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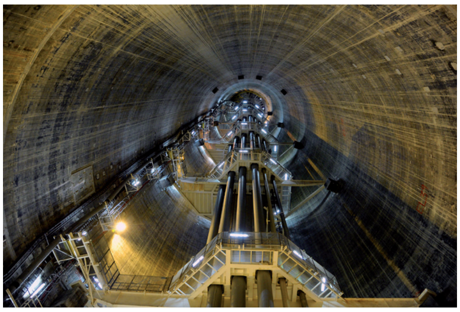
ENERGY STUDY



Reserves, Resources and Availability of Energy Resources

BGR

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ENERGY STUDY 2013

Reserves, Resources and Availability of Energy Resources

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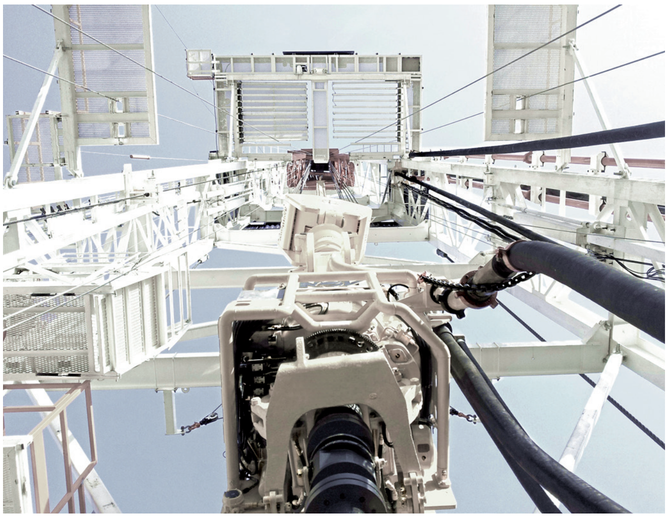
FOREWORD

The global oil production maximum – also known as peak oil – is getting closer. Not tomorrow, but within a time period which will also be relevant for today‘s societies. Either because the physical depletion of natural deposits allows no economic increase in production rates, or because demand is covered in other ways thanks to alternative energy supplies. The scenario one tends to believe, and the assumed proximity of the time when peak oil is reached, defines whether one belongs to the pessimists or the optimists. Either way, serious modifications to the energy systems will be associated with the move away from crude oil. Germany has charted a very clear course with its alternative energy strategy (also known as 'Energiewende'), which has attracted a great deal of international attention. Nevertheless, even Germany will still rely for many years on oil and other fossil fuels such as gas, hard coal and lignite. The dependency on fossil fuels which has evolved over many decades, and is now a source of concern from today‘s point of view, is simply too large to be dissipated within only a few years. This is demonstrated by the figures for 2012, when crude oil, natural gas, hard coal and lignite easily made the largest contribution (79 %) to satisfying primary energy consumption in Germany. Information on the availability of fossil fuels therefore continues to be of vital significance for the proper functioning of global energy supplies, the industrial nation Germany, and facilitating the transition to an energy mix primarily based on renewable energy sources.

One of the key responsibilities assigned to the Federal Institute for Geosciences and Natural Resources (BGR) is to provide sound scientific advice on all questions concerning fossil fuels. This is why we have prepared an energy study for over 35 years. It was first published in 1976 and then issued at irregular intervals until the start of the publication of an annually updated report beginning in 2004 – this year‘s report is therefore the 17th issue. Given its long and successful tradition, the energy study will be published in future in a series of its own with a serial number. The study forms the basis for providing German industry and the Federal Ministry of Economics and Technology (BMWi) with advice on commodity industry aspects. As usual, the report discusses the availability of fossil fuels and presents information in a comprehensive selection of tables. The database itself is founded on the continuous evaluation of information from journals, scientific publications, industry reports, technical organisations, political sources, internet sources, and the results of our own surveys. All of the data presented here is derived from the BGR energy commodity database unless expressly stated otherwise.

The current study is based on the analysis of the geological inventory of energy resources, with reliable conclusions on the reserves and resources of crude oil, natural gas, coal and nuclear fuels. This also takes into consideration the development of the commodity markets with respect to the global and German production, export, import, and consumption of fossil fuels. The special topics looked at in detail in this year‘s study highlight the shale gas deposits in Europe, the differentiation between the terms conventional and non-conventional, and a description of the oil and gas potential in the Arctic.



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1 SUMMARY

This energy study by the Federal Institute for Geosciences and Natural Resources (BGR) contains estimates of the geological inventory of non-renewable energy resources, and contains reliable conclusions on the reserves and resources of crude oil, natural gas, coal and nuclear fuel. It also looks at topical and socially relevant issues. The study serves as the common basis for providing advice on commodity industry aspects to the Federal Ministry of Economics and Technology (BMWi) and German industry as a whole. As in the past, the availability of fossil fuels will be looked at in detail and presented in a large number of tables. All of the data presented in the study is derived from the BGR energy commodity database unless explicitly stated otherwise.

Considered overall on the basis of the knowledge currently available, there are still extensive volumes of fossil fuels from a geological point of view. There is still enormous potential in all regions around the world on the basis of an assessment of the global reserves and resources, and the already consumed energy resources (Fig. 1). Whilst the potential has hardly been touched in the Austral-Asia, CIS and North American Regions, even in Europe, only a small percentage has been produced to date. This wealth in commodities is primarily founded on the huge coal deposits which are present on all continents and, unlike conventional oil and gas, are not concentrated in very localised regions. This means that the Near East region, which is extremely important in terms of oil and gas, only has a relatively minor total potential.

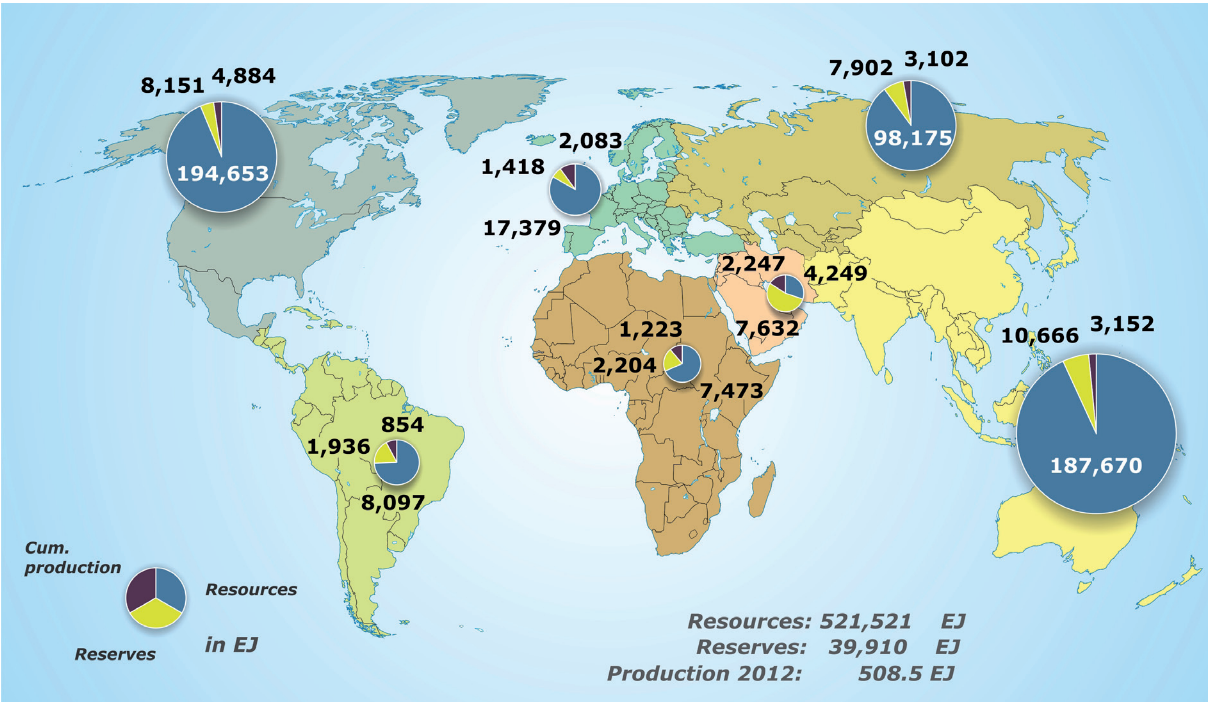

Fig. 1 Total potential of energy resources 2012: Regional distribution (excluding coal resources in the Antarctic, as well as excluding the resources of oil shale, aquifer gas, gas from gas hydrates and thorium because they are not regionally classifiable), (cumulative production of coal since 1950).

The largest proportion of the non-renewable global energy resources is defined as resources, and exceeds the reserves by a factor of more than 10. This applies to all types of energy resources with the exception of conventional crude oil – a fact which highlights the special role played by this energy resource. The energy content of all reserves in 2012 totalled 39,910 Exajoule (EJ), and has therefore grown slightly despite an increase in production. When looked at in terms of extractable energy content, coal is the dominant energy commodity, particular in the case of resources, but also in terms of reserves. Despite a growth in production of 2.8 % overall, the produced volumes were balanced out by transferring resources to the reserves. In the overall visualisation of the global energy mix, i.e. the actual amount of consumed energy including renewables, there is still a significant dominance by fossil fuels. Year-on-year, there are only minor changes in the reserves of energy resources, and this is primarily attributable to re-assessments of non-conventional hydrocarbons.

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

Crude oil

- **The supply of oil in the next few years can be maintained from a geological point of view even with a moderate rise in oil consumption.** There was a slight increase in reserves despite a rise in production. Significant changes to the resource estimates highlight the continuing uncertainties concerning the total crude oil potential.

- **Crude oil from non-conventional deposits, primarily including oil sand and light tight oil, gaining increasingly in importance.** The increase in the production figures for light tight oil in the USA have demonstrated that technological advances can enable new potential to be developed in only a few years if oil prices remain high.

- **There will be a rise in the share of condensate in the overall oil production figures.** Expansion of natural gas production, particularly also from non-conventional deposits, will therefore also have an impact on oil production.

- **Crude oil will continue to be the most important source of energy world-wide.** The proportion of global PEC (primary energy consumption) accounted for by oil is currently 33.1 %. The declining consumption in OECD countries attributable to rises in efficiency and substitution by renewable energy resources, is not enough to compensate for the rise in consumption in emerging economies such as China, India and many African countries.

- **It is not possible to predict how oil prices will develop in future. In all likelihood, permanent low prices will never establish themselves again.** In the short to medium term, oil prices are less dependent on geological availability than on political-economical influencing factors. More stringent safety regulations such as those applying to production from deep water oil fields and a growing proportion of non-conventional oil will lead to an increase in the costs of producing oil.

- **Crude oil is the only non-renewable energy commodity which will probably no longer be able to keep up with the growing demand in future decades.** The timely development of alternative energy systems will therefore be necessary given the long time periods involved in bringing about major changes in the energy sector. Increasing the exploitation of non-conventional oil deposits will not lead to a paradigm shift in the long term.

Natural gas

- **From a geological point of view, natural gas is still available in very large quantities.** Even in the face of the demand growth forecast, the very high remaining gas potential would be able to maintain global supplies for many decades to come.

- **Natural gas production in Europe passed its peak several years ago.** This increased the dependency on gas imports from the CIS, Africa and the Near East. Around 80 % of global gas reserves are held by countries belonging to OPEC and the CIS.

- **The success in developing non-conventional natural gas deposits, primarily in the USA, has reduced the import dependency in North America.** The USA could even become a large exporter of liquefied natural gas in the medium term.

- **With its integrated and expanding gas supply grid, Europe is connected to a large proportion of global natural gas reserves.** As a consequence, the European gas market is in a relatively comfortable position in principle.

- **The proportion of the trade with liquefied natural gas (LNG) has declined for the first time in many years.** This is mainly attributable to the slow expansion of LNG capacities, and the inadequate utilisation of the existing facilities. This ultimately led to a shortage in supply and a considerable rise in the price of LNG.

Coal

- **The reserves and resources of hard coal and lignite are adequate to cover the foreseeable demand for many decades from a geological point of view.** Coal boasts the largest potential of all non-renewable energy resources with a share of around 56 % of reserves and 89 % of resources.

- **Coal will continue to play a significant role against the background of the continuing rise in global primary energy consumption.** In 2012, it was the second most important source of energy used to satisfy global primary energy consumption, and was therefore again the fossil fuel with the highest reported growth rates.

- **The development in the global, and therefore also the European coal prices, has been largely determined by the rise in Asian coal imports since 2009**, which now account for 70 % of global hard coal trading volumes.

- **The global market for hard coal is currently affected by an oversupply situation as a result of the commissioning and expansion of production in coal exporting projects in many countries,** as well as the current increase in US exports attributable to the difficulty in selling coal on the domestic market.

- The **excess global supply of hard coal has already led to the closure of mines in the USA, Australia and China, as well as the announcement of planned closures in Europe as well.** At the same time as this oversupply situation, there is also a decline in the prices for coal – particularly when compared to oil and gas – which will therefore probably lead to only a very insignificant slow-down in the demand for coal.

Nuclear fuels

- **Global uranium production has grown again.** Uranium production has risen 8 % compared to the previous year. The largest uranium producing countries in the world, with a share of over 63 % of global production, are Kazakhstan, Canada and Australia. Canada's major McArthur River deposit alone supplies 13 % of the uranium mined world-wide.

- **No shortage in the supply of nuclear fuels is expected in the foreseeable future from a geological point of view.** The global uranium reserves are very extensive and currently total 2.16 Mt (cost category < 80 USD/kg U) and 13 Mt uranium resources.

- **Even after the reactor disaster in Fukushima, there is still a growing interest world-wide in using nuclear fuels for energy generation.** Despite Germany's decision to withdraw completely from the use of nuclear power, and the moratorium on expanding nuclear power capacities in a few other countries, most governments continue to rely on nuclear power generation. At the end of 2012, 68 nuclear power plants were being constructed in 14 countries. Another 110 nuclear power plants are currently in the planning or approval phases.

- **Uranium reserves are expected to increase in the medium to long term.** Despite the challenges currently facing the global uranium market, global uranium resources are increasing as a result of the growing number of exploration projects initiated in recent years. It is therefore likely that the reserves will also grow further in future.

2 ENERGY RESOURCES OVERVIEW

Energy resources in the global energy supply system

The energy systems around the world are still undergoing continuous change. However, at a global scale, these changes are almost imperceptible on an annual basis – they are only properly revealed over long-term historical time periods. Biomass (firewood) was the dominant source of energy right up to the 19th century until it was replaced by coal, which provided the energetic foundations for global industrialisation. At the beginning of the 20th century, the demand for oil began to grow because of its efficiency as a fuel, and it rapidly developed into the most important energy commodity, whose absolute growth in consumption has still continued right up to the present day. However, the maximum share of crude oil in primary energy consumption (PEC) already began to decline as a repercussion of the oil crises in the 1970s when oil was increasingly displaced in power plants by the increased use of other energy resources such as natural gas and nuclear fuels. Changes in the global energy mix since then have been relatively minor (Fig. 2). Although water power has already been used for a very long time period, its potential is only considered to have limited scope for expansion – in a similar way to nuclear power – even though for very different reasons. The latest development which came along in the new millennium was the increased use of renewable energy resources. Independent of the gradual, long-term change in the energy mix, global PEC has risen continuously since the middle of the 20th century. Every new source of energy added to the mix therefore tends only to cover the additional demand rather than replace already established energy resources. This means that today, the absolute volumes of even the most traditional fuels – biomass and coal – are higher than ever before. An overall trend which has already existed for many decades, is that fossil energy resources easily account for the largest proportion of global PEC, and that this dominance will probably also continue for a very long time into the future.

When looked at in detail, there were some significant developments in 2012 which have the potential to have an impact on energy supplies at a global scale: the USA boasted the biggest increase in crude oil production in the country‘s history. This was made possible by the increasingly efficient production of shale gas and light tight oil. Commercial production of these hydrocarbons is still limited to North America however, and it remains to be seen whether it will actually be possible to emulate this success in other countries and hydrocarbon deposits in future. In almost every country around the world with prospectivity for hydrocarbon-bearing shale formations, there are also activities to develop these resources. And although it appears unlikely that the production of shale gas and light tight oil will have the same significance in Europe as it is having in the USA, other countries such as China are still pursuing ambitious plans in this regard, and have already firmly incorporated the production of shale gas in their energy mix. In Europe, a number of countries such as Poland and Germany have already undertaken specific evaluations of their domestic shale gas deposits. Nevertheless, large-scale development in the near future is not expected despite the presence of significant deposits: this is because of the geological and engineering challenges, and the continuing controversial debates at a societal level. On the other side of the Atlantic in the USA however, the rise in the production of gas from shales, and the subsequent decline in gas prices, led to gas being substituted for other fuels in a way which was considered unimaginable even only a few years ago. Coal production in the USA has been in decline since 2009, primarily because of the drop in domestic demand. Coal produced in the USA is therefore being increasingly pushed onto the world market. Against the background of the doubling of global hard coal production between 2000 and 2012, and the fact that coal has become the fossil energy commodity with the largest annual growth rates, the shale gas boom in the USA is yet another factor adding to the current oversupply of coal on the global market. The influence of this situation on the energy systems and prices around the world is already tangible, independent of whether, and how fast, the production of shale gas and light tight oil might develop outside of the USA.

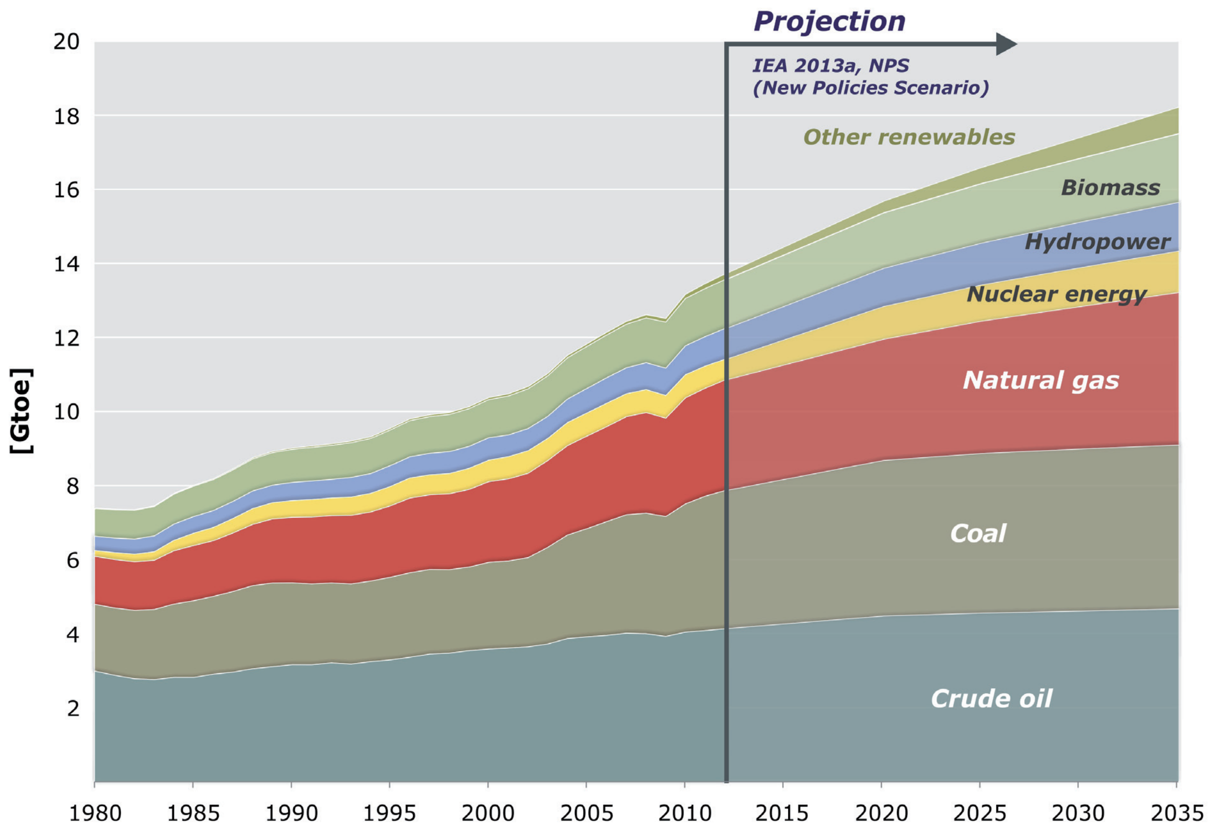

Fig. 2: Development of global primary energy consumption versus fuels, and a possible future development ("Scenario based on the new energy policy conditions" – New Policies Scenario, IEA 2013a).

Energy resources for Germany

Primary energy consumption (PEC) in Germany rose in 2012 by 0.9 % year-on-year, which meant that after the temporary rise in 2010, PEC was only slightly higher than the low level of consumption in 2009 attributable to the economic crisis (AGEB 2013). The main share of primary energy consumption was accounted for by crude oil (33.1 %) or petroleum, a level which has remained largely unchanged for many years (Fig. 3). Together with natural gas, hard coal and lignite, fossil fuels still accounted for more than three quarters of PEC in 2012 as well, and when added to nuclear power, accounted for more than 85 % of total energy consumption. The energy policies adopted in 2010 and 2011 to promote the use of renewable energy resources and to withdraw from the use of nuclear energy, have had an influence on the primary energy mix in 2012, with the proportion of nuclear energy declining further year-on-year to around 8 %, whilst renewable energy resources grew further to 11.6 %.

Primary energy consumption reached its peak at the end of the 1970s. The demand for energy ever since has remained at basically the same level with a slight downward trend. Nevertheless, as a highly developed industrial nation, and one of the largest energy consumers in the world, Germany has to import most of its energy resources. Despite the declining absolute consumption level, its dependence on imported crude oil, natural gas and hard coal continues to rise. Only around 2 % of its oil requirements and around 13 % of its gas needs are covered by domestic production (Fig. 3) because the domestic oil and gas fields have declining production rates due to natural depletion. The dependency on the imports of hard coal will also continue to rise further when the country stops subsidising domestic hard coal mining in 2018. In absolute terms as well, the consumption of hard coal rose by 3.1 % year-on-year. The proportion of lignite in primary energy consumption remained almost unchanged over the ten-year period from 2002 to 2012. However, the consumption of lignite experienced the strongest rise of all of the fossil fuels with a year-on-year increase of 5.3 %. Lignite is the only non-renewable energy commodity which is present in Germany in large, economically producible quantities. Germany can supply all of its own needs from domestic resources, and is the largest consumer of lignite world-wide. As expected, nuclear energy reported the strongest decline in the share of primary energy consumption, therefore losing even more of its significance. The only energy source which grew significantly was the share of renewables.

A special overview of the energy resources situation in Germany is given in the BGR report "Deutschland – Rohstoffsituation 2012" (BGR 2013) published in parallel to this study.

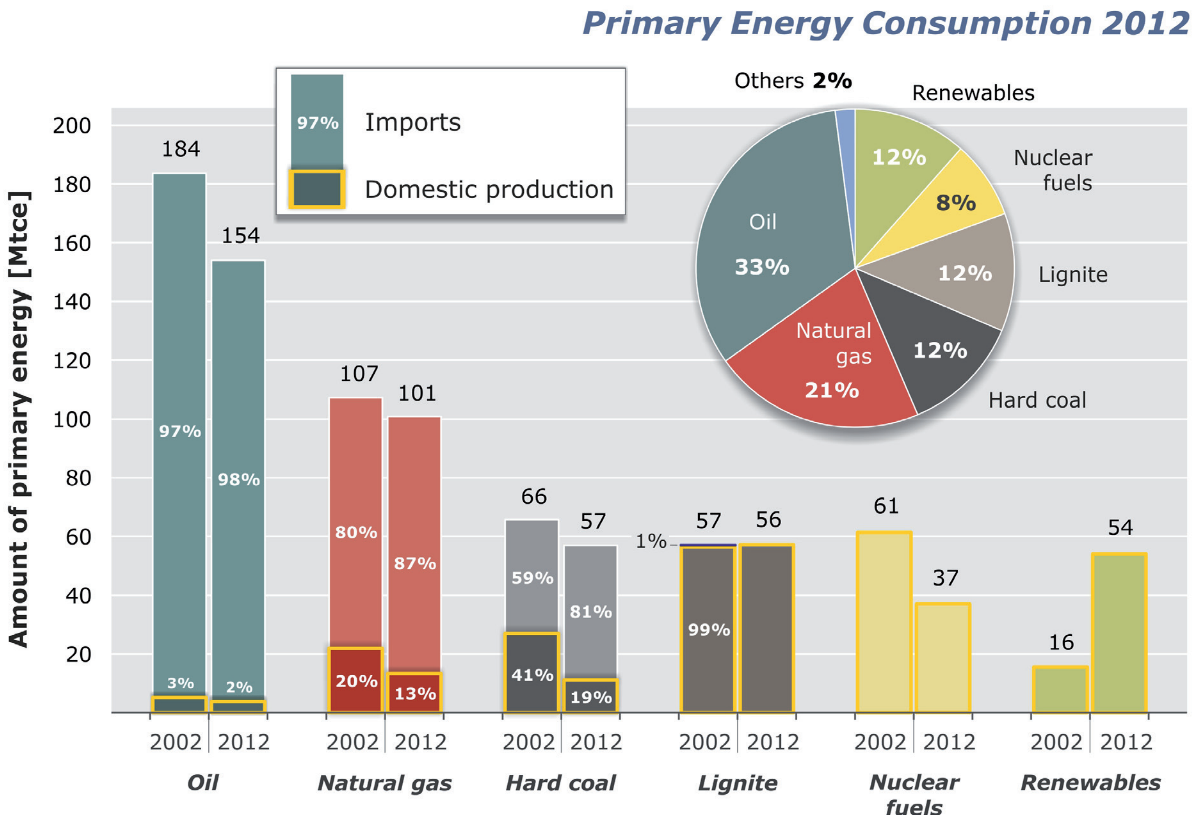

Fig. 3: Comparison of the use of primary energy resources and the relationship between domestic supply and imported commodities for Germany from 2002 to 2012, as well as relative proportions for 2012 (after AGEB 2013, LBEG 2013).

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Global reserves situation

Table 1 visualises the total known global potential of all fossil energy resources including nuclear fuels. The figures shown in this table are the totals of the country data which are listed separately in Tables 2 to 36 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 because their potential can only be estimated at a world-wide level due to the lack of insufficient information, and distribution data which cannot be subdivided further on a country-by-country basis. Despite the continuing presence of gaps in the data, we still show as far as possible the potential of non-conventional energy resources (Chapter 4.3 conventional versus non-conventional – definitions for crude oil and natural gas). These include the reserves and resources of extra heavy oil, light tight oil and bitumen (oil sand), as well as tight gas, shale gas and coal bed methane.

Table 1: Reserves and resources of non-renewable energy resources

Fuel	Units	Reserves (cf. left column)	EJ	Resources (cf. left column)	EJ
Conventional Crude Oil	Gt	169	7,050	161	6,732
Conventional Natural Gas	Tcm	191	7,244	310	11,779
Conventional Hydrocarbons [Total]	Gtoe	342	14,294	443	18,511
Oil Sand	Gt	27	1,115	63	2,613
Extra Heavy Oil	Gt	21	886	61	2,541
Shale Oil	Gt	–	–	47	1,969
Oil Shale	Gt	–	–	97	4,068
Non-Conventional Oil [Total]	Gtoe	48	2,002	268	11,191
Shale Gas	Tcm	3.7 [5)]	142 [5)]	205	7,804
Tight Gas	Tcm	– [6)]	– [6)]	63	2,397
Coal Bed Methane	Tcm	1.8	69	50	1,916
Aquifer Gas	Tcm	–	–	24	912
Gas Hydrates	Tcm	–	–	184	6,992
Non-Conventional Gas [Total]	Tcm	5.5	211	527	20,021
Non-Conventional Hydrocarbons [Total]	Gtoe	53	2,213	746	31,212
Hydrocarbons [Total]	Gtoe	395	16,507	1,189	49,723
Hard Coal	Gtce	650	19,061	14,506	425,155
Lignite	Gtce	111	3,259	1,689	49,500
Coal Total	Gtce	762	22,320	16,195	474,655
Fossil Fuels [Total]	–	–	38,826	–	524,378
Uranium [1)]	Mt	2.2 [2)]	1,084 [2)]	13 [3)]	6,509 [3)]
Thorium [4)]	Mt	–	–	5.2	2,606
Nuclear Fuels [Total]	–	–	1,084	–	9,116
Non-Renewable Fuels [Total]	–	–	39,910	–	533,494

– 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 USD 80 - 260 USD/kg U and IR and undiscovered < 260 USD/kg U

4) 1 t Thorium assumed to have the same tce-value as for 1 t U

5) only United States (Status 2011)

6) included in conventional natural gas reserves

This study pursues a conservative approach overall, and places a high priority on the potential economic extractability of energy resources as a vital criterion. Therefore, the enormous so-called in-place volumes – which according to the information available today will not even be producible in the long term – are not included in the table. The resources of aquifer gas and gas from gas hydrates in particular are reported in relatively low quantities in this visualisation.

