



The role of natural gas and biomethane in the fuel mix of the future in Germany.

Required action and potential solutions to accelerate
adoption in transport applications.

Abridged version.

Summary and recommended action.

— The energy and climate situation demands greater diversification of fuels and powertrain systems.

Energy prices rising into the foreseeable future, the scarcity of petroleum, which has previously been the dominant energy source in the transport sector, and ambitious climate protection targets demand the introduction of alternative fuels and powertrain systems. Against this background, the use of natural gas and biomethane as fuel is being stepped up worldwide and within the EU. The German federal government's 2004 fuel strategy accordingly assumes potential use of natural gas as a motor fuel of at least 0.5 to 1% in 2010 and 2 to 4% in 2020. That corresponds to around 1.4 million vehicles in 2020.

— The targets for the market share of natural gas and biomethane as motor fuel have not yet been achieved.

Despite mature technology, the potential of natural gas and biomethane as a motor fuel is still far from being fully exploited: at the end of 2009, usage of natural gas as motor fuel only accounted for 0.3% of total fuel consumption; only 85,000 of Germany's total of some 50 million vehicles are currently fuelled with natural gas. 2010 targets have only been one third achieved. Achieving 29% annual growth in natural gas vehicle numbers is the only way 2020 targets can be achieved. This will in particular require a growing proportion of natural gas fuelled commercial vehicles. In the EU, countries such as Sweden or Italy are demonstrating that such rapid market development is possible.

— The properties of natural gas support its being more rapidly adopted in the transport sector.

Of the fossil fuels, natural gas has the lowest emissions of the climate gas CO₂, these being around 24% lower than emissions from petrol. But it also does distinctly better than petrol or diesel in terms of pollutants such as soot and nitrogen oxides. Natural gas as a motor fuel contributes to the diversification of resources in the transport sector and expands the portfolio of products from energy supplying countries.

— Admixing biomethane can boost advantages in terms of the climate, environment and resource management.

Further improvements in terms of climate impact, environmental characteristics and availability of raw materials can be achieved by feeding biomethane produced in Germany into the existing natural gas grid and making use of it in transport applications. Admixing 20% biomethane can reduce CO₂ emissions by 39% in comparison with petrol, while if pure biomethane is used, reductions of up to 97% can be achieved depending on the method of assessment used. The resources needed for producing biomethane are still far from being depleted. Even if the stated 4% target were achieved, all natural gas vehicles in 2020 could in theory be fuelled with pure biomethane. According to German biofuel sustainability regulations, certification of the quantities used is required both for entering biomethane against the biofuel quotas and for tax relief purposes.

— To ensure market penetration, all stakeholders must commit to a specific roadmap.

One reason for what has, on a worldwide comparison too, so far been relatively sluggish adoption of natural gas as a fuel is the lack of a common definition of measures among stakeholders and compulsory implementation. It is true that some stakeholders have launched individual initiatives. Ultimately, however, policy makers and government, the petroleum industry with its filling station networks, the gas industry (including biomethane producers), vehicle manufacturers and dealers and research institutes, each with their own particular interests, have not been taking a harmonised approach to users. As a result, major customer requirements have in many cases not been met in a targeted manner.

The study outlines which actions must be implemented by the relevant stakeholders in order to be able to gain the greatest potential benefits from the use of natural gas and biomethane in the transport sector. Once all the groups of stakeholders have reached a binding agreement on these actions and implement a parallel monitoring process, natural gas and biomethane, together with other powertrain technologies, will be able to play their part in accelerating the diversification of the fuel mix and protecting our climate.

Government/policy makers should



- give a clear signal about natural gas and biomethane as ongoing motor fuel options and establish an appropriate framework beyond the 2018 horizon,
- update Germany's motor fuel strategy in this respect, taking account of the option of admixing biomethane,
- continue energy tax relief on natural gas and biomethane as a motor fuel and, on a CO₂ basis, differentiate it from LPG (liquified petroleum gas),
- state prices of the different fuels at filling stations on a uniform reference basis, so establishing consumer-friendly energy price transparency,
- step up the pace of expansion of the natural gas filling station network, including on federal motorways,
- introduce a technology-neutral category of "high efficiency vehicle", for example by an energy labelling scheme, for differentiated, regulatorily preferential treatment of energy-efficient vehicles,
- provide tax incentives for energy-efficient company cars.

