.874	0.888	0.884	0.848	0.960	1.135
<i>Excise taxes</i>							
Autogas	0.092	0.092	0.092	0.115	0.139	0.200	0.237
Diesel	0.470	0.470	0.470	0.470	0.470	0.537	0.635
Gasoline	0.655	0.655	0.655	0.654	0.654	0.709	0.838
<i>Pre-tax prices</i>							
Autogas	0.330	0.371	0.412	0.395	0.356	0.421	0.498
Diesel	0.454	0.521	0.635	0.617	0.496	0.644	0.762
Gasoline	0.440	0.499	0.576	0.554	0.450	0.609	0.720

7.3 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 35,000 km based on average 2021 prices (Figure B7.2). For an Autogas conversion, which is estimated to cost around €2,000 on average, the breakeven distance is slightly higher, at 39,000 km. These distances, which have changed little since the late 2010s, yielded a payback period for an Autogas vehicle of around two years.

¹ <http://auto-gas.net/mediaroom/german-regulation-underlines-sustainable-contribution-autogas/>.

Figure B7.2: Running costs of a non-commercial LDV, 2021 – Germany

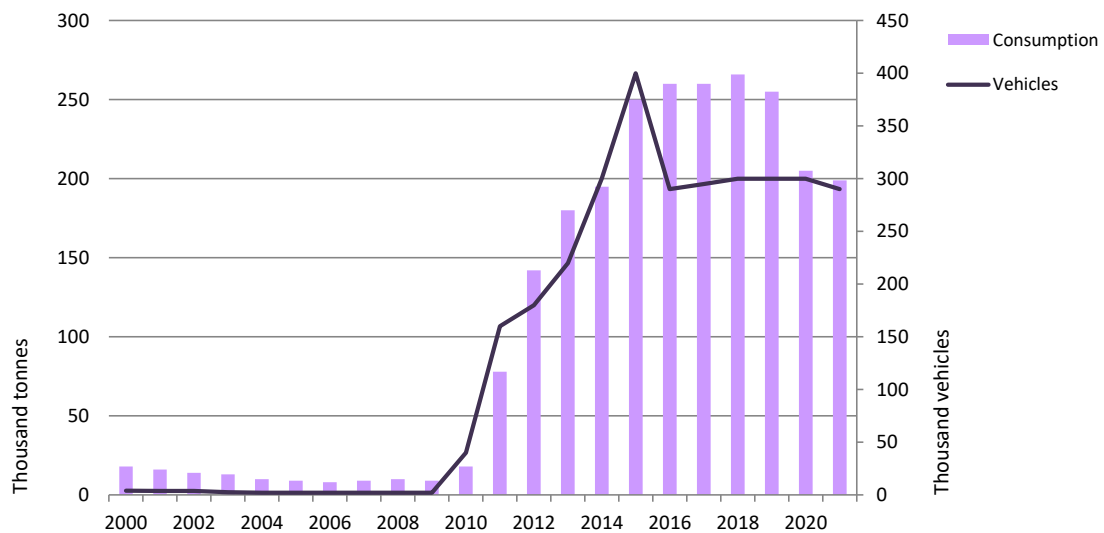


8 Greece

8.1 Autogas market trends

The Greek Autogas market grew spectacularly during the first half of the 2010s, but demand then levelled off, before falling heavily in 2020 – mainly due to the economic impact of the Covid-19 pandemic, notably on tourism. Consumption reached a peak of 266,000 tonnes in 2018, up from just 9 000 tonnes in 2009, but fell back to just under 200 000 tonnes in 2021 (Figure B8.1).¹ The government made it legal for all vehicles to use the fuel in 1999 (previously only taxis could), 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 4.5% of total road-fuel use in Greece and 40% of total LPG consumption.

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



Note: The dip in vehicle numbers in 2016 is due to a break in the series.
 Source: WLPGA/Argus (2022).

The first half of the 2010s saw phenomenal growth in the number of vehicles able to run on Autogas in Greece. In 2021, their number reached an estimated 290 000, compared with just 2 000 in 2009. Autogas vehicles now make up roughly 4.5% 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 Zavoli. A few OEM Autogas vehicle

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

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 expanded rapidly to accommodate the boom in demand, though has slowed in recent years with the number of refuelling stations reaching a record 1,350 in 2021. The majority of Autogas sales are made by two companies, Hellenic Petroleum and Motor Oil, and the rest by around 30 small retailers.

8.2 Government Autogas incentive policies

The excise tax on Autogas remains considerably lower than that on gasoline and diesel, despite an increase from €125 to €330/tonne (6.8 to 17.8 cents/litre) in 2012 and to €430/tonne (23.2 cents/litre) in 2017 (Table B8.1). The excise tax on both diesel and gasoline also increased in 2017, though by less than that on Autogas, and have remained unchanged since at 41 cents/litre for diesel and 70 cents/litre for gasoline. 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 53% that of gasoline and 63% that of diesel in 2021. These differentials have changed since over the last five years.

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

	Euros						US dollars
	2016	2017	2018	2019	2020	2021	2021
<i>Pump prices</i>							
Autogas	0.640	0.810	0.822	0.824	0.763	0.865	1.023
Diesel	1.062	1.254	1.371	1.373	1.187	1.370	1.620
Gasoline	1.383	1.500	1.580	1.578	1.444	1.642	1.942
<i>Total taxes</i>							
Autogas	0.299	0.389	0.391	0.391	0.380	0.399	0.472
Diesel	0.532	0.653	0.675	0.676	0.640	0.675	0.798
Gasoline	0.932	0.990	1.006	1.005	0.979	1.018	1.204
<i>Excise taxes</i>							
Autogas	0.178	0.232	0.232	0.232	0.232	0.232	0.274
Diesel	0.330	0.410	0.410	0.410	0.410	0.410	0.485
Gasoline	0.670	0.700	0.700	0.700	0.700	0.700	0.828
<i>Pre-tax prices</i>							
Autogas	0.341	0.421	0.431	0.433	0.383	0.466	0.551
Diesel	0.531	0.602	0.696	0.698	0.548	0.695	0.822
Gasoline	0.450	0.509	0.574	0.573	0.464	0.624	0.738

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 rise in the tax on diesel in 2017 signalled a change in policy, with sales of diesel cars now in decline.

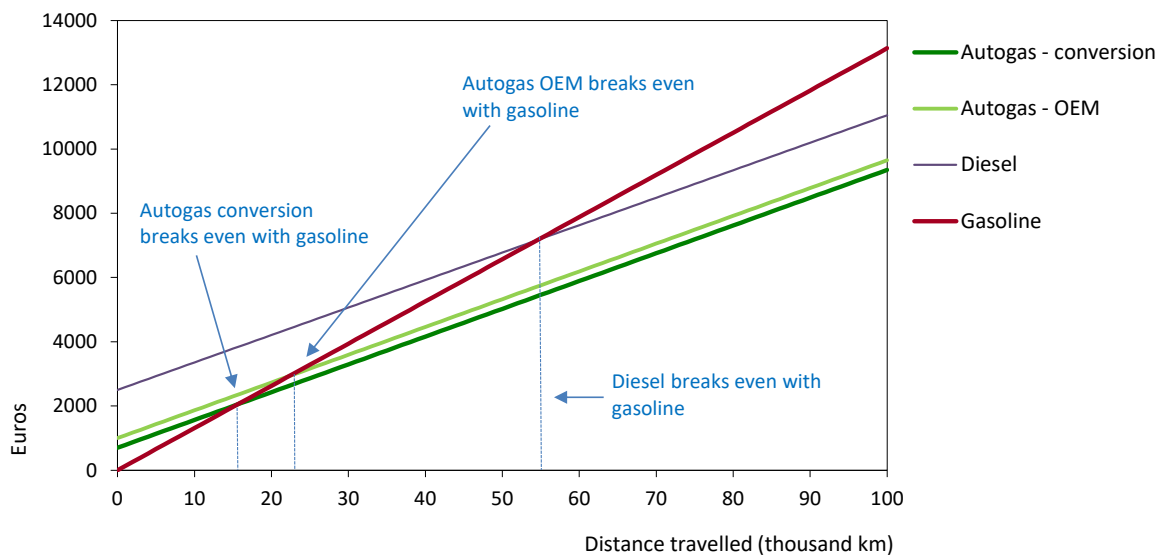
Other than taxation, there are no other central government incentives to encourage Autogas. However, the authorities recently modified the regulations relating to refuelling stations, reducing the minimum distance between Autogas pumps and LPG tanks to two metres. This will make it easier for refuelling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

In Athens, Autogas and other low- and zero-emissions vehicles are exempted from restrictions on access to the city centre (cars with license plates ending in an odd number can enter the area on odd days of the month and those with even numbers on even days). Those restrictions, which had been suspended during the COVID-19 pandemic, were reintroduced on 25th October 2021.

8.3 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 2021, Autogas broke even against gasoline at just 16,000 km – little more than a year of driving for an average private motorist (Figure B8.2). For a bi-fuelled OEM Autogas car, which typically costs €1,000 more than a gasoline model, the breakeven distance was higher, at around 23,000 km. Autogas is always competitive against diesel, as the price premium for a diesel car over a gasoline car is considerably higher (€2,500 on average). These breakeven distances, which are virtually unchanged since 2018, are among the lowest in the world.

Figure B8.2: Running costs of a non-commercial LDV, 2021 – Greece



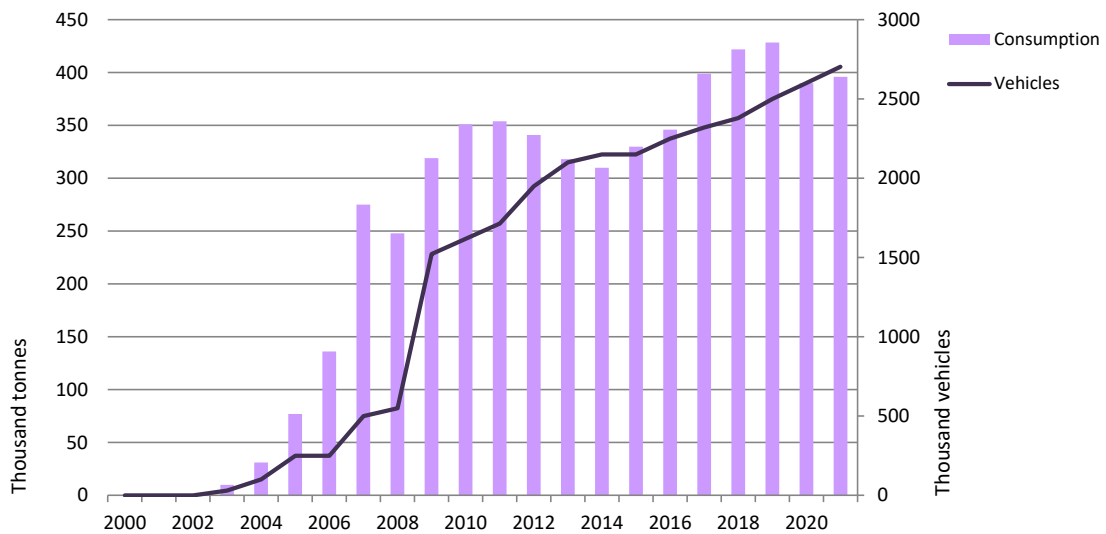
No other alternative fuel is competitive with gasoline or diesel: a CNG vehicle is much more expensive to convert (more than €2,000) and the fuel is not widely available, while an EV is still more expensive than a gasoline car.

9 India

9.1 Autogas market trends

The Indian Autogas market has followed a very uneven upward path since it took off in the early 2000s following the legalisation of the fuel in 2000, punctuated by a short period of decline in 2013-2014 and a slump in 2020 due to the COVID-19 pandemic. Sales recovered a little in 2021, reaching 396,000 tonnes – well below the all-time peak of 429,000 tonnes reached in 2019 (Figure B9.1). Autogas use remains tiny in comparison with the rest of the automotive-fuel market, accounting for a mere 0.5% of total fuel sales. CNG consumption, which has been heavily promoted in some cities, is around 18 times higher.

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



Note: Fuel consumption is official sales only. Vehicles include three-wheelers.
 Source: WLPGA/Argus (2022).

There are now an estimated 2.7 million vehicles capable of running on Autogas in India, the majority of which are three-wheelers (which explains why average consumption per vehicle is only around 300 litres per year). Roughly 4% of all the vehicles on the road in India (excluding two-wheelers) run on Autogas. The main vehicle manufacturers now offer factory-fitted Autogas models, such that OEM vehicles now make up about two-thirds of new Autogas vehicle registrations. 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 fall in Autogas prices relative to gasoline and diesel in recent years (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 around 1,510 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 around half of these stations, with the rest owned by a number of private companies, notably Reliance, Total, SHV, Aegis Logistics and IPPL.

9.2 Government Autogas incentive policies

The main public policy incentive for Autogas in India is an excise tax exemption. 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 applied at the national and state levels, the rates of which vary according to the fuel and state.

The taxation of LPG changed substantially with the introduction of a goods and services tax (GST) on 1st July 2017, a move that has favoured Autogas. GST is an indirect tax applied across India (except in Jammu and Kashmir) to replace a host of excise and sales taxes levied by the central and state governments. It was the biggest tax reform in India since the country's independence. LPG is now taxed at a single rate of 18% across all sectors. The rate has been held down so as not to increase the cost of the fuel to households for cooking too much (previously, taxes on domestic LPG were negligible with most states only levying a small rate of VAT). For the moment, gasoline and diesel are exempted from GST, but continue to be subject to state taxes.

As a result of the tax reform, the average pump price of Autogas rose only slightly in India in 2017, whereas the prices of gasoline and diesel rose significantly, due to both state higher taxes and wholesale prices. The price of Autogas rose more in percentage terms than that of both diesel and gasoline in 2021, having fallen more in 2020. Nonetheless, Autogas remains competitive: the price of Autogas averaged just 57% that of gasoline and 62% that of diesel – little changed from 2019 (Table B9.1). The shift in pricing is providing a significant boost to Autogas demand in India, as well as discouraging the diversion of domestic bottled (cylinder) LPG use to Autogas – a highly dangerous and illegal practice.²

¹ <http://www.iac.org.in/alds-stations>.

² Actual Autogas consumption, including the illegal use of domestic cylinders, is thought to be much higher than official figures show.

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

	Rupees						US dollars
	2016	2017	2018	2019	2020	2021	2021
<i>Pump prices</i>							
Autogas	37.24	37.50	46.13	41.55	41.81	56.50	0.764
Diesel	53.23	59.56	70.01	68.57	73.13	90.91	1.230
Gasoline	64.84	71.84	78.74	75.71	81.01	99.66	1.348
<i>Total taxes</i>							
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.
<i>Excise taxes</i>							
Autogas	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Diesel	15.74	16.84	14.96	14.81	26.83	30.21	0.409
Gasoline	20.45	20.99	19.11	18.72	28.90	32.11	0.434
<i>Pre-tax prices</i>							
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: Prices are averages across Delhi, Kolkata, Mumbai and Chennai (state tax rates vary). Excise taxes are central government duties only.

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.

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 Karnataka 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. However, national “type approval” regulations and a high rate of GST on conversion kits, currently 28%, are reportedly impeding the development of the conversion sector; the Indian Auto LPG Coalition (IAC) is pushing the government to reform these regulations and cut taxes.¹

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

¹ <https://auto-gas.net/mediaroom/indias-lpg-industry-urges-government-to-reduce-taxes-on-autogas/>.

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 2010.¹ Many of the 32 000 auto-rickshaws in Kolkata and its suburbs 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.²

The central government is increasing its support for EVs, with the budget for the financial year 2020/21 increasing by 39% to 6.93 billion rupees (\$70 million).³ Sales of EVs tripled to 14,800 in 2021.⁴ A goal of switching 30% of the car fleet to EVs by 2030 was adopted in 2018 and there are plans to mandate the conversion of all two-wheelers, which make up the bulk of the vehicle fleet, to electricity by 2026. Various fiscal demand incentives have been put in place to spur the sale of EVs and charging infrastructure, including income tax rebates of up to 150,000 rupees (\$2,100) for customers on interest paid on loans to buy EVs. 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 VAT rebate on EV sales.

9.3 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 11,000 km (Figure B9.2). The conversion costs is estimated at 25 000 rupees (about €350) in 2021 prices – 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 (\$1 350) more than a standard gasoline model – such that, although fuel costs per km are similar for diesel and Autogas, the latter fuel is always the most financially attractive option. 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.

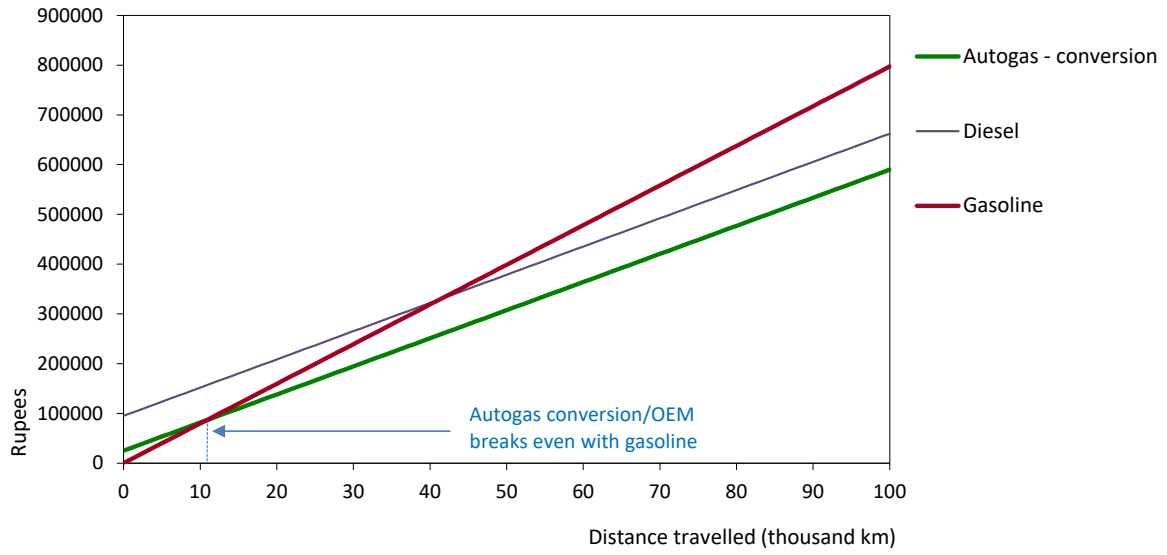
¹ <http://www.iac.org.in/auto-lpg-in-india>.

² <http://auto-gas.net/mediaroom/nearly-10000-cars-encouraged-to-switch-to-clean-fuels-in-northern-india/>.

³ <https://mercomindia.com/not-lot-ev-sector-in-the-budget/>.

⁴ <https://economictimes.indiatimes.com/industry/renewables/india-has-an-electric-opportunity-to-focus-on-budget-cars/articleshow/90054293.cms>

Figure B9.2: Running costs of a non-commercial LDV, 2021 – India

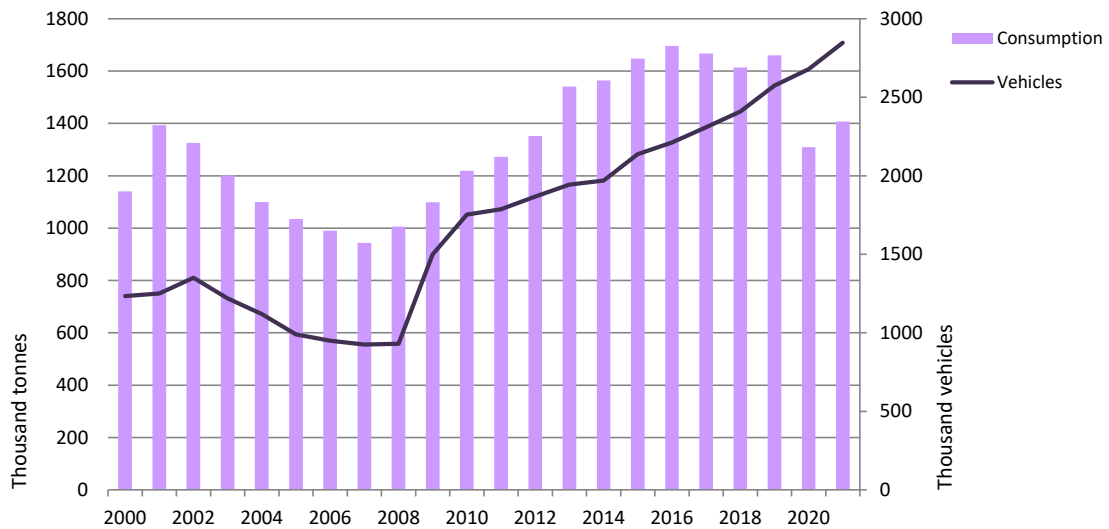


10 Italy

10.1 Autogas market trends

Italy has the second-largest Autogas market in the European Union after Poland and the sixth-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 1.70 Mt in 2016, thanks to favourable taxation, vehicle acquisition and conversion incentives, and local measures to encourage clean vehicles. Demand started to decline slowly through to 2019, but fell heavily in 2020 as a result of the Covid-19 crisis, which hit Italy particularly badly, reaching just over 1.3 Mt in 2020. It bounced back to more than 1.4 Mt in 2021 with the economic recovery (Figure B10.1). Autogas accounts for 44% of total LPG consumption in Italy and almost 5% of total automotive-fuel demand.

