

VIA VISION

VOLKSWAGEN GROUP

• SHAPING THE FUTURE OF MOBILITY

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+++ SPECIAL: VOLKSWAGEN ON THE QATAR MOTOR SHOW +++

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From Naught to a Hundred Qatar's Role in the World

51 percent

of Qatar's gross domestic product is attributed to natural gas and oil.

A Qatari has

an average income almost twice as high as a German.



Volkswagen's "Formula XL1"

One-liter Car Close to Production Maturity



Thanks to a combination of lightweight construction, low aerodynamic drag and a plug-in hybrid system, the Volkswagen prototype XL1 answers the question of how much the energy consumption of a car can be reduced.

Future mobility is one of the most stimulating topics of our time. The key question here: Just how much could the energy consumption of cars be reduced if all the stops were pulled out for efficiency?

There is now an answer to this question, and Volkswagen is delivering it in the form of the new XL1. Combined fuel consumption: 0.9 liter per 100 kilometers. No other hybrid car powered by an electric motor/internal combustion engine combination is more fuel efficient.

The prototype is unveiled in a world debut at the Qatar Motor Show.

Technical data of the new XL1

The new Volkswagen XL1 attains a CO₂ emissions value of 24 grams per kilometer, thanks to a combination of lightweight construction (monocoque and add-on parts made of carbon fibre), very low aerodynamic drag (drag coefficient 0.186) and a plug-in hybrid system consisting of a TDI engine (35 kilowatts/48 horse power), E-motor (20 kilowatts/27 horse power), 7-speed dual-clutch transmission (DSG) and lithium-ion battery.

Fun and efficiency

The new XL1 shows the way forward for extreme economy vehicles and clean technologies. It also demonstrates that such cars can be fun. The feeling when driving the XL1 is truly dynamic – not based on pure power, rather on pure efficiency.

- ➔ To move at 100 kilometers per hour, the prototype only needs 6.2 kilowatts/8.4 horse power – a fraction of the performance of today's cars (Golf 1.6 TDI with 77 kilowatts and 7-speed DSG: 13.2 kilowatts/17.9 horse power).
- ➔ In electric mode, the XL1 needs less than 0.1 kilowatt hours per kilometer (82 watt hours per kilometer) to complete a one kilometer driving course. These are record values.
- ➔ When the full power of the hybrid system is engaged, the Volkswagen prototype accelerates from 0 to 100 kilometers per hour in just 11.9 seconds; its top speed is 160 kilometers per hour (electronically limited).

Interplay of E-motor and TDI engine

As soon as the electric mode button on the instrument panel is pressed, the car is propelled exclusively by electrical power. In this mode, the TDI is decoupled from the drivetrain by disengaging a clutch, and it is shut down. Meanwhile, the clutch on the gearbox side remains closed, so the DSG is fully engaged with the electric motor.

Restarting the TDI is a very smooth and comfortable process: In what is known as "pulse starting" of the TDI engine while driving, the electric motor's rotor is sped up and is very quickly coupled to the engine clutch. This accelerates the TDI to the required speed and starts it.

When the XL1 is decelerated, the E-motor operates as a generator to charge the battery. In certain operating conditions the load shared between the TDI engine and the electric motor can be shifted so that the turbodiesel is operating at its most favourable efficiency level.

A perfect couple

The Most Fuel Efficient Hybrid Concept

With the new XL1, Volkswagen is implementing a plug-in hybrid concept, which utilises the fuel efficient technology of the common rail turbodiesel (TDI) and the dual clutch transmission (DSG). The TDI generates its stated maximum power of 35 kilowatts/48 horse power from just 0.8 liters displacement. The entire hybrid unit is housed above the vehicle's driven rear axle. The actual hybrid module with electric motor and clutch is positioned between the TDI and the 7-speed DSG; this module was integrated in the DSG transmission case in place of the usual flywheel. The integrated lithium-ion battery supplies the E-motor with energy.