Filling stations or the gas industry should



- establish natural gas as a brand, for example by uniform labelling across all filling stations, and make it more accessible by uniform fuel card systems,
- extend the filling station network in a coordinated manner on a demand-led basis,
- introduce more biomethane for use in the transport sector and carry out joint marketing,
- develop a certification system for the use of biomethane in the motor fuel market in line with German biofuel sustainability regulations.

Vehicle manufacturers and dealers should



- provide natural gas vehicles to cover all major brands, segments and applications,
- intensify marketing and sales efforts for natural gas vehicles.

Research institutes should



- carry out research to improve the cost structure of vehicle components of relevance to natural gas,
- highlight the climate advantages of biomethane as a motor fuel and verify them in demonstration projects.

All stakeholders should



- reduce the purchase costs of natural gas vehicles to below those for diesel vehicles by appropriate pricing policies or incentives,
- increase efforts to spread the word about natural gas as an alternative motor fuel or powertrain system,
- introduce natural gas vehicles into their own fleets, also or indeed especially in commercial vehicles and buses.

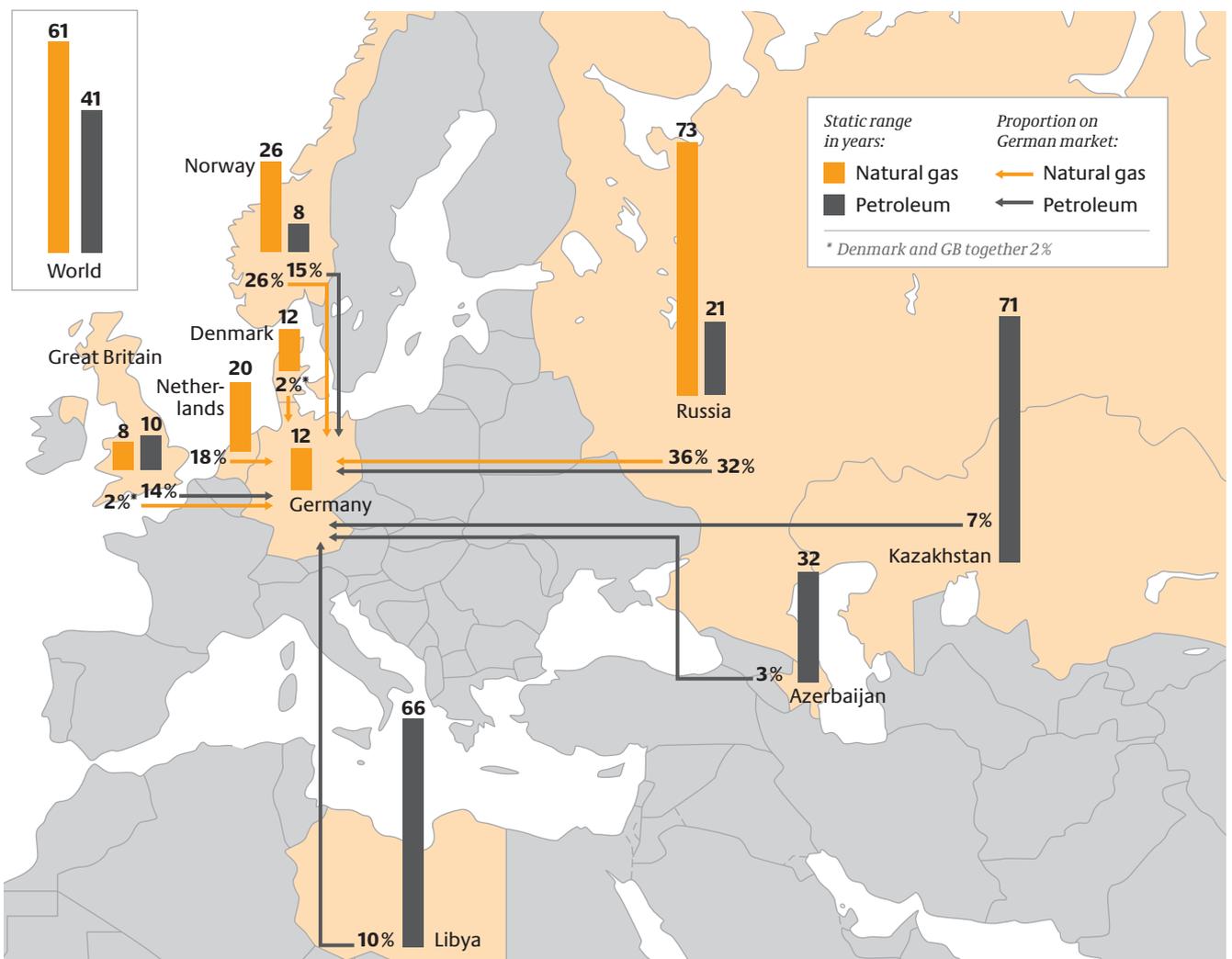
Key benefits of natural gas and biomethane as fuel.