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



Source: WLPGA/Argus (2022).

The number of Autogas vehicles in use has increased steadily in recent years, reaching over 2.87 million at end-2021 – around 6% of all cars and trucks in Italy. The Autogas fleet is almost two-thirds bigger than just a decade earlier. Historically most Autogas vehicles were converted gasoline-fuelled vehicles, but sales of OEM vehicles have now overtaken conversions. At present, 16 carmakers market a total of about 50 Autogas models in Italy, with Dacia the leading marketer: it has sold around 250,000 Autogas vehicles since 2019 and accounted for 40% of total Autogas OEM sales in the first four months of 2022.¹ Italy remains home to several Autogas engine and conversion-kit

¹ <https://auto-gas.net/mediaroom/italy-dacia-consolidates-leadership-in-the-autogas-market/>

manufacturers, with a well-established network of installers. The number of refuelling sites continues to grow, reaching a record 4,450 at end-2021 – just under one-quarter of the more than 18,000 service stations in Italy.

10.2 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 B10.1). There has been no significant change in tax rates since 2013. The pump price of Autogas in 2018 was equal to just 43% of that of gasoline and 47% of that of diesel, though these percentages have risen since 2019.

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

	Euros						US dollars
	2016	2017	2018	2019	2020	2021	2021
<i>Pump prices</i>							
Autogas	0.563	0.633	0.674	0.632	0.605	0.707	0.836
Diesel	1.282	1.384	1.488	1.480	1.317	1.487	1.758
Gasoline	1.444	1.528	1.599	1.574	1.431	1.626	1.923
<i>Total taxes</i>							
Autogas	0.249	0.261	0.269	0.261	0.256	0.275	0.325
Diesel	0.849	0.867	0.886	0.884	0.855	0.886	1.048
Gasoline	0.989	1.004	1.017	1.012	0.986	1.022	1.209
<i>Excise taxes</i>							
Autogas	0.147	0.147	0.147	0.147	0.147	0.147	0.174
Diesel	0.617	0.617	0.617	0.617	0.617	0.617	0.730
Gasoline	0.728	0.728	0.728	0.728	0.728	0.728	0.861
<i>Pre-tax prices</i>							
Autogas	0.314	0.372	0.405	0.371	0.349	0.432	0.511
Diesel	0.434	0.517	0.603	0.595	0.462	0.601	0.711
Gasoline	0.455	0.524	0.583	0.562	0.445	0.604	0.714

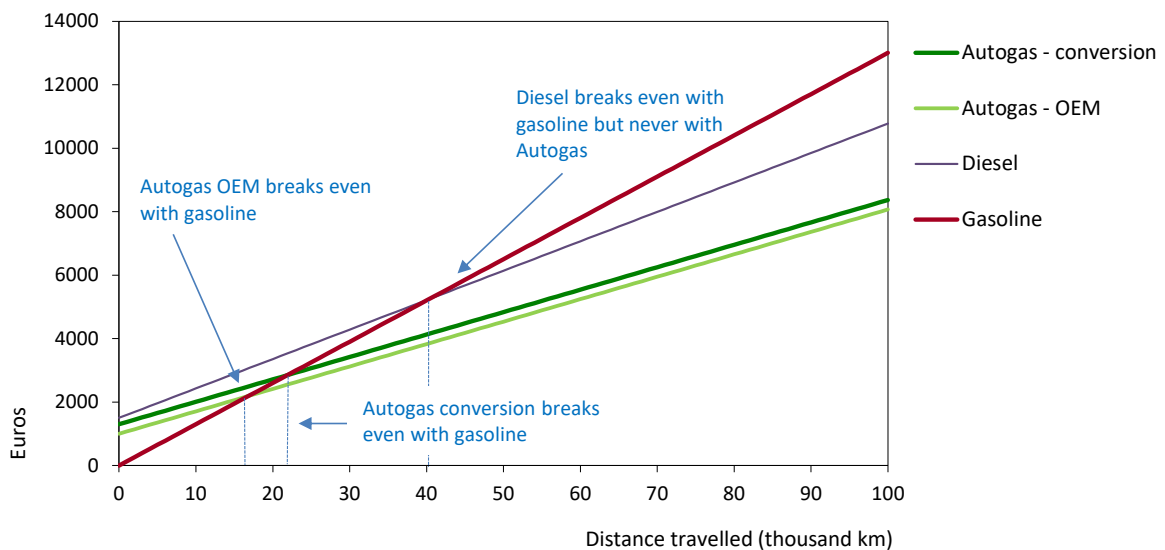
The Italian government no longer encourages Autogas through vehicle incentives. A grant scheme that covered the conversion of an existing vehicle or the purchase of an OEM Autogas or other type of AFV that had been in place since 2014 was phased out and replaced in 2019 by a new scheme, which offers grants of up to €6,000 for buyers of a new electric, hybrid or methane gas-powered car. Autogas vehicles are excluded.

Some local initiatives to promote cleaner transport benefit Autogas, including grants for replacing the most polluting vehicles with alternative fuelled ones, including Autogas. In many parts of Italy, Autogas vehicles also benefit from a lower annual vehicle road tax, which depends on engine power and CO₂ 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 and regions 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. In Milan, for example, traffic restrictions on diesel vehicles were tightened in October 2019 while Autogas and CNG vehicles and EVs remain exempt.¹

10.3 Competitiveness of Autogas against other fuels

The large fuel-tax advantage over gasoline and diesel makes Autogas the cheapest fuel option in Italy, regardless of eligibility for the conversion grants that are on offer in some regions. Assuming a typical price premium of €1,000 (in 2021 prices), an OEM Autogas car breaks even with gasoline at just 17,000 km – just over one year of driving for a private motorist – based on average 2021 fuel prices (Figure B10.2). 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 just over 43,000 km, but is never competitive with Autogas (assuming a diesel LDV costs €1,500 more than an equivalent gasoline vehicle).

Figure B10.2: Running costs of a non-commercial LDV, 2021 – Italy



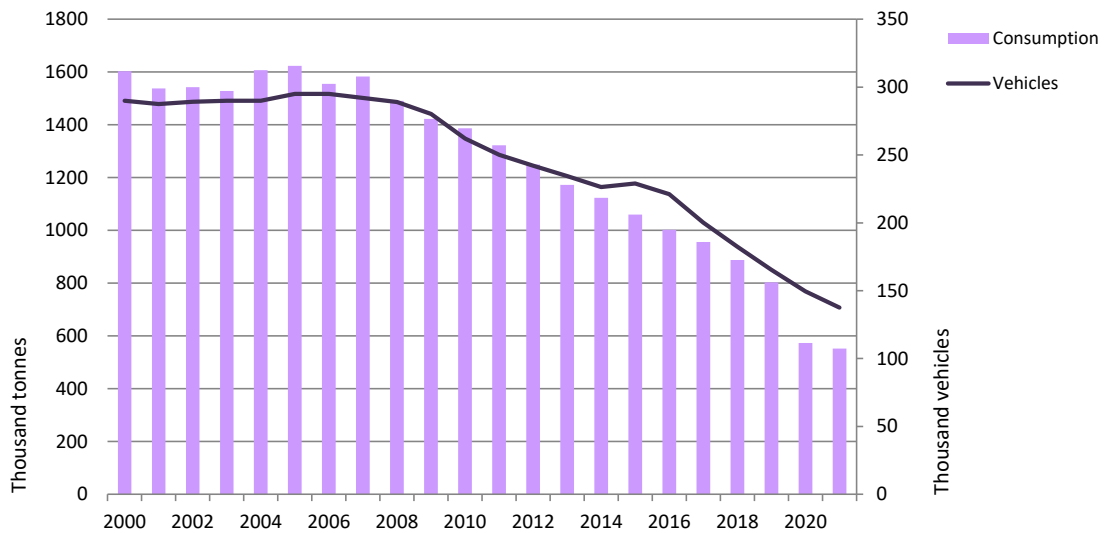
¹ <https://auto-gas.net/mediaroom/autogas-exempted-from-vehicle-restriction-in-milan/>.

11 Japan

11.1 Autogas market trends

Japan has a long history of Autogas use stretching back to the 1950s, but the market has been in decline for more than a decade. Autogas 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. Consumption has fallen almost every year since then, with the decline accelerating since 2016, reaching just 552,000 tonnes (mostly butane) in 2021 – over 31% down on two years before and more than 50% lower than in 2014 (Figure B11.1). Autogas now accounts for only about 1% of total road-transport fuel consumption and 4% of total Japanese LPG consumption. Official projections point to a further decline in Autogas use to 2024.¹

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



Source: WLPGA/Argus (2022).

The Autogas fleet contracted from a peak of just under 300 000 vehicles in 2006 to 137 000 in 2021 – a mere 0.2% of all motor vehicles in Japan. Taxis, most of which run on Autogas, account for the bulk of the Autogas fleet and commercial fleet LDVs, HDVs and minibuses account for almost all of the rest. A contraction in the overall size of the taxi fleet 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

¹ Argus LPG World, 16 April 2019.

criteria for the so-called Universal Design Taxi Cab (UDTC), which can accommodate passengers in a wheelchair together with other passengers in the same cabin. There are 1,212 refuelling stations selling Autogas in Japan – more than one-third fewer than in the mid-2000s.

11.2 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. The duty on Autogas has not changed for more than a decade; those on gasoline and diesel rose very slightly through to 2017 and have been unchanged since. The duty on Autogas is currently less than one-third the level of that on diesel and less than a fifth of that on gasoline (Table B11.1). 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 standard rate of VAT, which is applied to gasoline and diesel, was increased from 8% to 10% from the last quarter of 2019; Autogas continued to benefit from the 8% rate through to end-2019, but the standard rate was applied from the beginning of 2020. The pump price of Autogas was on average 75% of that of diesel and 66% of that of gasoline in per-litre terms in 2021 – little changed since 2019 but an increase of four percentage points in both cases since 2018.

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

	Yen						US dollars
	2016	2017	2018	2019	2020	2021	2021
<i>Pump prices</i>							
Autogas	78.48	89.13	91.78	94.65	86.77	101.73	0.926
Diesel	102.00	112.20	128.40	126.88	116.88	134.90	1.229
Gasoline	120.60	133.50	149.73	146.03	136.18	154.83	1.410
<i>Total taxes</i>							
Autogas	15.61	16.40	16.60	16.81	17.69	19.05	0.173
Diesel	40.01	40.83	42.03	42.32	42.61	44.25	0.403
Gasoline	65.47	66.49	67.69	68.04	68.98	70.68	0.644
<i>Excise taxes</i>							
Autogas	9.80	9.80	9.80	9.80	9.80	9.80	0.089
Diesel	34.84	34.90	34.90	34.90	34.90	34.90	0.318
Gasoline	56.54	56.60	56.60	56.60	56.60	56.60	0.515
<i>Pre-tax prices</i>							
Autogas	62.86	72.72	75.18	77.83	69.09	82.68	0.753
Diesel	61.99	71.37	86.37	84.55	74.27	90.66	0.826
Gasoline	55.13	67.01	82.03	77.99	67.20	84.15	0.766

Note: Pre-tax prices include duties and a carbon tax levied on imports of crude oil and refined products.

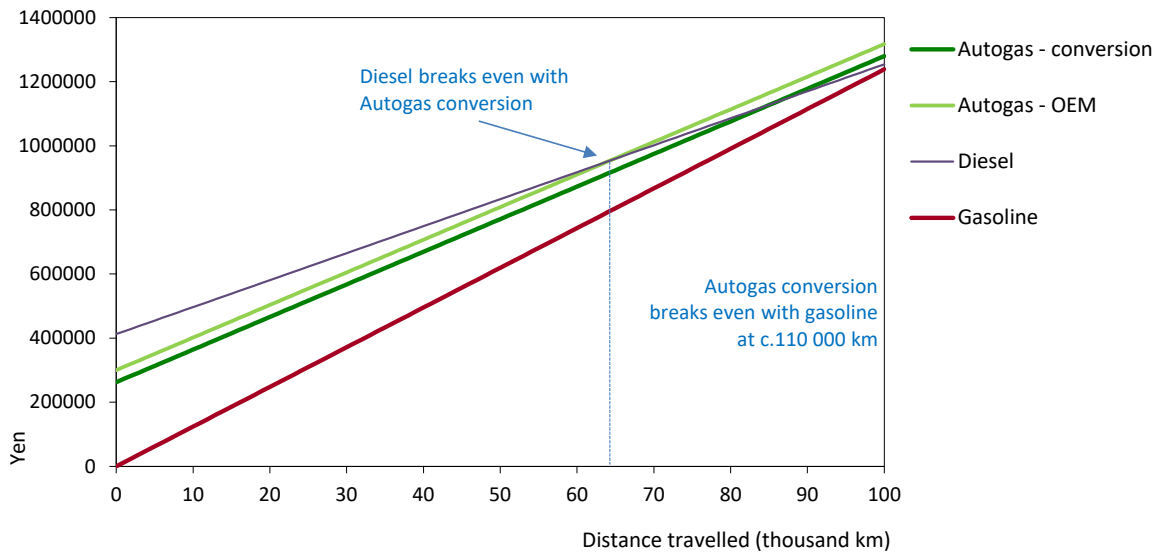
A scheme that provided grants for Autogas vehicles ended in March 2017. To compensate for this change, the government added Autogas vehicles to the

category of “eco-car”, which qualified for a reduction in the purchase tax for two years from April 2017. A new environmental tax on new vehicle purchases was introduced in October 2019, replacing the existing car purchase tax.¹ The intention is to favour less polluting cars, including those fuelled by Autogas. The environmental tax was lowered in 2020 in response to the economic slump caused by the Covid-19 crisis. The reduction was due to expire in September, but was extended to March 2021. Ahead of the 2020 Olympic Games (postponed to 2021), the Tokyo Metropolitan Government introduced grants of up to ¥600,000 (roughly \$5,500) for purchases of Universal Design Taxi Cabs that use electric or hybrid motors, including Autogas.

11.3 Competitiveness of Autogas against other fuels

Autogas currently struggles to compete against either diesel or gasoline. Autogas is cheaper than diesel, but only up to 64,000 km for an OEM vehicle, while Autogas breaks even with gasoline only at well over 100,000 km for both a converted LDV and an OEM vehicle (Figure B11.2). This analysis demonstrates clearly why the Autogas market is contracting. Restrictions on the use of diesel by taxis on environmental grounds and the reintroduction of incentives for Autogas will be needed to reverse this trend.

Figure B11.2: Running costs of a non-commercial LDV, 2021 – Japan



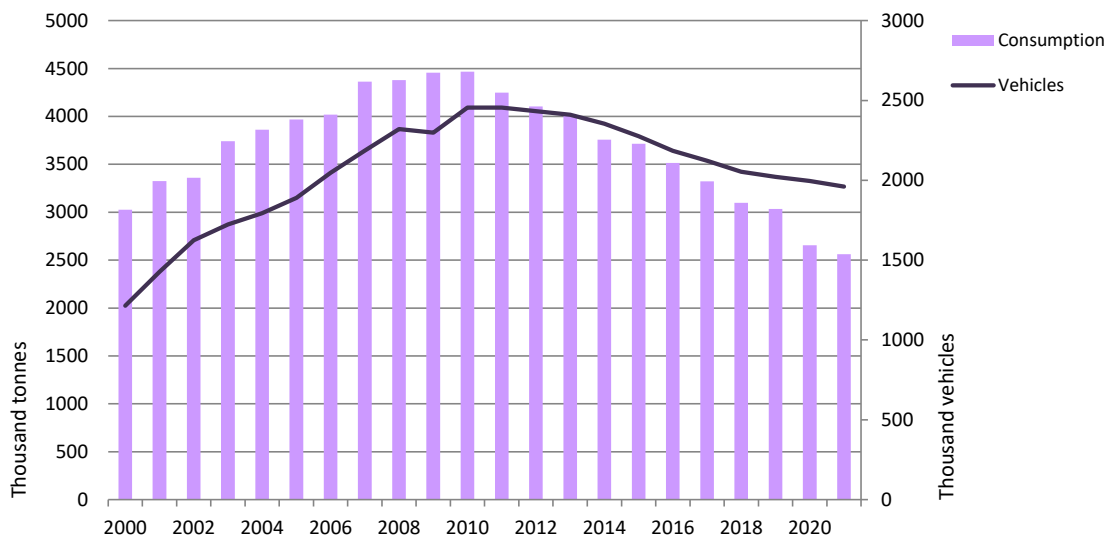
¹ http://mddb.apec.org/Documents/2019/AD/AD1/19_ad1_005.pdf.

12 Korea

12.1 Autogas market trends

The Republic of Korea was one of the first countries to promote the widespread use of Autogas and, for many years, 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 B12.1).

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



Source: WLPGA/Argus (2022).

The Autogas market began to contract in 2011, with sales falling every year since to just 2.56 million tonnes in 2019 – more than 42% below their 2010 peak. The opening up of the Autogas vehicle market to private owners in 2019 has failed to reverse the longer-term shift away from the fuel to diesel, gasoline and EVs. Korea no longer has the world’s largest Autogas market, falling behind both Turkey and Russia in 2018. The fall in consumption in 2021, at less than 2%, was nonetheless smaller than in 2020, when demand plunged by 13% due to successive COVID-19-related lockdowns. The main reason for the reversal in the fortunes of Autogas in Korea 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 progressively 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. Autogas now accounts for about 8% of total road-transport fuel consumption – down from over 16% at the end of the 2000s – and just under one-quarter of total LPG consumption in Korea.

The number of Autogas vehicles on the road in Korea has also declined since the turn of the decade, but at a slower rate than fuel use, reflecting the inherently slow rate of vehicle turnover and improved fuel efficiency. OEM Autogas vehicle sales picked up a little in 2019 as a result of the change in policy, but fell back again in 2020. At the end of 2021, there were still 1.96 million Autogas cars in use, supported by a network of 1 992 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 8% of the country's total vehicle fleet. Most of these vehicles are mono-fuelled OEMs manufactured locally by Hyundai, Kia, RSM and General Motors. Some school buses have also recently been converted to run on Autogas.¹

12.2 Government Autogas incentive policies

The relatively large 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 B12.1).

Government tax policy aims 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. Excise taxes on gasoline and diesel, which were constant until 2017, were reduced to 691 won/litre and 490 won/litre respectively in 2019, narrowing the tax advantage for Autogas, but were raised to restored to their 2017 levels of 745 won/litre and 514 won/litre in 2020. The taxes on all three fuels were temporarily reduced by 20% between November 2021 and April 2022 as part of a package of measures to stimulate economic activity in the wake of the Covid-19 pandemic. The pre-tax price of Autogas 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. The pump price of Autogas was on average equal to 59% that of gasoline and 67% that of diesel in 2021 – the

¹ <https://auto-gas.net/mediaroom/korea-pocheon-city-launches-project-to-switch-school-buses-to-autogas/>

highest shares since the start of the century and well above the official targets.

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

	Won						US dollars
	2016	2017	2018	2019	2020	2021	2021
<i>Pump prices</i>							
Autogas	734.04	826.46	874.53	806.27	790.79	932.24	0.814
Diesel	1182.54	1282.53	1391.90	1340.52	1189.65	1391.40	1.216
Gasoline	1402.64	1491.30	1581.37	1472.44	1381.39	1590.56	1.390
<i>Total taxes</i>							
Autogas	287.79	296.19	300.56	294.36	292.95	289.05	0.253
Diesel	636.25	645.34	643.18	611.61	636.90	640.76	0.560
Gasoline	873.40	881.46	872.56	824.58	871.47	870.01	0.760
<i>Excise taxes</i>							
Autogas	221.06	221.06	221.06	221.06	221.06	204.30	0.178
Diesel	528.75	528.75	516.64	489.74	528.75	514.27	0.449
Gasoline	745.89	745.89	728.80	690.72	745.89	725.41	0.634
<i>Pre-tax prices</i>							
Autogas	446.25	530.27	573.97	511.91	497.84	643.19	0.562
Diesel	546.29	637.19	748.72	728.91	552.75	750.64	0.656
Gasoline	529.24	609.84	708.81	647.86	509.92	720.55	0.630

An important change in Autogas policy occurred in March 2019 when the government lifted all remaining restrictions on the private ownership of Autogas vehicles with the goal of improving air quality. This was expected to give a major boost to the Autogas market – the government forecast that the change would boost the Autogas vehicle fleet and fuel demand by around a third by 2030¹ - though this has so far failed to materialise (see above). Previously, only commercial operators such as taxis and car-rental companies were allowed to buy and operate new OEM vehicles, though there are exemptions for disabled people, compact cars, vehicles that can carry more than seven people and hybrids. The rules had already been eased in January 2017, allowing anyone to own a used Autogas car once it has been registered for at least five years. This permitted second-hand Autogas taxis and rental cars to be sold to private owners. As a result, several car-rental companies launched leasing programmes, which include the option for customers to own Autogas cars after renting them for five years.

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

¹ Argus LPG World, 19 March 2019.

introduce extra NOx emission compliance tests during car inspections, which penalise diesel vehicles. And the government has introduced measures to scrap old, polluting diesel vehicles by offering incentives to replace them with Autogas or LNG vehicles, or EVs. In February 2021, the existing programme was expanded, including a doubling of subsidies. 340,000 diesel vehicles were due to be scrapped in 2021 – up from 300,000 in 2020.¹ The capital Seoul is also planning to successively ban the majority of diesel vehicles from the public sector and local transport fleets by 2025, though most will be replaced by electric and hydrogen fuel cell vehicles.²

The recent change in Autogas policy has led the country's leading carmakers to introduce new Autogas OEM models onto the market. In 2019, Hyundai released an Autogas model of the new Sonata, while Renault Samsung introduced the QM6 – the country's first Autogas-powered SUV – and Kia included an Autogas model of the K5 in its new line-up launched at the end of 2019.

