MSc Program
Renewable Energy in Central and Eastern Europe

The impact of looming peak oil on world oil price development

A Master's Thesis submitted for the degree of
"Master of Science"

supervised by
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27th of April 2015, Vienna

Affidavit

I, Mag. **Werner Scharner**, hereby declare

1. that I am the sole author of the present Master Thesis, " The impact of looming peak oil on world oil price development", 91 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and

2. that I have not prior to this date submitted this Master Thesis as an examination paper in any form in Austria or abroad.

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Date Signature

Abstract

Forecasting oil prices has been a real challenge in the last decades. The core objective of this thesis is to analyze which impact looming peak-oil has on price development.

To meet this target historical supply and demand data is being analyzed and interrelated with macroeconomic figures such as population trends and GDP. Trends of available conventional, but also unconventional, reserves and resources are being used to indicate whether peak-oil is forthcoming as predicted by scientists and what influence such negative forecasts had and will have on oil prices.

The major conclusion is: Especially after 2000, oil prices were mainly influenced by virtual demand and not by physical supply and demand. Currently, it is not likely that prices will significantly change due to shortness of supplies in the near future. Due to economic crises there is a moderate economic growth. Moreover, expensive extraction methods balance with a more efficient use of energy but also with regional overcapacities.

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List of abbreviations and symbols

AAPG	Association of Petroleum Geologists
ASPO	Association for the study of Peak Oil and Gas
bbl (boe)	barrels (1 bbl = 159 liters)
BGR	Federal Institute for Geosciences and Natural Resources
BP	British Petroleum (oil company)
BRIC	An acronym for the economies of Brazil, Russia, India and China combined
BTU	British thermal unit
C	Centi
cf.	Confer
CIS	Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russian Federation, Tajikistan, Turkmenistan, Ukraine, Uzbekistan
COGEH	Canadian Oil and Gas Evaluation Handbook
CP	Cumulative production
cum.	Cumulative
DERA	German Mineral Resources Agency
E	Exa
e.g.	exempli gradita (for example)
EJ	Exajoule
Eco.	Economic
EIA	Energy Information Administration
EROEI	energy return on energy invested
EU	European Union
EUR	estimated ultimate recoverable oil
G	Giga
GDP	gross domestic product
GEA	Global Energy Assessment
Gt	Gigatons
ICE	Intercontinental Exchange (previously known as International Petroleum Exchange (IPE))
IEA	International Energy Agency
K	Kilo
KPI	key performance indicator
M	Milli
M	Mega
MJ	Megajoule
Mt	Megatons
NGL	natural gas liquid
NAMEX	New York Mercantile Exchange
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries
P	Peta
R&D	research and development
reco.	Recoverable

RRR	Remaining recoverable resources
SPE	Society of Petroleum Engineers
T	Tera
Toe	tonnes of oil
UGES	Uppsala Global Energy Systems group
uneco.	Uneconomic
unreco.	Unrecoverable
URR	ultimately recoverable resource
USGS	US Geological Survey
WPC	World Petroleum Congress
WTI	West Texas Intermediate (Texas Light Sweet)
Yr	year
Z	Zeta
1P reserves	quantities recoverable with probability of at least 90%
2P reserves	quantities recoverable with probability of at least 50%
3P reserves	quantities recoverable with probability of at least 10%

1 Introduction

With a share of around 31% of primary energy consumption, oil continues to be the most important fuel worldwide and will remain so in the near future [cf. IEA (2014), p. 57]. Oil is a nonrenewable source, which means that – even though its days in the long run are numbered– it is a material which has influenced and will influence the history of the world.
As oil is still being used in many different areas of the industry and cannot be substituted easily, especially in the sectors transport and petrochemicals [cv. IEA (2014)], p. 101]. IEA predicts that oil will account for 85% of total transport demand in 2040. In petrochemicals the share of oil will be still above 70% in 2040.
Costs, decisions regarding investments, use of reserves, operations to cover risks, speculations, transactions and the policies of oil companies and nations are the main drivers which form the oil price. Peak oil seems to be a kind of sword of Damocles for oil prices and so a price of $ 200 per barrel and above has been predicted in the last years even though it is difficult to imagine at the moment.

1.1 Motivation

More and more voices claim that peak oil is looming. Peak oil is the concept that since oil is non-renewable, there will be a point in the future at which the rate of extraction will hit a peak and thereafter will decline [cf. ecolife (2015)]. The term was first used by M. King Hubbert in 1960s who dried to forecast the point in time when the maximum production, the peak of oil production will be reached.

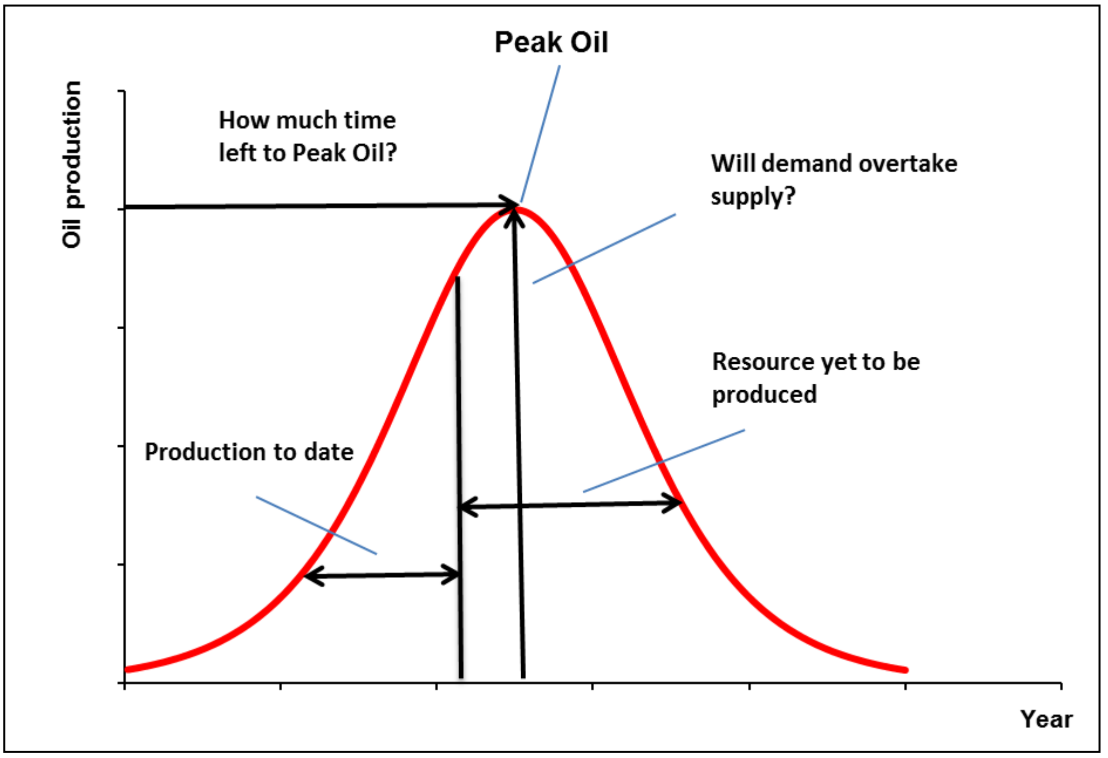

Figure 1.1: Peak Oil Graph
Source: Mohr (2010)

Currently, there is active debate on how to measure peak oil and the point in time this will happen. However, it is certain that the day will come when the maximum rate of oil extraction has been reached. Optimistic estimations forecast that the global decline will begin after 2020 and assume major investments in alternatives will occur before a crisis. Pessimistic predictions of future oil production are that the peak has already occurred and negative impact on the economy is unavoidable. However, the oil price is one of the most important indicators of the development of global economy. A key question is whether the shrinking oil production influences the price. As I work for a global energy company evaluating the root causes for oil price changes are of personal interest to me.

1.2 What is the core objective / the core question?

The core objective of this work is the impact of declining oil production on pricing. More precisely I will discuss whether looming peak oil is the reason for oil prices changes (mainly increases). As the status of world oil reserves is a contentious issue, extensive literature research and data collection will provide a sound foundation for the analysis of historical trends in supply of and demand for oil.

Derived questions are:

Core question

- Is peak oil the reason for oil prices changes (mainly increases)?

Questions of second order

- Is oil peak really imminent?
- What is the impact of extracting remaining oil reserves and resources in the context of technological progress?
- What is the impact of increasing production of oil from unconventional sources on price?
- What is the impact of investments in alternatives on price?
- What are other drivers and slowers of world oil prices beside scarce resources?

1.3 Structure of work

This paper is structured into ten chapters, namely introduction, method of approach, background, supply of oil, demand for oil, drivers and slowers of oil price, conclusions, acknowledgements, references and annexes.
Chapter one, the “introduction”, gives an introduction into the topic. Alongside the motives of the author for writing this thesis, objectives and scientific questions are raised.
Chapter two, the “method of approach”, describes the chosen methodology and the leitmotif of this paper in more detail.
Chapter three, the “background”, gives the most relevant key definitions.
Chapter four, the “supply of oil”, analyzes historical and trend data to evaluate possible correlations on oil prices.
Chapter five, the “demand for oil”, discusses the impact of population growth on demand. Additionally, the correlation between GDP and oil production and consumption are visualized.
Chapter six, the “drivers and slowers of oil price”, gives an overview about possible impact factors on oil price.
Chapter seven, the “conclusion”, summarizes the main findings and gives food for thought for further research.
All data used for calculations, figures and tables can be found in chapter 10, the “annexes”.

1.4 Major literature & data sources

Since the 1950s hundreds of analyses have been made about reserves and the time of peak oil. Thus all figures published in the literature and listed in this thesis should only be seen as an indication.
One of the most comprehensive estimates about resources and reserves is provided by the Federal Institute for Geosciences and Natural Resources (BGR). As they recently published the latest version of their annual report about reserves, resources and energy resources in 2014, BGR has been one of the first institutes so far to offer detailed energy data up to end of 2013. Incidentally, their estimates are also mentioned to be highly convincing in literature e.g.: Rogner (2012) p. 439. So BGR data is used in this thesis to not only consider up-to-date figures but also to examine the latest trends, e.g. the growing importance of non-conventional sources.
The international oil company BP is famous for its yearly updated statistical review of world energy. As this report delivers historical data going back to 1861, it was one of the main data source for most historical analysis mentioned in the following chapters.
M. King Hubbert is the inventor of o the peak oil theory. That is why his analysis is being discussed at the beginning of the thesis.
Additionally theories published by Collin Campbell and Kjell Aleklett are debated in this thesis. Both are members of the board of the association of study of Peak Oil & Gas (ASPO). In 2012 Kjell Aleklett published “Peeking at Peak Oil” where he summarized the research finding of the Uppsala Global Energy Systems group (UGES) at Uppsala University in Sweden.
For possible future scenarios also data from Shell´s recently published New Lens scenarios is being used. Additionally the latest data from the yearly published World Energy Outlook by IEA has been integrated in this paper. In the World Energy Outlook 2014 three different scenarios are developed to describe long-term energy trends. The Scenarios differ in their assumptions about the evolution of government policies with respect to supply and demand for energy and environmental impact.
To explain ups and downs of oil prices the economic explanations for oil price volatility published by Franz Wirl have been integrated in this thesis. Moreover the approach of Reinhard Haas about the impact of virtual demand on oil price is being discussed.

All data which has been used for analysis to underpin argumentation in this thesis have been listed in the appendices in chapter 10. Moreover the author used this data to create most of the tables and figures visualized in this paper.

2 Method of approach

To reach the above mentioned objectives, the following steps will be conducted in this work:

1. Literature review (overview of the facts to give the analysis a well researched foundation),
2. Comprehensive data collection and analysis,
3. Conduct econometric approaches.

At the beginning several key definitions are described. The definition oil peak and its difference to oil depletion are worked out. Different approaches how to categorize reserves and resources are discussed and the importance of unconventional sources is elaborated in the first part of the paper.

In the second part supply and demand data is being analysed to outline possible correlations to oil price changes.

In the third part impact factors on oil price and possible consequences of peak oil on oil price are being discussed.

3 Background

In 1859 Edwin Drake began to pump up oil in Titusville, Pennsylvania. It was realized that oil has a very high energy density and soon became a source of wealth for the western world as it is used to produce a wide range of products. Moreover, oil was abundant in the past and relatively easy to transport. However, it is a fact that there is a finite amount of oil available on earth.

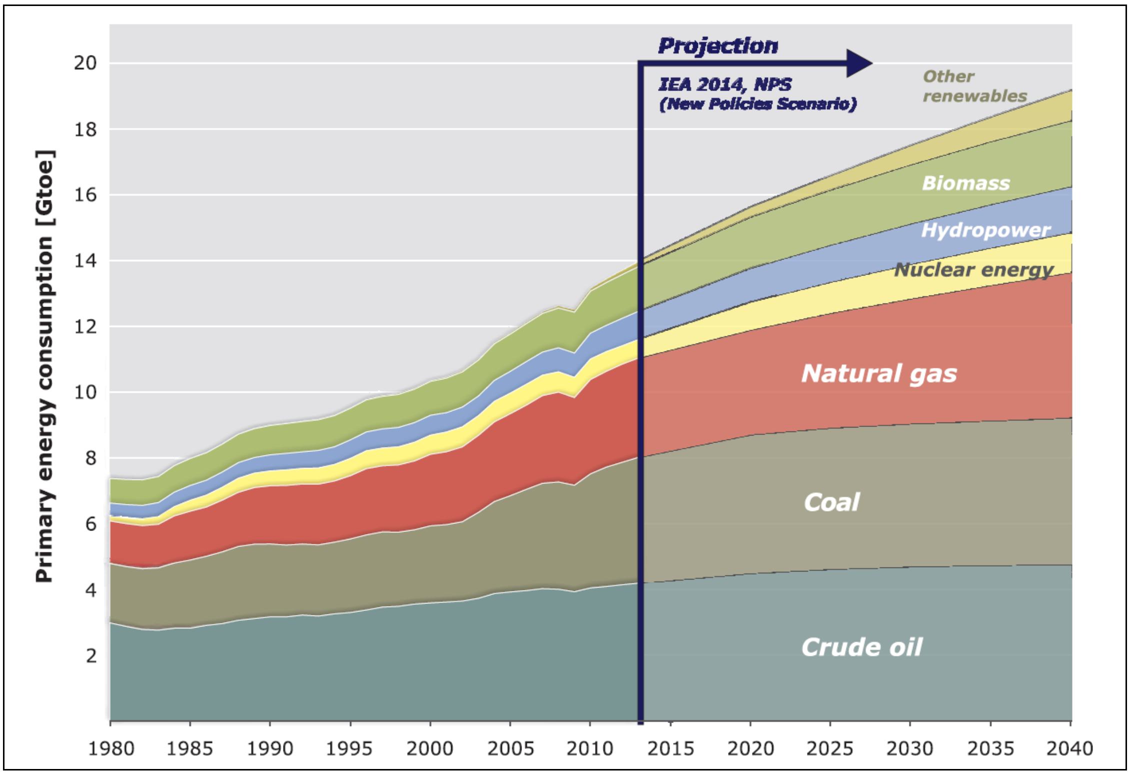

Figure 3.1: Development of past and future global primary energy consumption
Source: BGR (2014), p. 9

As noted in the New Lens Scenarios, published March 2013 by Shell, in the year 2030 demand for critical resources like water, energy and food will have risen by 40-50 percent. Even though other energy resources will take on greater significance, oil is needed as one of the main energy fuels in the near future (cf. figure 3.1). The scarcity of oil is unavoidable as the appetite for this product will continue to increase

due to population growth especially in the industrial regions of China and India [cf. Gorelick (2010), p. 2].
Output will stop rising. The question is when this will happen? Analysts have focused on four questions: How much oil exists to be exploited, what is the likely trend of new discoveries, what is the projected rate of global consumption and when will the end of the oil era arrive? [cf. Gorelick (2010), p. 3]. Before dealing with these questions a definition for “peak oil” is being given. Additionally Hubert’s peak theory and the terms “reserves” and “resources” are discussed in detail as these key words are an important basis in the following chapters.