Availability and static range.

Total worldwide natural gas potential is estimated at 509,000 billion m³ or 5.09 million TWh (as at 2007). These values are made up of cumulative natural gas extraction of around 86,800 billion m³ or 868,000 million TWh, reserves (currently technically extractable) of 182,800 billion m³ (1.83 million TWh) and resources (proven, but not economically viably extractable or geologically detected) of 239,400 billion m³ (2.4 million TWh). The German Federal Institute for Geosciences and Natural Resources (BGR) calculates that, to date, 32% of detected reserves and 17% of the total worldwide potential of conventional natural gas have been consumed (Federal Institute for Geoscience and Natural Resources. Energy Feedstock. 2009).

Natural gas currently accounts for 24% of worldwide primary energy consumption and is thus in third place after petroleum and coal. The world's largest natural gas consumers are the USA, Japan, Ukraine and Italy, followed by Germany in 5th place. Nat-

ural gas consumption in Germany is 96.3 billion m³ or 960 TWh per year, so amounting to 3.2 percent of worldwide gas consumption (ibid). Static ranges of conventional natural gas reserves can be estimated on the basis of annual extraction volumes. This static approach assumes a constant extraction rate or correspondingly constant consumption per year over the period in question. In 2007, worldwide extraction totalled 3,013.6 billion m³ or 30,136 TWh (ibid). Worldwide static ranges are accordingly 61 years. If attention is focussed on the static ranges for exporting countries of relevance to Germany, the ranges relating to reserves are between 8 and 73 years, depending on the country. A comparison with petroleum as an energy source, on which the German transport sector has so far been more than 90% dependent, clarifies the additional potential range of natural gas. Worldwide total potential available petroleum is estimated at 248,838 million tonnes (157,312 million tonnes of reserves and 91,526 million tonnes of resources). On the basis of



Static ranges of the natural gas and petroleum sources of greatest importance to Germany (ibid)



current extraction rates, this gives rise to global static ranges of round 40 years. Higher petroleum prices mean unconventional oils become more attractive and are extracted in greater volumes. These include heavy and ultra-heavy crude, oil sands and oil shale. These sources correspondingly increase the range. If attention is focussed on the ranges of exporting countries which have hitherto been of relevance to Germany, the ranges are between 8 and 71 years, depending on the country.

