2014

ENERGY STUDY

Reserves, Resources and Availability of Energy Resources

BGR

18

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Energy goes directly or indirectly into any type of economic activity. It clearly matters, and the link to the economy is not a one way street. But few economists devote time to it. By taking energy matters out of this wider context, the discussion suffers and often does not reflect the attention this topic deserves.

Christof Rühl, 2014

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Editor: Federal Institute for Geosciences and Natural Resources (BGR),
Department B1.3, Geology of energy resources, polar geology
Stilleweg 2
30655 Hannover, Germany
E-Mail: energierohstoffe@bgr.de

Authors: Harald Andruleit (coordination), Andreas Bahr, Hans Georg Babies, Bernd Hesse, Jürgen Meßner, Dorothee Rebscher, Michael Schauer, Sandro Schmidt, Peggy Schulz, Gabriela von Goerne

Contributions by: Uwe Benitz, Jennifer Bremer

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FOREWORD

"Do we still need fossil fuels?" or "Why is the Federal Institute for Geosciences and Natural Resources (BGR) still analysing global resources of energy?" These are critical questions that BGR has to answer more and more frequently. Germany is still set on its path of energy transition, intending to rely on renewables as its primary sources of energy in future. Already today, a common impression seems to be that wind and solar energies plus hydropower and geothermal energy could power Germany as a centre of industry, and that the use of traditional fossil fuels is obsolete and redundant. There is actually only one indisputable fact about energy: the major societal importance of the future energy supply in Germany and for Germany. It is therefore all the more important that this subject is handled in a responsible manner, and this is the approach that BGR wishes to support, by providing technical information gained through its professional work. Crude oil production in Germany, for instance, is negligible measured against major oil-producing countries. Nevertheless, it contributed more to the domestic energy supply in 2013 than the entire domestic photovoltaic sector. Today, more than 10 years after the energy transition was initiated, crude oil, natural gas, hard coal and lignite still contribute around 80 %, and thus by far the largest share, to cover energy consumption in Germany. Although the renewables may dominate in the public perception, Germany will, in fact, depend on an energy mix that also includes non-renewables for decades to come, to achieve a safe transition to a low-carbon energy system. Information on the availability of fossil fuels therefore continues to be of vital importance for safeguarding Germany's energy supply and its role as a centre of industry.

With its 2014 Energy Study, BGR aims for a balance between supplying up to date information and ensuring continuity of reporting regarding the availability of non-renewables. For the first time since 2009, this study will include deep geothermal energy as the only geological renewable source of energy. The growing interest worldwide in geothermal projects is not least due to the search for safe alternatives to fossil energy sources. A separate chapter and additional tables for all sources of energy in this study have been dedicated to the fuel situation in Germany in a wider scope than previously. The special topics in this year‘s study are the flaring of natural gas with its opportunities and challenges, particularly for developing countries. There is also a brief status report on gas hydrate as an energy resource.

TABLE OF CONTENTS

1 EXECUTIVE SUMMARY

Energy consumption in Germany and the world is at present covered primarily from fossil sources, and will continue to be in the foreseeable future. The dependency of our energy supply on fossil fuels will last for a long time yet. Moreover, a further rise in the global demand for fuels is expected, particularly as a result of population and economic growth in the emerging economies. Against this background, international competition for fuels is likely to increase. Germany, despite its considerable growth in the renewables, will also increasingly depend on imports.

This energy study by the Federal Institute for Geosciences and Natural Resources (BGR) provides an assessment of the geological inventory of fuels, as well as reliable information concerning the reserves, resources and availability of crude oil, natural gas, coal, nuclear fuels, and deep geothermal energy. It also looks at commodity market trends with respect to the production, export, import, and consumption of fossil fuels. In addition, the study addresses current energy topics of societal relevance. The study aims to provide the Federal Ministry of Economics and Energy (BMWi) and German industry with advice on commodity industry issues. It is based on data from the continuous evaluation of information from journals, scientific publications, reports from industry, professional and political organisations, internet sources, and BGR‘s own surveys. Unless specifically stated otherwise, all data presented here are from the BGR Database of Energy Resources.

Based on current geological knowledge, there are still extensive quantities of fossil energy resources. A comparison of global reserves, resources, and consumed fuels shows large potentials in all regions of the world (Fig. 1). In Australasia, the CIS and North America, these potentials appear to have hardly been touched; and even in Europe, only a small share has been recovered to date. This wealth in fuels is primarily based on the large coal deposits found on all continents. Unlike conventional crude oil and natural gas deposits, they are not so much concentrated in certain regions. The Middle East, which is so important for crude oil and natural gas, thus only has a relatively minor total potential of energy resources (Fig. 1).

Resources account for the largest share of global non-renewables, exceeding the reserves by a factor of 15. This applies to all fuels except conventional crude oil, highlighting its special role. The energy content of all reserves totalled 37,646 exajoules (EJ) in 2013, almost 6 % less than the previous year. While hydrocarbon reserves grew slightly, despite a rise in production, new evaluations put the reserves of coal and nuclear fuel at lower levels than before. In terms of its recoverable energy content, coal remains the major source of energy, particularly with regard to resources, but also to reserves. Crude oil, on the other hand, still dominates in consumption and production, and ranks second after coal in the reserves, because of its larger share of non-conventionals compared to natural gas. In the overall picture of the global energy mix, i.e. the amounts of energy actually consumed including renewables, fossil sources still dominate by far. From a geological perspective, the known inventories can provide a reliable supply of natural gas, coal and nuclear fuels even in the long term. Crude oil is the only fuel with an evident finiteness.

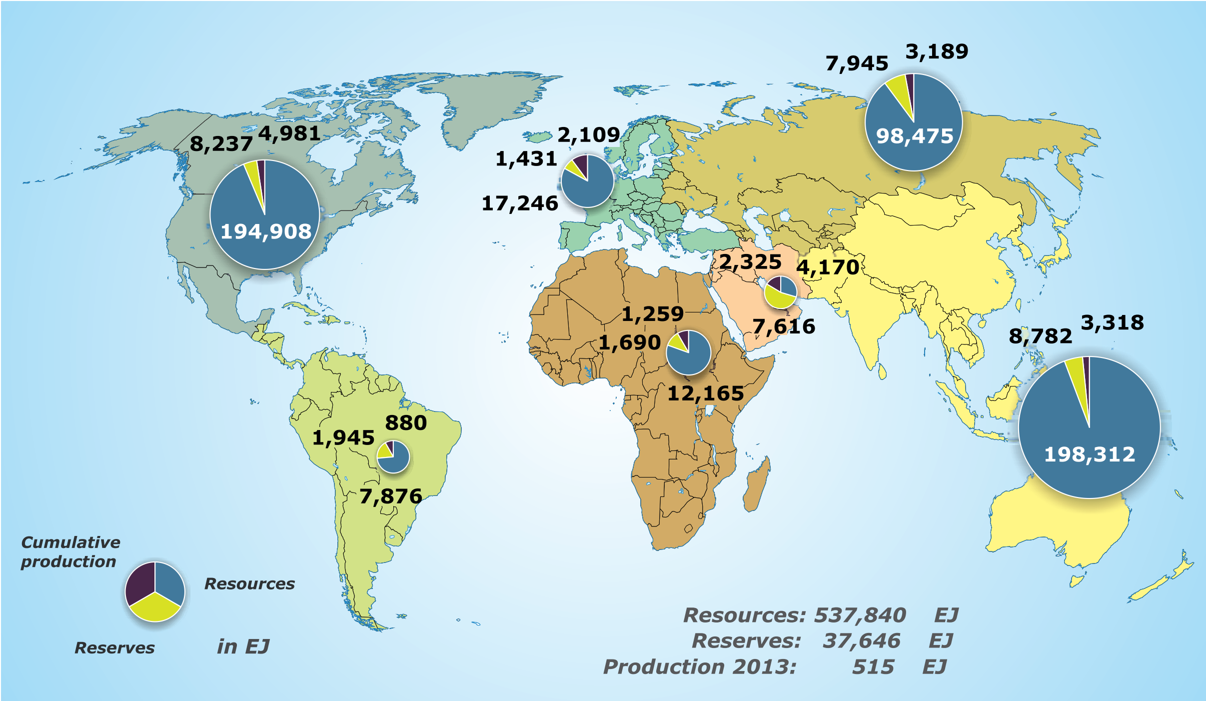

Fig. 1: Overall potential of fuels in 2013: regional distribution (excluding coal resources in the Antarctic, resources from oil shale, aquifer gas, natural gas from gas hydrates, and thorium, as none of these can be assigned to specific regions), (estimated cumulative production of coal since 1950).

Key statements on crude oil, natural gas, coal, nuclear fuels and deep geothermal energy:

Crude oil

- **Crude oil is, and will continue to be, the most important source of energy worldwide.** It accounts for about a third in the world's primary energy consumption.

- **From a geological perspective, the supply of crude oil is safeguarded for the next few years if there is a moderate rise in oil consumption.** Despite a rise in production, there was again a slight increase in reserves.

- **No forecasts can be made regarding the future development of the oil price.** Although, in the short to medium term, the oil price is affected less by geological availability than by political and economic factors, neither the Ukraine crisis nor the unrest in the Middle East have had much of an impact in the reporting year. Because of reduced imports to the United States, larger volumes were available on the global market.

- **Crude oil production from non-conventional sources, particularly from tight rocks in North America, by now has a global impact.** Developments in the production of crude oil from tight rocks (tight oil, shale oil) in the United States and Canada have demonstrated that technological advances combined with consistently high oil prices could help develop new potentials within only a few years.

- **Crude oil is the only non-renewable that will probably not be able to meet growing demand in the next few decades.** Given the long periods required for transitions in the energy sector, it is essential that alternative energy systems are developed in good time. The exploitation of non-conventional crude oil deposits represents a significant contribution to the global availability of crude oil; from a geological perspective, however, it will not lead to a paradigm shift in the long term.

- **Germany has diversified its crude oil supply, relying on 30 oil-exporting countries.** Given the decline in domestic production, Germany is 98 % dependent on crude oil imports, with Russia as its main supplier (almost 35 % of German imports).

Natural gas

- **From a geological perspective, natural gas is still available in large quantities.** Global reserves of natural gas rose again from 2012. Despite a foreseeable increase in demand, the very high remaining natural gas potential will thus safeguard global supply for several decades to come.

- **About 80 % of global natural gas reserves are held by OPEC members or CIS countries.** Over half are located in just three countries: Russia, Iran and Qatar.

- **Natural gas production in Europe passed its peak back in 2004.** As production is declining, dependency on gas imports from the CIS, Africa and the Middle East is growing. But with its supply grid, Europe is connected to a large portion of the global natural gas reserves.

- **The United States are planning to start exporting liquefied natural gas (LNG) from shale gas production in late 2015.** These additional volumes of natural gas on the global market could have an impact on existing market structures.

- **Domestic natural gas production in Germany is declining, accounting for just under 12 % of natural gas consumption in 2013.** And yet, domestic production and natural gas storage are reducing dependency on imports and improving supply security.

- **German imports of natural gas are pipeline-based, originating almost entirely from Russian, Norwegian and Dutch sources.** A stronger diversification of natural gas sources would be possible but costly, and could only be implemented in the medium to long term.

Coal

- **From a geological perspective, hard coal and lignite reserves and resources are adequate to cover the foreseeable demand for many decades to come.** With a share of around 54 % of reserves and 89 % of resources, coal has the largest potential of all non-renewables.

- **Coal will continue to play an important role, as the rise in global primary energy consumption is expected to continue.** Following several years of very high growth in the production and consumption of coal, the rise was relatively minor in 2013.

- **Since 2009, the development in global, and therefore also European, coal prices has been largely determined by the rise in coal imports to Asia and particularly China,** which now account for 72 % of the global coal trading volume.

- **Supply still exceeds demand on the global hard coal market.**

  - With the commissioning of new and highly productive coal mines and production growth in many coal export mines, this situation is unlikely to change in the near future.
  - In 2013, more mines with high production costs were closed down, most of them in the United States, Australia and China. In what remains of the European coal mining industry (particularly of hard coal), there are plans for major restructuring processes.

- **World market prices for coal have fallen again.** Because of the oversupply, price increases for steam coal and coking coal are unlikely in the near future, too.

- **Once more, Germany increased its imports of hard coal in 2013, to currently around 50 megatons (Mt).** Together with imports of coke and briquettes, Germany has to rely on imports to meet currently 87 % of its demand for hard coal and derived products.

Nuclear fuels

- **Global uranium production has grown again.** Uranium production rose by 2 % on the previous year. With a share of over 64 % in global production, Kazakhstan, Canada and Australia are the world‘s largest uranium-producing countries. Canada‘s major McArthur River deposit alone supplies 13 % of all uranium mined worldwide.

- **From a geological perspective, no shortage in the supply of nuclear fuels is expected, even in the long term.** Global inventories of uranium are very large, currently totalling 1.2 Mt of reserves (cost category < 80 USD/kg U) and 13.4 Mt of resources.

- **Global interest in the exploitation of nuclear fuels for power generation is still growing.** At the end of 2013, 70 nuclear power plants were under construction in 15 countries, 29 of them in China alone. Another 125 nuclear power plants are currently at the planning or approval stage.

- **In Germany, nuclear energy is declining in importance.** With the decision to abandon power generation in German nuclear power plants altogether in future, the share of nuclear energy in the German energy mix is falling. Its share in gross power generation fell to 15.4 %.

Deep geothermal energy

- **Deep geothermal energy is a form of energy generation that has been successfully tested and is attractive in regard to the discussion on climate change as well as from a geopolitical perspective.** It is a base load capable, low-emission innovative technology, which is relatively compact at the surface.

- **Globally, there is a vast geothermal potential, but as of yet it is only of minor use. In 2013, geo**thermal energy accounted for about 0.3 % of the power generation worldwide. Estimations for the global potential of geothermal energy up to a depth of 3 km lead to the production of 300 EJ/year of thermal energy and 100 EJ/year of electrical energy.

- **Outside of regions with favourable geothermal conditions, the practical implementation and economic viability of geothermal projects are still difficult.** Investment costs vary significantly and are hard to estimate in advance. Amortisation periods are typically of the order of 25 years or longer.

- **A global comparison shows a great diversity for the exploitation of geothermal energy.** Countries with high-enthalpy reservoirs are favoured. In developing countries, geothermal energy could gain particular interest as the technique could contribute to power generation in regions with weak infrastructure.

- **In Germany, the use of geothermal energy shows continuous growth over the last years.** In 2013, deep geothermal energy contributed with only 0.24 % to Germany‘s primary energy consumption. Over the past five years (2008 to 2013) the installed capacity for power has increased by almost an order of magnitude, amounting to more than 31 MW_e. Geothermal energy in Germany is subsidised under the Renewable Energies Act (EEG).

2 ENERGY RESOURCES OVERVIEW

The reliable and uninterrupted supply of energy is an essential requirement for the functioning of today‘s advanced societies. Economic growth and energy consumption are thus interdependent. This is why global demand for energy has been growing almost continuously for decades (Fig. 2). However, this development will not necessarily continue, as evidenced by the decline for a number of years in energy intensities. This applies particularly in the OECD countries, where GDP will grow even without an increase in energy demand. The distribution of energy, or rather the shares of the individual sources of energy used, are also continuously evolving. The energy transition is not limited to Germany – it is happening in many countries around the globe. The reasons are manifold. They range from climate protection to a lack of acceptance for individual sources of energy, and to the simple need to actually safeguard the future energy supply. But changing or restructuring energy systems takes time, witness the energy transition embraced by the German federal government, which is scheduled over several decades. Shifts in the shares that make up the global energy mix therefore only take effect many years down the line. On a decade scale, few surprises should be expected, except for the growing share of renewables. The dominance of the non-renewables, including nuclear power, will thus continue for a long time to come.

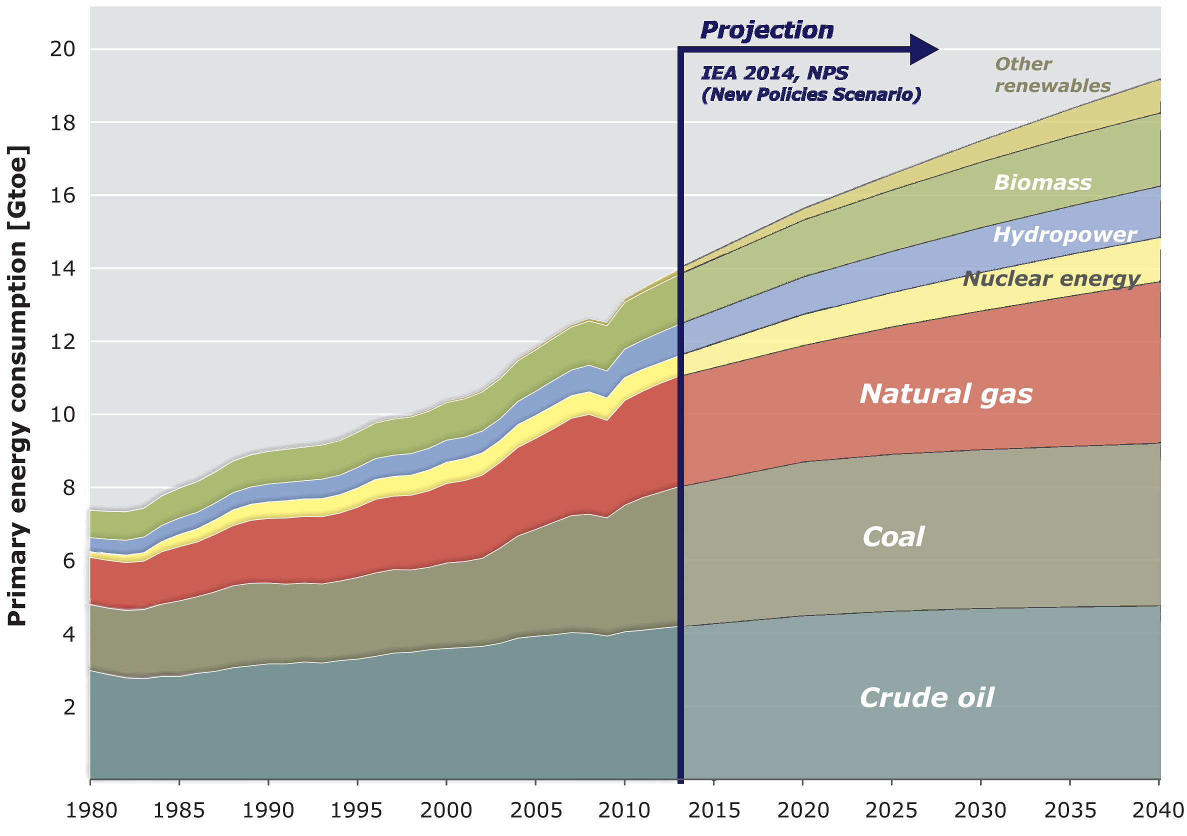

Fig. 2: Development of global primary energy consumption by sources of energy and a possible scenario for future development (New Policies Scenario, IEA 2014a).

2.1 Current global resources

Table 1 shows the total known global potential of all fossil fuels including nuclear fuels. The figures shown are the totals of the country data listed individually in Tables 10 to 41 in the appendix.

Table 1 also shows the global quantities of crude oil from oil shales, as well as natural gas in aquifers and from gas hydrates. Owing to a lack of information and to distribution data that cannot be broken down to the country level, their potential can only be estimated at the global level. Although there are still gaps in the data, the potential of non-conventional fuels is shown wherever possible. It includes the reserves and resources of extra heavy oil, oil from tight rocks (tight oil, shale oil), bitumen (oil sands), tight gas, shale gas and coal-bed methane.

Table 1: Reserves and resources of non-renewables

Fuel	Unit	Reserves (cf. left column)	EJ	Resources (cf. left column)	EJ
Conventional crude oil	Gt	170	7,126	161	6,745
Conventional natural gas	Tcm	193	7,318	318	12,099
Conventional hydrocarbons [total]	Gtoe	345	14,444	451	18,843
Oil sand	Gt	27	1,110	63	2,613
Extra heavy oil	Gt	21	886	61	2,541
Shale oil	Gt	< 0.5	14	49	2,060
Oil shale	Gt	–	–	102	4,248
Non-conventional oil [total]	Gtoe	48	2,011	274	11,462
Shale gas	Tcm	3.7 [5]	139 [5]	206	7,846
Tight gas	Tcm	– [6]	– [6]	63	2,397
Coal-bed methane	Tcm	1.8	69	50	1,915
Aquifer gas	Tcm	–	–	24	912
Gas hydrates	Tcm	–	–	184	6,992
Non-conventional gas [total]	Tcm	5.5	208	528	20,062
Non-conventional hydrocarbons [total]	Gtoe	53	2,219	754	31,524
Hydrocarbons [total]	Gtoe	398	16,662	1,204	50,367
Hard coal	Gtce	585	17,148	14,946	438,034
Lignite	Gtce	110	3,230	1,765	51,732
Coal [total]	Gtce	695	20,378	16,711	489,766
Fossil fuels [total]	–		37,040	–	540,133
Uranium [1]	Mt	1.2 [2]	606 [2]	13 [3]	6,681 [3]
Thorium [4]	Mt	–	–	6.4	3,178
Nuclear fuels [total]	–	–	606	–	9,858
Non-renewable fuels [total]	–	–	37,646	–	549,991

– no reserves or resources

1 1 t U = 14,000 - 23,000 tce, lower value used or 1 t U = 0,5 x 10^{15} J
2 RAR recoverable up to 80 USD / kg U
3 Total from RAR exploitable from 80 - 260 USD / kg U and IR and undiscovered < 260 USD / kg U
4 1 t Th assumed to have the same tce-value as for 1 t U
5 only USA (Status 2012)
6 included in conventional natural gas reserves

Overall, this study takes a conservative approach, placing high priority on the potential economic viability of extracting fuels. The vast so-called in-place volumes – which it will not be possible to recover even in the long term, as far as we know today – are therefore generally not included, or not without additional explanations (cf. Chapter 4.3). Particularly the resources of aquifer gas and natural gas from gas hydrates therefore appear relatively low in this table.

Resources account for the largest share of global non-renewables at 549,991 EJ, exceeding the reserves by a factor of 15. This applies to all fuels, with the exception of conventional oil because of the far advanced exploration and exploitation of this resource. In total, resources rose by 3 % compared to the previous year (BGR 2013). Increases were found primarily in hard coal and uranium resources; these were mainly due to new evaluations of the reserves and new discoveries (cf. Chapters 3.3 and 3.4). There were slight gains for both conventional and non-conventional hydrocarbons. In a comparison of all fuels, coal (hard coal and lignite) maintained its dominant position, with a share of around 89 % (Fig. 3). Far behind it at 5.8 % followed the resources of natural gas, with non-conventional deposits accounting for the larger share. In terms of their energy content, the other sources of energy including crude oil (3.3 %) only played a minor role. There were thus only slight changes on the previous year.

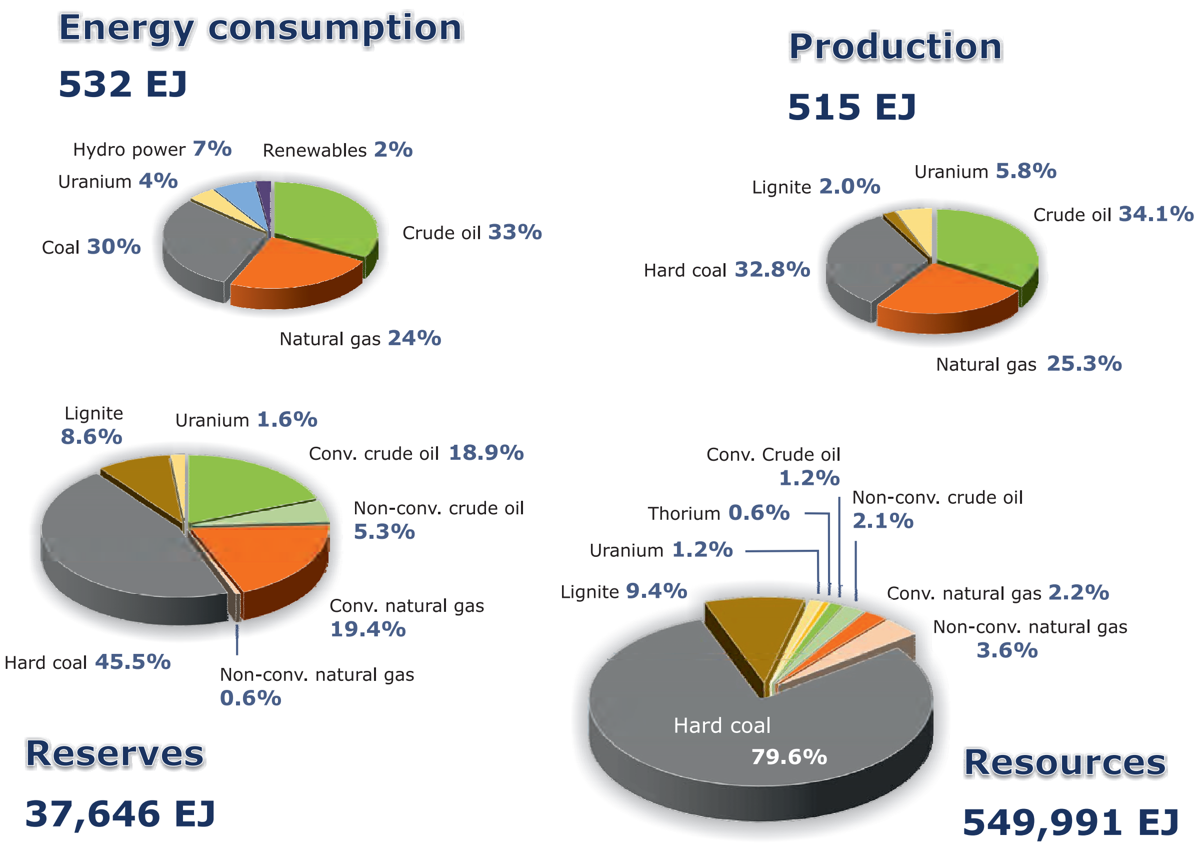

Fig. 3: Global shares of all sources of energy in consumption (BP 2014) and the shares of non-renewables in production, reserves and resources, as at the end of 2013.

The energy content of all reserves in 2013 totalled 37,646 EJ, i.e. almost 6 % less than the previous year. While hydrocarbon reserves grew slightly, despite a rise in production, new evaluations put resources of coal and nuclear fuel at lower levels than before. Significant changes were recorded particularly for hard coal reserves in China and South Africa, because of a better level of knowledge. The decline in uranium reserves is mostly the result of transfering reserves from lower to higher cost categories and redefining them as resources. In terms of the exploitable energy content, coal continues in its dominant position among the reserves, accounting for 54.1 % of the total. Crude oil (conventional and non-conventional) accounts for 24.2 % of total reserves, natural gas for 20 %, and uranium for 1.6 %. Compared with the previous year, the relative shares of all other sources of energy have risen, primarily because of the decline in hard coal reserves. Once more, the production volumes of crude oil and natural gas were balanced out by a transfer of resources to reserves. The relatively higher share of crude oil in the reserves reflects the intensive exploration and production activities concerning this fuel for a number of decades.

The non-renewables produced in 2013 had an energy content of around 515 EJ. This is equivalent to a slight growth in production of 1.2 % compared to the previous year. There were no significant changes in the individual shares in the production mix (Fig. 3).

In the overall picture of the global energy mix, i.e. the amounts of energy actually consumed, fossil sources still dominate by far. Their shares roughly correspond to the production figures, though not precisely, partly because of stockpiling. Of the renewables, only traditional hydropower could make a significant contribution. The other renewables – wind, geothermal power, solar energy, biomass and waste – account for a global share of only around 2 % (BP 2014).

Together, the reserves (37,646 EJ) and resources (549,991 EJ) of all fossil sources of energy add up to a global energy volume of 587,637 EJ. Although reserves have fallen, this represents a rise of just under 2.7 % compared to the previous year. A comparison of global annual production, reserves and resources shows a ratio of 1:73 and 1:1,070 (Fig. 3). Based on the current level of knowledge, there are still vast fossil energy volumes that, from a geological perspective, could in principle cover even a rising energy demand. However, to answer the question of whether sufficient quantities of each individual fuel can in future be made available whenever they are needed would go beyond the scope of this study. This challenge is particularly evident given the relatively low resources of crude oil. Whether specific sources of energy can be used, when and how, depends on factors such as technically and economically viable extraction, demand-centric availability, environmental compatibility, and public acceptance. This complex issue will have to be addressed in a different context.

2.2. Energy resources for Germany

2.2.1 Primary energy consumption and energy supply

Primary energy consumption (PEC) in Germany peaked at the end of the 1970s. Since then, energy demand has remained at a more or less high level, with a slight downward trend overall. In 2013, however, primary energy consumption in Germany rose by around 2.5 % compared to the previous year. This increase was in fact higher than total economic growth (AGEB 2014). The cold weather during the first half year was a major factor in this development. Without this temperature effect, energy consumption would have risen by only about 1.1 %. Crude oil or petroleum products accounted for the main share of primary energy consumption, as it has for many years, mostly unchanged. Once more, the fossil energy sources natural gas, hard coal and lignite together covered more than three quarters of total energy consumption in 2013, and more than 85 % if nuclear power is included.

Consumption growth rates for the fossil sources of energy were highest for natural gas and bituminous coal, at 6.4 and 4.1 % respectively. They were followed by petroleum products, which rose by 2.2 % (AGEB 2014). The main reason for this was the temperature-related rise in the consumption of light fuel oil, which interrupted the downward trend of recent years. The significant rise in natural gas consumption was due particularly to the cold weather and the resulting higher use of gas for heating in the first half of 2013. As weather conditions in the second half of the year were milder than in the previous year and less natural gas was used in power generation, this curbed the increase. This leaves natural gas with a share of 22.3 % (AGEB 2014) as the second most important source of energy overall. Consumption of hard coal in 2013 rose by around 4 % (AGEB 2014), mainly because of a considerably higher use for power and heat generation. At 12.8 %, the share of hard coal in total energy consumption hardly changed (previous year: 12.6 %), while lignite consumption fell slightly. But despite the drop of around 2 % in the use of lignite, power generation from this fuel rose by 0.8 % (AGEB 2014). This was due to the commissioning of new, highly efficient lignite power plant units and the closure of old lignite power plants. The share of lignite in total energy consumption fell to 11.7 % in 2013 (previous year: 12.1 %). As a result of the energy policies to promote the use of renewables and phase out nuclear power, the contribution of nuclear energy to the energy balance fell by a further 2.2 % to 7.6 % due to lower availability (2012: 8.0 %) (AGEB 2014). The total share of renewables rose by just under 5 % in 2013, while total consumption increased slightly to 11.5 % (previous year: 11.3 %). The share of other sources of energy in covering energy demand amounted to less than 2 %.

As a highly developed industrialised country and one of the world‘s largest energy consumers, Germany has to import most of its fuel. Based on the value of all imported goods, fuel accounted for 99.4 billion Euros and thus the largest share of import costs in 2013. Crude oil and natural gas accounted for the largest share of the cost of fuel, at around 56 % and 38.1 % respectively. Coal (4.8 %) and nuclear fuels (0.8 %) accounted for the remaining costs (BGR 2014).

Only around 2 % of crude oil and about 12 % of natural gas came from domestic production (Fig. 4), because of declining production rates of domestic oil and gas fields due to natural depletion. When subsidies for domestic hard coal mining are stopped in 2018, the share of domestic bituminous coal will disappear altogether.

Lignite is the only economically producible non-renewable energy resource in Germany with large reserves and resources. Germany can cover all of its own demand from domestic sources, and is the largest consumer of lignite worldwide. In a ten-year comparison, the share of lignite in primary energy consumption is unchanged, while the shares of the other domestic, non-renewable sources of energy have fallen. As expected, nuclear energy reported the strongest decline in the share of primary energy consumption, and thus a significant loss of importance. Of all sources of energy, only the renewables gained strongly in importance, including geothermal energy, whose share in absolute terms is relatively small, however. Despite the rising share of renewables, Germany's dependency on the import of fossil fuels can be expected to increase further in the future, because of the natural depletion of domestic conventional deposits of crude oil and natural gas, and the phasing out of subsidies for hard coal.

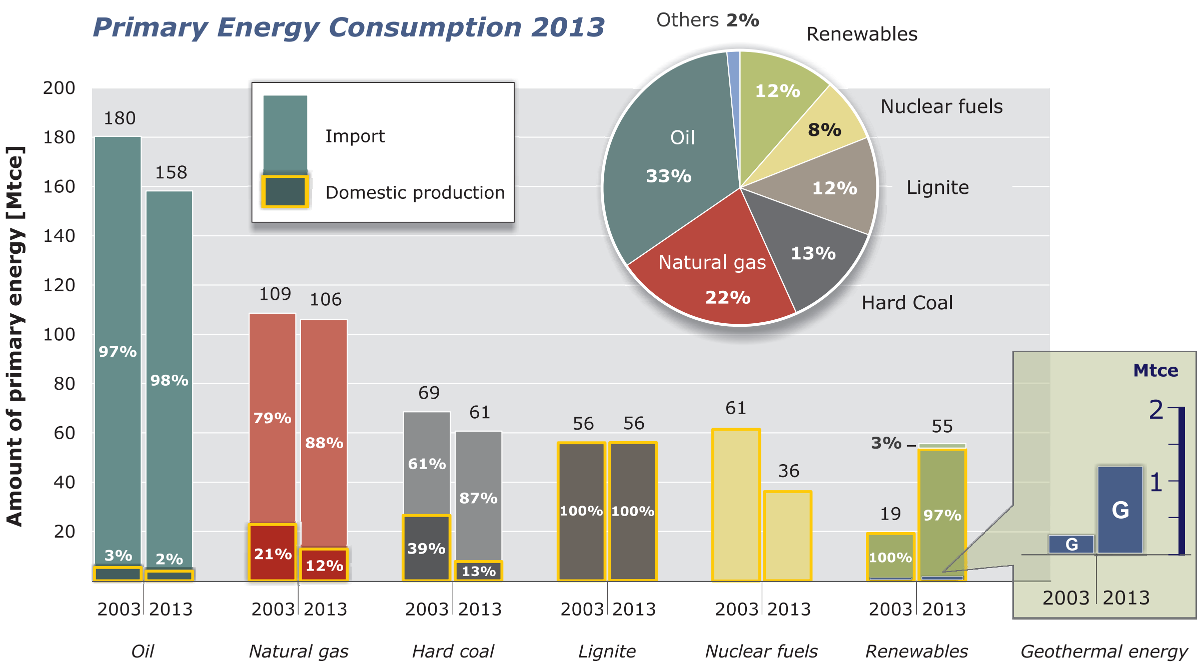

Fig. 4: Comparison of the use of primary sources of energy and of the ratio of domestic supply to imports for Germany in 2003 and 2013, and relative shares in 2013 (based on AGEB 2014, LBEG 2014).

Germany applies as candidate to the Extractive Industries Transparency Initiative EITI

In July 2014, the German federal cabinet officially announced it was taking steps to apply as a candidate to the Extractive Industries Transparency Initiative (EITI). This entails the introduction of disclosure requirements for companies in the domestic extractive industries. EITI is a global initiative whose aim it is to promote the transparency of payment flows from mining companies to governments. While the initiative has to date been implemented mostly by developing countries, a number of G7 nations have either joined or announced their intention to join EITI since 2013. Currently (as of November 2014), EITI has 48 member countries. Thirty-one of these have fully implemented the EITI standard, while 17 have candidate status. More than 90 companies from the mining and energy sector support EITI, among them industry giants such as BP, Rio Tinto, Glencore and Shell.

The initiative promotes standards obliging companies in the extractive industries to disclose their payments to governments. At the same time, governments have to disclose revenues from the extractive industries. Under EITI, each country must form a multi-stakeholder group (MSG), consisting of representatives from government, the extractive companies and civil society organisations. Together, they have to develop concrete rules for the implementation of EITI in their country and monitor the implementation process.

Germany has appointed Uwe Beckmeyer, Parliamentary State Secretary at the Federal Ministry for Economic Affairs and Energy (BMWi), as Special Representative for EITI. Currently the MSG, who will agree the details of the German reporting standard, is being set up. The MSG's duties will initially consist of submitting a work schedule and specifying the area of application of EITI in Germany. The payments concerned are, in particular, taxes and licensing fees related to extraction. In Germany, EITI is likely to apply to lignite, bituminous coal, crude oil and natural gas. Germany will then be able to submit an application to EITI for candidate status. This is scheduled for 2015, when Germany will assume G7 presidency. Once a country has been given candidate status, it has to submit a first report within 18 months to obtain member status.