The TDI engine

The 0.8 liter TDI (35 kilowatts/48 horse power) was derived from the 1.6 liter TDI, which drives such cars as the Golf and Passat. The 0.8 TDI and the 1.6 TDI exhibit identical cylinder spacing (88 millimeters), cylinder bore (79.5 millimeters) and stroke (80.5 millimeters). In addition, the XL1's two-cylinder and the mass produced four cylinder share key internal engine features for reducing emissions. They include special piston recesses for multiple injection and individual orientation of the individual injection jets.

The excellent smooth running properties of the 1.6 TDI engine were transferred to the two cylinder engine. It is also equipped with a balancer shaft; this is driven by the crankshaft turning at the same speed, and it makes a decisive contribution towards quiet engine running.

The electric motor

The XL1 prototype can be driven for up to 40 kilometers in pure electric mode, that is with zero emissions at point of use. The battery can be charged from a conventional household electric outlet. Naturally, battery regeneration is also employed to recover energy while slowing down and store as much of it as possible in the battery for re-use. In this case, the electric motor acts as an electric generator.

The high voltage energy flow from and to the battery or E-motor is managed by the power electronics, which operates at 220 Volts.



Fly weight

A Formula 1 Car Construction Technique

Despite the very high levels of efficiency, developers were able to design a body layout that offers greater everyday practicality, incorporating side by side seating rather than the tandem arrangement seen in both the first one-liter cars. In the new XL1, wing doors make it easier to enter and exit the car. Further progress has been made by manufacturing body parts from carbon fibre reinforced polymer parts, a technique used in Formula 1 car construction. Once again, Volkswagen has successfully achieved significant reductions in production costs – an important step forward to make viable a limited production run of the XL1.

- The drag coefficient of the XL1 is 2.5 times lower than that of the Golf – which is already very good for the compact class.
- The new XL1 is 3,888 millimeters long, 1,665 millimeters wide and just 1,156 millimeters tall – as long and wide as a Polo, but with a low profile like a Lamborghini.

Sustainability and safety

Large sections of the new XL1's body consist of carbon fibre reinforced polymer (CFRP), which is as lightweight as it is strong. Multiple layers of high-strength carbon fibres are integrated in a polymer matrix to form CFRP. This material mix produces an extremely durable and lightweight composite.

- The XL1 prototype weighs only 795 kilograms.
- A total of 21.3 percent of the new XL1, or 169 kilograms, consists of CFRP.
- Volkswagen uses lightweight metals for 22.5 percent of all parts (179 kilograms).
- Only 23.2 percent (184 kilograms) of the new XL1 is constructed from steel and iron materials.

The new XL1 is not only lightweight, but very safe as well. In the style of Formula 1 race cars, the Volkswagen has a high-strength monocoque. In contrast to Formula 1, however, this safety capsule is enclosed on top – for safety.



Ascension to Global Player

Qatar Finds its Way into the Economy

Qatar is being talked about, not just because it is to host the 2022 FIFA World Cup, but especially because of its role as an international investor. Within no time at all the country has become a global player. In August 2009, the Emirate became a 17 percent shareholder of Volkswagen AG. Last spring, they took over the British department store Harrods. The state, that has been governed by the Al-Thani dynasty since the middle of the 19th century, is defined through the interaction of a monarchistic form of government and constitution, Arabic and modern architectural styles, both traditional and cosmopolitan values. Qatar owes its progress to its resources: It has enormous natural gas reserves, the third largest in the world, as well as ample oil.

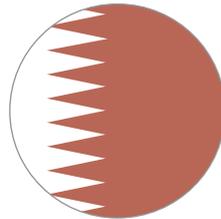
Per head income 2010:
(in US dollar)



40,512
Germany



47,132
USA



74,423
Qatar

With a per head income of 74,423 US dollars, Qatar comes third in world income terms, after Luxembourg and Norway, leaving the USA and Germany far behind.