3.1 Peak oil

Oil, which is a finite natural resource, was formed in the geological past and this happened in just two epochs of extreme global warming, 90 and 150 million years ago. Usually production follows the initial discovery and ends when the resources are exhausted [cf. Campbell (2013)]. Peak oil is the point in time when the maximum rate of oil extraction has been reached and the world´s oil supplies go into an irreversible decline [cf. Financial Times Lexicon (2012)]. Campbell defined Peak Oil as the maximum rate of production of oil in any area under consideration, recognizing that it is a finite natural resource, subject to depletion [cf. Aleklett (2012), p. 34]. As peak oil is the point of maximum production it should not be confused with oil depletion which normally occurs in the second half of the production curve.
Oil production has always followed a bell curve [cf. Ruppert (2009), p. 2]. Historically production always peaks approximately 40 years after discovery. Due to technological advances in extraction, the point of maximum production can, in the meantime, be reached already after 25 years. There is a consensus that point in time when rate of crude oil discovery was maximal has already been passed decades ago [cf. Aleklett (2012), p. 47]. As shown in figure 3.2 the global oil discovery peaked in the mid-1960s. The average discovery is just a tenth compared to the findings in the 1960s. The consumption of oil has a reverse development. As conclusion oil peak is foreseeable. The question is when? Possible answers to this question will be discussed in the following chapters.

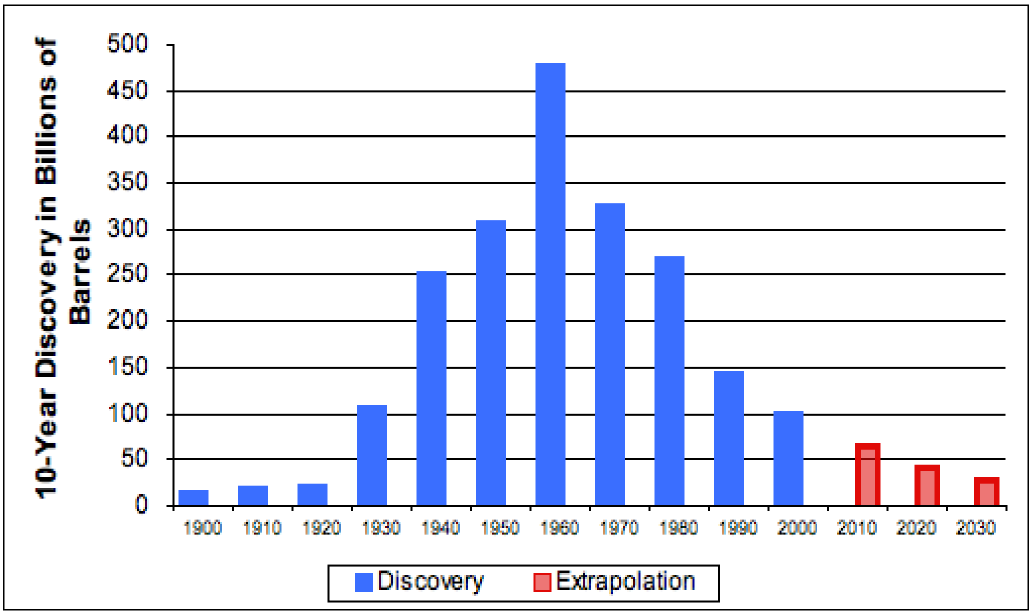

Figure 3.2: World oil discovery over 10-yr periods, by ASPO
Source: The oil drum: http://www.theoildrum.com/files/Oil%20discoveries.png

Most of the easy yields have been harvested within the last decades. As the human population continues to grow, the hunger and thirst for oil is unabatedly high. This is aggravated by the fact that emerging economies will further boost the demand for this commodity.

3.2 Hubbert peak theory

The oil geologist and physicist M. King Hubbert saw that oil discoveries in the United States has peaked in the 1930s and calculated that the domestic oil production would peak in 1970. Even though his analysis was initially not taken seriously, his forecast was absolutely right. Hubbert developed a quantitative method to represent the amount of a natural resource and its estimated rate of depletion [cf. Gorelick (2010), p. 5]. As illustrated in figure 3.3, Hubbert used a simple logistic curve with a typical symmetric bell shape to describe the rise, peak and fall in production of a fossil fuel over time.

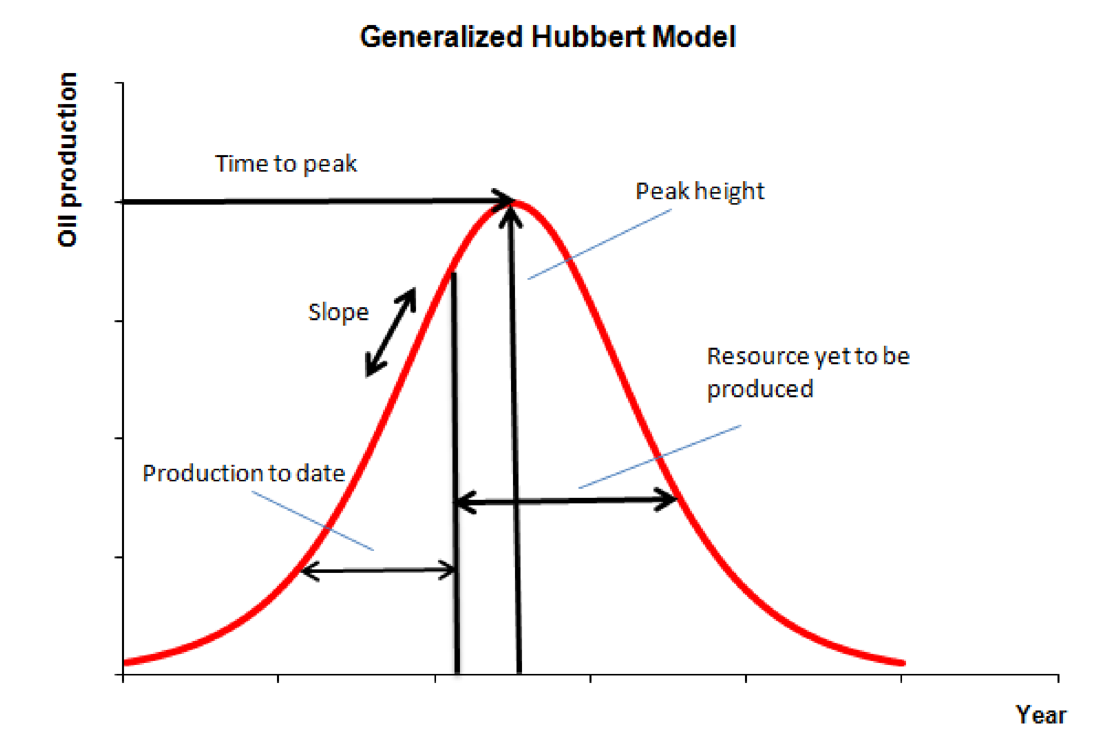

Figure 3.3: Generalized illustration of a logistic curve
Source: Gorelick (2010), p.6

He developed a formula to predict the future rate of resource production and depletion. The logistic curve is based on a simple, three-parameter formula in which P is the resource production, t is time, a is the peak height and b is the center of the symmetric curve. The changing slope, whose magnitude is the same on the rising and declining limbs, is represented by c [cf. Gorelick (2010), p. 14]. The area under the curve stands for the total amount of the resource and is calculated by the product 4*a*c.
Hubbert´s approach was to fit the logistic formula to historical data of oil production [cf. Gorelick (2010), p. 6]. He predicted that in the USA, a rapid increase was followed by a tremendous decline in oil discovery. Hubbert calculated a similar progression for the production with an all-over oil endowment of 200 billion barrels. In 1956 Hubbert could thus forecast oil peak for the US 14 years before it became reality. As visualized in figure 3.4 the actual Hubbert´s bell curve was nearly congruent with the run of the production curve. With his approach Hubbert could so forecast the oil peak but also the drop rate from 1970 to 2010.

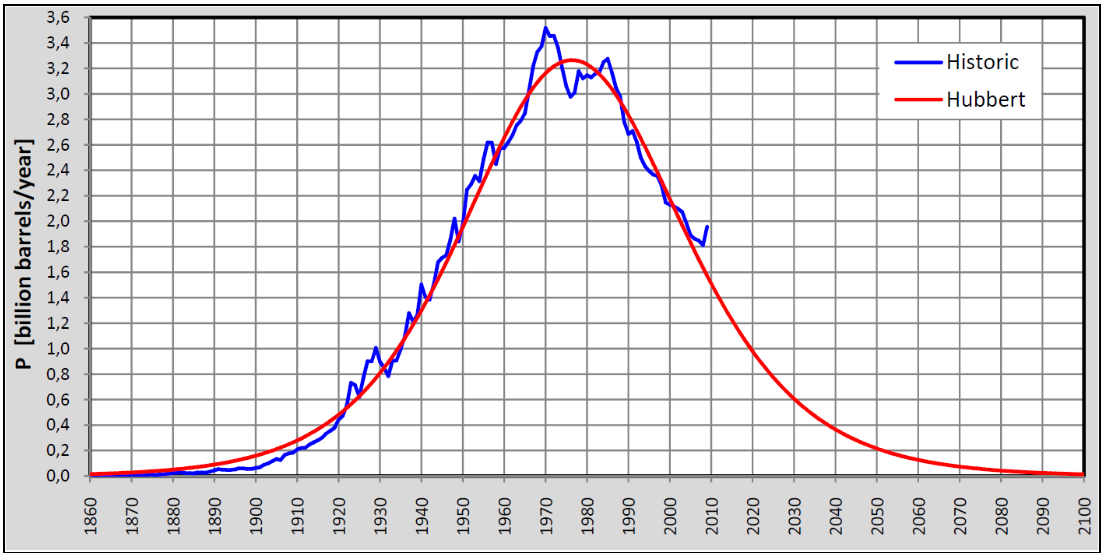

Figure 3.4: US lower 48 state oil production versus Hubbert´s bell curve
Source: EIA, Zandvliet (2011) p.6

There are two main factors of influence determining the time of peak oil in Hubbert´s approach. The first one is the historical data and the second one is the to-be-estimated sum of oil production over time. Hubbert also extended his analysis to global oil depletion. His estimates of global oil peak ranged from 1995 to 2000. Many other analysts as well as geologists have followed and further developed the studies of M. King Hubbert and predicted oil peak between 2005 and 2010, whereas oil companies and consultants believe that oil peak will not happen before 2020. Some are enclosed in the following table.

Table 3.1: Global oil peak predictions by various experts

Name	Profession	Estimation
M. King Hubbert	Oil geologist	2000-2005
A.M.S Bakhitari	Iranian oil geologist	2006-2007
M.R. Simmons	Investment banker	2007-2009
C. Skrebowski	Journalist	After 2007
K.S. Deffeyes	Oil geologist	Before 2009
D. Goodstein	Vice provost	Before 2010
C.J Campbell	Oil geologist	2010
World Energy Council	Non-government organization	After 2010
J. Laherrere	Oil geologist	2010-2020
EIA	US government	2016
CERA	Energy consultant	After 2020
Shell	Oil company	2025 or later

Source: Hirsch (2005) p. 19

Hallock and others published a study of global oil depletion in the journal Energy. They evaluated that the global production of conventional oil will decline irreversibly between 2004 and 2037 [cf. Hallock (2004)].

As it is very difficult to obtain reliable data for oil production, Zandvliet deduced oil peak via fossil carbon emissions. This seems to be an intelligent alternative as the same amount of oil will always release the same amount of CO2 and H2O when burnt [cf. Zandvliet (2011), p. 8].

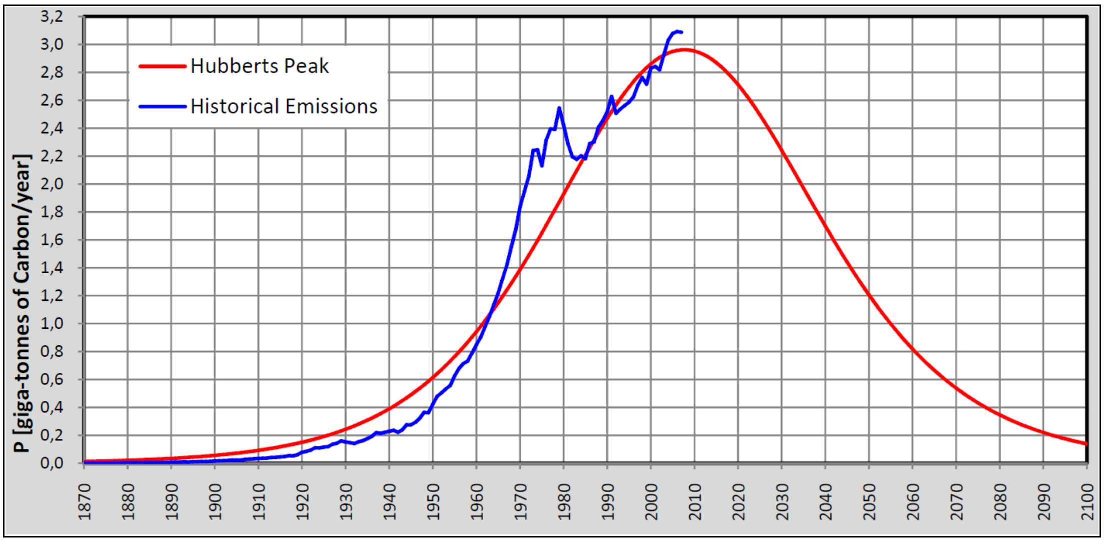

Figure 3.5:Hubbert's curve of global fossil carbon emissions from liquid fossil fuels
Source: Zandvliet (2011) p. 8

Zandvliet expects annual declines in world oil production of 0.8% in 2015, 1.3% in 2020, 2.3% by 2030, 3.1% by 2040 and up to 4.5% after 2050 [cf. Zandvliet (2011), p. 8].

Overall, the Hubbert curve approach has been classified by scientists as a "robust" model where uncertainty of data and parameters hardly affect the results. However, as we can see in chapter 4 most historical predictions about the point of time of global peak oil didn´t come true. The daily amount of oil production is still increasing.

3.3 Reserves and resources

Nobody completely trusts any published reserve numbers. What is the difference between estimated reserves, probable reserves and proven reserves? These numbers have nothing to do with how much oil is in the ground as there is often a deviation of up to 300%. The truth about reserve data is that there is often no honest scientific analysis. Due to tax reasons oil companies often use smaller numbers when reporting these. But when it comes to reporting to shareholders, they use larger numbers in order to fulfill shareholder expectations [cf. Ruppert (2009), p. 35]. Nations and organizations also abuse reserve data to gain personal advantages. In the 1980s OPEC states were faced with the dilemma that the production quota was determined as a ratio to “proven” reserves. To produce more oil most OPEC states simply adjusted the reports about available reserves as visualized in figure 3.6. Countries as Saudi Arabia, United Arab Emirates, Iran and Iraq just doubled their estimates on proven reserves even though no new oil fields were found to justify this approach.

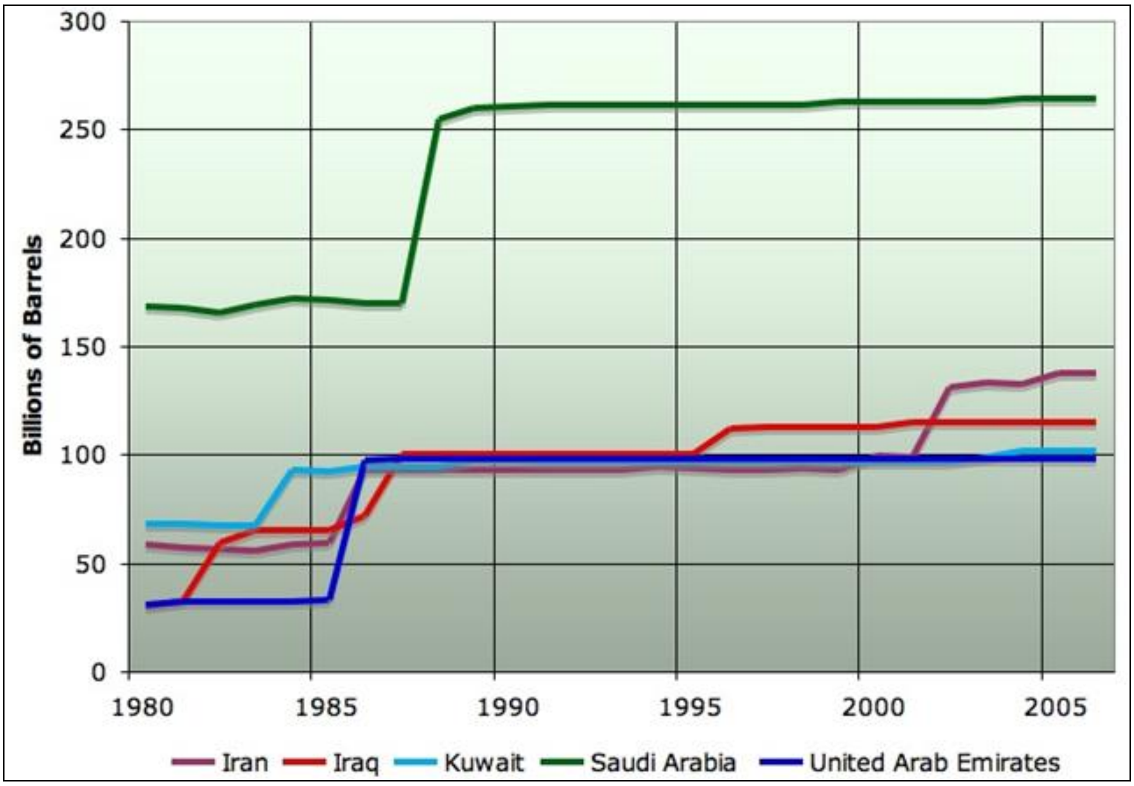

Figure 3.6: Reported reserves of important OPEC countries
Source: The oil drum: http://www.oilempire.us/opec.html

As there are no international standards for reserve reporting, there is wide scope for calculating reserve data. However, there are several definitions related to oil availability that are relevant for the discussion about oil.