Coking coal as a "critical" raw material

On 26 May 2014, the EU Commission published a revised list of critical raw materials. It classifies as critical 20 raw materials for which the risk of a supply shortage over the next few years is particularly high, and which are considered particularly important for the value chain. This is an update of the 2011 report, to which coking coal has now been added. Raw materials were classified as critical based on two parameters: (1) their economic importance to branches of industry in the EU, and (2) the supply risk. This also takes into account assessments of the availability of substitutes for these raw materials and their recyclability. In many cases, a raw material has no easily available substitutes and its recycling rate is low to non-existent. Coking coal was assigned critical status by the European Commission, as it is sourced mainly from two countries, China and Australia, which makes the supply risk relatively high. The economic importance of coking coal was assessed as very high, because it is an essential raw material for coking, and thus for the production of pig iron and steel, for which there is no real suitable substitute at present. Moreover, coking coal cannot be recycled (EC 2014).

In view of this update of the list of critical raw materials by the European Commission, the German Federal Ministry for Economic Affairs and Energy (BMWi) has amended the rules of the German government's exploration support programme. This provides funding for projects related to a total of 24 raw materials or groups of raw materials, which now include coking coal. The BMWi had set up the exploration support programme as part of the German government's raw materials strategy (BMWi 2010), in force since 1 January 2013, whose aim it is to improve Germany's supply of critical raw materials. The German Mineral Resources Agency (DERA), part of the Federal Institute for Geosciences and Natural Resources (BGR), has been commissioned by the BMWi to provide expert support for the programme (DERA 2014).

The list of raw materials compiled by DERA in 2012 (DERA 2012) includes raw materials with a high country concentration in production, which have an increased country risk. The resulting classification as a potentially critical raw material indicates higher price and supply risks. The revised list of raw materials compiled by DERA in 2014 (DERA – in progress) for the first time includes an assessment of coking coal. In view of the country concentration in mining, coking coal is in a potentially critical range, because production is limited to relatively few countries. In terms of the country risk, coking coal is classified as moderately critical, since the major producing and supplier countries include a relatively large number of countries with a low country risk, particularly the United States but also Australia and Canada.

2.2.2 Individual energy resources

Crude oil

At the end of 2013, Germany‘s proven and probable reserves of crude oil amounted to around 31.5 million t, i.e. over 1 million t less (down 3.2 %) than in the previous year. This decline is largely related to annual production and based on an updated calculation of reserves in existing fields (LBEG 2014). While reserves in the German states of Rhineland-Palatinate, Lower Saxony and Mecklenburg-Western Pomerania increased slightly, the new evaluation of the largest German oil field at Mittelplate/Dieksand in Schleswig-Holstein resulted in a drop of 1.2 million t (down 9.2 %). There were no new discoveries in the reporting period.

At 2.64 million t, Germany‘s production of crude oil and condensate in 2013 slightly exceeded the previous year‘s level by 0.6 %. There were a total of 49 oil-producing fields with 1,077 production wells. The Mittelplate/Dieksand field increased production to 1.45 million t, thus contributing almost 55 % to domestic crude oil production. Annual production at the next fields on the list, Rühle (Lower Saxony) and Römerberg (Rhineland Palatinate), amounted to 0.2 million t each (LBEG 2014). Condensate had a share of around 0.8 % (20,161 t) in total gas production in 2013. About a third of this accrued during production in the A6/B4 natural gas field in the German sector of the North Sea. On the fields at Emlichheim, Georgsdorf and Rühle, enhanced oil recovery (EOR) methods such as steam flooding and hot water flooding were used to improve the recovery rates. Compared to the previous year, additional production as a result of EOR activities fell by 0.65 % to 317,562 t (previous year: 330,120 t). By the end of 2013, Germany‘s cumulative production of crude oil and condensate amounted to about 296 million t.

The major domestic oil companies in 2013, based on their consortium shares and annual production figures, were (WEG 2014):

- Wintershall Holding AG 1,012,744 t
- RWE Dea AG 746,352 t
- GDF SUEZ E&P Deutschland GmbH 436,723 t
- BEB Erdgas und Erdöl GmbH & Co. KG 265,923 t

At the end of 2013, the German oil and gas industries employed 10,085 people, 202 more than in the previous year (WEG 2014).

German crude oil imports in 2013 fell by around 3 million t to 90.4 million t, thus reducing expenditure on annual crude oil imports by EUR 4.8 billion to EUR 55.3 billion. The major supplier regions have been the same for years: the CIS states, Europe and Africa (Fig. 5). The leading supplier countries are Russia, Norway and Britain, who jointly provide more than 57 % of German imports. Higher exports from countries such as Norway, Kazakhstan and Azerbaijan largely balanced out reduced supplies from Russia, United Kingdom and Libya (AGEB 2014, BAFA 2014a).Germany has more than 30 supplier countries, and thus highly diversified crude oil imports. Table 7 (in the appendix) provides an overview of all crude oil supplier countries in 2013.

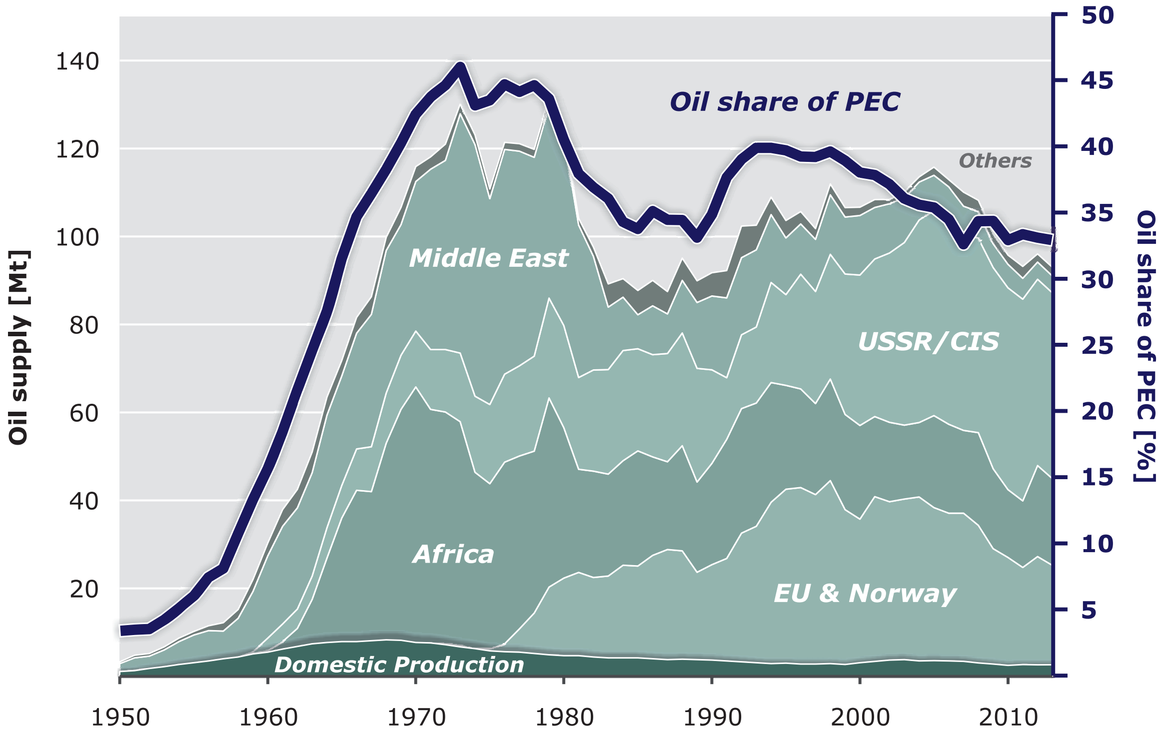

Fig. 5: Germany's crude oil supply 1950 - 2013.

Exports of crude oil to neighbouring countries fell by 80 % to around 34,000 t compared to the previous year (194,000 t). At the same time, the trade in petroleum products expanded, mostly with EU countries. Imports of crude oil products rose by 17 % to 37.65 million t (2012: 32.2 million t) and exports by 8 % to 20.2 million t (2012: 18.7 million t) (BAFA 2014a). The crude oil volumes produced by German companies abroad fell by 28 % compared to the previous year to 6.67 million t (2012: 9.3 million t). This was largely due to the production decline in Libya towards mid-2013, which affected Wintershall AG and Suncor Energy Germany GmbH. By contrast, crude oil production in countries such as Norway and Britain rose and was increased with the purchase and start-up of new fields.

The major German oil producers in 2013, based on their consortium shares abroad and annual production figures, were (EEK 2014, WEG 2014):

- Wintershall Holding AG 3,139,752 t
- RWE Dea AG 1,242,126 t
- E.ON Ruhrgas AG 1,023,000 t
- Suncor Energy Germany GmbH 848,792 t
- Bayerngas Norge AS 290,000 t
- EWE AG 81,565 t
- VNG-Verbundnetz AG 40,551 t

Natural gas

At the end of 2013, Germany had proven and probable natural gas reserves of 103.6 billion m^3 (Vn) of raw gas (down 15.9 % on 2012) and 96.5 billion m^3 (Vn) of clean gas (down 16.5 %), a considerable reduction from 2012. A comparison of current reserves with the previous year's reserves adjusted for production shows a negative balance for natural gas reserves in Germany. Due to the re-evaluation of some fields, additional reserves adjustments were required: raw gas reserves had to be revised downward by 9 billion m^3 and clean gas reserves by 9.4 billion m^3 (LBEG 2014).

In the reporting year 2013, natural gas production in Germany fell by roughly a further 1 to 10.7 billion m^3 (Vn) of raw gas and 9.7 billion m^3 (Vn) of clean gas. This is equivalent to a reduction by 8.8 % for raw gas and by 9.1 % for clean gas compared to the previous year. The continued decrease in production and in natural gas reserves is mostly the result of the advancing depletion of the large reservoirs. There have been no significant new discoveries in recent years and the produced volumes of natural gas have thus not been replaced with additional reserves.

Natural gas production in Germany amounts to 10.7 billion m^3, which includes only around 73 million m^3 of associated gas, mostly produced in Lower Saxony (61.3 %) and Schleswig-Holstein (27.6 %). In the reporting year, a total of 498 production wells were in operation, with most of the fields by far (94 %) located in Lower Saxony.

Definitions concerning natural gas in Germany

In Germany natural gas producing companies express production and reserves of natural gas both in terms of "raw gas volumes" for deposits and as "clean gas volumes" for natural gas as a commodity. Raw gas volumes refer to the volumes extracted from a reservoir, with natural calorific values that can vary considerably between individual reservoirs. All figures for clean gas relate to the upper calorific value Ho = 9.7692 kWh/m^3 (Vn), referred to as the "Groningen calorific value" in the German gas industry. It is used as a reference value in the gas sector (LBEG 2014).

Based on their consortium shares, five companies produced almost 100 % of domestic clean gas in 2013 (WEG 2014):

- BEB Erdgas und Erdöl GmbH — 4.158 billion m³
- Mobil Erdgas-Erdöl GmbH — 2.470 billion m³
- RWE-Dea AG — 1.554 billion m³
- GDF SUEZ E&P Deutschland GmbH — 0.898 billion m³
- Wintershall Holding AG — 0.644 billion m³

About 40 % of domestic natural gas reserves contain varying levels of hydrogen sulphide (H_2S). Natural gas with H_2S (sour gas) is produced mainly from fields in the production area between the Weser and Ems rivers. Around 0.75 million t of elemental sulphur accrued in the processing of sour gas in the plants at Großenkneten and, less so, Voigtei. The sulphur is used in the chemical industry and some of it is exported.

While natural gas from tight sandstones has been extracted in Germany for many years, the exploration of natural gas deposits in shales (shale gas) was discontinued following only a brief exploration stage. There is much controversy in Germany surrounding the extraction of natural gas from such rocks, because of the possible environmental impact of the required fracking technology. It is impossible to say whether shale gas could be produced at all, and, if so, when. The volumes of natural gas which can potentially be exploited (resources) in Germany are estimated to range from 0.7 and 2.3 trillion m^3 (BGR 2012). Additional natural gas resources amounting to 0.45 trillion m^3 and 0.09 trillion m^3 respectively are inferred to exist in coal seams and tight gas deposits.

Natural gas production by German companies abroad (CIS/Russia, South America, Europe, North Africa) amounted to around 23.3 billion m^3 in the reporting year, a rise of 2 % compared to 2012 (EEK 2014). Wintershall AG, Germany's largest internationally active crude oil and natural gas producer, again recorded the highest production figures in 2013, with a share of about 62 %. The group focuses its business in Europe, North Africa, South America, Russia and the Caspian Sea region. It has stepped up activities in the Middle East. Wintershall is one of the major producers of natural gas in the Netherlands. E.ON E&P GmbH (previously E.ON Ruhrgas AG) produced the second largest volume of natural gas among German companies abroad in 2013. They were able to increase production by about 4 % compared to 2012, but did not quite reach their 2011 level.

Only just under 12 % of the natural gas volume used in 2013 (previous year: 13 %) was from domestic production (Fig. 4), the rest had to be imported. All of Germany's imports of natural gas are pipeline-based. For many years, they have originated largely from Russian sources. In terms of the energy content, Russia's share in 2013 amounted to just under 39 % (Fig. 6). A share of over 29 % was imported from Norway.

Germany has been connected to Russian natural gas fields via pipelines since the 1970s. Recently, the 1,224 km Nord Stream pipeline was added. The two lines of this natural gas pipeline run from Vyborg in Russia through the Baltic Sea to Lubmin near Greifswald in Germany. The first line was commissioned in mid-November 2011, the second parallel line started operation in October 2012. The entire pipeline has a maximum annual discharge of 55 billion m^3 of gas and connects Germany directly with the Russian gas fields in Western Siberia. One of the most important is the Yuzhno-Russkoye oil and gas field. It is owned by Gazprom, with shares held by the German companies E.ON and Wintershall. It is one of the larger natural gas fields in the world, with a maximum annual production capacity of 25 billion m^3.

The Nord Stream pipeline would have more than enough capacity to supply Germany with the required volumes of natural gas. However, the gas is destined for other European consumers as well: from Lubmin, it is delivered to Belgium, Denmark, France, United Kingdom, the Netherlands and other countries.

The total calculated volume of natural gas in Germany, comprising gas from domestic production and imports, amounted to 111 billion m^3 in 2013. About 20.9 billion m^3 of this were exported again and 0.9 billion m^3 were taken from German gas storage sites, taking into account the quantities stored in 2012. The value of natural gas imports from Russian, Dutch, Norwegian, Danish and British production areas totalled EUR 28.7 billion, compared to EUR 29.4 billion the previous year.

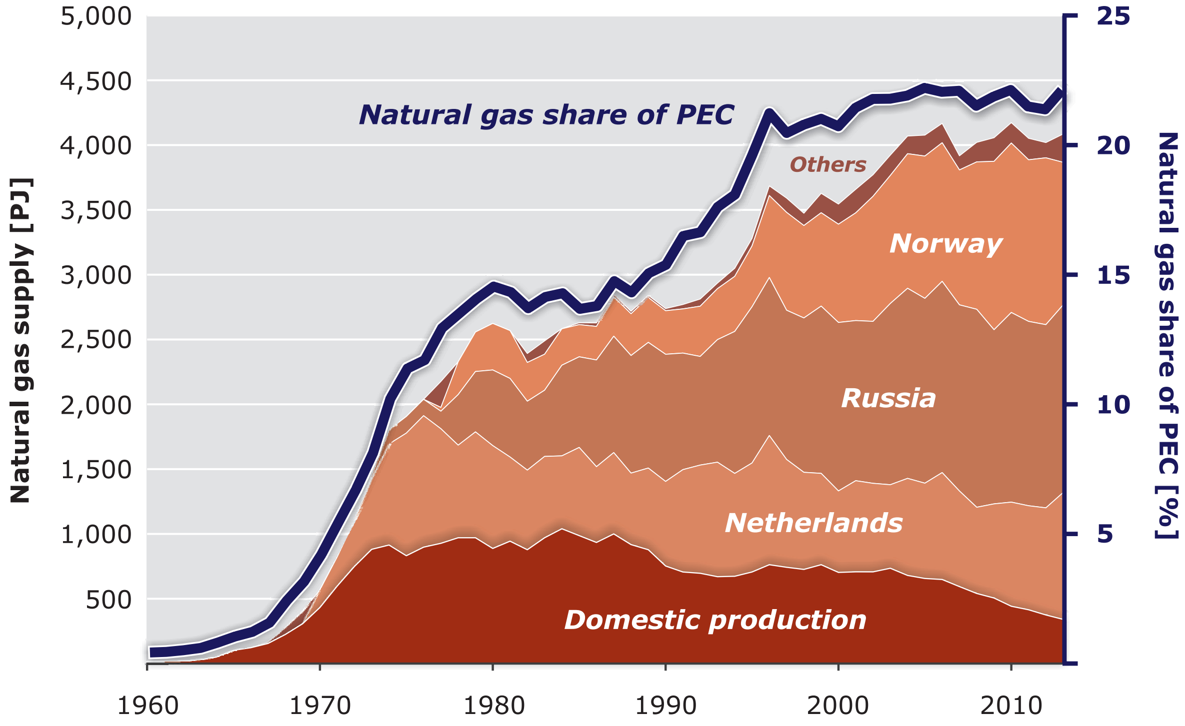

Fig. 6: Germany's natural gas supply 1960 - 2013.

Hard coal

Until the middle of the twentieth century, domestic hard coal was a major pillar of economic growth in Germany. Since then hard coal production has been in decline. The highest production figures after 1945 were recorded in 1956, with 151.4 million t of usable production (Fig. 7). In 2013, that figure had dropped to 7.6 million t (5 % of the 1956 level). In recent decades, domestic hard coal has been replaced with crude oil, natural gas and uranium, and especially with imported coal (Fig. 8). Germany has total resources (reserves plus resources) of hard coal of about 83 billion t. By the end of 2018, it will probably be possible to extract around 31 million t of that total.

In the Ruhr mining area, the Auguste Victoria and Prosper-Haniel mines still accounted for 74.7 % (5.7 million t of usable production) of German hard coal production in 2013. Production from one mine in the Ibbenbühren mining area amounted to 25.3 % (2.0 million t of usable production) of German hard coal production. Hard coal mining in the Saar mining area was discontinued at the end of June 2012. Throughout Germany, production per shift in 2013 fell slightly to 6,624 kg of usable production, and thus by 3.7 % compared to the previous year. Total sales of German hard coal in the reporting year decreased by 30.1 % or 3.6 million t to 8.4 million t (SDK 2014).

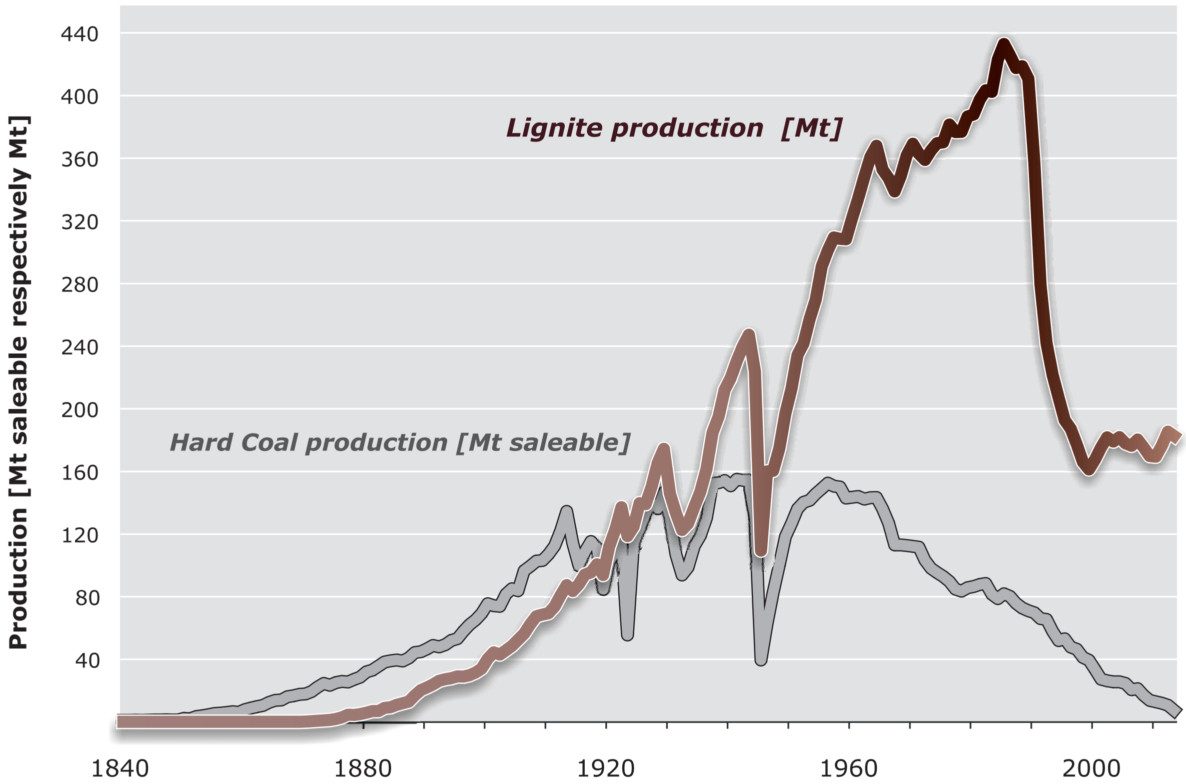

Fig. 7: Development of German coal production from 1840 to 2013 (based on SDK 2014).

For many years now, German hard coal mining has not been able to compete internationally, particularly because of unfavourable geological conditions. This is why it will probably not be possible to produce hard coal in Germany at world market prices in future. According to estimates by the German Coal Importers Association (Verein der Kohlenimporteure e.V., VDKI), average production costs in Germany amounted to 180 EUR/tce in 2013. By contrast, the average annual price of imported steam coal was 79.12 EUR/tce (VDKI 2014a). In order to still help safeguard the supply of hard coal to power plants and steel works, and to support the job market for political reasons, domestic hard coal mining receives public subsidies. In the 2013 reporting year, EUR 1.761 billion of public funds were pledged to the hard coal mining industry.

In February 2007, the German federal government and the states of North Rhine-Westphalia and Saarland agreed to phase out subsidised hard coal production in Germany in a socially responsible manner by the end of 2018. This agreement was due to be reviewed by German parliament in 2012. However, with the amendment of the law to phase out subsidies for hard coal mining (Steinkohlefinanzierungsgesetz) in spring 2011, the so-called review clause was omitted. Maximum subsidies for 2014 that have already been granted will be reduced to EUR 1.649 billion. Employment in German hard coal mining has fallen since 1958. In the reporting year, the number of employees fell by 17.4 % compared to 2012 to 14,549 (end of year 2013).

Consumption of hard coal in Germany was slightly higher in 2013 than in the previous year, rising by 4.1 % to around 61 million tce. The share of hard coal in primary energy consumption thus rose to 12.8 %. Of the hard coal used in Germany in 2013, only about 13 % was from domestic production. This continues the increase in the share of imported coal in total hard coal consumption in Germany. Imports of hard coal and coke amounted to 52.9 million t (AGEB 2014, VDKI 2014a).

Imports of hard coal and hard coal products rose significantly, by 10 %, to 52.9 million t compared to 2012 (Table 9 in the appendix). They originated largely from Russia, the United States, Colombia, Poland, Australia and South Africa (Fig. 8). Russia was again the most important supplier in 2013, with about 13.1 million t (24.8 %), followed closely by the United States (22.8 %) and Colombia (18.9 %). Imports from Poland, the only remaining EU-28 major coal exporter, rose slightly by 0.35 to about 4.3 million t, with coke accounting for 1.3 million t (VDKI 2014a). The share of imports in Germany's total hard coal demand rose further, to around 87 % in 2013. This development is likely to continue in the next few years, following further mine closures.

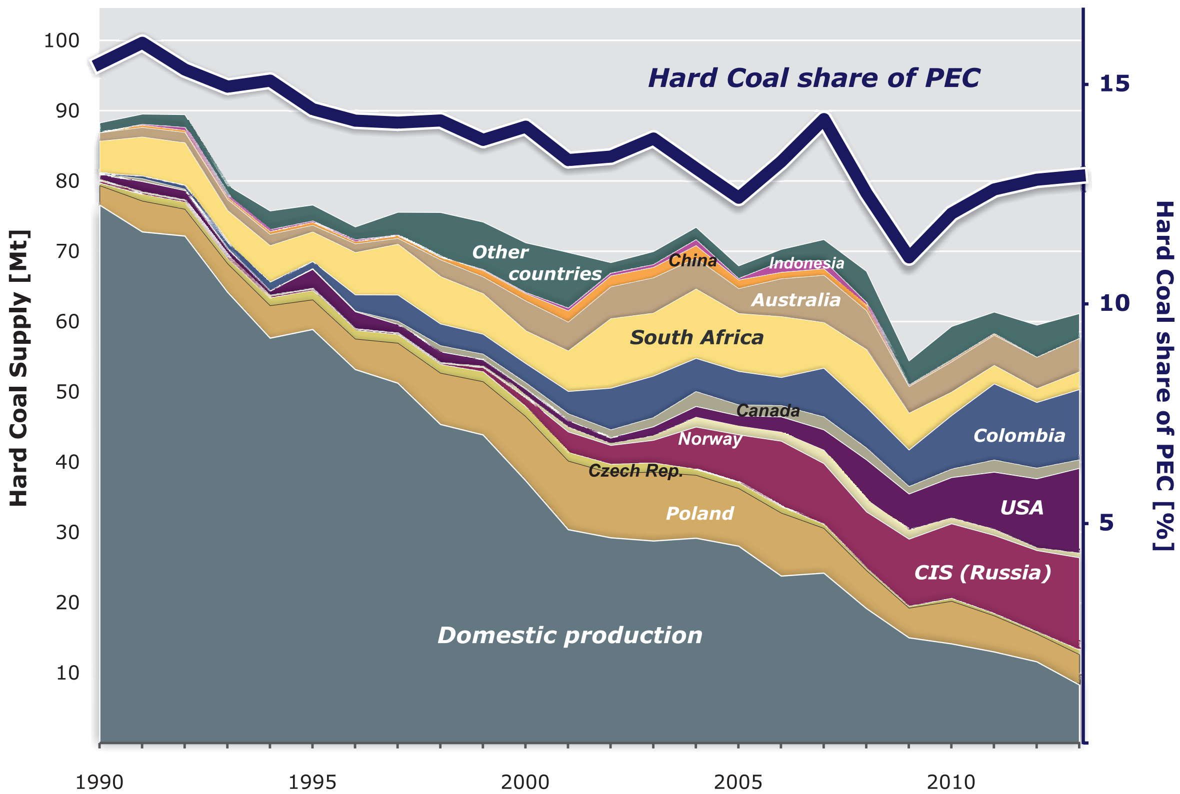

Abb. 8: Germany's bituminous coal supply from 1990 to 2013 (SDK 2013, IEA 2014b, AGEB 2014).

Prices (here: border prices) for imported steam coal fell almost continuously, from around 86 EUR/tce at the beginning of 2013 to around 77 EUR/tce at the end of the year. The average annual price was 79.12 EUR/tce (down 15 % on 2012). Prices developed along the same lines for coke, though with a drop by almost a third (down 30 %) compared to the previous year, and an annual average price of 204.88 EUR/t. The price of imported coking coal fell even further. Compared to the previous year, the average annual price dropped by 32.5 %, from 188.42 to 127.19 EUR/t (BAFA 2014b, VDKI 2014a, b). Because of an oversupply of both coking coal and steam coal on the global coal market, this price decline continued into 2014.

Lignite

Unlike hard coal, German lignite can compete with imported energy resources without subsidies. Favourable geological conditions of the deposits permit the use of efficient surface mining technology, so large volumes can be sold at market prices to local power plants for power generation. Germany has been the world‘s largest producer of lignite since industrial lignite mining started.

Lignite reserves of 5.2 billion t are accessible in Germany from developed and planned surface mines. Further reserves amount to 35.1 billion t, with resources totalling 36.5 billion t.

Lignite in Germany is mined in four areas. Total German production in 2013 amounted to 182.7 million t and thus 1.3 % less than in the previous year (Fig. 7). In the Rhenish lignite mining area, RWE Power AG operates three surface mines, Garzweiler, Hambach and Inden, with a combined production of 98.6 million t in 2013. The Garzweiler and Hambach surface mines supply lignite to the Frimmersdorf, Goldenberg, Neurath and Niederaußem power plants via a rail link. The Inden mine supplies the Weisweiler power plant. Production in the Lusatian lignite mining area, amounting to 63.6 million t in the reporting year, came from five surface mines, Jänschwalde, Cottbus-Nord, Welzow-Süd, Nochten and Reichwalde, all operated by Vattenfall Europe Mining AG. Almost all the lignite is sold to the upgraded or newly built Jänschwalde, Boxberg and Schwarze Pumpe power plants owned by Vattenfall Europe Generation AG & Co. KG. Production in the Central German lignite mining area in 2013 amounted to 19.6 million t, primarily from the Profen and Vereinigtes Schleenhain surface mines of Mitteldeutsche Braunkohlengesellschaft mbH (MIBRAG), which, since 2012, has been part of the Czech holding company EP Energy. Most of the lignite from the two surface mines is used for power generation in the Schkopau and Lippendorf power plants. Lignite extracted from the Amsdorf surface mine of Romonta GmbH is used mainly to produce montan wax. The Schöningen surface mine in the Helmstedt mining area, with production amounting to 1.2 million t in 2013, supplies the Buschhaus power plant. In the second half of 2013, MIBRAG bought the mine and power plant (Helmstedter Revier GmbH – HSR) from E.ON Kraftwerke GmbH (DEBRIV 2013, SDK 2014).

Total sales of lignite in 2013 fell by 1.3 % to 172 million t, slightly reducing the share of lignite in primary energy consumption to 11.7 % (55.5 million tce). Sales both of lignite briquettes and of pulverised lignite increased from the previous year. Briquette sales rose by 1.9 % to 2 million t, and sales of pulverised lignite by 3.7 % to 4.9 million t. The workforce was reduced slightly in the reporting period. Throughout Germany, 16,410 people were employed in lignite mining (AGEB 2014, SDK 2014).

The balance of trade for lignite and lignite products was positive in 2013, though at a slightly reduced level. Total imports increased to 92,000 t, while exports (of briquettes, coke, pulverised coal and lignite) fell slightly, by 1.7 %, to 1.64 million t. The main customers are the EU-28 countries (SDK 2014).

Nuclear energy

One key element of the energy transition in Germany is the phasing out of nuclear power. With its thirteenth amendment of the Atomic Energy Act on 6 August 2011, the German government decided to stop the use of nuclear energy for commercial power generation. Under this law, the last nuclear power plant in Germany will cease operation by 2022. For the first time in the history of the Federal Republic, there is thus a fixed date for an end to nuclear energy in Germany. The phase-out will be gradual, with precise shut-down dates for the individual power plants. These nine power plants still in operation will be shut down at the end of the given year: 2015 – Grafenrheinfeld, 2017 – Gundremmingen B, 2019 – Philippsburg 2, 2021 – Grohnde, Gundremmingen C and Brokdorf, 2022 – Isar 2, Emsland and Neckarwestheim 2.

German power plants generated 633.6 TWh of electricity, about 0.6 % more than the previous year (2012: 629.8 TWh). At the same time, the share of nuclear energy in gross power generation fell further, by 2.2 %, to 97.3 TWh, compared to 99.5 TWh in 2012. Net power generation amounted to 92.1 TWh (2012: 94.2 TWh). Before the shut-down of eight nuclear power plants in 2011, 17 plants with a gross output of 21,517 MW_e had been in operation. The remaining nine nuclear power plants with 12,696 MW_e (gross) were still in operation at the end of 2013. The energy availability factor and load factor were 89.24 % (2012: 91.1 %) and 88.67 % (2012: 90.7 %) respectively.

The demand for natural uranium fuel amounted to 1,900 t. This was met with imports and from stocks. Almost all the natural uranium required for the production of fuel was sourced based on long-term contracts with producers in France, Britain, Canada and the United States. There has been no production mining of natural uranium in Germany since the Sowjetisch-Deutsche Aktiengesellschaft (SDAG) WISMUT was closed in 1990. In 2013, however, as part of the treatment of flooding water by the Königstein remediation company, 27 t of natural uranium were separated and stored (2012: 50 t).

2013 was the 23rd year of decommissioning and remediation work at the former production site of SDAG WISMUT. This work is carried out by Wismut GmbH on behalf of the German Federal Ministry for Economic Affairs and Energy (BMWi) and assessed by the Federal Institute for Geosciences and Natural Resources (BGR), who also provides expert support. The key remediation objectives (decommissioning and flooding of the mines, water treatment, disassembly and demolition of contaminated mines and cavities, rehabilitation of mining dumps and tailings ponds, environmental monitoring) have been 80 % met. Of the EUR 7.1 billion made available, around 81 % (EUR 5.8 billion) had been spent by the end of 2013. In addition to the remediation of the mining dumps and sites, and the decommissioning of the industrial tailings ponds, the remaining work will focus on the treatment of the contaminated water from the mine flooding and the tailings ponds. About 22 million m^3 of contaminated water were treated and discharged into the dry wells in 2013. The work to drive a 2,900 m long connecting gallery, the so-called WISMUT-Stolln, from the Dresden-Gittersee mining fields to the Tiefer-Elbstolln gallery was completed in June 2014. At present, the gallery is being connected to the flooded pit via boreholes. Once mine decommissioning at the Königstein site was complete, demolition of the mines and the related structures started in August 2014. The backfilling of the last two shafts (#388 and #390) at the Königstein mine in April 2013 ended 50 years of mining history.

The Königstein site will, however, remain at the centre of the remediation work by Wismut GmbH, because of the geochemical environment in the pit cavity resulting from the in-situ leaching process used in the past. This environment will continue to mobilise metal-rich solutions for a long time, so the flooding water will need to be treated. Work to drive another gallery (southern shaft of the medieval Markus-Semmler-Stollen) at the Aue site of Wismut GmbH (located at Schlema-Alberoda) started back in 2011. This aims to ensure the safe discharge of pit waters without requiring any power. Of a projected total length of 1,155 m, 955 m had been driven by the end of 2013. This work will be completed in 2014.

Deep geothermal energy

Geothermal energy is a base load capable, demand-driven source of energy. Classed as renewable, it is considered almost inexhaustible on human time scales. Geothermal energy consists of heat in the Earth's interior originated from the formation of the planet and heat generated due to the decay of naturally occurring radioactive isotopes in the Earth's interior. Depending on location, solar heat will increase only the temperature in the upper tens of metres.

In general, a case discrimination is made between near-surface geothermal energy to a depth of 400 m (in some cases only to 150 m) and deep geothermal energy, starting at depths of 400 m (in the strict sense, below 1000 m). Both are used to provide thermal energy, but only in deep geothermal areas electrical power can be generated, as temperatures here are sufficiently high. Although near-surface geothermal energy accounts for the largest share of almost two thirds in geothermal energy use, this study focuses on deep geothermal energy only, since this originates exclusively from the Earth's interior.

There are two types of reservoirs suitable for the exploitation of deep geothermal energy: Firstly, the thermal energy stored in deep naturally thermal water-bearing layers (hydrothermal); and secondly, the thermal energy stored in solid rock (petrothermal). Consequently, petrothermal reservoirs can be exploited only after a stimulation has been performed.

In Germany, the use of geothermal energy is promoted with market incentives and legislations. The Renewable Energies Act (Erneuerbare-Energien-Gesetz, EEG) adopted in 2000 guarantees feed-in tariffs for electricity generated from geothermal energy over a period of 20 years. The last amendment of the EEG was made in 2014. Currently the feed-in tariff amounts to 25.20 euro cents per kilowatt hour, with an annual reduction of five percent scheduled to begin in 2018.