The Korean government does not make available grants or any other form of financial incentive for OEM Autogas LDV purchases on the grounds that favourable taxation is sufficient to encourage the use of Autogas.³ However, other measures are used to 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, 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% - 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 on highways to encourage their adoption. The government also funds a research and development programme for Autogas LDVs and HDVs. This led to the commercialisation of Autogas hybrid LDVs. More recently, the government has supported a research programme to develop direct injection Autogas engines.

In early 2017, the government drew up legislation to pave the way for the installation across the country of 200 new refuelling stations dedicated to selling alternative fuels, including Autogas and hydrogen, and recharging services for EVs vehicles.⁴ The stations are due to be completed by 2025. The plan involves licensing the stations to private operators over 30 years. It is expected that any revenue generated by the businesses would be reinvested

¹ <https://tricksfast.com/korea/the-subsidy-for-the-early-scraping-of-old-diesel-vehicles-was-doubled/>

² <https://www.electrive.com/2020/08/06/soul-bans-diesel-vehicles-from-public-sector-fleets-by-2025/>

³ Grants are available for CNG, fuel-cell and EVs, including hybrids.

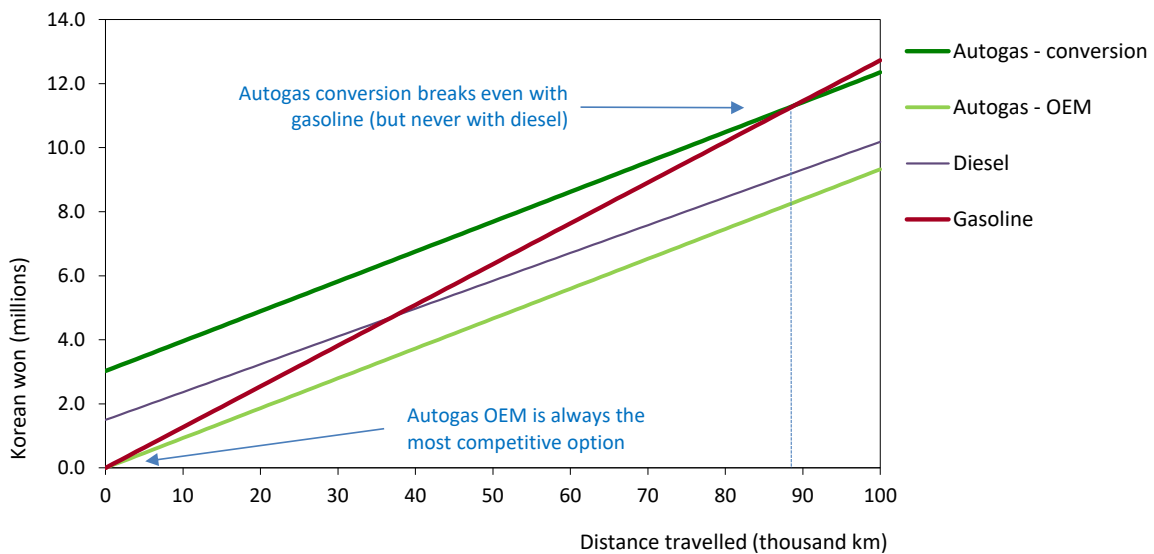
⁴ <https://auto-gas.net/mediaroom/government-korea-plans-install-200-alternative-fuel-stations-2025/>

in government-led fuel cell research projects. The first station, located in the Gangdong District in eastern Seoul, was opened in May 2020.¹

12.3 Competitiveness of Autogas against other fuels

Autogas remains 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 gasoline (Figure B12.2). After 100 000 km of operation, the total savings on fuel amount to an impressive 3.4 million won (\$3,000) based on 2021 prices. The payback period for a converted Autogas vehicle, which is rare in Korea, is 89 000 km. A diesel vehicle breaks even with a gasoline one at just over 40 000 km, but is never competitive with an OEM Autogas one, based on a price premium for a diesel car of about 1.5 million won over a gasoline car (at 2021 prices). This analysis clearly demonstrates the continuing appeal of Autogas vehicles in Korea.

Figure B12.2: Running costs of a non-commercial LDV, 2021 – 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.

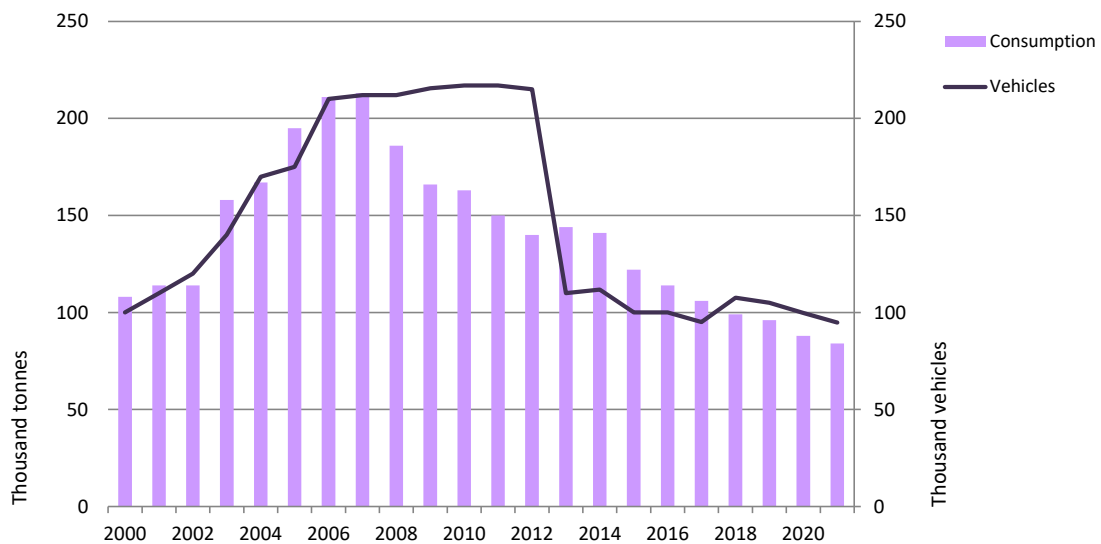
¹ <http://www.koreaherald.com/view.php?ud=20200527000723>.

13 Lithuania

13.1 Autogas market trends

Lithuania has a large Autogas market relative to the size of the country thanks to a traditionally favourable fuel-tax policy, though it has shrunk markedly over the last decade. Consumption fell steadily from a peak of 213,000 tonnes in 2006 to just 84,000 tonnes in 2021 – its lowest level since the turn of the century (Figure B13.1). Autogas met just over 4% of the country’s total automotive-fuel needs and accounted for 69% of total LPG consumption in 2021.

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



Note: the drop in vehicle numbers in 2013 is due to a break in the series.
 Source: WLPGA/Argus (2022).

Despite the big fall in fuel sales, the Autogas vehicle fleet has contracted only moderately in recent years, totalling 95,000 at end-2021 – just 5% less than in 2015. 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 300 refuelling sites throughout the country.

13.2 Government Autogas incentive policies

Autogas use is encouraged solely through a strong fuel-tax incentive. The excise duty on Autogas, at 16.1 euro cents/litre, is a little over one-third of that on gasoline and less than half that on diesel (Table B13.1). Excise duties on all three fuels barely changed between 2011 and 2018, but that on diesel increased in both 2018 and 2019, while that on gasoline rose in 2019, boosting the tax advantage favouring Autogas. However, this was more than offset by a jump in the pre-tax price of Autogas that exceeded that of both

the other fuels in 2021. The pump price of Autogas in that year averaged 49% that of gasoline and 54%.

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

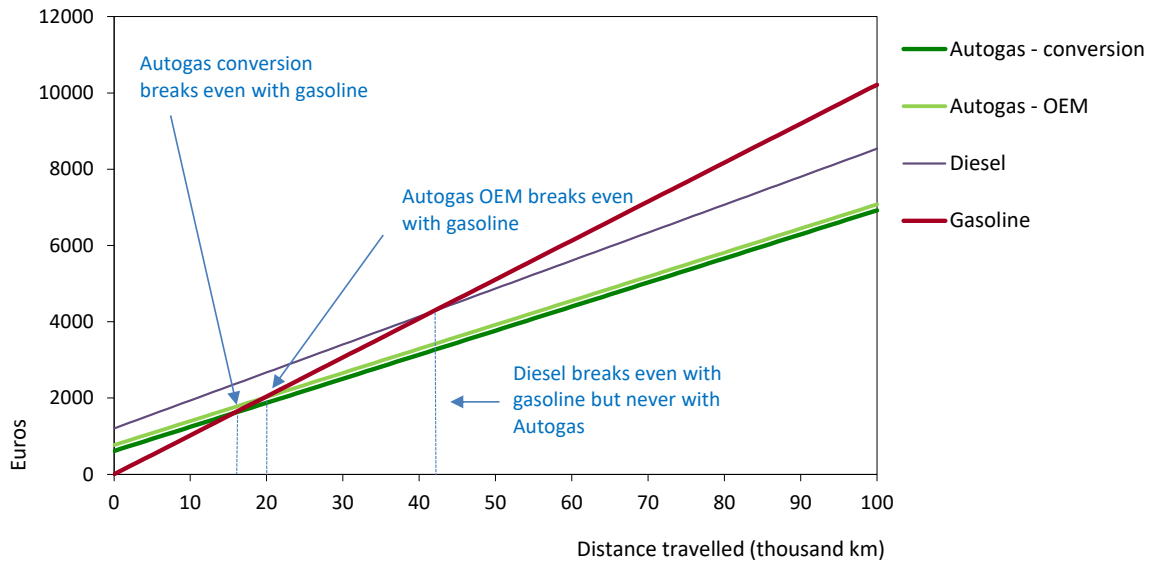
	Euros						US dollars
	2016	2017	2018	2019	2020	2021	2021
<i>Pump prices</i>							
Autogas	0.479	0.548	0.569	0.530	0.513	0.631	0.746
Diesel	0.948	1.030	1.148	1.142	0.997	1.175	1.390
Gasoline	1.063	1.133	1.212	1.200	1.098	1.277	1.510
<i>Total taxes</i>							
Autogas	0.244	0.256	0.260	0.253	0.250	0.271	0.320
Diesel	0.495	0.509	0.546	0.546	0.545	0.576	0.681
Gasoline	0.619	0.631	0.644	0.643	0.656	0.688	0.814
<i>Excise taxes</i>							
Autogas	0.161	0.161	0.161	0.161	0.161	0.161	0.190
Diesel	0.330	0.330	0.347	0.347	0.372	0.372	0.440
Gasoline	0.434	0.434	0.434	0.435	0.466	0.466	0.551
<i>Pre-tax prices</i>							
Autogas	0.234	0.292	0.310	0.277	0.263	0.360	0.426
Diesel	0.454	0.521	0.602	0.597	0.452	0.599	0.708
Gasoline	0.445	0.502	0.568	0.558	0.441	0.590	0.698

13.3 Competitiveness of Autogas against other fuels

Autogas is very competitively priced in Lithuania. The break-even distance for Autogas against gasoline is estimated at around 16,000 km for a converted Autogas LDV and 20 000 for an OEM vehicle based on 2021 fuel prices and vehicle costs (Figure B13.2). This assumes an average conversion cost of about €700 and an average price premium for an OEM vehicle over a new gasoline one of around €800.

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 for the owner of a converted Autogas vehicle over a distance of 100,000 km amount to around €3,300.

Figure B13.2: Running costs of a non-commercial LDV, 2021 – Lithuania

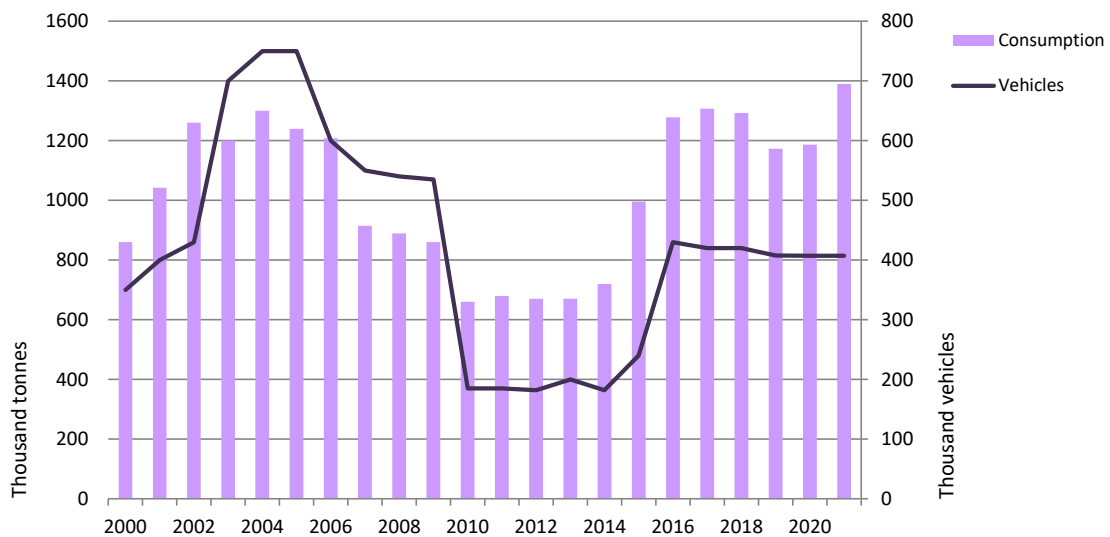


14 Mexico

14.1 Autogas market trends

Mexico’s Autogas market has been on a roller-coaster ride since the start of the century. Having expanded rapidly in the early 2000’s, demand went into decline over the second half of the decade, only to level off and then bounce back strongly between 2014 and 2017, reaching a peak of 1.31 Mt (Figure B14.1). Sales then fell back to 1.17 Mt in 2019, but then rebounded to an all-time record 1.39 Mt in 2021, despite the effects of the COVID-19 pandemic.

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



Note: The sharp fall in vehicle numbers in 2010 is due to a break in the series.
 Source: WLPGA/Argus (2022).

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. The Mexican government forecasts Autogas demand to grow by more than 25% between 2018 and 2032 (SENER, 2018). The use of CNG remains tiny and that of other alternative fuels negligible, though sales of EVs are starting to grow. Autogas accounts for close to 4% of total automotive-fuel consumption, up from just 1.3% in 2013.

There are currently an estimated 407,000 Autogas vehicles in use in Mexico – about 0.8% 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 Many of them operate as taxis. No OEM Autogas models are marketed in Mexico at present. However, an agreement was reached in early

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

2017 between the Mexican 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 are 2,080 refuelling sites selling Autogas around the country – a large number relative to the size of the fleet.

14.2 Government Autogas incentive policies

The Mexican government launched a major reform of the energy sector in 2013 aimed at liberalising the market and stimulating investment. The oil sector, which has traditionally been dominated by the state monopoly, Pemex, is being opened up partially to competition. Since 2016, private companies are allowed to import oil and participate in downstream markets. In 2021, the government announced the creation of a new state-owned LPG retail company, Gas Bienestar.

Government controls on transport fuel prices were largely removed in 2017. Previously, it set maximum retail prices on a monthly basis according to a formula that took account of a distribution margin based on actual costs and value-added tax. Price caps on Autogas were removed on 1 January 2017, while those on gasoline and diesel were removed progressively throughout 2017. However, retail price caps on LPG, including Autogas, were reintroduced in August 2021 in the face of rising international prices in order to relieve the pressure on the cost of living for Mexican households, most of whom rely on LPG for cooking and water heating. Those caps were extended for six months from January 2022. Gasoline and diesel prices remain unregulated, but the government has sought to limit the increase in pump prices by lowering fuel taxes.

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 6.60 US cents/litre for Autogas, compared with 10.38 cents for gasoline and 12.59 cents for diesel.² Value-added tax of 16% is applied to all fuels.

The pump prices of all transport fuels rose sharply in 2017 as the market was liberalised: Autogas prices jumped by 15% on average, diesel prices by 20% and gasoline prices by 25%³, boosting the competitiveness of Autogas, the price of which had tended to rise less rapidly than those of diesel and gasoline in previous years. Since then, prices of Autogas has tended to rise more than those of the other fuels, especially in 2021 – leading to the decision to cap prices. On average in that years, the pump price was on

¹ <http://auto-gas.net/mediaroom/mexico-supports-adoption-lpg-powered-vehicles/>

² www.thepmr.org/system/files/documents/Carbon%20Tax%20in%20Mexico.pdf

³ Wide differences in Autogas prices across Mexico and large price fluctuations were reported in 2017, possibly reflecting a lack of competition and the fact that motorists are unaccustomed to shopping around for the cheapest fuel (*LPG World*, 23 January 2018).

average equal to 60% of that of both gasoline and 61% of that of diesel, compared with around 46% for both fuels just two years earlier (Table B14.1).

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

	Pesos						US dollars
	2016	2017	2018	2019	2020	2021	2021
<i>Pump prices</i>							
Autogas	7.77	8.91	10.25	9.62	10.00	13.00	0.641
Diesel	14.01	16.87	18.94	21.16	19.58	21.45	1.058
Gasoline	14.20	17.70	19.32	20.78	18.76	21.78	1.074
<i>Total taxes</i>							
Autogas	1.07	1.23	1.41	1.33	1.38	1.79	0.088
Diesel	1.93	2.33	2.61	2.92	2.70	2.96	0.146
Gasoline	1.96	2.44	2.66	2.87	2.59	3.00	0.148
<i>Excise taxes</i>							
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
<i>Pre-tax prices</i>							
Autogas	6.70	7.68	8.84	8.29	8.62	11.21	0.552
Diesel	12.08	14.54	16.31	18.24	16.88	18.49	0.912
Gasoline	12.24	15.26	16.66	17.91	16.17	18.78	0.926

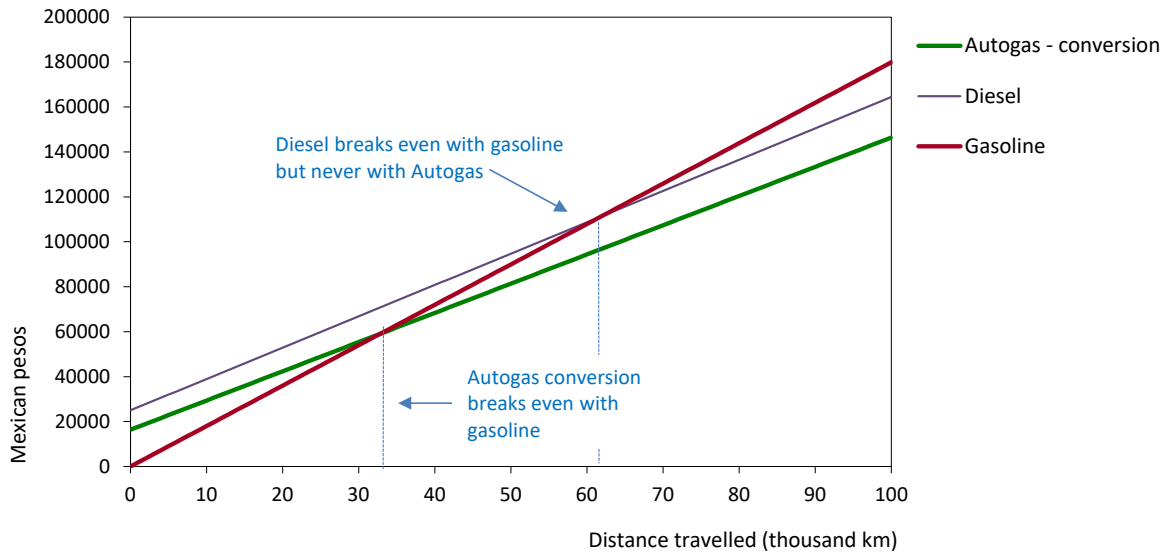
There are no subsidies for vehicle owners to convert to Autogas or purchase OEM vehicles. However, Autogas vehicles are exempt from the annual road tax. In addition, some Autogas vehicles are exempt from local driving restrictions imposed for air quality reasons, For example, under the “Hoy No Circula” 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. In early 2021, the municipal government of Guanajuato announced the launch of a pilot project to convert municipal gasoline-powered vehicles to run on Autogas as a means of reducing air pollution and reducing running costs.

14.3 Competitiveness of Autogas against other fuels

Assuming an average conversion cost of about 15,900 pesos (about \$840), Autogas becomes competitive with gasoline at 33,000 km based on 2021 fuel prices (Figure B14.2).¹ The net cost savings after 100,000 km amount to about 33,000 pesos (\$1,600). Autogas is always more competitive than diesel, which breaks even with gasoline at over 60,000 km. These calculations take account of the exemption from the annual road tax. The breakeven distance of Autogas against gasoline has risen in the last couple of years due to relatively higher Autogas pump prices.

¹ 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.