3.3.1 Definitions of oil reserves and resources

Nobody knows exactly how much oil is available under the earth´s surface and how much can be produced in the future. All numbers are, at best, informed estimates. Many institutions have developed their own definitions und sometime authors use different meanings for the same term. In this paper two common principles of resource classification are described, namely the concept from McKelvey and COGEH which will be explained in more detail in the next paragraphs.
The following definitions were set up by SPE, WPC and AAPG and have been summarized in the Canadian Oil and Gas Evaluation Handbook as followed: [cf. COGEH (2002), pp 1-21]

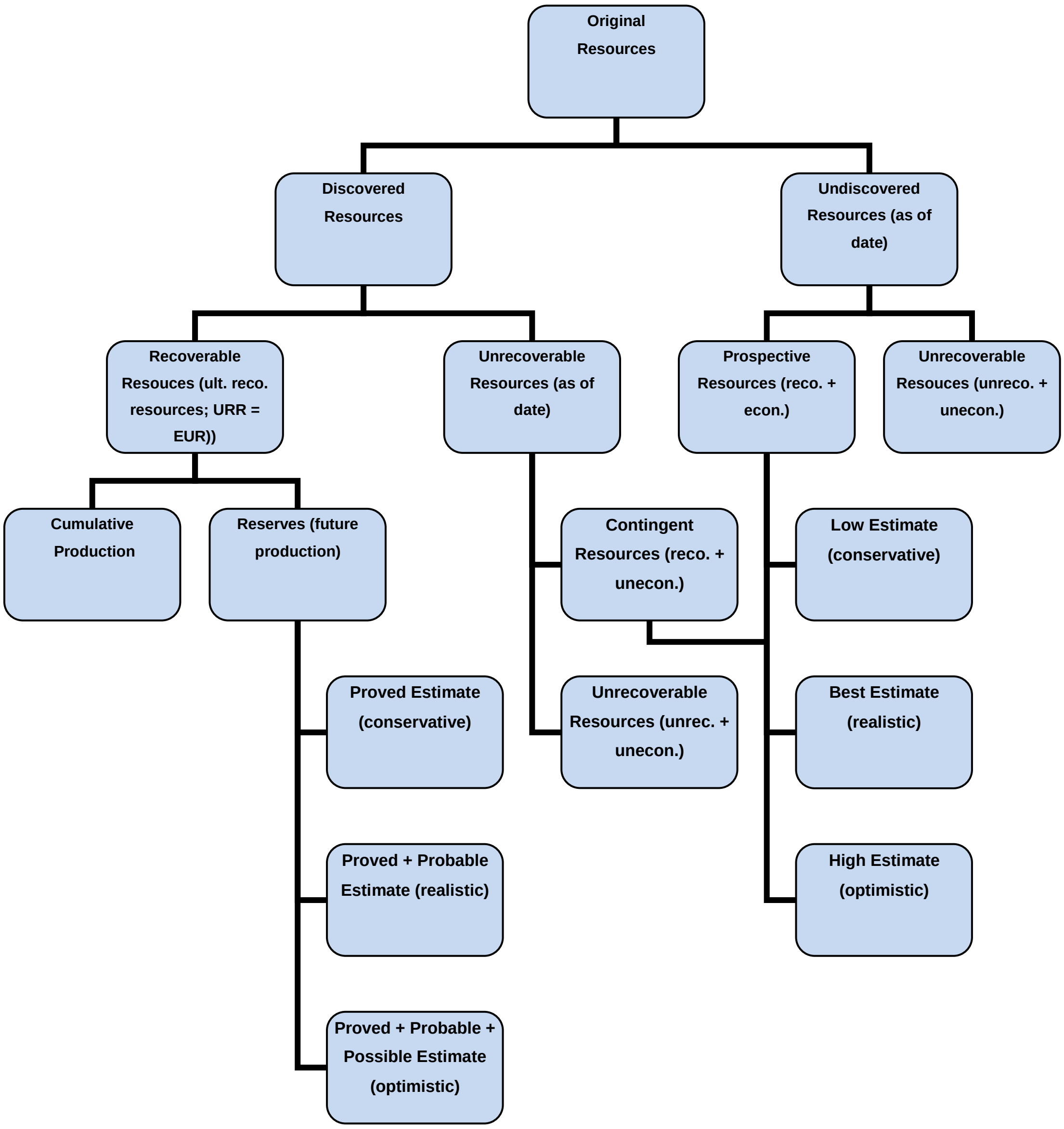

Figure 3.7: Different kind of reserves and resources
Source: COGEH section 5

The total amount of oil which originally existed in natural accumulations in the earth crust can be defined as original resources and can be segmented into discovered and undiscovered resources. Both types of resources consist of recoverable and unrecoverable shares. The main distinction is that recoverable resources are economic and the latter are uneconomic. The definition of economic efficiency depends on the local conditions of prices, cost and operating circumstances and is at the discretion of the operator (country or oil company). The discovered recoverable resources are also known as ultimately recoverable resources (URR). URR are the total amount of cumulative production from the past and the future production (reserves).The availability of URR is mostly a subjective estimate which in practice continues to grow as technology advances and economics change [cf. BP (2012)]. Cumulative production is the overall amount of oil produced up to a given date. Reserves are estimated from remaining quantities at oil recoverable from known accumulations from a given time. Estimations should be based on geological, geophysical and engineering data. Established technology and specified economic conditions have to be taken into account. Discovered reserves are typically divided into proved, probable and possible reserves and are classified according to the degree of certainty. Proved reserves (also called 1P reserves) have a probability of 90 percent or more of being produced over the life of the field. Probable reserves (also called 2P reserves; 50%) and possible reserves (also called 3 P reserves; 10%) have a much lower degree of probability. It is impossible to recover all of the oil discovered in a given reservoir. The ratio of reserves to oil in place for a given field is known as the recovery factor [cf. BP (2012)]. This factor may change over time due to technological improvements and changes in economics.

Another concept of resources classification developed by USGS is the McKelvey box and is visualized in figure 3.8. Reserves and resources are categorized in matrix by the degree of economic feasibility and the degree of geological assurance. Similar to the approach described by COGEH the boundary between reserves and resources can vary depending on expected market prices and production costs. Price increases and or production cost reductions expand reserves by moving resources into the reserve category and vice versa [cf. Rogner (2012), p. 434].

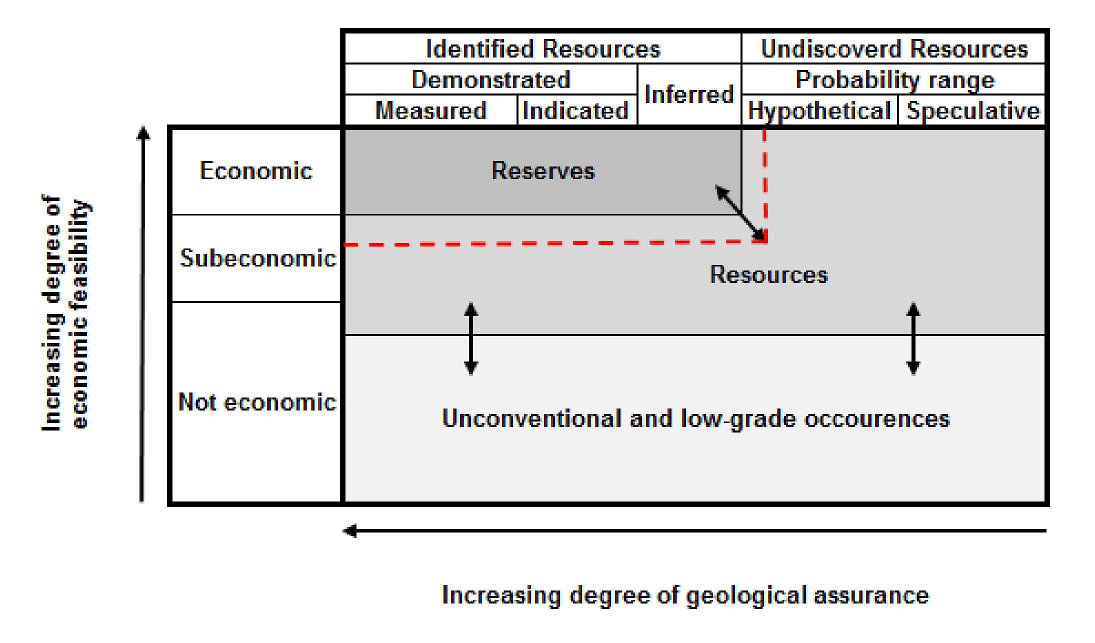

Figure 3.8: McKelvey diagram
Source: Rogner (2012)

As illustrated in figure 3.2 oil discoveries have been shrinking tremendously since the 1960s. Nonetheless, the continuous increase of proven reserves up to approximately 1700 billion barrels illustrated in figure 3.9 is strong evidence that there has been a great progress in technology. Additionally more resources became economic due to rising oil prices as shown in figure 6.1. These positive parameters have been the main driving force for the increase of reserves which are also categorized as recoverable economically over the last 30 years.

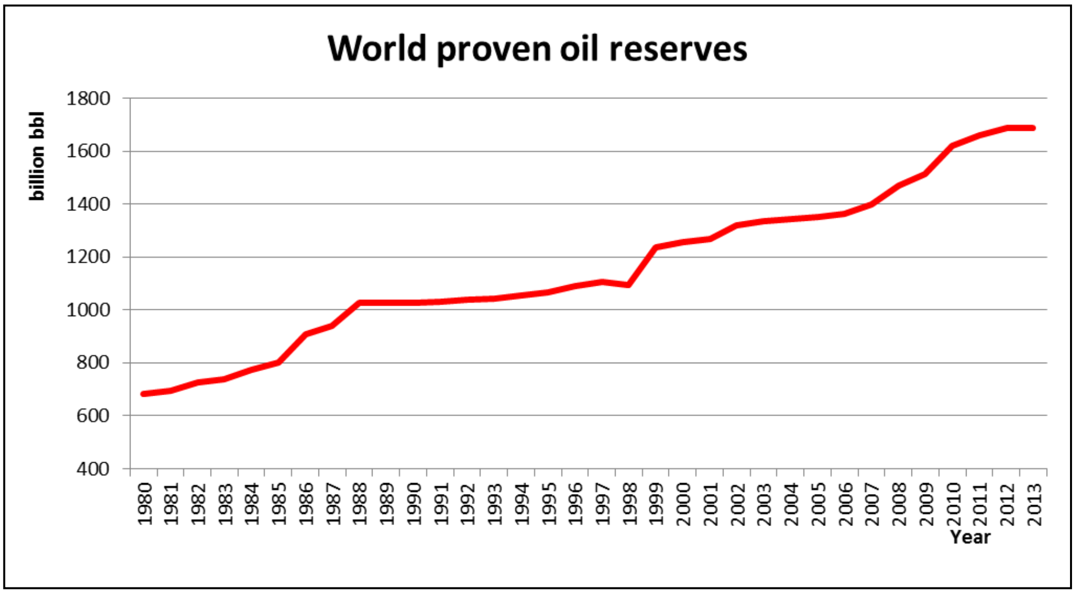

Figure 3.9: World proven conventional oil reserves (includes gas condensate and NGLs as well as crude oil)
Source: BP Statistical Review of World Energy (2014)

The USGS created the term total oil endowment which consists of four components, namely cumulative production, remaining reserves, reserve growth and undiscovered oil. Cumulative production is the total reported extracted volume up to date. Remaining reserves summarize the volume which can be produced economically. Reserve growth, also known as field growth, represents additional volume extracted from existing fields due to improved technology and/or more efficient operating methods and/or economic reasons.

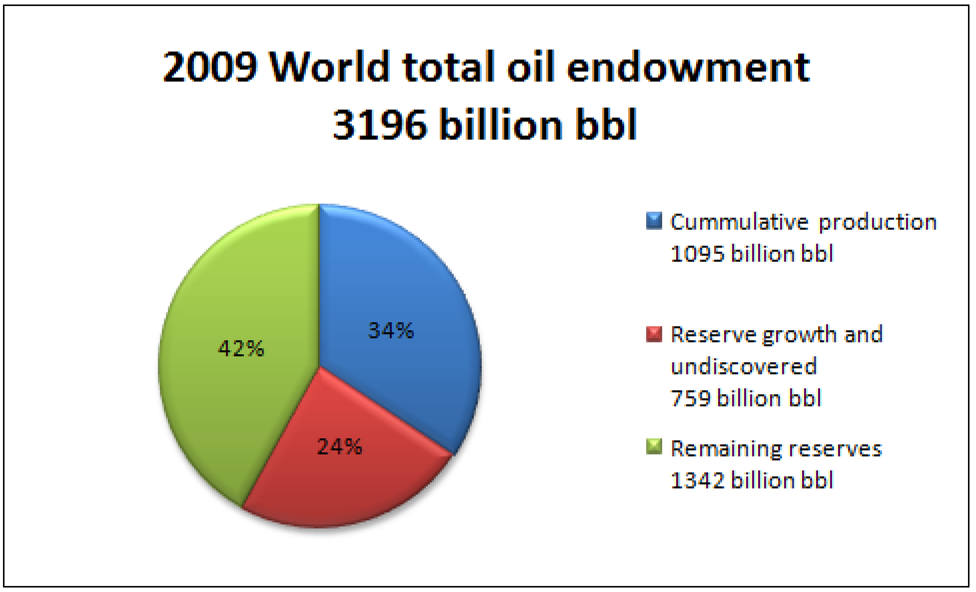

Figure 3.10: Global oil endowment components (incl. Canadian oil sands)
Source: EIA and USGS and further developed by Gorelick (2010), p. 30

Gorelick further fine-tuned the figures released by the USGS in the World Petroleum Assessment 2000. He added 175 billion bbl recoverable from Canada´s oil sands. The total world endowment of 3 200 billion bbl for 2009 would further increase to approximately 3500 billion bbl if NGLs were added. As shown in figure 3.10, in 2009 about one-third of the original conventional resources had already been consumed. Less than half of the oil endowment is left for future production. Only one-quarter remains due to new discoveries and additional output due to improved production. In the past hundreds of estimates have been made about those figures. The majority of calculations of estimated ultimate recoverable oil (cumulative production + remaining reserves = EUR=URR) lie in a range between 2200 billion bbl and 2900 billion bbl. [Rogner (2012), p. 436]. Whichever estimates are taken into account it is a fact that peak has already been reached or will be exceeded in the near future at least for conventional oil.

3.3.2 Conventional vs. unconventional sources

A very important factor in analyzing future availabilities of oil is the difference between conventional and unconventional occurrences. Conventional sources of oil can be defined as liquids which are readily pumped from a well [cf. Gorelick (2010), p. 27]. Unconventional sources are difficult and costly to exploit and require special technology to be produced. As unconventional oil cannot be extracted with the processes common for conventional sources, they require different cost profiles and lead to different environmental challenges [Rogner (2012), p. 434]. The future accessibility of unconventional oil correlates with the development of technology. Examples for unconventional sources are oil sands, oil shale, gas hydrates and heavy oil, and can be only included in EUR estimates when they become economically and technically producible.