In 2013, deep geothermal energy contributed 0.24 % to the total primary energy consumption in Germany, i.e. remaining quite low and hence of no significance for the German energy supply as of yet (AGEB 2014). Still, the use of geothermal heat has been increasing steadily since the mid-1990s. The direct use of geothermal energy for heating is possible at low temperatures and thus the use of shallow depths. Costs to develop these shallow reservoirs are relatively low. In Germany, the use of these layers for the generation of geothermal power started with Neustadt-Glewe in 2003. Ten years later, seven plants with a total installed capacity of 31.3 MW were in operation, producing 80 GWh_e of electricity. A total of 26 district heat plants with an output of 300.4 MW produced 870 GWh_{th} of heat (Fig. 9). Four of these plants are combined heat and power plants. At present, most of the geothermal power plants are situated in Bavaria with 19 plants in total. The ones with the highest performance are Insheim (Rhineland-Palatinate) and Unterhaching (Bavaria), each with an installed capacity of 38 MW_{th} and 3.36 MW_e (information by the operator). According to the German Geothermal Energy Association (Bundesverband Geothermie e.V., GtV), nine projects are currently under construction, and 38 projects are in their planning phase, including the first petrothermal (EGS) plant (GtV, status as of July 2014).

In Germany, a continuous increase from 0.4 to 80 GWh in geothermal energy was observed between the years of 2007 to 2014 (BMWi 2014). It can be assumed that this development will continue in the midterm, though a rapid increase is not to be expected. Despite a number of already successful ongoing projects, geothermal energy for power generation is still at a level of research and development in Germany. Regarding thermal energy, the Alpine Foreland is, and will be for the foreseeable future, the most prominent region for geothermal uses. This is due to the fact that the sedimentary Molasse Basin has in particular favourable properties for geothermal use, e.g. appropriate permeability. Overall, an increase of installed capacity from deep geothermal energy is expected in Germany, ‘from about 200 MW_{th} in 2011 to over 300 MW_{th} in 2015 with an annual heat production of about 1,075 GWh (Weber et al., 2015).

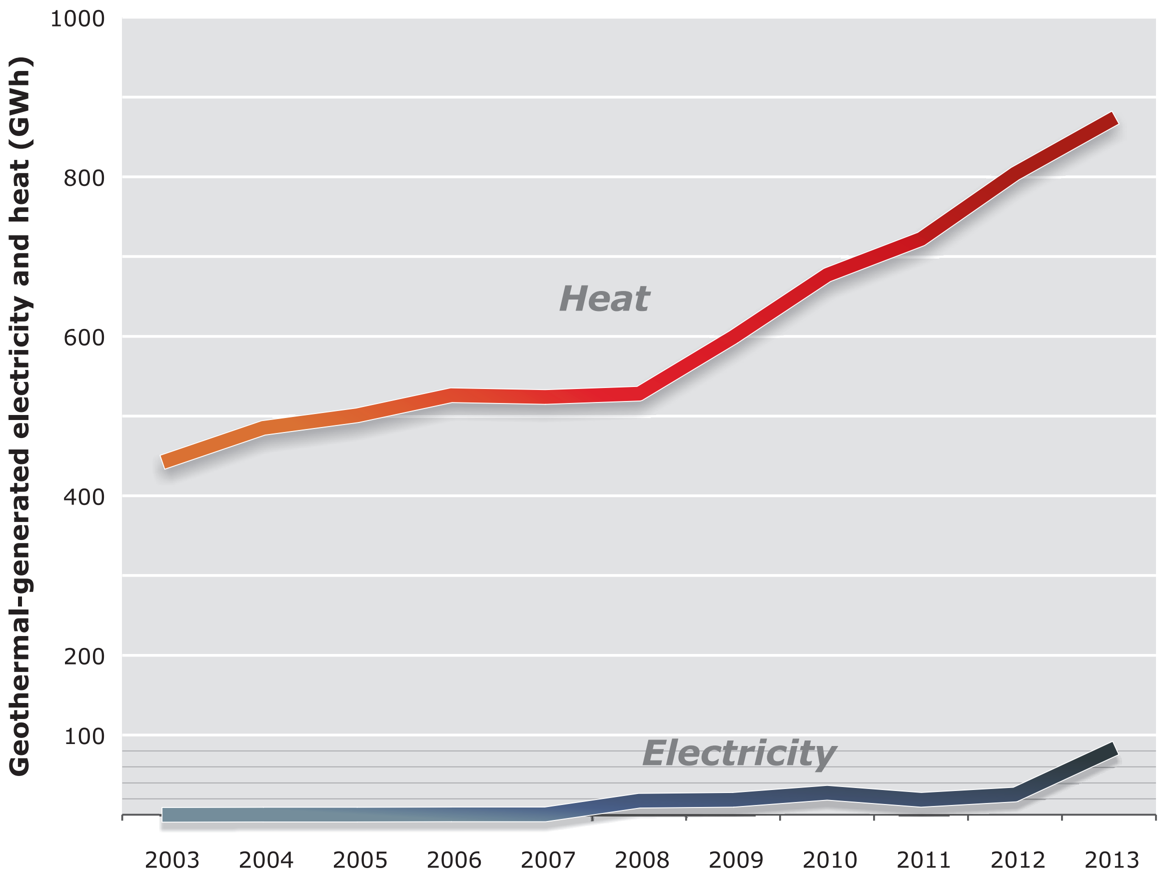

Fig. 9: Power and heat generated in geothermal plants in the time period 2003 - 2013.

Despite its minor significance to date, geothermal energy has the potential to make a considerable contribution to the primary energy demand. Germany is estimated to have a technical hydro geothermal energy potential of 12 EJ/year for electricity and 17 EJ/year for heat energy (Paschen et al., 2003). Three regions offer the best geological conditions for geothermal exploitation: the North German Basin, the Upper Rhine Graben, and the Molasse Basin of the Alpine Foreland.

Geothermal energy is used locally. Hence, there is no export in the classical sense, despite generated power feed-in into interconnected power grids. There are, however, a number of cross-border projects. These include the current prospecting area at Rupertiwinkel, a joint Austro-German project by the province of Salzburg and Bavaria. Another example is the collaboration between several nations on the EGS pilot project at Soultz-sous-Forêts. The project started in 1987 and reached production phase in 2010. GEOSTRAS, another Franco-German project, is also situated in the Alsace region. It is the only geothermal energy project among 19 low-carbon energy projects selected by the European Commission for the NER 300 programme. It is projected to generate 6.7 MW_e of power and 35 MW_{th} of heat.

3 ENERGY RESOURCES IN THE GLOBAL ENERGY SUPPLY SYSTEM

3.1 Crude oil

Crude oil is still the most important source of energy both worldwide and in Germany, with a share of around 33 % in primary energy consumption. Once more, oil production increased slightly (1.6 %) to an all-time high of 4,202 million t (2012: 4,137 million t).

Compared to the previous year, crude oil resources (both conventional and non-conventional) rose by about 3 billion t to around 334 billion t in 2013 (Fig. 10). Conventional resources on their own remained more or less at the same level of 161 billion t. Because of better data availability, the level of resources in some European countries such as Norway, the United Kingdom or Denmark was assessed as being slightly higher. Volumes of non-conventional crude oil resources rose slightly as well. There was a minor increase of over 2 billion t in crude oil resources from tight rocks (tight oil, shale oil) in Canada. Data for oil shale resources have improved in that there is for the first time an assessment for Serbia. This and other minor adjustments resulted in an increase by 4.8 % to almost 102 billion t of crude oil potential from oil shale. The volumes of non-conventional crude oil resources (bitumen, extra heavy oil and oil from tight rocks) totalled around 173 billion t.

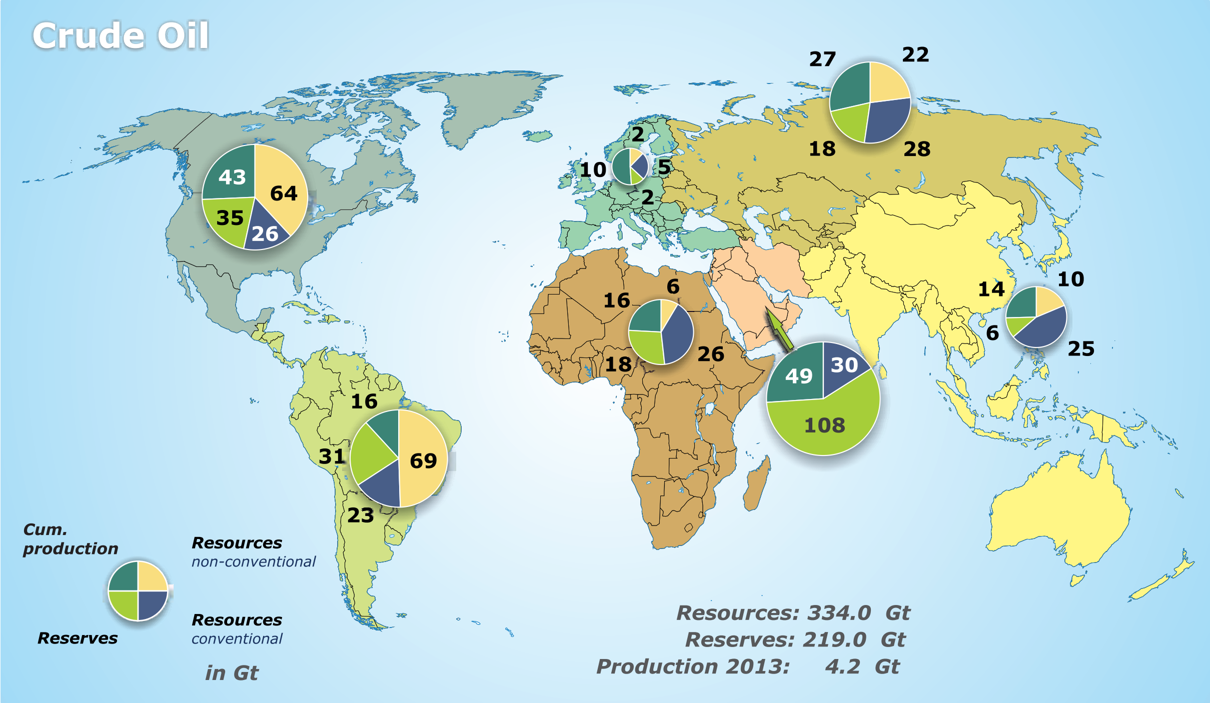

Fig. 10: Total crude oil potential in 2013: regional distribution.

The total crude oil reserves from conventional and non-conventional deposits rose by almost one percentage point from the previous year to 218.6 billion t. There was no major change in the ranking of the most important countries. For the first time, crude oil reserves from tight rocks (tight oil, shale oil) were reported for the United States and Canada, with 260 million t and 68 million t respectively. The share of crude oil reserves from non-conventional deposits amounted to around 22 % of total reserves.

Only five countries – Saudi Arabia, Canada, Venezuela, Iran and Iraq – accounted for 60 % of global reserves. The top 20 countries hold 93.5 % of the reserves, while the remaining 6.5 % are distributed over 83 countries. All 12 OPEC countries, who own almost 70 % of global reserves, are included in the group of top 20 countries. Reserves are also clearly concentrated in specific regions. More than half of all crude oil reserves (just under 54 %) are found in the MENA region (North Africa and the Middle East), highlighting the major importance of this region for crude oil availability. Only about one percent of reserves were found in Europe. According to IEA (2013), about 80 % of all crude oil reserves are controlled by state-owned companies, with the remaining 20 % held by private enterprises. By the end of 2013, around 175 billion t of crude oil had been produced since the start of industrial oil production. Around 44.5 % of the original reserves (cumulative production plus reserves) of 394 billion t have thus been used up.

Global crude oil production rose slightly in 2013 by 1.6 % to currently 4,202 million t. The most important production regions were the Middle East, North America and the CIS. These countries and regions have to date contributed more than 67 % to global crude oil production. A share of just under 4 % originated from Europe, which stayed at the same level as the previous year. The countries with the highest production rates, Saudi Arabia, Russia and the United States, all had relatively similar rates of around 500 million t per year. The United States were able to further increase total crude oil production by 12 % compared to the previous year to 485 million t, particularly with a further growth of oil production from tight rocks. This brings US production rates closer to those of Russia and Saudi Arabia, which are almost the same at over 520 million t. If the increase in US production continues, the United States could certainly move to top position in crude oil production within a few years. China stayed in fourth place (208 million t, up 0.3 %), and has now overtaken Canada. By further expanding its crude oil production from oil sands, Canada was able to increase total oil production by 7.4 %, overtaking Iran, whose production fell by more than 4 % as a result of international sanctions. These major oil-producing countries have considerably expanded production: United Arab Emirates (6.9 %), Kuwait (8.6 %), Venezuela (4.4 %), Iraq (3 %) and Mexico (13,4 %). Norway increased production by over 3 %, thus staying in 14th place, while production in the United Kingdom fell further (down 8.8 %, 22nd place). In Libya, crude oil production had largely recovered by the start of 2013; however, as a result of recurring unrest from the middle of the year, it declined dramatically and fell sharply at the end of the year, by 33.6 % compared to 2012.

Global consumption of petroleum products rose by 2.5 % (104.7 million t) to 4,227 million t compared to the previous year. Data availability was much improved, with data recorded for 199 countries (previously 184). However, the increase in consumption did not only result from better data availability, but from higher consumption (up by 71 million t) in the major consumer countries such as the United States, China, Japan, India, Russia and Brazil. The strongest rises were recorded for regions such as Australasia and the Americas. Europe used 2.9 million t less petroleum (down 1 %). The OECD countries accounted for about half the petroleum consumption, with the United States in first place at almost 20 %, followed by China at 12 %.

Slightly lower volumes of crude oil were traded globally than in the previous year. Exports fell by 1.2 % to 2.1 billion t, with the biggest reductions in Africa, the Middle East, and Europe. This decrease was largely due to lower production levels in Nigeria, Algeria and Libya. The Americas, on the other hand, increased exports significantly, particularly Canada and Venezuela. With an exemption regulation, the United States were able to almost double oil exports to Canada to around 6.6 million t.

Global imports fell by 2.5 % to 2.1 billion t. The decline was strongest in North America and Europe, while the most significant increases occurred in the Middle East and Australasia. Because of the further rise in the domestic production of crude oil from tight rocks, the United States imported 38 million t less oil (down 9 %), while maintaining top position with total oil imports of 383 million t. India, Syria and China in particular had to considerably expand imports. Germany, which was in sixth place, imported about 90.4 million t of crude oil in 2013, around 3 million t less than in 2012.

The average annual price for the Brent benchmark fell slightly compared to the previous year, from 111.70 to 108.63 USD/bbl in 2013. The price ranged from 98.09 USD/bbl (mid-April) to 118.1 USD/bbl (mid-February), remaining at a relatively constant level over several weeks. The price development for the OPEC Basket was much the same as for the Brent price, with a drop by just under USD 5 and an annual average price of 105.9 USD/bbl. The average 2013 price of the US benchmark West Texas Intermediate (WTI) was 97.92 USD/bbl. WTI temporarily fell to more than 20 USD/bbl below Brent, an unusually low level. This was related to a relative surplus of shale oil on the US market, which forced the WTI price down and had a calming effect on global prices.

Tables 10 to 16 in the appendix provide a country-by-country listing of resources, reserves, production and consumption, as well as exports and imports of crude oil (always for the top 20 countries).

The significance of crude oil as the most important global commodity and the basis for our modern economies, remains unchanged. In 2013, global crude oil production further increased, reaching a new peak. No fundamental trend reversal in the use of crude oil and thus the development of oil production can be recognised to date. It is therefore impossible to say for how much longer it will still be possible to meet the high and even rising demand in many parts of the world, particularly in the emerging economies China and India. There is great diversity of opinions regarding the future availability of crude oil. They range from forecasting an inevitable and irreversible decline in production in only a few years‘ time, to predictions that crude oil will remain the main source of energy for decades to come, in sufficient volumes to meet demand. What can be said for certain is that crude oil is the fuel whose depletion has progressed furthest (BGR 2009). From BGR‘s point of view, a moderate rise in global oil production to 2030 and beyond would appear possible, given the current geological and technical conditions. A significant increase in the production of conventional crude oil is not generally expected. Increases in production rates will probably come primarily from condensate (from increasing natural gas production), from non-conventional oil (bitumen from oil sands and crude oil from tight rocks), and from technological progress. New discoveries, particularly in the frontier regions (Arctic, deepwater), will also contribute to the supply.

3.2 Natural gas

With a share of 23.7 % (BP 2014) in global primary energy consumption, natural gas was still the third most important source of energy in 2013 after crude oil and hard coal. Global natural gas consumption rose by only around 1.3 % (previous year: 2.2 %), again below the historic average of 2.6 %. Many regard natural gas as a „bridging energy“ with a high potential for growth. Its share in the global energy mix, however, remained almost unchanged compared to 2012. While Europe and the CIS consumed less natural gas, consumption in all other regions of the world rose, particularly in the Middle East.

Russia possesses by far the largest (conventional and non-conventional) resources of natural gas, followed by China, the United States, Canada and Australia. With more than a third, Russia also has the most extensive conventional gas resources in the world, ahead of the United States, China, Saudi Arabia and Turkmenistan. Global natural gas resources of commercially exploited conventional and non-conventional deposits were estimated at 638 trillion m^3 (previous year: 629 trillion m^3). Total natural gas resources including aquifer gas and gas hydrates amount to 845 trillion m^3 (Fig. 11 and Table 1). The main type of non-conventional gas is shale gas, with global resources of around 206 trillion m^3, followed by tight gas and coal-bed methane (CBM). There are only few reliable country-specific estimates for natural gas from tight sandstones and carbonates (tight gas) and the figure of 63 trillion m^3 is thus a clear underestimate of the global potential. It can generally be assumed that tight gas is present in most basins with gas prospectivity, particularly in Palaeozoic layers. Regarding the resources of aquifer gas and gas from gas hydrates, there are currently mostly global estimates and only few detailed regional studies. Based on current information, 24 trillion m^3 gas in aquifers and 184 trillion m^3 of gas from gas hydrates can be reported. It is not clear at present whether this potential can be exploited commercially, and if so, when. Countries with very low domestic levels of conventional fuels, such as Japan, are running ambitious projects particularly involving gas hydrates, with the aim of developing such deposits in their own exclusive economic zones as potential sources of energy (cf. Chapter 4.3).

Global natural gas reserves increased by just under 1 % compared to 2012, and were estimated at 198 trillion m^3 as at the end of 2013 (2012: 196 trillion m^3). Global natural gas production in 2013 was more than balanced out by an increase of reserves, as had been the case in the previous year. On a global scale, the share of non-conventional reserves is still low and likely to remain so in the foreseeable future. However, tight gas reserves are generally not reported separately, making it impossible to estimate their quantities more accurately in a global survey. Only the United States reported significant shale gas reserves of 3,665 billion m^3 at the end of 2012 and thus almost 1.7 % less than the previous year (3,728 billion m^3). Adjusted for production, however (295 billion m^3 of shale gas produced in 2012), reserves grew by almost 7 %. Although US gas prices continue to stay at a rather low level, there has been no downward revision of the shale gas reserves to date.

More than half of global natural gas reserves (53.7 %) are concentrated in only three countries, Russia, Iran and Qatar; about 80 % of global reserves are located in the OPEC countries and the CIS (Fig. 11).

The rise in consumption in the Middle East, Asia and North America was the primary cause for the slight expansion in global natural gas production in 2013, by around 33 billion m^3 (up about 1 %) to 3,421 billion m^3. This rise was again well below the long-term historic growth rates, and also clearly below the figure for the previous year. Among the reasons are the decline in production from mature conventional natural gas deposits, and the inadequate development of new reserves, because of a reluctance to invest in the upstream sector. The highest growth rates in production were found in the Middle East, particularly Saudi Arabia, and the CIS, especially Russia. In early 2013, production capacity at the Zapolyarnoye supergiant natural gas and condensate field, discovered back in 1965, peaked at 130 billion m^3/year, making it Russia's gas field with the highest production. The largest declines in terms of the volumes produced were reported for Europe, particularly Norway, and Africa (especially Egypt).

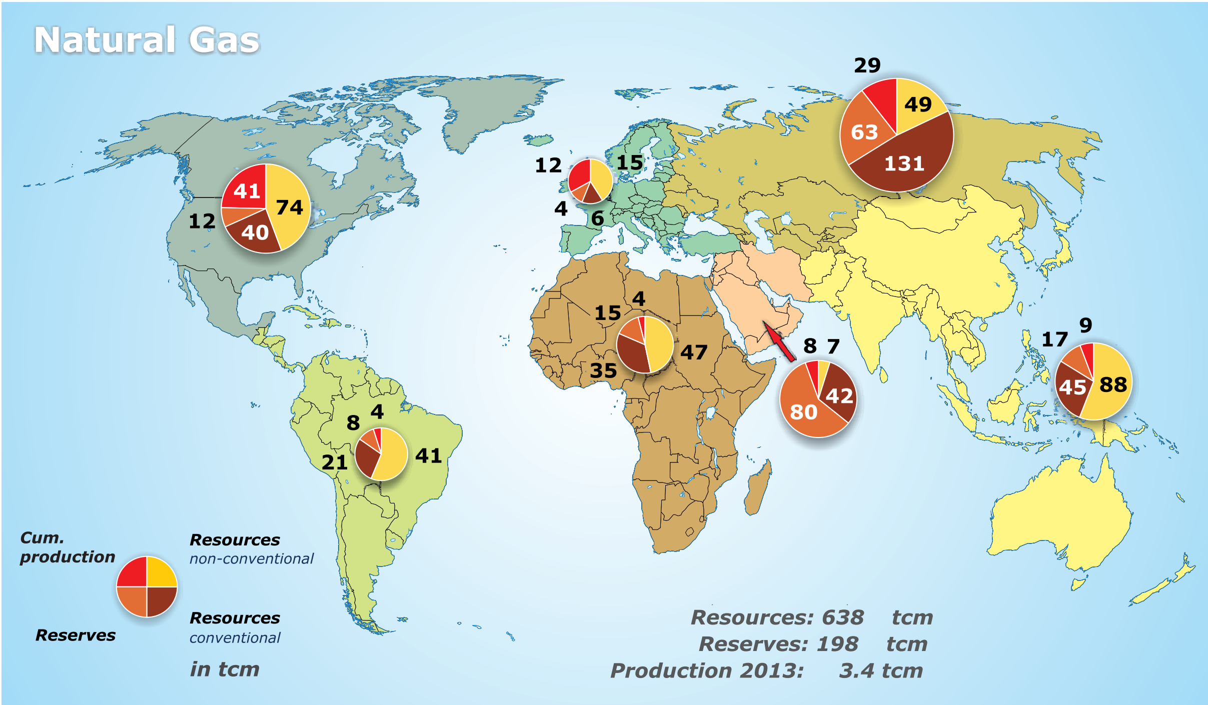

Fig. 11: Total natural gas potential in 2013 (excluding aquifer gas and gas hydrates): regional distribution.

Growing domestic demand in the Middle East (up 6.5 %) contributed to the development of natural gas deposits and boosted production in that region. In addition to projects in Saudi Arabia (Karan) and the United Arab Emirates (Shah), development started on the large tight gas field at Khazzan Makarem to increase production in Oman. Production is scheduled to start in 2017.

With the continued development of its large natural gas finds in the Levantine Basin in the eastern Mediterranean Sea, Israel was able to increase production by a factor of 2.5 from 2012, to 6.4 billion m^3 at present.

The United States were still the world‘s largest producer of natural gas, ahead of Russia and Iran. However, at just under one percent, US growth was much lower than in previous years. Given the relatively low prices for natural gas in the United States, and the relatively high prices for oil, it was more lucrative to produce liquid hydrocarbons. The production of dry shale gas deposits was partly scaled back and production shifted towards the development of zones with large shares of natural gas liquids. Nevertheless, the United States still met more than 90 % of their rising demand for natural gas from domestic production. There are plans to start exporting liquefied natural gas (LNG) from shale gas production in late 2015.

Russia increased its production significantly (up 2.9 %), Iran by 0.6 %. Although China produced around 119 billion m^3 and thus almost 8 % more natural gas than the previous year, this figure fell well short of the strong rise in consumption of 13.7 %. Production included over 2 billion m^3 of CBM, about 4 billion m^3 of mine gas and a very small amount (about 200 million m^3) of shale gas. India, on the other hand, produced almost 18 % less natural gas than the previous year; in Norway, one of Europe‘s major suppliers of natural gas, production dropped by 7.7 billion m^3 (6.7 %).

Production in Indonesia, one of the world's largest exporters of LNG, fell again (down 8.2 %), mainly because of a lack of investment. Together, Russia and the United States produced more than 1.3 trillion m^3 of natural gas in 2013, which is equivalent to around 38 % of global production.

Global natural gas consumption in 2013 rose by 1.3 % (previous year: 2.2 %) or 44 billion m^3 to around 3,434 billion m^3. Growth was therefore slightly lower than the previous year. The United States are still the world's largest gas consumer by far, followed by Russia, China, Iran and Japan. While overall natural gas consumption fell in Europe and the CIS, it rose in all other regions of the world. Consumption grew most in China, with a rise of 13.7 % (previous year: 8.6 %). High growth in consumption was also reported in the Middle East (up 6.5 %), especially Saudi Arabia, the United Arab Emirates, Oman and Israel. Japan imported around 119 billion m^3 of natural gas in 2013, all of which had to be in the form of LNG. After China, Japan is the second largest consumer in Asia; on a global scale, it is the biggest importer of natural gas, followed by Germany. India, on the other hand, again reduced its gas consumption (down 12.6 %), relying more on other fossil fuels, especially coal.

In 2013, about 1,039 billion m^3 or around 30 % of global natural gas production, were traded across borders (excluding transit trade), 31 % (325 billion m^3) in the form of liquefied natural gas (LNG). Overall, the global trade in natural gas grew only slightly compared to the previous year. This growth resulted entirely from an increase in pipeline-based transport, particularly from Russia. In the medium term, however, LNG trade is likely to increase considerably. Countries or regions that already export LNG, for instance, Australia, Africa or Russia, are expected to make larger volumes available to the global market. Japan remained the biggest importer of LNG worldwide, sourced from a large number of countries (18), though around two thirds were imported from only four countries, namely Australia, Qatar, Malaysia and Russia. Qatar was the world's largest exporter of LNG, followed by Malaysia. Singapore is on the way to becoming the largest LNG trading and transshipment centre in the world.

There are a number of transregional natural gas markets around the world that are still largely independent of each other. In the United States, natural gas was traded at the most favourable conditions of all liberalised markets. This was due to the high and still increasing share of shale gas. The average price for natural gas (Henry Hub spot price) in the United States was 3.7 USD/million Btu in 2013. In Germany, gas was on average almost three times as expensive, and prices for LNG imports to Japan in 2013 were at times even up to five times higher than those in the United States. As a rule, the price of gas is significantly influenced by the specific gas transport costs, which are much higher than those for oil and coal. In the medium to long term, the development of a global market for natural gas can be expected; the gas spot market will gain in importance.

Europe with its growing supply grid is linked to a large share of global natural gas reserves, either via pipelines or via LNG terminals. This puts the European gas market in a relatively comfortable position in principle. However, geopolitical factors remain a key factor in natural gas supply.

Tables 17 to 23 in the appendix provide a country-by-country listing of production, consumption, imports and exports, and of natural gas reserves and resources.

3.3 Coal

Among the fossil fuels, coal is the energy source with by far the largest global reserves and resources. With a share of 30.1 % (28.4 % hard coal, 1.7 % lignite) in global PEC, coal was the second most important source of energy in 2013 after crude oil (BP 2014). With a share of around 40 %, coal contributed more to power generation in 2012 than any other source of energy (IEA 2014c).

To enable a better comparability of data, this study distinguishes only between lignite and hard coal. Hard coal with an energy content of ≥ 16,500 kJ/kg comprises sub-bituminous coal, bituminous coal and anthracite. Because of its relatively high energy content, transport costs for hard coal are low and it is therefore traded worldwide. Lignite, on the other hand, with its lower energy content (< 16,500 kJ/kg) and higher water content, is primarily used for power generation close to the extraction sites.

Total coal resources (reserves plus resources) rose compared to the previous year, despite a decrease in global coal reserves. Proven global coal reserves at the end of 2013 totalled 968 Gt, of which around 688 Gt were hard coal and 280 Gt lignite. There were thus significant changes in the reserves compared to the previous study (BGR 2013), particularly the hard coal reserves (down 11.7 %). These decreases are based on new findings and the resulting re-evaluations, especially regarding hard coal reserves in China (based on Wang et al 2013) and South Africa (based on Council for Geoscience 2012). At the same time, coal resources rose to 22,089 Gt (up 3.5 %), both as a result of exploration work and following new evaluations. This applies primarily to hard coal resources in China (China Coal Resource 2014) and South Africa (based on Council for Geoscience 2012) and lignite resources in Australia (State Government of Victoria 2014; Holdgate 2003).

World coal production grew again slightly in 2013, to around 7,969 Mt. This is equivalent to an increase of 0.2 % on the previous year. Hard coal accounted for 6,913 Mt (up 0.8 %) and lignite for 1,056 Mt (down 3.7%).

Unlike conventional oil and gas deposits, coal fields and their production sites are located in many countries and exploited by a large number of companies. Tables 24 to 35 in the appendix provide a country-by-country listing of production, consumption, imports and exports, and of hard coal and lignite reserves and resources.

Hard coal

Figure 12 shows the regional distribution of hard coal reserves and resources, and estimated cumulative production since 1950. Australasia has the largest remaining potential of hard coal, with 7,516 Gt, followed by North America with 6,873 Gt, and the CIS with around 2,969 Gt. The world‘s largest reserves of hard coal of 223 Gt are located in the United States (32.5 % global share). Next come the People‘s Republic of China with around 121 Gt (17.5 %), and India with around 82 Gt (11.9 %), followed by Russia (10.1 %), Australia (9.0 %) and Ukraine (4.7 %). Germany has around 0.03 Gt of recoverable volumes (reserves) of hard coal, with production to be subsidised until 2018. The United States alone account for 6,458 Gt or around 37 % of global hard coal resources, followed by China (30.2 %) and Russia (14.8 %).

The three largest hard coal producers in 2013 were China, with a share of 51.1 % (3,533 Mt), the United States (11.9 %) and India (8.2 %). While China and India were able to increase production slightly, as in previous years – by 0.8 % (China) and 1.4 % (India) – production in the United States decreased (down 3.6 %). However, the drop in coal production in the United States was not as marked as in the previous year, as the use of coal in US power generation rose again slightly compared to 2012 (EIA 2014). This had been expected, given the slight rise in US natural gas prices. With 114 Mt, the European Union (EU-28) still accounted for a share of 1.6 % in global hard coal production.

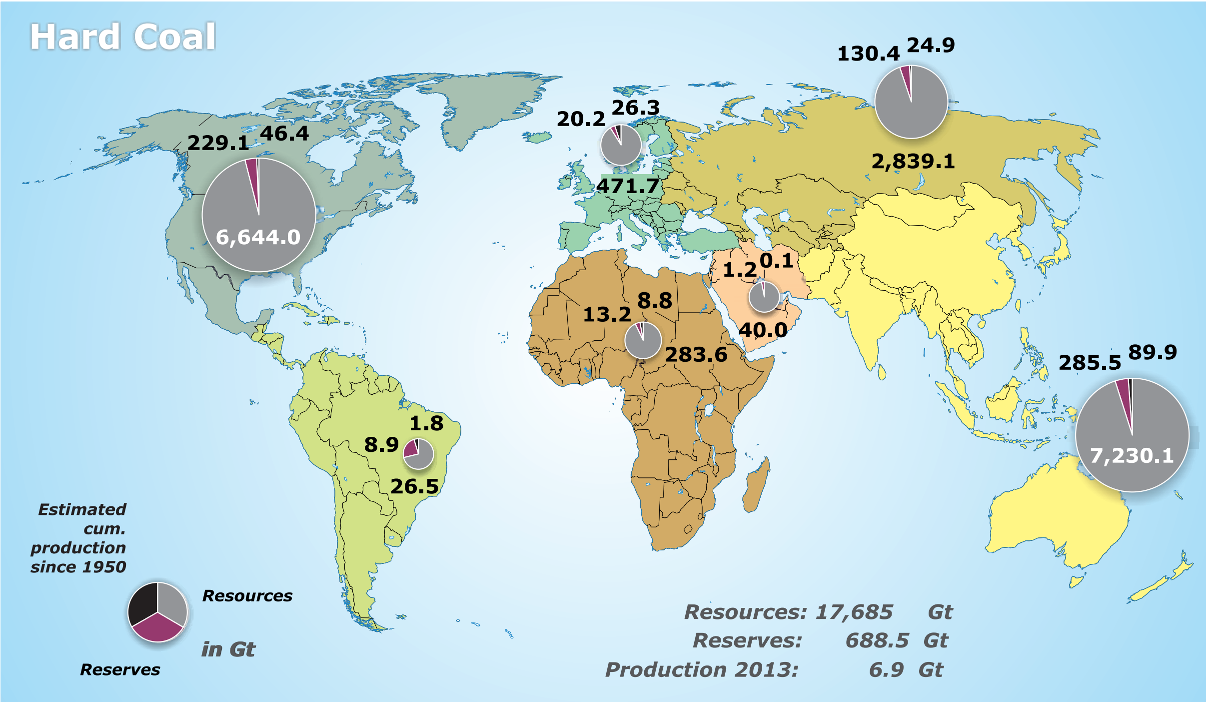

Fig. 12: Total hard coal potential in 2013 (18,373 Gt): regional distribution.

About 19 % or 1,349 Mt of hard coal produced in 2013 were traded globally, 1,142 Mt of it by sea (VDKI 2014a).This increased the global traded volume of hard coal by around 7 % on the previous year. In addition to the further rise in demand for coal, particularly in Asia, the almost continuous decline since early 2012 in world market prices for coal and lower freight rates also contributed to the further rise in the global coal trade. Indonesia dominated the global hard coal market, with exports totalling 424 Mt (31.5 %), followed by Australia (26.6 %) and Russia (10.6 %). Hard coal exports from the United States, on the other hand, fell by around 7 Mt to 107 Mt (down 6 %).

The largest hard coal importers were China, Japan and India, with a combined volume of around 689 Mt (52 %). China once more increased its imports in 2013 by 13 % compared to the previous year (289 Mt) to around 327 Mt, accounting for about a quarter of global hard coal imports that year. Japan, the second largest importer, also increased imports compared to the previous year, by 3 % to around 192 Mt. India imported 170 Mt, almost a quarter more than the previous year and could thus in the near future replace Japan as the second largest coal importer. Japan is planning to restart several of its nuclear power plants, which were shut down following the Fukushima nuclear disaster. This is likely to result in a lower demand for power from coal. As in previous years, Asia dominated the global hard coal import market, now with a share of 72 %. The European Union (EU-28) accounted for only 213.4 Mt or around one sixth of global hard coal imports, covering about two thirds of its hard coal demand.

The average annual spot prices for steam coal in northwest Europe (ports of Amsterdam, Rotterdam and Antwerp; cif ARA) fell from 109.15 USD/tce in 2012 to 95.52 USD/tce in 2013, a drop of around 14 USD/tce or 12 % (VDKI 2014b). As in the previous year, import prices for steam coal fell because of the continuing oversupply on the world market, which is not likely to change in the medium term. In contrast to the two previous years, European coal imports fell slightly in 2013, by around 2 %, according to preliminary estimates.

Coking coal prices continued to decline in 2013. Although prices rose slightly at the start of 2013, to about 170 USD/t, they had fallen to around 135 USD/t by summer 2013. In autumn 2013, prices recovered, rising to up to 150 USD/t, but fell again to 138 USD/t by December 2013. This price decline continued until summer 2014. Since July 2014, the price for coking coal has stayed at about 114 USD/t (VDKI 2014a, IHS McCloskey 2014). This is equivalent to a price drop of almost two thirds in the past three years. In the second quarter of 2011, prices had still been at levels between 300 and 330 USD/t (all-time high of the nominal price). This was because of massive flooding in the state of Queensland in Australia, resulting in a very limited supply of high-quality coking coal.

With the drop in global market prices for coal, more mines with high production costs were closed down in 2013 and 2014, most of them in the United States, Australia and China. At the same time, producers responded to the changed world market prices with cost-cutting programmes (mostly production increases). Producers in many exporting countries also benefited from external factors such as currency effects (strengthening US dollar) and decreasing oil and thus fuel prices. Compared to previous years, global coal consumption (steam coal and coking coal) increased only slightly, while production volumes rose further, as new mines were commissioned and production from existing mines was increased. Price rises for steam coal and coking coal are therefore unlikely in the near future. More mine closures can be expected worldwide, a development that started two years ago because of falling world market prices for coal and which will present major challenges to the remaining European hard coal industry.