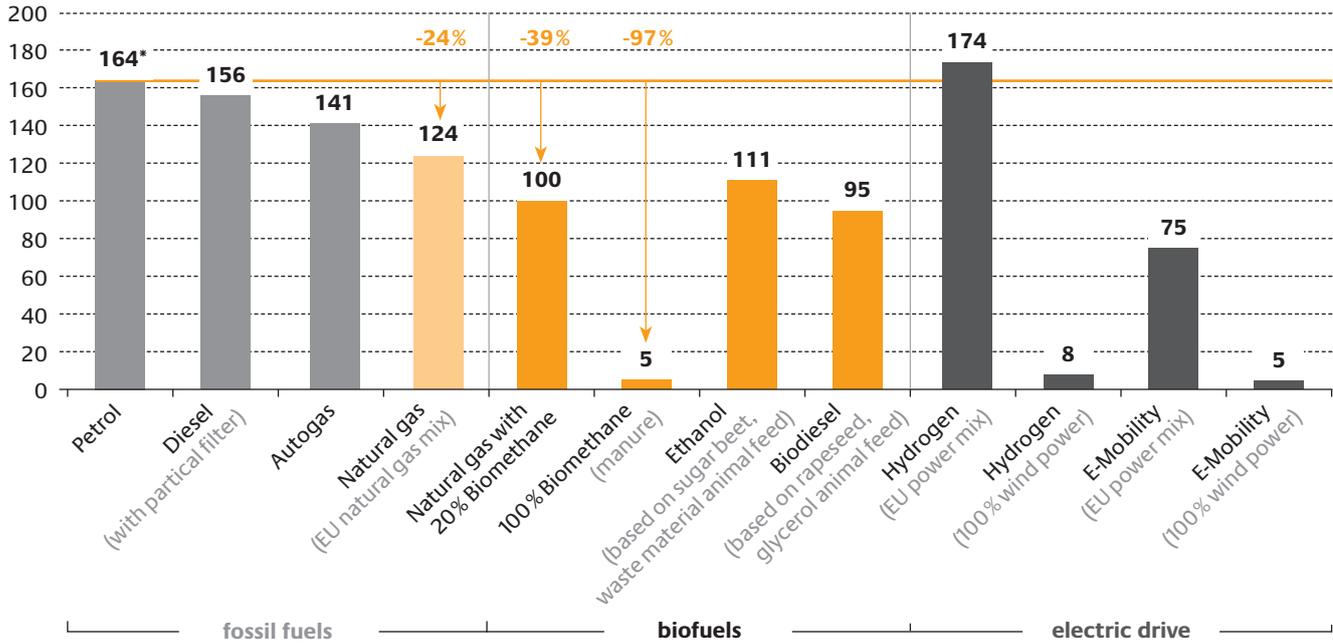
Climate impact.

Natural gas or methane (CH₄) is the simplest hydrocarbon compound. It burns in air with a bluish, non-sooty flame to form water and CO₂. Due to the 1:4 carbon:hydrogen ratio, combustion yields less CO₂ than when for example petrol is burnt.

In the greenhouse gas balance (GHG balance) of vehicle powertrain systems, emissions of greenhouse gases such as methane or CO₂ are recorded from the well, via the vehicle’s fuel tank, to the powertrain or wheel i.e. Well-to-Wheel (WTW). The greenhouse gas emissions are then converted into CO₂ equivalents (CO₂ eq.). According to the CONCAWE study, natural gas primarily has greenhouse gas reduction potential in comparison with petrol and diesel in the Tank-to-Wheel (TTW) range,

whereas the Well-to-Tank (WTT) figures are similar. Comparing fuels makes it clear that, within the group of fossil fuels, natural gas has the greatest potential for reducing GHG emissions. In comparison with petrol, emissions can be reduced by up to 24% (see figure below). Liquefied Petroleum Gas (LPG), also known as autogas, only has a reduction potential of the order of around 14%. Admixing 20% biomethane can reduce CO₂ emissions by 39% in comparison with petrol, while if pure biomethane is used, reductions of up to 97% can be achieved depending on the method of assessment used.