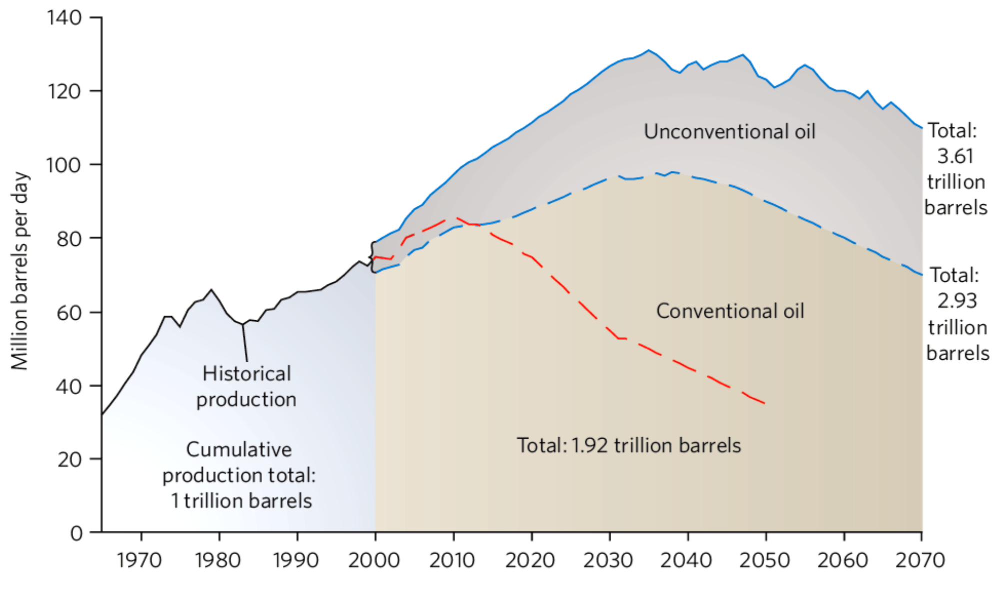

Figure 3.11: Effect of unconventional sources on peak oil
Source: Witze (2007) p. 14

In 2010 the most important component of oil production was conventional crude oil and represented 85% of total production [cf. Aleklett (2012), p. 43]. As displayed in figure 3.11 conventional oil production is going to peak in the foreseeable future between now and the middle of the century, with a peak production of 82-95 million bbl per day. [Rogner (2012), p. 437]. There are several constraints against the exploration of unconventional oil. It is very capital and energy intensive to bring unconventional oil to the market. Additionally, currently used production procedures can have enormous negative environmental impacts due to soil and water contamination. In the case that these sociopolitical issues can be overcome, the overall decline of oil will be deferred to the second half of the 21st century [Rogner (2012), p. 437].

As shown in figure 3.12, more than half of the total oil potential can be assigned to unconventional sources. 22 percent of total reserves are already non-conventional oil. Moreover, 66 percent of total resources are unconventional sources. The estimations from the BGR of unconventional oil resources seem to be rather conservative as other studies have evaluated a potential of more than 50000 EJ for unconventional resources [Rogner (2012), p. 445]. Therefore, those figures can only be taken as approximate calculations. In any event, the potential of unconventional oil is enormous.

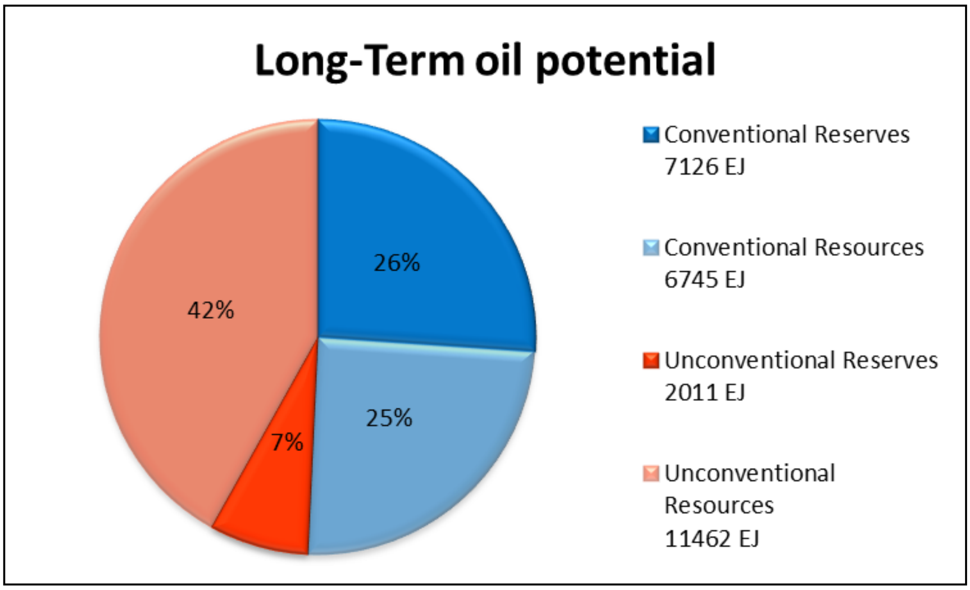

Figure 3.12: Potential of unconventional oil
Source: BGR (2014), p. 15

Figure 3.12 illustrates that with unconventional sources total potential oil deposits can be doubled which will delay a shortage of oil at least for several decades as shown in figure 3.11.

3.3.3 Trends of reserves and resources

Table 3.2 shows an overview of total crude oil sources per region. These figures include conventional and unconventional resources. Besides the oil sands in Canada and the heavy oil sources in Venezuela, the shale oil reserves available in the United States are also included. 44 percent of the total recoverable resources (cumulative production + reserves) have already been consumed. Europe has depleted more than 80 percent of its recoverable resources and becomes more and more dependent from other regions as Middle East where 40 of total recoverable resources are originated.

Table 3.2: Status of reserves and resources total crude oil in 2013 per region (Mt)

Country/Region	Production (Mt)	Cum. Production (Mt)	Reserves (Mt)	Resources (Mt)
Europe	165	9.706	2.116	6.992
CIS	671	26.920	18.055	49.307
Africa	431	16.034	17.796	31.187
Middle East	1.334	48.682	108.459	29.940
Austral-Asia	385	14.188	6.067	35.516
North Amrerica	821	43.107	35.065	89.705
Latin America	396	16.396	31.014	91.278
World	**4.202**	**175.033**	**218.572**	**333.925**

Sources: BGR (2014) p. 41

Between 1965 and 2013 there was an average yearly increase in production of 2.2 percent [cf. BP (2014)] with an average yearly economic growth of 3.3 percent. [cf. Knoema (2015)]. It can be assumed that those average values can also be expected in the coming years. And so the R/P ratio can be calculated. The R/P ratio is the volume or reserves divided by the annual rate of production [cf. Aleklett (2012), p. 120]. On the basis of the yearly production mentioned above, it would take until 2049 to exploit all recoverable resources estimated in 2013. Also, if all necessary technical prerequisites were given it would take until 2070 to use up all the reserves and resources which were calculated to be available in 2013.
Saudi Arabia, Canada, Venezuela, Iran and Iraq head the reserve ranking, whereas 60 percent of total oil reserves are owned by those top 5 states. Canada and Venezuela have mainly unconventional reserves and so they are dependent on a higher oil price and technological improvements to make the depletion of these reserves economical. Table 3.3 does not deliver any further surprises.

Table 3.3: Main countries with crude oil reserves in 2013 (Mt)

Ranking	Country/Region	Total (Mt)	Conventional (Mt)	Non-Conventional (Mt)		
				Oil Sand	Extra Heavy Oil	Tight oil
1	Saudi Arabia	35.400	35.400			
2	Canada	27.299	666	26.565		68
3	Venezuela	26.650	5.450		21.200	
4	Iran	21.469	21.469			
5	Iraq	19.621	19.621			
6	Kuwait	13.810	13.810			
7	United Arab Emirates	13.306	13.306			
8	Russia	12.657	12.657			
9	Libya	6.580	6.580			
10	USA	6.274	6.011		3	260
11	Nigeria	5.044	5.044			
12	Kazakhstan	4.082	4.082			
13	Qatar	3.435	3.435			
14	China	2.460	2.460			
15	Brazil	2.121	2.121			
16	Angola	1.723	1.723			
17	Algeria	1.660	1.660			
18	Mexico	1.492	1.492			
19	Ecuador	1.202	1.202			
20	Azerbaijan	952	952			
	Others	11.337	11.334		3	
	World	**218.574**	**170.475**	**26.565**	**21.206**	**328**

Source: BGR (2012) p. 75

Even though all BRIC states with the exception of India have control over a sufficient amount of reserves a high percentage of all available reserves are owned by oil exporting countries.

The further development of resources could be a lever to counter steer. Venezuela, Canada and Russia are the top three of the resource ranking and own 47 percent of all resources. The major part of the resources controlled by these states is unconventional.

Table 3.4: Main countries with crude oil resources in 2013 (Mt)

Ranking	Country/Region	Total (Mt)	Conventional (Mt)	Non-Conventional (Mt)		
				Oil Sand	Extra Heavy Oil	Tight oil
1	Venezuela	65.320	3.000		60.500	1.820
2	Canada	56.891	3.500	50.000	1	3.390
3	Russia	34.801	20.000	4.500	1	10.300
4	USA	24.553	15.727	850	76	7.900
5	China	20.724	16.200	25	119	4.380
6	Brazil	13.720	13.000			720
7	Saudi Arabia	11.800	11.800			
8	Kazakhstan	10.700	4.000	6.700		
9	Iran	7.200	7.200			
10	Iraq	6.100	6.100			
11	Angola	5.200	5.000	200		
12	Nigeria	5.090	5.000	90		
13	Mexico	4.761	2.980		1	1.780
14	Libya	4.750	1.200			3.550
15	Argentina	4.175	500			3.675
16	Indonesia	3.545	2.400	70		1.075
17	Greenland	3.500	3.500			
18	Australia	3.480	1.100			2.380
19	Algeria	2.375	1.600			775
20	Egypt	2.233	1.600		8	625
	Others	43.008	35.944	82	77	6.905
	World	**333.926**	**161.351**	**62.517**	**60.783**	**49.275**

Source: BGR (2014) p. 74

At least China, Russia, United States and Brazil have large amount resources available.

Discussions of global oil production are only relevant for countries that possess and produce oil but discussions of supply and consumptions concern every nation [cf. Aleklett (2012), p. 38]. As illustrated in the following chapters Oil Peak will affect us all.

4 Supply of oil

In this section the most important oil suppliers are listed. Additionally the historical trend in production and available capacities are analyzed to outline any possible coherences to oil price changes. The origin for the data analyzed in this part is BGR and BP. Further comments of the reasons why this data sources has been chosen for the analysis are explained in chapter 1.4.
Approximately 4200 Mt crude oil was produced all over the world in 2013 (cf. table 3.2). One third of this oil has its origin in the Middle East. Up to now, 28 percent of all cumulative production has been pumped out of the Arabian earth. As these countries have 50 percent of proven reserves in their territories, they will maintain a dominant position in crude oil production in the next decades.

Table 4.1: Crude oil production main countries in 2013 (Mt)

Ranking	Country / Region	Mt	Share (%)	
			Country	Cumulative
1	Saudi Arabia	524	12%	12%
2	Russia	523	12%	25%
3	USA	485	12%	36%
4	China	208	5%	41%
5	Canada	192	5%	46%
6	Iran	178	4%	50%
7	United Arab Emirates	166	4%	54%
8	Kuwait	165	4%	58%
9	Venezuela	158	4%	62%
10	Iraq	153	4%	65%
11	Mexico	144	3%	69%
12	Nigeria	118	3%	72%
13	Brazil	105	2%	74%
14	Norway	90	2%	76%
15	Angola	87	2%	78%
16	Qatar	84	2%	80%
17	Kazakhstan	84	2%	82%
18	Algeria	73	2%	84%
19	Colombia	53	1%	85%
20	Libya	48	1%	87%
	Others	565	13%	100%
	World	**4.202**		

Source: BGR (2014) p. 76

In 2013 Saudi Arabia, Russia, United States, China and Canada were the most important countries for oil production with a cumulative share of 46 percent. A comparison between tables 3.3 and 4.1 shows, that except for Saudi Arabia countries with the largest oil reserves do not automatically produce the most oil.
A reason for this is that Canada and Venezuela have mainly unconventional reserves where besides technical also environmental challenges need to be solved. Providing that issues can be hurdled, both Canada and Venezuela can extend production in the near future. Another cause is the unstable situation in the Arabic countries. Especially Iran and Iraq could increase productions tremendously if political challenges are solved.
However, as shown in table 4.1 non OPEC countries as Russia, United States, China, Canada, Mexico, Brazil, Norway, Kazakhstan and Colombia produce around 45 percent of the world´s oil even though these countries just own 17 percent of conventional reserves. Canada´s non-conventional oil sands increase this share up to 26 percent.

4.1 Historical trends in production

Figure 4.1 shows the historical development of daily oil production and includes crude oil, shale oil, oil sands and NGLs. The run of the production curve for world oil production is similar to that of OPEC which delivered approximately 40% of total production in the recent past.

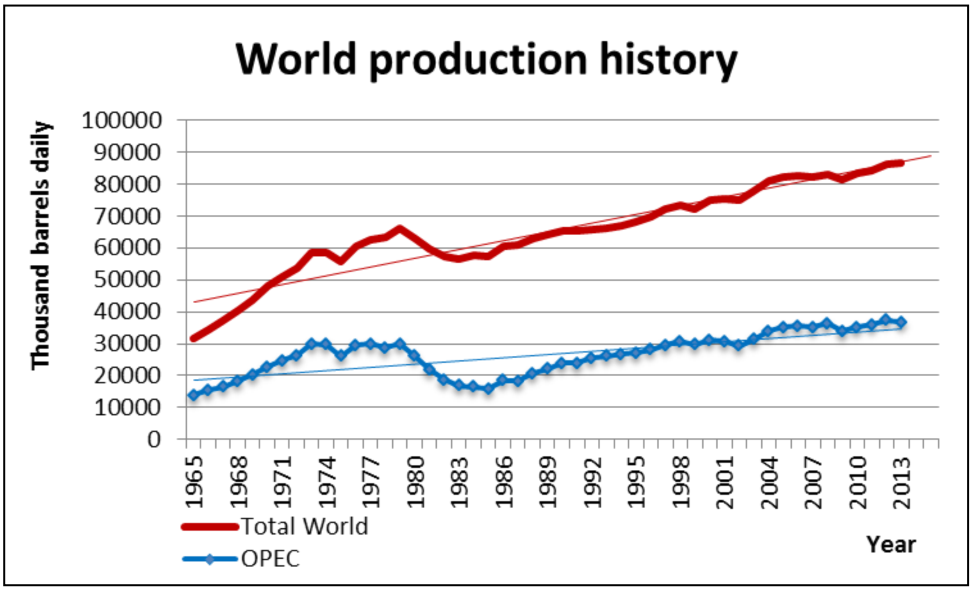

Figure 4.1: Historical development of daily oil production
Source: BP Statistical Review of World Energy (2014)

As visualized in figure 4.1 the trend line for production is steadily growing. The two declines in 1970s and at the beginning of the 1980s can be explained with the oil crisis where OPEC decided to reduce production for tactical reasons. In consequence of the Israeli-Palestine conflict in 1973 OPEC took over control of crude oil prices. The crude oil prices rose from 2 dollars up to 15 dollars per barrel. As a consequence there was a moderate decline of production. The second major decline was due to the break out of the Iran-Iraq war. Production difficulties in these countries and the panic buying of oil spiraled prices up to 40 dollars per barrel. In section 3.1 Peak oil was defined as the point in time when the maximum rate of oil extraction has been reached. As shown in figure 4.1 there are no visible indications for peak oil in the last 50 years. On the contrary, a steadily increase of production could be realized.

4.2 Refinery capacities

As depicted in figure 4.2 world refinery capacities have always been on a higher level than production and consumption. A reason for this is that capacities to process crude oil have been expanded step by step since 1965. The only exception, where overall capacities declined, was the first half of the 1980s. A reason for this was that industry tried to prevent overcapacities after the oil crisis.