Figure B14.2: Running costs of a non-commercial LDV, 2021 – Mexico



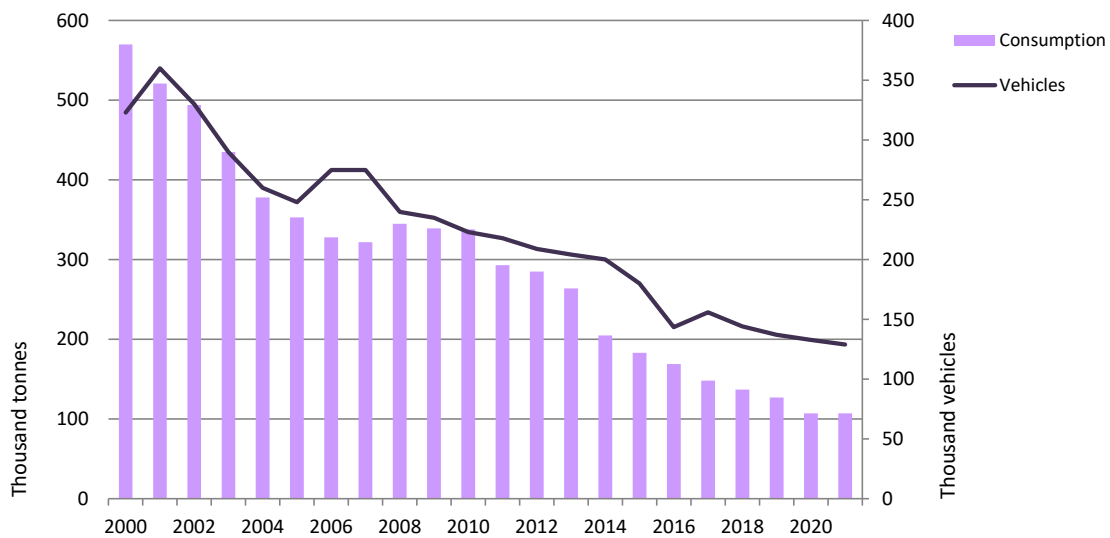
Note: Running costs here include the annual road tax, from which Autogas vehicles are exempt. The tax varies according to the size, type and age of the car. For the purposes of this analysis, it is assumed to amount to 1,000 pesos per year for both gasoline and diesel vehicles, which equals 55.5 pesos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

15 Netherlands

15.1 Autogas market trends

Autogas use in the Netherlands has a long history. The Dutch Government 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, more recently, EVs, despite Autogas remaining highly competitive. The decline in Autogas consumption accelerated in 2020 with the Covid-19 crisis, remaining flat in 2021 at 107,000 tonnes – 16 down on 2019 and 83% lower than in 2000 (Figure B15.1). Autogas now accounts for just 1.2% of the country’s total road-fuel demand and 4% of the country’s total LPG use.

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



Source: WLPGA/Argus (2022).

The Autogas vehicle fleet has been contracting almost without a break since the early 2000s. At end-2021, there were 129,000 Autogas vehicles in use – down from a peak of 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 drove down consumer interest in buying OEM Autogas cars or converting an existing car to run on the fuel. Only three carmakers – Chevrolet, Dacia and Opel – still offer Autogas versions, even though the prices are often not much more (and in some cases lower) than those of gasoline-powered equivalents and are much cheaper than diesel cars thanks to lower purchase taxes (see below). There are 1,124 refuelling sites that sell Autogas across the country, around 27% of the total.

The fleet of other types of alternative fuels is expanding. The number of EVs (including plug-in hybrids) on the road in the Netherlands has been growing very rapidly in the last few years, and the fleet, at 385,000 vehicles at end-2021 – the seventh-largest in the world – is now significantly larger than for Autogas. The CNG fleet has also been growing, but is much smaller than that for Autogas, made up mostly of HDVs and municipal fleet LDVs.

15.2 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 B15.1). In 2014, the tax on Autogas was increased sharply, causing the price gap to narrow suddenly. There has been no change in the tax on all three fuels since 2017. It currently stands at 18.6 cents/litre on Autogas, compared with 49.4 cents on diesel and 78 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 2021 was equal to just 43% of the price of gasoline and 53% of the price of diesel, though these shares have increased since 2019. In absolute terms, Autogas was just over €1/litre cheaper than gasoline and 58 cents/litre cheaper than diesel.

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

	Euros						US dollars
	2016	2017	2018	2019	2020	2021	2021
<i>Pump prices</i>							
Autogas	0.571	0.633	0.685	0.633	0.605	0.782	0.925
Diesel	1.141	1.221	1.335	1.356	1.237	1.461	1.728
Gasoline	1.477	1.552	1.618	1.647	1.562	1.814	2.145
<i>Total taxes</i>							
Autogas	0.285	0.296	0.305	0.296	0.291	0.322	0.381
Diesel	0.691	0.706	0.726	0.729	0.709	0.747	0.883
Gasoline	1.034	1.050	1.061	1.066	1.051	1.095	1.295
<i>Excise taxes</i>							
Autogas	0.186	0.186	0.186	0.186	0.186	0.186	0.220
Diesel	0.493	0.494	0.494	0.494	0.494	0.494	0.584
Gasoline	0.778	0.780	0.780	0.780	0.780	0.780	0.922
<i>Pre-tax prices</i>							
Autogas	0.286	0.337	0.380	0.337	0.314	0.460	0.544
Diesel	0.450	0.515	0.609	0.627	0.528	0.713	0.843
Gasoline	0.442	0.503	0.557	0.581	0.511	0.719	0.850

In March 2022, the Dutch government announced a 4.1 cents/litre reduction in the excise duty on LPG and LNG, to be applied from 1st April until the end of the year. The tax on gasoline was cut by 17.3 cents/litre and that on diesel

by 11.1 cents/litre. The move forms part of a broader package of measures to help people cope with rising energy prices and the overall cost of living.¹

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).² 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 1st 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. In July 2022, the government announced plans to reform the holdership tax, basing it on how much owners use their car.³

15.3 Competitiveness of Autogas against other fuels

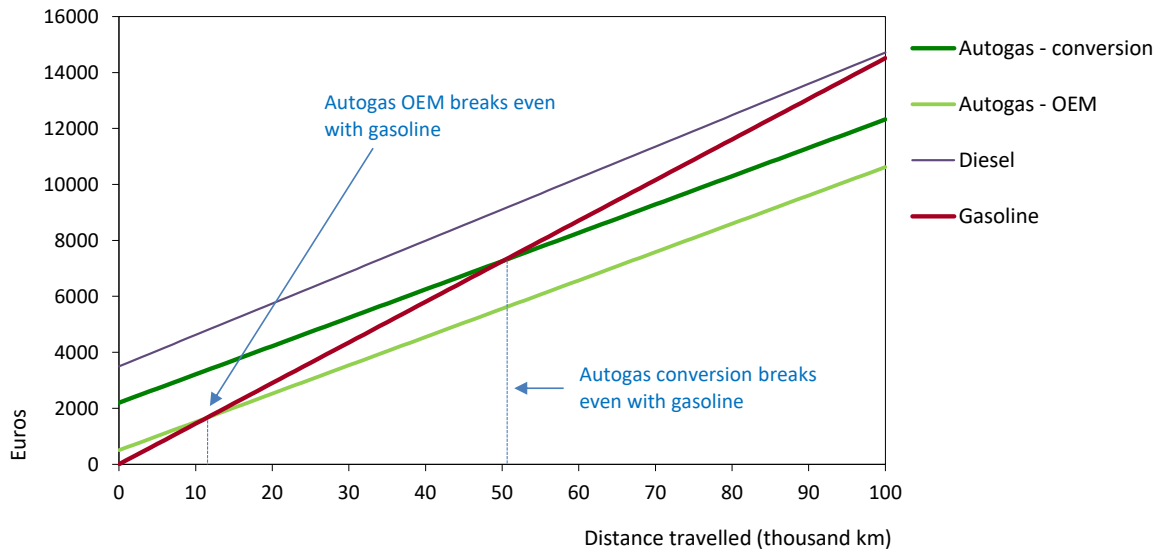
The relatively low pump price of Autogas resulted in a breakeven distance for Autogas against gasoline of around 12,000 km for an OEM Autogas LDV (based on a typical price premium of just €500, over a gasoline car thanks in part to a favourable the luxury tax) and 51,000 km for converted vehicles (assuming an average cost of installing a conversion kit of €2,200) in 2021 (Figure B15.2). These distances have barely changed in recent years. The 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 on average) and per-km fuel costs are higher.

¹ <https://business.gov.nl/amendment/taxes-on-energy-petrol-diesel-lowered/>

² The tax is 42.3% of the net catalogue price minus €1,442 for Autogas and gasoline cars and plus €307 for diesel ones.

³ <https://news.bloombergtax.com/daily-tax-report-international/netherlands-to-tax-motorists-on-how-often-they-drive-their-cars>

Figure B15.2: Running costs of a non-commercial LDV, 2021 – Netherlands



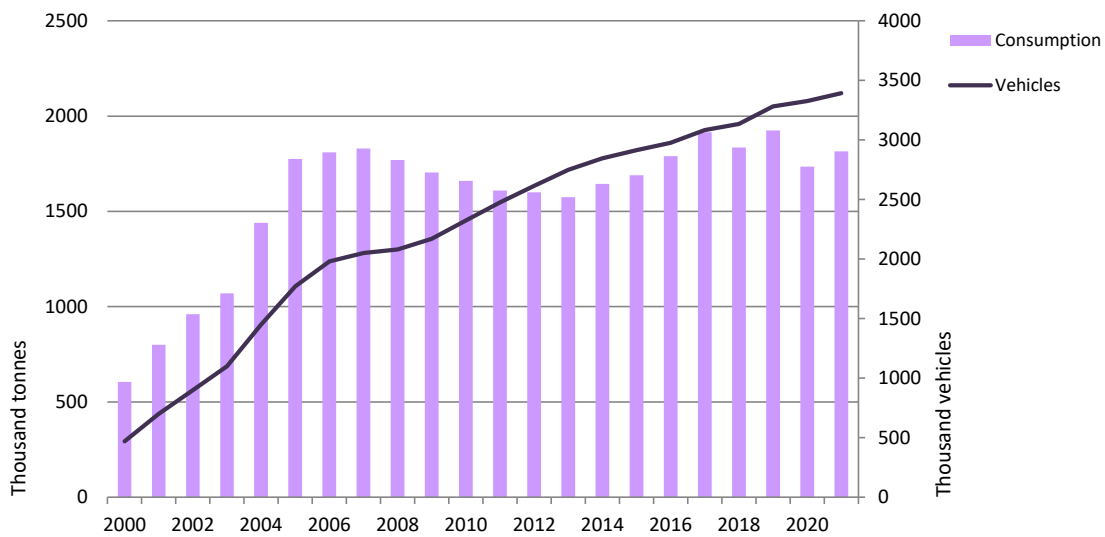
Note: The analysis takes into account differences in annual vehicle road taxes (assumed to be €23/1 000 km for Autogas and €21/1 000 for diesel based on 18,000 km distance per year).

16 Poland

16.1 Autogas market trends

Poland has the largest Autogas market in the European Union and the fourth-largest in the world after Russia, Turkey and Korea. 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 rebounded in 2014, 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 1.82 Mt in 2021 – 4.6% up on 2020 when the first wave of COVID-19 hit demand – but still just below the historic peak of just over 1.9 Mt in 2019 (Figure B16.1). It now accounts for roughly 14% of total road-fuel use in Poland and just under three-quarters of the country’s total LPG consumption. Most of the country’s LPG needs are imported, mainly from Russia (until recently), Sweden and Lithuania.

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



Source: WLPGA/Argus (2022).

The fleet of vehicles that are able to run on Autogas has grown steadily since the 1990s, reaching more than 3.39 million by the end of 2021 – almost 14% of all passenger cars registered in Poland – though as many as 900 000 of them are thought to be no longer in use (POGP, 2022). 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 EV fleet is still much smaller: total of 38,001 passenger and 1 657 commercial electric cars were registered in Poland at the end of 2021, though sales have been rising (POGP, 2022).

Conversion costs are low compared with 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. In 2021, 13,513 new OEM Autogas passenger cars were registered, compared with 9,143 a year earlier, of which Dacia accounted for 10,819 and Renault 2,624 (POGP, 2022).

The Autogas refuelling network in Poland has been expanding rapidly in recent years. At the end of 2021, there were 7,450 refuelling stations selling Autogas across the country – over one-third more than just five years earlier. Most of these stations are at service stations. Small, family-run businesses consist of nearly 12% of the total LPG retail sites.

16.2 Government Autogas incentive policies

The success of Autogas in Poland is the result of both a large excise-tax advantage over gasoline and diesel, which ensures a relatively low price of the fuel at the pump, and relatively low pre-tax prices. The excise duty on Autogas has barely increased since 2005, while that on the other two fuels have continues to rise slowly. The tax on Autogas is now less than a third of the amount charged on gasoline and diesel (Figure B16.1). 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 2021 was just 49% that of gasoline and 50% that of diesel, though these shares have risen significantly in the last two years.

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

	Zlotys						US dollars
	2016	2017	2018	2019	2020	2021	2021
<i>Pump prices</i>							
Autogas	1.807	2.075	2.233	2.128	2.047	2.691	0.697
Diesel	4.133	4.427	4.917	5.050	4.457	5.409	1.401
Gasoline	4.358	4.591	4.943	5.002	4.435	5.510	1.427
<i>Total taxes</i>							
Autogas	0.804	0.854	0.884	0.867	0.853	0.974	0.252
Diesel	2.232	2.287	2.384	2.413	2.307	2.493	0.646
Gasoline	2.484	2.528	2.596	2.608	2.504	2.707	0.701
<i>Excise taxes</i>							
Autogas	0.466	0.466	0.468	0.469	0.471	0.471	0.122
Diesel	1.459	1.459	1.464	1.469	1.474	1.482	0.384
Gasoline	1.669	1.669	1.671	1.673	1.675	1.676	0.434
<i>Pre-tax prices</i>							
Autogas	1.003	1.221	1.348	1.261	1.194	1.717	0.445
Diesel	1.901	2.140	2.534	2.637	2.149	2.916	0.755
Gasoline	1.874	2.063	2.347	2.394	1.931	2.803	0.726

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

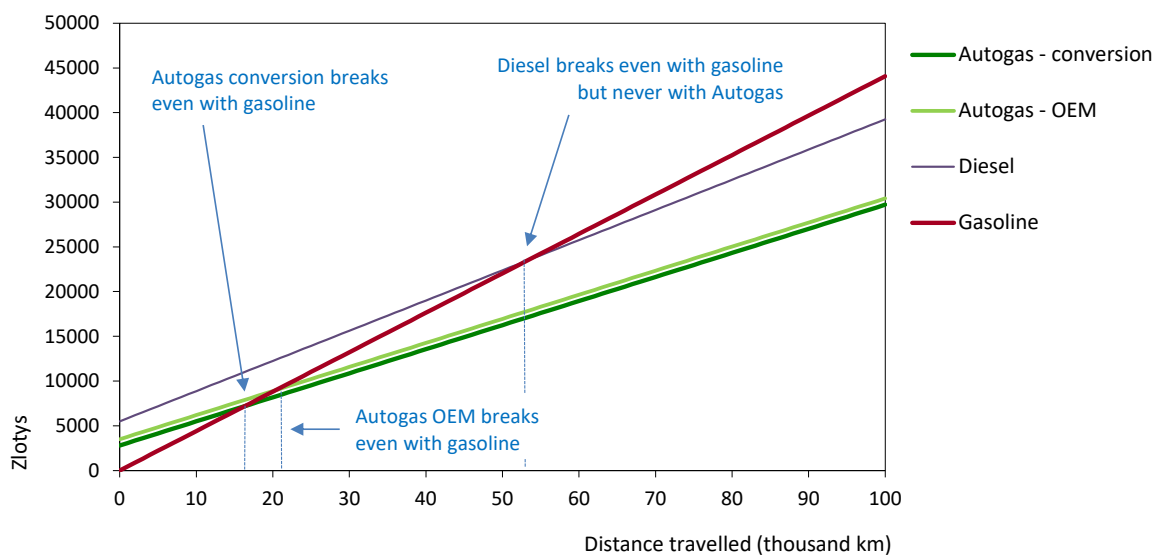
In response to rising energy prices and general inflation, excise taxes on transport fuels were cut to the minimum levels allowed under EU rules in December 2021. VAT was also reduced from 23% to 8% from 1st February 2022. These measures, which were due to expire after five months, were subsequently extended until later in 2022.

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. A law on the establishment of low-emission zones (LEZ) in city centres grants an exemption for Autogas vehicles. LEZs will be obligatory from 2030 although some will be introduced sooner in an effort to cut air pollution in major urban centres. Incentives for electric vehicles and alternative fuels such as hydrogen were not extended to Autogas.

16.3 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 price advantage 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 \$730) in 2021 prices. This yields a break-even distance of just 17,000 km – little more than one year of driving for a private car owner and much less for a taxi or commercial operator – based on average 2021 fuel prices (Figure B16.2). 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 (\$910), 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 B16.2: Running costs of a non-commercial LDV, 2021 – Poland

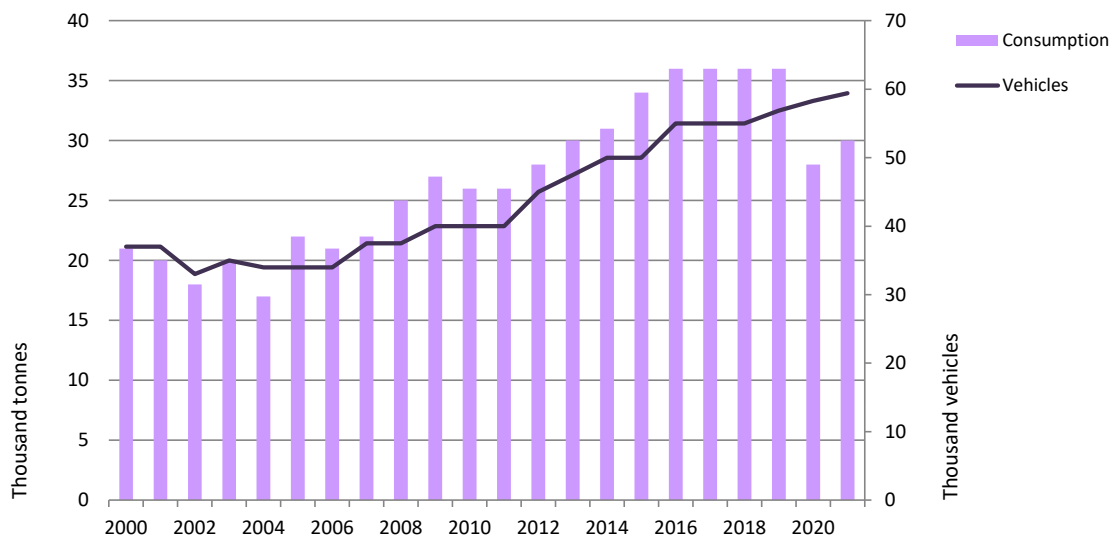


17 Portugal

17.1 Autogas market trends

The Portuguese Autogas market grew steadily through to 2016, but then levelled off before dipping in 2020 due to the effects of the health crisis. Autogas demand remains small both in absolute terms and relative to the size of the overall transport fuel market. Sales amounted to 30,000 tonnes in 2021 – down 17% on 2019, but an increase of about 7% on the previous year and 15% compared with a decade ago (Figure B17.1). Autogas accounts for a mere 0.6% of total automotive fuel sales in Portugal.

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



Source: WLPGA/Argus (2022).

The fleet of vehicles that are able to run on Autogas has grown since the mid-2000s, reaching around 59,000 by end-2021 having been flat at 55,000 in 2016-2018. Autogas vehicles make up close to 1% of all the vehicles in Portugal. Most of these vehicles are aftermarket conversions, but sales of OEM vehicles have been growing: there are currently 15 OEM models available: Alfa Romeo’s Giulietta; Dacia’s Sandero and Logan MVC; Fiat’s Punto, Evo, Bravo and 500; the Hyundai 10; the Lancia Ypsilon; the Mitsubishi Lancer; Opel’s Zafira, Insignia, Mokka X and Astra; and the Subaru Legacy. There are around 70 converters around the country. At the end of 2021, there were 405 refuelling stations selling Autogas across the country – 9 more than a year before.

17.2 Government Autogas incentive policies

A relatively low excise tax is the principal government incentive for Autogas. The tax amounted to 16.6 euro cents/litre in 2021, compared with 51.1 cents on diesel and 66.4 cents on gasoline (Table B17.1). The tax rate for Autogas

has increased only marginally since 2019, while that on the other two fuels has risen slightly more in absolute terms, strengthening the price advantage favouring Autogas. Combined with relatively low wholesale LPG prices, the low excise tax on Autogas results in a relatively low pump price. In 2021, the price averaged 72 cents/litre – just 45% of that of gasoline and 51% of that of diesel. These shares fell in 2021, but are still higher than in 2019.