The largest proportion of the non-renewable global energy resources is defined as resources, and exceeds the reserves by a factor of more than 10. This applies to all energy resources, with the exception of conventional oil because of the intensive exploration and utilisation of this hydrocarbon. In total, the resources remain at a similar level in comparison to the previous year (BGR 2012a). Any growth was primarily associated with shale gas, while light tight oil resources have now been reported at a much lower level because of the improvement in the data situation. Compared to all of the other energy resources (hard coal and lignite) it continues its overwhelming dominance with a share of around 89 % (Fig. 4). Well down in second place come the resources of gas accounting for 6 %, of which the share of non-conventional deposits clearly exceeds the figure for conventional deposits. With respect to their energy content, the other fuels including oil (3.4 %) play a minor role. Changes compared to the previous year are very insignificant and primarily associated with the re-evaluation of the non-conventional hydrocarbons.

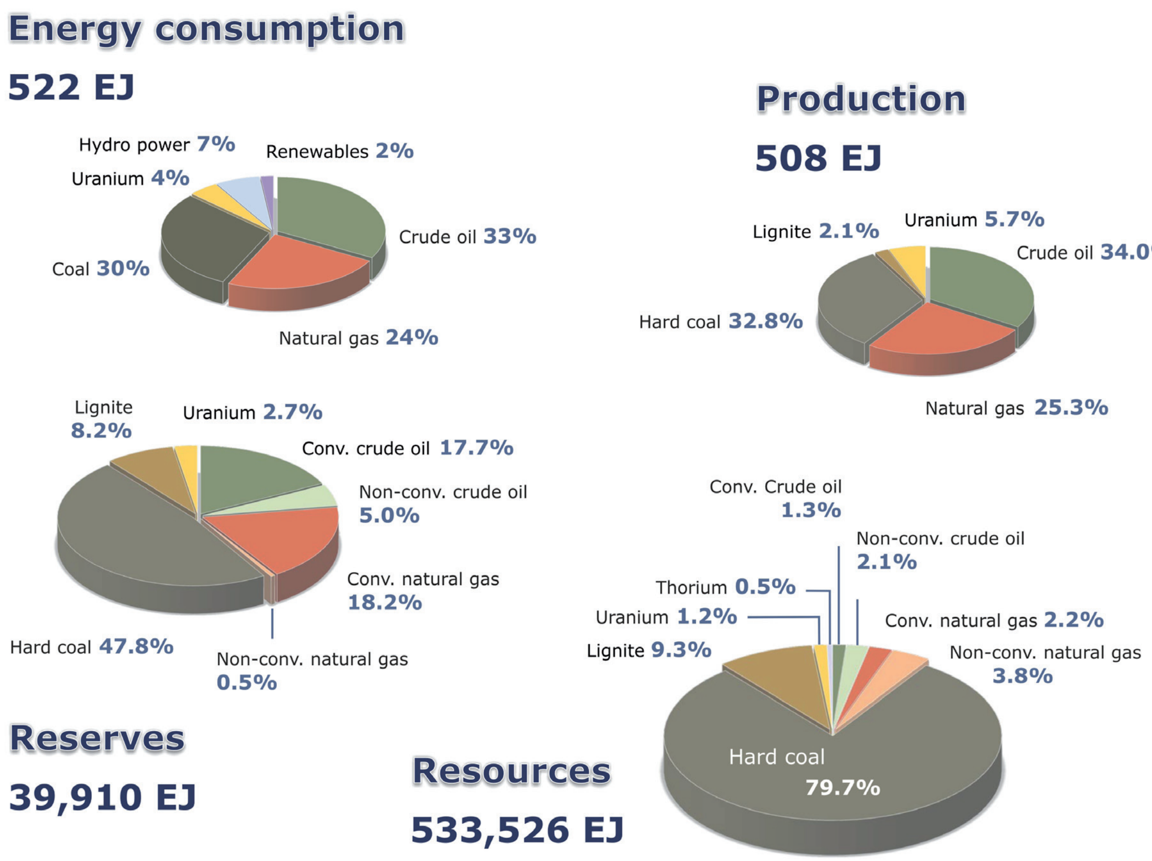

Fig. 4: Global share of all energy resources in terms of consumption (BP 2013) as well as the production, reserves and resources of non-renewable energy resources as at the end of 2012.

The energy content of the reserves in 2012 corresponded to 39,910 EJ and has therefore grown slightly despite the rise in production. In terms of the exploitable energy content, coal continues to be the dominant energy commodity with reserves accounting for 56 % of the total. Crude oil (conventional and non-conventional) accounts for 22.7 % of total reserves; natural gas 18.7 %; and uranium 2.7 %. Compared with the previous year, there have been hardly any changes in either absolute terms or in the relative proportions. The produced volumes of energy resources were balanced out by transferring resources to the reserves. The relatively high percentage of oil in the reserves is attributable to the intensive exploration and production activities focused on this commodity in recent decades.

Non-renewable energy resources with an energy content of around 508 EJ were produced in 2012. This corresponds to an overall growth in production of 2.8 % year-on-year. Although there only appear to be slight changes in the production mix, there is an unmistakable decline in the proportion of gas production from 25.7 to 25.3 % (in absolute terms though, gas production actually rose by 1.6 %). This drop in share is due to the large increase in the production of hard coal (plus 2.9 %) and in particular crude oil (plus 3.5 %). However, the strongest rise in production was accounted for by uranium which rose by 6.9 %. The long-term comparison for the time period since the beginning of the new millennium up to 2012 also reflects the significant trend in rising production, particularly in the case of hard coal and uranium (Fig. 5). These account for the largest levels of growth, with plus 97.1 % and plus 66 % respectively.

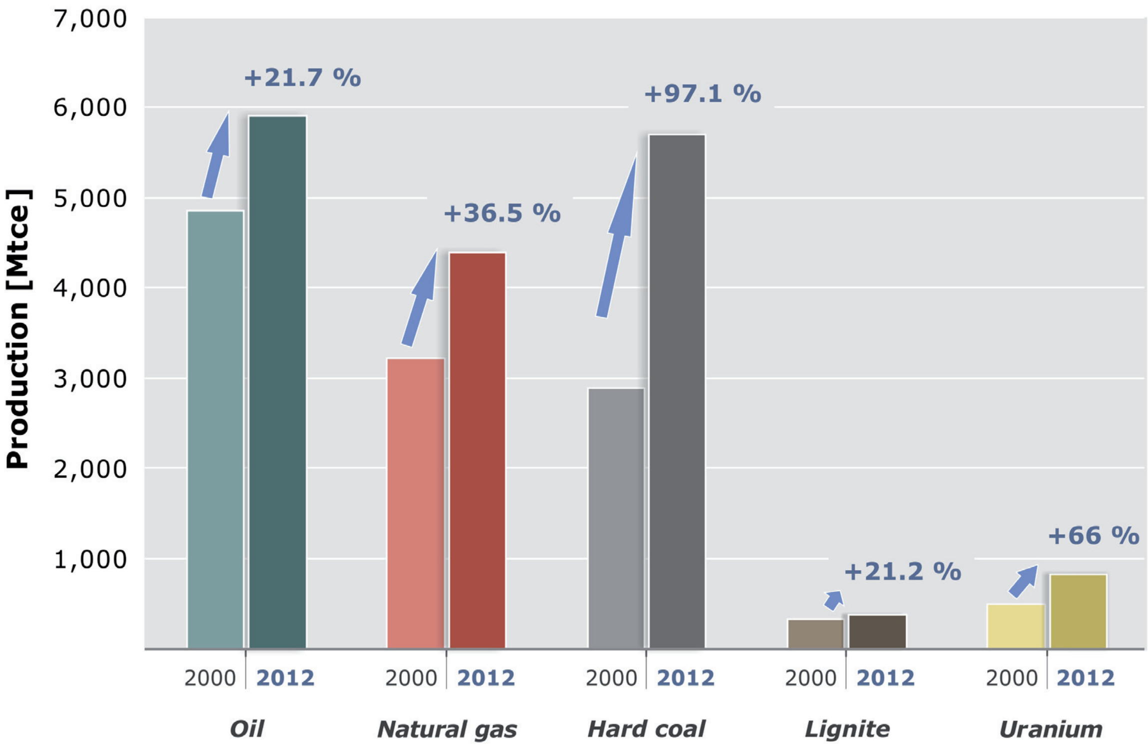

Fig. 5: Comparison of the global production of fossil energy resources between 2000 and 2012.

In the overall visualisation of the global energy mix, i.e. the amount of energy actually consumed, there is still a clear dominance by the fossil fuels. The proportions largely correspond to the production figures, although with some degree of approximation because of stockpiling amongst other reasons. Of the renewables, only traditional water power can make a significant contribution here. The other renewable energy resources – wind, geothermal power, solar energy, biomass, and thermally recoverable waste – only account for a share of slightly less than 2 % world-wide (BP 2013).

If the reserves (39,910 EJ) and resources (533,494 EJ) of all fossil fuels are added together, this corresponds to a globally available energy volume of 573,404 EJ.

Comparing the reserves and resources to global annual production gives a ratio of 1 to 78 or 1 to 1,049 respectively (Fig. 4). This means in principle, that the global inventories of energy resources can even satisfy a growth in energy demand from a geological point of view. The ratio is slightly lower than the previous year because production and/or consumption, has risen faster than the growth in reserves and resources. The question though is whether all energy resources when considered individually can always be made available in the future in adequate quantities whenever they are required. This question is particularly valid given the relatively low resources of crude oil.

Overall, there are still enormous volumes of fossil energy available from a geological point of view on the basis of the information available today. Whether and when they will be used depends on a number of factors including technical-economic extractability, demand-centric availability, environmental compatibility, and public acceptance. An answer to this complex question is not part of the brief of this report.

3 ENERGY RESOURCES IN DETAIL

3.1 Crude oil

Crude oil boasts the largest share of primary energy consumption, accounting for 33.1 % (Fig. 4). Despite a relatively slight decline compared to the previous year, oil still retains its status as the most important source of energy world-wide. Crude oil production rose during the reporting period by 3.6 % to a new all-time high of almost 4,140 million t, whilst oil consumption in the same period rose by almost 2 % to 4,122 million t.[1]

The oil resources (conventional and non-conventional) are estimated as 331 billion t (excluding oil shale), and are therefore around 8 % lower than the previous year's values. Conventional resources have risen slightly by around 2 billion t. This was largely due to updated evaluations of the deposits in Mexico, Morocco and Mongolia. Downward evaluations reduced the resources for the deposits in Italy and Poland. The data on light tight oil resources in particular was improved further by a study by the US Energy Information Administration (EIA) which estimated the potential of non-conventional hydrocarbons. This led to a significant reduction in the resources carried by Venezuela and China, and an increase in the resources found in Russia and the USA. The data situation for oil shale continues to be patchy and as a consequence, the resources can still only be reported in the form of a global potential (in tonnes of oil equivalent) (Tab. 1). The volumes of non-conventional oil resources (bitumen, extra heavy oil and light tight oil) therefore now total around 170 billion t (Fig. 6).

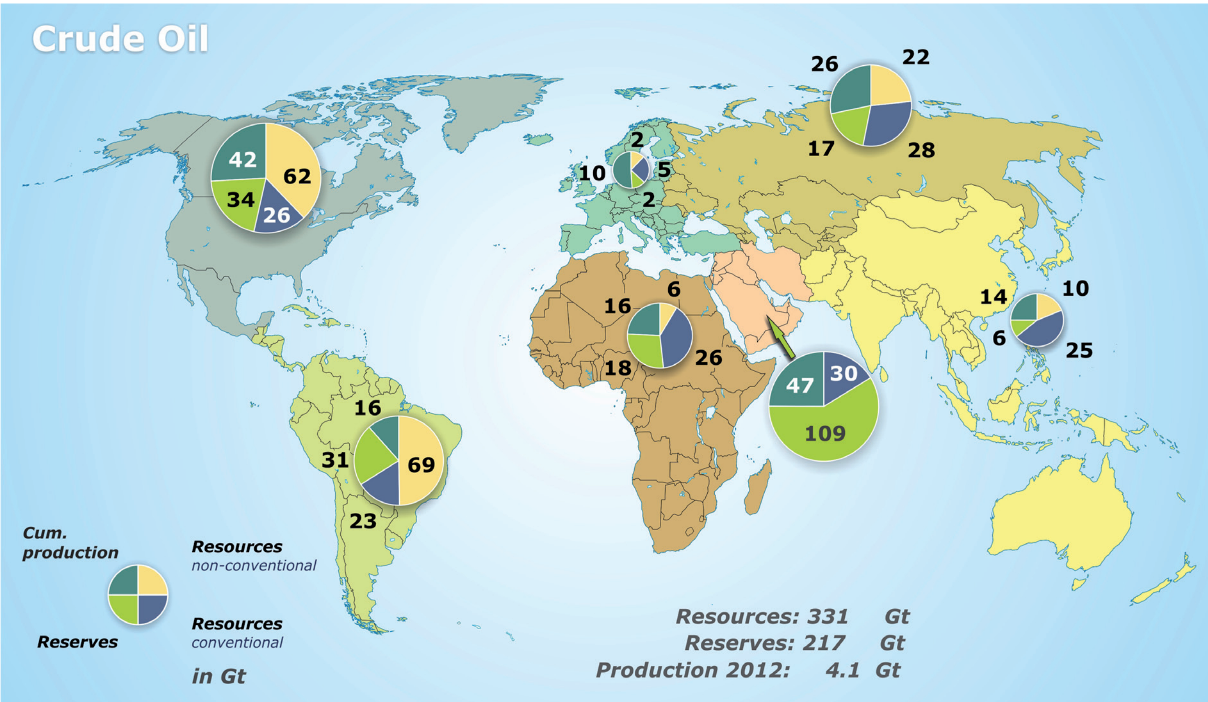

Fig. 6: Total crude oil potential: regional distribution.

[1] Differences in the figures for production and consumption are due to the use of different sources of information, as well as the varying influence of stockpiling.

The total crude oil reserves from conventional and non-conventional deposits added up to 216.6 billion t and were therefore only slightly higher (plus 0.5 %) than the previous year's value. There was also no significant shift in the ranking of the most important countries. The five leading countries in terms of reserves in rank order are Saudi Arabia, Canada, Venezuela, Iran and Iraq, who account for 60 % of the reserves in total. The OPEC countries alone account for almost 70 % of the reserves, whilst OECD countries only hold just under 17 %. The so-called MENA region (cf. glossary) hosts over 54 % of total oil reserves, which therefore underlines their regional importance for the continuing availability of oil despite the increase in non-conventional potential.

The share of non-conventional reserves (47.9 billion t) is much smaller than the figure for conventional reserves (168.7 billion t), and only accounts for around 22 % of total reserves. According to IEA (2013a), almost 80 % of conventional and non-conventional oil reserves are controlled by national oil companies, and only 20 % are held by private companies.

Around 171 billion t of crude oil have been produced from the beginning of industrial oil production until the end of 2012. This corresponds to around 44 % of the initial reserves (cumulative production plus reserves) totalling 387 billion t. The most important production regions include the Middle East, North America and the CIS. Saudi Arabia boasts the highest production figures and raised its oil production further by 4 % to 547 million t. The USA, behind Russia in third position, increased production by over 22 % from 352 million t to 431 million t, thanks to the development of considerable volumes of light tight oil (around 100 million t/a). If this trend continues, the USA could produce more crude oil than Russia during the course of 2014. China moved forward a place to fourth position (204.5 million t, plus 1.9 %) to overtake Iran (186 million t), which suffered a decline in production figures of almost 10 %. This was attributable to export restrictions as a result of sanctions implemented by the USA and the EU.

Other countries such as Canada, the United Arab Emirates, Venezuela, Kuwait, Iraq and Qatar boosted their production levels significantly in the 10 % range. Iraq in particular boasts a significant potential for expanding its production. Its production has risen by around 65 % since 2005 and could be increased considerably in the years to come thanks to its high level of reserves and the very favourable development costs. Libya, which was still in 30th position in 2011 because of its internal crisis, was well on the way in 2012 to reaching its previous production level and moved up to 19th position with 72.5 million t. However, renewed troubles since the middle of 2013 have strongly throttled the production again. The production quota in Europe sank by over 7 % because of a further decline in production rates, particularly in Norway (minus 5 %) and in the United Kingdom (minus 14 %). Norway's production levels have therefore halved since its production peak in 2000, whilst production in the United Kingdom is now only a third of its peak production in 1999.

The global consumption of petroleum products also rose in 2012 year-on-year to 4.1 billion t, an increase of 1.9 %. The strongest rises came about in Africa (plus 7.4 %), and Austral-Asia and Latin America each with slightly over 4 %. Europe (minus 2.6 %) and North America (minus 1 %) – of which the USA minus 1.9 % – lowered their consumption of petroleum. The OECD countries alone consume 50 % of the petroleum, led by the USA which accounts for almost 20 %. China consumed almost 12 %.

Global crude oil exports sank slightly in 2012 by 54 million t to 2,096 million t. Thanks to the further recovery in its production, Libya was able to considerably increase its oil exports in 2012 to 47.8 million t. Iraq, Kuwait, Angola and Algeria were largely responsible for the rise in exports from OPEC countries of around 3.3 %. This compensated for the strong decline in exports from Iran. European exports declined by around 2.5 % largely because of the lower production from Norway and Denmark.

In 2012, global crude oil imports remained at the same level as the previous year with almost 2.2 billion t. Because of its higher domestic production of tight oil, the USA imported 22 million t less oil (minus 4.8 %), but still maintained its number one position with total oil imports of 421 million t. The volumes of oil no longer needed by the USA are now available for the rest of the global market. According to preliminary reports, China imported more crude oil than the USA for the first time in September 2013. Countries like Japan, India, the Republic of Korea and Germany have boosted their imports between 2 % to 7 %. Lower imports primarily into Italy, France and the Netherlands, led to a decline in European imports overall which totalled almost 610 million t (minus 1.5 %) in 2012. Germany‘s main suppliers continued to be Russia, the United Kingdom and Norway who jointly cover around 60 % of German crude oil imports. Around 24 % of the crude oil imports are derived from OPEC countries (BAFA 2013).

The internationally active German energy companies Bayerngas Norge AS, E.ON Ruhrgas AG, EWE AG, RWE Dea AG, Suncor Energy Germany GmbH (formerly Petro-Canada Oil GmbH), VNG-Verbundnetz Gas AG and Wintershall AG boosted their overseas crude oil production levels considerably by over 70 % year-on-year to almost 9.3 million t (previous year: 5.4 million t). This was primarily attributable to increases in production by Wintershall and EWE in Russia, as well as in the Norwegian and British North Sea sectors. Wintershall and Suncor managed to boost their oil production in Libya during 2012 to very nearly reach the production amounts they had achieved in previous years. The international production of German companies in 2012 accounted for around 10 % (previous year: 6 %) of crude oil imports (EEK 2013).

The average annual price for the "Brent" oil reference type rose only slightly year-on-year in 2012 from 111 USD to 111.63 USD per barrel (bbl) (MWV 2013). The lowest price of 88.69 USD/bbl was reached in the middle of the year, whilst the highest price climbed to around 120 USD/bbl in spring and autumn. The average OPEC basket price[2] in 2012 was only slightly below the Brent price at 109.45 USD/bbl (OPEC 2013), whilst the reference type for the US-American market – West Texas Intermediate – averaged 94.05 USD/bbl (EIA 2013b). Prices were largely determined by the high demand from the emerging economies China and India, but particularly by the continuing uncertain political situation in the Middle East. It is not possible to give either a short-term or a medium-term forecast for the way the oil price will develop in future, particularly in the light of unforeseeable political or economic events, coupled with speculative transactions. In the long term, higher oil prices are considered probable because increasingly geologically complex and poorly accessible deposits are being developed with complex technology and relatively cost-intensive development programmes. A sustainable decline in prices to levels seen at the end of the last century are not expected despite technical advances such as the production of light tight oil.

Tables 6 to 12 in the appendix are a compilation of country-specific resources, reserves, production rates and consumption levels, as well as the exports and imports of crude oil (for the 20 most important countries in each case).

Oil‘s significance as the most important commodity traded world-wide, and the basis for our modern economic systems, remains unchanged. Global production is still increasing today driven by the rising demand. All of the previous "oil crises" only led to short-term global consumption shortages and associated declines in production. No fundamental changes in the trends for the utilisation of crude oil and the associated impact on oil production have been identified so far. The question of how long the high demand, and in many parts of the world, still rising demand can be covered in future still remains to be answered. There is a very broad spectrum of diverging opinions with regard to the future availability of oil. These range in their prognoses from an unavoidable and irreversible decline in production in only a few years, to those that predict that oil will still be available as the dominant energy commodity for decades to come and will still be able to satisfy all of the demand.

[2] Calculation from the 12 most important OPEC oil types.

Whatever the future brings, oil today is the energy commodity whose depletion has progressed to the furthest extent (BGR 2009).

Describing the future course of oil production, and being able to visualise future developments, is therefore the motivation behind a large number of approaches. Various methods are used for this purpose depending on the objectives. The most well-known approach to determine peak oil is the Hubbert model (HUBBERT 1956). This model is characterised by a bell-shaped curve with a clear maximum (peak). From today‘s point of view, the Hubbert model can only be used in a prudent way when assuming unrealistic conditions of "optimal" production, i.e. problem-free, independent of crises, politics and demand. In the production plateau model, instead of a peak on the curve there is a more or less extensive plateau phase following on from the growth phase, before production finally begins to decline. The plateau arises from the complex interactions between demand and supply. A third means of visualising oil production is characterised by a continuous rise within the period of assessment of at least 20 to 40 years. This therefore leaves open when maximum oil production actually occurs.

From BGR‘s point of view, a moderate rise in global oil production to 2030 and beyond appears possible given the current geological and technical frameworks. A significant rise in the production of conventional oil is not expected overall. Increases in production rates will probably be primarily attributable to condensate, non-conventional oil, and technological advances. Supplies will also be supported by new discoveries, particularly in frontier regions. Because of the mutual dependencies, an isolated assessment of each component, and particularly their production maxima, is unsuitable and irrelevant in the light of the global dynamism of the market. Because of the complexity of this topic, BGR‘s assessments are restricted to geoscientific-technical aspects. Moreover, many factors and developments can be envisaged which could cause the time when peak oil production is reached to happen earlier, or to put it another way, to already lead to shortages in supplies in the short term.

3.2 Natural gas

In 2012 as well, gas accounted for a share of around 24 % of global primary energy consumption and therefore retained its position behind oil and hard coal as the third most important energy commodity. Although gas is often considered a "bridging" energy with the strongest growth potential, its proportion in the global energy mix stagnated because other fuels have experienced faster growth rates.

By far the largest resources of natural gas in the world are in deposits in Russia, followed by China, the USA, Canada and Australia. With a share of around a third, Russia has the most extensive conventional gas resources in the world, ahead of the USA, China, Saudi Arabia and Turkmenistan. The global natural gas resources of conventional and non-conventional deposits total around 837 trillion m^3 (previous year 785 trillion m^3).

Shale gas is the dominant type of non-conventional gas with resources around the world in the order of 205 trillion m^3, followed by tight gas and coal bed methane (CBM) (Tab. 1). Shale gas has the largest reported increase. In the case of gas in tight sandstones and limestones (tight gas), reliable country-specific estimates are only patchily available, which means that the figure for the global potential given as 63 trillion m^3 is an underestimate. One can generally assume that tight gas is present in most basins in the world with gas prospectivity, particularly in Palaeozoic reservoirs. Only global estimates are available on the resources of aquifer gas and gas from gas hydrates because it is not possible to evaluate this commodity on a country-by-country basis. According to the information currently available there are 24 trillion m^3 gas in aquifers and 184 trillion m^3 gas in gas hydrates. However, whether and when this whole potential is actually commercially exploitable is still an open question. In the case of gas hydrates in particular, ambitious projects are being implemented by countries with very low domestic resources of conventional fuels, such as Japan, with the aim of developing domestic gas hydrate deposits in their own exclusive economic zones as potential resources of energy. Despite current advances, no break-through has yet been achieved.

Compared to 2011, global natural gas reserves increased only slightly (plus 0.5 %) and are estimated at 196 trillion m^3 at the end of 2012 (2011: 195 trillion m^3) – whereby the proportion of non-conventional reserves is currently still very low and will probably also remain so for the foreseeable future. Nevertheless, tight gas reserves are not usually reported separately, which means that it is not possible to estimate the size more accurately as part of a global survey. Currently, shale gas reserves (data as at 2011) are exclusively reported for the USA only, and have risen 35 % compared to the status of the data in 2010. A re-evaluation of the shale gas reserves has not taken place to date despite the continuing relatively low prices for US-American gas.

The natural gas production in the whole of 2012 was more than compensated for by additions to reserves, as was also the case in the previous year. The greatest increase in reserves was in North America and Iran. Over half of the global natural gas reserves are concentrated in three countries: Russia, Iran and Qatar. Around 80 % of the global reserves are in OPEC countries and the Confederation of Independent States (Fig. 7).

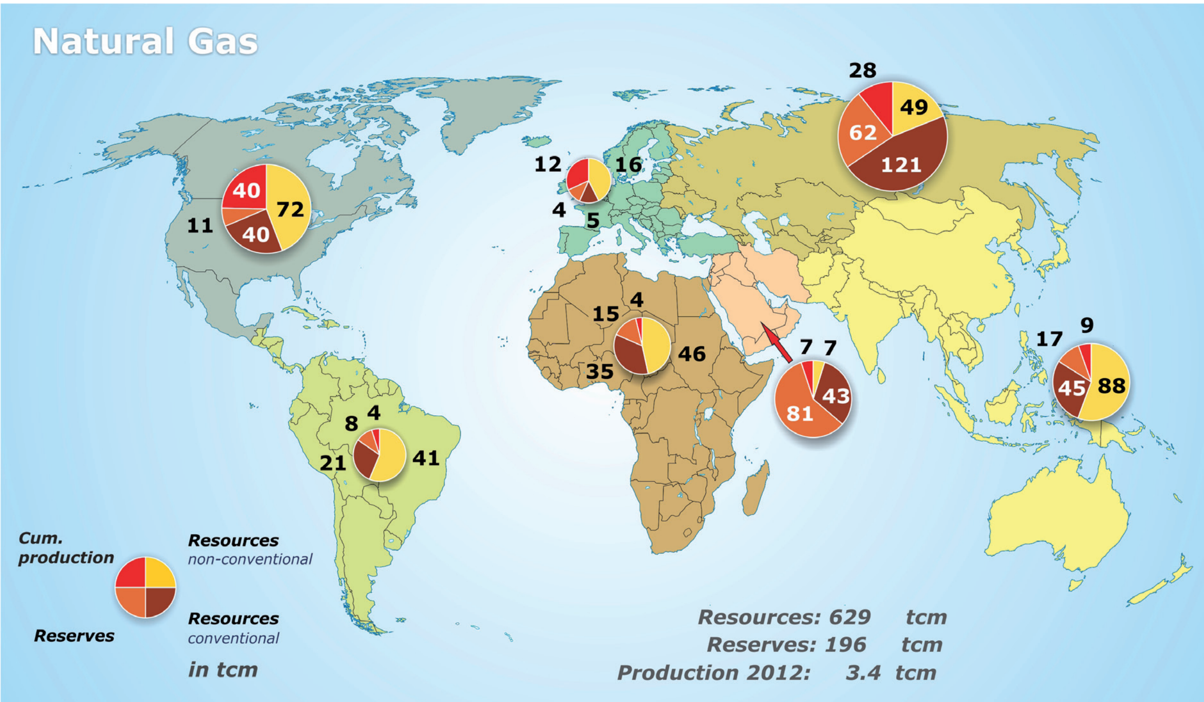

Fig. 7: Total natural gas potential (excluding aquifer gas and gas hydrates): regional distribution.