WTW GHG emissions in g CO₂ eq./km



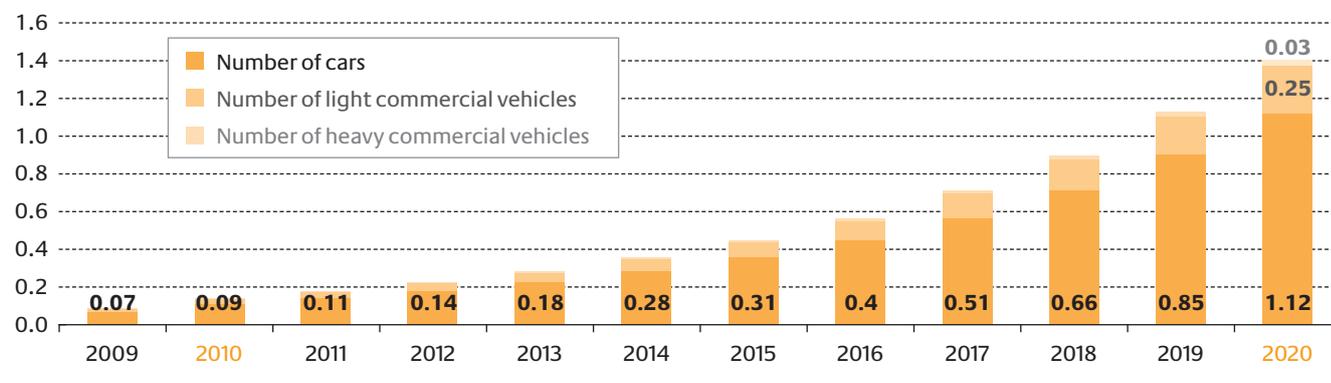
* reference vehicle: gasoline engine (induction engine), consumption 71 per 100 km

WTW greenhouse gas emissions for different fuels (CONCAWE et al. Well-to-wheel analysis of future automotive fuels and powertrains in the European context. 2007)



Targets for and existing levels of natural gas use in the fuel mix.

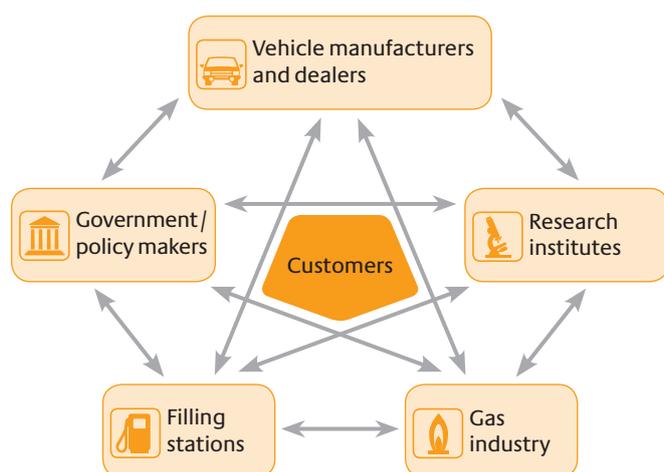
Number of natural gas vehicles in millions



Necessary growth in vehicle numbers to achieve 2020 target (Own calculation and research)

On the basis of the existing vehicle mix, if natural gas is to account for 4% of total fuel consumption by 2020 and so reach the target set in the German federal government's 2004 fuel strategy, vehicle numbers must rise to around 1.4 million or approx 2.6% of the current number of vehicles on the road. That would amount to around 1.1 million cars, 250,000 light and approx. 30,000 heavy commercial vehicles. To achieve this, every year new registrations of natural gas vehicles would have

to amount to approx. 29% of the preceding year's number of natural gas vehicles on the road, almost tripling the growth rate over 2009. If the existing vehicle mix were carried over into the natural gas fleet, identical growth would be required for cars and for light and heavy commercial vehicles. Accordingly, due to commercial vehicles' higher fuel consumption, an increase in their proportion could relieve the pressure on the car fleet in terms of meeting the fuel targets.



Relevant stakeholder groups in establishing alternative fuels and powertrain systems