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

	Euros						US dollars
	2016	2017	2018	2019	2020	2021	2021
<i>Pump prices</i>							
Autogas	0.545	0.602	0.653	0.621	0.650	0.722	0.854
Diesel	1.134	1.242	1.343	1.363	1.245	1.421	1.680
Gasoline	1.382	1.463	1.538	1.491	1.387	1.618	1.913
<i>Total taxes</i>							
Autogas	0.240	0.253	0.263	0.266	0.285	0.301	0.356
Diesel	0.663	0.699	0.722	0.741	0.742	0.777	0.919
Gasoline	0.926	0.925	0.947	0.921	0.924	0.966	1.142
<i>Excise taxes</i>							
Autogas	0.138	0.140	0.141	0.150	0.164	0.166	0.196
Diesel	0.452	0.466	0.471	0.486	0.509	0.511	0.604
Gasoline	0.668	0.652	0.659	0.643	0.664	0.664	0.785
<i>Pre-tax prices</i>							
Autogas	0.305	0.349	0.390	0.355	0.364	0.421	0.498
Diesel	0.470	0.543	0.621	0.622	0.503	0.644	0.762
Gasoline	0.455	0.538	0.591	0.570	0.463	0.651	0.770

Although prices in Portugal are unregulated, as required by EU legislation, a law allowing the government to cap marketing margins for transport fuels came into force in October 2021.¹ The law amends several decrees that establish the general principles related to the organisation and functioning of the National Petroleum System. Any cap that is introduced in the event of margins being deemed excessive is intended to apply for a limited period only.

No grants are available from the central government or local authorities for converting gasoline vehicles to Autogas. But the government has introduced legislation to facilitate the use of Autogas and CNG/LNG. Law 13, adopted in 2013, sets out technical standards for vehicle conversions and permits vehicles using gaseous fuels to use underground car parks. As in most other European countries, grants and tax rebates are available for purchasers of EVs.

In March 2018, Autogas filling nozzles in all refuelling stations in Portugal were replaced with the Euroconnector system, which was already used

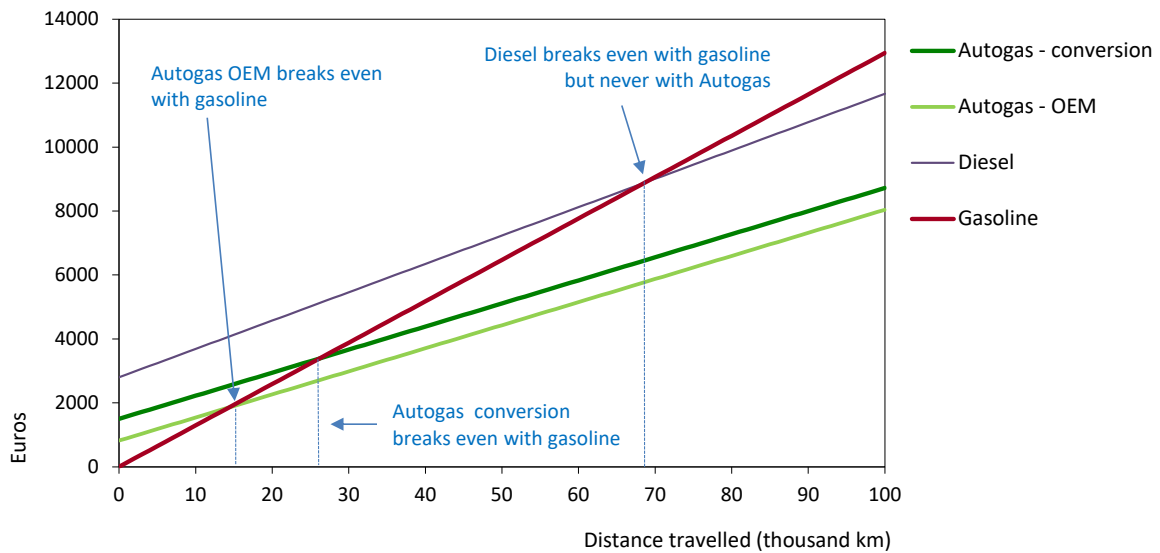
¹ https://www.euractiv.com/section/politics/short_news/portugal-to-cap-fuel-prices-from-friday/

everywhere in neighbouring Spain. Previously, several different filling systems were in use in Portugal.

17.3 Competitiveness of Autogas against other fuels

The highly attractive pump price and relatively low conversion costs result in very short payback periods for switching to Autogas. The break-even distance for Autogas against gasoline was just 15 000 km in 2021 for an OEM vehicle, or about one year’s driving for the average private motorist, based on a typical price premium of €820 (Figure B17.2). For a converted car, the breakeven distance was 27,000 km, assuming an average conversion cost of €1,500. These distances have changed little in recent years. Autogas is always cheaper than diesel regardless of distance.

Figure B17.2: Running costs of a non-commercial LDV, 2021 – Portugal

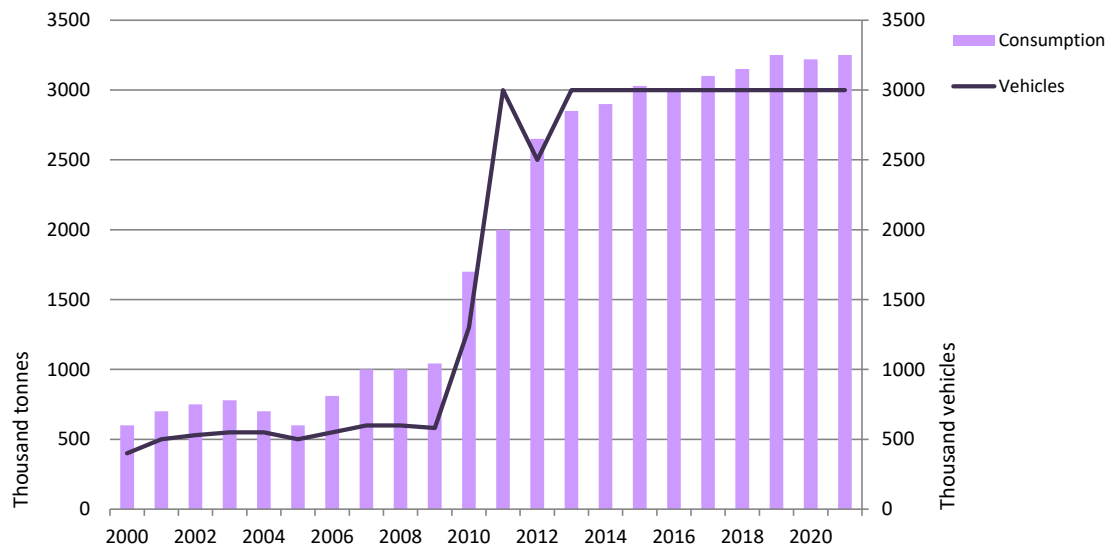


18 Russia

18.1 Autogas market trends

Russia has the world’s largest Autogas market. It 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 surged during the first part of the 2010s as Autogas became cheaper than competing fuels, though it has slowed in recent years. It reached an estimated 3.25 million tonnes in 2021 – almost three times the level of 2009 and more than five times that of 2000 – having dipped slightly in 2020 with the economic effects of the health crisis (Figure B18.1).¹ Autogas now accounts for about 6% of total road-fuel consumption (it was little more than 2% a decade earlier) and 30% of total LPG use.

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



Source: WLPGA/Argus (2022).

Autogas use held up well in 2020 despite lockdown measures to prevent the spread of COVID-19, with demand falling only slightly to around 3.2 Mt. Sales in the largest Autogas consuming region of Dagestan fell most as a result of a longer lockdown in April-July and the closure of 300 retail outlets, but sales rose or steadied in other regions.² Demand is thought to have fallen since the

¹ There is some uncertainty about the accuracy of Autogas consumption data for Russia. The data shown here are from WLPGA/Argus (2022). Data from the IEA were showing much lower consumption levels (392,300 tonnes for 2017, or just one-eighth of the level reported by WLPGA/Argus). This enormous discrepancy is thought to be due to misreporting of sales by retailers to the authorities. The IEA no longer reports any energy data for Russia after 2018.

² *LPG World*, 2 February 2021.

beginning of 2022 as a result of the economic disruption induced by Russia’s invasion of Ukraine.

There are an estimated three 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 commercial fleet LDVs and taxis. Most Autogas vehicles are thought to be more than ten years old. Demand for conversions of existing gasoline vehicles remains strong according to reports.¹ There are 4 900 Autogas refuelling stations across Russia, the majority of which are owned by Gazprom and sell CNG alongside Autogas. CNG use has been rising rapidly in recent years, reaching an estimated 249 000 tonnes of oil equivalent in 2017 (the latest year for which data are available), almost five times the level of 2014, but is still far less than that of Autogas. There are few EVs in Russia as yet, though sales are rising.

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

	Rubles						US dollars
	2016	2017	2018	2019	2020	2021	2021
<i>Pump prices</i>							
Autogas	20.12	21.78	23.76	28.71	31.90	33.90	0.460
Diesel	35.60	38.16	43.75	46.68	48.11	51.35	0.697
Gasoline	37.71	39.83	43.45	45.41	46.42	49.37	0.670
<i>Total taxes</i>							
Autogas	3.07	3.32	3.62	4.79	5.32	5.65	0.077
Diesel	9.93	11.60	13.44	15.04	15.52	n.a.	n.a.
Gasoline	13.34	14.18	15.87	17.42	17.94	n.a.	n.a.
<i>Excise taxes</i>							
Autogas	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Diesel	4.50	5.78	6.76	7.26	7.51	n.a.	n.a.
Gasoline	7.58	8.10	9.24	9.85	10.20	n.a.	n.a.
<i>Pre-tax prices</i>							
Autogas	17.05	18.46	20.14	23.93	26.58	28.25	0.383
Diesel	25.67	26.56	30.31	31.64	32.59	n.a.	n.a.
Gasoline	24.37	25.65	27.58	27.99	28.48	n.a.	n.a.

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

18.2 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 in Russia is the absence of an excise tax on the fuel (gasoline and diesel both carry taxes) though there have been reports recently that the government is considering introducing one.² The rate of excise tax on both gasoline and diesel has risen steadily in recent years, boosting the competitiveness of Autogas.³ The rate of VAT charged on all

¹ <https://auto-gas.net/mediaroom/autogas-market-gains-momentum-in-russia/>

² <https://divbracket.com/auto/21799.html>

³ In line with the 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 applied to the lowest-quality grades.

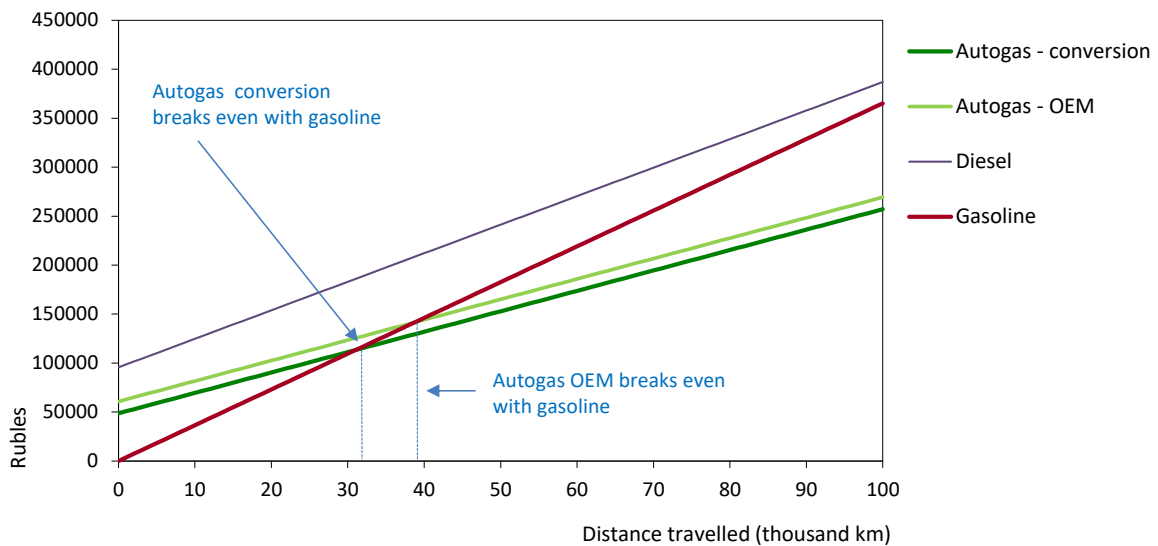
transport fuels was raised from 18% to 20% at the beginning of 2019. Retail fuel prices are deregulated.

The pump price of Autogas has risen significantly in recent years, apparently due to higher wholesale prices. As the pump prices of gasoline and diesel have risen less rapidly, the price advantage of Autogas has been eroded. In 2021, the price of Autogas was on average 69% of that of gasoline and 66% of that of diesel – up from less than half in the mid 2010s (Table B18.1).¹ However, the increase in the relative price of Autogas was largely due to a spike in prices in mid-2021, presumably due to supply problems; the pump price has since fallen sharply, to less than 20 rubles/litre in mid-2022 – less than half that of gasoline.

18.3 Competitiveness of Autogas against other fuels

The relatively high price of Autogas at the pump made it temporarily significantly less competitive with both gasoline and diesel in 2021 than in previous years and in 2022. Assuming a conversion cost of 48,000 rubles (about \$740), a converted Autogas car broke even with a gasoline-fuelled equivalent at 87,000 km based on 2021 prices (Figure B18.2). For an OEM Autogas vehicle, the break-even distance was over 100 000 km, assuming a price premium of 58,000 rubles (\$900). These distances have fallen back to around 25,000-30,000 km in mid-2022. Autogas is always competitive with diesel.

Figure B18.2: Running costs of a non-commercial LDV, 2021 – Russia



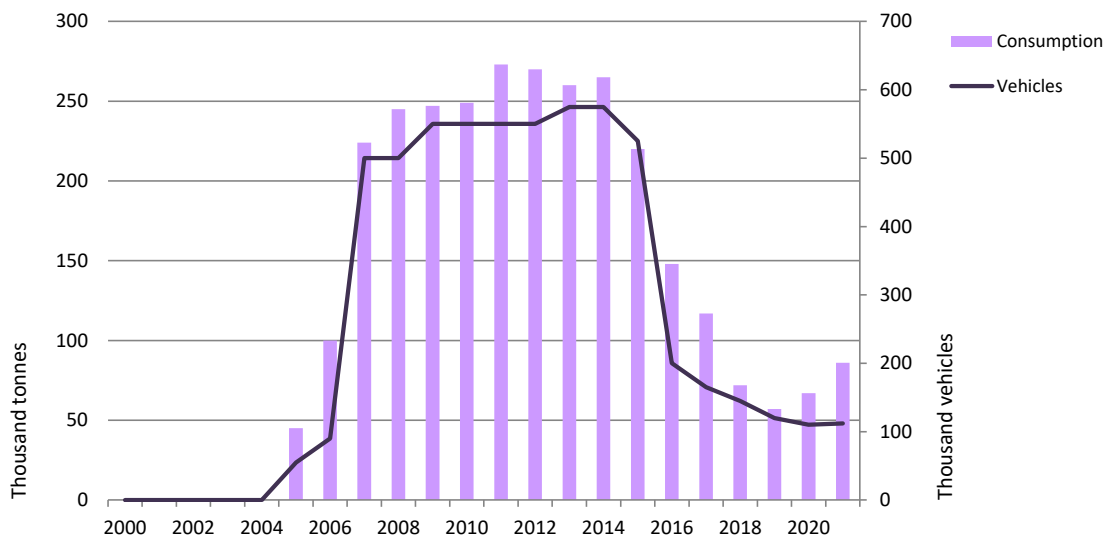
¹ There is considerable uncertainty about recent trends in fuel prices in Russia as the war in Ukraine has led to difficulties in obtaining reliable information about the Russian road fuels market.

19 Serbia

19.1 Autogas market trends

The Serbian Autogas market, until the mid-2010s one of the most buoyant in the world, suddenly contracted sharply. Fuel sales initially 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 then dropped back, reaching just 52,000 tonnes in 2019, but rebounded to 57,000 tonnes in 2021 (Figure B19.1). Autogas makes up little more than 3% of the road-fuel market (down from 16% in 2012) and 44% 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, though the EV fleet is growing.

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



Note: The sharp fall in vehicle numbers in 2016 is due partly to a break in the series.
 Source: WLPGA/Argus (2022).

The initial run-up in Autogas use was driven by a rapid expansion in the fleet of vehicles able to run on the fuel. Most of that increase took place in just five years up to 2009. It started to contract in 2015, dragging down fuel sales. By end-2021, there were an estimated 112 000 vehicles in use (about 4% of the total fleet), mostly converted gasoline cars. Most of the conversions kits that have been installed are from Italian companies, including Lovato and Tartarini. Over time, these cars are gradually being scrapped; as few new cars are being converted, the overall fleet is contracting. Autogas is still widely available throughout the country in urban areas and along major routes. At end-2021, there were 550 filling stations selling Autogas, some of them entirely dedicated to the fuel.

19.2 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 2021, the duty averaged 22.8 dinars/litre, compared with 59.3 dinars/litre for diesel and 57.4 dinars/litre for gasoline (Table B19.1). This resulted in a pump price of Autogas that was just 55% that of diesel and 57% that of gasoline. These shares have risen slightly over the last two years, mainly due to relatively higher wholesale LPG prices. Most of the excise duty on all three fuels is refundable for commercial users, including taxis and road hauliers.¹ In April 2022, the Serbian government cut excise duties on motor fuels by 15% to ease inflationary pressures.²

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

	Dinars						US dollars
	2016	2017	2018	2019	2020	2021	2021
<i>Pump prices</i>							
Autogas	63.24	62.30	63.94	65.80	75.11	89.69	0.901
Diesel	126.03	120.43	128.79	137.40	144.79	162.49	1.633
Gasoline	121.57	114.56	122.12	127.90	135.41	157.63	1.584
<i>Total taxes</i>							
Autogas	31.67	31.81	32.64	33.49	34.91	37.72	0.379
Diesel	75.01	74.93	77.63	80.43	82.49	86.44	0.868
Gasoline	72.76	72.43	74.97	77.25	78.97	83.63	0.840
<i>Excise taxes</i>							
Autogas*	21.13	21.42	21.98	22.52	22.39	22.77	0.229
Diesel	54.00	54.86	56.16	57.53	58.36	59.35	0.596
Gasoline	52.50	53.34	54.62	55.93	56.40	57.36	0.576
<i>Pre-tax prices</i>							
Autogas	31.57	30.50	31.30	32.31	40.20	51.97	0.522
Diesel	51.03	45.50	51.16	56.97	62.30	76.05	0.764
Gasoline	48.81	42.12	47.15	50.65	56.44	74.00	0.744

* Converted from the official rates in dinars/kg at 1.94 litres/kg. The tax rose from 43.52 to 44.26 dinars/kilogramme in mid-February 2021. The excise tax rates on diesel and gasoline are set in dinars/litre.

19.3 Competitiveness of Autogas against other fuels

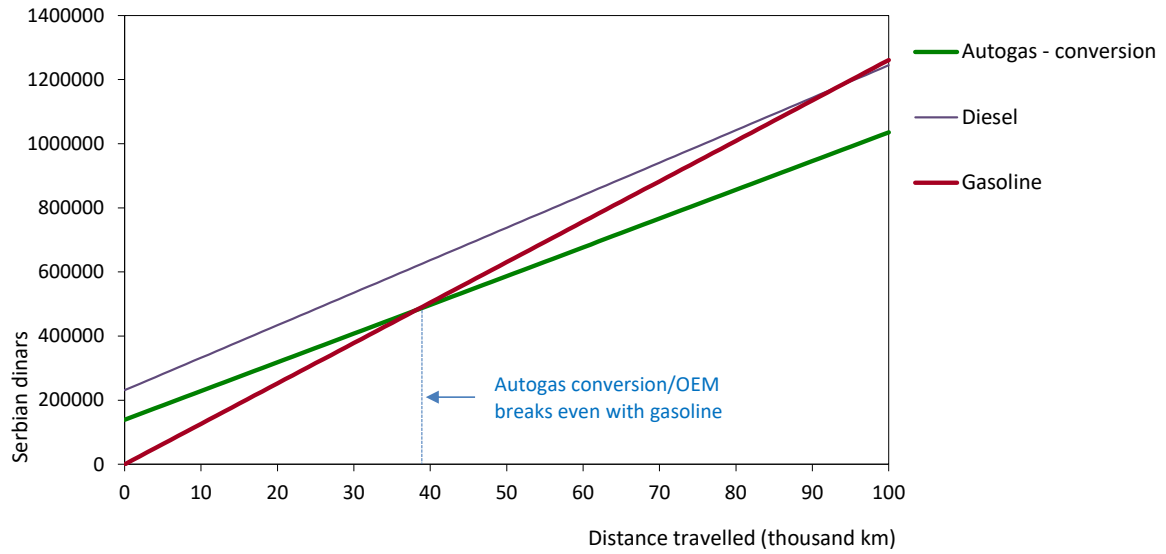
The low rate of excise duty and correspondingly low price of Autogas at the pump makes the fuel reasonably competitive with other road-transport fuels. Assuming the cost of converting a gasoline car to run on Autogas is around 140,000 dinars (about \$1,300), the breakeven distance was 39,000 km in 2021 – little changed since 2019 (Figure B19.2). After 100,000 km, the cost saving (net of the conversion cost) is around 225,000 dinars (\$2,250). The price premium of an OEM LPG car over gasoline version is generally about the

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

² <https://seenews.com/news/serbia-to-leave-lower-excise-duty-on-fuel-in-place-through-june-786164>

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 90,000 km.