The rising consumption in Asia, North America, Africa and the Middle East were the primary cause for the expansion in global natural gas production in 2012 by around 52 billion m3 (plus 1.6 %) to a total of 3,389 billion m^3. The rise was well below the long-term historical growth rates. Turkmenistan again produced more gas in the Caspian region, and will increase its production further with the progressive expansion of the giant Galkynysh sour gas/condensate field which began operations for the first time in 2013. Overall, the Caspian region has the potential to become an important gas exporting area, also to Europe. Nine European energy companies, including E.ON from Germany, have already contractually secured gas supplies from the major Shah Deniz field in the Azerbaijani part of the Caspian Sea. Deliveries are scheduled to start in 2019.

Israel has begun to develop its large gas finds in the Levante Basin in the eastern Mediterranean. It will be able to considerably boost its production rates in the medium term and also become an exporting country. Production is recovering in Libya but is still well below the production levels enjoyed before the troubles began.

Growing domestic demand in the Middle East has boosted activities to develop gas fields. In Saudi Arabia for instance, the first gas field (Karan) not associated with oil was commissioned in 2012 against the background of a growth in consumption of 3.3 %. The Abu Dhabi National Oil Company has begun developing sour gas fields in the United Arab Emirates which have remained undeveloped to date because of their high hydrogen sulphide content. The Shah gas field is scheduled to be the first to be developed by 2014. Large production rates of condensate and gas liquids (NGLs) are also expected from this field.

Together with Norway and Qatar, production in the USA grew the most, with a combined increase of 54 billion m^3. US-American production grew by almost 5 % in 2012 to around 682 billion m^3, although the increase was lower than in the previous year. The rise in production was driven by more production from shale gas deposits but also through an increase in the production of associated gas. The USA therefore retained its number one position as the world‘s largest producer of natural gas. The US gas prices (Henry-Hub spot price) reached their low point in April 2012 with a price of below 2 US dollar per million British thermal units (BTU). This made the production of many dry shale gas deposits uneconomical and led to a shift in production strategy in favour of the development of zones with high proportions of condensate.

Unlike the USA, gas production in Russia declined by more than 3 % to around 610 billion m^3, but the country continued to retain its ranking as the second largest producer of natural gas in the world. Production in Indonesia, one of the world‘s largest exporters of liquefied natural gas (LNG), sank considerably by more than 16 % (15 billion m^3) largely due to a shortage of investment. LNG exports also declined by more than 14 % compared to the previous year.

Together, Russia and the USA produced almost 1.3 trillion m^3 in 2012. This corresponds to around 38 % of global natural gas production. Following a strong decline in the previous year, production in Europe rose by around 3 % largely because of a significant rise in production in Norway.

The USA is still easily the world‘s largest gas consumer, followed by Russia, Iran, China and Japan. Global natural gas consumption in 2012 rose by 2.2 % or 73 billion m^3 to around 3,390 billion m^3. Growth was therefore slightly lower than in the previous year. Although the demand in Europe overall was at a comparable level to 2011, consumption in the CIS countries declined, particularly in Russia. Consumption rose in all of the other regions around the world. The highest growth in consumption in percentage terms was in Africa (plus 14.3 %), primarily accounted for by North Africa. In terms of volumes, the largest growth in gas consumption was in the Austral-Asia region (plus 29 billion m^3) and North America (plus 27.2 billion m^3). Consumption in China rose by around 8.6 % (previous year: 20 %), and therefore again reported the largest rise within Asia. Japan – the second largest consumer in Asia – was forced to import more gas in the form of LNG in 2012 as well (plus 5.8 %, 6.5 billion m^3) as a consequence of the accident at the Fukushima nuclear power plant. India on the other hand reduced its gas consumption by using other fossil fuels more intensely – especially coal. Gas consumption in Germany rose largely because of the extra day in the leap year and the cooler temperatures in the months of February, April and December 2012 compared to the previous year (AGEB 2013) – accounting for a rise of around 3 % to 89.3 billion m^3 gas. However, the share of gas in primary energy consumption remained almost constant at around 21.6 % compared to the previous year. Germany therefore continues to be the world‘s eighth largest gas consumer, and is largely dependent on gas imports. Demand has been covered for many years now by imports primarily from the Russian Federation and Norway.

Around 1,031 billion m^3 gas, and therefore around 30 % of global natural gas production, was traded across borders (excluding transit trade) in 2012 (Tab. 18). This includes 328 billion m^3 (32 %) of liquefied natural gas (LNG). The global trade in gas overall has declined only very slightly (< 1 %) compared to the previous year. Despite a significant decline, Russia still exported the largest amount of gas via pipelines, followed by Norway – which has considerably increased its pipeline-dependent exports. The trade in LNG, however, declined for the first time after many years of enjoying very high growth rates. The main reasons for this reversal are the slow expansion of LNG capacities and the unused capacities of the existing facilities. The latter sank because of growing domestic demand in the LNG exporting countries, lower production volumes and shut-downs because of technical problems. All of these factors resulted in a supply shortage and a significant rise in the price of LNG. Qatar was the world‘s largest exporter of LNG, followed by Malaysia.

Supra-regional gas markets exist around the world, and are largely independent of one another. Gas in the United States has become continuously cheaper because of the strong expansion of shale gas production. Thanks to the large supply on the North American market, gas was traded here under the most favourable conditions of all of the liberalised markets. The expansion of shale gas production pushed down the local gas price in April 2012 to a low point of less than 2 USD/ per million BTU. At the end of 2012, the price of gas had recovered somewhat here to 3.3 USD/ per million BTU. Outside of North America, gas prices moderated after a significant rise overall in 2011. Nevertheless, gas in Germany was more than three times as expensive as in the USA at the end of 2012. Prices for LNG imports to Japan at the end of 2012 were even almost five times higher than the price paid for gas in the USA.

The weighted average transit price of gas in Germany in 2012 was around 13 % higher than in 2011. It reflects the price of gas at the German border and still generally follows the prices of oil with a certain time lag. The new contracts, however, already contain clauses which take into consideration gas futures market indexes or spot market prices, and thus continue the trend of an increasing decoupling of gas prices from oil prices. In general, the price of gas is significantly influenced by the much higher specific gas transport costs compared to oil and coal.

In the medium to long term, natural gas is expected to develop into a global market with a further rise in the significance of gas spot market prices. With its integrated and growing supply network, Europe is connected to a large part of the global natural gas reserves, either directly by pipelines, or indirectly by LNG terminals. The European gas market therefore enjoys a relatively comfortable position in principle.

Tables 13 to 19 in the appendix, provide country-by-country figures on natural gas production, consumption, imports and exports, as well as natural gas reserves and resources.

3.3 Coal

Coal continues to be the most dominant energy resource because it easily has the largest global total resources (reserves plus resources) of all of the fossil fuels. With a share of 29.9 % (hard coal 28.1 %, lignite 1.8 %) of global PEC, coal was the second most important fuel in 2012 behind oil (BP 2013). Coal was the most important fuel for power generation in 2011 with a proportion of around 40 %, and therefore more than any other fuel (IEA 2013b).

To enable a better comparison between the data, coal in this study is only divided into lignite or hard coal. Hard coal with an energy content of > 16,500 kJ/kg includes sub-bituminous coal, bituminous coal and anthracite. Because of its relatively high energy content, hard coal benefits from favourable transport costs, and is therefore traded world-wide. The lignite, however, with an energy content < 16,500 kJ/kg is primarily used for power generation close to the extraction sites because of its lower energy content and higher water content.

The coal reserves world-wide at the end of 2012 totalled around 1,052 Gt, of which around 769 Gt is hard coal and 283 Gt lignite. The reserves therefore changed relatively little compared to the previous study (BGR 2012a). Hard coal reserves rose by around 14 Gt (plus 1.9 %) year-on-year, particularly as a result of more intense exploration in recent years, especially in Australia, Indonesia and India. There are no significant changes in the global resources compared to the previous year.

World coal production grew again in 2012 and increased to around 7,941 Mt. This corresponds to a rise of 3 % compared to the previous year. In detail, this is broken down into hard coal 6,835 Mt (plus 2.9 %) and lignite 1,106 Mt (plus 3.7 %).

Unlike oil and conventional gas deposits, coal fields and their production sites are located in many countries and exploited by many companies. Tables 20 to 31 in the appendix list country-by-country production, consumption, imports and exports, as well as reserves and resources of hard coal and lignite.

Hard coal

Figure 8 shows the regional distribution of hard coal reserves and resources, and the estimated cumulative production since 1950. The Austral-Asia region has the largest remaining potential of hard coal with 7,234 Gt, followed by North America with 6,875 Gt, and the CIS with around 2,969 Gt. The world‘s largest reserves of hard coal are in the United states with 224 Gt (29.2 % global share). The USA is followed by the People‘s Republic of China with around 181 Gt (23.5 %), and then India with 80 Gt (10.5 %), Russia (9.1 %), Australia (7.9 %) and South Africa (4.4 %). The producible volumes (reserves) in Germany where production will be subsidised until 2018, total around 0.04 Gt hard coal. In terms of resources, the USA alone accounts for 6,459 Gt or around 38 % of global hard coal resources, followed by China (29.3 %) and Russia (15.3 %).

The three largest hard coal producers in 2012 were China with a share of 51.3 % (3,404 Mt), the USA (12.4 %) and India (8.2 %). Unlike China and India – which boosted their production as in previous years by 3.6 % (China) and 3.3 % (India) – production in the USA shrank dramatically. Natural gas is increasingly displacing coal from the US-American power generation sector thanks to the rising supply of cheap domestic natural gas (cf. 3.2 Natural gas), especially in the first half of 2012. Despite the rise in US coal exports, hard coal production in the USA fell by around 70 Mt (minus 7.6 %). This means that hard coal production in the US dropped by more than the total annual German consumption of hard coal (around 56 Mt). The decline in US hard coal production continued into 2013 as well, and is already thought to have led to the closure of 151 coal mines in the first half of 2013 (PEABODY ENERGY 2013). However, the renewed rise in the amount of coal used for power generation in the US (EIA 2013a) as well as the preliminary estimates for US hard coal production in 2013, indicate that the reduction will be less significant this year than in the previous year. This situation was also expected given the (slight) rise in US natural gas prices (EIA 2013b).

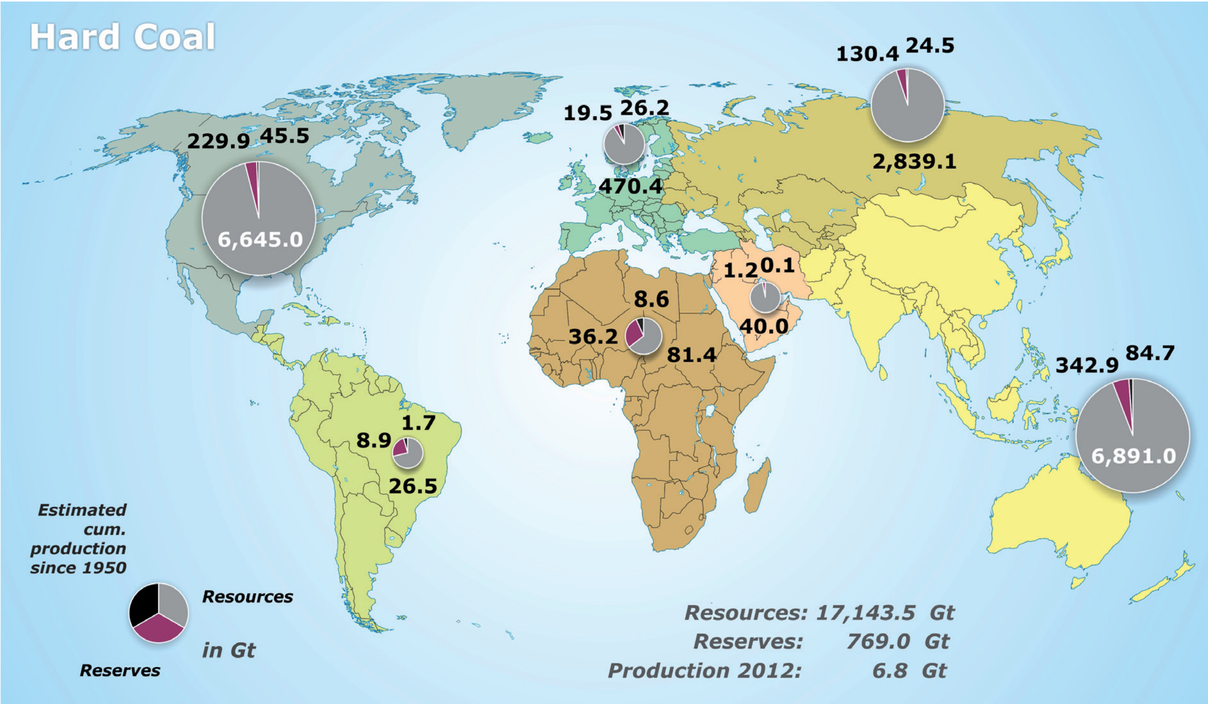

Fig. 8: Total hard coal potential 2012: Regional distribution.

Approximately 18 % or around 1,267 Mt of the hard coal produced in 2012 was traded globally, of which 1,082 Mt was transported by sea (VDKI 2013a). The global volume of traded hard coal therefore rose significantly by around 17 % year-on-year. In addition to the further rise in the demand for coal, particularly in the Asian region, the significant rise in the amount of coal traded globally was additionally supported by lower world market prices for coal and lower freight rates. Indonesia dominated the world hard coal market with exports totalling 384 Mt (30.3 %), followed by Australia (24.9 %) and Russia (9.9 %). As in the previous year, the USA significantly expanded its exports of hard coal by around 17 Mt (plus 17 %) to 114 Mt. This effect is largely attributable to the US-American shale gas production boom, and verifies the stability of the US coal industry to act as a swing supplier on the world coal market. In this case, however, the reason was not high world market prices (VDKI 2013a) – as was the case after the oil crises in the 1970s and 1980s for instance (EIA 2012) – but simply because of difficulties selling its coal on the domestic market. The largest hard coal importers were China, Japan and India with a total volume of 612 Mt (49.3 %). China again significantly boosted its imports in 2012 compared to the previous year (183.1 Mt) with a rise of 58 % to around 289 Mt. This places China well ahead of Japan as the second largest importer of hard coal, even though Japan has also increased its imports by around 6 % year-on-year with a total import volume of 185.2 Mt. India imported almost two fifths more coal than the previous year with a plus of 39 %, which pushed import levels to 137.6 Mt. This moved the country into third place in the coal import rankings, pushing down the Republic of Korea into fourth place with its imports of 125.6 Mt (minus 3 %). As in previous years, Asia dominates the global hard coal import market with a share that has now grown to 70 %.

The hard coal imported into Germany (44.9 Mt, excluding coke) is largely supplied by Russia (25 %), the USA (21.8 %), Colombia (20.7 %), Australia (9.9 %), Poland (5.4 %) and South Africa (4.4 %). Whilst hard coal imports from Russia and the USA increased further to 11.2 Mt (plus 4.6 %) and 9.8 Mt (plus 20.5 %), respectively, imports from Colombia in 2012 dropped by almost a seventh year-on-year to 9.3 Mt. Imports from Poland also shrank by around a tenth to 2.4 Mt in 2012. The proportion of South African hard coal declined again compared to the previous year, this time by a quarter to around 2 Mt. This coal is increasingly sold in Asia and particularly in India (VDKI 2013a). The European Union (EU-27) accounted for around one sixth of the world-wide imports of hard coal with a total of 211.4 Mt (plus 9 Mt compared to the previous year).

The average annual spot prices in north-western Europe for steam coal (ports of Amsterdam, Rotterdam and Antwerp; cif ARA) shrank from 142.81 USD/tce in 2011 to 109.15 USD/tce in 2012 (a drop of around 34 USD/tce; minus 24 %) (VDKI 2013b). As already seen in the previous year, 2012 was characterised by another rise in imports of coal to the European Union. However, the prices for the imported steam coal went down because of the oversupply on the world market.

Prices for coking coal shrank significantly in 2012 compared to the previous year. Whilst the first and second quarters 2011 saw prices at levels between 300 and 330 USD/t (nominal price: all-time high) – attributable to the consequences of the massive flooding in the state of Queensland in Australia and the associated significant drop in supply of high quality hard coking coal – the following period saw an almost continuous decline in the prices of coking coal right through to July 2013. Prices in the first half of 2012 were largely in the range between 210 and 230 USD/t. This slump in prices continued into the second half of 2012 against the background of stagnating global demand and the simultaneous increase in supplies. As a result, coking coal prices dropped to between 150 to 180 USD/t. Prices initially stabilised at the beginning of 2013 within the 175 to 185 USD/t range before sinking again to 130 to 140 USD/t by July 2013. Up to autumn 2013, prices have risen only slightly to around 150 USD/t (VDKI 2013a).

Lignite

North America has the largest remaining potential of lignite in the world with around 1,519 Gt, followed by the CIS (1,372 Gt, including sub-bituminous), and the Austral-Asian area (1,136 Gt) (Fig. 9). Of the global lignite reserves of 283 Gt in 2012, 90.7 Gt (including sub-bituminous) are found in Russia (32 % global share), followed by Australia (15.6 %), Germany (14.3 %), the USA (10.8 %), and China (3.9 %). The USA has the largest lignite resources with around 1,368 Gt (32.8 % global share), followed by Russia (30.5 %, including sub-bituminous) and China (7.4 %). More than 81 % of global lignite production totalling 1,105.8 Mt was produced by only 11 of the 34 producing countries in 2012. Germany, which boosted domestic production by 5 % compared to the previous year, was the largest producer of lignite accounting for 16.8 % (185.4 Mt) followed by China (13.1 %) and Russia (7.0 %).

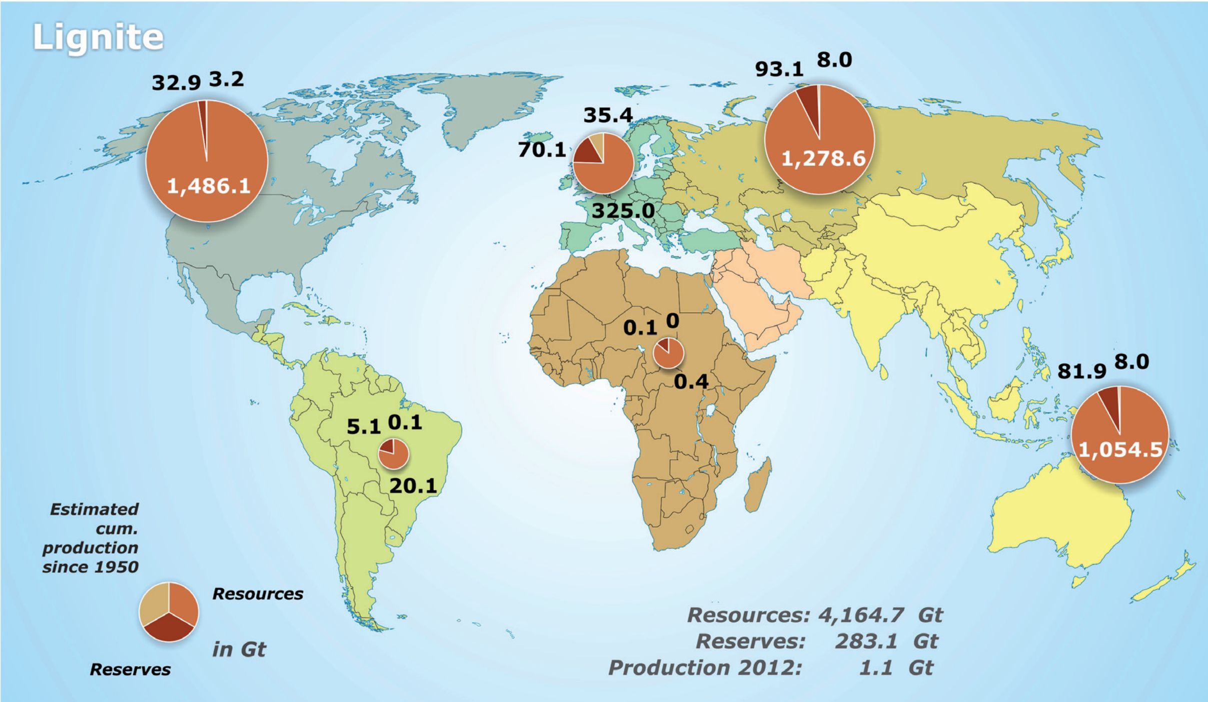

Fig. 9: Total lignite potential 2012: Regional distribution.

3.4 Nuclear fuels

Uranium

The global uranium market is still influenced by the consequences of the reactor disaster in Japan in 2011, and the financial crisis. The decline in the uranium spot market price which began in 2011 and continued into 2013, jeopardises the profitability of a number of mines and exploration projects. Spot market prices during the course of 2012 fell from 135 USD/kg U to 112 USD/kg U. A continuing decline is also observable in 2013 (as at September 2013: 91 USD/kg U). Compared with the spot market price of around 188 USD/kg U in January 2011, the spot price has therefore halved by the reporting date in September 2013. In addition, there is now also an oversupply of uranium derived from inventories as a result of the shut-down of 48 reactors in Japan and eight reactors in Germany. Nevertheless, a balanced situation is forecast in the medium to long term because of the global rise in demand. Although the demand for uranium will decline further in Europe in future, it will probably rise significantly in Asia and the Near East in particular. A moderate rise in the demand for uranium in the following decades is also expected for the North American, Latin American and African regions (IAEA 2013).

Uranium prices only account for a small proportion of the electricity production costs (WNA 2013a), but is crucial for the development of new exploration and production projects. Investments in many exploration projects were cancelled or reduced. And even China‘s ambitious expansion of its nuclear sector has currently been delayed by two years. With the exception of the current reduction of exploration projects attributable to the economic conditions, adequate potential is available to supply the global market from a geological point of view.

Uranium deposits occur in almost every region around the world. Resources have grown by 511 kt compared to the previous year as a result of re-evaluations and more intensive exploration activities. Growth attributable to successful exploration is primarily reported in Vietnam, India and Finland. The Tavivaara project in Finland is currently being prepared for production – copper and zinc are the primary natural resources being extracted in this project, but there are also large volumes of uranium which are produced as a by-product during the metal extraction process. Increases in the level of resources as a result of re-evaluations are primarily reported in Vietnam. Whilst countries such as Australia, China, India, Canada, Russia and Tanzania exclusively raised the volumes of their discovered resources, the main rise in Vietnam was in the volume of its speculative resources. Major producing countries such as Kazakhstan, Russia, South Africa and the USA stopped giving details on speculative resources for the first time in 2009, which led to a reduction in resource levels. Australia stopped providing data on these resources many years ago. Because of these reporting uncertainties, the resource figures given in this study must be considered as conservative. The reduction in the level of resources in the Ukraine is attributable to the transfer of some resources to reserves.

The current reserves of uranium are around 2.16 Mt (cost category < 80 USD/kg U). 98 % of the reserves are in only eleven countries, headed by Australia, and then followed by Canada, Kazakhstan, Brazil and China. According to the latest data, these five countries account for around 84 % of the global uranium reserves (Fig. 10).

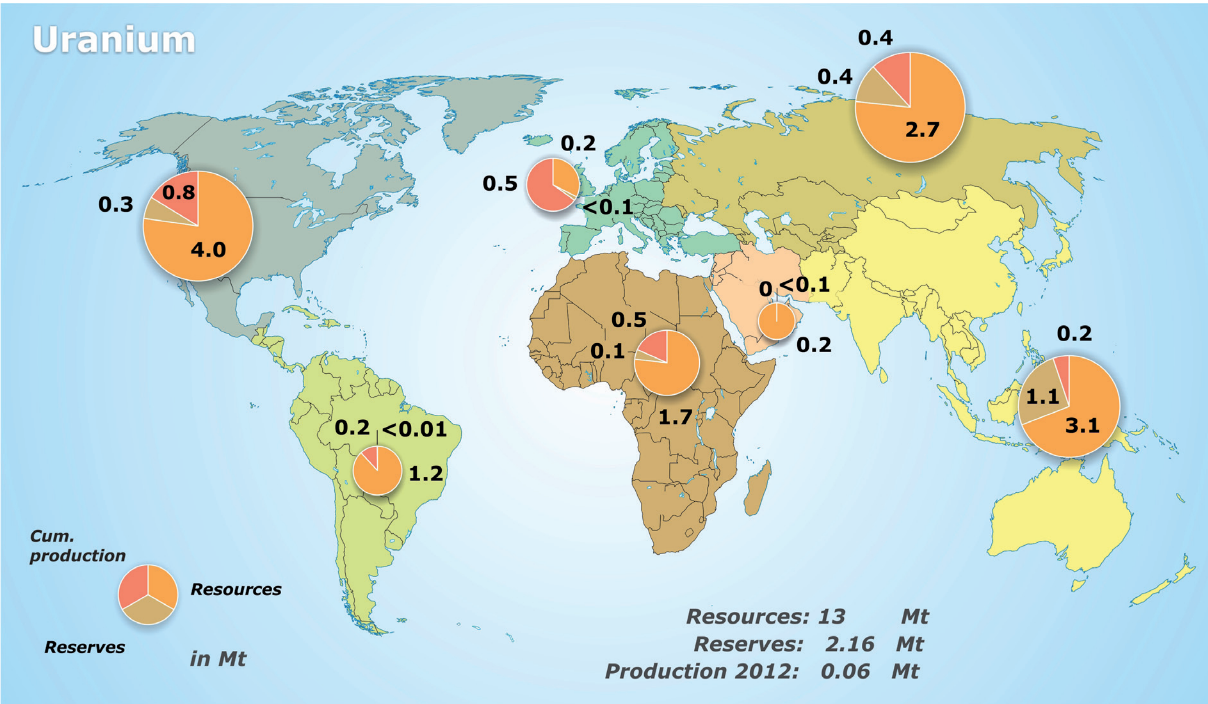

Fig. 10: Total uranium potential 2012: Regional distribution.

Unlike the other energy resources, uranium reserves are classified according to production costs. According to the definition of reserves, the limit for the extraction costs is currently < 80 USD kg U. However, the production costs in many countries are already much higher than this level. New projects in particular are currently only being further developed with delays or have been suspended. Numerous delayed projects are known in Australia, Canada, Malawi, Namibia, Russia and the USA. In recent years, reserves in countries with high production costs have already been transferred to higher cost categories. Australia‘s reserves in the < 80 USD/kg U cost category therefore reduced by almost 22 % in the previous year. Reserves in Canada and South Africa were also reduced. Malawi only publishes its resources starting from the cost category < 130 USD/kg U. In the light of the rise in the production costs in many countries, an adjustment of the reserves into the next highest cost category (< 130 USD/kg U) is expected in the foreseeable future. This will improve the comparison of the global reserves. Until this happens, the reserves reported in this study must be considered as conservative.

The reserve balances in 2012 changed positively compared to the previous year (2,167 kt for 2012, compared to 2,122 kt for 2011). Despite a decline in proven and economically exploitable resources at extraction costs lower than 80 USD/kg U in some countries in recent years (attributable to the rise in production costs), reserves rose primarily in the Ukraine, China and Canada. However, there were hardly any changes in the reserves levels overall because of the failure of some countries to update their reserves in this cost category.