Source: International Monetary Fund

Qatar's capital

The Qatar Investment Authority (QIA) was founded by the Government of Qatar in 2005. It commands assets worth 85 billion US dollars, derived from its earnings from selling gas and oil. Such a government fund serves many countries as a secure investment. States whose assets stem from natural resources, for example, are thus preparing for the time when they have run out of resources or for times of falling prices. The fund's capital can be invested in securities or government bonds, companies or property. QIA has been investing mainly in companies and research facilities in Germany and Britain as of now. The executive board is appointed by the Emir, the Head of State of Qatar. The Executive Director is his eleventh son, and designated heir to the throne, Sheikh Tamin Bin Hamad Al-Thani.

Sources: Qatar Investment Authority, Sovereign Wealth Fund Institute, *Wirtschaftswoche*

Selected investments* of the Qatar Investment Authority:

100 %	Harrods
26.1 %	Sainsbury's
17 %	VOLKSWAGEN
15.1 %	London Stock Exchange
10 %	PORSCHE
9.1 %	HOCHTIEF

* Harrods Holdings Ltd.; J Sainsbury plc; Volkswagen AG; London Stock Exchange Group plc; Porsche SE; Hochtief AG

The Emirate and Natural Resources

A Profitable Bond

From an economic perspective, Qatar's location in the Persian Gulf is ideal: On the one hand, large quantities of oil and gas have formed in the course of the world's history at their front door, so to speak, which today is sold on the global market by the once nomadic people. On the other hand, there is the Qatari peninsula in close proximity to the trade route between Europe and Asia so that the gas extracted can be shipped immediately.