Even China, who has more than trebled its coal production capacities since the start of the new millennium because of the almost continuous rise in demand, now reports overcapacity. China, which accounts for more than half the global demand for hard coal today, is therefore driving the restructuring of the coal sector, particularly the closure of smaller pits with low production capacities. At the same time, the country slowed down domestic coal production in 2014 and (re)introduced coal import duties in October 2014, to protect the domestic coal industry. These and other measures are likely to result in a slight drop both in production and in imports in 2014 compared to the previous year, the first in many years for China. There are also indications of a slight decrease in consumption. After more than a decade of very high growth in coal production and consumption in China, a significant slowdown is expected for the future (IEA 2014a). In other countries, particularly in Asia, for instance India, Malaysia, Thailand, the Philippines and Vietnam, coal consumption is likely to increase significantly over the next years, in order to meet the rising energy demand. A second "coal effect" as in China, however, is not currently expected.

Lignite

North America has the largest remaining potential of lignite, with around 1,519 Gt, followed by Australasia (1,373 Gt) and the CIS (1,372 Gt including sub-bituminous) (Fig. 13). Of the known global lignite reserves of 280 Gt in 2013, around a third or 90.7 Gt (including sub-bituminous) are found in Russia (32.4 % global share), followed by Australia (15.8 %), Germany (14.4 %), the United States (10.9 %), and Indonesia (3.2 %). The United States have the largest lignite resources, with around 1,368 Gt (31.1% global share), followed by Russia (28.9 % including sub-bituminous) and Australia (9.1 %). More than 82 % of global lignite production totalling 1,056 Mt came from only 11 of the 37 producing countries in 2013. Germany, whose domestic production fell by 1 % compared to the previous year, was the largest producer of lignite with a share of 17.3 % (183 Mt), followed by China (13.9 %) and Russia (6.9 % including sub-bituminous).

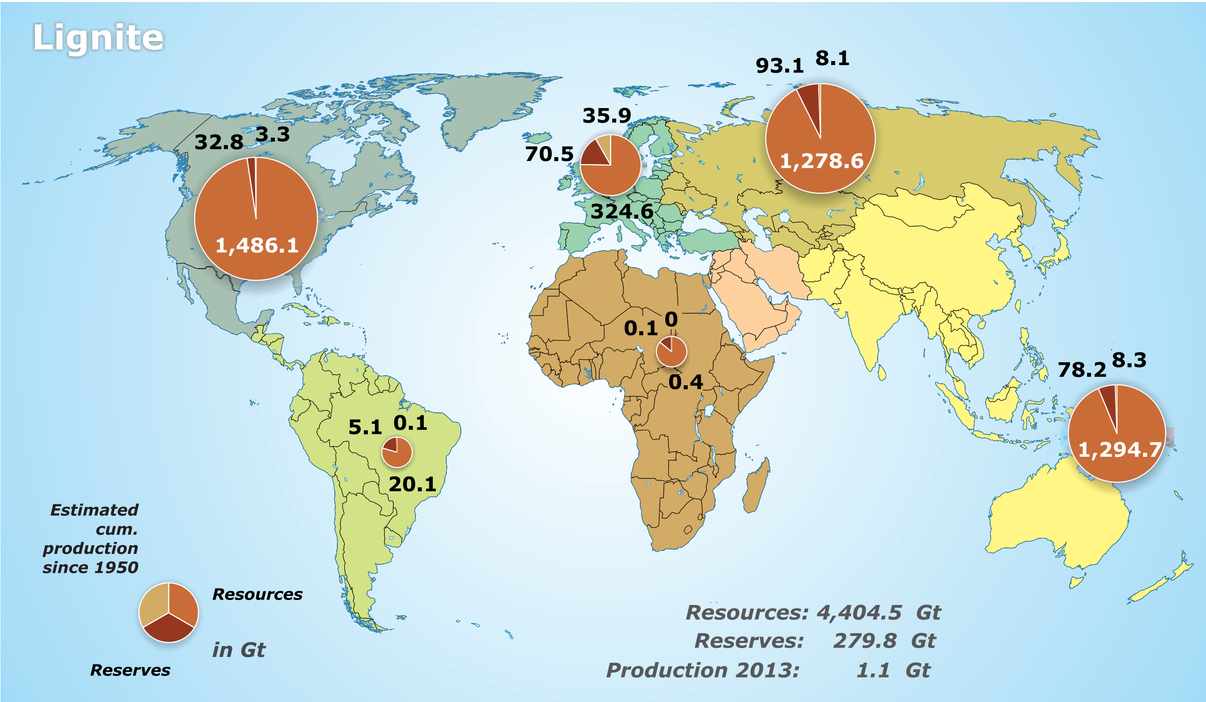

Fig. 13: Total lignite potential in 2013 (4,684 Gt): regional distribution.

3.4 Nuclear fuels

Uranium

As the use of nuclear energy for commercial power generation is being phased out in Germany, uranium as a raw material is becoming less important nationally. On an international level, however, uranium remains a sought-after fuel of great relevance. While the demand for uranium in Europe is likely to decline further in future, uranium consumption will probably rise, particularly in Asia and in the Middle East. Uranium demand in the Americas and Africa is also expected to rise moderately in the coming decades (IAEA 2013; OECD-NEA/IAEA 2014).

There are vast global uranium resources of 13.4 Mt, 342 Mt more than the previous year. This growth resulted mainly from a transfer of resources from lower to higher cost categories. The re-evaluation of reasonably assured resources in Australia, Canada, China, the Czech Republic, Greenland, Kazakhstan and South Africa are the main reasons for this. An increase in exploration efforts in recent years also played a part. Any decline in resources resulted from a reduction in speculative resources, with Argentina, Brazil, Iran, India and Vietnam not publishing any speculative data for the first time. Major producing countries such as Kazakhstan, Russia, South Africa and the United States stopped giving details on speculative resources in 2009, Australia as long as 15 years ago. Because of these reporting uncertainties, the resource figures given in this study should be considered as conservative.

Unlike the other energy resources, uranium resources are classified according to production costs. According to the definition of uranium reserves, the limit for extraction costs is < 80 USD/kg U. Current extraction costs are in fact much higher in many countries. Figure 14 illustrates how the various resource categories are linked. The x-axis describes the level of geological knowledge and the certainty regarding a specific quantity of resources. The y-axis shows the economic cost of extraction in US dollars. This system should be viewed as dynamic. Changes in the classification of resources are firstly the result of new findings on uranium deposits (such as their size and location), and reflect secondly the increasing technical and economic requirements and costs of extraction. For some of the resources, both the category and the class of extraction costs may thus be redefined. Figures in the cost category RAR < 80 USD/kg U are the most reliable. Based on the current BGR definition, these are classified as reserves (green). All resources with higher extraction costs are considered as resources (olive) by BGR.

A purely static view of the economically recoverable resources in cost category < 80 USD/kg U would reflect real conditions only to a point. In many mines, production costs currently exceed the spot market price. Average production costs amount to 130 USD/kg U (URAM 2014). This does not apply to the so-called in-situ leaching (ISL) projects, which can extract uranium at as little as 40 USD/kg U (average cost: 60 - 75 USD/kg U). This heterogeneity in the individual extraction classes makes a comparison harder. In order to do justice to the vast range of existing extraction costs, this Energy Study compares resources in cost categories < 80 USD/kg U and < 130 USD/kg U in the appendix (Table 38 and Table 39). Knowing that some countries such as Australia consider resources in cost category < 130 USD/kg U as economically recoverable, these are included among the resources here. Based on this conservative approach, only uranium resources in cost category < 80 USD/kg U are considered as reserves. All resources with higher extraction costs are currently viewed as resources, even though extraction may be in progress in some cases.

This results in considerable changes in uranium reserves compared to the previous year. In recent years, reserves in countries with high extraction costs have already been transferred in higher cost categories. Australia‘s reserves in cost category < 80 USD/kg U therefore fell by almost 22 % in 2012 and have not been reported since 2013.

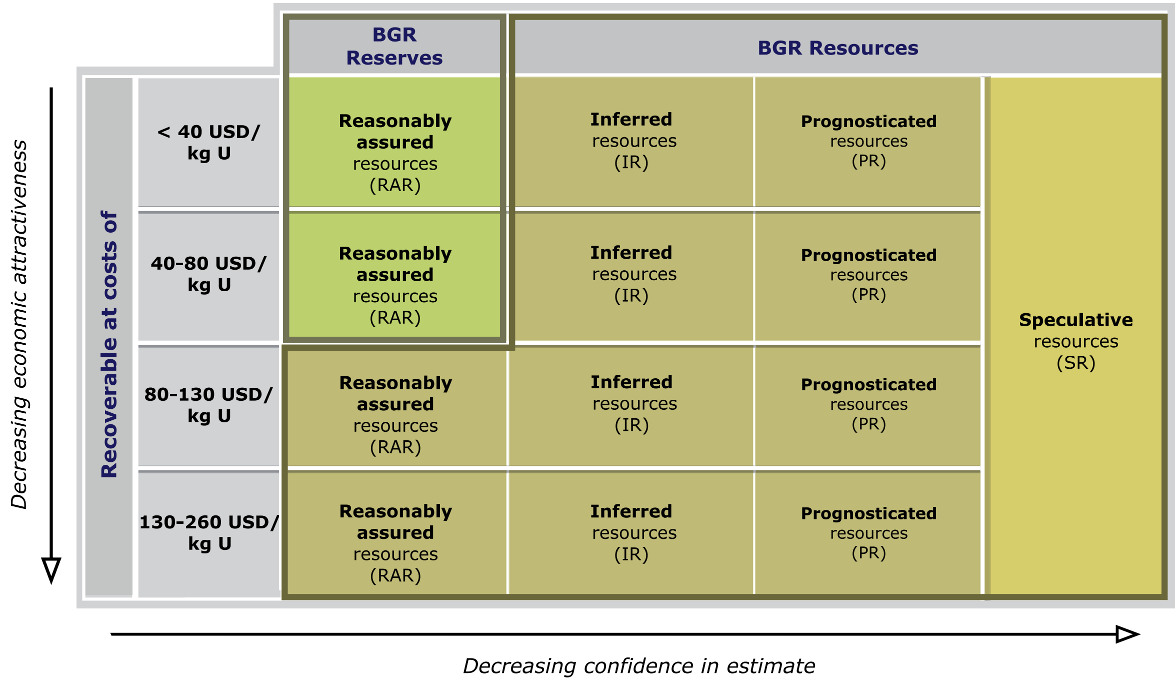

Fig. 14: Classification of uranium resources by cost categories (modified from IAEA 2013 and OECD-NEA/IAEA 2014).

Most of the reduction in global uranium reserves thus results from the loss of the Australian reserves (around 962,000 t U) in cost category < 80 USD/kg U. Many other countries also moved a large share of their reserves to cost category < 130 USD/kg U (cf. Table 38 < 80 and Table 39 < 130). As a result, global uranium reserves for the reporting year 2013 were almost halved. Current uranium reserves in cost category < 80 USD/kg U amount to 1.2 Mt (2012: 2.16 Mt). Ninety-six per cent of reserves are found in only eleven countries, with Canada in first place, followed by Kazakhstan and Brazil. According to the latest data, these three countries account for more than half of global uranium reserves (Fig. 15).

In view of the increase in extraction costs, uranium is extracted at an even higher cost in many countries. Despite its reduction of reserves in the < 80 USD/kg U cost category, Australia remains one of the world's major producer countries. A look at the next higher cost category (< 130 USD/kg U, Table 39) shows clearly that Australia has by far the largest volume of uranium resources. Around 75 % of resources in category RAR < 130 USD/kg U, Table 39) are located in Australia, Canada, Niger, Kazakhstan, Namibia, Russia and the United States. These are also the main uranium-producing countries (cf. Table 39 < 130 and Table 40 U production in 2013).

Compared to the previous year, global uranium production in 2013 rose by 2 % to 59,630 t U, with only six countries accounting for around 85 % of production. Kazakhstan was again the largest producer. It increased production further to 22,567 t U (2012:21,317 t; 2011: 19,451 t U), accounting for almost 38 % of global uranium production. Since 2006, uranium production in Kazakhstan has grown by 400 %. Canada, Australia, Niger, Namibia and Russia together accounted for 47 % of global production.

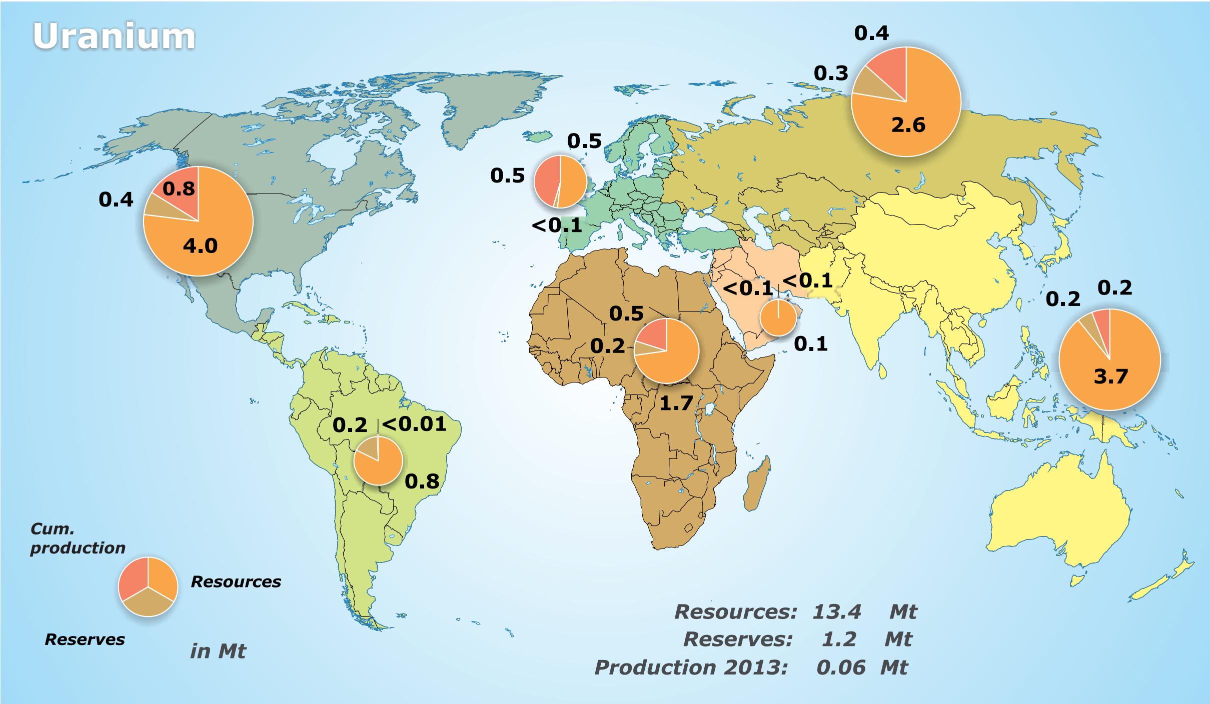

Fig. 15: Total uranium potential in 2013: regional distribution.

As in previous years, uranium production was concentrated in only few major companies, with only eight mining companies accounting for around 82 % of global production in 2013. Over half of the uranium produced worldwide was extracted by Kazatomprom (Kazakhstan, 16 % global share), Areva (France, 15 %), Cameco (Canada, 15 %) and the Russian-Canadian consortium ARMZ/Uranium One (14 %). McArthur River in Canada remained the single largest production site in the world (7,744 t U, 13 % of global production), followed by Olympic Dam in Australia (3,399 t U, 6 %), Somair in Niger (2,730 t U, 5 %) and Tortkuduk in Kazakhstan (2,563 t U, 4 %).

Concentration on the consumption side is similar, though with a different regional focus. Most of the produced uranium is used by very few countries. Only three countries accounted for over half of global uranium demand, the United States, France and China. Global demand for uranium in 2013 amounted to 65,068 t U (down 2,922 t U on 2012). The main reason for this is the continued shutdown of 48 reactors in Japan in 2011. Uranium demand in Japan thus fell from 4,636 t U in 2012 to 366 t U in 2013, a drop of 92 %. With the closure of eight German nuclear power plants in 2011, Germany‘s uranium demand fell further to 1,889 t (cf. Chapter 2.2). Growth in uranium demand was reported mainly in India and in Finland.

The global trade in uranium is mostly via long-term supply contracts. Uranium deliveries to the EU member countries totalled 17,023 t U in 2013 (a decrease by 1,616 t U or 8.7 %). The share of deliveries from spot market contracts was only 7.1 % (EU 2014).

The decline in the uranium spot market price, which had started in 2011 and continued into 2013, put further pressure on the uranium market and jeopardised the profitability of a number of mines and exploration projects. Over the course of 2013, spot market prices fell from 114 to 89 USD/kg U. Whereas the spot market price had been around 188 USD/kg U in January 2011, it had halved by the reporting date.

In addition, there is now also an oversupply of uranium from stocks as a result of the shut-down of reactors in Japan and Germany. While the uranium price accounts for only a small share of power generation costs (WNA 2014a), it is a key factor in the development of new exploration and production projects. Investments in many exploration projects were cancelled or reduced. An increasing number of projects have been put on hold or postponed. Despite the drop in spot market prices, many uranium producers still benefit from existing long-term contracts, which often include higher price guarantees.

A global rise in demand can be expected in the medium to long term. Particularly the increase in energy demand in the emerging economies and developing countries is likely to result in a rising demand for uranium. In Europe, there will still be demand for uranium as a fuel for a long time, despite the expected long-term decline in demand because of Germany‘s withdrawal from nuclear power and the cancellation of plans to expand nuclear power in Italy, Switzerland and Belgium. Countries such as the Czech Republic, Finland, France, Hungary, Romania, Russia, Sweden, Slovakia, Slovenia, Spain and the United Kingdom all consider nuclear energy an important part of their national energy mix. Poland is planning to build its first nuclear power plant by 2025. And there are plans in Turkey for the building of a first reactor by 2021 with Russian support.

At the end of 2013, 70 nuclear power plants were under construction in 15 countries, two more than in 2012: in China (29), Russia (10), India (6), the United States (5), South Korea (5), Slovakia (2), Japan (2), Pakistan (2), Taiwan (2), United Arab Emirates (2), Argentina (1), Brazil (1), Finland (1), France (1), and for the first time in Belarus (1). Another 125 nuclear power plants worldwide are currently at the planning or approval stage. There were closures in the United States (4) and Canada (2). Three new nuclear power plants were commissioned in China and one in India. The 437 nuclear power plants in operation worldwide in 2013, with a total gross output of 393 GW_e (DAtF 2014), consumed around 65,068 t of natural uranium. The largest share, 59,630 t, came from mining production.

The global production of uranium from mines amounted to between 50,773 and 59,630 t U in the last five years, with an annual consumption of over 60,000 t U. The difference between annual demand and primary production was met from civil and military stocks located primarily in the Russian Federation and the United States. These stocks had been built up from surplus production of uranium between 1945 and 1990, because of expected growth in civil demand and for military reasons. The military stocks in particular were gradually reduced. This was a result of the START treaties signed by the United States and the Russian Federation in 1992, who had agreed to convert highly enriched weapons-grade uranium (HEU) to low-enriched uranium (LEU). Over a period of 20 years, 500 t of HEU, which is equivalent to about 20,000 warheads, were converted to 14,446 t of LEU (WNA 2014b). The last delivery of Russian LEU in November 2013 ended the second phase of START treaties. A follow-up treaty to reduce more nuclear arms for civil use was signed by both countries in 2010 and ratified in 2011. This NEW-START treaty will run until 2020.

In addition to uranium from mining production, uranium from stocks and from the reduction of nuclear arms will also be available for future consumption. Another source of uranium is the reprocessing of fuel rods. More research is currently being carried out into enhancing the efficiency of reprocessed materials.

From a geological perspective, the potential should be sufficient to safeguard the global supply with uranium in the long term. The current reduction in exploration projects is entirely the result of the temporary economic situation. However, the development of new extraction projects is becoming increasingly time-consuming and costly. Whereas, in the 1970s, it took five to seven years on average to develop a deposit, it takes fifteen to twenty years today (URAM 2014). The use of more costly conventional extraction methods (open-cast mining, deep underground mining), however, is declining. The most widely used method in uranium mining is so-called in-situ leaching (ISL), with a share of 45 %. Average extraction costs with this method amount to less than 80 USD/kg U (as at 2013).

Tables 36 to 41 in the appendix provide a country-by-country listing of production, consumption, and uranium reserves and resources.

Thorium

Thorium is considered by the scientific community as a possible alternative to uranium. But it is not currently used for power generation and no commercial reactors using thorium as a fuel are in operation anywhere in the world. Nevertheless, thorium deposits have been discovered and evaluated in recent years as exploration for other raw materials (uranium, rare earth elements, phosphate) has increased. Generally speaking, thorium occurs three to four times more frequently in the Earth‘s crust than uranium (approx. 6-10 g/t). Resources in 2013 were reported to be more than 6.35 Mt.

3.5 Deep geothermal energy

Deep geothermal energy is considered a renewable energy resource, as the decrease of heat in the earth‘s interior is negligible on human time scales. Despite the fact that geothermics has an abundant energy potential, its use is as of yet quite limited. In 2013, about 167 TWh were generated worldwide, split between 91 TWh_{th} thermal and 76 TWh_e electrical energy, where the latter equals approximately 0.3 % of the global electricity. With an increase of 530 MW_e in 2013, the installed capacity of geothermal plants reached 12 GW_e. Total growth in geothermal power amounted to about 4.5 %, i.e. slightly above the average of the previous years (REN21 2014). With 78 %, the major part of the power supply is still based on non-renewable energies.

The technical terms resources and reserves are imperfectly applicable in the context of geothermal energy. Here, the so-called technical potential is often used for the evaluation of the geothermal potential. It is defined as the amount of energy (EJ/year) obtained based on the entire implementation of prevalent technology without regard to any economic or socio-economic constraints (IPCC 2011). The Technical potential is not equivalent to reserves, a term generally used in the field of fossil fuels in reference to proven quantitites, which are exploitable using present-day technology. Rather it is comparable to resources. In the context of geothermal energy, the term resources refers to quantities that are accessible and can be extracted with today’s technology, and for which economic gain can be expected (Schulz et al. 2013). In general, this is related to the subsurface with maximum depths of up to ten kilometres (IPCC 2011). The scope of this study is solely on deep geothermal energy and its electrical and thermal use, i.e. its generation of electricity and heat. There are heating plants and combined heat and power plants. The latter achieve optimized energy yield due to the combination. Besides given specifics of the respective energy demand, the actual usage is naturally determined by different temperature conditions as well as the existence and type of the thermal transport medium.

The use of geothermal energy varies widely across the globe. Countries with high-enthalpy reservoirs are in a favourable position. Here, leading countries are the United States, Indonesia, or the Philippines. All have considerable geothermal anomalies due to their geographic proximity to active plate boundaries. In Europe, Iceland and Italy have long-time positive experience. Not only the geological situation, but also specific national objectives, energy infrastructure, availability of water, level of technical know-how, propensity to invest, as well as ecomomical and social circumstances determine the respective development. Worldwide, there are 78 countries using geothermal energy. Hereof 24 countries produce geothermal electricity, eight of them in Europe. Regarding the generation of electricity, the United States of America is still the leading nation with 3,389 MW_e; whereas about 80 % of all US geothermal capacity is installed in California. In second place are the Philippines with 1,848 MW_e, followed by Indonesia with 1,341 MW_e and Mexico with 1,017 MW_e. Italy leads among the European countries with 875 MW_e. This is equivalent to fifth place on a global scale, followed by Iceland with 660 MWe. Converted to a per-capita rate, Iceland claims the highest value, as it can meet about half of its power demand with geothermal energy. The total values reported for 2012 by European countries amounts to 1,848 MW_e and 4,306 MW_{th}. Figure 16 provides a global overview of the countries using deep geothermal energy. On account of incomplete data sets, it is based on data for the time period 2010 to 2013. A comprehensive overview of all electrical and direct use worldwide is prepared every five years on the occasion of the World Geothermal Congress, which will be held next in Melbourne, Australia, in 2015. The compilation for 2010 was based on the then current reports from 68 countries (Lund and Bertani 2010).

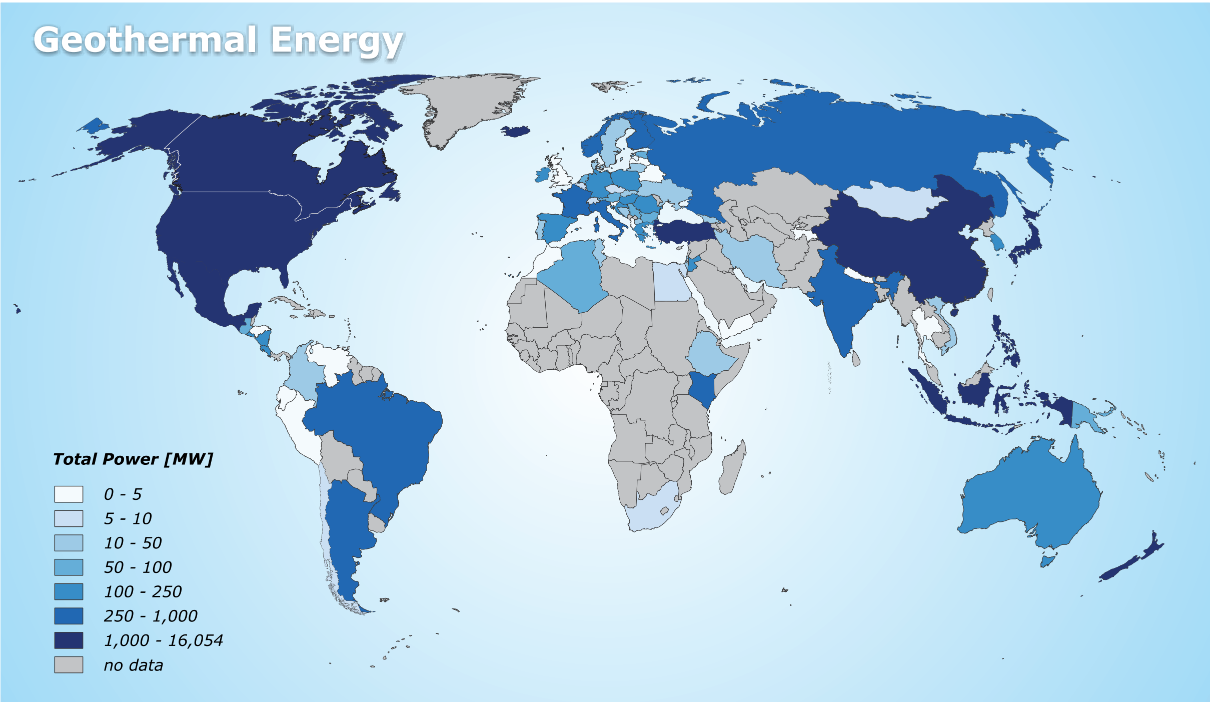

Fig.16: Countries using deep geothermal energy: installed capacity (thermal and electrical), based on data available for the time period 2010 - 2013.

In Africa, the development of geothermal energy has so far been limited to only a few countries in the region of the East African Rift system. In the year 1981, Kenya was the first country in Africa to build a geothermal power station. It is expected that the largest geothermal power plant in Africa will be built in Ethiopia. With support from the US and Iceland, the construction of a power plant with an installed capacity of 1,000 MW is planned in the Corbetti Caldera area.

At present, outside regions with favourable geothermal conditions, the practical implementation and economic efficiency of geothermal energy is still difficult. As technical expenses as well as exploration risk are relatively high, and vast geological differences exist between regions, investment costs vary considerably. Therefore, the use of geothermal energy in many places is small. For a compilation of country-by-country and region-by-region of electrical and thermal capacity as well as the use of deep geothermal energy reserves and resources, refer to appendix, Table 42. Regional data on technical potential (resources) are provided in the appendix, Table 43.

Global data on geothermal energy

The available data on deep geothermal energy are difficult to document, not only because of the many quite varying sources. In addition, energy data are not compiled systematically, and where they are avaiable, often there are country-specific differences concerning its quality and complexity. Data surveys and their timely publications are not handled consistently. For instance, intervals between surveys and publication, may take two years or longer. Furthermore, data are published with varying survey parameters, different classifications, and partly non-uniform summaries, respectivly. This applies in particular to electrical/thermal energy, near-surface/deep geothermal energy, single/entire power plants, energy provided/purchased, geothermal power plants in operation/under construction/planned, potential/resources. Downtimes are not always reported and underlying assumptions and/or survey methods and classifications used in the reports are not explicitly documented. This also applies to data sets where data groupings change during the reference period. Furthermore, data on geothermal energy are often included in other renewables data rather than listed separately. Hence, data quality assurance and traceability present a specific challenge for the compilation of geothermal data, comparability is partially limited.

4 FUTURE AVAILABILITY OF FOSSIL FUELS

4.1 Supply situation and future demand

In addition to providing details on deep geothermal energy, this study analyses the global geological inventory of non-renewables, and presents it on a country-by-country basis. Many factors determine what amounts will in future be produced and consumed, and forecasts are therefore of limited reliability. A long-term comparison of supply and demand can be made based on the projected consumption of these fuels up to 2040 in the New Policies Scenario of the IEA (2014a) (Fig. 17). This shows a relaxed situation for uranium, coal and natural gas from a geological perspective, because the projected demand comprises only a small share of the currently reported inventories of fuels and can be fully met with today's known reserves. Coal in particular stands out, with its huge inventory that far exceeds any demand. Extensive resources (compared to reserves) also indicate the presence of very large and hitherto unexploited potential that could be turned into economically recoverable reserves. Particularly non-conventional hydrocarbon deposits, which are already exploited on a large scale today, make the supply situation relatively relaxed. However, the resource figures also include figures on sources of energy that can so far not be exploited economically, such as oil from shale, and natural gas from aquifers and gas hydrates. Their potential is included in this study, without taking into account whether and to what extent they could be economically extracted in the foreseeable future. Only the availability of crude oil is limited from a geological perspective. For technical reasons, production is already declining at a time when major resources are still available. According to the IEA scenario, around half the currently proven crude oil reserves will be depleted by 2040.

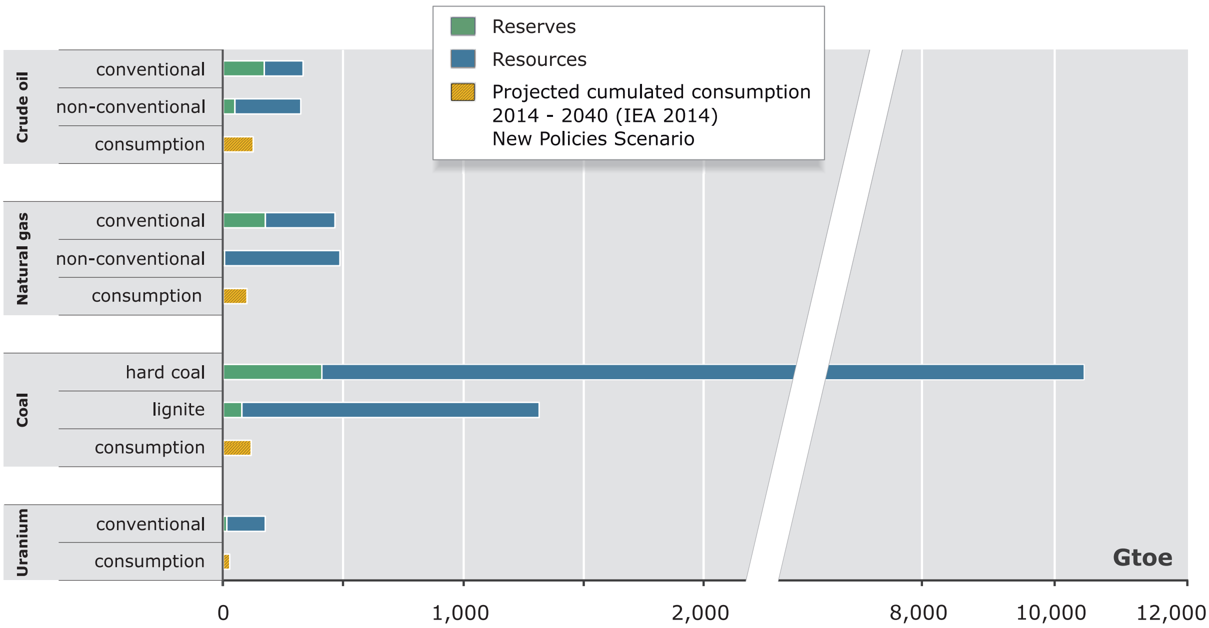

Fig. 17: Supply situation for non-renewables at the end of 2013.

4.2 Associated gas use instead of gas flaring – opportunities and challenges for developing countries

In 2011, around 140 billion m^3 of associated gas released during crude oil production were burnt off (GGFR 2012). This is equivalent to around 4.2 % of the global oil production of 3,337 billion m^3 in 2011 (BGR 2012). With the global increase in greenhouse gas emissions and a rising demand for natural gas, gas flaring should be viewed critically, from both an ecological and an economic perspective. By processing and marketing associated gas, countries and companies could achieve potential additional earnings worth several billion US dollars per year. Some studies estimate an annual average economic loss from gas flaring amounting to USD 15 to 20 billion globally, taking into account investment and operating costs for the use of the natural gas (GE Energy 2011). The revenues lost by countries in terms of taxes and duties are estimated to amount to USD 10 billion based on a natural gas price of USD 2 per million British thermal units (MMBtu), which was the lowest price in the United States in 2012. This is likely to concern mostly those developing countries in which earnings from the raw materials industry constitute a large share of the gross domestic product. The climate impact is also enormous. Considerable emissions are released during gas flaring, accounting for around one percent of global CO_2 emissions (Farnejad 2013, UN 2013). Methane is also released, which has a higher greenhouse potential than CO_2. Where gas flaring and venting are stopped or reduced, greenhouse gas emissions can be lowered considerably.

Definitions: gas flaring and venting

In the production of crude oil, associated gas is released, which can be either flared or vented. The flaring and venting of natural gas are two different processes that involve either the controlled burning of gas (flaring) or the release of unburnt gas into the atmosphere (venting).

Flaring

The German association of oil and gas producers defines gas flaring as the "controlled burning of natural gas that occurs together with oil, in the course of routine oil production operations". Exploiting this gas would not be "technically or economically feasible". A general distinction has to be made between continuous and temporary flaring. Continuous flaring involves associated gas being burnt continuously and not being put to any other use. This may be because use of the associated gas is not economically feasible because of the given circumstances, for instance, high investment costs for non-existing but required infrastructure. Temporary flaring is usually done for safety reasons. It can therefore not always be prevented and not stopped altogether, even where there are strict requirements or bans.

Venting

Venting involves natural gas being released into the atmosphere unburnt. It is frequently done alongside flaring, which is why data on flaring and venting are often combined. Depending on the efficiency of a gas flare, small amounts of gas will escape. Outside the gas flare, natural gas can also escape into the atmosphere, for instance, during exploration drilling of a deposit.

Associated gas

Oil and gas are formed when organic matter decomposes in the absence of oxygen. Gas formation generally requires higher temperatures. Where oil is formed, some quantities of natural gas will also form. Associated gas originates from crude oil deposits. It occurs both dissolved in the oil and as a free "gas cap" above the oil in the reservoir. It is thus a by-product of oil production.

Global importance of gas flaring

A comparison of the amounts of flared natural gas shows that gas flaring is a global challenge that cannot be reduced to a specific country or region. Gas flaring is most frequent where the largest amounts of crude oil are produced, mainly in the oil-producing CIS countries, the Middle East and Africa. In 2011, the top twenty gas flaring countries accounted for more than 85 % of total flared natural gas. In Russia, 37.4 billion m^3 and thus the largest volume of natural gas was flared, more than twice the figure of Nigeria, in second place with 14.6 billion m^3 (GGFR 2012; Table 2). The link between the volume of produced oil and the volume of flared gas is also evident in the United States: particularly in recent years, the rapid rise in non-conventional oil production (oil from tight rocks) has led to increased gas flaring.