Although uranium spot market prices have dropped, global uranium production in 2012 rose to 58,395 t U or plus 8 % compared to the previous year. Around 85 % was produced by only six countries. Kazakhstan was again the largest producing country: it increased its production further to the new level of 21,317 t U (2011: 19,451 t U) and therefore accounted for around 37 % of global uranium production. Uranium production in Kazakhstan has grown by 400 % since 2006. Canada, Australia, Niger, Namibia and Russia accounted for another 48 % of global production.

As in previous years, uranium production is concentrated in only a few major companies. Around 82 % of global production was produced by only eight mining companies in 2012. Over half of the uranium produced world-wide was extracted by Kazatomprom from Kazakhstan (15 % global share), Areva from France (15 %), Cameco from Canada (14 %) and the Russian-Canadian consortium ARMZ/Uranium One (13 %). The single largest production site in the world continues to be McArthur River in Canada (7,520 t U, 13 % of global production), followed by Olympic Dam, Australia (3,386 t U, 6 %), Ranger, Australia (3,146 t U, 5 %), and Arlit, Niger (3,065 t U, 5 %).

The situation on the consumption side is similarly concentrated although with a different regional focus. The produced uranium is predominantly used by only a very small number of countries. Over half of the global uranium demand is accounted for by only three countries: USA, France and China. The global demand for uranium in 2012 was 67,990 t U (plus 5,438 t U compared to 2011). The USA and China in particular have increased their consumption, but the rise in demand was also attributable to a large degree to Russia and Taiwan as well. The uranium demand in Germany declined significantly in 2011 because of the shut-down of eight nuclear power plants. The uranium demand in 2012 remained constant compared to 2011: around 1,934 t. The volume of natural uranium required for the production of fuel rods in Germany is almost exclusively derived from producers in France, the United Kingdom, Canada and the United States, and based on long-term contracts. The fuel rods themselves are produced in Germany which means that the nuclear power plants can be supplied for a long period from inventories within the country itself. Nuclear power is therefore classified as a domestic energy source. Uranium world-wide is largely traded via long-term supply contracts. Uranium supplies to EU member countries totalled 18,639 t U in 2012 (a rise of 807 t U or 4.5 %). The share of supplies from spot market contracts was only 3.8 % (ESA 2013).

Despite the forecast long-term decline in the demand for uranium in Europe (Germany‘s withdrawal from nuclear power production; termination of Italy‘s, Switzerland‘s and Belgium‘s plans to expand their nuclear power production), there will be a continuing demand in Europe for uranium as a source of energy. European countries such as Finland, France, the United Kingdom, Rumania, Russia, Sweden, Slovakia, Slovenia, Spain, Czech Republic and Hungary continue to depend on nuclear power as an important part of their national energy mix. Poland plans to build its first nuclear power plant by 2025. In the Czech Republic as well, the country intends to adopt a new energy concept in which 50 % of its electricity demand is to be covered by nuclear power by 2020/30 (2012: 33 %). Turkey also plans to build its first reactor in 2014 with Russian support. There is also continued interest in the rest of the world outside of Europe in the expansion of nuclear power programmes.

At the end of 2012, 68 nuclear power plants were under construction in 14 countries, including China, Russia, India, USA, South Korea, Slovakia, Japan, Pakistan, Taiwan, Argentina, Brazil, Finland, France, and for the first time, the United Arab Emirates. There are therefore five more nuclear power plants under construction than at the end of 2011. 2012 saw the construction start on nine new nuclear power plants: in China (four), USA (four) and the United Arab Emirates (one). Another 110 nuclear power plants are currently in the planning or authorisation phases world-wide. Nuclear power plants were abandoned in the United Kingdom (two) as well as in Canada and Spain (one each). New nuclear power plants were commissioned in China and South Korea. In Canada as well, two blocks which had been temporarily shut down were brought back into operation again. The 437 nuclear power plants operating world-wide in 2012, with a total gross output of 393 GWe (DATF 2013), consumed around 67,990 t natural uranium. The largest proportion of this or 58,395 t, came from mine production.

The global production of uranium from mines in the last five years varied between 43,853 to 58,395 t U, compared to an annual consumption of over 60,000 t U. The disparity revealed here between annual demand and primary production was covered by civil and military stocks, particularly those held in the Russian Federation and the United States. These stocks were built up from uranium overproduction between 1945 and 1990 in response to forecasts of growing civil demand as well as in response to military strategy. The military stocks in particular are currently being successively reduced. This is also in response to the START treaties signed by the United States and the Russian Federation in 1992 to convert highly enriched weapons-grade uranium (HEU) into low enriched uranium (LEU). This means that demand in future can continue to be satisfied by mine output as well as stocks and the reduction in nuclear weapon stockpiles. Another source of uranium is the reprocessing of fuel rods. More research is currently being carried out in this respect to enhance the efficiency of the reprocessed materials.

The growing demand for uranium and the current reduction in exploration activities leads to the conclusion that uranium reserves will decline. This is counteracted by an annual increase in production (also by the production of high-grade uranium ore), the more effective use of uranium, and the successful exploration results achieved in recent years. In 2010 alone, around 2 billion USD was spent on uranium exploration and mine development. This corresponds to a rise of 22 % compared to 2008 (OECD-NEA/IAEA2012). The World Nuclear Association (WNA 2013b) reports that 10 billion USD has been spent on exploration between 2003 and 2011. These exploration activities have already given rise and continue to give rise to an increase in the volumes of reserves and resources. Moreover, deposits can be developed in future which have not previously been taken into consideration. An example is the polymetallic Häggån deposit in central Sweden. With its estimated potential of over 300,000 t U, it is one of the largest still undeveloped uranium deposits anywhere in the world. New uranium deposits have also been discovered in China and Peru – albeit with smaller resources. Despite the reduction in exploration projects currently observed which can be largely explained for economic reasons, there is still adequate uranium potential from a geological point of view to supply the world-wide demand, even in the face of the predictable rise in demand expected in the following decades.

Tables 32 to 36 in the appendix provide a country-by-country listing of production, consumption, and the reserves and resources of uranium.

Thorium

Thorium is considered by the scientific community to be a potential alternative to uranium. However, it is currently not used for power generation. There are no commercial reactors operating anywhere in the world using thorium as a fuel. Nevertheless, thorium deposits have been discovered and evaluated in recent years as a by-product of the increasing exploration for other elements (uranium, rare earths, phosphate). Thorium resources world-wide in 2012 are reported to be more than 5.2 Mt.

4 FUTURE AVAILABILITY OF FOSSIL FUELS

4.1 Supply situation and future demand

This study analyses the global geological inventory of fossil energy resources, and presents it on a country-by-country basis. The amounts that are actually exploited and consumed in future depend on numerous factors and can only be predicted to a limited extent. An attempt to make a long-term comparison between supply and demand can be made on the basis of the projected consumption of these energy resources up to 2035 depicted in the New Policies Scenario of the IEA (2013a) (Fig. 11). According to this scenario, the situation for the fuels uranium, coal and natural gas is comfortable from a geological point of view because the projected demand is only a small fraction of the currently proven resource inventory and can already be covered solely on the basis of today's known reserves. Coal in particular stands out with its huge inventory which overwhelmingly satisfies any predicted demand. Very high resource figures (compared to reserves) also indicate that there is still very large and previously unexploited potential. The resource figures also, however, include figures on energy resources which have so far not been economically exploitable, such as oil shale, aquifer gas and natural gas from gas hydrates, even though their potential is incorporated in this study. The only fossil fuel with limited availability from a geological point of view is crude oil. Production is already declining for technical reasons at a time when there are still major resources available. According to the IEA scenario, around half of the crude oil reserves currently proven would be depleted by 2035.

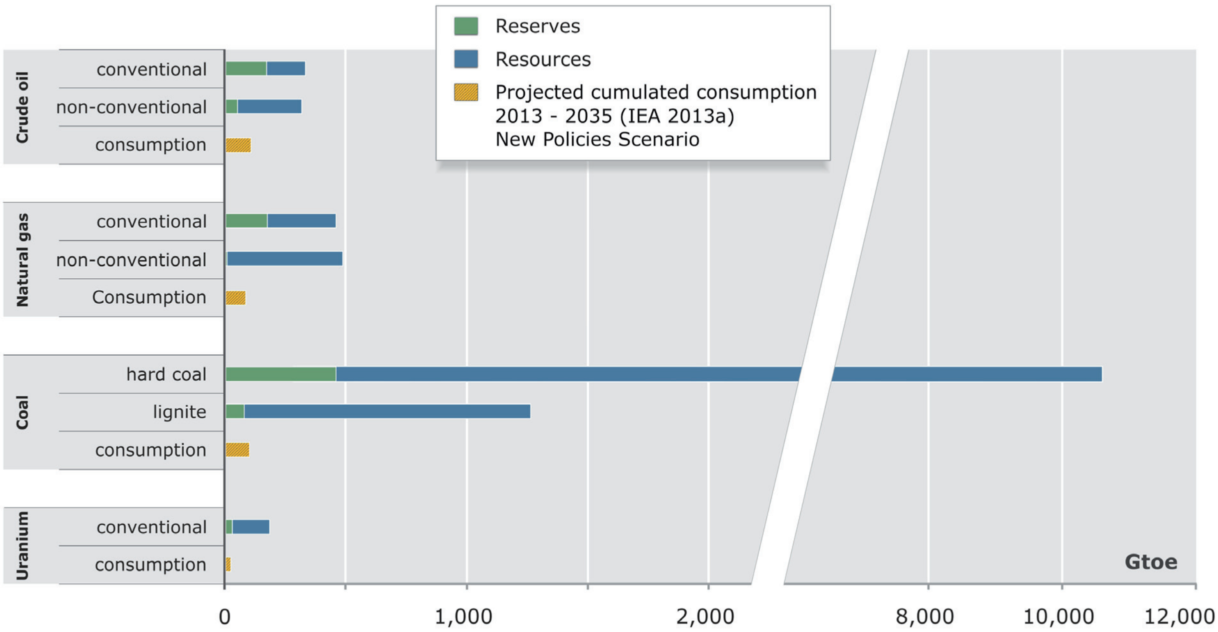

Fig. 11: Supply situation for non-renewable energy resources at the end of 2012.

4.2 Shale gas and light tight oil – European resources and exploration activities

The successful development of shale gas deposits, and with a relative time delay of a few years, also the tight oil deposits in the USA, have awakened a great deal of interest world-wide in these new energy resources. The exploration and development of potential deposits in Europe are still in the very earliest stages by comparison. In principle, according to our current level of understanding, all of the already well-known European hydrocarbon provinces also have potential for shale gas and light tight oil. However, in most cases, there is still inadequate information available to determine whether, and what quantities could actually potentially be produced. Because of this lack of investigation results, previous figures on potential resources have been very vague, strongly diverging in many cases, and should therefore generally be considered as preliminary (Fig. 12).

Most of the resource figures currently available are derived from the first EIA study (EIA 2011) which is incomplete according to the authors. This study was significantly expanded in 2013 and provides a comprehensive overview on the potential world-wide resources of shale gas and light tight oil (EIA 2013c). This report is itself largely based on data from the 2011 report and includes new information from countries which have started shale gas production. Light tight oil was evaluated for the first time in the 2013 EIA report. However, only a limited number of assessments of the potential have been made by the national geological surveys in Europe. The only known studies currently available are on Poland, the Netherlands, Germany, Spain and the United Kingdom. The current situation is sketched out in the following chapter on a country-by-country basis.

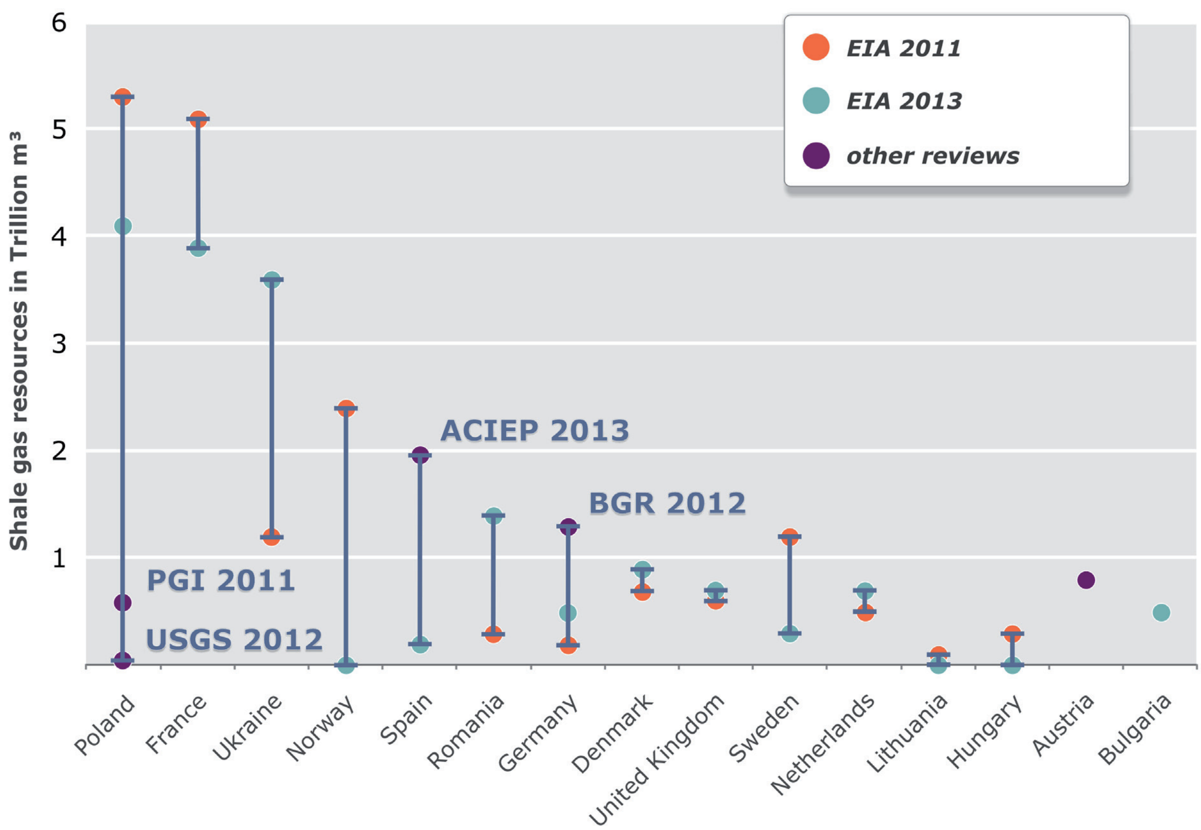

Fig. 12: Summary of the technically recoverable resources of shale gas in Europe .

The most intense activity so far has been in Poland where potential shale gas deposits have been explored since 2007. Assessments of the resources of the organic-rich Ordovician and Silurian shales in the Polish-Ukrainian basin have been carried out in various estimates and studies (Fig. 13), which produced some highly contradictory results in part (BGR 2012a). The study by the Polish geological survey (PGI 2011) estimated the shale gas potential as ranging from 0.35 to 0.77 trillion m^3 (median 0.56). The US geological survey (USGS) assessed the potential in Poland as much lower at 0.038 trillion m^3, whilst the EIA (EIA 2013c) largely confirmed its relatively high assessment (Fig. 12). PGI is currently working intensively on a new assessment of the resources. This will take into consideration data from the over 40 exploration wells drilled in recent years. The report is scheduled for publication in 2014 and should provide a realistic assessment of the technically recoverable shale gas resources for the first time. EIA (EIA 2013c) estimates the tight oil resources as 246 million t. There are no known activities being undertaken to develop these deposits.

Fig. 13: Schematic diagram of the geological basins with possible light tight oil and shale gas potential in Europe.

A large tight oil and shale gas potential by European standards is thought to exist in the Paris Basin in France. Crude oil has been produced from conventional oil fields in this basin for a long time already. The most prospective horizon is the Jurassic Black Shale which is geologically similar to the Posidonia Shale in Germany. In addition to the Paris Basin, other shale gas potential in France is deemed possible in the Liassic Black Shale in the Southeast Basin. Fracking technology was recently banned by law in France even though exploration licenses had already been issued. Shale gas exploration activities therefore came to a stop when the ban came into force in 2011.

The Lviv-Volynsker Basin in the western Ukraine is the south-eastern continuation of the Lublin Basin. The resources in the aforementioned basin and the assumed deposits in the Dnjepr-Donets Basin are estimated at a combined 3.63 trillion m3 shale gas and 150 million t light tight oil (EIA 2013c). The EIA‘s more positive assessment of the shale gas resources (2013c) is based on information from new drilling campaigns and seismic surveys. Exploration licenses have already been awarded in both basins.

An assessment of the non-conventional deposits in Spain was published in early 2013 (ACIEP 2013). The volumes of producible shale gas in the country are estimated at 1.98 trillion m3 and are therefore very much higher than the estimate of 0.27 trillion m^3 published by EIA (2013). According to this study, the largest resources are in the Cantabrian Basin. However, shortly after the study was published, the Cantabrian regional parliament adopted a law to ban fracking technology even though exploration licenses had already been awarded for non-conventional deposits.

The Carpathian-Balkan Basin and the Pannonian Basin in south-eastern Europe are considered prospective for shale gas, and to a minor extent, also for light tight oil. The basins extend across Bulgaria, Rumania and Hungary. The potential in Bulgaria is estimated at around 0.48 trillion m^3 shale gas and about 27 million t tight oil. The deposits in Rumania are estimated to have 1.44 trillion m^3 gas and 40 million t tight oil, whilst the basin in Hungary is considered to be too deep for the formation of shale gas or too complex for production to be successful (EIA 2013c). Bulgaria issued a moratorium on the use of fracking technology at the beginning of 2012 and combined this with a renouncement of the licenses which had already been issued. It is questionable whether the moratorium will be maintained in the medium term. The moratorium on the exploration of shale gas adopted previously in Rumania was renounced in March 2013, and exploration licenses have been issued for permits in the north and south of the country. Exploration activity in Hungary began as far back as 2007. The feasibility of developing the potential deposits has not yet been verified.

Intense efforts are currently under way in the United Kingdom to explore and develop shale gas deposits. However, these activities are accompanied by serious protests. Shale gas deposits are considered possible in the Bowland Shale (Carboniferous) in Central England, and in the Liassic sediments of the Wessex-Weald Basin. Previous studies quantified the resources as 0.15 trillion m^3 (DECC 2010), or 0.74 trillion m^3 (EIA 2013c). The latest estimate by the UK geological survey quantifies the shale gas in place in the Bowland Shale as 4.6 to 12.7 trillion m^3, with an average of 7.5 trillion m^3 (ANDREWS 2013). How much of this can actually be produced is not stated in the study with reference to the early stages of the exploration activities. According to EIA (2013c) light tight oil is only expected in the Wessex-Weald Basin, where the resources are quantified as 94 million t.

The shale gas potential of the Cambro-Ordovician Alum Shale in Sweden has been investigated (POOL ET AL. 2012). The study concludes that the Alum Shale has potential for shale gas in principle, but that economic production is probably unlikely because of the low gas concentrations in the formation. Further exploration activities in this area were terminated after the evaluation of the test results. Sweden and Norway – the two countries with the largest share of the Alum Shale Formation – had previously been assigned a high potential for shale gas – figures for Sweden have been significantly reduced recently though by EIA (EIA 2013c). EIA was unable to confirm the enormous resources previously assumed to be present in Norway, and now quantifies the resources as zero. Notwithstanding this assessment, shale gas has recently been verified in Spitzbergen. Estimates of the potential of this shale gas are not currently available but this finding does show that surprises and new discoveries are still on the cards. The potential in Denmark was upgraded slightly, and two exploration licenses are currently being issued in the north of the country.

In addition to the largely consistent EIA assessments of the prospectivity in the Netherlands, another study was carried out by the Dutch Organisation for Applied Scientific Research (TNO, the Netherland's geological survey) (TNO 2009). When making specific assumptions they estimated the resources as 16 trillion m^3 – a very high figure which significantly exceeds the estimates made using other approaches. No known exploration activities are currently being carried out in this regard. The government of the Netherlands postponed a decision on the future development of shale gas until autumn 2013 with reference to the ongoing public controversy regarding the use of fracking technology.

Estimates of the shale gas potential of the Baltic Basin have been relatively low to date. Planned investigations are focused on the Early Palaeozoic shales which are to be analysed to determine their total hydrocarbon potential. Results are not expected before 2015. The resources in Lithuania are currently estimated as maximum 0.1 trillion m^3 shale gas (EIA 2011) and 40 million t light tight oil (EIA 2013c). Despite the low volumes which are forecasted, there is still an interest in producing the shale gas. The first license for exploring an area in western Lithuania has, however, been renounced, most probably because of the uncertain regulatory conditions. There are no figures available for the neighbouring country of Latvia although there is also interest in developing the deposits in that country.

The argillaceous rocks of the Lower Carboniferous, Jurassic Posidonia Shale and the Wealden (Bückeburg Formation; Lower Cretaceous) in Germany were evaluated in a preliminary assessment by BGR. This study identified the biggest potential for shale gas in three areas: the southern edge and eastern part of the Northwest German Basin; in Northeast Germany; and in the central part of the Upper Rhine Graben (BGR 2012b). Taking a conservative approach, the BGR study assumes a technical recovery factor of 10 % of the GIP volumes. The technically recoverable volumes of gas (resources) were therefore estimated as ranging from 0.7 to 2.3 trillion m^3 (medium: 1.3 trillion m^3). This quantity is much higher than the EIA estimate of 0.48 trillion m^3 (EIA 2013c). However, the latter estimate did not include the Lower Carboniferous argillaceous rocks. When directly comparing the formations considered in both studies, BGR reports a similar value of around 0.4 trillion m^3. The oil and gas industry began exploration activities looking at shale gas in 2008, but this work has been scaled back in the light of the intense public discussions concerning its production. No shale gas production has been initiated to date, and there is therefore no empirical data on how much of the GIP volumes are technically recoverable. The only assessment of the tight oil potential was in a study by EIA (EIA 2013c). This reports the potential of the Posidonia Shale and Wealden Shale in the Lower Saxony Basin as around 90 million t. BGR will present its own estimate of the light tight oil potential by 2015.

The total share of shale gas resources reported for Europe is currently 14 trillion m^3 and therefore accounts for the biggest share of overall gas resources in Europe which add up to 21 trillion m^3. Of this, conventional resources are 5.2 trillion m^3, followed by 1.6 trillion m^3 of coal bed methane, and only 0.12 trillion m^3 of tight gas. The European tight oil resources are estimated as 2,231 million t and are therefore much lower than the conventional oil resources of 4,610 million t. At around 30 million t each, the European resources of bitumen from oil sands and extra heavy oil are relatively minor.

4.3 Conventional versus non-conventional – Definitions for crude oil and natural gas

Over the course of time, a number of terms with unclear or non-standardised definitions in part have "evolved" with respect to different types of energy commodity deposits and their technological development and production methods. These terms include the subdivision into conventional and non-conventional commodities. The term "non-conventional commodity" can refer to the raw material itself, the geological properties of the deposit, the production methods, or the development or production costs. The differentiation into conventional or non-conventional is therefore based neither on purely geological parameters nor purely economic factors, even though the terms are in common use internationally (IEA 2013a). The classification into conventional and non-conventional commodities is traditionally only applied to three fuels: oil, gas and uranium. A subdivision into conventional or non-conventional is not usually practised in the case of coal and mineral resources. The following explanations describe the situation in the case of oil and gas (Fig. 14).

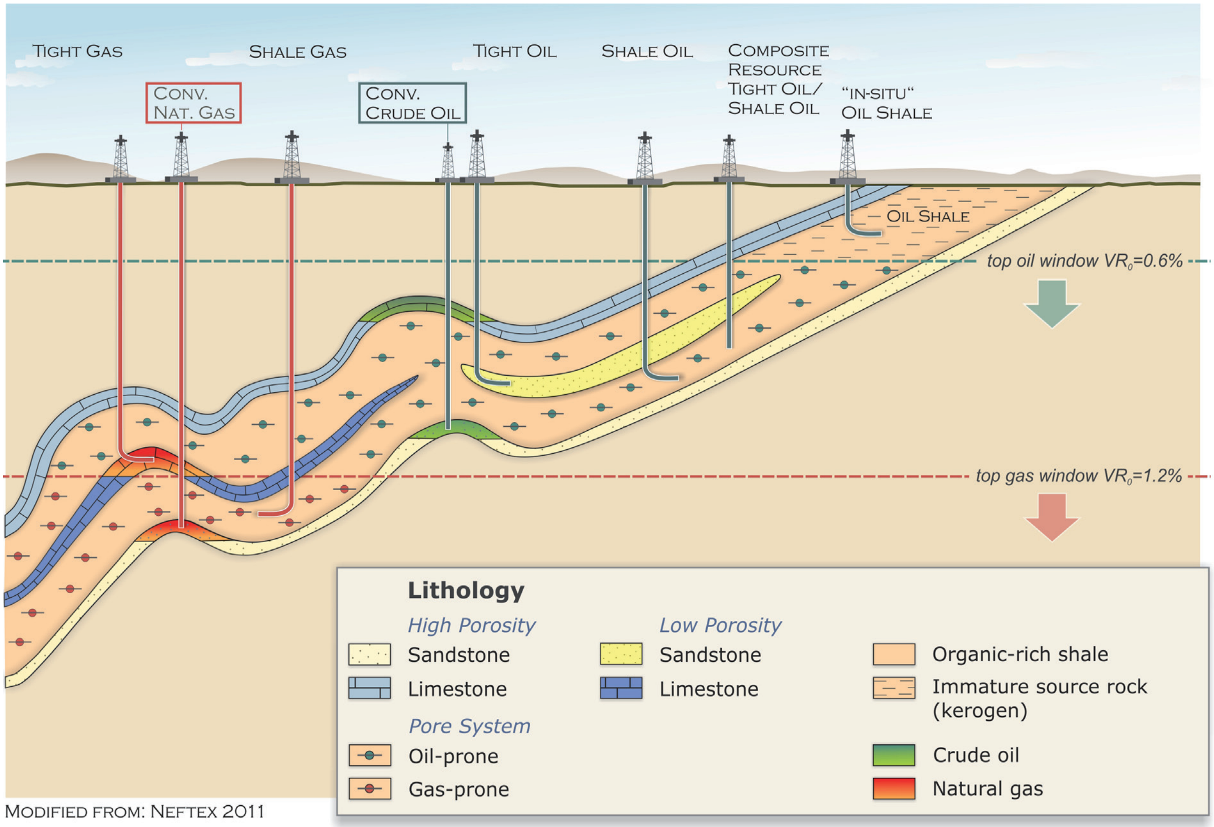

Fig. 14: Diagrammatic profile of a basin with conventional and non-conventional crude oil and natural gas reservoirs.

Non-conventional crude oil

Crude oil is differentiated into conventional or non-conventional depending on the properties of the oil in terms of viscosity and density (cf. definition in the appendix) as well as the nature of the reservoir.

The following are defined as non-conventional oil because of their properties:

- *Extra heavy oil*, which has a very high density, and flows very poorly because of its high viscosity
- *Bitumen* bound up in oil sand
- *Oil shale*. This is an immature oil source rock with a high percentage of organic constituents with only minor thermal overprinting, and whose organic matter (kerogen) has not yet been altered into liquid hydrocarbons

Crude oil can also be classified as non-conventional because of the nature of the reservoir:

- Oil in tight argillaceous rocks (shale oil or light tight oil). The term shale oil must not be confused with oil shale.

The distribution of oil in oil sands, oil shales and tight oil is not restricted to geological traps (Fig. 14). Tight oil usually involves a light form of oil which has not migrated out of the source rock or only undergone very slight migration. It can therefore occur with a widespread or continuous distribution throughout the whole source rock horizon. In the Anglo-American terminology, these deposits are therefore also known as "continuous accumulations".