QATAR • قطر

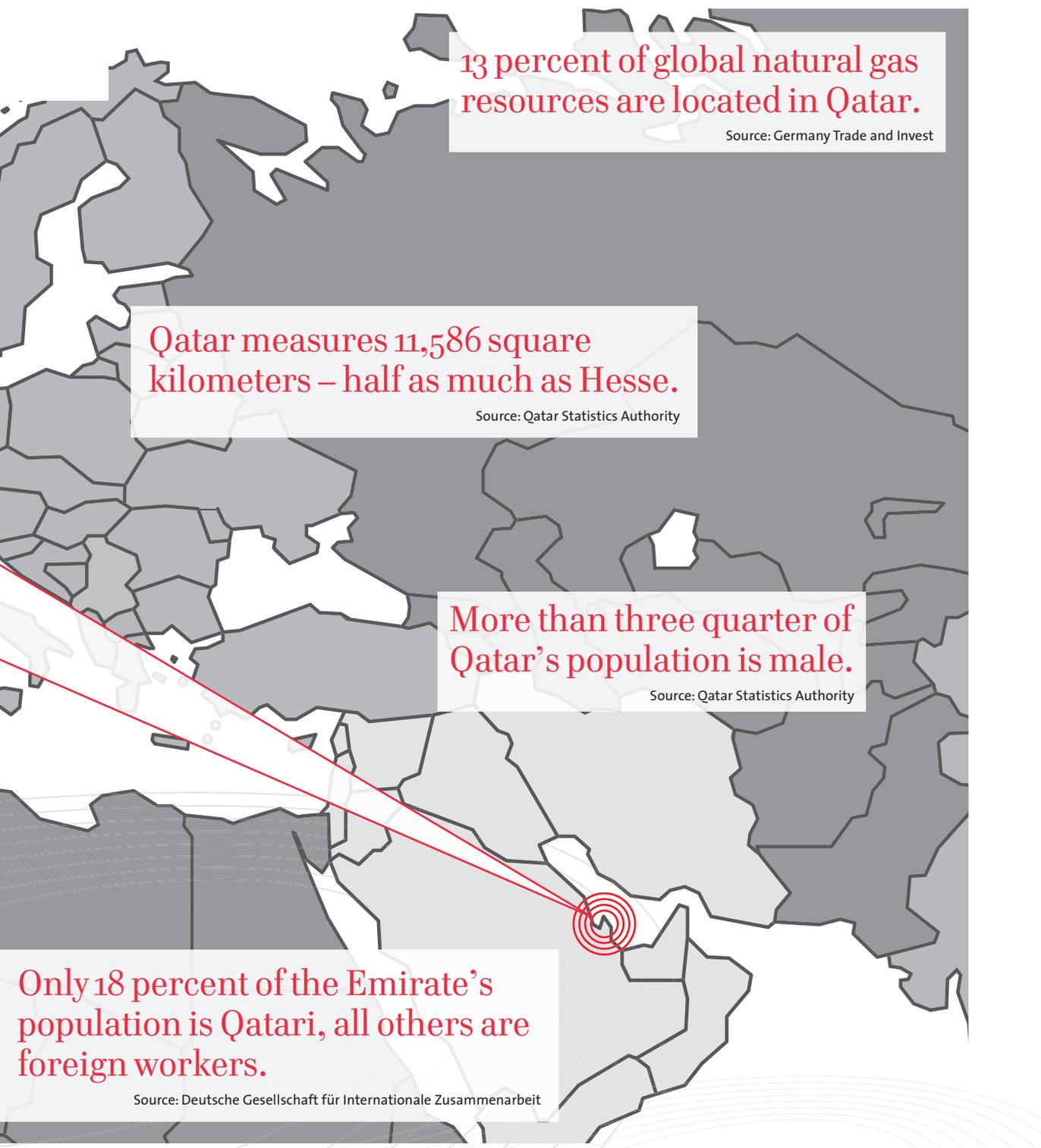


Head of State:	Sheikh Hamad Bin Khalifa Al-Thani, Emir of Qatar
Capital:	Doha, population of 796,947
Area:	11,586 square kilometers
Population:	1,699,435
Population growth:	3.7 percent
Population in cities:	96 percent
Religions:	Islam (77.5 percent), Christianity (8.5 percent)
Official language:	Arabic
Currency:	Qatari riyal, QAR (1 euro = 4.8 QAR = 480 dirhams)
Gross domestic product:	126 billion US dollars
Per head income:	74,423 US dollars
Economic growth:	16 percent (estimated)

All data for 2010

Sources (from top): Qatar Statistics Authority (4), Germany Trade and Invest, United Nations World Urbanization Prospects, CIA World Factbook (2), The Deutsche Bundesbank, International Monetary Fund (2), Germany Trade and Invest

Coordinates: 25° 30' N, 51° 15' E



13 percent of global natural gas resources are located in Qatar.

Source: Germany Trade and Invest

Qatar measures 11,586 square kilometers – half as much as Hesse.

Source: Qatar Statistics Authority

More than three quarter of Qatar's population is male.

Source: Qatar Statistics Authority

Only 18 percent of the Emirate's population is Qatari, all others are foreign workers.

Source: Deutsche Gesellschaft für Internationale Zusammenarbeit

A Growing Nation

Qatar's Economic Power

51 %

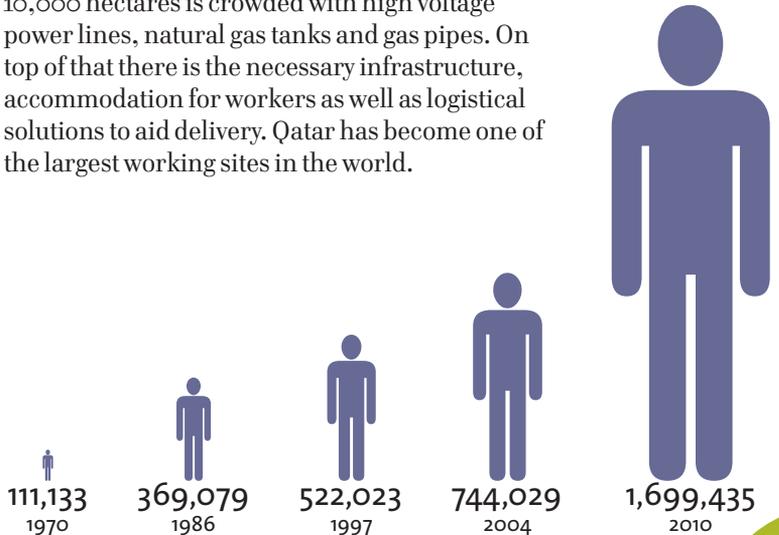
of Qatar's current gross domestic product is generated by the raw material extraction industry.