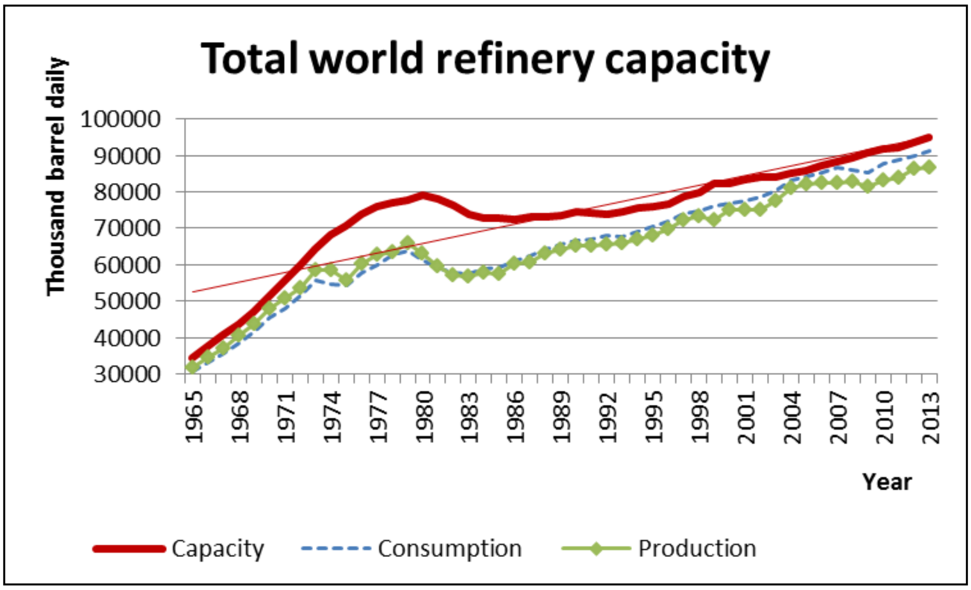

Figure 4.2: World refinery capacity
Source: BP Statistical Review of World Energy (2014)

Additionally, there was a marked learning curve in steadily processing crude oil in a more efficient way. At a first glance, figure 4.2 illustrates that available capacities have never been exploited by 100 percent in the last 50 years. So in general it can be assumed that refinery capacities should not have had any negative impact on oil prices. But today the quality of the crude oils is a more crucial factor than the quantity to meet the demand of products worldwide [cf. Carollo (2012), p. 10]. Due to environmental regulations in the last two decades there has been an increasing demand for high quality products. But refineries could not always deliver the desired finished products. For example there is a shortfall of up to 50 million tonnes per year of gasoline in the US and up to 40 million tonnes per year of gasoil in Europe. To bridge these gaps the western world had to import from other geographical areas. This deficit for high-quality finished products intensified the increase of oil prices.

4.3 Efficiency

Sufficient long-term supply is a function of investment in the R&D of exploration but also new production methods, extraction capacity, demand prospects and competitive markets [Rogner (2012), p. 434]. The energy return on energy invested (EROEI) will be a very important KPI in the coming years. As explained in section 3.3.2, unconventional sources will become more important in keeping pace with the rising demand for energy. 20 to 30 percent of the oil energy content has to be used for the production of unconventional oil compared to 10 to 15 percent for manufacture of conventional oil. So it will be one of the future challenges to steadily improve the EROEI for non-conventional reserves in order to prevent negative effects on oil prices.

5 Demand for oil

In this part the main countries where crude oil is consumed are discussed. Besides, the historical trends for demand and the impact of population’s growth on demand are reviewed. Afterwards a possible correlation between GDP and demand is being analyzed. Finally the difference between virtual and physical demand is being explained.

7 countries, namely United States, China, Japan, India, Russia, Brazi and Saudia Arabia, consumed 51 percent of world´s oil in 2013. Even though the United States represent only 5 percent of the world´s population, 19% of total world demand was consumed in the US alone. From a per capita standpoint, Saudi Arabia, Canada and United States are the largest consumers with more than 25 barrels per person per year [cf. Gorelick (2010), p. 33].

Table 5.1: Crude oil consumption main countries in 2013 (Mt)

Ranking	Country / Region	Mt	Share (%)	
			Country	Cumulative
1	USA	824	19%	19%
2	China	507	12%	31%
3	Japan	227	5%	37%
4	India	175	4%	41%
5	Russia	153	4%	45%
6	Brazil	148	3%	48%
7	Saudi Arabia	128	3%	51%
8	South Korea	115	3%	54%
9	Germany	113	3%	57%
10	Mexico	105	2%	59%
11	Canada	101	2%	61%
12	Iran	88	2%	63%
13	France	82	2%	65%
14	Indonesia	74	2%	67%
15	Unites Kingdom	67	2%	69%
16	Singapore	66	2%	70%
17	Italy	62	1%	72%
18	Spain	55	1%	73%
19	Austrailia	47	1%	74%
20	Taiwan	43	1%	75%
	Others	1.049	25%	100%
	World	**4.227**		

Source: BGR (2014) p. 77

After making a comparison between table 4.1 and 5.1 we can see that Unites States, China, Japan, India, Germany and South Korea consume much more oil than these states can produce domestically. Figure 5.1 gives an overview about the estimates of net oil importers in 2012 evaluated by EIA. The shown figures are estimates of production less consumptions, but do not account for stock building. Over the past 30 years United States became more and more dependent on foreign oil. Net imports increased from approximately 4.5 million in the beginning of the 1980s to 12.5 million barrels per day in 2007. Due to extraction of unconventional reserves this negative development could be reversed afterwards. At the moment net imports are at a level of 6.4 million barrel per day. China was a net oil exporter until 1992. Due to the enormous economic growth the world most populous country became the largest energy consumer and the second largest oil consumer. In 2013 the net oil imports were already on a level of 5.8 million barrels per day. Japan is the world third largest oil importer. The net imports have always been in a band between 4.5 and 5.5 million barrels per day. India is the fourth greatest energy consumer after China, the Unites States and Russia. India had a similar economic recovery as China on a lower level and so had net imports of 2.5 million barrels per day in 2013.

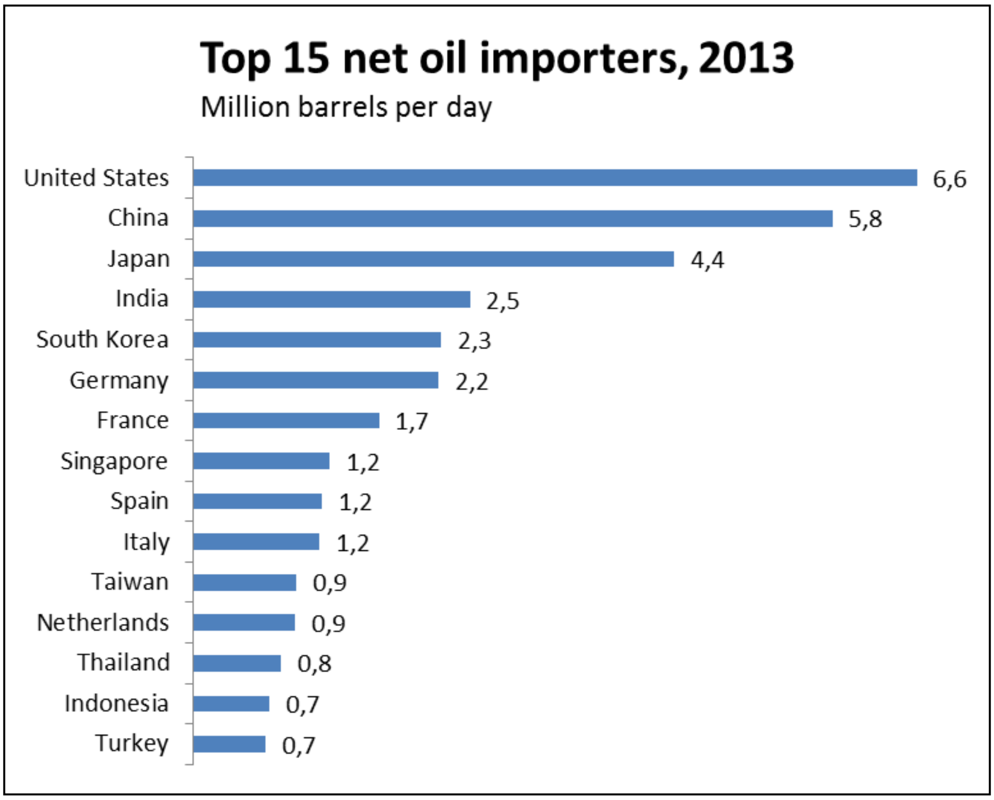

Figure 5.1: Net oil importers in 2013
Source: EIA (2015)

Ahead everyone Saudi Arabia is the most important oil exporting country for many years. On average it sold 8.7 million barrels per day in 2013 (cf. figure 5.2).
Beside the OPEC states Russia is a very important net oil exporter with 7.2 million barrels per day. Since the 1980s Canada is step by step becoming more and more important as an oil exporting country. Due to its enormous non-conventional reserves (cf. table 3.3) Canada will further expand its position as key player in the oil business. The same applies for Venezuela which was already an important supplier especially for the United States anyway. Exports from the Arab-Persian Gulf, namely Saudi Arabia, Kuwait, United Arab Emirates, Iran, Iraq and Qatar peaked during 2010 above 17 million barrels per day. That´s why other regions are needed to satisfy the increasing demand for oil. [cf. Wirl (2013) p 182]

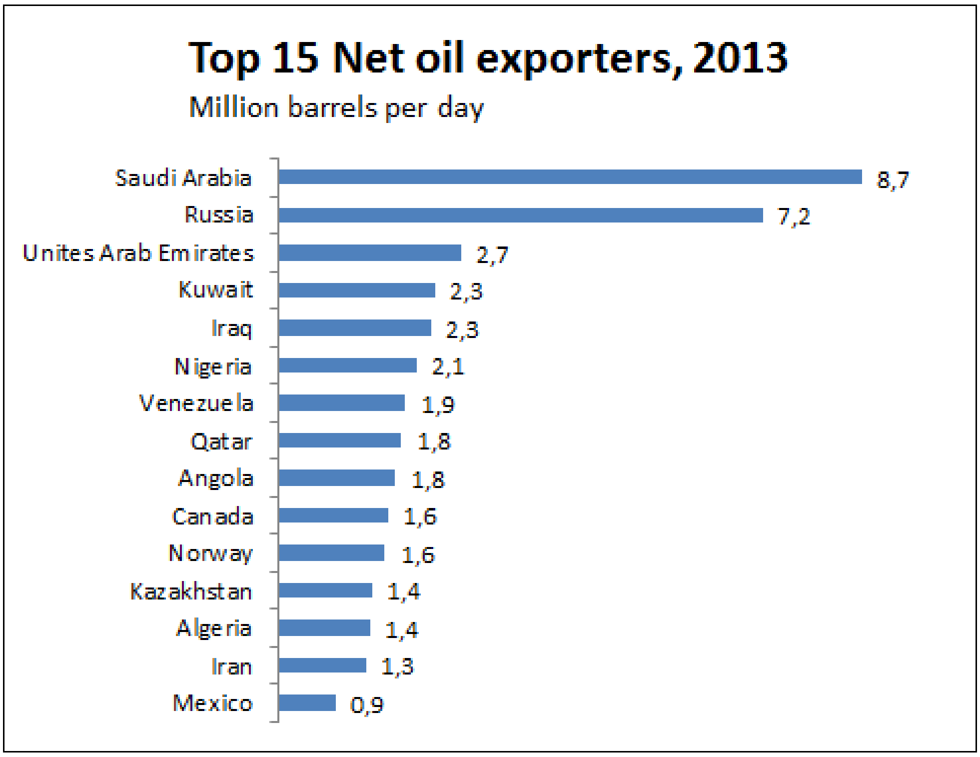

Figure 5.2: Net oil exporters, 2013
Source: EIA (2015)

5.1 Historical trends for demand

At a first glance it looks like as though the world, since the 1980s, has been consuming more oil than it has been producing (cf. figure 5.1). In fact, we consume what we produce [cf. Gorelick (2010), p. 38]. The main reason for the difference is processing gains which are consumed in addition to the oil pumped from the ground.

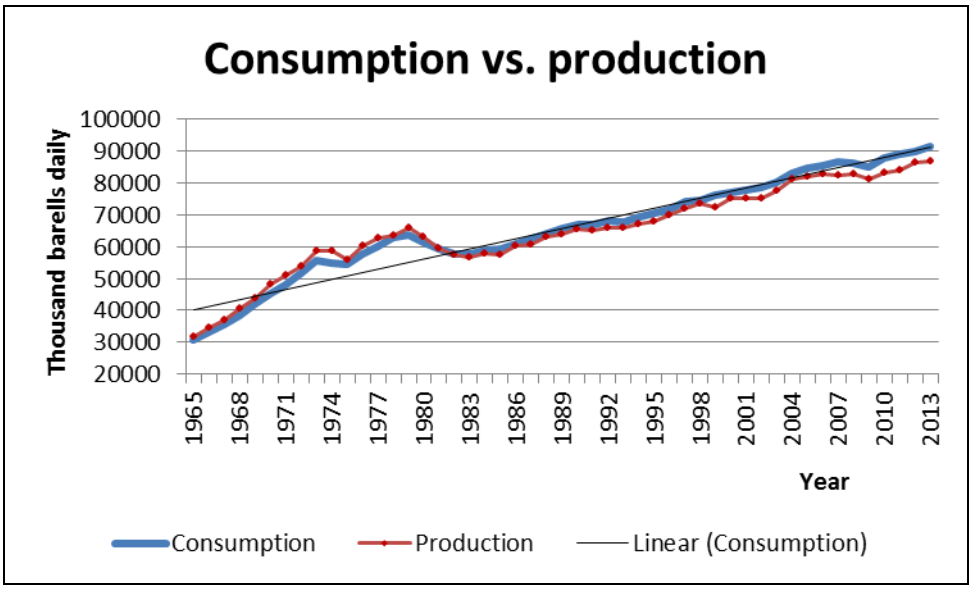

Figure 5.3: Historical development of daily oil consumption vs. production
Source: BP Statistical Review of World Energy (2014)

A main reason for the increasing demand for oil is the positive development of the economy in the second part of 20th century. Especially the positive economic development in the BRIC states will further increase the demand in these countries which cannot be covered by domestic production with the exception of Russia (cf. figure 5.2 and figure 5.3). Additionally, consumption was boosted by a tremendous increase in population.

5.2 Population

In this sub chapter some scenarios are being checked to evaluate the possible consequences of growth in world population on future oil demand. Additionally the leverage effect of BRIC states due to tremendous economic growth is being discussed

From 1950 to 2010 the world population has nearly tripled. The United Nations is evaluating scenarios about possible population development on a regular basis. One of the latest publication appeared in 2012. In the enclosed figure 5.4, two of these scenarios are visualized. In the worst case, the world population is expected to grow further to 17 billion people.

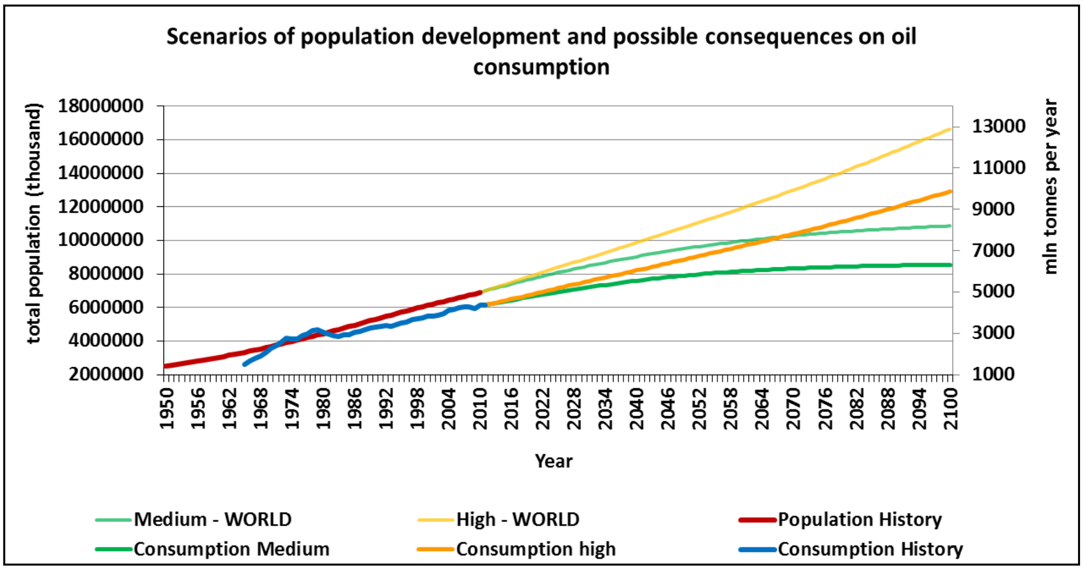

Figure 5.4: Future Production & consumption development on the basis population scenarios
Source: United Nations (2012), BP (2014), BP Statistical Review of World Energy (2014)

From 1950 to 2010 there was an average world yearly oil consumption of 0.626 tons per inhabitant. As this ratio didn´t change significantly in recent years, figure 5.4 shows an extrapolation with this ratio value to predict the consequences of the impending population growth on world oil demand. In the next hundred years, a consumption increase of 50 percent can be expected with the medium scenario. There could be even a doubling of oil demand under this term with an extrapolation of the high world scenario. If this tremendous increase of demand will have a negative impact on oil price will mainly depend on the following two factors: Firstly the oil exporting countries must agree to extend outputs and industry need to invest at an early stage in advance to enlarge refinery capacities.
As visualized in table 5.1 in 2013 19 percent of crude oil is being consumed in the United States, with about 5 percent of the world´s population. In comparison the BRIC states only used 23 percent of world´s oil, with about 42% of world´s population. As shown in figure 4.1 in 2013 approximately 87 million barrel crude oil was produced. If the BRIC states consumed the same amount of oil per inhabitant as the United States does this would mean that demand would increase by approximately 160 percent. In the case oil productions would remain flat, then the additional requested demand must come from redistribution such that United States, Europe and Japan reduce their consumption by an equivalent amount. [cf. Aleklett (2012), p. 52].