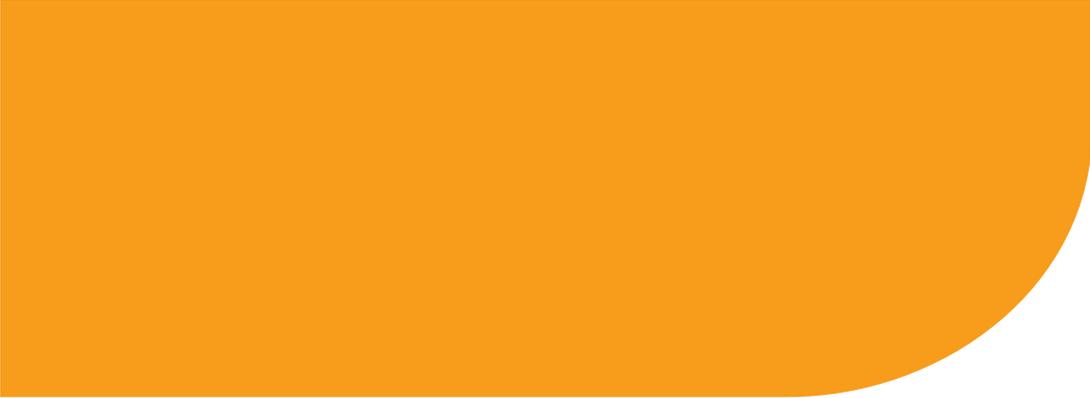
The approaches to the use of natural gas and biomethane as motor fuel which have recently been devised at a national and international level emphasise the long-term relevance of this technology to achieving climate protection targets. It is doubtful whether the parties concerned are on their way to achieving the stated targets.

One particularly problematic issue is the large number of different stakeholder groups who have to contribute to achieving the targets (see figure left): Vehicle manufacturers and dealers, research institutes, the gas industry (incl. biomethane producers), the petroleum industry with its filling station network, policy makers and finally the final consumers with their multiplicity of mobility needs.

dena's study (see masthead last page) reflects the status quo of natural gas and biomethane in the transport sector. It indicates which obstacles have to be overcome in Germany by which group of stakeholders in order to give this alternative more space in the future fuel mix.

Next page shows the catalogue of measures to accelerate the market share.

	User groups		
Purchasing criteria	Private	Commercial	Public
Differentiated range of vehicles and good marketing	 Provision of natural gas vehicles to cover all relevant brands and segments		
	 Intensification of marketing efforts and consumer sales offensive (e.g. dealer training/incentivisation)	 Intensification of marketing efforts and key account customer sales offensive	
		   Consistent introduction of natural gas vehicles into own fleets	 Consistent introduction of natural gas vehicles into own fleets by changing tendering practices (e.g. including public transport)
	    Intensification of customer information campaigns about alternative motor fuels		
	  Feed-in and marketing of biomethane		
Small purchasing price differential	 Modification of pricing policy (e.g. sales promotion)		
	  Modification of cost structure, for instance by research and development into vehicle natural gas components		
	 Creation of public purchasing incentives (e.g. by scrappage scheme)	 Differentiation of company car taxation on a CO ₂ basis, including preferential tax treatment of energy-efficient natural gas vehicles	  Promotion of conversion of municipal fleets (e.g. by subsidies)
	  Establishment of reduced interest rate loans for purchasing particularly energy-efficient vehicles		
Low running costs (in particular fuel costs)	 Updating of German federal government's fuel strategy, e.g. early continuation of energy tax relief for natural gas and biomethane as motor fuels and further development towards CO ₂ -based taxation of motor fuels		
	 Research into the climate advantages of biomethane as motor fuel		
	 Establishment of a technology-neutral "high efficiency vehicle" label with CO ₂ thresholds or classes as the basis for straightforward and indisputable incentivisation of energy-efficient vehicles		
	 Consumer-friendly changes to how motor fuel prices are stated, ensuring better comparability between the increasing number of different transport energy sources which will in future be available	 Preferential treatment of energy-efficient taxis, e.g. natural gas fuelled, at railway stations, airports etc.	 Introduction of key account customer tariffs for municipal fleet fuelling
	 Free inner city parking for particularly energy-efficient vehicles		
Dense filling station network and large vehicle range	  Demand-led extension of natural gas filling station network across Germany		
	   Stepping up the availability of natural gas filling stations along the federal motorways		
	   Increasing the visibility of natural gas at filling stations and uniform branding of this fuel		
			   Promotion of construction of filling stations at vehicle depots
	  Increasing vehicle range in natural gas operation to the level of petrol vehicles		
			  Introduction of common fuel cards for natural gas



Catalogues of measures to accelerate market penetration



Government / policy makers



Filling stations



Gas industry



Vehicle manufacturers and dealers



Research institutes

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