Table 2: Top 20 countries based on the volume of flared gas in 2011

Rank	Country	Billion m^3
1	Russia	37,4
2	Nigeria	14,6
3	Iran	11,4
4	Irak	9,4
5	USA	7,1
6	Algeria	5,0
7	Kazakhstan	4,7
8	Angola	4,1
9	Saudi Arabia	3,7
10	Venezuela	3,5
11	China	2,6
12	Canada	2,4
13	Libya	2,2
14	Indonesia	2,2
15	Mexico	2,1
16	Qatar	1,7
17	Uzbekistan	1,7
18	Malaysia	1,6
19	Oman	1,6
20	Egypt	1,6

Source: GGFR 2012

The particular relevance of this topic to developing countries becomes evident in the comparison of a country‘s volume of flared gas with its volume of produced hydrocarbons. While high-income countries such as industrialised countries or Saudi Arabia together accounted for 25 % of global flared gas volumes, their corresponding share in oil and gas production in 2011 amounted to over 40 % (NOAA 2012, EIA 2013, BGR 2012). This ratio is reversed in countries with low to medium incomes. Because of their lack of adequate policy frameworks and an adequate infrastructure, their share in the global volumes of flared gas is generally higher than the share in oil and gas production. Regional comparisons also confirm the link between gross national product and flaring intensity, i.e. the ratio of flared gas to total hydrocarbon production. Africa, where 33 of the world‘s 48 least developed countries are located, has the highest global level of flared gas per ton of produced hydrocarbons (Fig. 18).

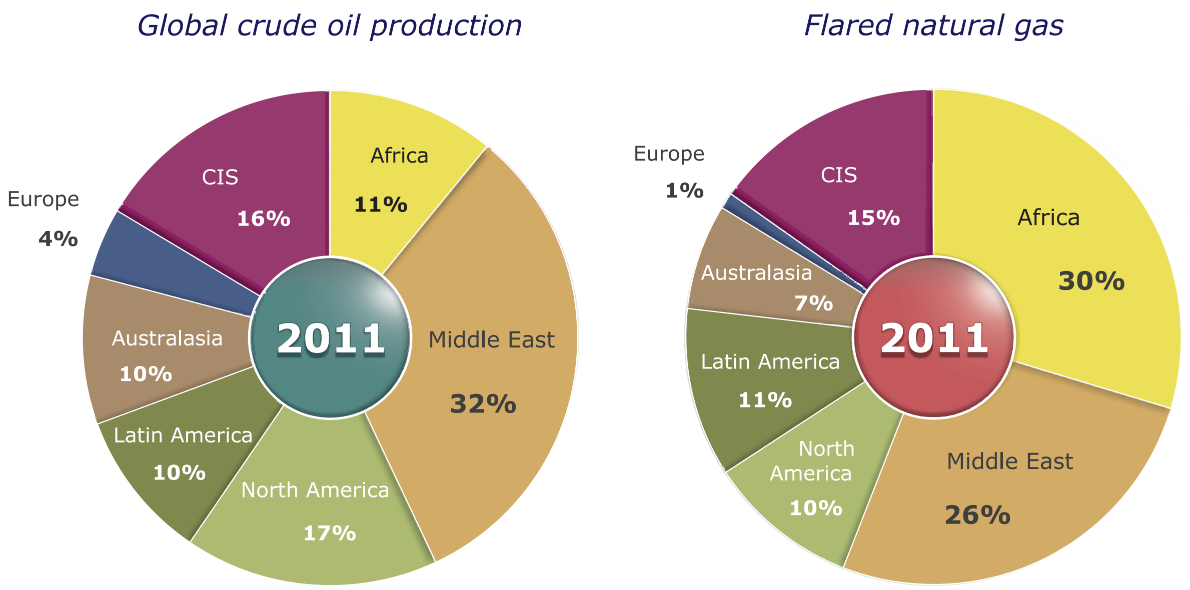

Fig. 18: Regional shares in global crude oil production in 2011 (left) and regional shares in the global volume of flared gas in 2011 (right) (EIA 2013, BGR 2012).

Associated gas use – opportunities and challenges for developing countries

In principle, a reduction in gas flaring or the use of associated gas presents vast opportunities for developing countries. One option that was much used in the past is the re-injection of natural gas. This involves re-injecting gas into the oil deposit, to maintain a more consistent pressure for oil production. The increase in oil production can result in higher revenues both for the companies involved and, in the form of appropriate taxes, for the respective country. The same applies to the export of natural gas. To what extent the processing and marketing of associated gas is a competitive alternative to the production and marketing of conventionally produced gas depends on the situation and has to be decided on a case-by-case basis. Another option would be to expand gas use within the country. This could help improve the country‘s power supply or the development of a gas-consuming sector. It would create employment opportunities and spill-over effects in other industries. A power grid to supply an entire country would improve its infrastructure. The development of a petrochemical industry would mean that products based on natural gas could be produced in the country. All these options would result in considerable added value for the developing countries concerned.

In addition to these opportunities associated with the use of associated gas, there are also a number of challenges. A legal framework would have to be developed and solutions found how to create the necessary conditions such as sufficient demand and an adequate infrastructure for the local and regional use of natural gas.

This applies particularly to Sub-Saharan Africa, where, by regional comparison, the fewest villages are connected to the power grid. Moreover, there are only few large customers and demand is low. Sub-Saharan Africa can be used to illustrate many of the problems found in developing countries; the following consideration of the challenges therefore focuses on this region.

Africa produces far more natural gas than it uses. Together, the African countries produced 210.5 billion m^3 and thus around 6.2 % of global gas production in 2012, the largest producers being Egypt, Algeria and Nigeria. Consumption was at 3.5 %, i.e. just more than half (BGR 2013). This is mainly because there are no markets for natural gas in most Sub-Saharan countries. One major reason for this is the poorly developed infrastructure. In the industrialised countries, natural gas is used mainly for power generation, as well as for heating, cooking and in petrochemical production. But most African countries have no need for heating or an industry that would use large volumes of natural gas. The lack of markets and an inadequate infrastructure are interdependent factors.

Regional gas pipelines could help expand the market and thus increase demand for the existing natural gas potential. But to date, there are hardly any regional markets or pipelines in Africa. The 678 km long West Africa Gas Pipeline, which links Nigeria to Benin, Togo and Ghana, has been in operation since 2008. This pipeline is also used to transport associated gas from Nigeria to its neighbouring countries and could thus help reduce the level of gas flaring in Nigeria. Because of technical and safety-related problems, however, constant operation cannot be guaranteed. Moreover, most oil fields in West Africa are found offshore, in the Gulf of Guinea and thus remote from any potential consumer centres. They could therefore be exploited only following investments in the transport infrastructure. Particularly when fields are small, investments often prove not to be economically viable. Today there is the option of processing associated gas at sea to produce, for instance LNG, which is then transported by ship.

In addition to LNG for export and the direct supply of natural gas, liquid gases such as propane or butane, which are suitable for cooking, can also be produced. This option would also be available for small gas fields. Some countries such as Ghana already have plants producing liquefied petroleum gas (LPG). Here, too, an infrastructure and a market would need to be developed. Alternatively, associated gas could be used to produce compressed natural gas (CNG) for the transport industry. But there are few gas-powered vehicles to date, even in the industrialised countries. It would also be possible to use the GTL (gas-to-liquids) method to produce synthetic fuel, but there are only few GTL plants worldwide. Another option would be the use of natural gas for direct local power generation. However, especially rural areas often lack the necessary power supply grid.

Many countries also lack the legal framework. Companies in Angola, for instance, do not have the right to use the natural gas. To prevent gas flaring or venting, the government would thus have to safeguard its use. In a few countries, for instance, Nigeria, regulations and bans concerning gas flaring have been in place since 1979. However, the deadlines for stopping gas flaring have been moved back more than once. Today, companies still prefer to pay the low fines rather than investing in plants that would permit the use of associated gas. However, some Sub-Saharan countries who have started oil production have now included gas flaring in their planning and legal framework. Ghana, for instance, who has been producing oil since December 2010, announced a policy to ban flaring from the start (Zero Flaring Policy). The Ghana National Petroleum Corporation (GNPC) has already drawn up plans for the use of associated gas from the Jubilee Field.

To sum up:

In many developing countries, a number of obstacles thus exist that make it difficult to reduce flaring. These are typically an inadequate infrastructure and a lack of gas markets, as well as an inadequate legal framework. This applies in particular to Sub-Saharan Africa, but countries in other regions face similar challenges. Nevertheless, there are approaches both at the national and international level to reduce gas flaring. At the national level, particularly bans on flaring or incentives to reduce flaring have been introduced. At the international level, the best-known initiative is the World Bank‘s Global Gas Flaring Reduction Partnership (GGFR).

4.3 Gas hydrate as an energy resource – a status report

Gas hydrate looks like ice, but it is not. It is a clathrate (from Latin: clatratus = cage). Clathrates are inclusion compounds in which host molecules form cage structures that trap guest molecules in a lattice. Gas hydrates consist of water (host) molecules and gas (guest) molecules; the gas is primarily methane. Gas hydrates are formed at low temperatures and high pressures. They are thus stable in permafrost and in the sea sediments of the continental shelves. Under atmospheric conditions, gas hydrates decompose, producing water and natural gas. Since the methane trapped in the cages is in a highly compressed form, 1 m^3 of hydrate releases about 164 m^3 of methane.

Estimates to date of the total inventory of natural gas in gas hydrate (gas-in-place, GIP) show a vast natural gas potential (Fig. 19) ranging from around 80 trillion m^3 to 255,000 trillion m^3 (Collett 2004). However, such assessments are from a global perspective and should be regarded as speculative. Most of these volumes will probably not be economically recoverable, even in the long term, since most of the gas hydrate occurs in fine distribution in clayey sea sediments. Currently only sandy deposits are considered for exploitation, as they have highly saturated gas hydrates and high permeability. Where such deposits are associated with free natural gas, they become particularly attractive for exploitation, both from a technical and economic perspective.

The Alaska North Slope is the only region to date for which a detailed assessment of resources exists (Collett et al. 2008). Based on this study, BGR derived a recoverability factor of around 15 % in 2012 and used this for an assessment of global GIP in sandy gas hydrate deposits (Johnson 2011). This analysis shows a volume of around 184 trillion m^3 of global gas hydrate resources. But a global perspective will ultimately only be highly approximate. More reliable assessments of the resource potential of gas hydrate will be possible only based on extensive regional studies, which have not been conducted to date.

Those interested in the commercially viable exploitation of this non-conventional source of energy include first and foremost industrialised countries with low or depleting domestic deposits of conventional fuels. Japan is leading in this area. During six days of production testing in the area around the eastern Nankai Trough, about 120,000 m^3 natural gas from gas hydrate were extracted, with average production rates of 20,000 m^3 per day. This makes Japan the third country after the United States and Canada who has succeeded in producing gas from gas hydrate. It was the first production test on a marine gas hydrate reservoir, which account for the largest share of the potential. Production was through depressurisation, and far larger volumes were produced than in previous production tests on land. This method is currently considered the first option for the long-term production of natural gas from gas hydrate.

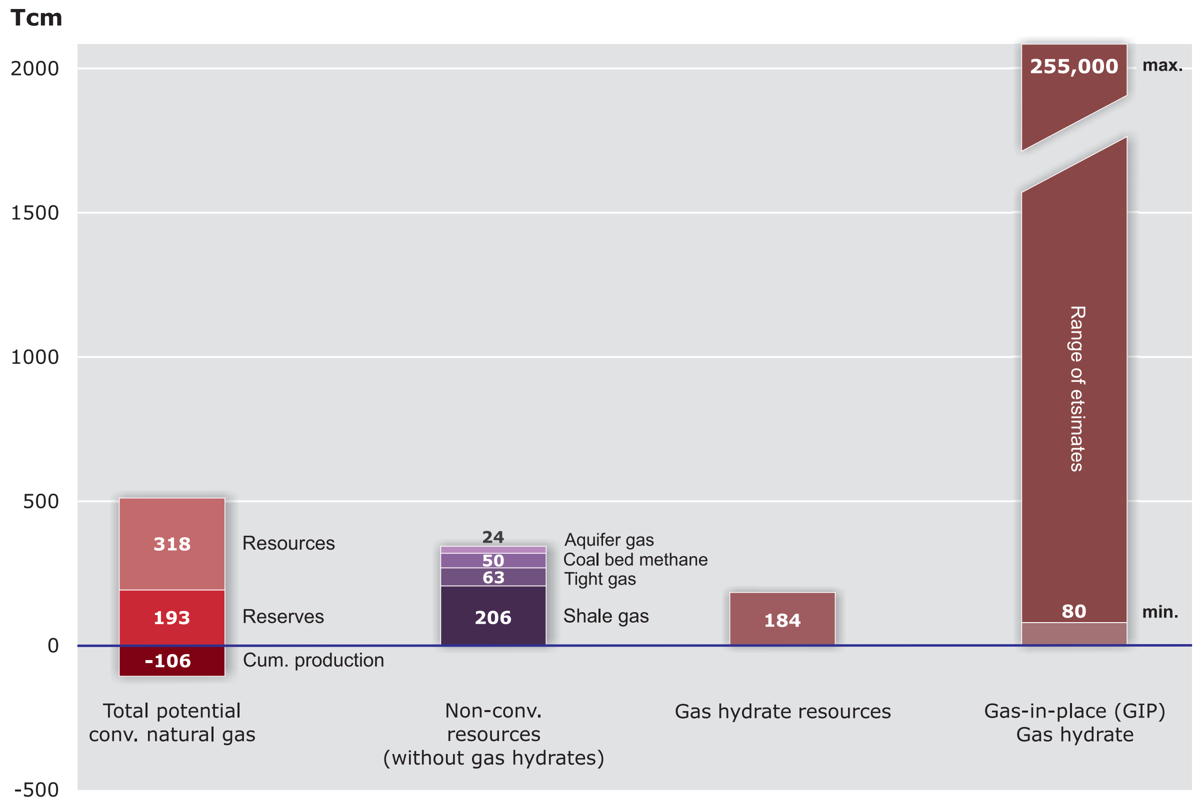

Fig. 19: Comparison of the global potentials of gas hydrate, conventional and non-conventional natural gas.

Despite these successes, the production of gas from gas hydrate is no trivial matter, even with depressurisation. Many problems will need to be solved if long-term use is envisaged. In addition to the unavoidable production of large volumes of sand and water caused by the in-situ decomposition of the gas hydrate, probably the greatest challenges are increasing production rates, which are still too low, and maintaining them over a longer period. The decomposition of the hydrate is an endothermic reaction, which therefore absorbs heat from its surroundings, causing the rock formation to "cool". In the long term, this process can have an adverse effect on production rates, because it recreates the conditions for stability of the hydrate. In addition, secondary hydrate and/or ice may form in the emptied pores, which lowers the permeability of the rock. According to the current state of knowledge, different methods have to be used in combination to maintain production rates at a permanently high level. Long-term production using depressurisation could thus be combined with intermittent thermal stimulation or the use of inhibitors, to remove secondary hydrate or ice from the formation and the production lines (Moridis et al. 2008). Suitable drilling and production methods first have to be developed and tested.

When and where the commercial exploitation of gas hydrate can start, and whether it will in fact start at all, depends on many factors. One crucial issue is certainly the motivation of the individual countries. Because of the domestic shale gas boom, the United States have reduced their research activities relating to the exploitation of gas hydrate. Canada has also announced a growing interest in the exploitation of domestic shale gas deposits, shifting the focus away from gas hydrate. Japan, India, China and South Korea, on the other hand, are pursuing intensive research programmes, including exploratory drilling and production testing. A breakthrough currently appears most likely from Japan‘s activities in the eastern Nankai Trough.

Should a method for the production of gas hydrate reach technical and economic maturity, the production of natural gas from gas hydrate is in principle likely to have a similar impact as the production of conventional oil and gas deposits. A release of significant volumes of methane into the atmosphere is not to be expected, particularly from gas production from continental gas hydrate. An undesirable release of methane from a production well following a blow-out would have less of an impact than in a conventional gas deposit, because less free gas would be available. Even the special marine ecosystems linked with near-surface gas hydrate deposits would not be affected, because depressurisation would only be used for deeper gas hydrate deposits. Gas hydrate in marine sediments consolidates the loose rock, thus contributing to the stabilisation of the continental shelves. The destabilisation of the gas hydrate for the production of natural gas could therefore trigger submarine slides and gas could escape from the seabed. Such a mechanism triggered by natural global processes (fluctuations of the sea level during the ice ages) has been debated as a possible cause of known large-scale landslide events in the more recent history of the Earth. The hazard potential of landslides triggered by the active destabilisation of gas hydrate would by comparison be limited to the small area around the production plant.

In summary, the commercial production of natural gas from gas hydrate is still in its infancy. The development of new extraction methods will be one factor to determine the role of gas hydrate as a future source of energy. Should it become possible to exploit gas hydrate reserves on a large scale, this could have a similar effect on global gas markets as the commercial exploitation of shale gas and coal-bed methane.

5 SUMMARY AND OUTLOOK

Crude oil

There was a slight increase in both resources and reserves. From a geological perspective, the oil supply will be secure in the next few years if the moderate rise in consumption continues. Notwithstanding crisis-related production losses, the global oil supply remained stable, thanks to the consistent OPEC quotas and production increases in the CIS and other non-OECD and OECD countries. Particularly the rapid rise in oil production from tight rocks in the United States is increasingly having an impact on US import activities and thus on the global oil market. Additional oil volumes are available for new consumers and can compensate for production declines in other regions. There has, however, been no global break-through as yet in expanding the production of oil from tight rocks. The inadequate infrastructure and an uncertain political and social framework are obstacles to further development. Outside the United States and Canada, commercial production could succeed in the coming years, for instance, in Argentina, Russia and United Kingdom. As a result of the higher supply of crude oil worldwide, the oil price changed relatively little in 2013, with a marked decline in the course of 2014. Should the oil price stay at a low level in the longer term, this could have an adverse effect on investment decisions regarding technically or geographically challenging exploration projects in deep and very deep water, high-temperature and high-pressure reservoirs, or in the Arctic frontier regions. Provided there are no unpredictable events such as the further escalation of political crises or natural disasters, there are no foreseeable supply risks in the short term from a geological perspective.

Natural gas

With a share of 23.7 % in global primary energy consumption in 2013, natural gas was the third most important source of energy after crude oil and hard coal. Many regard it as a "bridging energy" with a high potential for growth. Its share in the global energy mix, however, remained almost the same as in 2012. Global reserves of natural gas rose again from 2012. Despite the foreseeable increase in demand, the very high remaining natural gas potential will thus be able to safeguard global supply for many decades to come. With the expansion of their shale gas production activities, the United States can cover well over 90 % of their high gas consumption from domestic production. Overall, the global trade in gas has grown only slightly compared to the previous year. This growth resulted purely from an increase in pipeline-based transport, particularly from Russia. The envisaged export of shale gas in the form of LNG from the United States, due to start in late 2015 already, will have an impact on existing market structures and global trade patterns. With its supply grid, Europe is connected to a large share of global natural gas reserves via pipelines and LNG terminals. Yet geopolitical risks remain a key factor in natural gas supply.

Coal

From a geological perspective, global reserves and resources of hard coal and lignite are adequate to cover the foreseeable demand for many decades to come. Reflecting demand, global coal production increased only slightly in 2013 for the first time in many years. However, it had almost doubled since the start of the new millennium, reporting by far the highest growth rates of all fossil fuels.

With the further decline in global coal market prices and freight rates remaining at a low level, the global coal trade in 2013 reported significant increases of 7 % compared to 2012. The importance of the Pacific market is continuously on the rise, with almost three quarters (72 %) of global coal imports destined for Asia today. Since 2011, China has been not only by far the largest producer but also the largest importer of hard coal, having increased its share to about a quarter of global hard coal imports today. The consolidation stage in the global coal sector, which started in 2012, will continue beyond 2014. While, on the one hand, mines with high production costs are closed, on the other hand, highly productive new coal mines are starting up. As the growth in coal demand is today assumed to be slowing down, a relaxed market situation can be expected for consumers in the short to medium term. The strong rise in the global demand for coal in recent years is expected to continue, though at a lesser rate, driven by the Asian countries.

Nuclear fuels

As there are extensive global resources of uranium, no shortage in the supply of nuclear fuels is expected in the long term from a geological perspective. Nuclear power will continue to gain in importance globally. The demand for uranium will be rising particularly in the emerging economies and developing countries. While the demand for uranium in Europe is likely to decline further in future, uranium consumption will probably rise, particularly in Asia and in the Middle East. Uranium demand in the Americas and Africa is also estimated to rise moderately in the coming decades. Should the Japanese reactors be started up again as planned, uranium demand may even be higher in the short term. The Japanese operators have currently applied to start up about half of the shut down reactors. Although there is no definite decision from the government as yet, the first reactors are likely to start up again in 2015. The uranium market continues to face major challenges. Current market conditions (a very low spot market price) have resulted in delays in many mining projects.

Deep geothermal energy

In general, there is an increasing trend in the use of geothermal energy. Determining factors are the cost development in comparison to other energy sources, and the respective geopolitical situation. The IEA (2011) prognosticates that by 2050 geothermal energy worldwide will be expanded to 1,400 TWh_e for electrical energy and to 1,600 TWh_{th} for thermal energy. This would be equivalent to a contribution of 3.5 and 3.9 %. of the global energy production The IPCC (2011) assumes similar values: by 2050, geothermal energy could meet 3 % of the global electricity demand and 5 % of the global demand for heat. In Europe, the economic potential for electricity produced from geothermal energy in 2050 is estimated to total 4,160 TWh_e.

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APPENDIX

- Tables
- Sources
- Glossary
- Definitions
- Country groups
- Economic country groupings
- Units
- Conversion factors

Table 3: Reserves of non-renewable energy resources 2013: Regional distribution [EJ]

Region	Crude oil		Natural gas		Coal		Uranium	Total	Share [%]
	conven-tional	non-conven-tional	conven-tional [1]	non-conven-tional	Hard coal	Lignite			
Europe	88	< 0.5	151	–	536	641	13	1,431	3.8
CIS	755	–	2,404	2	3,282	1,354	148	7,945	21.1
Africa	744	–	553	–	309	1	83	1,690	4.5
Middle East	4,534	–	3,052	–	30	–	–	7,616	20.2
Australasia	254	–	575	51	6,999	802	102	8,782	23.3
North America	341	1,124	289	156	5,759	389	179	8,237	21.9
Latin America	410	886	293	–	232	43	81	1,945	5.2
World	**7,126**	**2,011**	**7,318**	**208**	**17,148**	**3,230**	**606**	**37,646**	**100.0**
OECD 2000	448	1,124	539	193	7,951	1,406	191	11,853	31.5
EU-28	48	–	72	–	513	512	10	1,155	3.1
OPEC 2009	5,380	886	3,612	–	59	1	–	9,937	26.4

[1] including tight gas

Table 4: Resources of non-renewable energy resources 2013: Regional distribution [EJ]

Region	Crude oil		Natural gas		Coal		Uranium	Thorium	Total	Share [%]
	conven-tional	non-conven-tional	conven-tional	non-conven-tional [1]	Hard coal	Lignite				
Europe	198	95	210	569	12,608	3,021	260	286	17,246	3.2
CIS	1,155	906	4,994	1,857	69,471	18,705	1,284	103	98,475	18.3
Africa	1,071	232	1,321	1,774	6,656	4	842	264	12,165	2.3
Middle East	1,251	1	1,605	251	1,008	–	53	–	4,170	0.8
Australasia	1,049	436	1,669	3,350	176,914	12,284	1,841	771	198,312	36.9
North America	1,075	2,675	1,513	2,797	166,866	17,546	2,011	427	194,908	36.2
Latin America	946	2,869	786	1,560	686	173	389	466	7,876	1.5
World	**6,745**	**7,214**	**12,099**	**12,158**	**438,034** [2]	**51,732**	**6,681**	**3,178** [3]	**537,840**	**100.0**
OECD 2000	1,311	2,871	1,921	4,319	220,245	24,032	3,151	1,010	258,858	48.1
EU-28	103	68	121	533	12,569	2,685	259	55	16,393	3.0
OPEC 2009	1,818	2,798	1,753	1,496	1,220	3	18	150	9,256	1.7

1) without natural gas in gas hydrates and aquifer gas (7,904 EJ)

2) including hard coal in the Antarctic (3,825 EJ)

3) including Thorium without country allocation (62 EJ)

Table 5: Production of non-renewable energy resources 2013: Regional distribution [EJ]

Region	Crude oil	Natural gas	Hard coal	Lignite	Uranium	Total	Share [%]
Europe	6.9	10.5	3.1	4.7	0.2	25.4	4.9
CIS	28.1	31.0	12.0	1.2	14.6	86.9	16.9
Africa	18.0	7.7	6.3	< 0.05	5.3	37.2	7.2
Middle East	55.7	21.5	0.1	–	–	77.3	15.0
Australasia	16.1	18.7	122.3	3.5	4.1	164.7	32.0
North America	34.3	33.7	22.4	0.9	5.6	97.0	18.9
Latin America	16.6	6.8	2.5	0.1	0.1	26.0	5.0
World	**175.6**	**130.0**	**168.7**	**10.3**	**29.8**	**514.5**	**100.0**
OECD 2000	41.7	45.9	36.5	5.2	8.9	138.2	26.9
EU-28	2.9	6.4	3.0	3.7	0.2	16.2	3.1
OPEC 2009	74.4	24.9	0.1	–	–	99.5	19.3

Table 6: Consumption of non-renewable energy resources 2013: Regional distribution [EJ]

Region	Crude oil	Natural gas	Hard coal	Lignite	Uranium	Total	Share [%]
Europe	27.6	19.6	8.9	4.7	10.5	71.3	13.8
CIS	8.9	24.2	8.6	1.2	3.8	46.6	9.0
Africa	7.5	4.6	4.7	< 0.05	0.2	16.8	3.2
Middle East	15.9	16.7	0.4	–	0.1	33.0	6.4
Australasia	59.6	24.7	124.3	3.1	7.0	218.8	42.2
North America	43.0	34.4	20.4	0.9	10.8	109.5	21.1
Latin America	14.1	6.4	1.1	0.1	0.3	21.9	4.2
World	**176.7**	**130.5**	**168.4**	**10.0**	**32.5**	**518.1**	**100.0**
OECD 2000	85.6	60.8	38.3	5.2	23.3	213.0	41.1
EU-28	24.9	17.4	8.2	3.7	10.2	64.4	12.4
OPEC 2009	18.3	17.7	0.1	–	0.1	36.1	7.0

– no reserves, resources, production or consumption

Table 7: Germany: Supply of crude oil 2012/2013 [kt]

Country / Region	2012	2013	%	Changes 2012 / 2013	%
Russia	34,702	31,447	34.8	-3,255	-9.4
Norway	9,349	11,031	12.2	1,682	18.0
United Kingdom	13,261	9,270	10.3	-3,991	-30.1
Nigeria	6,652	7,306	8.1	654	9.8
Kazakhstan	5,430	7,055	7.8	1,625	29.9
Libya	8,613	6,670	7.4	-1,943	-22.6
Azerbaijan	2,146	3,672	4.1	1,526	71.1
Algeria	2,330	2,608	2.9	278	11.9
Saudi Arabia	2,381	2,433	2.7	52	2.2
Egypt	1,307	1,172	1.3	-135	-10.3
Denmark	679	1,170	1.3	491	72.3
Colombia	534	961	1.1	427	80.0
Iraq	839	799	0.9	-40	-4.8
Angola	428	796	0.9	368	86.0
Côte d'Ivoire	452	614	0.7	162	35.8
Kuwait	591	563	0.6	-28	-4.7
Netherlands	584	554	0.6	-30	-5.1
Poland	211	403	0.4	192	91.0
Venezuela	707	325	0.4	-382	-54.0
Tunisia	518	309	0.3	-209	-40.3
Brazil	468	281	0.3	-187	-40.0
Mexico	87	198	0.2	111	127.6
Ghana	171	197	0.2	26	15.2
Italy	424	160	0.2	-264	-62.3
Canada	0	93	0.1	93	
Albania	61	66	0.1	5	8.2
Georgia	33	65	0.1	32	97.0
Trinidad and Tobago	0	56	0.1	56	
Equatorial Guinea	79	41	0.0	-38	-48.1
U. Arab. Emirates	0	31	0.0	31	
Latvia	0	13	0.0	13	
France	5	5	0.0	0	0.0
Congo, Rep.	20	0	0.0	-20	-100.0

continuation of table 7
[kt]

Country / Region	2012	2013	%	Changes 2012 / 2013	%
Turkmenistan	39	0	0.0	-39	-100.0
Lithuania	76	0	0.0	-76	-100.0
Gabon	120	0	0.0	-120	-100.0
Iran	96	0	0.0	-96	-100.0
Total import	**93,393**	**90,364**	**100.0**	**-3,029**	**-3.2**
OPEC 2009	22,637	21,531	23.8	-1,106	-4.9
Middle East	3,907	3,826	4.2	-81	-2.1
Africa	20,690	19,713	21.8	-977	-4.7
CIS	42,350	42,239	46.7	-111	-0.3
Europe	24,650	22,672	25.1	-1,978	-8.0

Table 8: Germany: Origin of consumed natural gas [bcm]

Country of origin	2012	%	2013	%
Russia	37.0	34.0	37.9	34.1
Netherlands	24.8	22.8	29.4	26.4
Norway	32.5	29.8	27.7	25.0
Other countries	2.9	2.7	5.4	4.8
Domestic production	11.7	10.8	10.7	9.6
Total amount	**108.8**	**100.0**	**111.0**	**100.0**
Export	19.7	18.1	20.9	18.8
Gas storage balance	0.2	0.2	0.9	0.8
Total consumption	**89.3**	**82.0**	**91.0**	**81.9**

Table 9: Germany: Imports of hard coal and coke by supplying countries [kt]

Country / Region	2009	2010	2011	2012	2013	Changes 2012 / 2013	%
EU	5,888	8,506	7,025	6,704	8,364	1,660	24.8
hard coal	3,212	4,974	3,524	4,089	5,891	1,802	44.1
coke	2,676	3,533	3,501	2,615	2,473	-142	-5.4
non-EU	33,517	36,677	41,353	41,218	44,502	3,284	8.0
hard coal	33,244	36,096	40,626	40,858	44,228	3,370	8.2
coke	273	581	727	360	274	-86	-23.9
Australia	3,758	4,303	4,280	4,451	4,739	288	6.5
hard coal	3,758	4,303	4,280	4,451	4,739	288	6.5
coke	0	0	0	0	0	0	
Canada	1,070	1,203	1,736	1,516	1,214	-302	-19.9
hard coal	1,070	1,203	1,736	1,516	1,214	-302	-19.9
coke	0	0	0	0	0	0	
China	146	206	196	11	8	-3	-27.3
hard coal	5	7	12	9	8	-1	-11.1
coke	141	199	184	2	0	-2	-100.0
CIS	9,536	10,590	11,092	11,546	13,091	1,545	13.4
hard coal	9,434	10,342	10,731	11,227	12,842	1,615	14.4
coke	102	248	361	319	249	-70	-21.9
Colombia	5,194	7,628	10,826	9,352	9,999	647	6.9
hard coal	5,173	7,588	10,764	9,319	9,974	655	7.0
coke	21	39	62	33	25	-8	-24.2
Czech Republic	280	443	360	323	690	367	113.6
hard coal	151	63	30	7	365	358	5.114.3
coke	129	379	330	316	325	9	2.8
Indonesia	86	70	34	0	0	0	
hard coal	86	70	34	0	0	0	
coke	0	0	0	0	0	0	
Norway	1,321	856	857	395	680	285	72.2
hard coal	1,321	856	857	395	680	285	72.2
coke	0	0	0	0	0	0	
Poland	4,225	6,058	5,139	3,971	4,325	354	8.9
hard coal	2,513	3,659	2,659	2,406	3,008	602	25.0
coke	1,712	2,399	2,481	1,565	1,317	-248	-15.8

continuation of table 9
[kt]

Country / Region	2009	2010	2011	2012	2013	Changes 2012 / 2013	%
South Africa	5,250	3,331	2,644	1,972	2,533	561	28.4
hard coal	5,250	3,331	2,644	1,972	2,533	561	28.4
coke	0	0	0	0	0	0	
USA	5,104	5,727	8,140	9,809	12,044	2,235	22.8
hard coal	5,104	5,727	8,140	9,809	12,044	2,235	22.8
coke	0	0	0	0	0	0	
Venezuela	353	432	161	112	59	-53	-47.3
hard coal	346	431	161	111	59	-52	-46.8
coke	7	2	0	1	0	-1	-100.0
other non-EU countries	1,699	2,332	1,389	2,054	135	-1,919	-93.4
hard coal	1,697	2,239	1,269	2,049	135	-1,914	-93.4
coke	2	93	120	5	0	-5	-100.0
Total	**39,405**	**45,183**	**48,378**	**47,922**	**52,866**	**4,944**	**10.3**
hard coal	36,456	41,069	44,151	44,947	50,119	5,172	11.5
coke	2,949	4,114	4,228	2,975	2,747	-228	-7.7

Table 10: Crude oil 2013 [Mt]

	Country / Region	Production	Cum. Production	Reserves	Resources	EUR	Remaining Potential
EUROPE	Albania	1.2	56	26	23	104	49
	Austria	0.9	123	8	10	140	18
	Bosnia & Herzegovina	–	–	–	10	10	10
	Bulgaria	0.1	9	2	32	43	34
	Croatia	0.8	103	8	20	130	28
	Cyprus	–	–	–	35	35	35
	Czech Republic	0.6	11	2	30	43	32
	Denmark	8.7	339	93	187	619	280
	Estonia	0.6	6	–	–	6	–
	Finland	0.6	3	–	–	3	–
	France	0.8	126	12	710	848	722
	Germany	2.6	299	31	115	446	146
	Greece	0.1	17	1	35	53	36
	Hungary	1.2	100	4	20	124	24
	Ireland	–	–	–	224	224	224
	Italy	5.5	186	80	187	452	267
	Lithuania	0.2	4	1	60	65	61
	Malta	–	–	–	5	5	5
	Netherlands	1.1	145	41	455	641	496
	Norway	90.2	3,540	885	2,150	6,575	3,035
	Poland	1.0	63	19	261	344	281
	Romania	4.1	768	82	200	1,049	282
	Serbia	1.0	45	8	20	72	28
	Slovakia	< 0.05	3	1	5	9	6
	Slovenia	< 0.05	n.s.	n.s.	n.s.	n.s.	n.s.
	Spain	0.4	38	20	34	92	54
	Turkey	2.3	142	47	710	899	757
	United Kingdom	40.6	3,580	746	1,453	5,779	2,199
CIS	Azerbaijan	43.5	1,804	952	1,245	4,002	2,197
	Belarus	1.7	137	27	30	194	57
	Georgia	< 0.05	24	5	51	79	55
	Kazakhstan	83.8	1,622	4,082	10,700	16,404	14,782
	Kyrgyzstan	< 0.05	11	5	10	27	15
	Moldova, Republic	–	–	–	10	10	10
	Russia	522.6	22,218	12,657	34,801	69,676	47,458
	Tajikistan	< 0.05	8	2	60	69	62
	Turkmenistan	13.1	536	191	1,700	2,427	1,891
	Ukraine	3.3	363	54	300	717	354
	Uzbekistan	3.2	196	81	400	677	481

continuation of table 10
[Mt]

	Country / Region	Production	Cum. Production	Reserves	Resources	EUR	Remaining Potential
AFRICA	Algeria	72.6	2,957	1,660	2,375	6,992	4,035
	Angola	87.4	1,475	1,723	5,200	8,398	6,923
	Benin	–	4	1	70	75	71
	Cameroon	2.7	183	21	350	555	371
	Chad	5.0	70	204	275	549	479
	Congo, DR	1.2	45	24	145	214	169
	Congo, Rep.	14.5	355	204	451	1,010	655
	Côte d'Ivoire	1.2	31	14	300	344	314
	Egypt	32.8	1,588	599	2,233	4,420	2,832
	Equatorial Guinea	14.6	208	232	350	790	582
	Eritrea	–	–	–	10	10	10
	Ethiopia	–	–	< 0.5	20	20	20
	Gabon	11.8	536	272	1,400	2,208	1,672
	Gambia	–	–	–	20	20	20
	Ghana	4.9	17	90	210	317	300
	Guinea	–	–	–	150	150	150
	Guinea-Bissau	–	–	–	40	40	40
	Kenya	–	–	–	250	250	250
	Liberia	–	–	–	160	160	160
	Libya	48.1	3,783	6,580	4,750	15,113	11,330
	Madagascar	–	–	–	90	90	90
	Mauritania	0.3	7	3	164	174	167
	Morocco	< 0.05	2	< 0.5	1,627	1,629	1,627
	Mozambique	n.s.	n.s.	2	2,000	2,002	2,002
	Namibia	–	–	–	150	150	150
	Niger	1.0	n.s.	20	30	50	50
	Nigeria	118.3	4,343	5,044	5,090	14,476	10,134
	Sao Tome and Príncipe	–	–	–	180	180	180
	Senegal	–	–	–	140	140	140
	Seychelles	–	–	–	470	470	470
	Sierra Leone	–	–	60	200	260	260
	Somalia	–	–	1	20	21	21
	South Africa	0.2	16	2	400	418	402
	South Sudan, Republic of	4.9	–	641	365	1,006	1,006
	Sudan	6.0	–	206	365	571	571
	Sudan & South Sudan	10.9	210	846	730	1,786	1,576
	Tanzania	–	–	–	400	400	400
	Togo	–	–	–	70	70	70
	Tunisia	3.0	204	58	300	562	358
	Uganda	–	–	136	300	436	436
	Western Sahara	–	–	–	57	57	57
	Zimbabwe	–	–	–	10	10	10

continuation of table 10
[Mt]