5.3 Impact of GDP on oil production and consumption

In this section the correlation between economic growth and steadily increasing amount of available oil is being discussed and coherencies to prices changes are reviewed.

The hunger for energy is unabatedly growing on a yearly basis as steadily more mouths have to be fed. The average world economic growth was a real success story as depicted in figure 5.5. GDP grew by more than 600 percent between 1960 and 2013. Unfortunately, this economic growth didn´t reach all parts of the world. Nevertheless, even GDP per capita could be nearly tripled. It stands to reason that the main lever for this positive development of GDP was oil as one of the major energy sources. Oil has a very high energy density and is used for a wide range of products. Oil is used in different areas, from the manufacture of synthetic, pharmaceutical, chemical goods, to transport of goods and people, to food production, to operating construction equipment. Even though it is possible to become more independent from oil in some areas the prospects for substitution to alternatives are limited.

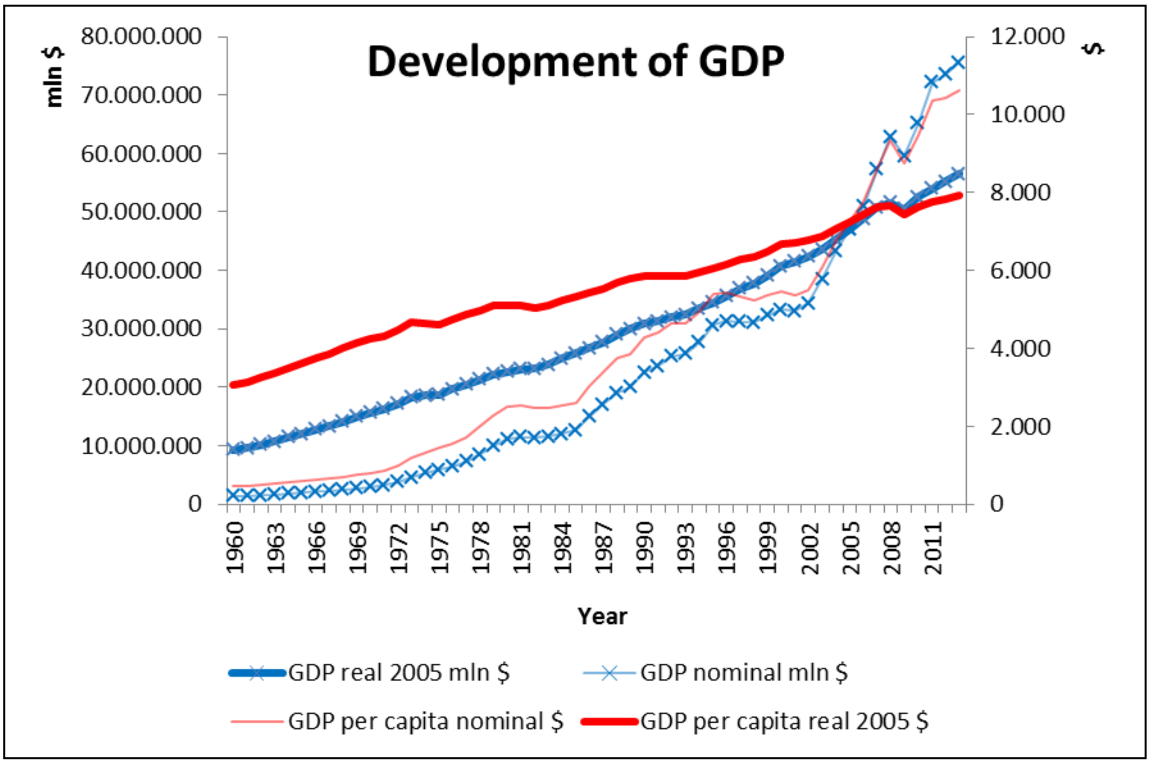

Figure 5.5: Development of GDP
Source: Knoema (2015)

In the year 2012 31% of the overall energy demand was accommodated with oil. Furthermore this commodity will also remain dominant in the coming decades as predicted by IEA in the New Policies Scenario [cf. IEA (2014), p. 56]. As a consequence a sustainable positive development of GDP and the world economy can only be assured if enough additional energy is available. As the most important feedstock in the primary fuel mix oil has and will have a key role to keep global economy booming. Figure 5.6 illustrates, that for a positive GDP development, a corresponding increase in oil production is an important prerequisite. The line for oil consumption is similar to the one of production whereas the last one is more volatile.

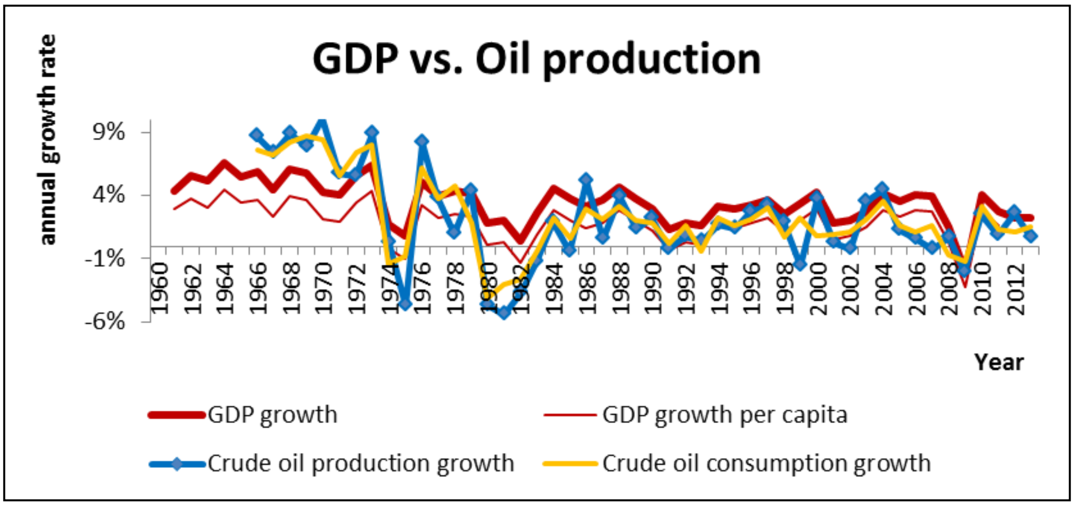

Figure 5.6: GDP growth versus production growth
Source: Knoema (2015)

Production and consumption rate became three times negative in recent history. The first two occasions were caused by the oil crisis in the 1970s and at the beginning of the 1980s. The last breakdown of production and consumption happened in 2008. Even though the collapse of consumption was more moderate the world dropped into a recession. One of the reasons for this is that beside the physical demand there was also a virtual demand which tremendously crashed as several important banks didn´t have sufficient liquidity anymore to deal with oil futures.

5.4 Physical vs. virtual demand

In this sub chapter the difference between physical and virtual demand is being elaborated to understand if additional virtual demand is a lever for price changes. In recent history there have been 3 major price changes. As there didn´t exist a virtual demand in the 1970s and at the beginning of the 1980s the differences to the crisis in 2008 can be analyzed.

As worked out in 5.1 there was a constant growth in consumption over the past 40 years. This increasing demand was met by a similar growing production. That´s why there have to be other additional reasons for tremendous oil price change in recent years. One reason was that in 1980s an oil future market was created. This almost unnoticed change transferred the control of the international oil market out of the hands of OPEC countries into those of the financial metropolises as London and New York [cf. Carollo (2012), p. 12.]

From that time on total demand consisted of physical demand which equals consumption and virtual demand. Virtual demand is a second type of demand due to future contracts in addition to physical demand [cf. Haas (2011)]. As depicted in figure 5.7 there was a rapid increase of virtual demand after the year 2000 which had direct impact on the price volatility of oil. The price changes in the 1970s and the 1980s had been caused by oil crises due to act of war in oil producing countries.

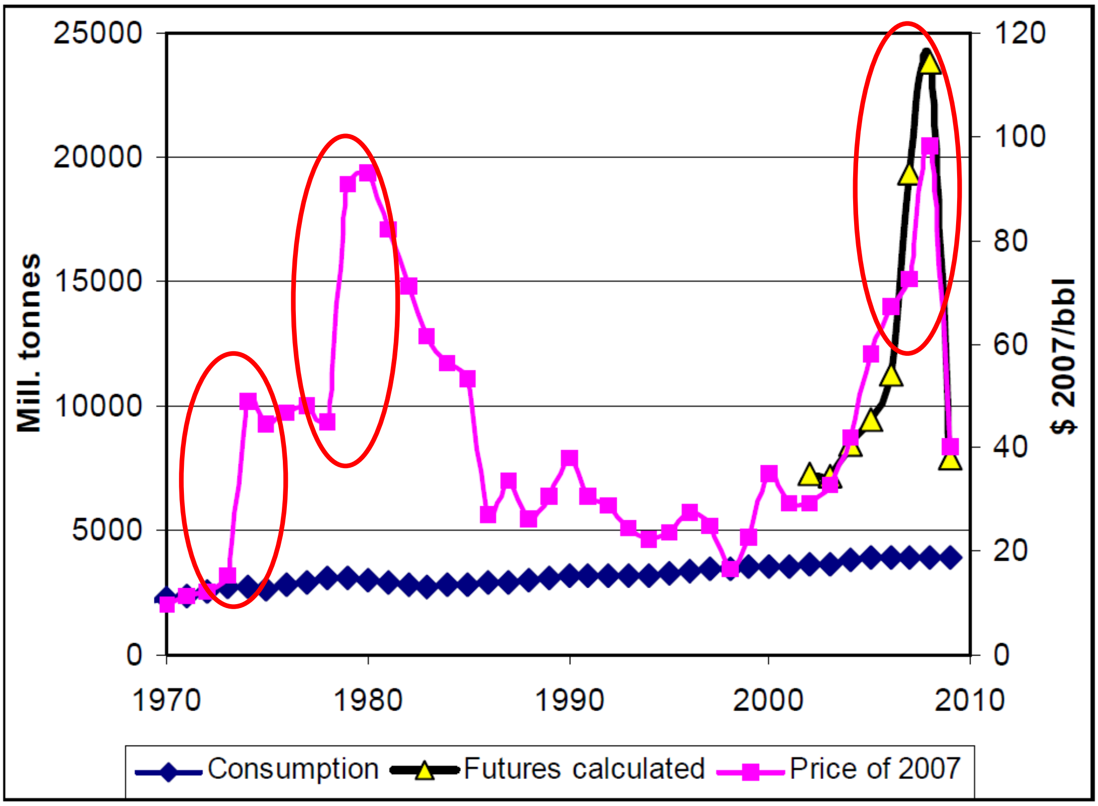

Figure 5.7: Physical vs. virtual demand
Source: Haas (2011)

6 Drivers and slowers of oil price

In the following chapter the main parameters for price setting of crude oil are discussed. Firstly, the historical development of oil prices and the complexity of the oil market are being discussed. Secondly, the interdependencies between physical and virtual oil market are illustrated. Furthermore, the impact of supply and demand on oil price is further analyzed. After illustrating the influence of OPEC and politics on oil price possible future price scenarios are being discussed.

6.1 Historical development of oil prices

In general crude oil is of different qualities and yields differing amounts. The price of crude oil is determined by its quality and market factors [cf. Gorelick (2010), p.40]. Figure 6.1 illustrates the development of oil prices since records began. The line with normalized prices at a dollar value of 2013 shows three main price fluctuations which happened around 1865, around 1980 and after 2000. None of these price peaks have been caused by production bottlenecks as illustrated in chapter 5.4.

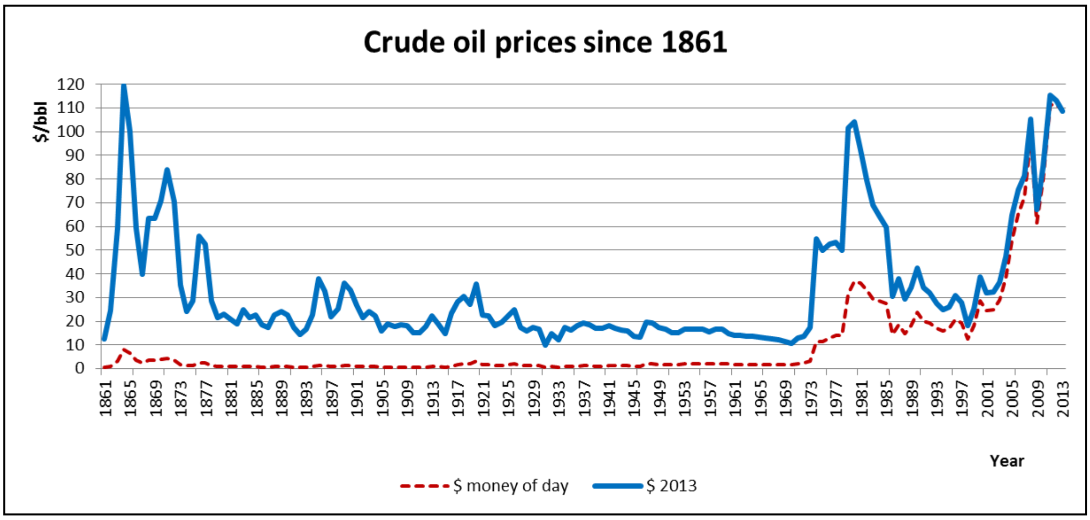

Figure 6.1: Historical development of crude oil prices
Source: BP Statistical Review of World Energy (2014)

More than 150 different oils are traded all over the world. The most common benchmarks are Brent and West Texas Intermediate (WTI). Brent Blend stays for 15 oil fields in the North Sea and is a sweet light crude oil. WTI from Texas is also a sweet light crude oil but with 0.24 sulfur sweeter than Brent.

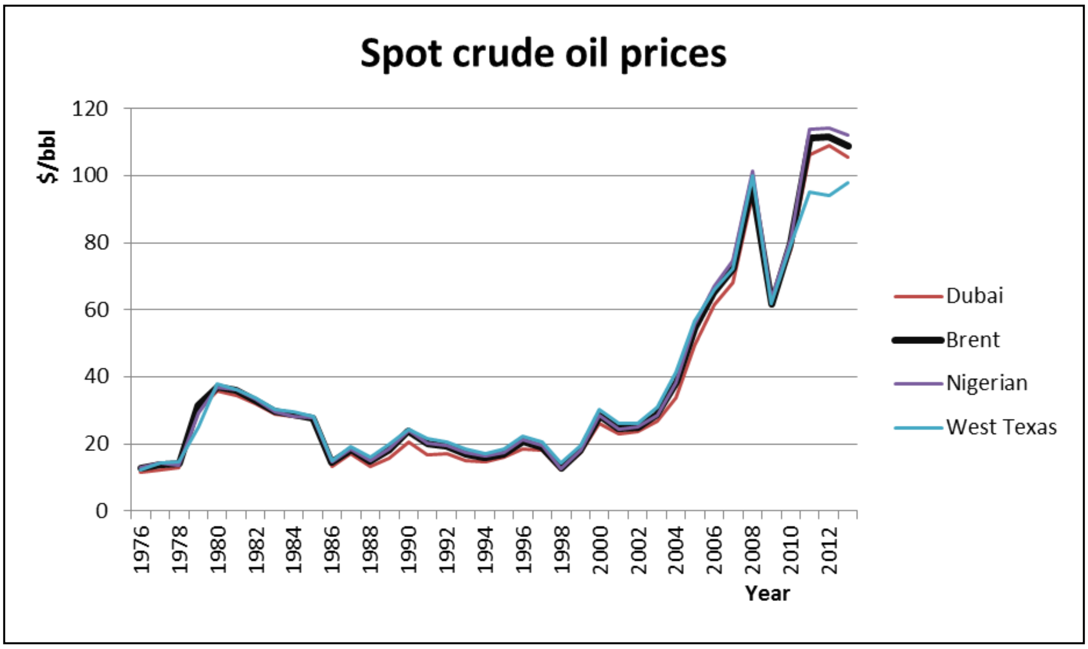

Figure 6.2: Development of spot crude oil prices
Source: BP Statistical Review of World Energy (2014)

As quality is a main price indicator it can account for a price differential of over 10 percent [cf. Gorelick (2010), p.41]. However, the most important benchmark baskets have in general a similar price trend as they follow the ups and downs of the global market (cf. figure 6.2). Western Texas Intermediate was priced approximately 10 to 15 below other benchmarks in recent years as there was an oversupply in the United States due to shale oil.