Figure B19.2: Running costs of a non-commercial LDV, 2021 – Serbia

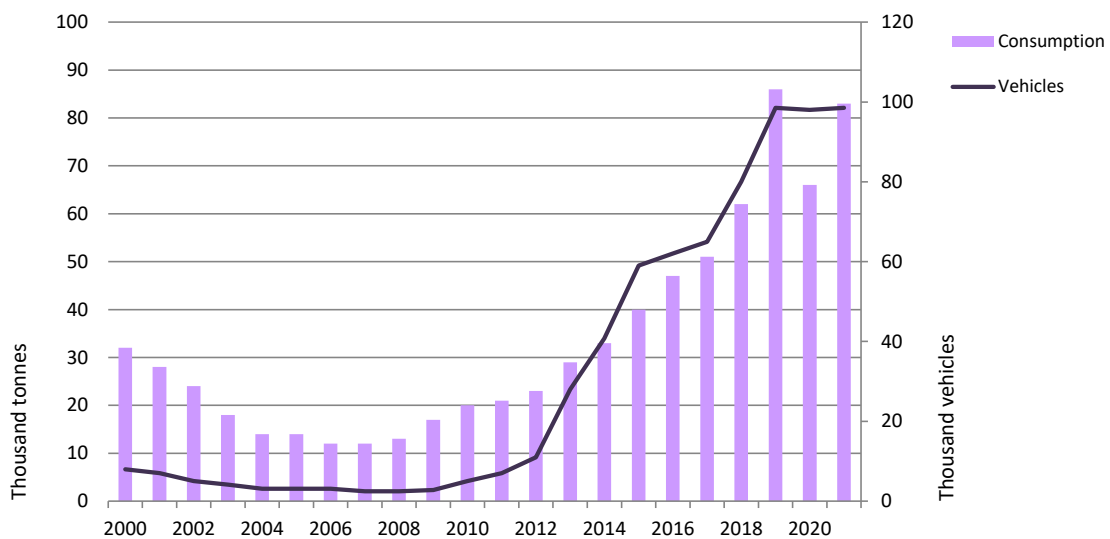


20 Spain

20.1 Autogas market trends

Spain has a very small Autogas market, but it has been 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 had dwindled to little more than 10,000 tonnes by the mid-2000s, but has since risen steadily, reaching 86,000 tonnes in 2019. Sales slumped in 2020 due to the COVID-19 crisis, but recovered most of those losses in 2021, rebounding to 83,000 tonnes (Figure B20.1). Autogas now accounts for around 0.3% of total use of automotive fuel in the country and about 5% of the country’s total LPG consumption.

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



Source: WLPGA/Argus (2022).

The rise in Autogas use has been driven mainly by a jump in OEM vehicle sales. At the end of 2019, there were an estimated 99,000 Autogas vehicles in use, unchanged from 2019 but up from just 3,000 as recently as 2009. One reason for the surge in interest in Autogas is that such vehicles qualify for the ECO label alongside hybrids and CNG/LNG vehicles, allowing them to be used on high-pollution days in major cities (see below) and to benefit from lower car taxes. Until recently, most Autogas vehicles in use were conversions. However, a growing number of carmakers now sell OEM Autogas models: sales jumped by 34.5% in the first half of 2022.¹ 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.

¹ <https://www.lainformacion.com/mercados-y-bolsas/venta-coches-glp-menor-precio-mitad-gasolina/2868369/>

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 1 100 at the end of 2021. Repsol operates most of these sites. According to a recent study by the Spanish Association of LPG Operators, the refuelling network is able to meet the demand of five times the current fleet of vehicles that use it.¹

20.2 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. An excise tax of 3.2 euro cents/litre was introduced in 2012 and was unchanged up to 2018, increasing very slightly to 3.4 cents in 2019 (Table B20.1). By contrast, the tax increased steadily on gasoline, reaching 47 cents in 2019, and climbing to 38 cents on diesel. Those rates have not changed since. Combined with a lower wholesale price, the favourable excise tax results in a relatively low price of Autogas at the pump. In 2021, it averaged 76 cents/litre – 45% lower than the price of gasoline and 39% lower than that of diesel. In absolute and relative terms, these price differentials have changed very little in recent years. In April 2022, the Spanish government introduced a 20 cents/litre rebate on the pump price of all transport fuels in response to rising international prices and inflationary pressures.

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

	Euros						US dollars
	2016	2017	2018	2019	2020	2021	2021
<i>Pump prices</i>							
Autogas	0.595	0.630	0.680	0.708	0.679	0.755	0.893
Diesel	1.014	1.101	1.204	1.215	1.072	1.243	1.470
Gasoline	1.151	1.218	1.290	1.298	1.178	1.377	1.628
<i>Total taxes</i>							
Autogas	0.135	0.141	0.150	0.157	0.152	0.165	0.195
Diesel	0.544	0.558	0.576	0.590	0.565	0.595	0.704
Gasoline	0.662	0.673	0.685	0.698	0.677	0.712	0.842
<i>Excise taxes</i>							
Autogas	0.032	0.032	0.032	0.034	0.034	0.034	0.040
Diesel	0.368	0.367	0.367	0.379	0.379	0.379	0.448
Gasoline	0.462	0.461	0.461	0.473	0.473	0.473	0.559
<i>Pre-tax prices</i>							
Autogas	0.460	0.489	0.530	0.551	0.527	0.590	0.698
Diesel	0.470	0.543	0.627	0.625	0.507	0.648	0.766
Gasoline	0.489	0.546	0.604	0.600	0.500	0.665	0.786

¹ <https://auto-gas.net/mediaroom/new-study-compares-autogas-with-other-alternative-fuels-in-spain/>

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 reaffirmed its support for Autogas in 2017 and launched a new plan, called MOVEA, to promote clean vehicles. The budget for 2017 was €1.5 million, to be used in part to fund grants of up to €2,750 for vehicle conversions or OEM purchases.¹ The plan was superseded by another, called MOVALT, in 2018, with the budget increased substantially to €20 million for 2018 and €67 million for 2019.² In June 2020, the MOVES II Program of Incentives for Efficient and Sustainable Mobility, including grants for AFVs, was approved by the Council of Ministers, with a total budget of €100 million. The funds are being dispersed to autonomous regions and cities. For example, the city of Madrid has launched a scheme under the MOVES II programme to fund the acquisition of Autogas and other ECO label vehicles and other sustainable transport measures, with a total budget of €11 million.

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 the “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. 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. A permanent ban is to be introduced from 2025.³ Barcelona introduced a low-emissions zone at the start of 2020.

Regions and provinces also have programmes to support the uptake of Autogas and other alternative fuels. For example, Madrid approved in 2020 the first line of aid announced in the Madrid 360 Environmental Sustainability Strategy for the transition towards a low-emission taxi fleet, with a fund of almost €2.8 million.⁴ In 2021, it announced a plan to subsidise the replacement of polluting vehicles with clean ones, including Autogas vehicle, with a budget of €5.5 million for 2021. A target of converting up to 17,800 vehicles was set. Given the overwhelming demand for the grants of up to €6

¹ <http://auto-gas.net/mediaroom/spain-catalonia-commits-encourage-autogas-adoption/>

² <https://auto-gas.net/mediaroom/spanish-government-plans-to-allocate-67-million-euros-for-sustainable-mobility/>

³ <https://auto-gas.net/mediaroom/madrid-will-ban-circulation-of-vehicles-without-environmental-label-from-2025/>

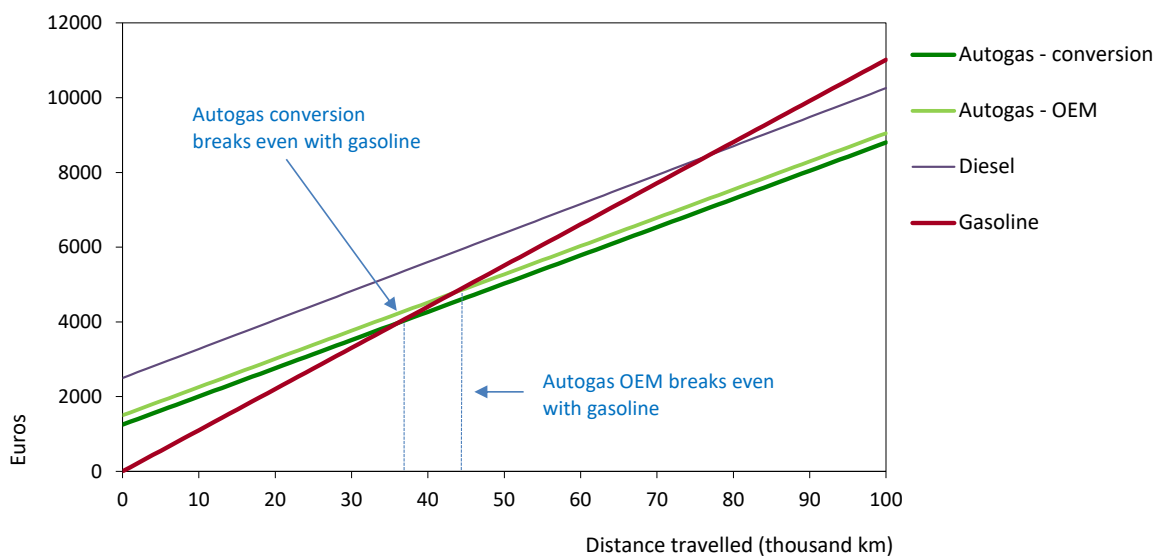
⁴ <https://auto-gas.net/mediaroom/madrid-awards-more-than-2-7-million-euros-to-help-renew-citys-most-polluting-taxis/>

000 per vehicle on offer, the budget was subsequently increased to €10.5 million for 2022.¹

20.3 Competitiveness of Autogas against other fuels

The current structure of fuel prices makes Autogas highly competitive in Spain. Based on average 2021 prices, Autogas breaks even against gasoline at just 37,000 km for converted vehicle (based on an average cost of around €1,250) and 44,000 km for an OEM vehicle (based on an average price premium of €1,500) (Figure B20.2). These distances do not take account of any vehicle grants that may be available. Diesel breaks even against gasoline at around 75,000 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).

Figure B20.2: Running costs of a non-commercial LDV, 2021 – Spain



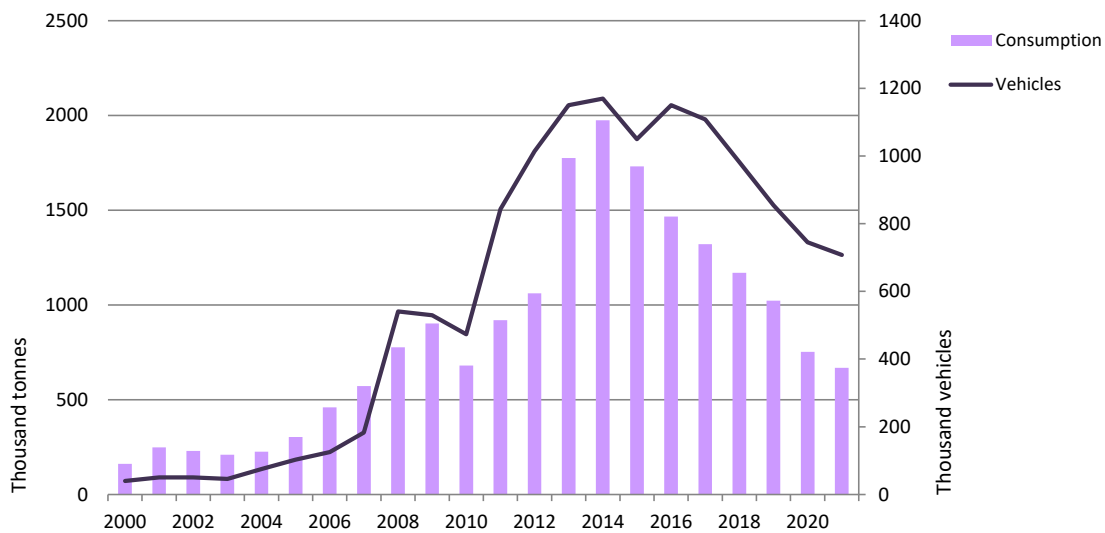
¹ <https://auto-gas.net/mediaroom/madrid-duplicates-subsidies-to-renew-private-fleet-with-eco-and-zero-vehicles/>

21 Thailand

21.1 Autogas market trends

Thailand’s Autogas market has been on a roller-coaster ride over the last decade and a half, 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 peaked at almost two Mt in 2014, rising by a remarkable 710 000 tonnes, or two-thirds, in 2013 alone (Figure B21.1). They have since fallen heavily, to just 668,000 tonnes in 2021 with higher prices, the health crisis accentuating the downward trend in 2020. Autogas now accounts for less than 3% of total road-transport fuel sales – down from over 9% in 2014. Autogas makes up 11% of Thailand’s total consumption of LPG.

Figure B21.1: 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.
 Source: WLPGA/Argus (2022).

The number of vehicles running on Autogas grew rapidly after 2003 to 1.15 million in 2014, but declined to 708,000 in 2021 – roughly 4% 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 now account for a bigger share of the fleet. Virtually all the Autogas vehicles in use in Thailand are converted gasoline cars; no OEM Autogas models are marketed in Thailand. The recent contraction in the Autogas fleet is largely due to switching to ethanol (see below). At end-2021, there were 1,570

refuelling stations selling Autogas, most of which are in or around Bangkok; in 2017, there were close to 2,000.

21.2 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. The price then rose, narrowing slightly the gap with those prices of gasoline and diesel. The regime that came to power after the military coup in 2014 shifted most of the remaining subsidies from the oil fund away from LPG and towards two ethanol-gasoline blends (Gasohol E20 and E85) produced locally (LPG was more heavily subsidised than other transport fuels).

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

	Baht						US dollars
	2016	2017	2018	2019	2020	2021	2021
<i>Pump prices</i>							
Autogas	11.06	11.22	11.49	11.81	10.55	10.19	0.319
Diesel	23.26	25.64	28.35	26.46	19.71	25.70	0.804
Gasoline	31.80	34.54	36.32	35.33	29.29	35.94	1.124
<i>Total taxes</i>							
Autogas	-4.29	-8.38	-8.91	-4.88	-4.50	-13.15	-0.411
Diesel	7.91	8.37	4.40	8.59	8.36	8.17	0.255
Gasoline	15.40	15.97	16.47	17.34	15.84	16.17	0.506
<i>Excise taxes**</i>							
Autogas	-5.01	-9.11	-9.66	-5.65	-5.19	-13.82	-0.432
Diesel	6.39	6.69	2.54	6.86	7.07	6.49	0.203
Gasoline	13.32	13.71	14.09	15.03	13.92	13.82	0.432
<i>Pre-tax prices</i>							
Autogas	15.34	19.59	20.40	16.69	15.05	23.34	0.730
Diesel	15.34	17.26	23.95	17.88	11.35	17.53	0.548
Gasoline	16.40	18.57	19.85	17.99	13.45	19.77	0.618

* In Bangkok. **Including oil fund levies and subsidies, and conservation levies. A negative figure indicates a subsidy.

Since January 2015, in order to better reflect the cost of supply, the government has set a uniform LPG wholesale price for all sectors based on a weighted average of market prices (IEA, 2017b). This has resulted in a broadly stable Autogas price, increasing modestly to 2019 and then falling back in 2020 and 2021. The price gaps between Autogas and the two other fuels have also been broadly stable. In October 2021, the Thai government froze domestic LPG prices until February 2022 to offset the impact of rising

global oil and gas prices on consumers.¹ CNG prices were completely deregulated in 2016 and subsidies removed.

The average pump price of Autogas in 2021 was just 28% of that of gasoline and 40% of that of diesel – the lowest rates of any of the countries surveyed in this report (Table B21.1). 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 and the price controls in place have effectively resulted in a subsidy for Autogas every year since 2015. 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 2017, CNG consumption was more than a quarter higher than that of Autogas in energy terms. But demand for CNG, like that for Autogas, has been falling (by 57% between 2014 and 2020) 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 rapidly in the last few years, though ethanol consumption dipped for the first time in 2020 due to the economic slump caused by the Covid-19 pandemic. The low prices of the subsidised ethanol blends (see below) is boosting demand for ethanol as a transport fuel: sales of gasohol have soared and it is now the leading type of road fuel in the country.² 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 small for now due to their high prices.

21.3 Competitiveness of Autogas against other fuels

The pump price of Autogas remains low enough to make the fuel competitive with both gasoline and diesel. The breakeven distance for a typical passenger car converted to run on Autogas against gasoline was around 17 000 km in 2021 – little changed from previous years (Figure B21.2). This analysis assumes a conversion cost of 30,000 baht (roughly \$970). Diesel breaks even with gasoline at a distance of 39,000 km (assuming a premium of 50,000 baht, or around \$1,600, 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.

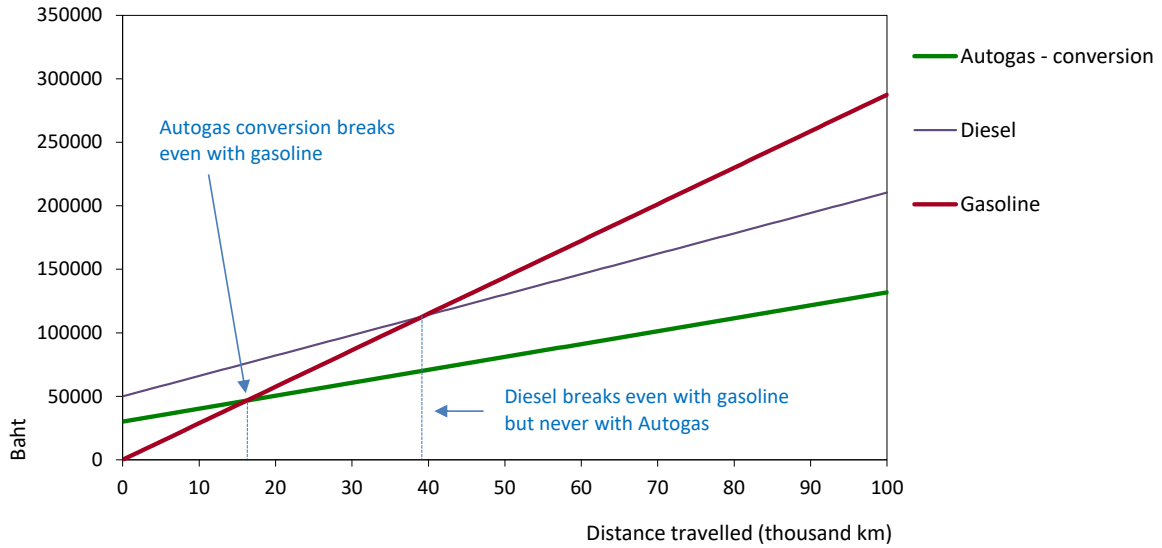
Although Autogas remains competitive with conventional fuels, it has lost ground to ethanol, the prices of which have fallen significantly compared with Autogas. In 2021, the price of E85 (gasohol with 85% ethanol content) in Bangkok averaged 22.06 Baht/litre and that of E 26.90 Baht. Adjusting for differences 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

¹ *LPG World*, 19 October 2021.

² <https://www.bangkokpost.com/business/1869419>.

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) and there is no loss of space in the boot/trunk, ethanol is now often preferred to Autogas where available, which explains the recent slump in Autogas sales.

Figure B21.2: Running costs of a non-commercial LDV, 2021 – Thailand

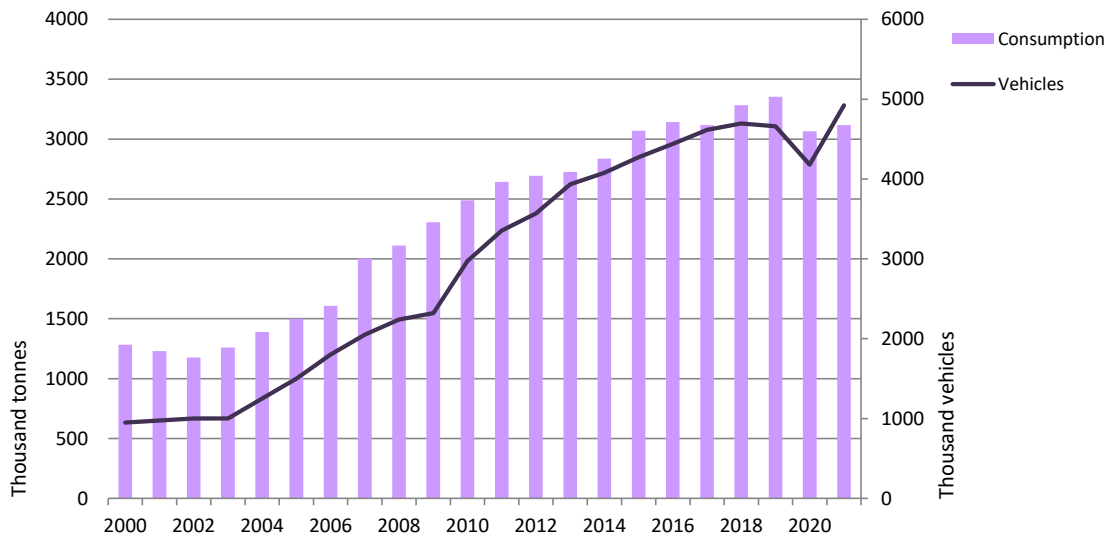


22 Turkey

22.1 Autogas market trends

Turkey today has the second-largest Autogas market in the world after Russia – 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 grew by 46% over the ten years to 2019, reaching a record 3.35 Mt, though demand has since fallen back, partly as a result of the effects of the Covid-19 pandemic, including a full lockdown in April-May 2021, as well as higher prices (Figure B22.1). Sales in 2021 totalled 3.1 Mt. Autogas accounts for 12% of the country’s total demand for automotive fuels and 75% of Turkey’s total LPG consumption, around three-quarters of which is met by imports.