	Country / Region	Production	Cum. Production	Reserves	Resources	EUR	Remaining Potential
MIDDLE EAST	Bahrain	9.5	241	5	200	447	205
	Iran	177.7	9,564	21,469	7,200	38,233	28,669
	Iraq	152.6	4,973	19,621	6,100	30,693	25,721
	Israel	< 0.05	2	2	371	375	373
	Jordan	< 0.05	–	< 0.5	19	19	19
	Kuwait	164.7	6,049	13,810	700	20,558	14,510
	Lebanon	–	–	–	150	150	150
	Oman	46.1	1,396	748	700	2,845	1,448
	Qatar	84.2	1,587	3,435	700	5,722	4,135
	Saudi Arabia	523.6	19,241	35,400	11,800	66,441	47,200
	Syria	2.1	742	340	400	1,482	740
	U. Arab. Emirates	165.7	4,495	13,306	1,100	18,901	14,406
	Yemen	7.4	391	324	500	1,215	824
AUSTRALASIA	Afghanistan	–	–	–	290	290	290
	Australia	15.9	1,016	538	3,480	5,034	4,018
	Bangladesh	0.2	3	4	30	37	34
	Brunei	6.6	514	150	160	824	310
	Cambodia	–	–	–	25	25	25
	China	208.1	6,082	2,460	20,724	29,266	23,184
	India	37.7	1,258	758	1,420	3,436	2,178
	Indonesia	43.0	3,351	488	3,545	7,385	4,033
	Japan	0.6	51	4	24	79	28
	Korea, Rep.	1.0	n.s.	n.s.	n.s.	n.s.	n.s.
	Laos	–	–	–	< 0.5	< 0.5	< 0.5
	Malaysia	30.2	1,064	796	850	2,710	1,646
	Mongolia	0.7	3	35	1,010	1,048	1,045
	Myanmar	0.8	56	4	560	620	564
	New Zealand	1.8	59	19	243	321	262
	Pakistan	3.8	100	47	1,390	1,536	1,437
	Papua New Guinea	1.4	66	25	290	381	315
	Philippines	1.0	17	16	270	303	286
	Sri Lanka	–	–	–	90	90	90
	Taiwan	< 0.05	5	< 0.5	5	10	5
	Thailand	11.2	181	60	335	576	395
	Timor-Leste	3.9	43	63	175	280	238
	Viet Nam	16.7	321	599	600	1,520	1,199
NORTH AMERICA	Canada	192.4	5,464	27,299	56,891	89,654	84,190
	Greenland	–	–	–	3,500	3,500	3,500
	Mexico	143.5	6,282	1,492	4,761	12,535	6,253
	USA	485.2	31,360	6,274	24,553	62,186	30,826

continuation of table 10
[Mt]

	Country / Region	Production	Cum. Production	Reserves	Resources	EUR	Remaining Potential
LATIN AMERICA	Argentina	30.5	1,540	320	4,175	6,035	4,495
	Barbados	< 0.05	2	< 0.5	30	33	30
	Belize	0.1	1	1	15	17	16
	Bolivia	2.8	80	26	280	386	306
	Brazil	105.0	2,032	2,121	13,720	17,873	15,841
	Chile	0.3	62	20	330	412	350
	Colombia	52.9	1,191	323	1,790	3,305	2,113
	Cuba	3.4	63	7	1,008	1,078	1,015
	Dominican Rep.	–	–	–	150	150	150
	Ecuador	27.6	743	1,202	107	2,051	1,309
	Falkland Islands	–	–	–	800	800	800
	(French) Guiana	–	–	–	800	800	800
	Guatemala	0.5	21	11	40	72	51
	Guyana	–	–	–	450	450	450
	Haiti	–	–	–	100	100	100
	Panama	–	–	–	122	122	122
	Paraguay	–	–	–	575	575	575
	Peru	7.9	377	209	351	938	560
	Puerto Rico	–	–	–	75	75	75
	Suriname	0.7	14	10	700	724	710
	Trinidad and Tobago	6.2	516	113	65	694	178
	Uruguay	–	–	–	275	275	275
	Venezuela	158.2	9,754	26,650	65,320	101,723	91,970
	World	**4,202.0**	**175,033**	**218,573**	**333,925**	**727,531**	**552,498**
COUNTRY GROUP	Europe	164.8	9,706	2,116	6,992	18,814	9,108
	CIS	671.3	26,920	18,055	49,307	94,282	67,362
	Africa	430.5	16,034	17,796	31,187	65,018	48,983
	Middle East	1,333.5	48,682	108,459	29,940	187,082	138,399
	Australasia	384.6	14,188	6,067	35,516	55,772	41,583
	North America	821.1	43,107	35,065	89,705	167,876	124,769
	Latin America	396.3	16,396	31,014	91,278	138,689	122,293
ECONOMIC COUNTRY GPG.	OPEC 2009	1,780.7	68,963	149,898	110,442	329,303	260,340
	OPEC-Gulf	1,268.4	45,909	107,040	27,600	180,549	134,640
	OECD 2000	997.0	52,948	37,616	100,039	190,603	137,655
	EU-28	70.0	5,923	1,151	4,079	11,152	5,230

n. s. not specified
– no production, reserves or resources

Table 11: Crude oil resources 2013 [Mt]
The most important countries (top 20) and distribution by regions and economic country groupings

Rank	Country / Region	Total	conventional	non-conventional oil sand	non-conventional extra heavy oil	non-conventional tight oil
1	Venezuela	65,320	3,000	–	60,500	1,820
2	Canada	56,891	3,500	50,000	1	3,390
3	Russia	34,801	20,000	4,500	1	10,300
4	USA	24,553	15,727	850	76	7,900
5	China	20,724	16,200	25	119	4,380
6	Brazil	13,720	13,000	–	–	720
7	Saudi Arabia	11,800	11,800	–	–	–
8	Kazakhstan	10,700	4,000	6,700	–	–
9	Iran	7,200	7,200	–	–	–
10	Iraq	6,100	6,100	–	–	–
11	Angola	5,200	5,000	200	–	–
12	Nigeria	5,090	5,000	90	–	–
13	Mexico	4,761	2,980	–	1	1,780
14	Libya	4,750	1,200	–	–	3,550
15	Argentina	4,175	500	–	–	3,675
16	Indonesia	3,545	2,400	70	–	1,075
17	Greenland	3,500	3,500	–	–	–
18	Australia	3,480	1,100	–	–	2,380
19	Algeria	2,375	1,600	–	–	775
20	Egypt	2,233	1,600	–	8	625
	...					
95	Germany	115	20	–	–	95
	...					
	other countries [118]	42,892	35,924	82	77	6,810
	World	**333,925**	**161,350**	**62,517**	**60,783**	**49,275**
	Europe	6,992	4,726	30	30	2,206
	CIS	49,307	27,635	11,201	21	10,450
	Africa	31,187	25,630	331	8	5,218
	Middle East	29,940	29,925	–	1	14
	Australasia	35,516	25,095	95	119	10,207
	North America	89,705	25,707	50,850	78	13,070
	Latin America	91,278	22,632	10	60,526	8,110
	OPEC 2009	110,442	43,500	290	60,507	6,145
	OPEC-Gulf	27,600	27,600	–	–	–
	OECD 2000	100,039	31,361	50,880	105	17,693
	EU-28	4,079	2,456	30	27	1,566

– no resources

Table 12: Crude oil reserves 2013 [Mt]
The most important countries (top 20) and distribution by regions and economic country groupings

Rank	Country / Region	Total	conventional	non-conventional		
				oil sand	extra heavy oil	tight oil
1	Saudi Arabia	35,400	35,400	–	–	–
2	Canada	27,299	666	26,565	–	68
3	Venezuela	26,650	5,450	–	21,200	–
4	Iran	21,469	21,469	–	–	–
5	Iraq	19,621	19,621	–	–	–
6	Kuwait	13,810	13,810	–	–	–
7	U. Arab. Emirates	13,306	13,306	–	–	–
8	Russia	12,657	12,657	–	–	–
9	Libya	6,580	6,580	–	–	–
10	USA	6,274	6,011	–	3	260
11	Nigeria	5,044	5,044	–	–	–
12	Kazakhstan	4,082	4,082	–	–	–
13	Qatar	3,435	3,435	–	–	–
14	China	2,460	2,460	–	n.s.	–
15	Brazil	2,121	2,121	–	–	–
16	Angola	1,723	1,723	–	–	–
17	Algeria	1,660	1,660	–	–	–
18	Mexico	1,492	1,492	–	–	–
19	Ecuador	1,202	1,202	–	n.s.	–
20	Azerbaijan	952	952	–	n.s.	–
	...					
59	Germany	31	31	–	–	–
	...					
	other countries [83]	11,306	11,303	–	3	–
	World	**218,573**	**170,474**	**26,565**	**21,206**	**328**
	Europe	2,116	2,113	–	3	–
	CIS	18,055	18,055	–	–	–
	Africa	17,796	17,796	–	–	–
	Middle East	108,459	108,459	–	–	–
	Australasia	6,067	6,067	–	–	–
	North America	35,065	8,169	26,565	3	328
	Latin America	31,014	9,814	–	21,200	–
	OPEC 2009	149,898	128,698	–	21,200	–
	OPEC–Gulf	107,040	107,040	–	–	–
	OECD 2000	37,616	10,720	26,565	3	328
	EU–28	1,151	1,151	–	–	–

n. s. not specified
– no reserves

Table 13: Crude oil production 2013
The most important countries (top 20) and distribution by regions and economic country groupings

Rank	Country / Region	Mt	Share [%] country	Share [%] cumulative
1	Saudi Arabia	523.6	12.5	12.5
2	Russia	522.6	12.4	24.9
3	USA	485.2	11.5	36.4
4	China	208.1	5.0	41.4
5	Canada	192.4	4.6	46.0
6	Iran	177.7	4.2	50.2
7	U. Arab. Emirates	165.7	3.9	54.1
8	Kuwait	164.7	3.9	58.1
9	Venezuela	158.2	3.8	61.8
10	Iraq	152.6	3.6	65.5
11	Mexico	143.5	3.4	68.9
12	Nigeria	118.3	2.8	71.7
13	Brazil	105.0	2.5	74.2
14	Norway	90.2	2.1	76.3
15	Angola	87.4	2.1	78.4
16	Qatar	84.2	2.0	80.4
17	Kazakhstan	83.8	2.0	82.4
18	Algeria	72.6	1.7	84.1
19	Colombia	52.9	1.3	85.4
20	Libya	48.1	1.1	86.6
	...			
57	Germany	2.6	0.1	99.3
	...			
	other countries [81]	562.5	13.4	100.0
	World	**4,202.0**	**100.0**	
	Europe	164.8	3.9	
	CIS	671.3	16.0	
	Africa	430.5	10.2	
	Middle East	1,333.5	31.7	
	Australasia	384.6	9.2	
	North America	821.1	19.5	
	Latin America	396.3	9.4	
	OPEC 2009	1,780.7	42.4	
	OPEC-Gulf	1,268.4	30.2	
	OECD 2000	997.0	23.7	
	EU-28	70.0	1.7	

Table 14: Oil consumption 2013
The most important countries (top 20) and distribution by regions and economic country groupings

Rank	Country / Region	Mt	Share [%]	
			country	cumulative
1	USA	823.7	19.5	19.5
2	China	507.4	12.0	31.5
3	Japan	226.8	5.4	36.9
4	India	175.2	4.1	41.0
5	Russia	153.1	3.6	44.6
6	Brazil	147.6	3.5	48.1
7	Saudi Arabia	127.7	3.0	51.1
8	Korea, Rep.	114.6	2.7	53.8
9	Germany	113.0	2.7	56.5
10	Mexico	104.6	2.5	59.0
11	Canada	100.9	2.4	61.4
12	Iran	88.2	2.1	63.5
13	France	81.9	1.9	65.4
14	Indonesia	73.8	1.7	67.1
15	United Kingdom	67.0	1.6	68.7
16	Singapore	65.9	1.6	70.3
17	Italy	62.2	1.5	71.8
18	Spain	54.6	1.3	73.1
19	Australia	47.0	1.1	74.2
20	Taiwan	42.7	1.0	75.2
	...			
	other countries [179]	1,049.3	24.8	100.0
	World	**4,227.2**	**100.0**	
	Europe	661.4	15.6	
	CIS	212.7	5.0	
	Africa	178.5	4.2	
	Middle East	379.6	9.0	
	Australasia	1,426.5	33.7	
	North America	1,029.4	24.4	
	Latin America	337.5	8.0	
	OPEC 2009	436.7	10.3	
	OPEC-Gulf	327.2	7.7	
	OECD 2000	2,046.9	48.4	
	EU-28	596.6	14.1	

Table 15: Crude oil export 2013
The most important countries (top 20) and distribution by regions and economic country groupings

Rank	Country / Region	Mt	Share [%] country	Share [%] cumulative
1	Saudi Arabia	376.2	18.2	18.2
2	Russia	235.0	11.4	29.5
3	Canada	144.2	7.0	36.5
4	U. Arab. Emirates	126.3	6.1	42.6
5	Iraq	118.7	5.7	48.3
6	Nigeria	109.0	5.3	53.6
7	Kuwait	102.3	4.9	58.5
8	Venezuela	96.1	4.6	63.2
9	Angola	83.0	4.0	67.2
10	Kazakhstan	69.5	3.4	70.6
11	Mexico	62.9	3.0	73.6
12	Norway	59.4	2.9	76.5
13	Iran	54.6	2.6	79.1
14	Oman	41.6	2.0	81.1
15	Algeria	37.0	1.8	82.9
16	Azerbaijan	36.6	1.8	84.7
17	United Kingdom	35.6	1.7	86.4
18	Qatar	29.8	1.4	87.8
19	Libya	29.3	1.4	89.2
20	Ecuador	19.3	0.9	90.2
	...			
71	Germany	< 0.05	< 0.05	100.0
	...			
	other countries [54]	203.5	9.8	100.0
	World	**2,069.8**	**100.0**	
	Europe	110.8	5.4	
	CIS	347.2	16.8	
	Africa	315.4	15.2	
	Middle East	854.6	41.3	
	Australasia	69.5	3.4	
	North America	213.0	10.3	
	Latin America	159.4	7.7	
	OPEC 2009	1,181.5	57.1	
	OPEC-Gulf	807.9	39.0	
	OECD 2000	339.3	16.4	
	EU-28	50.9	2.5	

Table 16: Crude oil import 2013
The most important countries (top 20) and distribution by regions and economic country groupings

Rank	Country / Region	Mt	Share [%] country	Share [%] cumulative
1	USA	383.3	17.9	17.9
2	China	278.1	13.0	31.0
3	India	187.9	8.8	39.8
4	Japan	183.2	8.6	48.3
5	Korea, Rep.	121.8	5.7	54.0
6	Germany	90.4	4.2	58.3
7	Italy	58.6	2.7	61.0
8	Spain	57.9	2.7	63.7
9	France	55.5	2.6	66.3
10	United Kingdom	48.9	2.3	68.6
11	Netherlands	47.3	2.2	70.8
12	Taiwan	42.3	2.0	72.8
13	Thailand	41.9	2.0	74.8
14	Singapore	39.0	1.8	76.6
15	Canada	34.8	1.6	78.2
16	Belgium	30.5	1.4	79.7
17	Australia	24.2	1.1	80.8
18	Poland	23.3	1.1	81.9
19	Greece	23.0	1.1	83.0
20	Brazil	20.1	0.9	83.9
	...			
	other countries [65]	344.1	16.1	100.0
	World	**2,136.1**	**100.0**	
	Europe	571.8	26.8	
	CIS	30.2	1.4	
	Africa	16.5	0.8	
	Middle East	41.0	1.9	
	Australasia	986.9	46.2	
	North America	418.6	19.6	
	Latin America	71.2	3.3	
	OECD 2000	1,290.8	60.4	
	EU-28	539.9	25.3	

Table 17: Natural gas 2013 [bcm]

	Country / Region	Production	Cum. Production	Reserves	Resources	EUR	Remaining Potential
EUROPE	Albania	< 0.05	8	2	50	60	52
	Austria	1.4	97	14	33	143	47
	Bulgaria	0.3	7	5	575	587	580
	Croatia	1.9	70	23	50	143	73
	Cyprus	–	–	–	250	250	250
	Czech Republic	0.4	15	3	130	148	133
	Denmark	4.8	178	34	950	1,162	984
	France	0.3	228	10	3,984	4,222	3,994
	Germany	11.1	1,010	104	1,860	2,973	1,964
	Greece	< 0.05	1	1	10	12	11
	Hungary	1.9	227	11	347	585	358
	Ireland	0.3	56	25	50	131	75
	Italy	7.1	743	52	405	1,199	456
	Lithuania	–	–	–	< 0.5	< 0.5	< 0.5
	Malta	–	–	–	10	10	10
	Netherlands	84.5	3,461	947	1,621	6,029	2,568
	Norway	107.1	1,874	2,049	2,095	6,018	4,144
	Poland	4.6	257	92	797	1,146	889
	Portugal	–	–	–	40	40	40
	Romania	10.6	1,286	116	1,590	2,992	1,706
	Serbia	0.6	33	21	10	64	31
	Slovakia	0.1	26	12	10	48	22
	Slovenia	< 0.05	n.s.	1	15	16	16
	Spain	0.1	11	3	2,435	2,449	2,438
	Sweden	–	–	–	280	280	280
	Turkey	0.5	14	7	1,153	1,174	1,160
	United Kingdom	38.5	2,459	452	1,761	4,672	2,213
CIS	Armenia	–	–	–	180	180	180
	Azerbaijan	16.7	544	991	2,000	3,535	2,991
	Belarus	0.2	13	3	10	26	13
	Georgia	< 0.05	3	8	102	113	110
	Kazakhstan	32.1	503	1,939	3,400	5,842	5,339
	Kyrgyzstan	< 0.05	7	6	20	33	26
	Moldova, Republic	–	–	–	20	20	20
	Russia	627.6	21,080	47,804	152,050	220,934	199,854
	Tajikistan	< 0.05	9	6	100	114	106
	Turkmenistan	62.3	2,494	9,967	15,000	27,461	24,967
	Ukraine	19.4	1,984	960	5,930	8,874	6,890
	Uzbekistan	58.7	2,195	1,635	1,500	5,330	3,135
AFRICA	Angola	0.9	22	275	1,200	1,497	1,475
	Algeria	79.6	2,228	4,504	26,720	33,452	31,224

continuation of table 17
[bcm]

	Country / Region	Production	Cum. Production	Reserves	Resources	EUR	Remaining Potential
AFRICA	Benin	–	n.s.	1	100	101	101
	Botswana	–	–	–	1,840	1,840	1,840
	Cameroon	0.3	n.s.	151	200	351	351
	Chad	–	–	–	200	200	200
	Congo, DR	n.s.	n.s.	1	10	11	11
	Congo, Rep.	0.2	n.s.	121	200	321	321
	Côte d'Ivoire	1.8	26	16	400	442	416
	Egypt	56.1	775	2,185	10,830	13,790	13,015
	Equatorial Guinea	6.3	42	119	120	281	239
	Eritrea	–	–	–	100	100	100
	Ethiopia	n.s.	n.s.	25	20	45	45
	Gabon	0.4	5	26	600	631	626
	Gambia	–	–	–	25	25	25
	Ghana	n.s.	n.s.	27	300	327	327
	Guinea	–	–	–	200	200	200
	Guinea-Bissau	–	–	–	50	50	50
	Kenya	–	–	–	600	600	600
	Liberia	–	–	–	200	200	200
	Libya	12.0	294	1,549	4,650	6,493	6,199
	Madagascar	–	–	2	4,700	4,702	4,702
	Mauritania	n.s.	n.s.	28	200	228	228
	Morocco	0.1	3	1	2,220	2,224	2,221
	Mozambique	3.6	29	127	5,200	5,356	5,327
	Namibia	–	–	70	250	320	320
	Niger	–	–	–	250	250	250
	Nigeria	36.1	450	5,079	3,000	8,529	8,079
	Rwanda	–	–	–	50	50	50
	Sao Tome and Príncipe	–	–	–	100	100	100
	Senegal	n.s.	n.s.	2	200	202	202
	Seychelles	–	–	–	600	600	600
	Sierra Leone	–	–	–	300	300	300
	Somalia	–	–	6	400	406	406
	South Africa	1.2	41	27	12,620	12,688	12,647
	Sudan & South Sudan	n.s.	n.s.	85	250	335	335
	Tanzania	1.0	n.s.	37	1,400	1,437	1,437
	Togo	–	–	–	100	100	100
	Tunisia	2.7	49	65	800	914	865
	Uganda	–	–	14	–	14	14
	Western Sahara	–	–	–	228	228	228
	Zimbabwe	–	–	–	10	10	10

continuation of table 17
[bcm]

	Country / Region	Production	Cum. Production	Reserves	Resources	EUR	Remaining Potential
MIDDLE EAST	Bahrain	14.7	265	191	200	656	391
	Iran	159.1	2,207	33,780	10,000	45,987	43,780
	Iraq	5.8	119	3,588	4,000	7,706	7,588
	Israel	6.4	24	285	2,000	2,309	2,285
	Jordan	0.2	5	6	350	361	356
	Kuwait	15.6	321	1,784	500	2,605	2,284
	Lebanon	–	–	–	850	850	850
	Oman	31.9	374	950	1,650	2,974	2,600
	Palestine	–	–	30	350	380	380
	Qatar	158.5	1,268	24,681	2,000	27,949	26,681
	Saudi Arabia	103.0	1,683	8,162	24,664	34,509	32,826
	Syria	5.3	132	285	300	717	585
	U. Arab. Emirates	56.0	1,146	6,091	1,500	8,737	7,591
	Yemen	10.3	37	479	500	1,015	979
AUSTRALASIA	Afghanistan	0.1	57	50	350	457	400
	Australia	50.1	1,034	3,677	32,430	37,142	36,107
	Bangladesh	21.9	324	276	800	1,400	1,076
	Brunei	12.9	399	276	200	875	476
	Cambodia	–	–	–	50	50	50
	China	119.3	1,378	3,272	67,980	72,631	71,252
	India	34.5	729	1,355	6,530	8,614	7,885
	Indonesia	70.4	2,008	2,927	10,480	15,414	13,407
	Japan	2.9	133	21	5	158	26
	Korea, Rep.	0.5	n.s.	1	50	51	51
	Laos	–	–	–	5	5	5
	Malaysia	69.1	1,200	2,351	1,900	5,451	4,251
	Mongolia	–	–	–	133	133	133
	Myanmar	12.1	170	283	2,000	2,453	2,283
	New Zealand	4.8	155	29	353	538	382
	Pakistan	38.6	797	723	4,570	6,090	5,293
	Papua New Guinea	0.1	3	155	1,000	1,158	1,155
	Philippines	3.5	36	83	502	621	585
	Sri Lanka	–	–	–	300	300	300
	Taiwan	0.3	51	6	5	63	11
	Thailand	41.8	532	272	740	1,544	1,012
	Timor-Leste	n.s.	n.s.	88	300	388	388
	Viet Nam	9.8	91	617	1,392	2,100	2,009
NORTH AMERICA	Canada	154.8	5,833	2,023	37,493	45,349	39,516
	Greenland	–	–	–	3,900	3,900	3,900
	Mexico	45.8	1,570	348	17,770	19,687	18,118
	USA	687.2	33,556	9,345	54,246	97,147	63,591

continuation of table 17
[bcm]

	Country / Region	Production	Cum. Production	Reserves	Resources	EUR	Remaining Potential
LATIN AMERICA	Argentina	36.9	1,104	316	23,710	25,129	24,026
	Barbados	n.s.	n.s.	2	150	152	152
	Belize	–	–	–	10	10	10
	Bolivia	20.8	240	317	1,620	2,177	1,937
	Brazil	21.3	266	458	18,440	19,164	18,898
	Chile	0.9	108	41	1,510	1,659	1,551
	Colombia	12.6	243	162	2,282	2,688	2,444
	Cuba	1.0	14	71	400	485	471
	Ecuador	0.6	6	6	20	32	26
	Falkland Islands	–	–	–	1,500	1,500	1,500
	(French) Guiana	–	–	–	400	400	400
	Grenada	–	–	–	25	25	25
	Guatemala	–	–	–	10	10	10
	Guyana	–	–	–	100	100	100
	Haiti	–	–	–	50	50	50
	Paraguay	–	–	–	2,420	2,420	2,420
	Peru	12.8	103	435	200	739	635
	Puerto Rico	–	–	–	30	30	30
	Suriname	–	–	–	300	300	300
	Trinidad and Tobago	42.8	587	352	500	1,439	852
	Uruguay	–	–	–	828	828	828
	Venezuela	28.4	1,079	5,558	7,230	13,867	12,788
	World	**3,421.0**	**106,244**	**198,051**	**638,349**	**942,643**	**836,399**
COUNTRY GROUP	Europe	276.3	12,062	3,983	20,510	36,554	24,493
	CIS	817.1	28,832	63,319	180,312	272,462	243,631
	Africa	202.2	3,963	14,544	81,443	99,950	95,987
	Middle East	566.8	7,580	80,311	48,864	136,754	129,175
	Australasia	492.5	9,098	16,461	132,075	157,634	148,536
	North America	887.8	40,959	11,715	113,410	166,083	125,124
	Latin America	178.3	3,751	7,718	61,735	73,205	69,454
ECONOMIC COUNTRY GRP.	OPEC 2009	655.6	10,822	95,057	85,484	191,363	180,541
	OPEC-Gulf	498.0	6,743	78,086	42,664	127,493	120,750
	OECD 2000	1,209.0	52,938	19,258	164,208	236,404	183,466
	EU-28	168.0	10,133	1,904	17,202	29,239	19,106

n. s. not specified
– no production, reserves or resources

Table 18: Natural gas resources 2013 [bcm]
The most important countries (top 20) and distribution by regions and economic country groupings

Rank	Country / Region	Total	conventional	non-conventional		
				shale gas	CBM	tight gas
1	Russia	152,050	110,000	9,500	12,550	20,000
2	China	67,980	20,000	25,080	10,900	12,000
3	USA	54,246	23,500	17,276	4,470	9,000
4	Canada	37,493	10,110	16,230	3,653	7,500
5	Australia	32,430	5,400	12,380	6,650	8,000
6	Algeria	26,720	1,200	20,020	–	5,500
7	Saudi Arabia	24,664	19,000	5,664	–	–
8	Argentina	23,710	1,000	22,710	–	–
9	Brazil	18,440	11,500	6,940	–	–
10	Mexico	17,770	2,300	15,440	30	–
11	Turkmenistan	15,000	15,000	–	–	–
12	South Africa	12,620	1,000	11,050	570	–
13	Egypt	10,830	8,000	2,830	–	–
14	Indonesia	10,480	6,000	1,300	3,180	–
15	Iran	10,000	10,000	–	–	–
16	Venezuela	7,230	2,500	4,730	–	–
17	India	6,530	2,000	2,720	1,810	–
18	Ukraine	5,930	500	3,630	1,800	–
19	Mozambique	5,200	5,200	–	–	–
20	Madagascar	4,700	4,700	–	–	–
	...					
38	Germany	1,860	20	1,300	450	90
	...					
	other countries [122]	92,465	59,462	27,683	4,338	982
	World	**638,349**	**318,392**	**206,483**	**50,401**	**63,072**
	Europe	20,510	5,527	13,257	1,615	112
	CIS	180,312	131,430	13,130	15,752	20,000
	Africa	81,443	34,765	39,768	1,410	5,500
	Middle East	48,864	42,250	5,864	–	750
	Australasia	132,075	43,915	44,700	23,260	20,200
	North America	113,410	39,810	48,946	8,153	16,500
	Latin America	61,735	20,695	40,818	212	10
	OPEC 2009	85,484	46,120	33,864	–	5,500
	OPEC-Gulf	42,664	37,000	5,664	–	–
	OECD 2000	164,208	50,547	72,663	16,386	24,612
	EU-28	17,202	3,172	12,587	1,332	112

– no resources / not specified

Table 19: Natural gas reserves 2013 [bcm]
The most important countries (top 20) and distribution by regions and economic country groupings

Rank	Country / Region	Total	conventional [1]	non-conventional [2]	
				shale gas	CBM
1	Russia	47,804	47,760	–	44
2	Iran	33,780	33,780	–	–
3	Qatar	24,681	24,681	–	–
4	Turkmenistan	9,967	9,967	–	–
5	USA	9,345	5,295	3,665	385
6	Saudi Arabia	8,162	8,162	–	–
7	U. Arab. Emirates	6,091	6,091	–	–
8	Venezuela	5,558	5,558	–	–
9	Nigeria	5,079	5,079	–	–
10	Algeria	4,504	4,504	–	–
11	Australia	3,677	2,698	< 0.5	979
12	Iraq	3,588	3,588	–	–
13	China	3,272	3,201	n.s.	71
14	Indonesia	2,927	2,927	–	–
15	Malaysia	2,351	2,351	–	–
16	Egypt	2,185	2,185	–	–
17	Norway	2,049	2,049	–	–
18	Canada	2,023	1,971	n.s.	52
19	Kazakhstan	1,939	1,939	–	–
20	Kuwait	1,784	1,784	–	–
	...				
53	Germany	104	104	–	–
	...				
	other countries [83]	17,183	16,902	–	280
	World	**198,051**	**192,575**	**3,665**	**1,811**
	Europe	3,983	3,983	–	–
	CIS	63,319	63,275	–	44
	Africa	14,544	14,544	–	–
	Middle East	80,311	80,311	–	–
	Australasia	16,461	15,131	< 0.5	1,330
	North America	11,715	7,613	3,665	436
	Latin America	7,718	7,718	–	–
	OPEC 2009	95,057	95,057	–	–
	OPEC-Gulf	78,086	78,086	–	–
	OECD 2000	19,258	14,178	3,665	1,415
	EU-28	1,904	1,904	–	–

[1] including tight gas
[2] partly data status 2012

n. s. not specified
– no reserves

Table 20: Natural gas production 2013
The most important countries (top 20) and distribution by regions and economic country groupings

Rank	Country / Region	bcm	Share [%] country	Share [%] cumulative
1	USA	687.2	20.1	20.1
2	Russia	627.6	18.3	38.4
3	Iran	159.1	4.7	43.1
4	Qatar	158.5	4.6	47.7
5	Canada	154.8	4.5	52.2
6	China	119.3	3.5	55.7
7	Norway	107.1	3.1	58.9
8	Saudi Arabia	103.0	3.0	61.9
9	Netherlands	84.5	2.5	64.3
10	Algeria	79.6	2.3	66.7
11	Indonesia	70.4	2.1	68.7
12	Malaysia	69.1	2.0	70.7
13	Turkmenistan	62.3	1.8	72.6
14	Uzbekistan	58.7	1.7	74.3
15	Egypt	56.1	1.6	75.9
16	U. Arab. Emirates	56.0	1.6	77.6
17	Australia	50.1	1.5	79.0
18	Mexico	45.8	1.3	80.4
19	Trinidad and Tobago	42.8	1.3	81.6
20	Thailand	41.8	1.2	82.8
	...			
41	Germany	11.1	0.3	96.9
	...			
	other countries [69]	576.1	16.8	100.0
	World	**3,421.0**	**100.0**	
	Europe	276.3	8.1	
	CIS	817.1	23.9	
	Africa	202.2	5.9	
	Middle East	566.8	16.6	
	Australasia	492.5	14.4	
	North America	887.8	26.0	
	Latin America	178.3	5.2	
	OPEC 2009	655.6	19.2	
	OPEC-Gulf	498.0	14.6	
	OECD 2000	1,209.0	35.3	
	EU-28	168.0	4.9	

Table 21: Natural gas consumption 2013
The most important countries (top 20) and distribution by regions and economic country groupings

Rank	Country/Region	bcm	Share [%]	
			country	cumulative
1	USA	736.8	21.5	21.5
2	Russia	466.8	13.6	35.1
3	China	161.6	4.7	39.8
4	Iran	155.2	4.5	44.3
5	Japan	122.0	3.6	47.8
6	Canada	103.5	3.0	50.8
7	Saudi Arabia	103.0	3.0	53.8
8	Germany	91.0	2.7	56.5
9	United Kingdom	77.3	2.3	58.7
10	Italy	70.1	2.0	60.8
11	U. Arab. Emirates	68.3	2.0	62.8
12	Mexico	64.6	1.9	64.7
13	Korea, Rep.	53.2	1.5	66.2
14	Thailand	52.2	1.5	67.7
15	India	51.4	1.5	69.2
16	Egypt	51.4	1.5	70.7
17	Argentina	48.0	1.4	72.1
18	Turkey	45.6	1.3	73.5
19	Uzbekistan	45.2	1.3	74.8
20	Ukraine	45.0	1.3	76.1
	...			
	other countries [90]	821.4	23.9	100.0
	World	**3,433.7**	**100.0**	
	Europe	515.4	15.0	
	CIS	636.5	18.5	
	Africa	119.8	3.5	
	Middle East	438.3	12.8	
	Australasia	650.8	19.0	
	North America	904.9	26.4	
	Latin America	168.2	4.9	
	OPEC 2009	465.3	13.6	
	OPEC-Gulf	383.1	11.2	
	OECD 2000	1,599.3	46.6	
	EU-28	458.7	13.4	

Table 22: Natural gas export 2013
The most important countries (top 20) and distribution by regions and economic country groupings

Rank	Country / Region	bcm	Share [%]	
			country	cumulative
1	Russia	210.7	20.3	20.3
2	Qatar	125.5	12.1	32.4
3	Norway	102.8	9.9	42.3
4	Canada	78.9	7.6	49.9
5	Netherlands	59.5	5.7	55.6
6	Algeria	46.7	4.5	60.1
7	USA	44.5	4.3	64.4
8	Turkmenistan	40.1	3.9	68.2
9	Malaysia	35.4	3.4	71.6
10	Indonesia	31.3	3.0	74.6
11	Australia	30.2	2.9	77.6
12	Nigeria	24.5	2.4	79.9
13	Germany	20.9	2.0	81.9
14	Trinidad and Tobago	19.8	1.9	83.8
15	Bolivia	17.6	1.7	85.5
16	Uzbekistan	12.0	1.2	86.7
17	Kazakhstan	11.8	1.1	87.8
18	Oman	11.5	1.1	88.9
19	Myanmar	10.7	1.0	90.0
20	United Kingdom	10.0	1.0	90.9
	...			
	other countries [30]	94.3	9.1	100.0
	World	**1,038.7**	**100.0**	
	Europe	218.2	21.0	
	CIS	282.7	27.2	
	Africa	89.3	8.6	
	Middle East	160.7	15.5	
	Australasia	119.2	11.5	
	North America	123.4	11.9	
	Latin America	45.1	4.3	
	OPEC 2009	219.4	21.1	
	OPEC-Gulf	142.2	13.7	
	OECD 2000	371.5	35.8	
	EU-28	114.8	11.1	

Table 23: Natural gas import 2013
The most important countries (top 20) and distribution by regions and economic country groupings