6.2 Interdependences in the oil market.

In this subchapter the different dimensions and its interdependences of the oil market will be described. Moreover an explanation for the instabilities in this market is being given. Beside the physical oil market the financial oil market gained in importance which has been set up in the 1980s. Figure 6.3 visualizes the complexity in the oil market.

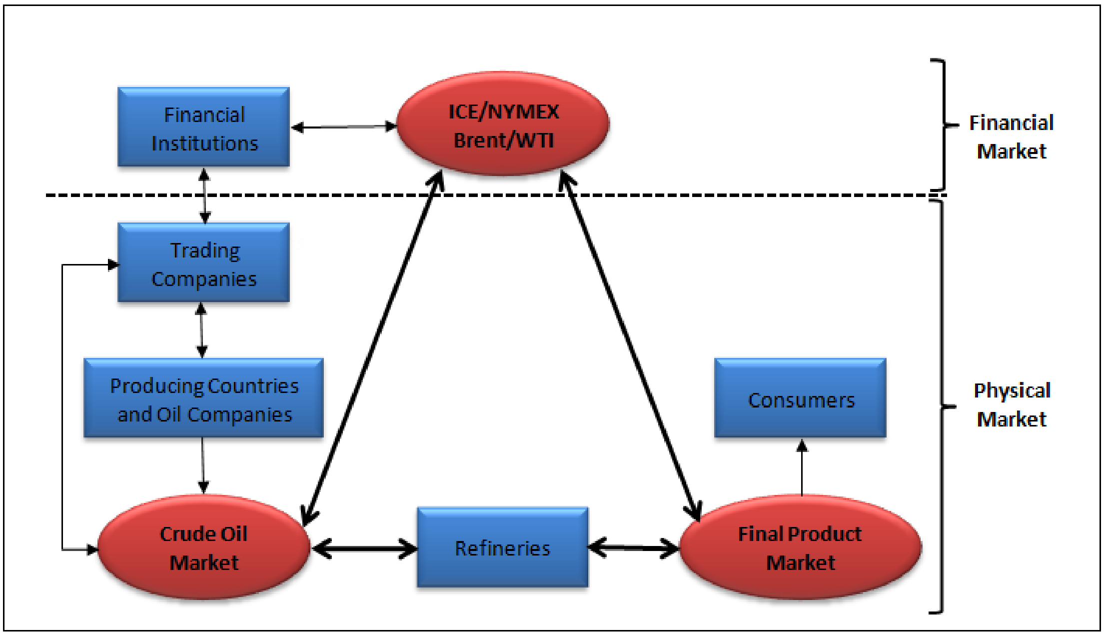

Figure 6.3: Complexity in the oil market
Source: Carollo (2012)

What is commonly known as the oil market is the conjunction of different markets which operate independently, but which are linked through complex mechanisms and dynamics. [cf. Carollo (2012), p. 4]. The oil market consists of the crude oil market (raw material), the final product market (e.g. gasoline, diesel, jet fuel, lubricants) and the financial market for crude oil and finished products (future market) as illustrated in figure 6.3. Financial speculation is not the only reason for the chaos in the oil market in recent years. Stability will only return if structural problems are solved. At the moment there is a lack of an energy policy to harmonize the growing energy demand. The environmental regulations in the last decades have led to a shortage of clean end products in the western world which have to be imported from other areas. This has a negative impact on the local consumers as this behaviour boosts the price spiral. Unfortunately, these regulations were not motivating enough to bring about structural investments for producing compliant energy and products.

6.3 Impact of supply and demand on oil price

A key question is what if oil price simply follows the classic models of economics which assume that price is a function of supply and demand.

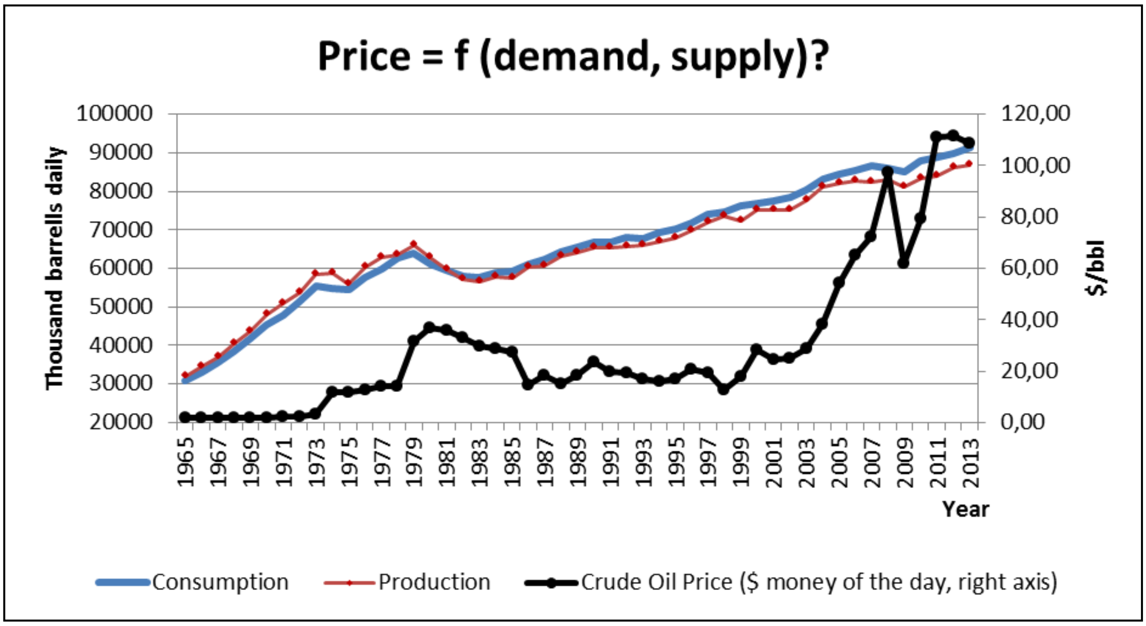

Figure 6.4: Development of price in comparison to consumption & production
Source: BP Statistical Review of World Energy (2014)

As illustrated in figure 6.4, oil price movements in general follow the classic model of economics. Even the price increases after 2000 were caused by demand. As discussed in chapter 5.4 this virtual demand was driven by financial markets and was not caused by physical consumption. In chapter 5.1 it was explained in detail that in the past consumption was equal to production. Thus, the frequently used argument that price increases happened because consumption is over production is not right. Especially after the year 2000 it is obvious that beside physical supply and demand other factors like virtual demand determined the price of crude oil.
Moreover atypical market behaviors occurred, for example, when public announcements about increasing production by OPEC lead to higher prices. These are clear indicators that oil prices are mainly steered by the financial markets rather than the physical market in the past.
Moreover, the demand (but also supply) sluggishness needs to be considered. [cf. Wirl (2013) p 181]. For example oil demands depend on the energy efficiency of durables and consequently consumption is incompatible with static demand. In

addition, supply for additional oil needs a lead time several years. That is why a dynamic analysis of oil prices is needed. [cf. Wirl (2007) p 1032]

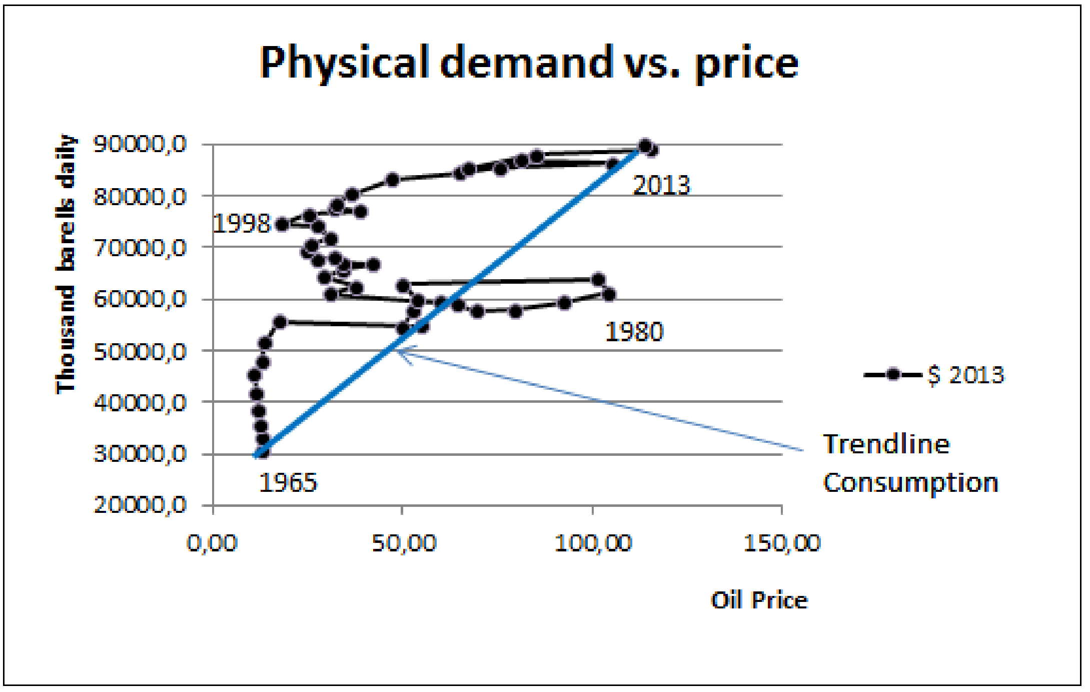

Figure 6.5: Physical demand vs. price
Source: BP Statistical Review of World Energy (2014)

Figure 6.5 illustrates the development of physical demand and the oil price from 1965 to 2013. Real consumption of oil has increased steadily. There have been just three relevant exceptions, namely the two oil crises in the 1970s and 1980s, but also the economic crisis in 2007. It can be seen that in general there is no direct correlation between physical demand and oil price. As shown in figure 5.7, the financial markets seem to be the main triggers for price changes from demand side. Furthermore, the uncertainty of demand and also of supply in regional markets is a relevant driver or slower for world oil prices [cf. Wirl (2013) p 181]. Examples are the oil embargo in 1973 or the recent hype for shale oil in US. But also demand shocks caused from booming BRIC states as China and India are examples for demand shocks.

Finally, it needs to be taken into account that with increasing prices long-term demand is mainly convex [cf. Wirl (2013) p 181]. The more elastic segments of demand are reduced as oil prices increase. High oil prices reduce for example the share of oil in heating and industrial uses and leave the transport as the major

demand sector for refined products. In the case of a convex demand situation it is optimal for OPEC to switch between a high and low price strategy. [cf. Wirl (2007) p 1032]
Based on this assumptions Wirl and Caban [cf. Wirl (2013) p 182] developed a model for oil prices with the meta-target to maximize present value of profits which can be assumed as the price strategy of the key players of the oil market. Especially for OPEC decisions profit maximization has been assumed as the standard assumption of economics [cf. Wirl (2007) p 1031].
To satisfy the increasing hunger for oil, unconventional reserves and resources become increasingly important. As it is very capital and energy intensive to bring unconventional oil to the market, these higher production costs will lead to increasing prices. Different studies [cf. Rogner (2012), p. 447 and Haas (2011)] have predicted the end of cheap oil and estimate that unconventional oil costs will cost many times more than conventional oil. As a consequence it can be assumed that the peak of conventional oil sources will lead to higher oil prices even though new energy sources, such as shale oil and gas, can, in the short term, have a decreasing impact on prices.

6.4 Political impact on oil prices

As the importance of politics in energy markets cannot be neglected. BP linked its yearly published statistical review of world energy all major price changes to large external political events which have been visualized for the most important oil price changes in figure 6.6 [cf. BP (2014), p. 15].

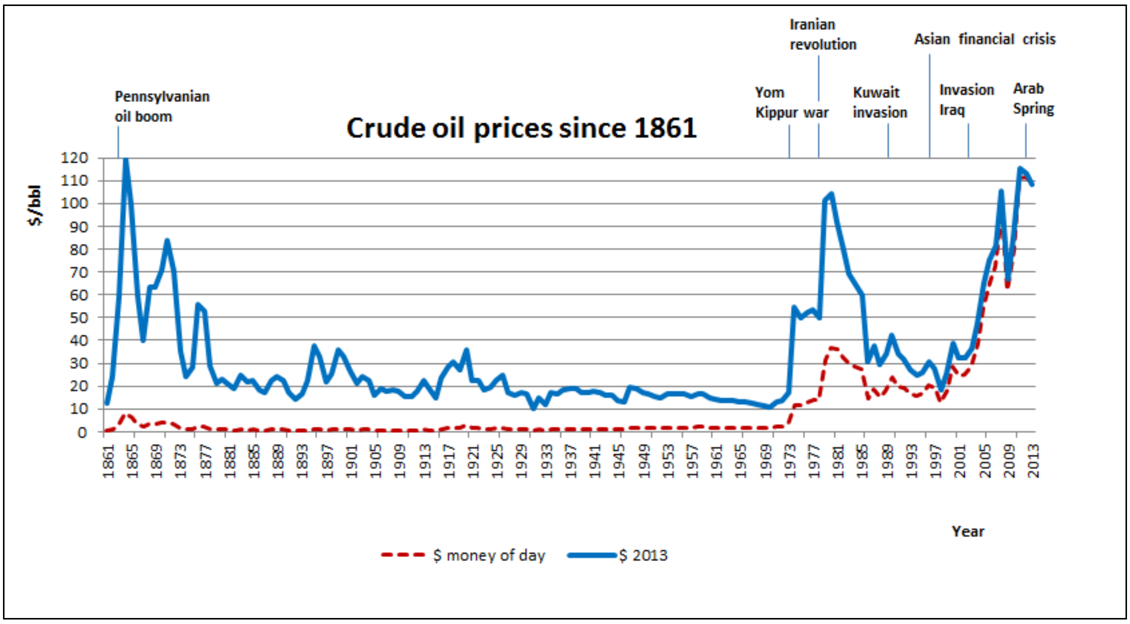

Figure 6.6: Political influence on oil price
Source: BP Statistical Review of World Energy (2014)

Especially since the Arab Spring national tendencies increasingly appeared. That is why the use of the oil weapon could be rational for decision makers in the Arab-Persian Gulf countries to harm the West even if it reduces long-term profits. Moreover the sluggishness of demand motivates such political behaviors as the short–term revenues would increase at times of high demand. [cf. Wirl (2013) p 190]. In general, politicians are much less profit oriented than businessman as politicians may be rewarded for decisions that harm the economy [cf. Wirl (2007) p 1037]. Anyhow, political influence is just one of several impact factors on oil price and should not be overvalued.

6.5 Impact of OPEC on oil prices

As depicted in figure 4.1, OPEC delivers approximately 40 percent of world oil production. So this cartel plays an important role as it has very high production flexibility [cf. Haas (2009)]. OPEC is the only organization which can easily reduce and extend or reduce production as most members do have a low rate of own consumption. In general, OPEC has a high interest in high oil prices as long as consumption is high. As depicted in figure 6.6, up to the mid-1980s OPEC always tried to adjust its supply in order to keep the high price level stable. This strategy works as long as all members followed these arrangements.