Source: Qatar Statistics Authority

The discovery of natural gas resources about 40 years ago started a new era in Qatar. In the north of the country, where a gigantic bubble of natural gas is sitting under the sea bed, the Ras Laffan industrial complex is being literally produced out of the desert sand in order to convey this valuable resource. An area of 10,000 hectares is crowded with high voltage power lines, natural gas tanks and gas pipes. On top of that there is the necessary infrastructure, accommodation for workers as well as logistical solutions to aid delivery. Qatar has become one of the largest working sites in the world.

Population growth:

Source: Qatar Statistics Authority



Gross domestic product growth:

(in billion US dollars)

Source: Qatar Statistics Authority



Natural gas production:

(in billion cubic meters)

Source: BP Statistical Review of World Energy



With the enormous boom comes a growing population; 310,000 native Qataris are currently living with 1.4 million residents from foreign nations.

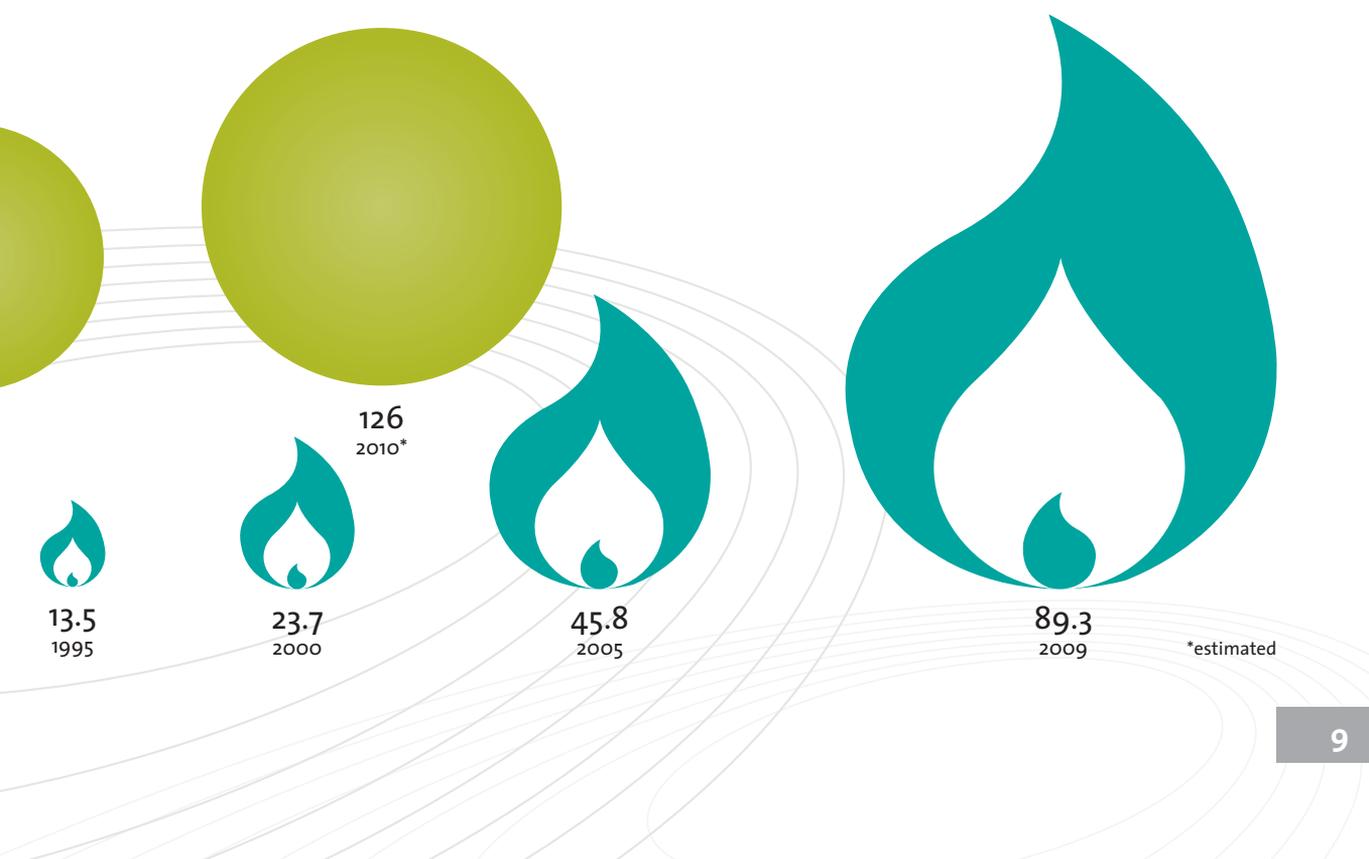
The production of liquid natural gas is growing particularly quickly: The demand for this frozen resource is increasing because production and logistical costs have decreased considerably over the past few years. Today, Qatar exports its gas to the whole of the world, with an export share that never went below sixty percent in recent years. Gross domestic product and per head income grow continuously too and an unemployment rate of 0.5 percent suggests that there is almost no-one in Qatar that does not have a job.