Other classifications of non-conventional oil also take into consideration the nature of the deposit, which can give rise to relatively high development costs. Some authors therefore also refer to offshore oil fields, oil fields below a specific water depth, or oil fields in certain regions, as non-conventional oil. CAMBELL (2006) considers non-conventional oil to also include offshore oil in water depths exceeding 500 m (deep water), oil in Arctic regions, and condensate. Other authors such as SCHOLLNBERGER (1998) define conventional oil as any oil which can be economically produced independent of its physical properties, the nature of the deposit and the technology required for its production.

Non-conventional oil has been commercially produced for a long time. However, the terms conventional and non-conventional are not used in a standardised way in oil statistics. The reserves figures reported by many countries also include non-conventional deposits. The production data for most countries also includes non-conventional oil, which is not reported separately.

Non-conventional natural gas

Unlike oil, the term non-conventional gas does not refer to the commodity itself (which is usually in the form of methane), but to the nature of the natural gas deposit. The differentiation between conventional and non-conventional can already be determined on the basis of the properties and characteristics of the reservoir. Non-conventional gas deposits are also not dependent on geological traps, and the gas does not usually flow into the production well in adequate quantities without undertaking additional technical measures because the gas is either not present in a free gas phase or the reservoir rock is not sufficiently permeable. The term non-conventional gas comprises natural gas in tight sandstones and carbonates (tight gas), shale gas, coal bed methane, aquifer gas, and gas from gas hydrates.

In the case of gas deposits in impermeable rocks, an additional differentiation is made between those in only slightly permeable sandstones and carbonates (tight gas) and those in extremely low permeable shales (shale gas). The oil and gas industry generally defines a tight gas reservoir as a deposit with a permeability of less than 0.1 Millidarcy (mD). The usual limit used in Germany is 0.6 mD, but this is not explicitly used for tight gas, but instead is used to define the amount of the royalties paid for wells in very low permeable rocks as a means of taking into consideration the very high investment costs. On the basis of decades of experience in the development and economic exploitation of such hydrocarbon occurrences, specific deposits of this type in Germany are also defined as low permeable (conventional) sandstone reservoirs. Tight gas reservoirs can have higher porosities than shale gas deposits and be distributed in varying concentrations over large parts of geological basin structures (also known as basin centred gas). Natural gas has been economically produced from tight gas reservoirs around the world for many decades independent of and without any influence on its classification as non-conventional gas.

Shale gas is gas which formed and still remains in the source rock. The deposits are not restricted to clearly defined structures and the source rocks containing shale gas can form geographically very extensive areas. The term "continuous accumulations" is also used here in analogy to light tight oil deposits. The gas can be present in gaseous form within pores and fracture spaces, as well as in adsorptive form on the surfaces of the organic and argillaceous rock particles. In most countries around the world with shale gas deposits, production is either planned, or public debates are taking place on its potential exploitation. However, the only commercial production to date is restricted to North America.

The methane in coal bed methane (CBM) is bound adsorptively to the organic or coal particles in much higher proportions than in the case of shale gas – the proportion of free gas is therefore also often very low. Deposits of coal bed methane include occurrences in unmined coal sequences as well as gas extracted from coal mines (mine gas). Coal bed methane has been economically produced around the world for many decades.

Aquifer gas is the term used to describe gas dissolved in groundwater which can be released by the drop in pressure which occurs when water is allowed to flow up to the surface of the earth. Gas hydrate is a solid mixture of methane in water which takes the form of ice which can form under certain low temperature and high pressure conditions. Gas hydrates are therefore found in permafrost regions and in sediments at extreme water depths along the continental margins of oceans around the world. No economic use of either of these gas types is currently foreseeable.

Conclusions

Despite the increasingly imprecise use and subdivision into conventional and non-conventional commodities, these terms will also continue to be used in future to describe different assessments and situations. Non-conventional hydrocarbons can be economically produced to an increasing degree thanks to continuous advancements in production technologies and rises in commodity prices. Making a subdivision on the basis of an economic approach will therefore not be possible without simultaneously re-categorising as non-conventional those deposits currently labelled as conventional but which are currently not economically producible. Instead of geological aspects, regional factors such as the availability of infrastructure or the legislative frameworks would become the determining factor. An approach based exclusively on technical experience or the acquisition of knowledge during development lacks a clear definition. Production of shale gas in the USA is now considered to be state-of-the-art technology in that country: nevertheless, shale gas is still classified as a non-conventional commodity. Because of the geological properties of the deposits, and in view of the more complex and expensive extraction technologies required in principle to produce them, it still remains prudent and helpful to report separately as far as possible special deposits classified as non-conventional when trying to assess the global availability of oil and gas. This requires a geoscientific-technological approach which can be applicable to reserves as well as resources. Classifying a commodity as conventional or non-conventional is not significant when making a decision on whether, and under what circumstances, hydrocarbons can be produced from a reservoir. What is required here is an assessment of the supply security, economic efficiency and environmental compatibility of the commodity taking into consideration the site-specific conditions.

4.4 The crude oil and natural gas potential in the Arctic

Crude oil and natural gas exploration and production has already taken place in the Arctic for many decades (Fig. 15). Over 450 significant oil and gas discoveries, including eleven "giants" have been reported since the beginning of exploration in the middle of the 1930s in the onshore and offshore areas north of the Arctic Circle. Around 5 billion t oil and 30 trillion m³ gas have been discovered in the Arctic since 1963[3] (Chew and Arbouille 2011). Around 10 % of global oil production and around one quarter of global gas production is currently derived from fields within the Arctic (EID 2012). Moreover, on the basis of its investigations, the US Geological Survey estimates that of the world's so far undiscovered conventional deposits, around 30 % of the gas resources and around 13 % of the oil resources could lie within this frontier region (Gautier et al. 2009), not to mention considerable non-conventional deposits. The areas with the most intense activity at the moment are in Northern Alaska (USA and Canada), the Barents Sea (Norway and Russia), the Timan-Petschora Basin, and in West Siberia (Russia). The potential for these regions is typified by the Prudhoe Bay and Kuparuk River oil fields in Alaska, and the Shtokman gas field in the Barents Sea, which are amongst the largest fields of their kind anywhere on the earth. Activities to date have concentrated on onshore areas. However, offshore oil production in the Arctic is now scheduled to start with the Prirazlomnaya platform – the first ice-resistant production platform – located south of Nowaja Semlja in the south-eastern part of the Barents Sea (Petschora Sea). The Prirazlomnaya field was discovered in 1989 at a water depth of 20 metres, and has reported reserves of around 70 million tonnes of oil. The field is to be developed from one platform using several deviated wells. Although production was scheduled to start in 2012, these plans had to be revised several times for technical reasons. The project is also criticised by environmental organisations even though an international team of experts examined the safety standards on the platform on behalf of the operator Gazprom Neft.

Regional overview

The discoveries in the Arctic have been dominated since the 1980s by the new discoveries in the Norwegian Barents Sea which account for around 26 % of all new offshore oil and gas discoveries. The only offshore production currently operating in the Barents Sea produces gas from the Snøhvit gas field located around 140 km north-west of Hammerfest – this is Norway's fifth largest gas field. The field production is controlled from the island of Melkøya located only three kilometres from Hammerfest. Oil was also discovered in the Goliat field (85 km north of Hammerfest), and in the Skrugard field (100 km north Snøhvit), and it is therefore expected that production will also start here in the near future. The production facilities will be largely located on the sea floor by making use of remote-controlled sub-sea operating units. Loading will take place using a floating and therefore flexible production and storage unit. The most northerly oil discovery was made at

[3] proven plus probable technically recoverable resources

the Wisting field in 2013 in the Hoop-Maud Basin north of the 73rd line of latitude (around 300 km north of Hammerfest). Initial estimates indicate the presence of around 8 to 22 million tonnes of recoverable oil as well as suggesting the presence of gas fields. This oil discovery will probably give rise to additional exploration activity and possibly more discoveries.

Western oil companies withdrew from the development of the Shtokman gas field because of high investment costs and uncertain economics – the field was discovered around 1988 around 900 km north of the Arctic Circle in the Russian part of the Barents Sea. The field is reported to contain around 3.5 trillion m^3 gas and 31 to 37 million t condensate, corresponding to around 8 % of all of the gas resources previously discovered in the Arctic. Despite this enormous potential, the development of the Shtokman gas field is still questionable.

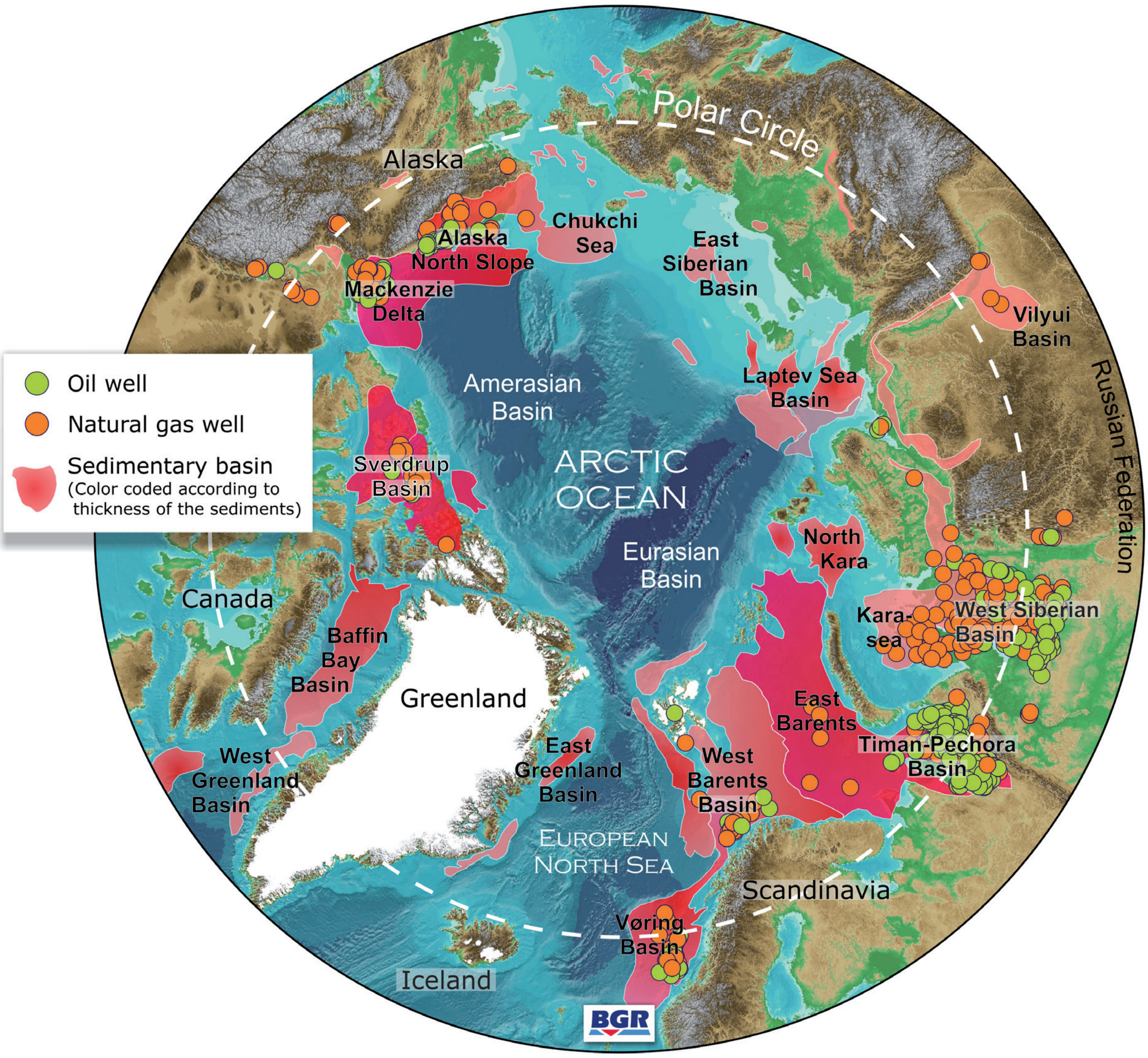

Fig. 15: The Arctic region with sedimentary basins, and oil and gas discovery wells.

Greenland is currently seen by the US Geological Survey (USGS) as the region with the possibly largest as yet undiscovered hydrocarbon deposits (Gautier et al. 2009). Five wells have been drilled offshore south-western Greenland since the middle of the 1970s and provided indications of wide-spread gas prospectivity. A large number of natural oil seeps on the sea floor were discovered in the early 1990s as a result of intensive exploration activities, and these oil seeps may indicate the presence of potential oil fields. Five exploration licenses have been issued to date, and two wells have been drilled, one onshore and one offshore. Another seven licenses were issued offshore west Greenland, seven more in Baffin Bay, and four more offshore south Greenland since 2007. Oil was encountered in several wells but no commercial find has been made so far. The first licence rounds have also taken place in north-east Greenland. If the USGS forecasts prove correct, north-east Greenland will move into 19th position of the 500 known major oil and gas provinces.

Relatively intense petroleum-geological investigations have been undertaken in the Canadian Arctic in recent decades, which included the drilling of more than 100 wells. Although major gas potential is assigned to the Mackenzie Delta and the Sverdrup Basin, the complex geology and high costs have meant that no fields have been developed so far.

The shelf regions framing the Siberian Arctic area are among the least investigated areas on the earth even though the first oil exploration well was drilled on the southern coast of the Laptev Sea way back in the 1940s. BGR‘s research activities in the Laptev Sea have made a major contribution to re-evaluating the originally suspected oil and gas potential, but resulted in a significant lowering of the assumed prospectivity. This is mainly due to the relatively young age of the sedimentary basins which are dated as Upper Cretaceous, which rules out prospectivity in many cases. Nevertheless, ExxonMobil and the Russian national oil company Rosneft recently set up a joint venture to explore the Laptev Sea and the neighbouring Kara Sea.

The outlook for crude oil and natural gas exploration

Despite many years of exploration in some parts of the huge Arctic region, there are still large virtually unexplored areas. Nevertheless, the oil and gas potential of the Arctic is unanimously assessed as being very high. Analogies with previous studies in comparable hydrocarbon provinces around the world form the basis for the US Geological Survey‘s assessments of the global distribution of oil and gas fields. The estimates are based on comparisons between the Arctic sedimentary basins and the potential in comparable basins outside of the Arctic. Most of the still undiscovered fields are expected to be present in the shallow shelf areas of the Arctic Ocean in water depths less than 500 m. These are the locations of the largest sedimentary basins with adequate sedimentary thicknesses to enable the generation of oil and gas (Fig. 15). However, the presence of large unexplored areas means that forecasts of the potential in the Arctic are associated with considerable uncertainties which can only be clarified by undertaking regional exploration activities. The general opinion though is that the undiscovered resources primarily involve gas fields. This interpretation is based on the composition of the potential source rocks and the subsidence history of each of the basins.

From today‘s point of view, political conflicts regarding potential oil and gas fields are considered to be fairly unlikely. The UN Convention on the Law of the Sea (UNCLOS) which has been ratified by all of the bordering countries with the exception of the USA, also applies to the Arctic Ocean. However, the USA is a signatory to the Ilulissat Declaration which came into force in May 2008, and which obliges all the countries to regulate any issues concerning the Arctic Ocean in a peaceful fashion on the basis of the UN Convention on the Law of the Sea. Moreover, Russia and Norway reached a bilateral agreement in 2010 on the border in the Barents Sea which had been the subject of dispute for 40 years. The exploration and production of oil and gas in future will also largely take place in the sovereign areas of other countries bordering the Arctic, and therefore remain the responsibility of the individual countries. According to the information available to date, most of the economically producible oil and gas fields will be located in undisputed areas, i.e. in sovereign waters around the Arctic.

Developing new fields and producing oil and gas under Arctic conditions is an exceptional technical challenge. The costs for producing these resources are also very high because of the remoteness of the locations and the extreme environmental conditions. Whether or not resources can be economically developed therefore strongly depends on the oil and gas prices. If the global demand for fossil fuels continues or grows further, greater efforts will probably be made to develop these remote deposits. The continuing decline in ice cover in recent decades also opens up new opportunities and could make further development more favourable.

Environmental regulations are usually more stringent in the Arctic than in regions lying further to the south. The provision of a second drilling platform for instance is stipulated when drilling in US-American parts of the Arctic, a regulation adopted to ensure that a relief well can be drilled immediately if required in the event of an incident. Nevertheless, incidents which might occur during production or the transport of oil could also damage the vulnerable Arctic ecosystem more seriously and more durably than a similar incident in milder climates. Water temperatures in the Arctic Ocean are close to zero degrees Celsius, which slows down the microbial decomposition of oil and the break-down of the individual oil components. Sea ice would prevent a clean-up after a potential incident and therefore increase the period during which the region is affected by environmental pollution. In BGR‘s opinion, it is essential that the highest environmental standards and the use of the most modern technological measures are stipulated in all cases to ensure the environmentally-compatible exploration and production of oil and gas in the vulnerable Arctic region.

BGR research activities in the Arctic

Relevant data and findings are necessary to make predictions and decisions on the sustainable use of natural resources, and to provide the basis for elaborating scenarios and recommendations for action.

The German government‘s strategy is to respect the special circumstances existing in the Arctic and to make it a key aspect of German foreign policy. It also recognises the enormous economic potential and the major environmental challenges associated with developing natural resources in the Arctic, and the associated prospects for German and European economies – always taking into consideration the highest environmental standards ("Leitlinien deutscher Arktispolitik" – AUSWÄRTIGES AMT 2013 and "The German Government‘s raw materials Strategy", BMWI 2010).

This is the background against which BGR developed a strategy concept last year for oil and gas research activities in northern European waters and neighbouring regions. This part of the Arctic will probably become particularly important for Germany‘s future supply of fossil fuels because of its geographic proximity to European coastal countries. Around 63 % of the gas and 47 % of the oil used in Germany was imported from Russia and Norway in 2011. BGR strategy will also take into account environmental aspects which have an impact on the production of oil and gas in this vulnerable region.

4.5 Summary and outlook

Crude oil

From a geological point of view, the demand for oil will be satisfied in the coming years even in the face of a moderate rise in consumption. No supply risks are foreseeable in the short term with the exception of unpredictable events such as political crises or natural disasters.

Notwithstanding the cuts in crude oil production associated with various crises, global oil supplies remain stable thanks to the reserve capacities of OPEC and the strong rise in light tight oil production in the USA. Despite the sanctions affecting Iran, there was a further rise in the proportion of crude oil produced by OPEC Gulf states in particular. Production in Iraq is scheduled to triple by 2020 on the basis of the intense expansion of production capacities. The increase in tight oil production in North America in recent years is having a tangible impact on the USA's import activities. Crude oil no longer imported into North America is now also available to supply the overall global oil market. Although it is currently not possible to assess the sustainability of the tight oil boom in the USA, a collapse in production in the short term is considered unlikely based on the information currently available. However, there has not been any break-through yet in the global expansion of tight oil production. Its further development is hindered in particular by the lack of infrastructure and unclarified political and social conditions regarding this resource. Commercial light tight oil production outside of the USA could begin in Argentina, Australia, Russia or China in the next few years. Within the European context, the Ukraine and the United Kingdom are the countries with the most active programmes aimed at developing this resource.

In recent years, the oil and gas industry has made significant exploration and production advances on the back of technological innovations – favoured by the continuing high oil prices. As a consequence, the limits of what is and what is not feasible have been increasingly moved with an eye on technically and geographically challenging oil and gas fields in deep and very deep water, high temperature and high pressure reservoirs, and in Arctic frontier regions.

Natural gas

Unlike crude oil, the availability of gas for the production of energy in coming decades will not be limited by a lack of reserves, even in the face of growing demand. Moreover, the successes that have been achieved in the development of non-conventional gas deposits – primarily in the USA – have led to an improvement in the global supply situation. Thanks to the expansion of their shale gas production activities, the USA has reduced its gas imports by almost a third in recent years, and even has the potential to become a gas exporting country in the foreseeable future. No short-term decline in shale gas production in the USA is expected.

After enjoying high growth rates for many years, the LNG market in 2012 experienced a downturn for the first time in years. This was largely attributable to the slow expansion of LNG capacities, and the inability to utilise the capacities of the existing facilities. The latter declined because of growing domestic demand, lower production volumes, and outages because of technical problems. This ultimately led to a shortage in supply and a significant rise in the price of LNG. With its integrated and growing supply network, Europe is connected to a large proportion of the global natural gas reserves via pipelines and LNG terminals. The European gas market therefore enjoys a relatively comfortable position.

Although gas is often referred to as a "bridging" energy resource with the strongest potential for growth, its proportion in the global energy mix is stagnating because other fuels having higher growth rates. The future will tell which proportion gas will occupy in the power and heat market in the long term.

Coal

The demand-driven doubling of global hard coal production capacities since the beginning of the new millennium, and the continuing expansion of existing mines and the opening up of new mines, have given rise to today‘s excess capacities and therefore to an oversupply situation in the global hard coal market. As a consequence, coal prices are dropping and mines with high production costs are closing. The market in future is expected to favour consumers given today‘s forecast slow-down in the growth of coal demand in the short to medium term. This would therefore maintain the competitiveness of coal in the power generation sector in particular compared to other fossil fuels, if any possible climate-policy interventions are ignored. With respect to the producers, there is still no end to the consolidation phase, particularly in the USA. The strong rise in the global demand for coal in recent years is expected to continue- albeit less strong -with the overall demand for coal continuing to be driven by the Asian countries.

Nuclear fuels

The observable trend of a growing global interest in the expansion of nuclear power production continues. Despite the withdrawal from nuclear production and a halt to the expansion of nuclear power plants in some countries, most countries around the world continue to support the utilisation of nuclear power. Whilst the demand for uranium will decline further in Europe in the long term, it will probably grow significantly in Asia and the Near East. A moderate rise in the demand for uranium is also expected in the North America, Latin America and Africa regions in the coming decades. With global uranium reserves of around 2.16 Mt (cost category < 80 USD/kg U) and another 13 Mt of uranium resources, no shortage in the supply of nuclear fuels is expected in future from a geological point of view, even in the light of the foreseeable rise in demand in the coming decades. Global production increased by 8 % in 2012 compared to the previous year. Kazakhstan is expected to remain the largest producer of uranium. Kazakhstan succeeded in boosting its production again and now produces around 37 % of global uranium output. This strong upwards trend is also expected to continue beyond 2013. However, uncertainties currently exist on how global exploration and production projects will develop in future. Rising production costs and declining uranium spot market prices are behind a reduction in the amount being invested by the uranium extraction and exploration industry, and jeopardise the economics of some mines and exploration projects. Ongoing projects are currently either being delayed or suspended. It is virtually impossible to realise new mine projects under the current market conditions.

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APPENDIX

- Tables
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- Conversion factors

Table 2: Reserves of non-renewable fuels 2012: Regional distribution [EJ]

Region	Crude oil		Natural gas		Coal		Uranium	Total	Share [%]
	conven-tional	non-conven-tional	conven-tional [1)]	non-conven-tional	Hardcoal	Lignite			
Europe	93	< 0,5	162	–	517	638	8	1,418	3.6
CIS	722	–	2,339	2	3,282	1,354	203	7,902	19.8
Africa	745	–	555	–	850	1	54	2,204	5.5
Middle East	4,541	–	3,060	–	30	–	–	7,632	19.1
Austral-Asia	252	–	591	47	8,371	834	571	10,666	26.7
North America	291	1,116	248	162	5,779	389	166	8,151	20.4
Latin America	404	886	289	–	232	43	81	1,936	4.9
World	**7,050**	**2,002**	**7,244**	**211**	**19,061**	**3,259**	**1,084**	**39,910**	**100.0**
OECD 2000	403	1,116	512	197	7,925	1,404	654	12,210	30.6
EU-27	51	–	79	–	493	508	3	1,135	2.8
OPEC 2009	5,388	886	3,621	–	59	1	–	9,954	24.9

[1)] including tight gas

Table 3: Resources of non-renewable fuels 2012: Regional distribution [EJ]

Region	Crude oil		Natural gas		Coal		Uranium	Thorium	Total	Share [%]
	conven-tional	non-conven-tional	conven-tional [1)]	non-conven-tional	Hardcoal	Lignite				
Europe	193	96	199	600	12,574	3,024	106	588	17,379	3.3
CIS	1,155	906	4,614	1,869	69,471	18,705	1,350	105	98,175	18.8
Africa	1,071	231	1,321	1,763	1,917	4	841	325	7,473	1.4
Middle East	1,251	1	1,643	251	1,008	–	80	15	4,249	0.8
Austral-Asia	1,049	435	1,707	3,350	168,784	10,047	1,535	763	187,670	36.0
North America	1,072	2,584	1,509	2,725	166,890	17,546	1,981	346	194,653	37.3
Latin America	941	2,870	786	1,560	686	173	616	465	8,097	1.6
World	**6,732**	**7,123**	**11,779**	**12,117**	**425,155** [2)]	**49,500**	**6,509**	**2,606** [3)]	**521,521**	**100.0**
OECD 2000	1,304	2,780	1,905	4,277	220,116	21,957	2,485	1,196	256,021	49.1
EU-27	99	69	118	563	12,535	2,686	106	56	16,233	3.1
OPEC 2009	1,818	2,798	1,791	1,496	1,220	3	37	185	9,348	1.8

[1)] without natural gas from 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 4: Production of non-renewable fuels 2012: Regional distribution [EJ]

Region	Crude oil	Natural gas	Hard coal	Lignite	Uranium	Total	Share [%]
Europe	6.9	10.9	3.5	5.0	0.2	26.5	5.2
CIS	27.6	30.2	11.9	1.3	13.8	84.8	16.7
Africa	19.3	8.0	6.3	–	5.4	39.0	7.7
Middle East	56.1	20.6	< 0.05	–	–	76.7	15.1
Austral-Asia	16.3	18.7	119.5	3.5	4.5	162.3	31.9
North America	30.8	33.6	23.0	0.9	5.3	93.7	18.4
Latin America	16.0	6.7	2.5	0.1	0.1	25.4	5.0
World	**172.9**	**128.8**	**166.8**	**10.8**	**29.2**	**508.5**	**100.0**
OECD 2000	38.3	46.2	36.5	5.5	8.9	135.5	26.6
EU-27	3.0	6.4	3.4	3.9	0.2	16.9	3.3
OPEC 2009	75.6	24.6	0.1	–	–	100.3	19.7

Table 5: Consumption of non-renewable fuels 2012: Regional distribution [EJ]

Region	Crude oil	Natural Gas	Hard coal	Lignite	Uranium	Total	Share [%]
Europe	27.8	20.0	9.3	5.0	10.0	72.1	14.1
CIS	8.5	24.5	8.8	1.2	4.0	47.0	9.2
Africa	7.1	4.5	4.7	–	0.2	16.4	3.2
Middle East	15.6	15.6	0.4	–	0.1	31.7	6.2
Austral-Asia	58.3	24.1	123.0	3.4	8.7	217.5	42.4
North America	42.3	33.9	20.0	1.0	10.8	107.9	21.0
Latin America	12.8	6.2	0.9	0.1	0.2	20.3	3.9
World	**172.3**	**128.8**	**167.1**	**10.7**	**34.0**	**513.0**	**100.0**
OECD 2000	85.3	60.3	38.5	5.5	24.8	214.4	41.8
EU-27	24.9	17.7	8.4	3.9	9.7	64.6	12.6
OPEC 2009	17.4	17.2	0.1	–	0.1	34.9	6.8

– no reserves, resources, production or consumption

Table 6: Crude Oil 2012 [Mt]