Rank	Country/Region	bcm	Share [%] country	Share [%] cumulative
1	Japan	119.0	11.5	11.5
2	Germany	100.4	9.7	21.1
3	USA	81.6	7.9	29.0
4	Italy	62.0	6.0	35.0
5	Korea, Rep.	53.2	5.1	40.1
6	China	51.9	5.0	45.1
7	United Kingdom	48.6	4.7	49.8
8	France	47.9	4.6	54.4
9	Turkey	45.3	4.4	58.7
10	Spain	35.4	3.4	62.1
11	Russia	33.5	3.2	65.4
12	Ukraine	26.9	2.6	68.0
13	Canada	26.6	2.6	70.5
14	Belgium	23.0	2.2	72.7
15	U. Arab. Emirates	19.9	1.9	74.7
16	Mexico	18.5	1.8	76.4
17	Belarus	18.1	1.7	78.2
18	India	17.1	1.6	79.8
19	Brazil	15.9	1.5	81.4
20	Netherlands	15.5	1.5	82.8
	...			
	other countries [55]	178.1	17.2	100.0
	World	**1,038.1**	**100.0**	
	Europe	460.0	44.3	
	CIS	90.5	8.7	
	Africa	7.9	0.8	
	Middle East	31.1	3.0	
	Australasia	286.6	27.6	
	North America	126.7	12.2	
	Latin America	35.2	3.4	
	OPEC 2009	28.9	2.8	
	OPEC-Gulf	27.1	2.6	
	OECD 2000	751.7	72.4	
	EU-28	408.7	39.4	

Table 24: Hard coal 2013 [Mt]

	Country / Region	Production	Reserves	Resources	Remaining Potential
EUROPE	Belgium	–	–	4,100	4,100
	Bulgaria	2.1	192	3,920	4,112
	Czech Republic	8.6	1,115	15,419	16,534
	France	0.3	–	160	160
	Germany	8.3	31	82,959	82,990
	Hungary	–	276	5,075	5,351
	Ireland	–	14	26	40
	Italy	0.1	10	600	610
	Montenegro	–	142	195	337
	Netherlands	–	497	2,750	3,247
	Norway	1.9	12	79	91
	Poland	77.0	15,890	162,581	178,471
	Portugal	–	3	n.s.	3
	Romania	–	11	2,435	2,446
	Serbia	0.1	402	453	855
	Slovakia	–	–	19	19
	Slovenia	–	56	39	95
	Spain	4.4	868	3,363	4,231
	Sweden	–	1	4	5
	Turkey	1.9	384	801	1,185
	United Kingdom	12.8	264	186,700	186,964
CIS	Armenia	–	163	154	317
	Georgia	0.4	201	700	901
	Kazakhstan	114.6	25,605	123,090	148,695
	Kyrgyzstan	0.3	971	27,528	28,499
	Russia	279.0	69,634	2,624,612	2,694,246
	Tajikistan	0.5	375	3,700	4,075
	Turkmenistan	–	–	800	800
	Ukraine	83.4	32,039	49,006	81,045
	Uzbekistan	< 0.05	1,375	9,477	10,852
AFRICA	Algeria	–	59	164	223
	Botswana	1.5	40	21,200	21,240
	Congo, DR	0.1	88	900	988
	Egypt	0.3	16	166	182
	Madagascar	–	–	150	150
	Malawi	0.1	2	800	802
	Morocco	–	14	82	96
	Mozambique	5.6	1,792	21,844	23,636
	Namibia	–	–	350	350
	Niger	0.2	–	90	90
	Nigeria	< 0.05	287	1,857	2,144
	South Africa	255.9	9,893	203,667	213,560
	Swaziland	0.2	144	4,500	4,644
	Tanzania	0.2	269	1,141	1,410
	Uganda	–	–	800	800
	Zambia	0.4	45	900	945
	Zimbabwe	3.0	502	25,000	25,502
ME	Iran	2.0	1,203	40,000	41,203

continuation of table 24
[Mt]

	Country / Region	Production	Reserves	Resources	Remaining Potential
AUSTRALASIA	Afghanistan	0.7	66	n.s.	66
	Australia	409.6	62,095	1,536,666	1,598,761
	Bangladesh	0.9	293	2,967	3,260
	Bhutan	0.1	n.s.	n.s.	n.s.
	China	3,533.0	120,697	5,344,649	5,465,346
	India	565.6	81,897	175,656	257,552
	Indonesia	430.0	13,511	91,285	104,796
	Japan	1.2	340	13,543	13,883
	Korea, DVR	31.6	600	10,000	10,600
	Korea, Rep.	1.8	326	1,360	1,686
	Laos	0.2	4	58	62
	Malaysia	2.6	141	1,068	1,209
	Mongolia	25.3	1,170	39,854	41,024
	Myanmar	1.1	3	248	252
	Nepal	< 0.05	1	7	8
	New Caledonia	–	2	n.s.	2
	New Zealand	4.2	825	2,350	3,175
	Pakistan	1.9	207	5,789	5,996
	Philippines	7.8	211	1,012	1,223
	Taiwan	–	1	101	102
	Viet Nam	41.0	3,116	3,519	6,635
NORTH-AMERICA	Canada	59.9	4,346	183,260	187,606
	Greenland	–	183	200	383
	Mexico	15.7	1,160	3,000	4,160
	USA	823.1	223,435	6,457,573	6,681,008
LATIN AMERICA	Argentina	0.1	500	300	800
	Bolivia	–	1	n.s.	1
	Brazil	–	1,547	4,665	6,212
	Chile	2.4	1,181	4,135	5,316
	Colombia	85.5	4,881	9,928	14,809
	Costa Rica	–	–	17	17
	Peru	0.2	102	1,465	1,567
	Venezuela	2.3	731	5,981	6,712
	World	**6,913.0**	**688,456**	**17,685,012**	**18,373,468**
COUNTRY GROUP	Europe	117.4	20,169	471,678	491,847
	CIS	478.2	130,362	2,839,068	2,969,429
	Africa	267.4	13,150	283,611	296,761
	Middle East	2.0	1,203	40,000	41,203
	Australasia	5,058.7	285,506	7,230,132	7,515,638
	North America	898.8	229,124	6,644,033	6,873,157
	Latin America	90.4	8,943	26,491	35,434
	Antarktis	–	–	150,000	150,000
ECONOMIC COUNTRY GRP.	OPEC 2009	4.3	2,279	48,002	50,281
	OPEC-Gulf	2.0	1,203	40,000	41,203
	OECD 2000	1,430.8	312,076	8,662,587	8,974,663
	EU-28	113.6	19,229	470,150	489,379

n.s. not specified
– no production, reserves or resources

Table 25: Hard coal resources 2013
The most important countries (top 20) and distribution by regions and economic country groupings

Rank	Country / Region	Mt	Share [%] country	Share [%] cumulative
1	USA	6,457,573	36.5	36.5
2	China	5,344,649	30.2	66.7
3	Russia [1]	2,624,612	14.8	81.6
4	Australia	1,536,666	8.7	90.3
5	South Africa	203,667	1.2	91.4
6	United Kingdom	186,700	1.1	92.5
7	Canada	183,260	1.0	93.5
8	India	175,656	1.0	94.5
9	Poland	162,581	0.9	95.4
10	Kazakhstan	123,090	0.7	96.1
11	Indonesia	91,285	0.5	96.6
12	Germany	82,959	0.5	97.1
13	Ukraine [1]	49,006	0.3	97.4
14	Iran	40,000	0.2	97.6
15	Mongolia [1]	39,854	0.2	97.8
16	Kyrgyzstan	27,528	0.2	98.0
17	Zimbabwe	25,000	0.1	98.1
18	Mozambique	21,844	0.1	98.3
19	Botswana	21,200	0.1	98.4
20	Czech Republic [1]	15,419	0.1	98.5
	...			
	other countries [57]	272,464	1.5	100.0
	World	**17,685,012**	**100.0**	
	Europe	471,678	2.7	
	CIS	2,839,068	16.1	
	Africa	283,611	1.6	
	Middle East	40,000	0.2	
	Australasia	7,230,132	40.9	
	North America	6,644,033	37.6	
	Latin America	26,491	0.1	
	Antarktis	150,000	0.8	
	OPEC 2009	48,002	0.3	
	OPEC-Gulf	40,000	0.2	
	OECD 2000	8,662,587	49.0	
	EU-28	470,150	2.7	

[1] Hard coal resources contains only bituminous coal and anthracite according to national classification

Table 26: Hard coal reserves 2013
The most important countries (top 20) and distribution by regions and economic country groupings

Rank	Country/Region	Mt	Share [%] country	Share [%] cumulative
1	USA	223,435	32.5	32.5
2	China	120,697	17.5	50.0
3	India	81,897	11.9	61.9
4	Russia [1]	69,634	10.1	72.0
5	Australia	62,095	9.0	81.0
6	Ukraine [1]	32,039	4.7	85.7
7	Kazakhstan	25,605	3.7	89.4
8	Poland	15,890	2.3	91.7
9	Indonesia	13,511	2.0	93.7
10	South Africa	9,893	1.4	95.1
11	Colombia	4,881	0.7	95.8
12	Canada	4,346	0.6	96.4
13	Viet Nam	3,116	0.5	96.9
14	Mozambique	1,792	0.3	97.1
15	Brazil	1,547	0.2	97.4
16	Uzbekistan	1,375	0.2	97.6
17	Iran	1,203	0.2	97.7
18	Chile	1,181	0.2	97.9
19	Mongolia [1]	1,170	0.2	98.1
20	Mexico	1,160	0.2	98.3
	...			
56	Germany [2]	31	< 0.05	100.0
	...			
	other countries [50]	11,959	1.7	100.0
	World	**688,456**	**100.0**	
	Europe	20,169	2.9	
	CIS	130,362	18.9	
	Africa	13,150	1.9	
	Middle East	1,203	0.2	
	Australasia	285,506	41.5	
	North America	229,124	33.3	
	Latin America	8,943	1.3	
	OPEC 2009	2,279	0.3	
	OPEC-Gulf	1,203	0.2	
	OECD 2000	312,076	45.3	
	EU-28	19,229	2.8	

[1] Hard coal reserves contains only bituminous coal and anthracite according to national classification

[2] Deviating from the BGR reserves definition, RAG AG refers to a „Technically extractable planned inventory“ of 2.5 billion t (status 2011)

Table 27: Hard coal production 2013
The most important countries (top 20) and distribution by regions and economic country groupings

Rank	Country / Region	Mt	Share [%]	
			country	cumulative
1	China	3,533.0	51.1	51.1
2	USA	823.1	11.9	63.0
3	India	565.6	8.2	71.2
4	Indonesia	430.0	6.2	77.4
5	Australia	409.6	5.9	83.3
6	Russia [1]	279.0	4.0	87.4
7	South Africa	255.9	3.7	91.1
8	Kazakhstan	114.6	1.7	92.7
9	Colombia	85.5	1.2	94.0
10	Ukraine [1]	83.4	1.2	95.2
11	Poland	77.0	1.1	96.3
12	Canada	59.9	0.9	97.2
13	Viet Nam	41.0	0.6	97.8
14	Korea, DVR	31.6	0.5	98.2
15	Mongolia [1]	25.3	0.4	98.6
16	Mexico	15.7	0.2	98.8
17	United Kingdom	12.8	0.2	99.0
18	Czech Republic [1]	8.6	0.1	99.1
19	Germany	8.3	0.1	99.2
20	Philippines	7.8	0.1	99.3
	...			
	other countries [38]	45.2	0.7	100.0
	World	**6,913.0**	**100.0**	
	Europe	117.4	1.7	
	CIS	478.2	6.9	
	Africa	267.4	3.9	
	Middle East	2.0	0.0	
	Australasia	5,058.7	73.2	
	North America	898.8	13.0	
	Latin America	90.4	1.3	
	OPEC 2009	4.3	0.1	
	OPEC-Gulf	2.0	0.0	
	OECD 2000	1,430.8	20.7	
	EU-28	113.6	1.6	

[1] Hard coal production contains only bituminous coal and anthracite according to national classification

Table 28: Hard coal consumption 2013
The most important countries (top 20) and distribution by regions and economic country groupings

Rank	Country / Region	Mt	Share [%]	
			country	cumulative
1	China	3,840.0	55.6	55.6
2	USA	760.0	11.0	66.6
3	India	740.0	10.7	77.3
4	South Africa	186.0	2.7	80.0
5	Japan	180.0	2.6	82.6
6	Russia[1]	170.0	2.5	85.0
7	Korea, Rep.	128.0	1.9	86.9
8	Ukraine[1]	87.0	1.3	88.1
9	Kazakhstan	83.0	1.2	89.3
10	Poland	76.0	1.1	90.4
11	Taiwan	68.0	1.0	91.4
12	Germany	61.3	0.9	92.3
13	United Kingdom	60.1	0.9	93.2
14	Australia	51.0	0.7	93.9
15	Canada	31.8	0.5	94.4
16	Viet Nam	27.5	0.4	94.8
17	Turkey	27.0	0.4	95.2
18	Malaysia	25.0	0.4	95.5
19	Mexico	22.0	0.3	95.8
20	Italy	20.5	0.3	96.1
	...			
	other countries [79]	267.2	3.9	100.0
	World	**6,911.4**	**100.0**	
	Europe	339.1	4.9	
	CIS	341.1	4.9	
	Africa	198.7	2.9	
	Middle East	16.2	0.2	
	Australasia	5,158.4	74.6	
	North America	813.8	11.8	
	Latin America	44.0	0.6	
	OPEC 2009	4.8	0.1	
	OPEC-Gulf	4.5	0.1	
	OECD 2000	1,506.0	21.8	
	EU-28	309.8	4.5	

[1] Hard coal consumption contains only bituminous coal and anthracite according to national classification

Table 29: Hard coal export 2013
The most important countries (top 20) and distribution by regions and economic country groupings

Rank	Country / Region	Mt	Share [%] country	Share [%] cumulative
1	Indonesia	424.3	31.5	31.5
2	Australia	358.2	26.6	58.0
3	Russia	143.0	10.6	68.6
4	USA	106.7	7.9	76.5
5	Colombia	76.7	5.7	82.2
6	South Africa	73.0	5.4	87.6
7	Canada	36.6	2.7	90.3
8	Kazakhstan	29.0	2.1	92.5
9	Mongolia	18.4	1.4	93.9
10	Korea, DVR	16.5	1.2	95.1
11	Viet Nam	15.0	1.1	96.2
12	Poland	10.8	0.8	97.0
13	Ukraine	10.5	0.8	97.8
14	China	7.3	0.5	98.3
15	Czech Republic	4.8	0.4	98.7
16	Mozambique	4.5	0.3	99.0
17	Philippines	3.4	0.3	99.3
18	New Zealand	2.1	0.2	99.4
19	Norway	2.1	0.2	99.6
20	Venezuela	2.0	0.2	99.7
	...			
29	Germany	0.1	< 0.05	100.0
	...			
	other countries [6]	3.8	0.3	100.0
	World	**1,348.9**	**100.0**	
	Europe	19.2	1.4	
	CIS	182.5	13.5	
	Africa	77.6	5.8	
	Australasia	846.2	62.7	
	North America	143.3	10.6	
	Latin America	80.0	5.9	
	OPEC 2009	2.0	0.2	
	OECD 2000	522.9	38.8	
	EU-28	17.2	1.3	

Table 30: Hard coal import 2013
The most important countries (top 20) and distribution by regions and economic country groupings

Rank	Country / Region	Mt	Share [%]	
			country	cumulative
1	China	327.0	24.7	24.7
2	Japan	191.5	14.5	39.1
3	India	170.0	12.8	52.0
4	Korea, Rep.	126.5	9.5	61.5
5	Taiwan	66.0	5.0	66.5
6	Germany	50.1	3.8	70.3
7	United Kingdom	49.4	3.7	74.0
8	Russia	29.6	2.2	76.2
9	Turkey	27.0	2.0	78.2
10	Malaysia	23.1	1.7	80.0
11	Italy	20.3	1.5	81.5
12	Brazil	18.0	1.4	82.9
13	Thailand	17.3	1.3	84.2
14	France	17.1	1.3	85.5
15	Philippines	14.4	1.1	86.6
16	Ukraine	14.2	1.1	87.6
17	Spain	13.6	1.0	88.7
18	Hong Kong	13.0	1.0	89.6
19	Israel	11.8	0.9	90.5
20	Netherlands	11.5	0.9	91.4
	...			
	other countries [54]	114.0	8.6	100.0
	World	**1,325.4**	**100.0**	
	Europe	242.5	18.3	
	CIS	44.8	3.4	
	Africa	9.9	0.7	
	Middle East	14.6	1.1	
	Australasia	954.0	72.0	
	North America	24.1	1.8	
	Latin America	35.5	2.7	
	OPEC 2009	2.5	0.2	
	OPEC-Gulf	2.5	0.2	
	OECD 2000	578.9	43.7	
	EU-28	213.4	16.1	

Table 31: Lignite 2013 [Mt]

	Country / Region	Production	Reserves	Resources	Remaining Potential
EUROPE	Albania	< 0.05	522	205	727
	Austria	–	–	333	333
	Bosnia & Herzegovina	7.0	2,264	3,010	5,274
	Bulgaria	26.2	2,174	2,400	4,574
	Croatia	–	n.s.	300	300
	Czech Republic	40.6	2,635	7,162	9,797
	France	–	n.s.	114	114
	Germany	183.0	40,300	36,500	76,800
	Greece	53.6	2,876	3,554	6,430
	Hungary	9.5	2,633	2,704	5,337
	Italy	–	7	22	29
	Kosovo	8.2	1,564	9,262	10,826
	Macedonia	6.7	332	300	632
	Montenegro	2.0	n.s.	n.s.	n.s.
	Poland	65.8	4,971	222,109	227,079
	Portugal	–	33	33	66
	Romania	24.7	280	9,640	9,920
	Serbia	39.6	7,112	13,074	20,186
	Slovakia	2.4	135	938	1,073
	Slovenia	3.7	315	341	656
	Spain	–	319	n.s.	319
	Turkey	58.0	2,055	11,617	13,672
	United Kingdom	–	–	1,000	1,000
CIS	Belarus	–	–	1,500	1,500
	Kazakhstan	5.3	n.s.	n.s.	n.s.
	Kyrgyzstan	1.2	n.s.	n.s.	n.s.
	Russia	73.0	90,730	1,271,672	1,362,402
	Ukraine	0.2	2,336	5,381	7,717
	Uzbekistan	4.1	n.s.	n.s.	n.s.
AFRICA	Central African Rep.	–	3	n.s.	3
	Ethiopia	< 0.05	–	–	–
	Madagascar	–	–	37	37
	Mali	–	–	3	3
	Morocco	–	–	40	40
	Niger	–	6	n.s.	6
	Nigeria	–	57	320	377
	Sierra Leone	–	–	2	2
	Australia	62.6	44,164	399,267	443,431
	Bangladesh	–	–	3	3
	China	147.0	7,350	325,465	332,815
	India	44.3	4,755	37,066	41,821

continuation of table 31
[Mt]

	Country / Region	Production	Reserves	Resources	Remaining Potential
AUSTRALASIA	Indonesia	65.0	9,002	29,023	38,025
	Japan	–	10	1,026	1,036
	Korea, DVR	7.0	n.s.	n.s.	n.s.
	Laos	0.5	499	22	521
	Malaysia	–	39	412	451
	Mongolia	8.0	1,350	119,426	120,776
	Myanmar	< 0.05	3	2	5
	New Zealand	0.3	6,750	4,600	11,350
	Pakistan	1.2	2,857	176,739	179,596
	Philippines	–	105	912	1,017
	Thailand	18.0	1,063	826	1,889
	Viet Nam	–	244	199,876	200,120
NORTH-AMERICA	Canada	9.0	2,236	118,270	120,506
	Mexico	–	51	n.s.	51
	USA	69.8	30,555	1,367,838	1,398,393
LATIN AMERICA	Argentina	–	–	7,300	7,300
	Brazil	8.6	5,049	12,587	17,636
	Chile	0.6	n.s.	7	7
	Dominican Rep.	–	–	84	84
	Ecuador	–	24	n.s.	24
	Haiti	–	–	40	40
	Peru	–	–	100	100
	World	**1,056.3**	**279,762**	**4,404,463**	**4,684,225**
COUNTRY GROUP	Europe	531.0	70,527	324,616	395,143
	CIS	83.7	93,065	1,278,553	1,371,618
	Africa	< 0.05	66	402	468
	Middle East	–	–	–	–
	Australasia	353.8	78,190	1,294,666	1,372,855
	North America	78.7	32,842	1,486,108	1,518,950
	Latin America	9.1	5,073	20,118	25,191
ECONOMIC COUNTRY GRP.	OPEC 2009	–	81	320	401
	OECD 2000	554.5	139,730	2,177,087	2,316,816
	EU-28	409.5	56,678	287,149	343,827

n.s. not specified

– no production, reserves or resources

Table 32: Lignite resources 2013
The most important countries (top 20) and distribution by regions and economic country groupings

Rank	Country / Region	Mt	Share [%] country	Share [%] cumulative
1	USA	1,367,838	31.1	31.1
2	Russia [1]	1,271,672	28.9	59.9
3	Australia	399,267	9.1	69.0
4	China	325,465	7.4	76.4
5	Poland	222,109	5.0	81.4
6	Viet Nam	199,876	4.5	86.0
7	Pakistan	176,739	4.0	90.0
8	Mongolia [1]	119,426	2.7	92.7
9	Canada	118,270	2.7	95.4
10	India	37,066	0.8	96.2
11	Germany	36,500	0.8	97.0
12	Indonesia	29,023	0.7	97.7
13	Serbia	13,074	0.3	98.0
14	Brazil	12,587	0.3	98.3
15	Turkey	11,617	0.3	98.5
16	Romania	9,640	0.2	98.8
17	Kosovo	9,262	0.2	99.0
18	Argentina	7,300	0.2	99.1
19	Czech Republic [1]	7,162	0.2	99.3
20	Ukraine [1]	5,381	0.1	99.4
	...			
	other countries [32]	25,189	0.6	100.0
	World	**4,404,463**	**100.0**	
	Europe	324,616	7.4	
	CIS	1,278,553	29.0	
	Africa	402	0.0	
	Australasia	1,294,666	29.4	
	North America	1,486,108	33.7	
	Latin America	20,118	0.5	
	OPEC 2009	320	0.0	
	OECD 2000	2,177,087	49.4	
	EU-28	287,149	6.5	

[1] Lignite resources contains subbituminous coal

Table 33: Lignite reserves 2013
The most important countries (top 20) and distribution by regions and economic country groupings

Rank	Country / Region	Mt	Share [%] country	Share [%] cumulative
1	Russia [1]	90,730	32.4	32.4
2	Australia	44,164	15.8	48.2
3	Germany	40,300	14.4	62.6
4	USA	30,555	10.9	73.5
5	Indonesia	9,002	3.2	76.8
6	China	7,350	2.6	79.4
7	Serbia	7,112	2.5	81.9
8	New Zealand	6,750	2.4	84.3
9	Brazil	5,049	1.8	86.1
10	Poland	4,971	1.8	87.9
11	India	4,755	1.7	89.6
12	Greece	2,876	1.0	90.7
13	Pakistan	2,857	1.0	91.7
14	Czech Republic [1]	2,635	0.9	92.6
15	Hungary	2,633	0.9	93.6
16	Ukraine [1]	2,336	0.8	94.4
17	Bosnia & Herzegovina [1]	2,264	0.8	95.2
18	Canada	2,236	0.8	96.0
19	Bulgaria	2,174	0.8	96.8
20	Turkey	2,055	0.7	97.5
	...			
	other countries [22]	6,960	2.5	100.0
	World	**279,762**	**100.0**	
	Europe	70,527	25.2	
	CIS	93,065	33.3	
	Africa	66	0.0	
	Australasia	78,190	27.9	
	North America	32,842	11.7	
	Latin America	5,073	1.8	
	OPEC 2009	81	0.0	
	OECD 2000	139,730	49.9	
	EU-28	56,678	20.3	

[1] Lignite reserves contains subbituminous coal

Table 34: Lignite production 2013
The most important countries (top 20) and distribution by regions and economic country groupings

Rank	Country/Region	Mt	Share [%] country	Share [%] cumulative
1	Germany	183.0	17.3	17.3
2	China	147.0	13.9	31.2
3	Russia [1]	73.0	6.9	38.2
4	USA	69.8	6.6	44.8
5	Poland	65.8	6.2	51.0
6	Indonesia	65.0	6.2	57.1
7	Australia	62.6	5.9	63.1
8	Turkey	58.0	5.5	68.6
9	Greece	53.6	5.1	73.6
10	India	44.3	4.2	77.8
11	Czech Republic [1]	40.6	3.8	81.7
12	Serbia	39.6	3.7	85.4
13	Bulgaria	26.2	2.5	87.9
14	Romania [1]	24.7	2.3	90.2
15	Thailand	18.0	1.7	91.9
16	Hungary [1]	9.5	0.9	92.8
17	Canada	9.0	0.8	93.7
18	Brazil	8.6	0.8	94.5
19	Kosovo	8.2	0.8	95.3
20	Mongolia [1]	8.0	0.8	96.0
	...			
	other countries [17]	41.9	4.0	100.0
	World	**1,056.3**	**100.0**	
	Europe	531.0	50.3	
	CIS	83.7	7.9	
	Australasia	353.8	33.5	
	North America	78.7	7.5	
	Latin America	9.1	0.9	
	OECD 2000	554.5	52.5	
	EU-28	409.5	38.8	

[1] Lignite production contains subbituminous coal

Table 35: Lignite consumption 2013
The most important countries (top 20) and distribution by regions and economic country groupings

Rank	Country/Region	Mt	Share [%] country	Share [%] cumulative
1	Germany	183.0	17.8	17.8
2	China	145.0	14.1	31.9
3	Russia [1]	73.0	7.1	39.0
4	USA	69.5	6.8	45.8
5	Poland	65.8	6.4	52.2
6	Australia	62.5	6.1	58.3
7	Turkey	59.0	5.7	64.0
8	Greece	53.5	5.2	69.2
9	India	44.3	4.3	73.5
10	Czech Republic [1]	40.6	3.9	77.5
11	Indonesia	40.0	3.9	81.4
12	Serbia	39.6	3.9	85.2
13	Bulgaria	26.1	2.5	87.7
14	Romania [1]	24.7	2.4	90.2
15	Thailand	18.7	1.8	92.0
16	Hungary [1]	9.5	0.9	92.9
17	Canada	9.0	0.9	93.8
18	Brazil	8.6	0.8	94.6
19	Kosovo	8.4	0.8	95.4
20	Mongolia	7.8	0.8	96.2
	...			
	other countries [15]	39.4	3.8	100.0
	World	**1,027.7**	**100.0**	
	Europe	532.1	51.8	
	CIS	82.6	8.0	
	Australasia	325.5	31.7	
	North America	78.5	7.6	
	Latin America	9.1	0.9	
	OECD 2000	555.1	54.0	
	EU-28	409.4	39.8	

[1] Lignite consumption contains subbituminous coal

Table 36: Uranium 2013 [kt]

Region	Country / Region	Production	Cum. Production	Reserves	Resources	EUR	Remaining Potential
EUROPE	Bulgaria	–	–	–	25	25	25
	Czech Republic	0.2	112	–	342	454	342
	Finland	n.s.	< 0.5	–	15	15	15
	France	< 0.05	76	–	12	88	12
	Germany	< 0.05	220	–	7	227	7
	Greece	–	–	–	13	13	13
	Hungary	–	21	–	27	48	27
	Italy	–	–	5	11	16	16
	Portugal	–	4	5	4	12	9
	Romania	0.1	19	–	13	32	13
	Slovakia	n.s.	–	9	18	26	26
	Slovenia	n.s.	–	2	9	10	10
	Spain	–	5	–	14	19	14
	Sweden	n.s.	< 0.5	–	10	10	10
	Turkey	–	–	7	2	9	9
CIS	Kazakhstan	22.6	223	200	1,381	1,803	1,580
	Russia	3.1	156	12	789	957	801
	Ukraine	1.1	19	43	323	384	365
	Uzbekistan	2.4	48	42	74	164	116
AFRICA	Algeria	–	–	–	20	20	20
	Botswana	–	–	–	69	69	69
	Central African Rep.	–	–	–	32	32	32
	Chad	–	–	–	2	2	2
	Congo, DR	–	26	–	3	28	3
	Egypt	–	–	–	2	2	2
	Gabon	n.s.	25	–	6	31	6
	Malawi	1.1	4	–	15	19	15
	Mali	–	–	–	13	13	13
	Namibia	4.3	118	–	513	630	513
	Niger	4.5	132	15	455	602	470
	Somalia	–	–	–	8	8	8
	South Africa	0.5	159	113	448	720	561
	Tanzania	–	–	38	20	58	58
	Zambia	–	< 0.5	–	54	54	54
	Zimbabwe	–	–	–	26	26	26
MIDDLE EAST	Iran	–	< 0.5	–	17	17	17
	Jordan	–	–	–	90	90	90
AUST-RALASIA	Australia	6.4	189	–	1,798	1,987	1,798
	China	1.5	37	94	113	244	207
	India	0.4	11	–	205	216	205

continuation of table 36
[kt]

	Country / Region	Production	Cum. Production	Reserves	Resources	EUR	Remaining Potential
AUSTRALASIA	Indonesia	–	–	2	30	32	32
	Japan	n.s.	< 0,5	–	7	7	7
	Mongolia	–	1	108	1,444	1,553	1,553
	Pakistan	< 0.05	1	–	–	1	–
	Viet Nam	–	–	–	84	84	84
NORTH-AMERICA	Canada	9.3	474	319	1,182	1,975	1,501
	Greenland	–	–	–	271	271	271
	Mexico	n.s.	< 0.5	–	6	6	6
	USA	1.8	372	39	2,564	2,975	2,603
LATIN AMERICA	Argentina	–	3	5	85	92	90
	Brazil	0.2	4	155	421	580	576
	Chile	–	–	–	4	4	4
	Colombia	–	–	–	228	228	228
	Peru	–	–	1	41	43	43
	World	**59.6**	**2,457**	**1.212**	**13,361**	**17,030**	**14,573**
COUNTRY GROUP	Europe	0.3	456	27	520	1,003	547
	CIS	29.2	445	296	2,567	3,308	2,863
	Africa	10.5	464	166	1,685	2,315	1,851
	Middle East	–	< 0.5	–	107	107	107
	Australasia	8.2	239	203	3,681	4,124	3,885
	North America	11.2	846	358	4,023	5,227	4,381
	Latin America	0.2	6	162	779	947	940
ECONOMIC COUNTRY GRP.	OPEC 2009	–	< 0.5	–	36	36	36
	OPEC-Gulf	–	< 0.5	–	17	17	17
	OECD 2000	17.8	1,473	383	6,301	8,157	6,684
	EU-28	0.3	456	20	518	994	538

n. s. not specified
– no production, reserves or resources

Table 37: Uranium resources 2013 (> 20 kt U) [kt]
The most important countries and distribution by regions and economic country groupings

Country / Region	Discovered		Total	Undiscovered		Total	Share [%]	
	RAR 80-260 USD / kg	inferred < 260 USD / kg		prognosticated < 260 USD / kg	speculative < 260 USD / kg		country	cumu-lative
1	2	3	4 = 2 + 3	5	6	7 = 4 + 5 + 6	8	9
USA	433	n.s.	433	1,273	858	2,564	19.2	19.2
Australia	1,208	590	1,798	n.s.	n.s.	1,798	13.5	32.6
Mongolia	–	33	33	21	1,390	1,444	10.8	43.5
Kazakhstan	173	503	676	405	300	1,381	10.3	53.8
Canada	136	196	332	150	700	1,182	8.8	62.6
Russia	250	427	677	112	n.s.	789	5.9	68.5
Namibia	297	159	456	57	n.s.	513	3.8	72.4
Niger	310	80	390	14	51	455	3.4	75.8
South Africa	121	217	338	110	n.s.	448	3.4	79.1
Brazil	–	121	121	300	n.s.	421	3.2	82.3
Czech Republic	51	68	119	223	–	342	2.6	84.9
Ukraine	99	81	180	23	120	323	2.4	87.3
Greenland	–	221	221	n.s.	50	271	2.0	89.3
Colombia	–	n.s.	n.s.	11	217	228	1.7	91.0
India	98	22	120	85	n.s.	205	1.5	92.5
China	26	79	105	4	4	113	0.8	93.4
Jordan	–	40	40	–	50	90	0.7	94.1
Argentina	4	11	15	14	56	85	0.6	94.7
Viet Nam	1	2	3	81	n.s.	84	0.6	95.3
Uzbekistan	18	32	50	25	–	74	0.6	95.9
Botswana	13	56	69	n.s.	n.s.	69	0.5	96.4
Zambia	10	15	25	30	n.s.	54	0.4	96.8
Peru	–	2	2	20	20	41	0.3	97.1
Central African Rep.	32	n.s.	32	n.s.	n.s.	32	0.2	97.3
Indonesia	5	2	7	24	n.s.	30	0.2	97.6
Hungary	–	14	14	13	n.s.	27	0.2	97.8
Zimbabwe	1	n.s.	1	–	25	26	0.2	98.0
Bulgaria	–	–	–	25	n.s.	25	0.2	98.2
...								
Germany	3	4	7	–	–	7	0.1	99.7

continuation of table 37
[kt]

Country/Region	Discovered		Total	Undiscovered		Total	Share [%]	
	RAR 80-260 USD/kg	inferred <260 USD/kg		prognosticated <260 USD/kg	speculative <260 USD/kg		country	cumu-lative
1	*2*	*3*	*4=2+3*	*5*	*6*	*7=4+5+6*	*8*	*9*
World	**3.387**	**3.062**	**6.449**	**3.058**	**3.855**	**13.361**	**100,0**	**–**
Europe	91	132	223	284	13	520	3.9	–
CIS	540	1,043	1,583	564	420	2,567	19.2	–
Africa	835	563	1,398	210	76	1,685	12.6	–
Middle East	1	43	44	12	50	107	0.8	–
Australasia	1,344	729	2,073	214	1,394	3,681	27.6	–
North America	572	417	989	1,426	1,608	4,023	30.1	–
Latin America	4	134	139	347	293	779	5.8	–
OPEC 2009	21	3	24	12	–	36	0.3	–
OPEC-Gulf	1	3	4	12	–	17	0.1	–
OECD 2000	1,874	1,129	3,003	1,681	1,618	6,301	47.2	–
EU-28	91	130	221	284	13	518	3.9	–

n. s. not specified
– no resources

Table 38: Uranium reserves 2013 (extractable < 80 USD / kg U)
The most important countries (top 20) and distribution by regions and economic country groupings

Rank	Country / Region	kt	Share [%] country	Share [%] cumulative
1	Canada	319	26.3	26.3
2	Kazakhstan	200	16.5	42.8
3	Brazil	155	12.8	55.6
4	South Africa	113	9.3	64.9
5	Mongolia	108	8.9	73.9
6	China	94	7.7	81.6
7	Ukraine	43	3.5	85.1
8	Uzbekistan	42	3.4	88.6
9	USA	39	3.2	91.8
10	Tanzania	38	3.2	94.9
11	Niger	15	1.2	96.2
12	Russia	12	1.0	97.1
13	Slovakia	9	0.7	97.9
14	Turkey	7	0.6	98.4
15	Argentina	5	0.4	98.9
16	Italy	5	0.4	99.2
17	Portugal	5	0.4	99.6
18	Slovenia	2	0.1	99.8
19	Indonesia	2	0.1	99.9
20	Peru	1	0.1	100.0
	World	**1,212**	**100.0**	
	Europe	27	2.2	
	CIS	296	24.4	
	Africa	166	13.7	
	Australasia	203	16.8	
	North America	358	29.5	
	Latin America	162	13.3	
	OECD 2000	383	31.6	
	EU-28	20	1.6	

Table 39: Uranium resources 2013 (extractable < 130 USD/kg U)
The most important countries (top 20) and distribution by regions and economic country groupings

Rank	Country/Region	kt	Share [%]	
			country	cumulative
1	Australia	1,174.0	31.7	31.7
2	Canada	357.5	9.7	41.4
3	Niger	325.0	8.8	50.2
4	Kazakhstan	285.6	7.7	57.9
5	Namibia	248.2	6.7	64.6
6	Russia	216.5	5.9	70.5
7	USA	207.4	5.6	76.1
8	South Africa	175.3	4.7	80.8
9	Brazil	155.1	4.2	85.0
10	China	120.0	3.2	88.3
11	Mongolia	108.1	2.9	91.2
12	Ukraine	84.8	2.3	93.5
13	Uzbekistan	59.4	1.6	95.1
14	Tanzania	40.4	1.1	96.2
15	Central African Rep.	32.0	0.9	97.0
16	Botswana	12.8	0.3	97.4
17	Zambia	9.9	0.3	97.7
18	Slovakia	8.8	0.2	97.9
19	Argentina	8.6	0.2	98.1
20	Mali	8.5	0.2	98.4
	...			
	other countries [15]	61.0	1.6	100.0
	World	**3,698.9**	**100.0**	
	Europe	38.6	1.0	
	CIS	646.3	17.5	
	Africa	865.1	23.4	
	Middle East	1.0	0.0	
	Australasia	1,415.0	38.3	
	North America	567.8	15.4	
	Latin America	165.1	4.5	
	OPEC 2009	1.0	0.0	
	OPEC-Gulf	1.0	0.0	
	OECD 2000	1,782.2	48.2	
	EU-28	31.8	0.9	