Sources: Germany Trade and Invest, CIA World Factbook, Qatar Statistics Authority

559,066

people work on the construction sites of the growing desert state – almost 45 percent of all employees.

Source: Qatar Statistics Authority

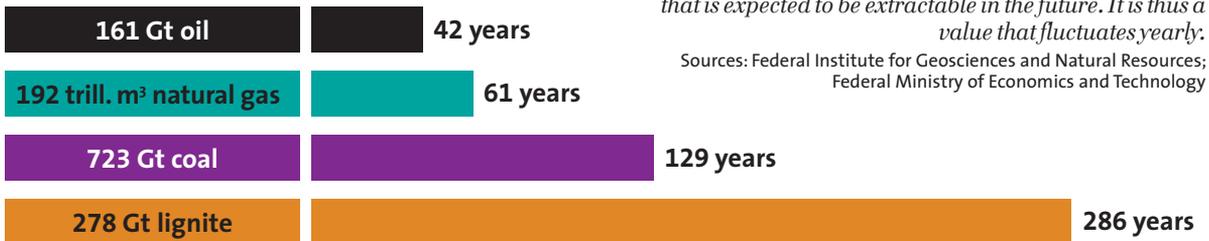


It's All in the Mix

Natural Gas's Role in the Global Energy Mix

Rising heating costs, exploding oil prices – energy is already a scarce commodity. Global demand will increase by 70 to 100 percent over the next forty years, according to World Energy Council (WEC) forecasts. Fossil resources which provide the majority of the energy needed for our lives will be getting much more expensive. Resource rich countries like Qatar are profiting from this increase in prices. Natural gas is playing an important role in this context. Already, this source of energy is supplying more than 21 percent of global demand.

Raw material resources and duration of supply in comparison:



The duration of supply of these energy carriers is a function of their corresponding reserves, that is the amount of raw material that is currently extractable using today's technology, plus the amount of resources that is expected to be extractable in the future. It is thus a value that fluctuates yearly.