Country/Region	Production	Cum. Production	Reserves	Resources	EUR	Remaining Potential
Albania	0.8	54	26	23	104	49
Austria	0.9	122	6	10	138	16
Bosnia & Herzegovina	–	–	–	10	10	10
Bulgaria	< 0.05	9	2	32	43	34
Croatia	0.6	102	8	20	130	28
Cyprus	–	–	–	35	35	35
Czech Republic	0.2	11	2	30	43	32
Denmark	10.2	330	110	172	612	282
Estonia	0.6	5	–	–	5	–
Finland	0.5	3	–	–	3	–
France	0.8	125	12	709	846	721
Germany	2.6	297	32	115	445	148
Greece	0.1	17	1	35	53	36
Hungary	0.7	99	4	20	123	24
Ireland	–	–	–	224	224	224
Italy	5.4	180	82	200	462	282
Lithuania	0.1	4	1	61	66	62
Malta	–	–	–	5	5	5
Netherlands	1.1	144	35	455	634	490
Norway	87.5	3,450	940	2,100	6,490	3,040
Poland	0.7	62	10	260	332	270
Romania	4.1	763	82	201	1,046	282
Serbia	1.0	44	9	20	72	29
Slovakia	< 0.05	3	1	5	9	6
Slovenia	< 0.05	n. s.	n. s.	n. s.	n. s.	n. s.
Spain	0.1	38	20	34	91	54
Turkey	2.3	140	43	709	893	753
United Kingdom	44.6	3,540	811	1,414	5,765	2,225
Azerbaijan	42.0	1,761	952	1,245	3,958	2,197
Belarus	1.6	136	27	30	193	57
Georgia	< 0.05	24	5	50	79	55
Kazakhstan	79.2	1,538	4,082	10,700	16,320	14,782
Kyrgyzstan	0.1	11	5	10	27	15
Moldova, Republic	–	–	–	10	10	10
Russia	517.9	21,696	11,868	34,800	68,364	46,669
Tajikistan	< 0.05	8	2	60	69	62
Turkmenistan	13.0	523	204	1,700	2,427	1,904
Ukraine	2.4	360	54	300	714	353
Uzbekistan	3.2	193	81	400	674	481
Algeria	76.1	2,884	1,660	2,376	6,920	4,035
Angola	86.9	1,387	1,723	5,200	8,311	6,923

Continuation of table 6
[Mt]

Country / Region	Production	Cum. Production	Reserves	Resources	EUR	Remaining Potential
Benin	–	4	1	70	75	71
Cameroon	3.3	181	24	350	555	374
Chad	5.3	65	204	275	544	479
Congo, DR	1.1	43	24	145	213	169
Congo, Rep.	15.3	341	219	451	1,010	670
Côte d'Ivoire	1.6	29	14	300	343	314
Egypt	34.5	1,555	599	2,234	4,388	2,832
Equatorial Guinea	14.9	194	232	350	776	582
Eritrea	–	–	–	10	10	10
Ethiopia	–	–	< 0.5	20	20	20
Gabon	12.3	524	272	1,400	2,196	1,672
Gambia	–	–	–	20	20	20
Ghana	3.9	13	90	210	312	300
Guinea	–	–	–	150	150	150
Guinea–Bissau	–	–	–	40	40	40
Kenya	–	–	–	250	250	250
Liberia	–	–	–	160	160	160
Libya	72.5	3,735	6,595	4,751	15,081	11,346
Madagascar	–	–	–	90	90	90
Mauritania	0.3	7	3	164	173	166
Morocco	< 0.05	2	< 0.5	1,600	1,602	1,600
Mozambique	n. s.	n. s.	2	2,000	2,002	2,002
Namibia	–	–	–	150	150	150
Niger	1.0	n. s.	n. s.	30	30	30
Nigeria	123.8	4,224	5,053	5,090	14,367	10,143
São Tomé 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	1.5	–	646	365	1,011	1,011
Sudan	4.1	–	212	365	577	577
Sudan & South Sudan	5.6	210	857	730	1,797	1,587
Tanzania	–	–	–	400	400	400
Togo	–	–	–	70	70	70
Tunisia	3.1	201	58	304	563	362
Uganda	–	–	136	300	436	436
Western Sahara	–	–	–	57	57	57
Zimbabwe	–	–	–	10	10	10
Bahrain	9.6	232	15	200	447	215

Continuation of table 6
[Mt]

Country / Region	Production	Cum. Production	Reserves	Resources	EUR	Remaining Potential
Iran	185.8	9,386	21,401	7,200	37,987	28,601
Iraq	148.1	4,820	19,088	6,100	30,009	25,188
Israel	< 0.05	2	2	370	374	372
Jordan	< 0.05	–	< 0.5	19	19	19
Kuwait	151.6	5,884	13,810	700	20,394	14,510
Lebanon	–	–	–	150	150	150
Oman	45.8	1,350	748	700	2,799	1,448
Qatar	83.0	1,503	3,435	700	5,637	4,135
Saudi Arabia	547.0	18,717	36,170	11,800	66,688	47,970
Syrian	9.0	740	340	400	1,480	740
U. Arab Emirates	155.0	4,329	13,306	1,100	18,736	14,406
Yemen	8.0	384	331	500	1,215	831
Afghanistan	–	–	12	290	302	302
Australia	18.7	1,000	534	3,481	5,014	4,015
Bangladesh	0.3	3	4	30	37	34
Brunei	7.8	507	150	160	817	310
Cambodia	–	–	–	25	25	25
China	207.5	5,874	2,359	20,725	28,957	23,083
India	38.1	1,220	760	1,417	3,397	2,177
Indonesia	43.6	3,308	548	3,545	7,402	4,093
Japan	0.7	51	5	24	79	29
Korea, Rep.	1.0	n. s.	n. s.	n. s.	n. s.	n. s.
Laos	–	–	–	< 0.5	< 0.5	< 0.5
Malaysia	30.6	1,034	796	850	2,680	1,646
Mongolia	0.5	2	35	1,013	1,050	1,048
Myanmar	0.8	55	5	560	620	565
New Zealand	2.0	57	18	245	320	263
Pakistan	3.2	96	34	1,388	1,518	1,422
Papua New Guinea	1.5	65	21	290	376	311
Philippines	0.8	16	17	270	303	287
Sri Lanka	–	–	–	90	90	90
Taiwan	< 0.05	5	< 0.5	5	10	5
Thailand	11.1	170	57	327	553	384
Timor-Leste	4.0	39	67	175	280	242
Viet Nam	16.7	304	599	600	1,503	1,199
Canada	179.2	5,272	27,353	54,698	87,323	82,051
Greenland	–	–	–	3,500	3,500	3,500
Mexico	126.6	6,139	1,546	4,702	12,387	6,249
USA	431.2	30,875	4,764	24,557	60,196	29,321
Argentina	31.0	1,510	337	4,173	6,020	4,511
Barbados	< 0.05	2	< 0.5	30	33	30
Belize	0.2	1	1	15	17	16
Bolivia	2.7	77	29	282	387	310
Brazil	108.2	1,927	2,009	13,721	17,657	15,730

Continuation of table 6
[Mt]

Country/Region	Production	Cum. Production	Reserves	Resources	EUR	Remaining Potential
Chile	0.3	62	20	333	415	353
Colombia	46.9	1,138	323	1,790	3,252	2,114
Cuba	3.1	59	10	1,008	1,078	1,018
Dominican Rep.	–	–	–	150	150	150
Ecuador	26.5	715	1,120	107	1,942	1,227
Falkland Islands	–	–	–	800	800	800
(French) Guiana	–	–	–	800	800	800
Guatemala	0.5	20	11	40	71	51
Guyana	–	–	–	450	450	450
Haiti	–	–	–	100	100	100
Paraguay	–	–	–	578	578	578
Peru	6.4	369	169	351	889	520
Puerto Rico	–	–	–	75	75	75
Suriname	0.8	13	10	700	724	710
Trinidad and Tobago	4.0	510	113	65	688	178
Uruguay	n. s.	n. s.	n. s.	277	277	277
Venezuela	151.5	9,596	26,724	65,323	101,643	92,047
World	**4,137.0**	**170,844**	**216,551**	**331,447**	**718,842**	**547,998**
Europe	165.0	9,541	2,239	6,901	18,680	9,139
CIS	659.3	26,249	17,280	49,305	92,834	66,585
Africa	461.6	15,615	17,828	31,166	64,610	48,995
Middle East	1,343.0	47,349	108,646	29,939	185,934	138,585
Austral-Asia	388.8	13,805	6,019	35,510	55,333	41,529
North America	737.0	42,286	33,662	87,458	163,406	121,121
Latin America	382.3	16,000	30,877	91,168	138,045	122,045
OPEC 2009	1,807.8	67,182	150,085	110,447	327,714	260,532
OPEC-Gulf	1,270.6	44,640	107,210	27,600	179,450	134,810
MENA	1,529.2	55,937	117,558	41,203	214,698	158,761
OECD 2000	917.1	51,952	36,329	97,702	185,982	134,031
EU-27	72.8	5,751	1,212	4,018	10,980	5,230

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

Table 7: Crude oil resources 2012 [Mt]
The most important countries (top 20) and distribution by regions and economic policy organisations

Rank	Country / Region	Total	conventional	non-conventional		
				oil sand	extra heavy oil	shale oil
1	Venezuela	65,323	3,000	–	60,500	1,823
2	Canada	54,698	3,500	50,000	1	1,197
3	Russia	34,800	20,000	4,500	1	10,299
4	USA	24,557	15,727	850	76	7,905
5	China	20,725	16,200	25	119	4,381
6	Brazil	13,721	13,000	–	–	721
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	Libya	4,751	1,200	–	–	3,551
14	Mexico	4,702	2,920	–	< 0.5	1,782
15	Argentina	4,173	500	–	–	3,673
16	Indonesia	3,545	2,400	70	–	1,075
17	Greenland	3,500	3,500	–	–	–
18	Australia	3,481	1,100	–	–	2,381
19	Algeria	2,376	1,600	–	–	776
20	Egypt	2,234	1,600	–	8	626
	...					
94	Germany	115	20	–	–	95
	...					
	other countries [117]	42,652	35,686	81	73	6,813
	World	**331,444**	**161,052**	**62,516**	**60,777**	**47,098**
	Europe	6,901	4,610	30	29	2,231
	CIS	49,305	27,635	11,200	21	10,449
	Africa	31,166	25,630	331	8	5,197
	Middle East	29,939	29,925	–	< 0,5	14
	Austral-Asia	35,510	25,095	95	119	10,200
	North America	87,458	25,647	50,850	77	10,884
	Latin America	91,168	22,510	10	60,526	8,122
	OPEC 2009	110,447	43,500	290	60,507	6,150
	OPEC-Gulf	27,600	27,600	–	–	–
	MENA	41,203	36,025	–	8	5,170
	OECD 2000	97,702	31,185	50,880	103	15,534
	EU-27	4,018	2,370	30	26	1,592

– no resources

Table 8: Crude oil reserves 2012 [Mt]
The most important countries (top 20) and distribution by regions and economic policy organisations

Rank	Country / Region	Total	conventional	non–conventional		
				oil sand	extra heavy oil	shale oil
1	Saudi Arabia	36,170	36,170	–	–	–
2	Canada	27,353	667	26,686	–	–
3	Venezuela	26,724	5,524	–	21,200	–
4	Iran	21,401	21,401	–	–	–
5	Iraq	19,088	19,088	–	–	–
6	Kuwait	13,810	13,810	–	–	–
7	U. Arab Emirates	13,306	13,306	–	–	–
8	Russia	11,868	11,868	–	–	–
9	Libya	6,595	6,595	–	–	–
10	Nigeria	5,053	5,053	–	–	–
11	USA	4,764	4,761	–	3	n.s.
12	Kazakhstan	4,082	4,082	–	–	–
13	Qatar	3,435	3,435	–	–	–
14	China	2,359	2,359	–	n.s.	–
15	Brazil	2,009	2,009	–	–	–
16	Angola	1,723	1,723	–	–	–
17	Algeria	1,660	1,660	–	–	–
18	Mexico	1,546	1,546	–	–	–
19	Ecuador	1,120	1,120	–	n.s.	–
20	Azerbaijan	952	952	–	n.s.	–
	...					
59	Germany	32	32	–	–	–
	...					
	other countries [83]	11,501	11,498	–	3	–
	World	**216,551**	**168,659**	**26,686**	**21,206**	**–**
	Europe	2,239	2,236	–	3	–
	CIS	17,280	17,280	–	–	–
	Africa	17,828	17,828	–	–	–
	Middle East	108,646	108,646	–	–	–
	Austral-Asia	6,019	6,019	–	–	–
	North America	33,662	6,973	26,686	3	–
	Latin America	30,877	9,677	–	21,200	–
	OPEC 2009	150,085	128,885	–	21,200	–
	OPEC-Gulf	107,210	107,210	–	–	–
	MENA	117,558	117,558	–	–	–
	OECD 2000	36,329	9,640	26,686	3	–
	EU-27	1,212	1,212	–	–	–

n. s. not specified
– no reserves

Table 9: Crude oil production 2012
The most important countries (top 20) and distribution by regions and economic policy organisations

Rank	Country / Region	Mt	Share [%] country	Share [%] cumulative
1	Saudi Arabia	547.0	13.2	13.2
2	Russia	517.9	12.5	25.7
3	USA	431.2	10.4	36.2
4	China	207.5	5.0	41.2
5	Iran	185.8	4.5	45.7
6	Canada	179.2	4.3	50.0
7	U. Arab Emirates	155.0	3.7	53.7
8	Kuwait	151.6	3.7	57.4
9	Venezuela	151.5	3.7	61.1
10	Iraq	148.1	3.6	64.7
11	Mexico	126.6	3.1	67.7
12	Nigeria	123.8	3.0	70.7
13	Brazil	108.2	2.6	73.3
14	Norway	87.5	2.1	75.4
15	Angola	86.9	2.1	77.5
16	Qatar	83.0	2.0	79.5
17	Kazakhstan	79.2	1.9	81.5
18	Algeria	76.1	1.8	83.3
19	Libya	72.5	1.8	85.1
20	Colombia	46.9	1.1	86.2
	...			
56	Germany	2.6	0.1	99.3
	...			
	other countries [81]	569.0	13.8	100.0
	World	**4,137.0**	**100.0**	
	Europe	165.0	4.0	
	CIS	659.3	15.9	
	Africa	461.6	11.2	
	Middle East	1,343.0	32.5	
	Austral-Asia	388.8	9.4	
	North America	737.0	17.8	
	Latin America	382.3	9.2	
	OPEC 2009	1,807.8	43.7	
	OPEC-Gulf	1,270.6	30.7	
	MENA	1,529.2	37.0	
	OECD 2000	917.1	22.2	
	EU-27	72.8	1.8	

Table 10: Oil Demand 2012
The most important countries (top 20) and distribution by regions and economic policy organisations

Rank	Country / Region	Mt	Share [%] country	Share [%] cumulative
1	USA	799.5	19.4	19.4
2	China	483.7	11.7	31.1
3	Japan	235.0	5.7	36.8
4	India	171.6	4.2	41.0
5	Russia	147.5	3.6	44.6
6	Saudi Arabia	127.1	3.1	47.6
7	Brazil	125.6	3.0	50.7
8	Korea, Rep.	112.7	2.7	53.4
9	Germany	111.5	2.7	56.1
10	Mexico	108.9	2.6	58.8
11	Canada	102.2	2.5	61.3
12	Iran	87.7	2.1	63.4
13	France	81.3	2.0	65.4
14	Indonesia	71.6	1.7	67.1
15	United Kingdom	67.8	1.6	68.7
16	Singapore	66.2	1.6	70.3
17	Italy	63.7	1.5	71.9
18	Spain	55.3	1.3	73.2
19	Australia	50.6	1.2	74.5
20	Netherlands	44.1	1.1	75.5
	...			
	other countries [164]	1,009.0	24.5	100.0
	World	**4,122.5**	**100.0**	
	Europe	664.3	16.1	
	CIS	204.5	5.0	
	Africa	170.1	4.1	
	Middle East	372.2	9.0	
	Austral-Asia	1,394.0	33.8	
	North America	1,010.8	24.5	
	Latin America	306.5	7.4	
	OPEC 2009	416.9	10.1	
	OPEC-Gulf	316.0	7.7	
	MENA	458.3	11.1	
	OECD 2000	2,040.6	49.5	
	EU-27	596.6	14.5	

Table 11: Crude oil exports 2012
The most important countries (top 20) and distribution by regions and economic policy organisations

Rank	Country / Region	Mt	Share [%] country	Share [%] cumulative
1	Saudi Arabia	375.5	17.9	17.9
2	Russia	239.4	11.4	29.3
3	Canada	128.0	6.1	35.5
4	Iraq	120.7	5.8	41.2
5	U. Arab Emirates	120.6	5.8	47.0
6	Nigeria	117.7	5.6	52.6
7	Kuwait	102.9	4.9	57.5
8	Venezuela	85.7	4.1	61.6
9	Angola	82.7	3.9	65.5
10	Iran	76.0	3.6	69.1
11	Kazakhstan	67.3	3.2	72.4
12	Norway	67.1	3.2	75.6
13	Mexico	66.2	3.2	78.7
14	Libya	47.8	2.3	81.0
15	Azerbaijan	42.0	2.0	83.0
16	Algeria	40.2	1.9	84.9
17	Oman	38.2	1.8	86.7
18	United Kingdom	34.0	1.6	88.4
19	Qatar	29.2	1.4	89.8
20	Brazil	27.5	1.3	91.1
	...			
64	Germany	0.2	< 0.05	100.0
	...			
	other countries [52]	186.9	8.9	100.0
	World	**2,095.7**	**100.0**	
	Europe	120.4	5.7	
	CIS	351.7	16.8	
	Africa	332.9	15.9	
	Middle East	869.2	41.5	
	Austral-Asia	72.4	3.5	
	North America	197.1	9.4	
	Latin America	151.8	7.2	
	OPEC 2009	1,216.7	58.1	
	OPEC-Gulf	824.9	39.4	
	MENA	963.1	46.0	
	OECD 2000	333.0	15.9	
	EU-27	53.3	2.5	

Table 12: Crude oil imports 2012
The most important countries (top 20) and distribution by regions and economic policy organisations

Rank	Country / Region	Mt	Share [%] country	Share [%] cumulative
1	USA	421.7	19.2	19.2
2	China	271.0	12.4	31.6
3	Japan	184.9	8.4	40.0
4	India	176.9	8.1	48.1
5	Korea, Rep.	127.3	5.8	53.9
6	Germany	93.4	4.3	58.2
7	Italy	68.6	3.1	61.3
8	United Kingdom	60.6	2.8	64.1
9	Spain	58.8	2.7	66.8
10	France	57.2	2.6	69.4
11	Netherlands	49.9	2.3	71.6
12	Taiwan	44.7	2.0	73.7
13	Singapore	41.4	1.9	75.6
14	Thailand	40.7	1.9	77.4
15	Canada	35.8	1.6	79.1
16	Belgium	33.9	1.5	80.6
17	Poland	24.6	1.1	81.7
18	Australia	23.6	1.1	82.8
19	Greece	22.9	1.0	83.9
20	Sweden	21.1	1.0	84.8
	...			
	other countries [64]	332.7	15.2	100.0
	World	**2,191.6**	**100.0**	
	Europe	609.9	27.8	
	CIS	29.8	1.4	
	Africa	19.3	0.9	
	Middle East	27.7	1.3	
	Austral-Asia	974.8	44.5	
	North America	457.9	20.9	
	Latin America	72.3	3.3	
	MENA	35.9	1.6	
	OECD 2000	1,371.9	62.6	
	EU-27	569.7	26.0	

Table 13: Natural gas 2012 [bcm]

Country / Region	Production	Cum. Production	Reserves	Resources	EUR	Remaining Potential
Albania	< 0.05	8	2	50	60	52
Austria	1.7	95	15	820	930	835
Bulgaria	0.4	7	5	575	587	580
Croatia	1.9	68	24	50	142	74
Cyprus	–	–	–	250	250	250
Czech Republic	0.3	15	5	130	150	135
Denmark	6.4	173	43	950	1,166	993
France	0.5	228	11	3,984	4,223	3,995
Germany	12.1	999	123	1,870	2,992	1,993
Greece	< 0.05	1	1	10	12	11
Hungary	2.2	225	8	347	580	355
Ireland	0.4	56	25	50	131	75
Italy	7.8	736	55	405	1,195	459
Lithuania	–	–	–	< 0,5	< 0,5	< 0,5
Malta	–	–	–	10	10	10
Netherlands	80.1	3,377	1,130	1,505	6,012	2,635
Norway	114.8	1,767	2,090	1,820	5,677	3,910
Poland	4.5	253	88	797	1,138	885
Portugal	–	–	–	40	40	40
Romania	10.9	1,276	102	1,590	2,968	1,692
Serbia	0.5	32	48	10	90	58
Slovakia	0.2	26	13	10	49	23
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	0.7	13	7	1,153	1,173	1,160
United Kingdom	41.1	2,421	461	1,849	4,731	2,310
Armenia	–	–	–	180	180	180
Azerbaijan	16.0	527	991	2,000	3,518	2,991
Belarus	0.2	13	3	10	25	13
Georgia	< 0.05	3	8	102	113	110
Kazakhstan	29.1	471	1,950	3,700	6,121	5,650
Kyrgyzstan	< 0.05	7	6	20	33	26
Moldova, Republic	–	–	–	20	20	20
Russia	609.7	20,453	46,000	142,050	208,503	188,050
Tajikistan	< 0.05	9	6	100	114	106
Turkmenistan	64.4	2,431	10,000	15,000	27,431	25,000
Ukraine	18.6	1,965	969	5,930	8,864	6,899
Uzbekistan	57.7	2,136	1,661	1,500	5,297	3,161
Algeria	81.5	2,148	4,504	26,720	33,372	31,224
Angola	0.8	21	297	1,200	1,518	1,497

Continuation of table 13
[bcm]

Country / Region	Production	Cum. Production	Reserves	Resources	EUR	Remaining Potential
Benin	–	n. s.	1	100	101	101
Botswana	–	–	–	1,840	1,840	1,840
Cameroon	0.3	n. s.	153	200	353	353
Chad	–	–	–	200	200	200
Congo, DR	n. s.	n. s.	1	10	11	11
Congo, Rep.	0.2	n. s.	124	200	324	324
Côte d'Ivoire	1.7	24	16	400	440	416
Egypt	60.9	719	2,190	10,830	13,739	13,020
Equatorial Guinea	6.5	35	121	120	276	241
Eritrea	–	–	–	100	100	100
Ethiopia	n. s.	n. s.	28	20	48	48
Gabon	0.2	5	27	600	632	627
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	12.2	282	1,547	4,650	6,479	6,197
Madagascar	–	–	2	4,700	4,702	4,702
Mauritania	n. s.	n. s.	28	200	228	228
Morocco	0.1	2	1	2,220	2,224	2,221
Mozambique	3.4	25	127	5,200	5,353	5,327
Namibia	–	–	62	250	312	312
Niger	–	–	–	250	250	250
Nigeria	37.9	414	5,118	3,000	8,532	8,118
Rwanda	–	–	–	50	50	50
São Tomé and Príncipe	–	–	–	100	100	100
Senegal	n. s.	n. s.	10	200	210	210
Seychelles	–	–	–	600	600	600
Sierra Leone	–	–	–	300	300	300
Somalia	–	–	6	400	406	406
South Africa	1.4	39	16	12,330	12,385	12,346
Sudan & South Sudan	n. s.	n. s.	85	250	335	335
Tanzania	0.9	n. s.	37	1,400	1,437	1,437
Togo	–	–	–	100	100	100
Tunisia	2.7	47	65	800	912	865
Uganda	–	–	14	–	14	14
Western Sahara	–	–	–	228	228	228
Zimbabwe	–	–	–	10	10	10

Continuation of table 13
[bcm]

Country / Region	Production	Cum. Production	Reserves	Resources	EUR	Remaining Potential
Bahrain	12.5	250	199	200	650	399
Iran	158.2	2,048	33,620	11,000	46,668	44,620
Iraq	5.8	113	3,588	4,000	7,701	7,588
Israel	2.5	17	269	2,000	2,286	2,269
Jordan	0.2	5	6	350	361	356
Kuwait	14.5	305	1,784	500	2,589	2,284
Lebanon	–	–	–	850	850	850
Oman	29.0	342	950	1,650	2,942	2,600
Palestine	–	–	30	350	380	380
Qatar	157.0	1,109	25,069	2,000	28,178	27,069
Saudi Arabia	95.2	1,580	8,151	24,664	34,395	32,815
Syrian	6.7	127	285	300	712	585
U. Arab Emirates	51.7	1,090	6,090	1,500	8,680	7,590
Yemen	7.8	26	479	500	1,005	979
Afghanistan	0.1	57	50	350	457	400
Australia	48.8	984	3,759	32,430	37,174	36,189
Bangladesh	21.8	302	349	800	1,451	1,149
Brunei	12.5	386	288	200	874	488
Cambodia	–	–	–	50	50	50
China	110.7	1,263	3,096	68,980	73,339	72,076
India	41.9	695	1,330	6,530	8,555	7,860
Indonesia	76.7	1,937	2,927	10,480	15,344	13,407
Japan	3.2	130	21	5	156	26
Korea, Rep.	0.4	n. s.	5	50	55	55
Laos	–	–	–	5	5	5
Malaysia	63.0	1,131	2,389	1,900	5,420	4,289
Mongolia	–	–	–	133	133	133
Myanmar	11.8	158	283	2,000	2,441	2,283
New Zealand	4.6	150	29	353	533	382
Pakistan	41.3	758	766	4,570	6,094	5,336
Papua New Guinea	0.1	3	442	1,000	1,445	1,442
Philippines	3.8	33	87	502	622	589
Sri Lanka	–	–	–	300	300	300
Taiwan	0.4	51	6	5	62	11
Thailand	41.4	490	256	740	1,486	996
Timor-Leste	n. s.	n. s.	101	300	401	401
Viet Nam	9.4	81	617	1,392	2,090	2,009
Canada	156.5	5,678	1,930	35,883	43,492	37,813
Greenland	–	–	–	3,900	3,900	3,900
Mexico	47.0	1,524	360	17,770	19,654	18,130
USA	681.5	32,868	8,495	53,850	95,213	62,345

Continuation of table 13
[bcm]

Country / Region	Production	Cum. Production	Reserves	Resources	EUR	Remaining Potential
Argentina	38.7	1,067	333	23,710	25,110	24,043
Barbados	n. s.	n. s.	2	150	152	152
Belize	–	–	–	10	10	10
Bolivia	18.7	220	282	1,620	2,121	1,902
Brazil	17.4	245	452	18,440	19,137	18,892
Chile	1.2	107	41	1,510	1,658	1,551
Colombia	12.0	231	155	2,282	2,668	2,437
Cuba	1.0	13	71	400	484	471
Ecuador	0.5	6	7	20	33	27
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	12.7	91	359	200	650	559
Puerto Rico	–	–	–	30	30	30
Suriname	–	–	–	300	300	300
Trinidad and Tobago	42.2	545	375	500	1,420	875
Uruguay	–	–	–	828	828	828
Venezuela	32.8	1,051	5,528	7,230	13,809	12,758
World	**3,388.5**	**102,831**	**196,173**	**628,846**	**927,850**	**825,019**
Europe	286.8	11,786	4,259	21,005	37,050	25,264
CIS	795.9	28,015	61,594	170,612	260,221	232,206
Africa	210.5	3,762	14,609	81,153	99,524	95,762
Middle East	541.1	7,013	80,519	49,864	137,396	130,383
Austral-Asia	491.9	8,610	16,801	133,075	158,486	149,876
North America	885.0	40,071	10,786	111,403	162,259	122,189
Latin America	177.3	3,573	7,605	61,735	72,913	69,340
OPEC 2009	648.2	10,167	95,303	86,484	191,953	181,787
OPEC-Gulf	482.5	6,245	78,302	43,664	128,211	121,966
MENA	698.4	10,212	88,912	95,334	194,458	184,246
OECD 2000	1,215.0	51,731	18,677	162,696	233,103	181,373
EU-27	168.9	9,898	2,088	17,922	29,908	20,010

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

Table 14: Natural gas resources 2012 [bcm]
The most important countries (top 20) and distribution by regions and economic policy organisations