Figure B22.1: Autogas consumption and vehicle fleet – Turkey



Source: WLPGA/Argus (2022).

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 2021, there were an estimated 4.92 million Autogas vehicles in use – close to 40% of the country’s total fleet of passenger vehicles and almost one-quarter of all vehicles. No other country has more Autogas vehicles on the road. 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 starting to reverse with growing concerns about pollution from diesel engines.¹

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 10 950 refuelling sites at end-2021 – more than 80% of all the filling stations in Turkey.

22.2 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 hold 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.

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). The excise tax on Autogas has been held below that applied to the other two fuels, though the differentials have tended to narrow in recent years. In 2020, the tax on Autogas was reduced slightly, while that on gasoline and diesel increased, while the tax was slashed on all three fuels in 2021 to help counter the effect of rising international prices (Table B22.1).

As result of the tax reforms, together with an increase in the wholesale price of LPG relative to that of the other two fuels, the price advantage of Autogas at the pump shrunk alarmingly in 2021. The Autogas price was not much lower than that of gasoline and diesel in per-litre terms. The average price of Autogas was 85% of that of gasoline and 91% of that of diesel – up from 70% and 76% respectively in 2018.

¹ <https://www.dailysabah.com/business/automotive/hybrid-car-sales-edge-out-lpg-cars-in-turkey-in-jan-feb>

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

	Liras						US dollars
	2016	2017	2018	2019	2020	2021	2021
<i>Pump prices</i>							
Autogas	3.202	3.836	4.411	5.015	5.350	6.786	0.765
Diesel	3.867	4.692	5.770	6.394	6.023	7.486	0.843
Gasoline	4.563	5.337	6.292	6.837	6.481	7.951	0.896
<i>Total taxes</i>							
Autogas	1.168	1.424	1.670	1.731	1.684	1.128	0.127
Diesel	2.234	2.510	2.675	2.717	2.921	2.038	0.230
Gasoline	2.923	3.190	3.336	3.377	3.489	2.262	0.255
<i>Excise taxes</i>							
Autogas	0.680	0.839	0.998	0.966	0.868	0.093	0.010
Diesel	1.645	1.795	1.795	1.742	2.002	0.896	0.101
Gasoline	2.227	2.377	2.377	2.334	2.501	1.049	0.118
<i>Pre-tax prices</i>							
Autogas	2.034	2.412	2.740	3.284	3.666	5.658	0.637
Diesel	1.633	2.181	3.096	3.677	3.102	5.448	0.614
Gasoline	1.641	2.145	2.955	3.461	2.992	5.689	0.641

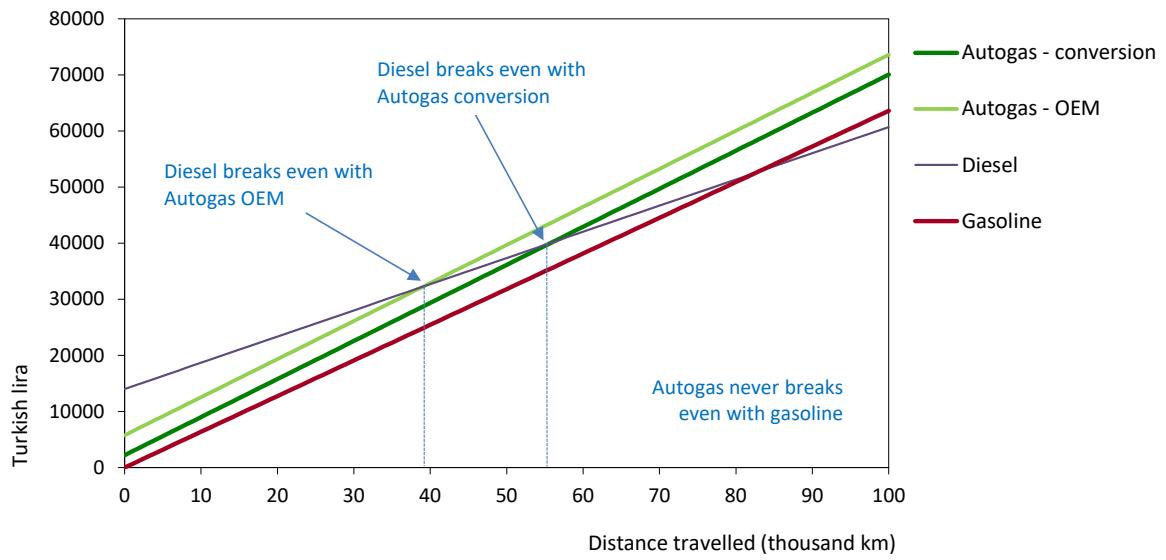
To improve technical performance and ensure safety, the government established stringent conversion standards and laws in 2005. All conversion centres must be licensed by the Turkish Standards Institute and all conversions must be approved by a qualified engineer; the converted vehicle must then be tested for leaks by an independent organisation every two years. As a result, the safety and reliability of conversions has increased. There are now around 1800 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.

22.3 Competitiveness of Autogas against other fuels

The recent changes in fuel taxes and pump prices has led to Autogas becoming uncompetitive with the other two fuels, despite the relatively low cost of conversions in Turkey. Up to 2019, Autogas broke even with gasoline at relatively short distances – about 49,000 km for a good-quality conversion (assumed to cost around 2,200 lira, or \$390¹). But, based on average 2021 fuel prices, Autogas never breaks even with gasoline because the running costs are higher (Figure B22.2). In addition, the running costs of diesel cars are even lower, such that diesel breaks even with Autogas at 39,000 km for an OEM vehicle and 55,000 km for an Autogas conversion (assuming a diesel car costs about 8,000 liras, or \$1,400, more than an Autogas OEM car). This analysis partly explains the recent slowdown in the Autogas market.

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

Figure B22.2: Running costs of a non-commercial LDV, 2021 – Turkey

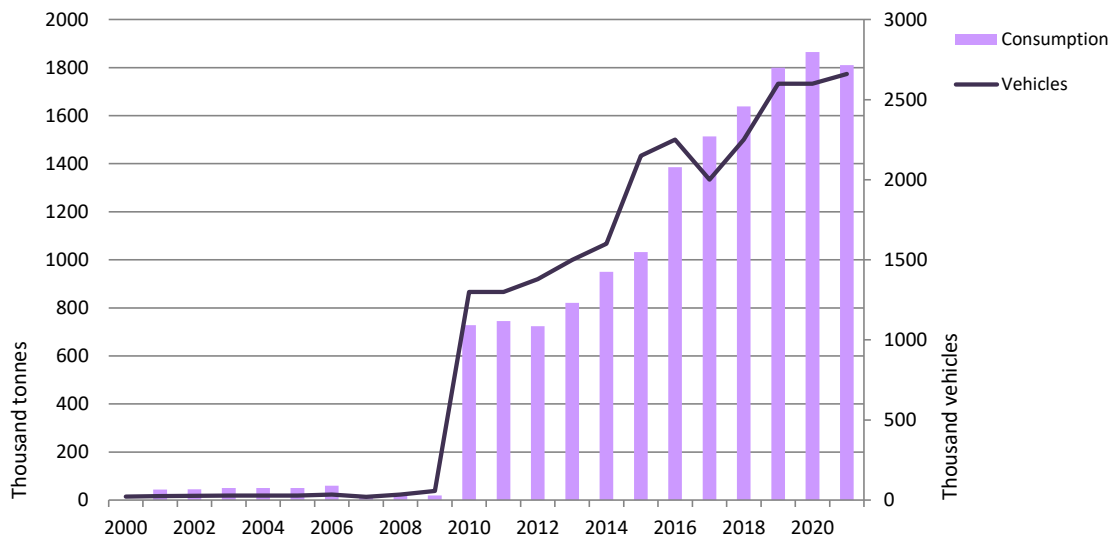


23 Ukraine

23.1 Autogas market trends

Prior to the Covid-19 pandemic and the Russian invasion, Autogas use in Ukraine had been growing spectacularly in response to extremely favourable pump prices, helped by low taxes, and the low cost of converting gasoline cars to run on both fuels. Another factor that reportedly boosted the use of Autogas was the damage to infrastructure caused by the conflict in eastern Ukraine, which has disrupted the distribution of fuels by pipeline; Autogas proved easier to distribute, since it only needs tanker trucks.¹ Consumption reached an all-time peak of 1.86 Mt in 2020 despite restrictions on travel and the economic effects of COVID-19 lockdowns, but fell back slightly in 2021 to around 1.81 Mt – 10% up on 2018 and two-and-a-half times the level at the start of the decade (Figure B23.1). Demand has undoubtedly fallen much further since, as a result of the war. Autogas accounted for close to 28% of all road-fuel sales in 2021 and 92% of total LPG use in Ukraine in 2021. Until the invasion, Russia had been the main supplier of LPG to the Ukrainian market.

Figure B23.1: Autogas consumption and vehicle fleet – Ukraine



Note: The jump in consumption and vehicle numbers in 2010 is due to a break in the series.
 Source: WLPGA/Argus (2022).

The Autogas fleet has continued to expand rapidly, driving higher consumption. By end-2021, there were an estimated 2.66 million Autogas-enabled cars in Ukraine – close to a quarter of all vehicles on the road. Most of them are converted gasoline-powered cars, including some old locally made vehicles from the 1990s, 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

¹ <https://auto-gas.net/mediaroom/ukrainian-drivers-switch-to-alternative-fuels/>

at a few dedicated Autogas stations. In total, there were around 5,500 stations selling Autogas throughout the country at end-2021 – up from 3,000 just seven years earlier.

23.2 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 2019, the tax averaged 0.69 hryvnia per litre, compared with 3.04 for diesel and 4.05 for gasoline (Table B23.1). Because of ongoing difficulties in obtaining information about the Ukrainian fuel market due to the war, it is not known how excise taxes changed in 2020 and 2021, though it has been reported that they were abolished for all automotive fuels and the rate of VAT cut from 20% to 7% in March 2022.¹ The price advantage of Autogas at the pump in absolute terms had been growing in recent years, though it declined somewhat in 2021. The price of Autogas averaged slightly over 16 hryvnia/litre in 2021 – 43% lower than that of gasoline and 41% below that of diesel.

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

	Hryvnia						US dollars
	2016	2017	2018	2019	2020	2021	2021
<i>Pump prices</i>							
Autogas	8.81	10.32	13.25	12.22	11.73	16.12	0.593
Diesel	18.77	21.24	26.43	26.62	25.32	27.18	1.000
Gasoline	20.39	22.18	28.60	26.26	24.67	28.13	1.035
<i>Total taxes</i>							
Autogas	2.21	2.43	2.93	2.73	n.a.	n.a.	n.a.
Diesel	5.55	6.57	7.60	7.48	n.a.	n.a.	n.a.
Gasoline	7.21	7.75	9.02	8.43	n.a.	n.a.	n.a.
<i>Excise taxes</i>							
Autogas	0.74	0.71	0.73	0.69	n.a.	n.a.	n.a.
Diesel	2.42	3.03	3.19	3.04	n.a.	n.a.	n.a.
Gasoline	3.82	4.06	4.25	4.05	n.a.	n.a.	n.a.
<i>Pre-tax prices</i>							
Autogas	6.60	7.89	10.31	9.49	n.a.	n.a.	n.a.
Diesel	13.22	14.67	18.83	19.14	n.a.	n.a.	n.a.
Gasoline	13.17	14.43	19.58	17.83	n.a.	n.a.	n.a.

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

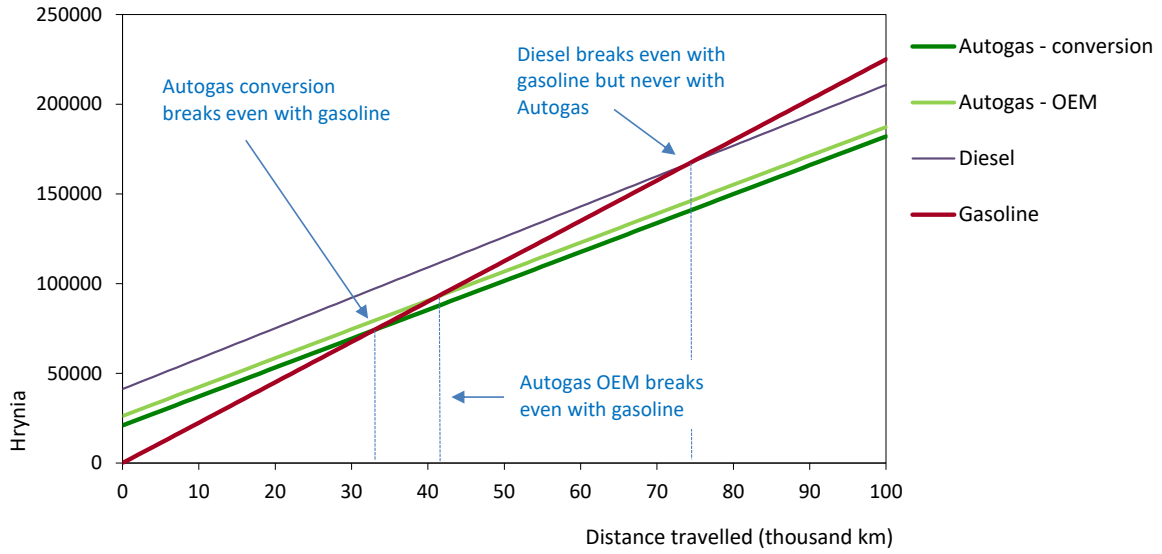
23.3 Competitiveness of Autogas against other fuels

Unsurprisingly, the low price of Autogas vis-à-vis gasoline results in a low break-even distance – just 33,000 km for a converted vehicle or about two years of driving for a private motorist, assuming a typical conversion cost of 18,000 hryvnia (about \$700) (Figure B23.2). This distance has nonetheless increased significantly since 2019, when it was just 24,000 km. An OEM vehicle breaks even at 42,000 km (up from 30,000 km in 2019) assuming a price premium of 22,500 hryvnia (\$870). Autogas is always more competitive

¹ <https://ubn.news/ukraine-will-cancel-excise-duties-on-fuel-and-reduce-vat/>

with diesel regardless of distance as per-km fuel costs are lower and the price premium for a diesel vehicle is generally higher. This analysis demonstrates very clearly why Autogas demand had been rising so strongly in Ukraine.

Figure B23.2: Running costs of a non-commercial LDV, 2021 – Ukraine

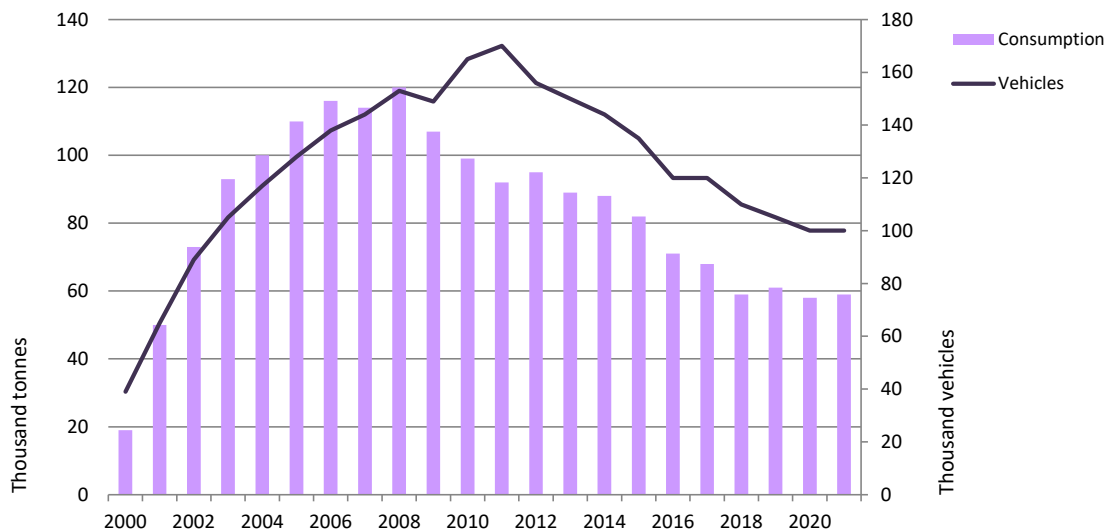


24 United Kingdom

24.1 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. Autogas consumption peaked at 120,000 tonnes in 2008 (Figure B24.1). 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 less than 60,000 tonnes in 2018 – less than half the peak of 13 years earlier. Demand has since levelled off, totalling 59,000 tonnes in 2021, recovering slightly from the previous year, mainly due to the rebound in economic activity after successive Covid-19 lockdowns.¹ Autogas meets just 0.2% of the country’s road-fuel needs. The consumption of other unblended alternative fuels is minimal, though sales of EVs are rising, in part thanks to fiscal incentives.

Figure B24.1: Autogas consumption and vehicle fleet – United Kingdom



Source: WLPGA/Argus (2022).

There are a total of 100,000 vehicles in the United Kingdom that are able to run on Autogas, down 5,000 from the previous year and a peak of 170,000 in 2011. Sales of OEM Autogas vehicles had dried up completely as none of the major carmakers that market Autogas models imported them any longer, though Dacia started to market Autogas versions of its Duster, Sandero and

¹ Consumption in the first half of 2021 was also depressed by fuel shortages, notably in London, caused by domestic refinery maintenance work that cut propane production (LPG World, 15 June 2021).

Logan models in mid-2020.¹ There are several companies that install conversion kits and around 200 UKLPG approved installers.² 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 the adverse impact of diesel vehicles on urban air quality. There were ,000 refuelling stations selling Autogas across the country at end-2021 – 100 fewer than two years earlier. Shell removed the last Autogas pumps from its network of refuelling stations in October 2020.³

24.2 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, would 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 B24.1). In addition, the wholesale price of LPG has remained well below though that of the other two fuels on a per-litre basis. As a consequence, the pump price of Autogas in 2021 was just 51% of the price of gasoline and 50% that of diesel.

Table B24.1: Automotive-fuel prices and taxes per litre – United Kingdom

	Pounds						US dollars
	2016	2017	2018	2019	2020	2021	2021
<i>Pump prices</i>							
Autogas	0.670	0.683	0.710	0.639	0.621	0.670	0.921
Diesel	1.101	1.201	1.300	1.315	1.191	1.349	1.855
Gasoline	1.088	1.176	1.252	1.249	1.139	1.313	1.806
<i>Total taxes</i>							
Autogas	0.273	0.275	0.280	0.268	0.265	0.273	0.375
Diesel	0.763	0.780	0.796	0.799	0.778	0.804	1.106
Gasoline	0.761	0.775	0.788	0.788	0.769	0.798	1.097
<i>Excise taxes</i>							
Autogas	0.161	0.161	0.161	0.161	0.161	0.161	0.222
Diesel	0.580	0.580	0.580	0.580	0.580	0.580	0.798
Gasoline	0.580	0.580	0.580	0.580	0.580	0.580	0.798
<i>Pre-tax prices</i>							
Autogas	0.397	0.408	0.430	0.371	0.356	0.397	0.546
Diesel	0.338	0.422	0.504	0.516	0.413	0.545	0.750
Gasoline	0.328	0.400	0.464	0.461	0.370	0.514	0.707

¹ <https://auto-gas.net/mediaroom/lpg-versions-of-the-dacia-duster-sandero-and-logan-officially-available-in-the-uk/>.

² <https://www.uklpg.org/about/lpg-as-a-transport-fuel>. UKLPG is the UK trade association for the LPG industry.

³ *LPG World*, 1 December 2020.

The commitment to maintaining tax advantage of Autogas and other alternative fuels was extended in 2018. In the Autumn Budget, delivered on 30 October 2018, the government announced that it would maintain the difference between alternative and main road fuel duty rates until 2032 to support the decarbonisation of the UK transport sector, subject to review in 2024. As a result, the duty paid on alternative fuels will remain 50% lower than diesel for the next 14 years. In the 2022 Spring Statement 2022, the government cut the excise duty on gasoline and diesel by 5 pence/litre and that on Autogas by 2.7 pence/litre for 12 months to compensate for high international prices and curb rising inflation.

The only other fiscal incentive for Autogas is a small discount of £10 (\$13) or £25 (\$33) 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. 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 (ULEZ) – an area of central London within which all vehicles will need to meet exhaust emission standards by 2020 or pay a daily charge to travel. At present, Euro-5, Euro-4 and Euro-3 taxi operators have to retire their vehicles at 12 years. From 2018, all newly licensed taxis and private hire vehicles have had to meet the new emission standards.¹ In addition, in December 2018, the Mayor of London doubled to £5 million (\$6.7 million) the existing £2.5 million (\$3.3 million) grant funding for repowering London TX4 Euro-5 taxis to Autogas and announced plans to invest an extra £24 million (\$32 million) to help more black-cab taxi drivers switch to alternative fuel vehicles.

Under the UK government's 2019 Clean Air Strategy, which sets out its general approach to reducing pollution and CO₂ emissions from road transport, a number of cities have been required to introduce a Clean Air Zone (CAZ) – an area where targeted action by the local authorities is taken to improve air quality, including charging for entry and penalties for non-compliance.² Local authorities are responsible for the implementation of CAZs. Whether a vehicle is charged when entering or moving through a CAZ depends on the type of vehicle and the Euro standard of the vehicle. The amount charged is up to the local authority. All Autogas vehicles that comply with Euro-6 standards will be exempt from any traffic restrictions or charges. To date, CAZs have been introduced in Bath, Birmingham, Bradford, Bristol, Derby (non-charging), Greater London, Greater Manchester, Newcastle, Nottingham (non-charging), Portsmouth and Southampton.