Table 40: Natural uranium production 2013
The most important countries and distribution by regions and economic country groupings

Rank	Country / Region	kt	Share [%] country	Share [%] cumulative
1	Kazakhstan	22.6	37.8	37.8
2	Canada	9.3	15.6	53.5
3	Australia	6.4	10.6	64.1
4	Niger	4.5	7.6	71.7
5	Namibia	4.3	7.2	79.0
6	Russia	3.1	5.3	84.2
7	Uzbekistan	2.4	4.0	88.3
8	USA	1.8	3.1	91.3
9	China	1.5	2.4	93.8
10	Malawi	1.1	1.9	95.7
11	Ukraine	1.1	1.8	97.5
12	South Africa	0.5	0.9	98.4
13	India	0.4	0.7	99.0
14	Czech Republic	0.2	0.4	99.4
15	Brazil	0.2	0.3	99.8
16	Romania	0.1	0.1	99.9
17	Pakistan	< 0.05	0.1	100.0
18	Germany [1]	< 0.05	< 0.05	100.0
	World	**59.6**	**100.0**	
	Europe	0.3	0.6	
	CIS	29.2	48.9	
	Africa	10.5	17.6	
	Australasia	8.2	13.8	
	North America	11.2	18.7	
	Latin America	0.2	0.3	
	OECD 2000	17.8	29.8	
	EU-28	0.3	0.6	

[1] only in the form of uranium concentrate as part of the remediation of production sites

Table 41: Uranium consumption 2013
The most important countries (top 20) and distribution by regions and economic country groupings

Rank	Country / Region	kt	Share [%]	
			country	cumulative
1	USA	19.62	30.2	30.2
2	France	9.32	14.3	44.5
3	China	6.71	10.3	54.8
4	Russia	5.09	7.8	62.6
5	Korea, Rep.	4.22	6.5	69.1
6	Ukraine	2.35	3.6	72.7
7	Germany	1.89	2.9	75.6
8	United Kingdom	1.83	2.8	78.4
9	Canada	1.76	2.7	81.1
10	Sweden	1.51	2.3	83.4
11	Spain	1.36	2.1	85.5
12	India	1.33	2.0	87.6
13	Taiwan	1.23	1.9	89.5
14	Finland	1.13	1.7	91.2
15	Belgium	1.02	1.6	92.8
16	Slovakia	0.68	1.0	93.8
17	Czech Republic	0.57	0.9	94.7
18	Switzerland	0.52	0.8	95.5
19	Japan	0.37	0.6	96.0
20	Hungary	0.36	0.5	96.6
	...			
	other countries [11]	2.22	3.4	100.0
	World	**65.07**	**100.0**	
	Europe	20.90	32.1	
	CIS	7.53	11.6	
	Africa	0.31	0.5	
	Middle East	0.17	0.3	
	Australasia	13.97	21.5	
	North America	21.66	33.3	
	Latin America	0.53	0.8	
	OPEC 2009	0.17	0.3	
	OPEC-Gulf	0.17	0.3	
	OECD 2000	46.51	71.5	
	EU-28	20.38	31.3	

Table 42: Geothermal energy 2012 [1]

	Region	El. Power [MW_e]	El. Energy Consumption [GWh]	therm. Power [MW_{th}]	therm. Energy Consumption [GWh]	Total Power [MW]	Total Energy Consumption [GWh]
EUROPE	Austria	2	3	52	159	53	162
	Belgium	–	–	6	18	6	18
	Czech Republic	–	–	7	25	7	25
	Denmark	–	–	33	289	33	289
	Germany	29	65	220	349	249	414
	France	17	86	287	1,229	305	1,315
	Hungary	–	–	188	355	188	355
	Iceland	660	5,211	2,169	8,097	2,829	13,308
	Italy	876	5,235	77	166	952	5,401
	Lithuania	–	–	14	94	14	94
	Macedonia	–	–	43	144	43	144
	Netherlands	–	–	51	989	51	989
	Poland	–	–	102	160	102	160
	Portugal	23	185	2	–	25	185
	Romania	< 0.5	< 0.05	107	144	107	144
	Serbia	–	–	54	231	54	231
	Slovakia	–	–	14	–	14	–
	Slovenia	–	–	4	6	4	6
	Sweden	–	–	33	270	33	270
	Switzerland	–	–	8	10	8	10
	Turkey	242	950	835	–	1,077	950
	United Kingdom	–	–	3	–	3	–
CIS	Georgia	–	–	43	145	43	145
AFRICA	Ethiopia	8	–	–	–	8	–
	Kenya	249	–	–	–	249	–
AUSTRALASIA	China	27	–	–	–	27	–
	Indonesia	1,341	–	–	–	1,341	–
	Japan	537	–	–	–	537	–
	New Zealand	843	–	–	–	843	–
	Papua–Neuguinea	56	–	–	–	56	–
	Philippines	1,848	–	–	–	1,848	–
	Thailand	< 0.5	–	–	–	< 0.5	–

continuation of table 42

	Region	El. Power [MW_e]	El. Energy Consumption [GWh]	therm. Power [MW_{th}]	therm. Energy Consumption [GWh]	Total Power [MW]	Total Energy Consumption [GWh]
NORTH AMERICA	Mexico	1,017	–	–	–	1,017	–
	USA	3,389	18,800	–	–	3,389	18,800
LATIN AMERICA	Costa Rica	207	–	–	–	207	–
	El Salvador	204	–	–	–	204	–
	Guatemala	48	–	–	–	48	–
	Nicaragua	150	–	–	–	150	–
	World	**11,772**	**72,700**	**4,349**	**148,655**	**16,121**	**221,355**
COUNTRY GROUP	Europe	1,848	11,735	4,306	12,734	6,155	24,469
	CIS	–	–	43	145	43	145
	Africa	257	1,500	–	–	257	1,500
	Middle East	–	–	–	–	–	–
	Australasia	4,652	30,800	–	–	4,652	30,800
	North America	4,406	28,400	–	–	4,406	28,400
	Latin America	609	–	–	–	609	–
ECON. COUNTRY GRP.	OECD 2000	7,634	30,535	4,086	12,115	11,721	42,650
	EU-28	946	5,575	1,198	4,252	2,144	9,827

[1] Data set is incomplete. The next global data set will be published in 2015 during the World Geothermal Congress (WGC 2015)

– Data not available

Table 43: Geothermal energy resources 2012

Region	Theoretical Potential [EJ]	Technical Potential [EJ/year]		
	Total	Electricity	Heat	Total
Europe	2,342,000	37.1	3.5	40.6
CIS	6,607,000	104.0	9.9	113.9
Africa	6,083,000	95.0	9.1	104.1
Middle East	1,355,000	21.0	2.0	23.0
Australasia	10,544,000	164.3	15.2	179.5
North America	8,025,000	127.0	11.8	138.8
Latin America	6,886,000	109.0	9.9	118.9
World	**41,842,000**	**657.4**	**61.4**	**718.8**

SOURCES

Asociación Española de Compañías de Investigación, Exploración, Producción de Hidrocarburos y Almacenamiento Subterraneo – ACIEP (Spain)

Advanced Resources International Inc. – ARI (USA)

Agência Nacional do Petróleo, Gás Natural e Biocombustíveis - Ministério de Minas e Energia (Brazil)

Arbeitsgruppe Erneuerbare Energien-Statistik – AGEE

British Petroleum – BP

British Geological Survey – BGS

Bundesamt für Wirtschaft und Ausfuhrkontrolle – BAFA

Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit – BMU

Bundesministerium für Wirtschaft und Energie –BMWi

Bundesverband Geothermal Energy – GtV

Bureau of Ocean Energy Management – BOEMRE (USA)

Bureau of Resources and Energy Economics – BREE (Australia)

Canadian Society for Unconventional Resources – CSUR

CARBUNION (Spain)

China Coal Information Institute

Customs Statistics of Foreign Trade (Russian Federation)

Dart Energy (United Kingdom)

Department of Business Enterprise & Regulatory Reform – BERR (United Kingdom)

Department of Energy & Climate Change – DECC (United Kingdom)

Department of Energy – DOE (Philippines)

Department of Energy (South Africa)

Department of Natural Resources and Mines (Australia)

Department of Resources, Energy and Tourism (Australia)

Deutsche Energie-Agentur – dena

Deutsche Rohstoffagentur - DERA

Deutscher Braunkohlen-Industrie-Verein e.V. – DEBRIV

Ecopetrol (Colombia)

Energy Delta Institute (Netherlands)

Energy Resources Conservation Board – ERCB (Canada)

Energistyrelsen – ENS (Denmark)

Euratom Supply Agency, European Commission – ESA

EuroGas Inc. (USA)

European Geothermal Congress – EGC

European Geothermal Energy Council – EGEC (Belgium)

Gazprom (Russian Federation)

Geología de Exploración y Síntesis – GESSAL (Spain)

Geological Survey of Czech Republic – ČGS

Geological Survey of India – GSI

Geological Survey of Namibia

Geoscience Australia

Geothermal Energy Association – GEA (USA)

Gesamtverband Steinkohle e.V. – GVSt

Global Methan Initiative – GMI (USA)

Grubengas Germany e. V. – IVG

IHS McCloskey

Instituto Colombiano de Geología y Minería – INGEOMINAS

Interfax Russia & CIS

Intergovernmental Panel on Climate Change – IPCC

International Atomic Energy Agency – IAEA

International Energy Agency – IEA (France)

International Geothermal Association – IGA

International Journal of Geothermal Research and its Applications – GEOTHERMICS

Kimberly Oil NL – KBO (France)

KNOC (Korea Republic)

Korea Energy Economics Institute – KEEI

Korea Gas Corporation – KOGAS

L&M Energy Ltd. – LME (New Zealand)

Mineral Resources Authority of Mongolia

Ministerio de Energia y Minas (Peru)

Ministério de Minas e Energia (Brazil)

Ministerio del Poder Popular para la Energía y Petróleo (Venezuela)

Ministry of Coal (India)

Ministry of Ecology, Sustainable Development and Energy (France)

Ministry of Economic Development (New Zealand)

Ministry of Energy of the Russian Federation (Russian Federation)

Ministry of Energy and Coal Mining (Ukraine)

Ministry of Energy and Energy Affairs of Trinidad & Tobago

Ministry of Energy and Mineral Resources of the Republic of Indonesia – ESDM

Ministry of Energy and Mining (Algeria)

Ministry of Energy and Natural Resources (Turkey)

Ministry of Energy Myanmar

Ministry of Energy, Energy Policy and Planning Office – EPPO (Thailand)

Ministry of Energy (Islamic Republic Iran)

Ministry of Energy (United Arab Emirates)

Ministry of Energy, Water and Communications – MEWC (Malaysia)

Minister of Energy and Mineral Resources of Kazakhstan – MEMP PK

Ministry of Environment, Wildlife and Tourism Department of Meteorological Services – MEWT (Botswana)

Ministry of Country and Resources (MLR) (China)

Ministry of Minerals, Energy and Water Resources, Department of Mines (Botswana)

Ministry of Mines and Energy – MME (Brazil)

Ministry of Mines, Industry and Energy (Equatorial Guinea)

Ministry of Petroleum and Natural Gas (India)

Ministry of Petroleum (Egypt)

Nadra Luganshching LLC (Ukraine)

National Coal and Mineral Industries Holding Corporation – Vinacomin (Viet Nam)

National Coal Mining Engineering Technology Research Institute (China)

Natural Gas Europe – NGE

Netherlands Organization for Applied Scientific Research – TNO

Norwegian Petroleum Directorate – NPD

Nuclear Energy Agency – NEA

Oberbergamt des Saarlandes

Office National des Hydrocarbures et des Mines (Morocco)

Oil & Gas Journal

Oxford Institute for Energy Studies (United Kingdom)

Petrobangla (Bangladesh)

Philippine Department of Energy – DOE

Polish Geological Institute – National Research Institute; Department of Deposits and Mining Areas Information – PSH (Poland)

Proceedings World Geothermal Congress 2010 – WGC2010

Proceedings World Geothermal Congress 2015 – WGC2015

Renewables 2014 Global Status Report – REN21

Research Institute of Petroleum Exploration & Development – PetroChina

Russian Energy Agency – REA

Servico Geológico Mexicano – SGM (Mexico)

Servicio Nacional de Geología y Minería – Sernageomin (Chile)

South African Oil and Gas Alliance

Statistics Africa
Statistics Bosnia and Herzegovina
Statistics Bulgaria
Statistics Canada
Statistics China
Statistics Croatia
Statistics Czech Republic
Statistics Finland
Statistics Hong Kong
Statistics Israel
Statistics Japan
Statistics Kazakhstan
Statistics Kosovo
Statistics Macedonia
Statistics Malaysia
Statistics Montenegro
Statistics Netherlands
Statistics Norway
Statistics Pakistan
Statistics Poland
Statistics Romania
Statistics Russian Federation
Statistics Slovakia
Statistics Slovenia
Statistics Taiwan
Statistics Thailand
Statistics Viet Nam
Statistik der Kohlenwirtschaft e.V. – SdK
Statistisches Bundesamt – Destatis
Tanzania Chamber of Minerals and Energy
The Coal Authority (United Kingdom)
Türkiye Taşkömürleri Kurumu – TTK
Turkish Petroleum Corporation
Unión Cuba-Petróleo – CUPET
U.S. Energy Information Administration – EIA
U.S. Environmental Protection Agency - EPA

U.S. Geological Survey – USGS

Universidad Nacional de Colombia

University of Miskolc, Department of Geology and Mineral Resources (Hungary)

Verein der Kohlenimporteure e.V. – VDKI

World Coal Association

World Energy Council – WEC

World Nuclear Association – WNA

GLOSSARY

AGEB	Arbeitsgemeinschaft Energiebilanzen e. V., headquarters in Berlin
AGEE-Stat	Arbeitsgruppe Erneuerbare Energien-Statistik, headquarters in Berlin
Aquifer gas	Natural gas dissolved in groundwater
API	American Petroleum Institute; umbrella organisation of the oil, gas and petroleum industry in the USA
°API	Unit for the density of liquid hydrocarbons: the lower the degree, the heavier the oil
ARA	Abbreviation for Amsterdam, Rotterdam, Antwerp
Associated gas	Natural gas dissolved in the crude oil in the reservoir which is released when the oil is produced
b, bbl	Barrel; standard American unit for oil and oil products; cf. *Units*
BMU	Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, office in Berlin (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety)
BMWi	Bundesministerium für Wirtschaft und Technologie, office in Berlin (Federal Ministry of Economics and Technology)
boe	Barrel(s) oil equivalent; energy unit corresponding to the amount of energy released when combusting on barrel of oil
BP	British Petroleum; internationally active energy corporation, headquarters in London
Brent	The most important crude oil type in Europe
BTL	Biomass to liquid; synthetic fuel made from biomass
BTU	British thermal unit(s); English energy unit
CBM	Coal-bed methane; gas contained in coal
ce	Coal equivalent; corresponds to the amount of energy released when burning 1 kg hard coal, *cf.: Conversion factors*
Clean gas	Standardised natural gas with a calorific value of 9.7692 kWh / Nm³ in Germany
cif	Cost, insurance, freight; a typical transport clause incorporated in maritime transport transactions, corresponding to the \`free on board\` clause where the seller also bears the cost of delivery, insurance and freight to a defined port

Crude oil	Natural mixture of liquid hydrocarbons. The liquid hydrocarbons such as natural gas liquids (NGL) and condensates co-produced from a natural gas well are also categorised as oil production *Conventional crude oil:* Generally used to describe crude oil that can be produced by relatively simple methods and inexpensively thanks to its low viscosity and a density of less than 1g per cm³ (heavy oil, light oil, condensate) *Non-conventional crude oil:* Hydrocarbons that are not extracted using „traditional“ methods, but instead require more sophisticated production techniques. They are only slightly or not at all flowable in the reservoir, because of either their high viscosity or density (extra heavy oil, bitumen) or the low permeability of the host rock (oil in tight rocks, tight oil, shale oil). In shale oil deposits, oil only occurs in a preliminary stage called kerogen.
CTL	Coal to liquid; synthetic fuel made from coal
Cumulative production	Total production since the start of production operations
dena	German Energy Agency; office in Berlin
Deposit	Part of the earth’s crust with a natural concentration of economically extractable mineral and/or energy commodities
DOE	Department of Energy (USA)
downstream	Activities in the production chain after the oil or gas has been produced from the production well: such as processing, transport, handling, sales
EEG	Renewable Energy Sources Act
EGS	Enhanced Geothermal Systems
EIA	U.S. Energy Information Administration
EOR	Enhanced oil recovery; processes used to improve the natural recovery rate of an oilfield
ESA	Euratom Supply Agency – European Commission
EUR	Estimated ultimate recovery; Estimated total amount of an energy commodity that can be extracted from a deposit
Field growth	Increase/growth in original reserves during the production of an oil or gas field as a result of improvements in production technology, and a better understanding of the reservoir and production processes
Gas hydrate	Solid (ice-like) molecular compound consisting of gas and water which is stable under high pressures and low temperatures

Giant, Super-Giant, Mega-Giant	Categories of crude oil and natural gas fields depending on the size of their reserves: Giant: > 68 million t (>500 Mb) oil or > 85 billion m³ (>3 TCF) natural gas, Super-Giant: > 680 million t (>5,000 Mb) crude oil or > 850 billion m³ (>30 TCF) natural gas, Mega-Giant: > 6,800 million t (>50,000 Mb) crude oil or > 8,500 billion m³ (>300 TCF) natural gas
GTL	Gas to liquid: using different methods to produce synthetic fuels from natural gas. Methods include Fischer-Tropsch synthesis
Hard coal	Anthracite, bituminous coal, hard lignite with an energy content >16,500 kJ/kg (ash-free)
HEU	Highly enriched uranium: (> 90 % U-235), mainly used for military purposes
High-enthalpy reservoir	Geothermal energy reservoir with a high heat anomaly. Large differences in temperature permit a high level of efficiency in electrical power generation. Deposits of this kind are mostly found near active plate boundaries
IAEA	International Atomic Energy Agency; UN agency; headquarters in Vienna. *cf. Economic country groupings*
IEA	International Energy Agency OECD organisation; headquarters in Paris
Initial reserves	Cumulative production plus remaining reserves
in-place	Total natural resource contained in a deposit/field (volume figure)
in-situ	Located within the deposit: also refers to a reaction or a process occurring at the point of origin; also a synonym for in-place
IOC	International oil companies, including the super majors: Chevron Corp., ExxonMobil Corp., BP plc, Royal Dutch Shell plc, Total, etc.
IR	Inferred resources; resources of uranium comprising those proven resources which do not satisfy the reserves criteria. Corresponds to the now obsolete class EAR I (estimated additional resources)
J	Joule; *cf. Units*
LBEG	Landesamt für Bergbau, Energie und Geologie, headquarters in Hannover (State Office of Mining, Energy and Geology)
LEU	Low enriched uranium
LIAG	Leibniz-Institut für Angewandte Geopysik; headquarters in Hannover (Leibniz Institute for Applied Geopysics)
Lignite	Raw coal with an energy content (ash free) < 16,500 kJ/kg
LNG	Liquefied natural gas. Natural gas liquefied at -162 °C for transport (1 t LNG contains approx. 1,400 Nm³ natural gas, 1 m³ LNG weighs approx. 0.42 t)

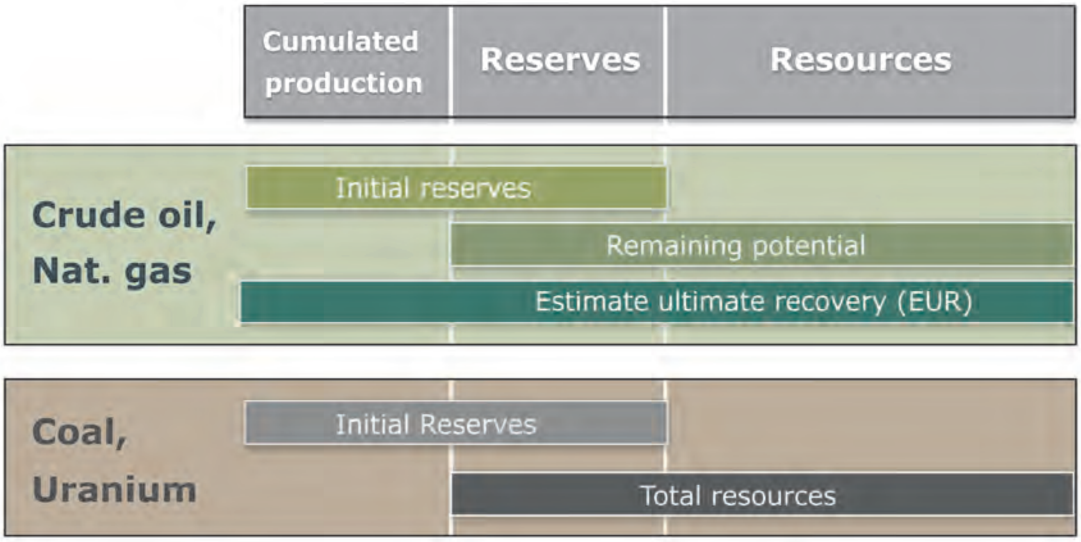
MENA	Country Group (Algeria, Bahrain, Djibouti, Egypt, Iran (Islamic Rep.), Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Palestinian territories, Qatar, Saudi Arabia, Sudan, Syria, Tunisia, United Arab Emirates, Yemen
Methane	Simplest hydrocarbon (CH_4)
Natural gas	Gas occurring naturally underground or flowing out at the surface. Gases can have variable chemical compositions but in this context are understood to be combustible natural gases *Wet gas* contains methane as well as longer chain hydrocarbon constituents *Dry gas* only contains gaseous components and mainly consists of methane *Sour gas* contains varying amounts of hydrogen sulphide (H_2S) in the ppm range *Conventional natural gas:* free natural gas or associated gas in structural or stratigraphic traps *Natural gas from non-conventional deposits* *(in short: non-conventional gas):* Due to the nature and properties of the reservoir, the gas does not usually flow in adequate quantities into the production well without applying additional technical measures, either because it is not present in the rock in a free gas phase, or because the reservoir is not sufficiently permeable. These non-conventional deposits of natural gas include shale gas, tight gas, coal bed methane, aquifer gas and gas from gas hydrates
NEA	Nuclear Energy Agency; part of OECD, headquarters in Paris
NGL	Natural gas liquids
OECD	Organisation for Economic Co-operation and Development headquarters in Paris; *cf. Economic country groupings*
OPEC	Organization of Petroleum Exporting Countries; headquarters in Vienna; *cf. Economic country groupings*
Peak Oil	Time when maximum crude oil production level is reached
Permeability	Measure of the hydraulic transmissivity of a rock; unit: Darcy [D]; symbol: k; *cf.: Units*
Petroleum	Crude oil and petroleum products produced in refineries
Porosity	Pore space in a rock: unit: [%]
Potential	Total potential: cumulative production plus reserves plus resources Remaining potential: reserves plus resources
PEC	Primary energy consumption; describes the total amount of energy required to supply an economy

Raw gas	Untreated natural gas recovered during production
Recovery rate	Amount of oil which can be recovered from an oilfield in per cent
reserve growth	(→ field growth)
Reserves	Proven volumes of energy commodities economically exploitable at today's prices and using today's technology *Initial reserves:* cumulative production plus remaining reserves
Resources	Proven amounts of energy resources which cannot currently be exploited for technical and/or economic reasons, as well as unproven but geologically possible energy resources which may be exploitable in future. For coal this term is used for all in-place resources
Shale gas	Natural gas from fine-grained rocks (shales)
SPE	Society of Petroleum Engineers
tce	Ton(s) coal equivalent; corresponds to approx. 29.308 x 10^9 Joules; *cf.: Conversion factors*
Tight gas	Natural gas from tight sandstones and limestones
toe	Ton(s) oil equivalent an energy unit corresponding to the energy released when burning one tonne of crude oil. *cf.: Conversion factors*
upstream	All activities in the production chain which take place before hydrocarbons leave the production well. Exploration, development and exploitation/production
Uranium	A natural constituent of rocks in the earth's crust. Natural uranium [Unat] (standard uranium) is the uranium which occurs naturally with an isotope composition of U-238 (99.2739 %), U-235 (0.7205 %) and U-234 (0.0056 %). Uranium has to be present in a deposit in concentrated form to enable it to be extracted economically. The following deposit types are currently of economic importance: unconformity-related deposits (dep), sandstones dep, hydrothermal vein-type dep, quartz-pebble conglomerate dep, Proterozoic conglomerates, breccia complex deposits, intrusive and metasomatite deposits *Uranium from non-conventional deposits (in short: non-conventional uranium):* Uranium resources in which uranium is exclusively subordinate, and is extracted as a by-product. These deposits include uranium in phosphates, non-metals, carbonates, black shales and lignites. Uranium is also dissolved in seawater in concentrations of approx. 3 ppb (3 µg/l) and is theoretically extractable.
USGS	United States Geological Survey
VDKi	Verein der Kohlenimporteure e.V.; headquarters in Hamburg (Organisation of Coal Importers)

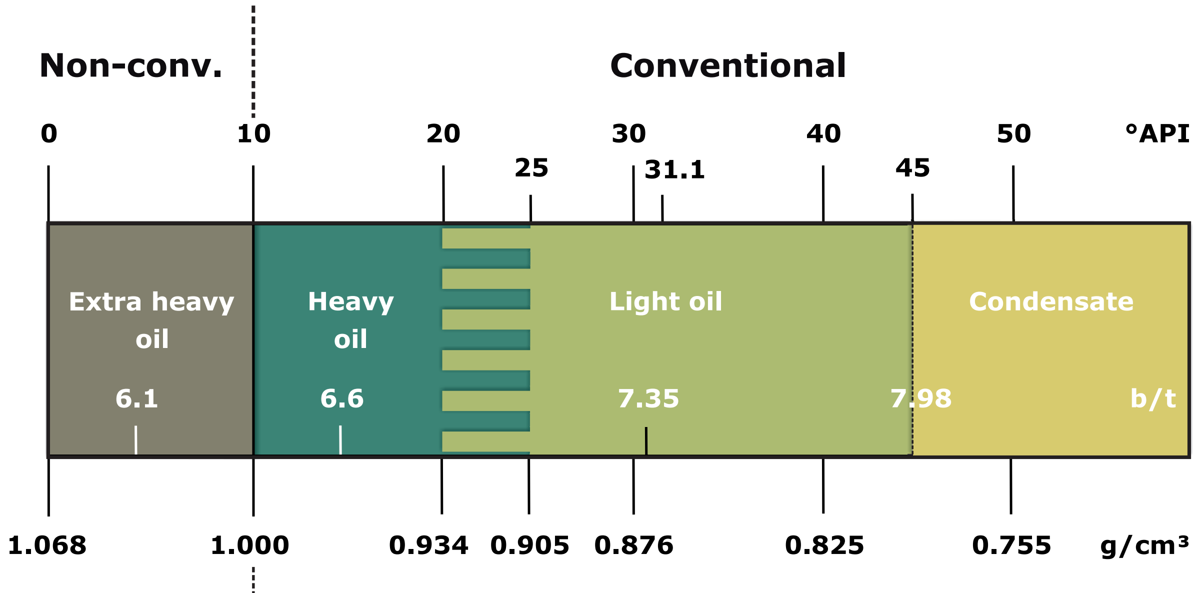
WEC	World Energy Council, headquarters in London; organises the World Energy Congress
WNA	World Nuclear Association; headquarters in London
WPC	World Petroleum Council, headquarters in London, organises the World Petroleum Congress

DEFINITIONS

Distinction between reserves and resources



Classification of crude oil according to its density



COUNTRY GROUPS

Europe

Albania, Andorra, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Faroe Islands, Finland, France, Germany, Gibraltar, Greece, Guernsey, Hungary, Isle of Man, Ireland, Iceland, Italy, Jersey, Kosovo, Latvia, Liechtenstein, Lithuania, Luxembourg, Macedonia (former Yugoslav Republic), Malta, Monaco, Montenegro, Netherlands, Norway, Poland, Portugal, Romania, San Marino, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, Vatican City State

CIS

Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova (Republic), Russian Federation, Tajikistan, Turkmenistan, Ukraine, Uzbekistan

Africa

Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Comoros, Congo (Democratic Republic), Congo (Republic), Côte d'Ivoire, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kap Verde,Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mayotte, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Saint Helena, Ascension and Tristan da Cunha, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, South Sudan, Sudan, Swaziland, Tanzania (United Republic), Togo, Tunisia, Uganda, Western Sahara, Zambia, Zimbabwe

Middle East

Bahrain, Iran (Islamic Republic), Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, Syrian Arab Republic, United Arab Emirate, Yemen

Australasia

„Austral"-Part:

Australia, Cook Islands, Fiji, French-Polynesia (Territory), Guam, Kiribati, Marshall Islands, Micronesia (Federated States), Nauru, New Caledonia, New Zealand, Northern Mariana, Norfolk Island, Palau, Pacific Islands (USA), Pitcairn, Ryukyu Islands, Salomon Islands, Samoa, Timor-Leste, Tokelau, Tonga, Tuvalu, Vanuatu, Wallis and Futuna, West-Timor (Indonesia)

„Asia"-Part:

Afghanistan, Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, Hong Kong, India, Indonesia, Japan, Korea (Democratic People's Republic), Korea (Republic), Laos (People's Democratic Republic), Macao, Malaysia, Maledives, Mongolia, Myanmar, Nepal, Pakistan, Papua New Guinea, Philippines, Singapore, Sri Lanka, Taiwan, Thailand, Viet Nam

North America

Canada, Greenland, Mexico, United States

Latin America (Middle- and South America without Mexico)

Anguilla, Antigua and Barbuda, Argentina, Bahamas, Barbados, Belize, Bermudas, Bolivia (Plurinational State), Brazil, Cayman Islands, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Falkland Islands (Islas Malvinas), Grenada, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Montserrat, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Saint Pierre and Miquelon, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Turks and Caicos Islands, Uruguay, Venezuela (Bolivarian Republic), Virgin Islands (Brit.), Virgin Islands (Americ.)

ECONOMIC COUNTRY GROUPINGS *STATUS:2013*

European Union

EU-15	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom
EU-25	European Union (from 1.5.2004): EU-15 plus new Member: Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia
EU-27	European Union (from 1.1.2007): EU-25 plus new Member: Bulgaria and Romania
EU-28	European Union (from 01.07.2013) EU-27 plus new Member: Croatia

IAEA (International Atomic Energy Agency; 160 countries)

Afghanistan (Islamic Republic), Albania, Algeria, Angola, Argentina, Armenia, Australia, Austria, Azerbaijan, Bahrain, Bangladesh, Belarus, Belgium, Belize, Benin, Bolivia (Plurinational State), Bosnia and Herzegovina, Botswana, Brazil, Bulgaria, Burkina Faso, Burundi, Cambodia, Cameroon, Canada, Central African Republic, Chad, Chile, China, Colombia, Congo (Democratic Republic), Congo (Republic), Costa Rica, Côte d'Ivoire, Croatia, Cuba, Cyprus, Czech Republic, Denmark, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Eritrea, Estonia, Ethiopia, Fiji, Finland, France, Gabon, Georgia, Germany, Ghana, Greece, Guatemala, Haiti, Honduras, Hungary, Iceland, India, Indonesia, Iran (Islamic Republic), Iraq, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Kyrgyzstan, Korea (Republic), Kuwait, Lao (People's Democratic Republic), Latvia, Lebanon, Lesotho, Liberia, Libya, Liechtenstein, Lithuania, Luxembourg, Madagascar, Malawi, Malaysia, Mali, Malta, Morocco, Marshall Islands, Mauritania, Mauritius, Macedonia (former Yugoslav Republic), Mexico, Moldova (Republic), Monaco, Mongolia, Montenegro, Mozambique, Myanmar, Namibia, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Oman, Pakistan, Palau, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Qatar, Romania, Rwanda, Russian Federation, San Marino, Saudi Arabia, Senegal, Serbia, Seychelles, Sierra Leone, Singapore, Slovakia, Slovenia, South Africa, South Sudan, Spain, Sri Lanka, Sudan, Swaziland, Sweden, Switzerland, Syrian Arab Republic, Tajikistan, Tanzania (United Republic), Thailand, Togo, Trinidad and Tobago, Turkey, Tunisia, Uganda, Ukraine, United Arab Emirates, United Kingdom, United States, Uruguay, Uzbekistan, Vatican City State, Venezuela (Bolivarian Republic), Viet Nam, Yemen, Zambia, Zimbabwe,

NAFTA (North American Free Trade Agreement)

Canada, Mexico, United States

OECD (Organization for Economic Co-operation and Development; 34 countries)

Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea (Republic), Luxembourg, Mexico, New Zealand, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States

OPEC (Organization of the Petroleum Exporting Countries; 12 countries)

Algeria, Angola, Ecuador, Iran (Islamic Republic), Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates, Venezuela (Bolivarian Republic),

OPEC-Gulf	Iran (Islamic Republic), Iraq, Kuwait, Qatar, Saudi Arabia, United Arab Emirates
OPEC-2009	OPEC-Member with Status end-2009

UNITS

b, bbl	barrel	1 bbl = 158.984 liter
cf	cubic feet	1 cf = 0.02832 m^3
J	Joule	1 J = 0.2388 cal = 1 Ws (Watt second)
kJ	Kilojoule	1 kJ = 10^3 J
MJ	Megajoule	1 MJ = 10^6 J
GJ	Gigajoule	1 GJ = 10^9 J = 278 kWh = 0.0341 t tce
TJ	Terajoule	1 TJ = 10^{12} J = 278 x 10^3 kWh = 34.1 t tce
PJ	Petajoule	1 PJ = 10^{15} J = 278 x 10^6 kWh = 34.1 x 10^3 t tce
EJ	Exajoule	1 EJ = 10^{18} J = 278 x 10^9 kWh = 34.1 x 10^6 t tce
cm, m^3	cubic meter	
Nm^3	standard cubic meter	Volume of Gas in 1 m^3 at 0° C and 1,013 mbar
mcm	million cubic meter	1 mcm = 10^6 m^3
bcm	billion cubic meter	1 bcm = 10^9 m^3
tcm	trillion cubic meter	1 tcm = 10^{12} m^3
lb	pound	1 lb = 453.59237 g
t	ton	1 t = 10^3 kg
t / a	metric ton(s) per year	
toe	ton(s) oil equivalent	
kt	Kiloton	1 kt = 10^3 t
Mt	Megaton	1 Mt = 10^6 t
Gt	Gigaton	1 Gt = 10^9 t
Tt	Teraton	1 Tt = 10^{12} t
W	Watt	1 W = 1 J/s = 1 kg m^2/s^3
MW_e	Megawatt electric	1 MW = 106 W
MW_{th}	Megawatt thermal	1 MW = 106 W
Wh	Watt hour	1Wh = 3.6 kW = 3.6 kJ

CONVERSION FACTORS

1 t crude oil	1 toe = 7.35 bbl = 1.428 tce = 1,101 m^3 natural gas = 41.8 x 10^9 J
1 t LNG	1,380 m^3 natural gas = 1.06 toe = 1.52 tce = 44.4 x 10^9 J
1,000 Nm^3 nat. gas	35,315 cf = 0.9082 toe = 1.297 tce = 0.735 t LNG = 38 x 10^9 J
1 tce	0.70 toe = 770.7 m^3 natural gas = 29.3 x 10^9 J
1 EJ (10^{18} J)	34.1 Mtce = 23.9 Mtoe = 26.3 G. m^3 natural gas = 278 billion TWh
1 t uranium (nat.)	14,000 - 23,000 tce; value varies depending on degree of capacity utilisation
1 kg uranium (nat.)	2.6 lb U_3O_8

DISCLAIMER

Bundesanstalt für Geowissenschaften
und Rohstoffe (BGR)
Federal Institute for Geosciences and
Natural Resources (BGR)
Stilleweg 2
30655 Hannover, Germany

E-Mail: energierohstoffe@bgr.de
Web: http://www.bgr.bund.de