Rank	Country/Region	Total	conventional	non-conventional		
				shale gas	CBM	tight gas
1	Russia	142,050	100,000	9,500	12,550	20,000
2	China	68,980	21,000	25,080	10,900	12,000
3	USA	53,850	25,000	15,380	4,470	9,000
4	Canada	35,883	8,500	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	12,330	1,000	11,050	280	–
13	Iran	11,000	11,000	–	–	–
14	Egypt	10,830	8,000	2,830	–	–
15	Indonesia	10,480	6,000	1,300	3,180	–
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	–	–	–
	...					
37	Germany	1,870	20	1,300	450	100
	...					
	other countries [122]	93,249	59,159	28,470	4,638	982
	World	**628,846**	**309,979**	**205,374**	**50,411**	**63,082**
	Europe	21,005	5,224	14,044	1,615	122
	CIS	170,612	121,430	13,130	16,052	20,000
	Africa	81,153	34,765	39,768	1,120	5,500
	Middle East	49,864	43,250	5,864	–	750
	Austral-Asia	133,075	44,915	44,700	23,260	20,200
	North America	111,403	39,700	47,050	8,153	16,500
	Latin America	61,735	20,695	40,818	212	10
	OPEC 2009	86,484	47,120	33,864	–	5,500
	OPEC-Gulf	43,664	38,000	5,664	–	–
	MENA	95,334	55,700	33,384	–	6,250
	OECD 2000	162,696	50,134	71,554	16,386	24,622
	EU-27	17,922	3,094	13,374	1,332	122

– no resources / not specified

Table 15: Natural gas reserves 2012 [bcm]
The most important countries (top 20) and distribution by regions and economic policy organisations

Rank	Country/Region	Total	conventional [1]	non-conventional [2] shale gas	CBM
1	Russia	46,000	45,955	–	45
2	Iran	33,620	33,620	–	–
3	Qatar	25,069	25,069	–	–
4	Turkmenistan	10,000	10,000	–	–
5	USA	8,495	4,291	3,728	476
6	Saudi Arabia	8,151	8,151	–	–
7	U. Arab Emirates	6,090	6,090	–	–
8	Venezuela	5,528	5,528	–	–
9	Nigeria	5,118	5,118	–	–
10	Algeria	4,504	4,504	–	–
11	Australia	3,759	2,827	–	932
12	Iraq	3,588	3,588	–	–
13	China	3,096	3,025	–	71
14	Indonesia	2,927	2,927	–	–
15	Malaysia	2,389	2,389	–	–
16	Egypt	2,190	2,190	–	–
17	Norway	2,090	2,090	–	–
18	Kazakhstan	1,950	1,950	–	–
19	Canada	1,930	1,874	n. s.	57
20	Kuwait	1,784	1,784	–	–
	...				
51	Germany	123	123	–	–
	...				
	other countries [83]	17,772	17,534	–	237
	World	**196,173**	**190,627**	**3,728**	**1,818**
	Europe	4,259	4,259	–	–
	CIS	61,594	61,549	–	45
	Africa	14,609	14,609	–	–
	Middle East	80,519	80,519	–	–
	Austral-Asia	16,801	15,561	–	1,240
	North America	10,786	6,525	3,728	533
	Latin America	7,605	7,605	–	–
	OPEC 2009	95,303	95,303	–	–
	OPEC-Gulf	78,302	78,302	–	–
	MENA	88,912	88,912	–	–
	OECD 2000	18,677	13,485	3,728	1,465
	EU-27	2,088	2,088	–	–

n. s. not specified
– no reserves
[1] including tight gas
[2] partly status 2011

Table 16: Natural gas production 2012
The most important countries (top 20) and distribution by regions and economic policy organisations

Rank	Country / Region	bcm	Share [%]	
			country	cumulative
1	USA	681.5	20.1	20.1
2	Russia	609.7	18.0	38.1
3	Iran	158.2	4.7	42.8
4	Qatar	157.0	4.6	47.4
5	Canada	156.5	4.6	52.0
6	Norway	114.8	3.4	55.4
7	China	110.7	3.3	58.7
8	Saudi Arabia	95.2	2.8	61.5
9	Algeria	81.5	2.4	63.9
10	Netherlands	80.1	2.4	66.3
11	Indonesia	76.7	2.3	68.5
12	Turkmenistan	64.4	1.9	70.4
13	Malaysia	63.0	1.9	72.3
14	Egypt	60.9	1.8	74.1
15	Uzbekistan	57.7	1.7	75.8
16	U. Arab Emirates	51.7	1.5	77.3
17	Australia	48.8	1.4	78.7
18	Mexico	47.0	1.4	80.1
19	Trinidad and Tobago	42.2	1.2	81.4
20	India	41.9	1.2	82.6
	...			
39	Germany	12.1	0.4	96.2
	...			
	other countries [69]	576.8	17.0	100.0
	World	**3,388.5**	**100.0**	
	Europe	286.8	8.5	
	CIS	795.9	23.5	
	Africa	210.5	6.2	
	Middle East	541.1	16.0	
	Austral-Asia	491.9	14.5	
	North America	885.0	26.1	
	Latin America	177.3	5.2	
	OPEC 2009	648.2	19.1	
	OPEC-Gulf	482.5	14.2	
	MENA	698.4	20.6	
	OECD 2000	1,215.0	35.9	
	EU-27	168.9	5.0	

Table 17: Natural gas consumption 2012
The most important countries (top 20) and distribution by regions and economic policy organisations

Rank	Country/Region	bcm	Share [%] country	Share [%] cumulative
1	USA	721,7	21,3	21,3
2	Russia	459,6	13,6	34,9
3	Iran	156,1	4,6	39,5
4	China	142,0	4,2	43,6
5	Japan	119,0	3,5	47,2
6	Canada	100,7	3,0	50,1
7	Saudi Arabia	95,2	2,8	52,9
8	Germany	89,3	2,6	55,6
9	United Kingdom	78,3	2,3	57,9
10	Italy	74,9	2,2	60,1
11	Mexico	68,6	2,0	62,1
12	U. Arab Emirates	62,9	1,9	64,0
13	India	58,8	1,7	65,7
14	Egypt	52,6	1,6	67,3
15	Thailand	51,2	1,5	68,8
16	Korea, Rep.	49,6	1,5	70,2
17	Ukraine	49,6	1,5	71,7
18	Uzbekistan	47,9	1,4	73,1
19	Argentina	47,3	1,4	74,5
20	Turkey	45,3	1,3	75,8
	...			
	other countries [90]	818,8	24,2	100,0
	World	**3.389,5**	**100,0**	
	Europe	525,6	15,5	
	CIS	645,2	19,0	
	Africa	118,2	3,5	
	Middle East	411,5	12,1	
	Austral-Asia	634,3	18,7	
	North America	891,0	26,3	
	Latin America	163,7	4,8	
	OPEC 2009	453,9	13,4	
	OPEC-Gulf	369,6	10,9	
	MENA	507,1	15,0	
	OECD 2000	1.587,3	46,8	
	EU-27	465,6	13,7	

Table 18: Natural gas exports 2012
The most important countries (top 20) and distribution by regions and economic policy organisations

Rank	Country / Region	bcm	Share [%] country	Share [%] cumulative
1	Russia	186.9	18.1	18.1
2	Qatar	124.6	12.1	30.2
3	Norway	109.1	10.6	40.8
4	Canada	83.8	8.1	48.9
5	Netherlands	60.4	5.9	54.8
6	Algeria	50.1	4.9	59.6
7	USA	45.9	4.5	64.1
8	Turkmenistan	41.1	4.0	68.1
9	Indonesia	37.2	3.6	71.7
10	Malaysia	31.8	3.1	74.7
11	Australia	28.1	2.7	77.5
12	Nigeria	26.5	2.6	80.0
13	Germany	20.9	2.0	82.1
14	Trinidad and Tobago	20.3	2.0	84.0
15	Bolivia	14.5	1.4	85.4
16	United Kingdom	13.1	1.3	86.7
17	Oman	11.9	1.2	87.9
18	Uzbekistan	11.0	1.1	88.9
19	Myanmar	10.1	1.0	89.9
20	Iran	9.2	0.9	90.8
	...			
	other countries [29]	94.9	9.2	100.0
	World	**1,031.3**	**100.0**	
	Europe	225.4	21.9	
	CIS	255.2	24.7	
	Africa	98.7	9.6	
	Middle East	160.1	15.5	
	Austral-Asia	118.8	11.5	
	North America	129.7	12.6	
	Latin America	43.3	4.2	
	OPEC 2009	224.4	21.8	
	OPEC-Gulf	141.3	13.7	
	MENA	224.1	21.7	
	OECD 2000	383.1	37.1	
	EU-27	115.6	11.2	

Table 19: Natural gas imports 2012
The most important countries (top 20) and distribution by regions and economic policy organisations

Rank	Country / Region	bcm	Share [%]	
			country	cumulative
1	Japan	116.0	11.2	11.2
2	Germany	98.4	9.5	20.8
3	USA	88.7	8.6	29.3
4	Italy	67.7	6.6	35.9
5	United Kingdom	49.9	4.8	40.7
6	Korea, Rep.	49.2	4.8	45.5
7	Turkey	45.9	4.4	50.0
8	France	45.1	4.4	54.3
9	China	38.4	3.7	58.0
10	Spain	34.7	3.4	61.4
11	Russia	32.3	3.1	64.5
12	Ukraine	30.9	3.0	67.5
13	Canada	29.3	2.8	70.3
14	Mexico	22.0	2.1	72.5
15	Belgium	21.1	2.0	74.5
16	Belarus	20.3	2.0	76.5
17	U. Arab Emirates	18.2	1.8	78.2
18	India	16.9	1.6	79.9
19	Taiwan	16.4	1.6	81.5
20	Netherlands	15.3	1.5	83.0
	...			
	other countries [54]	176.1	17.0	100.0
	World	**1,032.7**	**100.0**	
	Europe	460.2	44.6	
	CIS	96.3	9.3	
	Africa	7.7	0.7	
	Middle East	30.6	3.0	
	Austral-Asia	267.5	25.9	
	North America	140.0	13.6	
	Latin America	30.4	2.9	
	OPEC 2009	29.6	2.9	
	OPEC-Gulf	27.5	2.7	
	MENA	34.2	3.3	
	OECD 2000	755.7	73.2	
	EU-27	407.5	39.5	

Table 20: Hard coal 2012 [Mt]

Country / Region	Production	Reserves	Resources	Remaining Potential
Belgium	–	–	4,100	4,100
Bulgaria	2.3	192	3,920	4,112
Czech Republic	10.8	1,123	15,421	16,543
France	0.3	–	160	160
Germany	11.6	36	82,962	82,998
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	1.2	13	75	88
Poland	79.6	15,160	161,331	176,491
Portugal	–	3	n. s.	3
Romania	< 0.05	11	2,435	2,446
Serbia	0.2	402	453	855
Slovakia	–	–	19	19
Slovenia	–	56	39	95
Spain	6.1	868	3,363	4,231
Sweden	–	1	4	5
Turkey	3.3	384	801	1,185
United Kingdom	16.8	264	186,700	186,964
Armenia	–	163	154	317
Georgia	0.5	201	700	901
Kazakhstan	112.8	25,605	123,090	148,695
Kyrgyzstan	0.2	971	27,528	28,499
Russia	276.1	69,634	2,624,612	2,694,246
Tajikistan	0.2	375	3,700	4,075
Turkmenistan	–	–	800	800
Ukraine	85.6	32,039	49,006	81,045
Uzbekistan	0.2	1,375	9,477	10,852
Algeria	–	59	164	223
Botswana	0.7	40	21,200	21,240
Congo, DR	0.1	88	900	988
Egypt	0.2	16	166	182
Madagascar	–	–	150	150
Malawi	0.1	2	800	802
Morocco	–	14	82	96
Mozambique	4.5	849	23,338	24,187
Namibia	–	–	350	350
Niger	0.2	–	90	90
Nigeria	< 0.05	287	1,857	2,144
South Africa	260.0	33,896	n. s.	33,896
Swaziland	0.1	144	4,500	4,644
Tanzania	0.1	269	1,141	1,410
Uganda	–	–	800	800
Zambia	0.8	45	900	945
Zimbabwe	1.9	502	25,000	25,502
Iran	1.2	1,203	40,000	41,203

Continuation of table 20
[Mt]

Country / Region	Production	Reserves	Resources	Remaining Potential
Afghanistan	0.7	66	n. s.	66
Australia	374.1	61,082	1,532,148	1,593,230
Bangladesh	1.0	293	2,967	3,260
Bhutan	0.1	n,s,	n. s.	n,s,
China	3.505.0	180,600	5,010,000	5,190,600
India	557.7	80,417	175,732	256,149
Indonesia	382.8	13,511	91,285	104,796
Japan	1.3	340	13,543	13,883
Korea, DPR	32.2	600	10,000	10,600
Korea, Rep.	2.1	326	1,360	1,686
Laos	0.3	4	58	62
Malaysia	2.9	141	1,068	1,209
Mongolia	23.6	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	4.6	825	2,350	3,175
Pakistan	2.8	207	5,789	5,996
Philippines	8.2	211	1,012	1,223
Taiwan	–	1	101	102
Viet Nam	42.4	3,116	3,519	6,635
Canada	57.0	4,346	183,260	187,606
Greenland	–	183	200	383
Mexico	13.7	1,160	3,000	4,160
USA	850.7	224,225	6,458,553	6,682,778
Argentina	0.2	500	300	800
Bolivia	–	1	n. s.	1
Brazil	–	1,547	4,665	6,212
Chile	0.1	1,181	4,135	5,316
Colombia	89.2	4,881	9,928	14,809
Costa Rica	–	–	17	17
Peru	0.2	102	1,465	1,567
Venezuela	3.1	731	5,981	6,712
World	**6,835.0**	**768,999**	**17,143,481**	**17,912,480**
Europe	132.3	19,452	470,429	489,881
CIS	475.5	130,362	2,839,068	2,969,429
Africa	268.9	36,210	81,438	117,648
Middle East	1.2	1,203	40,000	41,203
Austral-Asia	4,942.9	342,917	6,891,042	7,233,958
North America	921.4	229,914	6,645,013	6,874,927
Latin America	92.8	8,943	26,491	35,434
Antarctica	–	–	150,000	150,000
OPEC 2009	4.3	2,279	48,002	50,281
OPEC-Gulf	1.2	1,203	40,000	41,203
MENA	1.4	1,291	40,412	41,703
OECD 2000	1.,33.3	311,136	8,657,800	8,968,936
EU-27	127.6	18,511	468,905	487,416

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

Table 21: Hard coal resources 2012
The most important countries (top 20) and distribution by regions and economic policy organisations

Rank	Country / Region	Mt	Share [%] country	Share [%] cumulative
1	USA	6,458,553	37.7	37.7
2	China	5,010,000	29.2	66.9
3	Russia [1)]	2,624,612	15.3	82.2
4	Australia	1,532,148	8.9	91.1
5	United Kingdom	186,700	1.1	92.2
6	Canada	183,260	1.1	93.3
7	India	175,732	1.0	94.3
8	Poland	161,331	0.9	95.3
9	Kazakhstan	123,090	0.7	96.0
10	Indonesia	91,285	0.5	96.5
11	Germany	82,962	0.5	97.0
12	Ukraine [1)]	49,006	0.3	97.3
13	Iran	40,000	0.2	97.5
14	Mongolia [1)]	39,854	0.2	97.8
15	Kyrgyzstan	27,528	0.2	97.9
16	Zimbabwe	25,000	0.1	98.1
17	Mozambique	23,338	0.1	98.2
18	Botswana	21,200	0.1	98.3
19	Czech Republic [1)]	15,421	0.1	98.4
20	Japan	13,543	0.1	98.5
	...			
	other countries [56]	258,917	1.5	100.0
	World	**17,143,481**	**100.0**	
	Europe	470,429	2.7	
	CIS	2,839,068	16.6	
	Africa	81,438	0.5	
	Middle East	40,000	0.2	
	Austral-Asia	6,891,042	40.2	
	North America	6,645,013	38.8	
	Latin America	26,491	0.2	
	Antarctica	150,000	0.9	
	OPEC 2009	48,002	0.3	
	OPEC-Gulf	40,000	0.2	
	MENA	40,412	0.2	
	OECD 2000	8,657,800	50.5	
	EU-27	468,905	2.7	

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

Table 22: Hard coal reserves 2012
The most important countries (top 20) and distribution by regions and economic policy organisations

Rank	Country / Region	Mt	Share [%] country	Share [%] cumulative
1	USA	224,225	29.2	29.2
2	China	180,600	23.5	52.6
3	India	80,417	10.5	63.1
4	Russia [1]	69,634	9.1	72.2
5	Australia	61,082	7.9	80.1
6	South Africa	33,896	4.4	84.5
7	Ukraine [1]	32,039	4.2	88.7
8	Kazakhstan	25,605	3.3	92.0
9	Poland	15,160	2.0	94.0
10	Indonesia	13,511	1.8	95.7
11	Colombia	4,881	0.6	96.4
12	Canada	4,346	0.6	96.9
13	Viet Nam	3,116	0.4	97.3
14	Brazil	1,547	0.2	97.5
15	Uzbekistan	1,375	0.2	97.7
16	Iran	1,203	0.2	97.9
17	Chile	1,181	0.2	98.0
18	Mongolia [1]	1,170	0.2	98.2
19	Mexico	1,160	0.2	98.3
20	Czech Republic [1]	1,123	0.1	98.5
	...			
56	Germany [2]	36	< 0.05	100.0
	...			
	other countries [50]	11,694	1.5	100.0
	World	**768,999**	**100.0**	
	Europe	19,452	2.5	
	CIS	130,362	17.0	
	Africa	36,210	4.7	
	Middle East	1,203	0.2	
	Austral-Asia	342,917	44.6	
	North America	229,914	29.9	
	Latin America	8,943	1.2	
	OPEC 2009	2,279	0.3	
	OPEC-Gulf	1,203	0.2	
	MENA	1,291	0.2	
	OECD 2000	311,136	40.5	
	EU-27	18,511	2.4	

[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 23: Hard coal production 2012
The most important countries (top 20) and distribution by regions and economic policy organisations

Rank	Country / Region	Mt	Share [%] country	Share [%] cumulative
1	China	3,505.0	51.3	51.3
2	USA	850.7	12.4	63.7
3	India	557.7	8.2	71.9
4	Indonesia	382.8	5.6	77.5
5	Australia	374.1	5.5	83.0
6	Russia [1)]	276.1	4.0	87.0
7	South Africa	260.0	3.8	90.8
8	Kazakhstan	112.8	1.7	92.5
9	Colombia	89.2	1.3	93.8
10	Ukraine [1)]	85.6	1.3	95.0
11	Poland	79.6	1.2	96.2
12	Canada	57.0	0.8	97.0
13	Viet Nam	42.4	0.6	97.6
14	Korea, DPR	32.2	0.5	98.1
15	Mongolia [1)]	23.6	0.3	98.4
16	United Kingdom	16.8	0.2	98.7
17	Mexico	13.7	0.2	98.9
18	Germany	11.6	0.2	99.1
19	Czech Republic [1)]	10.8	0.2	99.2
20	Philippines	8.2	0.1	99.3
	...			
	other countries [39]	45.3	0.7	100.0
	World	**6,835.0**	**100.0**	
	Europe	132.3	1.9	
	CIS	475.5	7.0	
	Africa	268.9	3.9	
	Middle East	1.2	0.0	
	Austral-Asia	4,942.9	72.3	
	North America	921.4	13.5	
	Latin America	92.8	1.4	
	OPEC 2009	4.3	0.1	
	OPEC-Gulf	1.2	0.0	
	MENA	1.4	0.0	
	OECD 2000	1,433.3	21.0	
	EU-27	127.6	1.9	

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

Table 24: Hard coal consumption 2012
The most important countries (top 20) and distribution by regions and economic policy organisations

Rank	Country / Region	Mt	Share [%] country	Share [%] cumulative
1	China	3,784.5	55.2	55.2
2	USA	745.0	10.9	66.0
3	India	692.0	10.1	76.1
4	South Africa	187.0	2.7	78.8
5	Japan	183.8	2.7	81.5
6	Russia [1]	173.3	2.5	84.1
7	Korea, Rep.	127.3	1.9	85.9
8	Ukraine [1]	90.0	1.3	87.2
9	Kazakhstan	81.0	1.2	88.4
10	Poland	75.6	1.1	89.5
11	Taiwan	64.2	0.9	90.4
12	United Kingdom	64.0	0.9	91.4
13	Indonesia	60.2	0.9	92.2
14	Australia	59.0	0.9	93.1
15	Germany	56.2	0.8	93.9
16	Canada	32.4	0.5	94.4
17	Turkey	32.2	0.5	94.9
18	Spain	28.0	0.4	95.3
19	Malaysia	24.6	0.4	95.6
20	Italy	24.1	0.4	96.0
	...			
	other countries [83]	275.1	4.0	100.0
	World	**6,859.5**	**100.0**	
	Europe	355.7	5.2	
	CIS	346.4	5.1	
	Africa	199.9	2.9	
	Middle East	18.2	0.3	
	Austral-Asia	5,102.6	74.4	
	North America	798.2	11.6	
	Latin America	38.6	0.6	
	OPEC 2009	4.7	0.1	
	OPEC-Gulf	3.9	0.1	
	MENA	25.4	0.4	
	OECD 2000	1,516.4	22.1	
	EU-27	319.5	4.7	

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

Table 25: Hard coal exports 2012
The most important countries (top 20) and distribution by regions and economic policy organisations

Rank	Country / Region	Mt	Share [%] country	Share [%] cumulative
1	Indonesia	384.0	30.3	30.3
2	Australia	315.5	24.9	55.2
3	Russia	125.2	9.9	65.1
4	USA	114.1	9.0	74.1
5	Colombia	83.3	6.6	80.7
6	South Africa	75.9	6.0	86.7
7	Canada	34.6	2.7	89.4
8	Kazakhstan	32.8	2.6	92.0
9	Mongolia	22.1	1.7	93.7
10	Viet Nam	19.8	1.6	95.3
11	Korea, DPR	12.0	0.9	96.2
12	China	9.3	0.7	97.0
13	Poland	7.1	0.6	97.5
14	Ukraine	6.1	0.5	98.0
15	Czech Republic	5.1	0.4	98.4
16	Mozambique	4.5	0.4	98.8
17	Philippines	3.2	0.3	99.0
18	India	2.8	0.2	99.2
19	Venezuela	2.7	0.2	99.5
20	New Zealand	2.2	0.2	99.6
	...			
29	Germany	0.1	< 0.05	100.0
	...			
	other countries [8]	4.6	0.4	100.0
	World	**1,267.0**	**100.0**	
	Europe	16.3	1.3	
	CIS	164.3	13.0	
	Africa	80.7	6.4	
	Austral-Asia	770.9	60.8	
	North America	148.9	11.8	
	Latin America	86.0	6.8	
	OPEC 2009	2.7	0.2	
	OECD 2000	482.9	38.1	
	EU-27	15.0	1.2	

Table 26: Hard coal imports 2012
The most important countries (top 20) and distribution by regions and economic policy organisations

Rank	Country / Region	Mt	Share [%] country	Share [%] cumulative
1	China	288.8	23.3	23.3
2	Japan	185.2	14.9	38.2
3	India	137.6	11.1	49.3
4	Korea, Rep.	125.6	10.1	59.4
5	Taiwan	64.6	5.2	64.6
6	Germany	45.0	3.6	68.2
7	United Kingdom	44.8	3.6	71.8
8	Turkey	29.2	2.4	74.2
9	Italy	25.9	2.1	76.2
10	Spain	22.4	1.8	78.0
11	Malaysia	22.0	1.8	79.8
12	Russia	21.4	1.7	81.5
13	Thailand	18.4	1.5	83.0
14	Brazil	16.5	1.3	84.3
15	France	15.9	1.3	85.6
16	Ukraine	14.8	1.2	86.8
17	Israel	14.0	1.1	87.9
18	Hong Kong	12.4	1.0	88.9
19	Philippines	11.9	1.0	89.9
20	Netherlands	11.3	0.9	90.8
	...			
	other countries [62]	114.1	9.2	100.0
	World	**1,241.5**	**100.0**	
	Europe	244.1	19.7	
	CIS	38.4	3.1	
	Africa	11.2	0.9	
	Middle East	17.0	1.4	
	Austral-Asia	873.0	70.3	
	North America	25.6	2.1	
	Latin America	32.1	2.6	
	OPEC 2009	3.5	0.3	
	OPEC-Gulf	2.8	0.2	
	MENA	24.3	2.0	
	OECD 2000	573.1	46.2	
	EU-27	211.4	17.0	

Table 27: Lignite 2012 [Mt]

Country / Region	Production	Reserves	Resources	Remaining Potential
Albania	< 0.05	522	205	727
Austria	–	–	333	333
Bosnia & Herzegovina	6.3	2,264	3,010	5,274
Bulgaria	31.0	2,174	2,400	4,574
Croatia	–	n. s.	300	300
Czech Republic	43.7	2,670	7,072	9,742
France	–	n. s.	114	114
Germany	185.4	40,400	36,500	76,900
Greece	61.8	2,876	3,554	6,430
Hungary	9.3	2,633	2,704	5,337
Italy	–	7	22	29
Kosovo	8.0	1,564	9,262	10,826
Macedonia	7.3	332	300	632
Montenegro	2.0	n. s.	n. s.	n. s.
Poland	64.3	4,443	222,620	227,063
Portugal	–	33	33	66
Romania	34.1	280	9,640	9,920
Serbia	37.5	7,112	13,074	20,186
Slovakia	2.3	135	938	1,073
Slovenia	4.4	315	341	656
Spain	–	319	n. s.	319
Turkey	75.0	2,055	11,617	13,672
United Kingdom	–	–	1,000	1,000
Belarus	–	–	1,500	1,500
Kazakhstan	7.7	n. s.	n. s.	n. s.
Kyrgyzstan	1.0	n. s.	n. s.	n. s.
Russia	77.9	90,730	1,271,672	1,362,402
Ukraine	0.2	2,336	5,381	7,717
Uzbekistan	3.8	n. s.	n. s.	n. s.
Central African Rep.	–	3	n. s.	3
Madagascar	–	–	37	37
Mali	–	–	3	3
Morocco	–	–	40	40
Niger	–	6	n,s,	6
Nigeria	–	57	320	377
Sierra Leone	–	–	2	2
Australia	69.0	44,164	177,578	221,742
Bangladesh	–	–	3	3
China	145.0	11,000	307,000	318,000
India	46.6	4,799	37,035	41,834
Indonesia	60.0	9,002	29,023	38,025

Continuation of table 27
[Mt]

Country / Region	Production	Reserves	Resources	Remaining Potential
Japan	–	10	1,026	1,036
Korea, DPR	7.0	n. s.	n. s.	n. s.
Laos	0.5	499	22	521
Malaysia	–	39	412	451
Mongolia	7.5	1,350	119,426	120,776
Myanmar	n.s.	3	2	5
New Zealand	0.3	6,750	4,600	11,350
Pakistan	–	2,857	176,739	179,596
Philippines	–	105	912	1,017
Thailand	18.8	1,063	826	1,889
Viet Nam	–	244	199,876	200,120
Canada	9.5	2,236	118,270	120,506
Mexico	–	51	n. s.	51
USA	71.3	30,625	1,367,874	1,398,499
Argentina	–	–	7,300	7,300
Brazil	6.6	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	**1,105.8**	**283,134**	**4,164,736**	**4,447,869**
Europe	572.4	70,134	325,038	395,172
CIS	90.6	93,065	1,278,553	1,371,618
Africa	–	66	402	468
Middle East	–	–	–	–
Austral-Asia	354.7	81,884	1,054,481	1,136,365
North America	80.8	32,912	1,486,144	1,519,056
Latin America	7.2	5,073	20,118	25,191
OPEC 2009	–	81	320	401
MENA	–	–	40	40
OECD 2000	592.0	139,407	1,955,856	2,095,263
EU-27	436.3	56,285	287,271	343,556

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

Table 28: Lignite resources 2012
The most important countries (top 20) and distribution by regions and economic policy organisations