Sources: Federal Institute for Geosciences and Natural Resources; Federal Ministry of Economics and Technology

Gt = giga metric tons (10⁹ tons), trill. m³ = trillion cubic meters (10¹² cubic meters)

How much raw material is needed to power a two person home with electricity for a year:

Lignite has the worst energy balance by far. One would need to burn 448 kilograms in order to power a two person home (consumption: 2,500 kWh) with electricity for a year. Slightly less than half as much oil would generate the same amount of electricity.

Source: Swiss Federal Office for Energy



Fuel oil



Natural gas

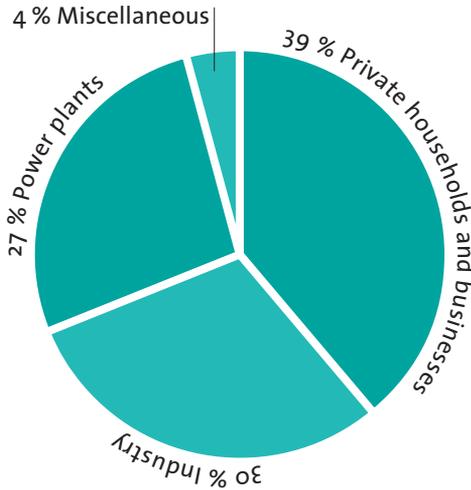


Coal



Lignite

Gas sales in Europe per sector (2009):



Private households and businesses consume the most gas in Europe. Comparing countries, the USA is the biggest gas consumer, before Russia. Source: Eurogas

Gas from Qatar

From the Ship to the World

In 2009, about 25 percent of European gas imports came from Qatar – a rising trend. The Emirate which is the world’s largest producer of liquefied natural gas, is usually not delivering the energy carrier via pipelines in its natural aggregate state but as a liquid using ships. The gas is being cooled down to minus 161 degrees Celsius in this process. Despite the high energy costs associated with this method, liquefying gas is economical: During the cooling procedure, the energy carrier’s volume is reduced by a factor of six hundred and is thus easier to transport.

Sources: Bundesverband der Energie- und Wasserwirtschaft, Eurogas

Strategy for the future

Qatar is increasingly improving its image as a high technology location in order to avoid complete dependence on its raw material resources. So far, the Emirate has invested 600 million US dollars in the development of the Qatar Science & Technology Park near Doha. It is a place where foreign companies can conduct their research and make contacts with a global network. Amongst others, Cisco, EADS, Shell, Total and Microsoft are already on board.

Energy on its way

98

transport ships are clearing from the Qatari port of Ras Laffan into the world.

13

stories high, and as long as three football fields, is the size of each of these super tankers.

160,000

metric tons of liquefied gas can be stored on a ship. This amount is sufficient to power 30,000 households with energy for one year.

18

hours are needed to fill a tanker with liquid natural gas.

15

percent of the total energy of the natural gas is consumed during the liquefying process and its transportation. Source: 3sat

Room for Potential

Natural Gas Fuel

30,449,617 petrol cars

While it was once simply burnt off as a waste product during the process of refining oil, today natural gas plays an important role in the global energy mix. The fuel strategy of the German government sees four percent of all cars on its roads powered by natural gas by 2020. This would amount to some 1.4 million vehicles.

The use of natural gas as a fuel is also economically worthwhile: It has the lowest carbon dioxide combustion value of all fossil fuels. It produces 24 percent less CO₂ when compared to petrol and diesel engines.

Sources: German Energy Agency

10.9 million natural gas vehicles are on the world's streets. This equates to 1.1 percent of all vehicles. Source: Center Automotive Research

Natural gas cars in Germany 2010:

With a share of just 0.2 percent, natural gas powered vehicles are still lagging far behind the German Government's expectations. 73 percent of all cars on German roads are still petrol driven. Only a few car manufacturers are mass-producing pure natural gas models. Amongst them is Volkswagen with the Passat Eco Fuel.



68,515 natural gas vehicles

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