The UK government published in July 2017 an Air Quality Plan, which is predominantly aimed at reducing NO_x emissions in urban areas. Under the

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

² https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/863730/clean-air-zone-framework-feb2020.pdf.

plan, a new Clean Air Fund was set up to provide funding for local authority initiatives, such as retrofitting buses to run on alternative fuels, including Autogas. A total of £220 million (\$290 million) of funding was allocated by the government for the period 2018-2021.¹ In 2018, the UK government issued a paper called *The Road to Zero*², which identifies Autogas as a credible alternative to diesel in urban driving conditions and proposes measures to unlock investment in this technology. The UK Low Carbon Vehicle Partnership also launched the Clean Vehicle Retrofit Accreditation Scheme, which includes Autogas.³

The Government's transport policy involves the progressive phasing out of has conventional internal combustion engine vehicles and their replacement with EVs and other low-carbon vehicles. In November 2020, the government announced that, from 2030, the sale of new petrol and diesel cars will be banned in the UK, though the sale of some hybrid cars will be allowed to continue until 2035. At present, subsidies of up to £1,500 are available for battery EVs costing up to £32,000. EVs are also exempt from road tax and congestion charges.

24.3 Competitiveness of Autogas against other fuels

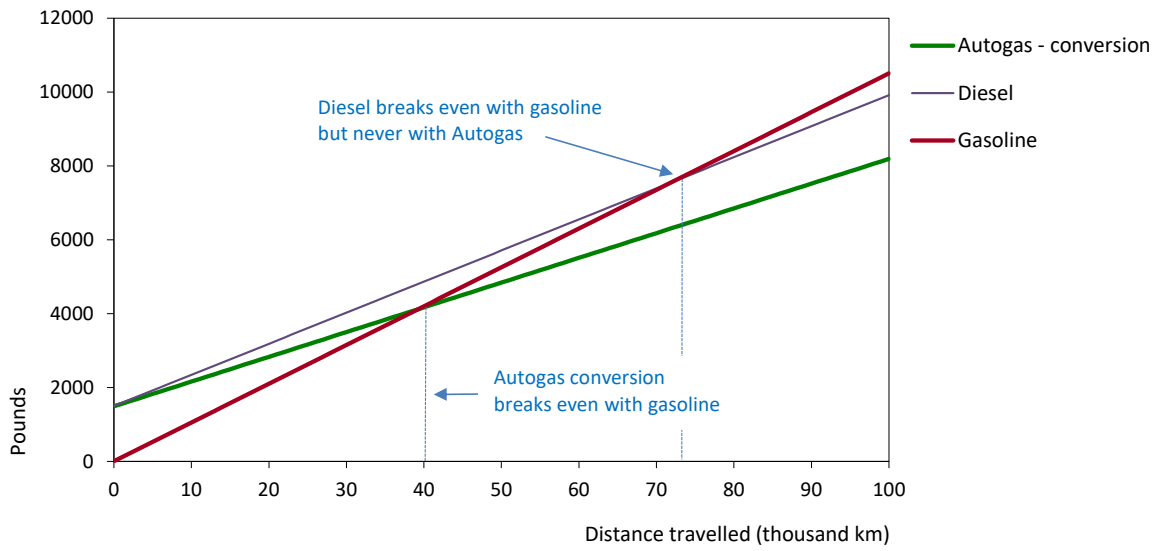
A converted Autogas LDV breaks even with an equivalent gasoline-powered vehicle at around 40,000 km – or around three years of driving for a typical private motorist – based on an average conversion costs of about £1,500 (\$1,900) and average 2021 fuel prices (Figure B24.2). Diesel breaks even with gasoline at around 73,000 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.

¹ <https://www.drivelpg.co.uk/news/uk-clean-air-fund-supports-retrofitting-of-vans-and-taxis-to-autogas/>.

² https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/739460/road-to-zero.pdf.

³ <https://www.lowcvp.org.uk/projects/joint-working-projects/clean-vehicle-retrofit-accreditation-scheme.htm>.

Figure B24.2: Running costs of a non-commercial LDV, 2021 – United Kingdom

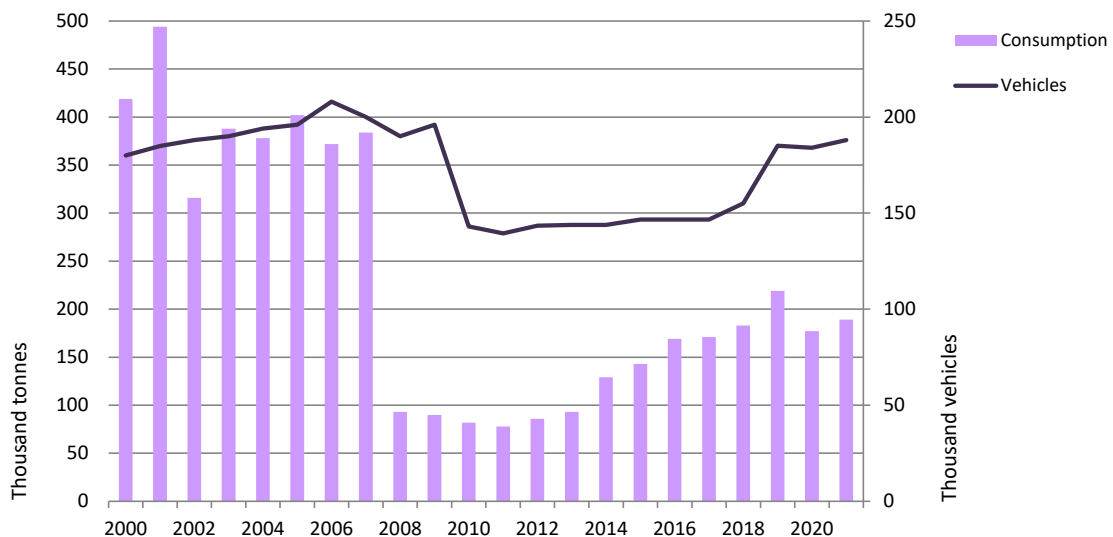


25 United States

25.1 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 189,000 tonnes in 2021, accounting for a mere 0.04% of total road-fuel sales – the lowest share of any of the countries surveyed in this report (Figure B25.1). Autogas demand had been rising strongly in the last few years, more than doubling between 2013 and 2019, but fell back sharply in 2020 with the COVID-19 crisis, recovering some of those losses in 2021. High pump prices of Autogas relative to conventional fuels for non-commercial end users is the main reason for the very 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 B25.1: Autogas consumption and vehicle fleet – United States



Note: The sharp declines in fuel consumption and vehicle numbers in 2008 and 2010 respectively are due to breaks in the series (the data before then are believed to have included off-road forklift trucks).

Sources: WLPGA/Argus (2022); IEA databases.

There are currently an estimated 188,000 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 one-fifth in 2019 alone, but has barely grown since then. Two OEM Autogas vehicles were available in 2021, both marketed by Ford (the Super Duty F-250 and Transit Connect Van), but none

in 2022.¹ Several new vehicle platforms are under development, including medium- and heavy-duty trucks and school buses. Manufacturers include Alliance AutoGas, Blue Bird Corp, CleanFuel USA, Collins Bus, Icom North America, Impco Technologies, Roush CleanTech and Freightliner. Market penetration is highest in the school-bus segment, with more than 22 400 buses nationwide – around 5% of all such buses and ten times more than a decade ago.² 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 (EPA) has led to a reduction in the number of conversion kits available on the market and an increase in the prices of OEM vehicles.³ Installing a conversion kit typically costs at least \$4 000 (in 2021 prices). At the end of 2021, there were around 3,100 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 natural gas (CNG/LNG). The overall CNG/LNG fleet has grown to 175,000⁴ and is projected to grow further if gas prices fall back from recent highs. Sales of EVs are also rising quickly as the performance of new models improves, production expands, and prices drop, more than doubling to around 700 000 in 2021 (IEA, 2022).

25.2 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.

25.2.1 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.

¹ A list of all AFVs on sale in the United States can be found at: <https://afdc.energy.gov/vehicles/search/download.pdf?year=2022>

² <https://www.rhoadsenergy.com/blog/propane-school-buses-the-verdict-is-in/>; <https://www.fuelsfix.com/2022/01/propane-school-buses-enjoy-huge-adoption-increase-in-past-five-years/>

³ 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>.

⁴ <https://www.ngvamerica.org/vehicles/>

States also levy taxes at varying rates on transport fuels. Pre-tax Autogas prices fell less than those of gasoline and diesel in 2020 as the effects of the Covid-19 pandemic curbed transport fuel demand, but rebounded less sharply in 2021 as natural gas production, which had dipped in 2020, resumed its upward trajectory, boosting natural gas liquids supply. As a result, the competitiveness of Autogas has improved significantly since 2020. The average price of Autogas at the pump in 2021 (including state taxes) for non-commercial users was 13% lower than that of gasoline and 9% lower than that of diesel in per-litre terms (Table B25.1). But in energy-content terms, Autogas prices are still higher than both the other fuels.

Table B25.1: Automotive-fuel prices and taxes per litre – United States

	Dollars						Euros
	2016	2017	2018	2019	2020	2021	2021
<i>Pump prices</i>							
Autogas*	0.726	0.738	0.740	0.753	0.726	0.788	0.666
Diesel	0.610	0.701	0.841	0.808	0.675	0.869	0.735
Gasoline	0.633	0.709	0.808	0.791	0.683	0.905	0.765
<i>Total taxes**</i>							
Autogas	0.151	0.139	0.123	0.130	0.149	0.120	0.102
Diesel	0.150	0.152	0.156	0.160	0.162	0.163	0.138
Gasoline	0.143	0.146	0.148	0.150	0.152	0.153	0.129
<i>Excise taxes***</i>							
Autogas	0.036	0.036	0.036	0.036	0.036	0.036	0.030
Diesel	0.064	0.064	0.064	0.064	0.064	0.064	0.054
Gasoline	0.049	0.049	0.049	0.049	0.049	0.049	0.041
<i>Pre-tax prices</i>							
Autogas	0.574	0.599	0.617	0.623	0.577	0.668	0.565
Diesel	0.460	0.549	0.685	0.648	0.513	0.706	0.597
Gasoline	0.490	0.563	0.660	0.641	0.531	0.752	0.636

* 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

¹ These reports can be downloaded from http://www.afdc.energy.gov/afdc/price_report.html

(ICF, 2012).¹ In addition, commercial and public fleets reportedly pay much lower prices as they are able to negotiate sizeable discounts.

In addition, effective Autogas prices are lower for most users thanks to the Alternative Fuel Tax Credit. The credit, which had been in place for many years, expired on 31 December 2021, but will be extended to 2024 and made retroactive to the start of 2022 under a deal reached in the Senate in July 2022.² 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) from 2016. It is 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.

25.2.2 Federal clean-fuel incentive and programmes

There are several federal programmes, regulations and incentives in place to encourage alternative fuels, including Autogas.³ The main form of federal support for Autogas other than the Alternative Fuel Tax Credit is 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 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.⁴ 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

¹ Some private price reporting services also report lower prices (see, for example: <https://www.mylpg.eu/stations/united-states-of-america/prices/> and <https://allianceautogas.com/autogas-benefits/autogas-savings-and-stability/>).

² <https://news.bloomberglaw.com/environment-and-energy/biodiesel-alternative-fuel-tax-breaks-get-extension-in-deal>

³ A full list of current programmes and incentives can be found at <https://www.afdc.energy.gov/fuels/laws/LPG/US>.

⁴ For more information, go to <https://cleancities.energy.gov/>.

programme.¹ The Environmental Protection Agency plans a clean school bus rebate programme under the Bipartisan Infrastructure Law, providing about \$10 million to fund the replacement of old diesel school buses with new Autogas, CNG or electric buses that meet current emission standards.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.

The 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. Like the Alternative Fuel Tax Credit, it expired at the end of 2021, but is set to be extended and applied retroactively to the beginning of 2002, as in previous years. In addition, the 2021 Infrastructure Investment and Jobs Act provides over \$9 billion in funding for clean refuelling infrastructure and vehicles, including Autogas.³ Some \$2.5 billion in grants are available for refuelling infrastructure, \$2.5 billion for the Clean School Bus programme, \$1.6 billion in grants for buses and bus facilities and \$2.5 billion in grants for emissions reductions at port facilities. The Invest in America Act, adopted in June 2020, also includes provisions to expand federal support for infrastructure relating to the supply of Autogas and natural gas as alternative fuels. Both fuels are now eligible to receive federal grants under the Alternative Fuel Corridors Grant Programme.⁴ Federal grants are no longer available for Autogas vehicle purchases or conversions.

25.2.3 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.⁵ Alternatively, a taxpayer may take a tax credit of 7.2% of the cost of the vehicle, up to \$1,500. The Ohio Environmental Protection Agency launched a new \$5 million programme in 2018 to provide grants to owners of diesel or gasoline-powered trucks and buses to convert to alternative fuels, including Autogas.

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

¹ For more information, go to <https://www.epa.gov/cleandiesel/clean-school-bus>

² <https://auto-gas.net/mediaroom/u-s-epa-allocates-17-million-to-help-replace-diesel-powered-school-buses/>

³ <https://auto-gas.net/mediaroom/united-states-new-law-helps-develop-infrastructure-for-low-emission-fuels/>

⁴ <https://auto-gas.net/mediaroom/u-s-bipartisan-support-for-amendment-that-helps-expand-autogas-infrastructure/>.

⁵ <https://www.afdc.energy.gov/laws/6603>.

switching to Autogas, limited to \$30,000 per fleet.¹ Also, the Texas Light Duty Motor Vehicle Purchase or Lease Incentive Programme provides rebates to purchasers or leasers of alternative fuel vehicles, including those using Autogas.² In September 2020, nearly 1,000 grants were still available for Autogas or CNG vehicles. In Pennsylvania, the state awarded more than \$2.1 million in Alternative Fuel Incentive Grants to 18 cleaner fuel vehicle projects in 2019, including five involving Autogas.³ The programme supports the replacement of older gasoline- or diesel-fuelled vehicles with cleaner fuel vehicles and fuelling stations to reduce pollution and greenhouse gas emissions. In September 2021, Virginia announced more than \$10 million in funding to public school districts to replace diesel school buses with vehicles powered by cleaner fuels, including Autogas, under the federal Clean School Bus Programme.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.

25.3 Competitiveness of Autogas against other fuels

At officially reported prices for non-commercial end users, Autogas struggles to compete with either gasoline or diesel regardless of distance travelled, even allowing for the federal Alternative Fuel Tax Credit and any vehicle-related grants. This is 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 B25.2). 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 200 000 km (which explains why diesel is not a very popular alternative to gasoline in the United States).

Autogas appears to be much more competitive for commercial and public fleets, such as school buses. For example, based on average industry-

¹ <https://www.afdc.energy.gov/laws/11500>. In January 2017, the programme was expanded to public vehicles to include school district, municipal, county, and state fleets (<http://auto-gas.net/mediaroom/texas-offers-incentives-support-adoption-lpg-vehicle-fleets/>).

² <https://www.tceq.texas.gov/airquality/terp/ld.html>.

³ <https://auto-gas.net/mediaroom/pennsylvania-awards-over-2-million-to-encourage-adoption-of-clean-fuel-vehicles/>.

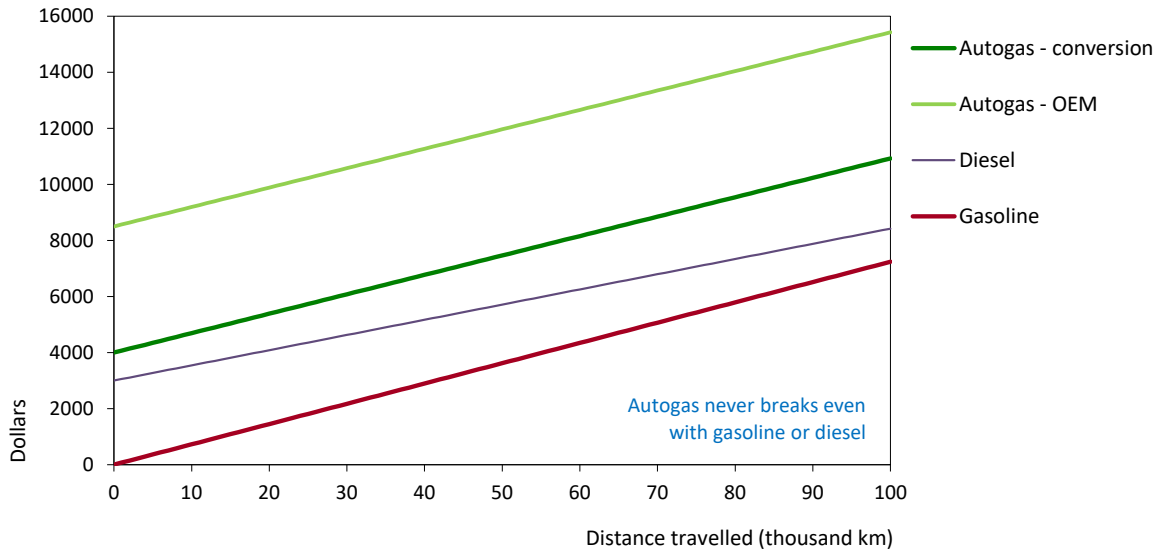
⁴ <https://auto-gas.net/mediaroom/united-states-virginia-allocates-10-million-to-help-replace-diesel-school-buses-with-greener-vehicles/>

⁵ <https://www.afdc.energy.gov/laws/4246>.

⁶ <https://www.afdc.energy.gov/laws/6307>.

reported prices for 2021 that include sizeable bulk discounts,¹ Autogas would break even with gasoline at around 90 000 km in the case of an aftermarket LDV conversion costing \$4,000 and a vehicle subsidy of \$2,000, making it an attractive option for high-mileage vehicles.

Figure B25.2: Running costs of a non-commercial LDV, 2021 – United States



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

This analysis demonstrates very clearly why Autogas has failed to make major 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 United States for non-commercial end users on an energy-equivalent basis (Table B25.2). In the longer term, EVs are set to emerge as the primary alternative automotive technology for LDVs.

¹ <https://allianceautogas.com/autogas-benefits/autogas-savings-and-stability/>

Figure B25.2: Pump prices of road-transport fuels per gasoline gallon equivalent (GGE) for non-commercial users – United States

	2105	2106	2017	2018	2019	2020	2021
Autogas*	4.00	3.79	3.86	3.87	3.91	3.76	4.08
Gasoline	2.47	2.13	2.36	2.41	2.62	2.23	2.87
Ethanol (E85)	2.95	2.48	2.68	2.68	2.91	2.59	3.18
CNG	2.10	2.06	2.15	2.16	2.21	2.18	2.23
Diesel	2.56	2.07	2.31	2.39	2.71	2.34	2.78
Biodiesel (B20)	2.64	2.17	2.30	2.36	2.57	2.23	2.60
Biodiesel (B99/B100)	3.62	3.00	3.12	3.23	3.54	3.36	3.47

* The price of Autogas does not take account of the Alternative Fuel Tax Credit of 9.5 cents/litre.
 Source: US Department of Energy, *Clean Cities 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	
	2020	2021	2020	2021	2020	2021
Australia	216	157	330	270	2,500	2,400
Bulgaria	390	380	480	480	2,700	2,700
Canada	210	216	54	54	2,250	2,230
China	1,197	1,163	202	192	620	580
Czech Republic	91	89	165	161	880	870
France	38	49	183	220	1,547	1,559
Germany	234	244	347	331	6,229	6,028
Greece	205	199	300	290	1,300	1,350
India	390	396	2,600	2,704	1,450	1,510
Italy	1,309	1,407	2,679	2,847	4,300	4,450
Japan	573	552	150	137	1,322	1,212
Korea	2,655	2,563	1,996	1,961	1,954	1,992
Lithuania	88	84	100	95	350	300
Mexico	1,187	1,390	407	407	2,080	2,080
Netherlands	107	107	133	129	1,223	1,124
Poland	1,735	1,815	3,327	3,394	7,409	7,450
Portugal	28	30	58	59	396	405
Russia	3,220	3,250	3,000	3,000	4,900	4,900
Serbia	67	86	110	112	500	550
Spain	66	83	98	99	1,100	1,100
Thailand	752	668	745	708	1,651	1,570
Turkey	3,065	3,117	4,180	4,923	10,800	10,950
Ukraine	1,865	1,810	2,600	2,660	5,500	5,500
United Kingdom	58	59	100	100	1,000	1,000
United States	177	189	184	188	3,000	3,100
<i>Rest of the world</i>	4,453	5,033	2,747	2,829	14,353	14,638
Total world	24,376	25,136	27,273	28,349	81,314	81,548

Source: WLPGA/Argus Media (2022).

Annex 2: References

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Annex 3: Note on data sources

Data on automotive-fuel prices and taxes were compiled from a range of sources. For many countries, the online database of 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.

Data on Autogas consumption, vehicles and refuelling sites are from the WLPGA/Argus annual publication, *Statistical Review of Global LPG*, except where otherwise stated. The latest edition of that report was published in October 2022. Data on total road-vehicle fleets were compiled from national sources. Data on total automotive fuel consumption are from the IEA online database.