Rank	Country / Region	Mt	Share [%] country	Share [%] cumulative
1	USA	1,367,874	32.8	32.8
2	Russia [1)]	1,271,672	30.5	63.4
3	China	307,000	7.4	70.7
4	Poland	222,620	5.3	76.1
5	Viet Nam	199,876	4.8	80.9
6	Australia	177,578	4.3	85.2
7	Pakistan	176,739	4.2	89.4
8	Mongolia [1)]	119,426	2.9	92.3
9	Canada	118,270	2.8	95.1
10	India	37,035	0.9	96.0
11	Germany	36,500	0.9	96.9
12	Indonesia	29,023	0.7	97.6
13	Serbia	13,074	0.3	97.9
14	Brazil	12,587	0.3	98.2
15	Turkey	11,617	0.3	98.5
16	Romania	9,640	0.2	98.7
17	Kosovo	9,262	0.2	98.9
18	Argentina	7,300	0.2	99.1
19	Czech Republic [1)]	7,072	0.2	99.3
20	Ukraine [1)]	5,381	0.1	99.4
	...			
	other countries [32]	25,189	0.6	100.0
	World	**4,164,736**	**100.0**	
	Europe	325,038	7.8	
	CIS	1,278,553	30.7	
	Africa	402	0.0	
	Austral-Asia	1,054,481	25.3	
	North America	1,486,144	35.7	
	Latin America	20,118	0.5	
	OPEC 2009	320	0.0	
	MENA	40	0.0	
	OECD 2000	1,955,856	47.0	
	EU-27	287,271	6.9	

[1)] Lignite resources contains subbituminous coal

Table 29: Lignite reserves 2012
The most important countries (top 20) and distribution by regions and economic policy organisations

Rank	Country / Region	Mt	Share [%] country	Share [%] cumulative
1	Russia [1)]	90,730	32.0	32.0
2	Australia	44,164	15.6	47.6
3	Germany	40,400	14.3	61.9
4	USA	30,625	10.8	72.7
5	China	11,000	3.9	76.6
6	Indonesia	9,002	3.2	79.8
7	Serbia	7,112	2.5	82.3
8	New Zealand	6,750	2.4	84.7
9	Brazil	5,049	1.8	86.5
10	India	4,799	1.7	88.2
11	Poland	4,443	1.6	89.7
12	Greece	2,876	1.0	90.8
13	Pakistan	2,857	1.0	91.8
14	Czech Republic [1)]	2,670	0.9	92.7
15	Hungary	2,633	0.9	93.6
16	Ukraine [1)]	2,336	0.8	94.5
17	Bosnia & Herzegovina [1)]	2,264	0.8	95.3
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	**283,134**	**100.0**	
	Europe	70,134	24.8	
	CIS	93,065	32.9	
	Africa	66	0.0	
	Austral-Asia	81,884	28.9	
	North America	32,912	11.6	
	Latin America	5,073	1.8	
	OPEC 2009	81	0.0	
	OECD 2000	139,407	49.2	
	EU-27	56,285	19.9	

[1)] Lignite reserves contains subbituminous coal

Table 30: Lignite production 2012
The most important countries (top 20) and distribution by regions and economic policy organisations

Rank	Country / Region	Mt	Share [%] country	Share [%] cumulative
1	Germany	185.4	16.8	16.8
2	China	145.0	13.1	29.9
3	Russia [1]	77.9	7.0	36.9
4	Turkey	75.0	6.8	43.7
5	USA	71.3	6.5	50.2
6	Australia	69.0	6.2	56.4
7	Poland	64.3	5.8	62.2
8	Greece	61.8	5.6	67.8
9	Indonesia	60.0	5.4	73.2
10	India	46.6	4.2	77.4
11	Czech Republic [1]	43.7	4.0	81.4
12	Serbia	37.5	3.4	84.8
13	Romania [1]	34.1	3.1	87.9
14	Bulgaria	31.0	2.8	90.7
15	Thailand	18.8	1.7	92.4
16	Canada	9.5	0.9	93.2
17	Hungary [1]	9.3	0.8	94.1
18	Kosovo	8.0	0.7	94.8
19	Kazakhstan [1]	7.7	0.7	95.5
20	Mongolia [1]	7.5	0.7	96.2
	...			
	other countries [14]	42.4	3.8	100.0
	World	**1,105.8**	**100.0**	
	Europe	572.4	51.8	
	CIS	90.6	8.2	
	Austral-Asia	354.7	32.1	
	North America	80.8	7.3	
	Latin America	7.2	0.7	
	OECD 2000	592.0	53.5	
	EU-27	436.3	39.5	

[1] Lignite production contains subbituminous coal

Table 31: Lignite consumption 2012
The most important countries (top 20) and distribution by regions and economic policy organisations

Rank	Country / Region	Mt	Share [%] country	Share [%] cumulative
1	Germany	185.2	16.8	16.8
2	China	143.0	13.0	29.8
3	Russia [1)]	77.8	7.1	36.9
4	Turkey	74.5	6.8	43.6
5	USA	72.0	6.5	50.2
6	Australia	68.8	6.2	56.4
7	Poland	64.1	5.8	62.2
8	Greece	61.5	5.6	67.8
9	Indonesia	58.0	5.3	73.1
10	India	46.6	4.2	77.3
11	Czech Republic [1)]	42.6	3.9	81.2
12	Serbia	38.6	3.5	84.7
13	Romania [1)]	33.7	3.1	87.7
14	Bulgaria	32.5	3.0	90.7
15	Thailand	18.4	1.7	92.4
16	Hungary [1)]	9.6	0.9	93.2
17	Canada	9.4	0.9	94.1
18	Kosovo	8.3	0.8	94.8
19	Kazakhstan [1)]	7.7	0.7	95.5
20	Macedonia	7.4	0.7	96.2
	...			
	other countries [16]	41.7	3.8	100.0
	World	**1,101.4**	**100.0**	
	Europe	574.2	52.1	
	CIS	89.6	8.1	
	Austral-Asia	349.0	31.7	
	North America	81.4	7.4	
	Latin America	7.2	0.7	
	OECD 2000	591.3	53.7	
	EU-27	437.0	39.7	

[1)] Lignite consumption contains subbituminous coal

Table 32: Uranium 2012 [kt]

Country / Region	Production	Cum. Production	Reserves	Resources	EUR	Reamaining Potential
Bulgaria	–	–	–	25	25	25
Czech Republic	0.2	111	–	1	112	1
Finland	n. s.	< 0.5	–	36	36	36
France	< 0.05	76	–	12	88	12
Germany	0.05	220	–	7	227	7
Greece	–	–	–	13	13	13
Hungary	–	21	–	31	52	31
Italy	–	–	–	16	16	16
Portugal	–	4	5	4	12	9
Romania	0.1	19	–	13	31	13
Slovakia	n. s.	–	–	17	17	17
Slovenia	n. s.	–	2	11	13	13
Spain	–	5	–	14	19	14
Sweden	n. s.	< 0.5	–	14	14	14
Turkey	–	–	9	n.s.	9	9
Kazakhstan	21.3	200	279	1,455	1,934	1,734
Russia	2.9	153	12	869	1,034	881
Ukraine	1.0	18	68	302	388	370
Uzbekistan	2.4	45	47	74	166	121
Algeria	–	–	–	25	25	25
Botswana	–	–	–	82	82	82
Central African Rep.	–	–	–	12	12	12
Congo, DR	–	26	–	3	28	3
Egypt	–	–	–	2	2	2
Gabon	n. s.	25	–	6	31	6
Malawi	1.1	3	–	18	20	18
Namibia	4.5	113	6	512	632	518
Niger	4.7	127	6	505	638	510
Somalia	–	–	–	8	8	8
South Africa	0.5	159	96	386	641	482
Tanzania	–	–	–	52	52	52
Zambia	–	< 0.5	–	45	46	45
Zimbabwe	–	–	–	26	26	26
Iran	–	< 0.5	–	50	50	50
Jordan	–	–	–	110	110	110
Australia	7.0	182	962	837	1,980	1,798
China	1.5	36	138	141	315	279
India	0.4	11	–	239	250	239
Indonesia	–	–	2	32	34	34
Japan	n. s.	< 0.5	–	7	7	7

Continuation of table 32
[kt]

Country / Region	Production	Cum. Production	Reserves	Resources	EUR	Reamaining Potential
Mongolia	–	1	41	1,444	1,486	1,485
Pakistan	< 0.05	1	–	–	1	–
Viet Nam	–	–	–	370	370	370
Canada	9.0	465	294	1,207	1,966	1,501
Greenland	–	–	–	185	185	185
Mexico	n. s.	< 0.5	–	7	7	7
USA	1.6	370	39	2,564	2,973	2,603
Argentina	–	3	5	28	36	33
Brazil	0.2	4	156	921	1.080	1.077
Chile	–	–	–	14	14	14
Colombia	–	–	–	228	228	228
Peru	–	–	2	42	43	43
World	**58.4**	**2,398**	**2,167**	**13,019**	**17,583**	**15,186**
Europe	0.4	456	16	213	685	229
CIS	27.5	416	406	2,700	3,521	3,106
Africa	10.7	453	108	1,682	2,243	1,789
Middle East	–	< 0.5	–	160	160	160
Austral-Asia	8.9	231	1,143	3,069	4,443	4,212
North America	10.6	835	333	3,962	5,130	4,295
Latin America	0.2	6	163	1,233	1,401	1,395
OPEC 2009	–	< 0.5	–	75	75	75
OPEC-Gulf	–	< 0.5	–	50	50	50
MENA	–	< 0.5	–	187	187	187
OECD 2000	17.9	1,455	1,308	4,970	7,732	6,277
EU-27	0.4	456	7	213	676	220

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

Table 33: Uranium resources 2012 (>20 kt U) [kt]
The most important countries and distribution by regions and economic policy organisations

Country / Region	Discovered RAR 80-260 USD/kg	Discovered inferred <260 USD/kg	Total	Undiscovered prognosticated <260 USD/kg	Undiscovered speculative <260 USD/kg	Total	Share [%] country	Share [%] 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	19.7	19.7
Kazakhstan	179	475	655	500	300	1,455	11.2	30.9
Mongolia	–	33	33	21	1,390	1,444	11.1	42.0
Canada	153	204	357	150	700	1,207	9.3	51.2
Brazil	–	121	121	300	500	921	7.1	58.3
Russia	250	427	677	192	n.s.	869	6.7	65.0
Australia	247	590	837	n.s.	n.s.	837	6.4	71.4
Namibia	357	155	512	n.s.	n.s.	512	3.9	75.3
Niger	335	105	440	14	51	505	3.9	79.2
South Africa	96	179	276	110	n.s.	386	3.0	82.2
Viet Nam	–	18	18	61	292	370	2.8	85.0
Ukraine	75	84	159	23	120	302	2.3	87.3
India	129	29	158	64	17	239	1.8	89.2
Colombia	–	< 0.5	< 0.5	11	217	228	1.8	90.9
Greenland	n.s.	135	135	n.s.	50	185	1.4	92.4
China	28	106	134	4	4	141	1.1	93.4
Jordan	45	< 0.5	45	15	50	110	0.8	94.3
Botswana	23	59	82	n.s.	n.s.	82	0.6	94.9
Uzbekistan	18	32	50	25	–	74	0.6	95.5
Tanzania	36	16	52	n.s.	n.s.	52	0.4	95.9
Iran	1	3	4	12	33	50	0.4	96.3
Zambia	10	6	16	30	n.s.	45	0.3	96.6
Peru	–	2	2	20	20	42	0.3	96.9
Finland	22	13	36	–	–	36	0.3	97.2
Indonesia	6	2	8	24	–	32	0.2	97.4
Hungary	–	18	18	13	n.s.	31	0.2	97.7
Argentina	3	11	14	14	n.s.	28	0.2	97.9
Zimbabwe	1	n.s.	1	< 0.5	25	26	0.2	98.1
Algeria	25	n.s.	25	n.s.	n.s.	25	0.2	98.3
Bulgaria	–	–	–	25	n.s.	25	0.2	98.5
...								
Deutschland	3	4	7	–	–	7	0.1	99.7
World	**2,566**	**2,882**	**5,449**	**2,924**	**4,646**	**13,019**	**100.0**	**–**
Europe	66	76	142	57	13	213	1.6	–
CIS	522	1,019	1,541	739	420	2,700	20.7	–
Africa	919	533	1,452	153	76	1,682	12.9	–
Middle East	46	3	49	27	83	160	1.2	–
Austral-Asia	416	778	1,194	172	1,703	3,069	23.6	–
North America	590	338	928	1,426	1,608	3,962	30.4	–
Latin America	6	135	141	349	743	1,233	9.5	–
OPEC 2009	26	3	30	12	33	75	0.6	–
OPEC-Gulf	1	3	4	12	33	50	0.4	–
MENA	71	5	77	27	83	187	1.4	–
OECD 2000	906	991	1,897	1,454	1,618	4,970	38.2	–
EU-27	66	76	142	57	13	213	1.6	–
MENA	71	5	77	27	83	187	1.4	–
OECD 2000	906	991	1,897	1,454	1,618	4,970	38.2	–
EU-27	66	76	142	57	13	213	1.6	–

n. s. not specified
– no resources

Table 34: Uranium reserves 2012 (extractable < 80 USD / kg U)
The most important countries and distribution by regions and economic policy organisations

Rank	Country / Region	kt	Share [%] country	Share [%] cumulative
1	Australia	962	44.4	44.4
2	Canada	294	13.5	57.9
3	Kazakhstan	279	12.9	70.8
4	Brazil	156	7.2	78.0
5	China	138	6.4	84.3
6	South Africa	96	4.4	88.8
7	Ukraine	68	3.2	91.9
8	Uzbekistan	47	2.2	94.1
9	Mongolia	41	1.9	96.0
10	USA	39	1.8	97.8
11	Russia	12	0.5	98.3
12	Turkey	9	0.4	98.7
13	Namibia	6	0.3	99.0
14	Niger	6	0.3	99.3
15	Argentina	5	0.2	99.5
16	Portugal	5	0.2	99.7
17	Indonesia	2	0.1	99.8
18	Slovenia	2	0.1	99.9
19	Peru	2	0.1	100.0
	Deutschland	–	–	
	World	**2,167**	**100.0**	
	Europe	16	0.7	
	CIS	406	18.7	
	Africa	108	5.0	
	Austral-Asia	1,143	52.7	
	North America	333	15.4	
	Latin America	163	7.5	
	OECD 2000	1,308	60.3	
	EU-27	7	0.3	

– no reserves

Table 35: Natural uranium production 2012
The most important countries and distribution by regions and economic policy organisations

Rank	Country / Region	kt	Share [%] country	Share [%] cumulative
1	Kazakhstan	21.3	36.5	36.5
2	Canada	9.0	15.4	51.9
3	Australia	7.0	12.0	63.9
4	Niger	4.7	8.0	71.9
5	Namibia	4.5	7.7	79.6
6	Russia	2.9	4.9	84.5
7	Uzbekistan	2.4	4.1	88.6
8	USA	1.6	2.7	91.3
9	China	1.5	2.6	93.9
10	Malawi	1.1	1.9	95.8
11	Ukraine	1.0	1.6	97.4
12	South Africa	0.5	0.8	98.2
13	India	0.4	0.7	98.9
14	Brazil	0.2	0.4	99.3
15	Czech Republic	0.2	0.4	99.7
16	Romania	0.1	0.2	99.8
17	Germany [1)]	0.1	0.1	99.9
18	Pakistan	< 0.05	0.1	100.0
19	France	< 0.05	< 0.05	100.0
	World	**58.4**	**100.0**	
	Europe	0.4	0.6	
	CIS	27.5	47.2	
	Africa	10.7	18.4	
	Austral-Asia	8.9	15.3	
	North America	10.6	18.1	
	Latin America	0.2	0.4	
	OECD 2000	17.9	30.6	
	EU-27	0.4	0.6	

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

Table 36: Uranium consumption 2012
The most important countries (top 20) and distribution by regions and economic policy organisations

Rank	Country / Region	kt	Share [%] country	Share [%] cumulative
1	USA	19.72	29.0	29.0
2	France	9.25	13.6	42.6
3	China	6.55	9.6	52.3
4	Russia	5.49	8.1	60.3
5	Japan	4.64	6.8	67.1
6	Korea, Rep.	3.97	5.8	73.0
7	Ukraine	2.35	3.5	76.4
8	United Kingdom	2.10	3.1	79.5
9	Germany	1.93	2.8	82.4
10	Canada	1.69	2.5	84.9
11	Sweden	1.39	2.1	86.9
12	Spain	1.36	2.0	88.9
13	Taiwan	1.29	1.9	90.8
14	Belgium	1.00	1.5	92.3
15	India	0.94	1.4	93.6
16	Czech Republic	0.58	0.9	94.5
17	Switzerland	0.53	0.8	95.3
18	Finland	0.47	0.7	96.0
19	Hungary	0.33	0.5	96.4
20	Brazil	0.32	0.5	96.9
	...			
	other countries [11]	2.09	3.1	100.0
	World	**67.99**	**100.0**	
	Europe	19.98	29.4	
	CIS	7.90	11.6	
	Africa	0.30	0.4	
	Middle East	0.17	0.3	
	Austral-Asia	17.50	25.7	
	North America	21.70	31.9	
	Latin America	0.45	0.7	
	OPEC 2009	0.17	0.3	
	OPEC-Gulf	0.17	0.3	
	MENA	0.17	0.3	
	OECD 2000	49.65	73.0	
	EU-27	19.45	28.6	

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Advanced Resources International Inc. – ARI (USA)

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

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Bundesamt für Wirtschaft und Ausfuhrkontrolle – BAFA

Bundesverband Braunkohle e.V. – DEBRIV

Bureau of Ocean Energy Management – BOEMRE (USA)

Bureau of Resources and Energy Economics – BREE (Australia)

Canadian Society for Unconventional Resources – CSUR

CARBUNION (Spain)

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Cubapetroleo – Cupet (Cuba)

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

Department of Energy – DOE (Philippines)

Department of Energy (South Africa)

Department of Resources, Energy and Tourism (Australia)

DUKE (Great Britain)

Ecopetrol (Colombia)

Energy Resources Conservation Board – ERCB (Canada)

Energistyrelsen – ENS (Denmark)

Euratom Supply Agency, European Commission – ESA

EuroGas Inc. (USA)

Gazprom (Russian Federation)

GEOFOND (Czech Republic)

Geological Survey of Czech Republic – ČGS

Geological Survey of India – GSI

Geological Survey of Namibia

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Grubengas Germany e. V. – IVG

IHS McCloskey

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International Energy Agency – IEA

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KNOC (Korea Republic)

Korea Energy Economics Institute (KEEI)

Korea Gas Corporation – KOGAS

L&M Energy Ltd. – LME (New Zealand)

Methane Center of Kazakhstan, Azimut Energy Services

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)

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

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Ministry of Energy Myanmar

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Natural Gas Europe – NGE

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Norwegian Petroleum Directorate – NPD

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The Coal Authority (United Kingdom)
Türkiye Taşkömürleri Kurumu – TTK (Türkische Steinkohlegesellschaft)
Turkish Petroleum Corporation
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

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. *Mass units*
BMWi	Bundesministerium für Wirtschaft und Technologie, office in Berlin (German 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, including methane
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 / Nm^3 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 cm^3 (heavy oil, light oil, condensate)

	Non-conventional crude oil: Hydrocarbons that cannot be produced used classic methods, but which require more complicated technology to produce them from the ground. In the reservoir itself, this oil is either incapable of flowing or can only flow marginally because of its high viscosity and/or density (extra heavy oil, bitumen), or because of the very low permeability of the reservoir rock (shale/ tight oil). In the case of oil shale, the oil is still in the form of kerogen in an early alteration stage
CTL	Coal to liquid; synthetic fuel made from coal
Cumulative production	Total production since the start of production operations
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
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 fuel 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

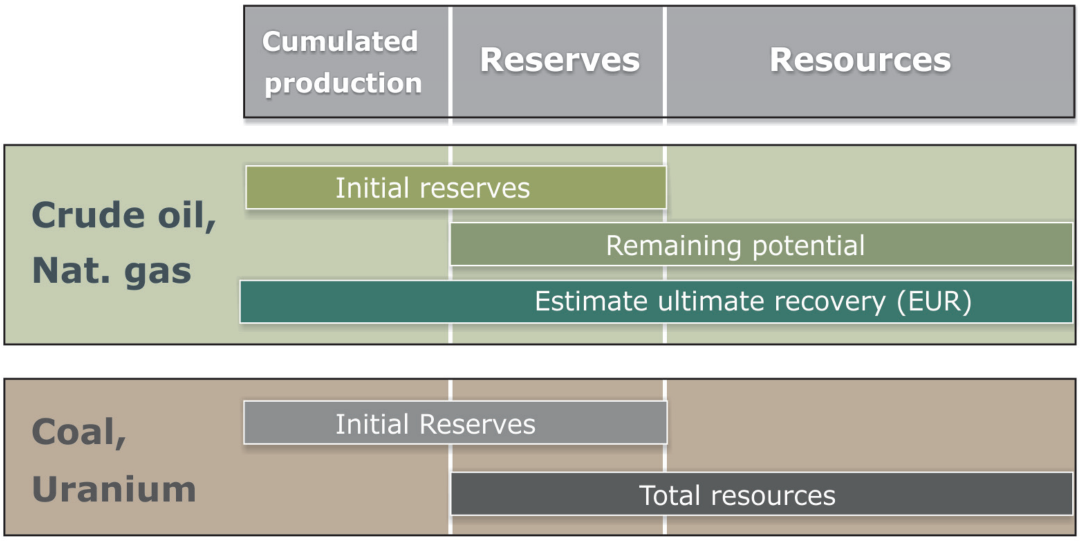
IAEA	International Atomic Energy Agency; UN agency; headquarters in Vienna. *cf. Economic organisations*
IEA	International Energy Agency OECD organisation; headquarters in Paris
Initial reserves	Cumulative production plus remaining reserves
in-place	Total natural resource contained in a deposit/field (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. Mass Units*
LBEG	Landesamt für Bergbau, Energie und Geologie, headquarters in Hannover (State Office of Mining, Energy and Geology)
LEU	Low enriched uranium
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)
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 undertaking additional technical measures, either because it is not present in the rock in a free gas phase, or because the reservoir is

	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 Sitz: Paris; *cf. Economic organisations*
OPEC	Organization of Petroleum Exporting Countries; headquarters in Vienna; *cf. Economic organisations*
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.: Mass 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
Recovery rate	Amount of oil which can be recovered from an oilfield in per cent
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
Raw gas	Untreated natural gas recovered during production
Shale gas	Natural gas from fine-grained rocks (shales)
SPE	Society of Petroleum Engineers
tce	Tonne 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*

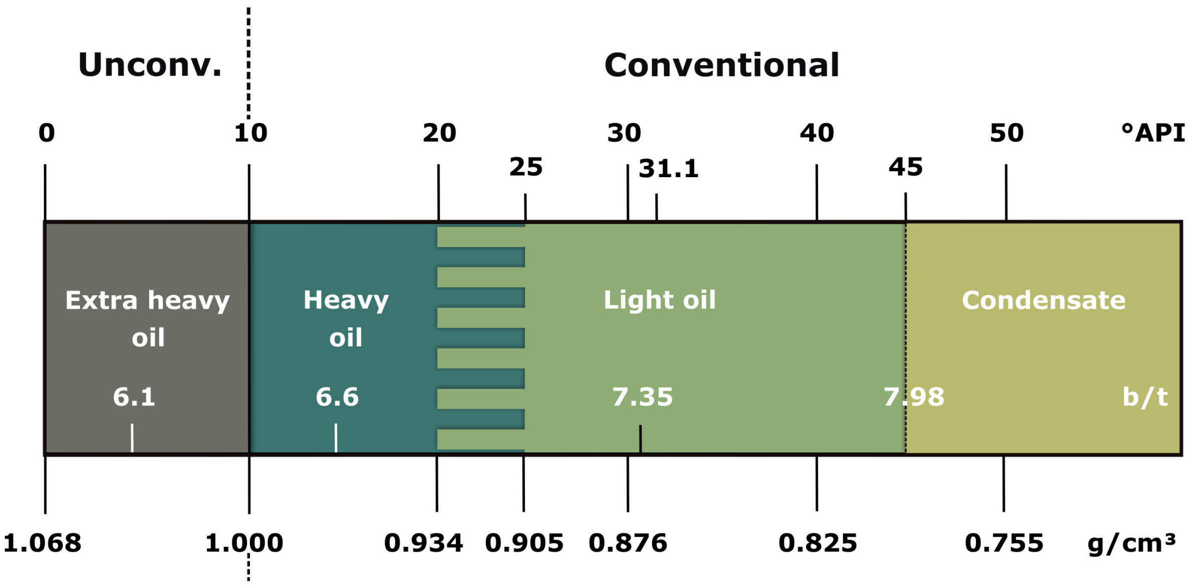
upstream	All activities in the production chain which take place before hydrocarbons leave the production well. Exploration, development and exploitation/production
Uranium	A natural constituent of rocks in the earth's crust. Natural uranium [Unat] (standard uranium) is the uranium which occurs naturally 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 the 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 around 3 ppb (3 µg/l) and is theoretically extractable.
USD	US-Dollar; currency of the United States of America
USGS	United States Geological Survey
VDKi	Verein der Kohlenimporteure e.V. (Organisation of Coal Importers); headquarters in Hamburg
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

Differentiation 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, Swaszland, 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

Austral-Asia

„Austral"-Part:

Australia, Cook Islands, Fiji, French-Polynesia (Territory), Guam, Kiribati, Marshall Islands, Micronesia (Federated States), Nauru, New Caledonia, New Zealand, Northern Mariana Islands, 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), Lao (People's Democratic Republic), 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), (French) Guiana, Grenada, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Montserrat, Nicaragua, Netherlands, Panama, Paraguay, Peru, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Saint Pierre and Miquelon, Saint Vincent and the Grenadines, Suriname, Trinidad andTobago, Turks and Caicos Islands, Uruguay, Venezuela (Bolivarian Republic), Virgin Islands (Brit.), Virgin Islands (Americ.)

MENA (Middle East and North Africa)

Algeria, Bahrain, Egypt, Iran (Islamic Republic), Iraq, Israel, Jordan, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Sudan, Tunisia, United Arab Emirates, Yemen,

ECONOMIC POLICY ORGANISATIONS *STATUS:2012*

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 und Romania

IAEA (International Atomic Energy Agency; 158 countries)

Afghanistan, 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, India, Indonesia, Iraq, Iran (Islamic Republic), Ireland, Iceland, 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, Saudi Arabia, Senegal, Serbia, Seychelles, Sierra Leone, Singapore, Slovakia, Slovenia, South Africa, South Sudan, Spain, Sri Lanka, Sudan, 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; 33 countries)

Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Iceland, 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, Iraq, Iran (Islamic Republic), Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates, Venezuela (Bolivarian Republic)

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

MASS UNITS

b, bbl	barrel	1 bbl = 158.984 litre
cf	cubic feet	1 cf = 0.02832 m^3
J	Joule	1 J = 0.2388 cal = 1 Ws (Wattsecond)
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 TWh = 34.1 t tce
PJ	Petajoule	1 PJ = 10^{15} J = 278 x 10^6 TWh = 34.1 x 10^3 t tce
EJ	Exajoule	1 EJ = 10^{18} J = 278 x 10^9 TWh = 34.1 x 10^6 t tce
cm, m^3	cubik 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 cubik meter	1 bcm = 10^9 m^3
tcm	trillion cubik 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

CONVERSION FACTORS

1 t crude oil	1 toe = 7.35 bbl = 1.428 tce = 1,101 m³ natural gas = 41.8 x 10^9 J
1 t LNG	1,380 m³ natural gas = 1.06 toe = 1.52 tce = 44.4 x 10^9 J
1,000 Nm³ 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 m³ natural gas = 29.3 x 10^9 J
1 EJ (10^{18} J)	34.1 Mtce = 23.9 Mtoe = 26.3 G. m³ 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

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