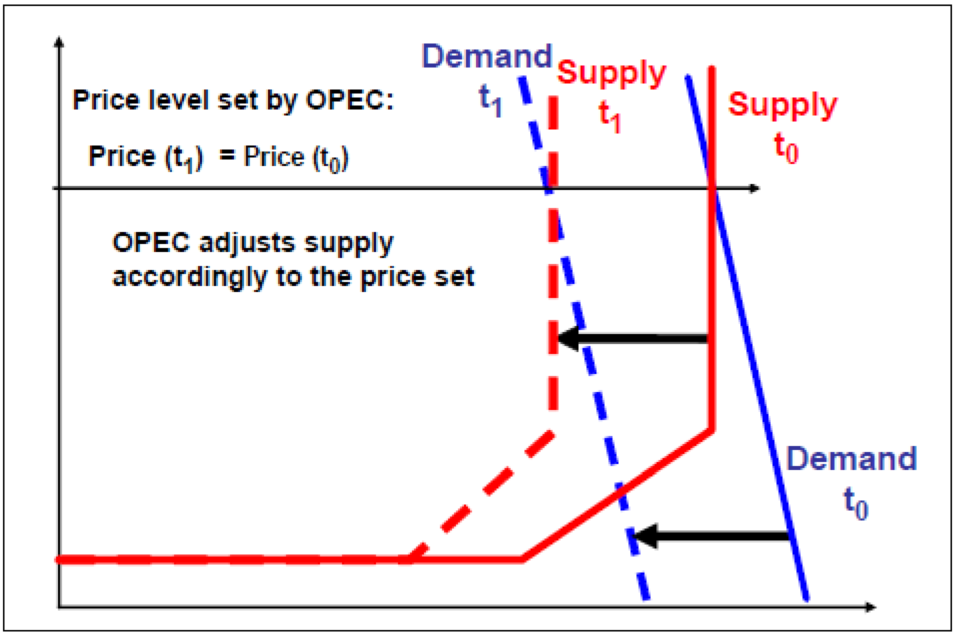

Figure 6.7: Steering of oil prices by OPEC in 1982-1985
Source: Haas (2009)

Output cuts as visualized in figure 6.7 offer OPEC decision makers two important benefits: high short-term revenues and support of their followers. In 1985, Saudia Arabia broke out and canceled the above pricing policy. As a consequence OPEC lost part of its power but is still having dominant influence as its members hold approximately 69% of world oil reserves [cf. BP (2014)]. While non OPEC producers produce at their capacity, the core members of OPEC vary their output substantially, reflecting market fundamentals as well as strategic moves. [cf. Wirl (2013) p 180]. A practical example is the behavior of Saudi Arabia in 2014/2015. In recent years OPEC had to face with global competitors as US shale fracking operators. As a consequence Saudi Arabia, the key player in OPEC, decided not to reduce production for indefinite time, even though oil prices went below 50 USD in 2014. A reason for this is that Saudi Arabia has the lowest production costs in the world which are estimated to be around 15 USD per barrel. As US fracking operators have to deal with costs of approximately 70 USD per barrel it became uneconomic to invest in new fracking projects. OPEC still has the long term goal to keep high oil prices. But there is also a high interest to push high cost producers out of the market to assure not to lose any more control. Due to such strategic considerations Saudi Arabia is operating with production ranges between 3,6 and 10 million barrels per day. As a consequence the marginal barrel is a low cost barrel from OPEC and not a high cost one as economic efficiency would require. [cf. Wirl (2013) p 180]. Anyhow, the OPEC members need to bear in mind the convex demand. According to calculations done by Wirl and Caban a high price strategy around 100 USD per barrel reduces exports of the core OPEC members to 10 million barrels per day whereas prices at extractions costs would boost demand up to 30 million barrels per day. Such dynamic marketing conditions lead to cartel policies which alternate between high and low oil prices [cf. Wirl (1990) p 761].

6.6 Impact of virtual demand on oil price

The energy economics group from Vienna University of Technology led by Professor Haas compared the parameters for volatile prices in the 1970s and 1980s with reasons for price changes after 2000 [cf. Haas (2009)]. The result of this study was that formerly price increases were mainly driven by OPEC whereas price drops happened due to significant decreases in demand (cf. figure 6.7). The reasons for volatile prices after the year 1985 were increases or decreases of virtual demand which can be seen as an indicator that OPEC had lost some of its market power to financial markets. (cf. figure 6.8 and figure 6.9)

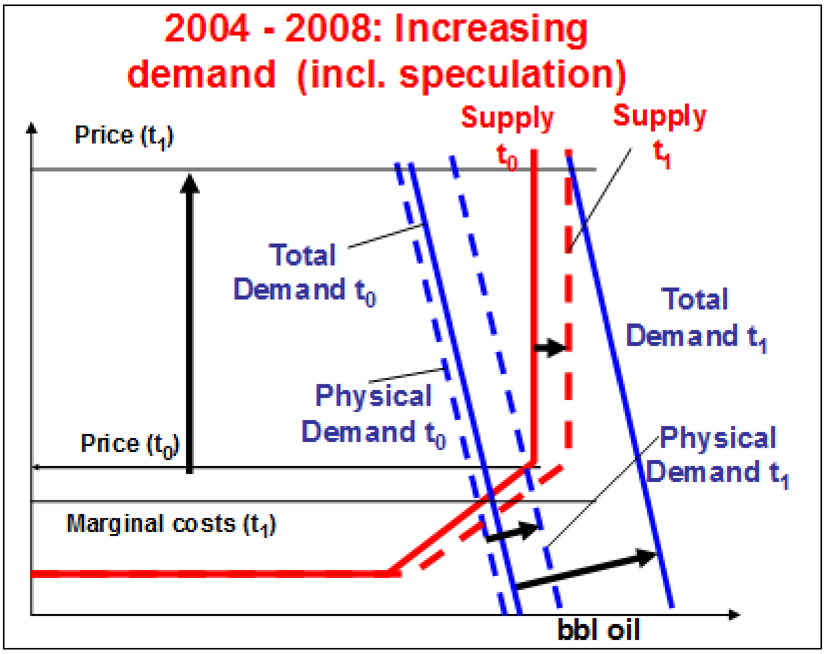

Figure 6.8: Oil price development between 2004 and 2008
Source: Haas (2009)

The result of the research group steered by Prof. Haas shows that the main trigger for increasing oil prices between 2004 and 2008 was financial speculation which boosted total demand in addition to the increasing physical demand.

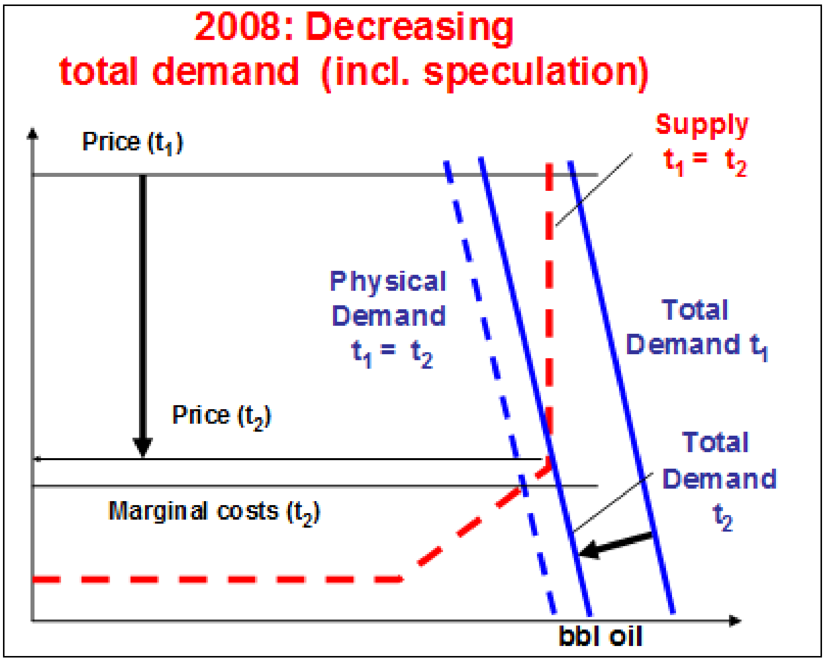

Figure 6.9: Oil price development after 2008
Source: Haas (2009)

In 2008 virtual demand collapsed due to the economic crisis even though the physical demand and supply remained stable. Nevertheless, the enormous lift in total demand led to decreasing prices.

6.7 Possible consequences of peak oil on prices

As described in chapter 3.3.2, we will run out of cheap oil somewhere between now and 2050, which can also be labeled “cheap peak oil” [cf. Hass (2011)]. Investments in new technology to pump up more unconventional oil will lead to additional supply.

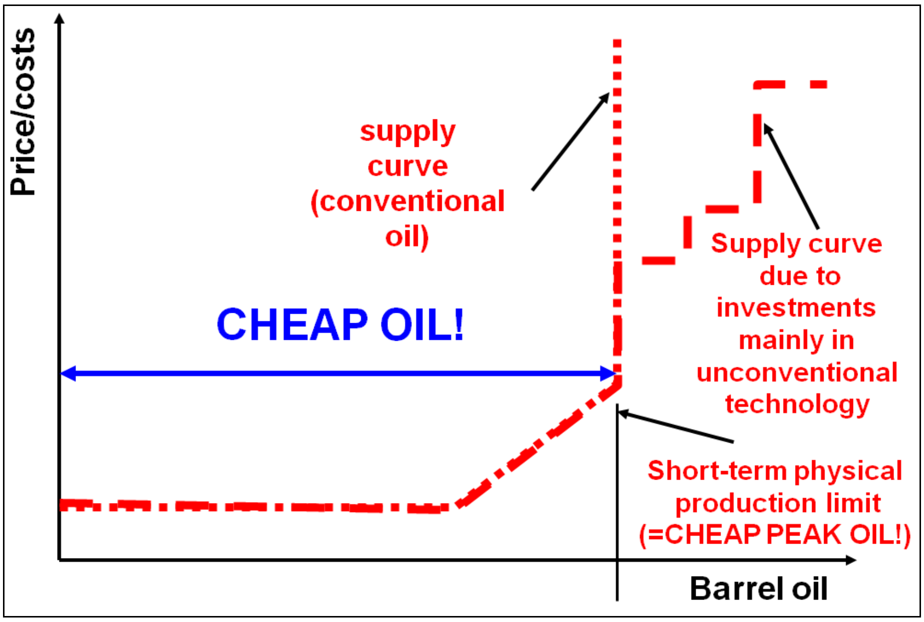

Figure 6.10: Impact of investment in unconventional technology on supply curve
Source: Haas (2009)

After all spare capacities and remaining inventories have been depleted, peak oil would lead to a supply shortage as production couldn´t satisfy the increasing demand anymore. Afterwards prices are likely to rise soon due to supply shortages. Increasing prices will reduce the demand for oil.

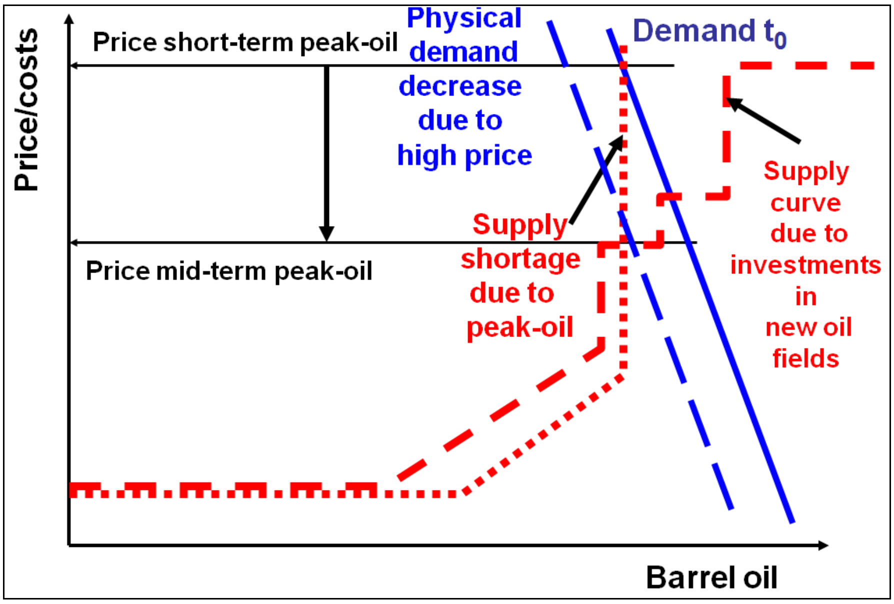

Figure 6.11: Short-term and long-term effects of peak oil on price
Source: Haas (2009)

Although the day will come when we run out of cheap oil, this will not lead to peak oil in general. A shortage in supply combined with a high short-term oil price will stimulate investments in new more expensive oil fields and unconventional technology. As analysed in chapter 3.3, an enormous amount of resources still exist. This additional production will slash prices on the market. Due to higher production costs, the oil price will level off at a higher price than before peak oil.

6.8 Future oil price scenarios

In the recently by IEA published World Energy Outlook 2014 scenarios are used to offer projections of long-term energy trends. In the report three scenarios, namely the "New Policy scenario", the Current Policies Scenario" and the "450 Scenario", are presented which differ in their assumptions about the evolution of government policies with respect to energy and environment [cf. IEA (2014) pp 36-39].

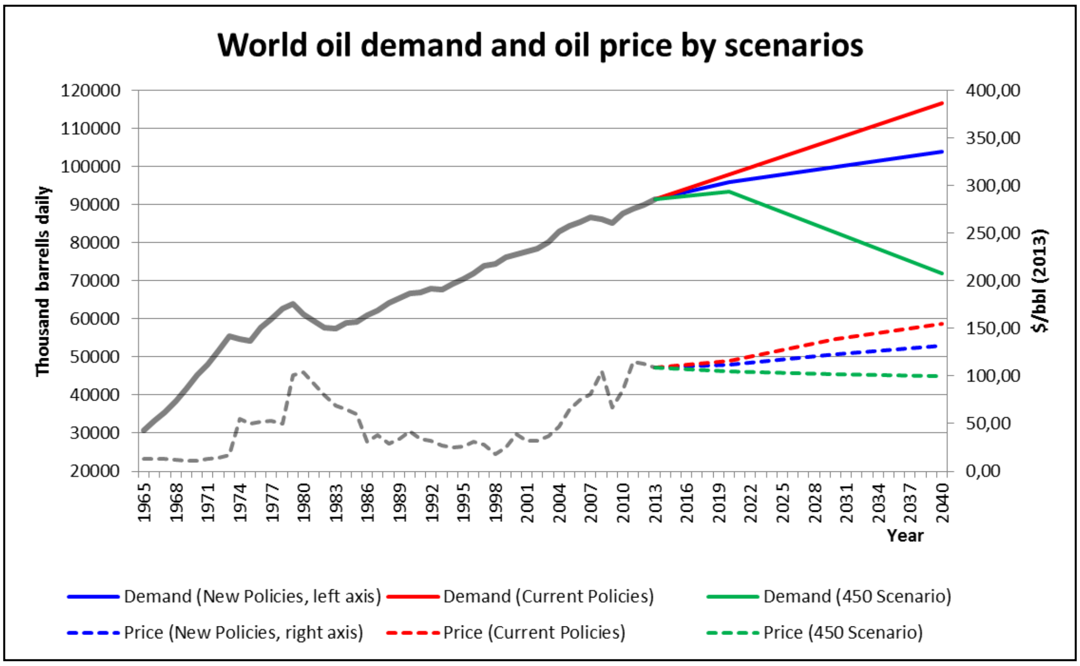

Figure 6.12: World oil demand and oil price by scenarios
Source: BP Statistical Review of World Energy (2014), IEA (2014)

The oil price required to balance supply and demand out to 2040 differs between the scenarios, depending on how different forms of policy intervention impact on market

conditions [cf. IEA (2014) pp 96-97]. These long-term estimates are illustrated in figure 6.12 as trend lines. In reality, prices will fluctuate in shorter time steps, as we can see for example in the first half of 2015. In the New Policies Scenario, a steadily growing demand is being estimated, which will lead to a demand of 108 million barrels per day and an average oil price of 132 USD per barrel in 2040. In the Current Policies Scenario price rises more quickly and will reach a level around 155 USD per barrel in 2040. In this scenario higher prices are needed to keep supply in line with higher demand, as reserves are depleted faster and consequently oil from more cost intensive new sources needs to be taken. In the 450 Scenario, the oil price stagnates around 105 USD per barrel. The impact of lower oil prices is not reflected in an increase of consumption in this scenario, as government will initiate polices to keep end user prices at a high level in order to push society to substitute oil products wherever possible.
Even with the extension of crude oil demand in the three mentioned scenarios, remaining recoverable resources of oil are sufficient to meet the estimated demand in all three variants. As a consequence there shouldn´t be any supply bottlenecks over the next decades subject to the condition that there will be an ongoing progress in efficiency activities.

7 Conclusions

This chapter summarizes the main findings, derives the major conclusions and addresses questions and fields for further research.
As Colin Campbell noticed Peak Oil is quite a simple theory and one that any beer drinker understands. The glass starts full and ends empty and the faster you drink it the quicker it´s gone [cf. Campbell (2007)]. Unconventional sources will postpone peak oil at least until the second half of the 21st century. Additional unconventional oil reserves will help to better meet the rising demand and can have a positive effect on prices. The flowing of shale oil and gas in North America is an example for this phenomenon.
Already in 1981, the world started using more oil than was found in new fields and the gap between discovery and production is widening steadily. It is a fact that the peak for conventional oil has already been exceeded or will be reached in the foreseeable future. At least several important countries including relevant producers have already passed their peak. [cf. Campbell (2013)]
However, there were always largely enough refinery capacities available so far. In general, production bottlenecks, which could have had excessive impacts on the oil price in recent years, didn´t exist.
Positive economic growth rates and steadily increasing population numbers will lead to a doubling or even tripling of demand. This enormous need for energy can only be met with unconventional oil which is, from a technical point of view, already available. These unconventional resources will at least prevent production bottlenecks in the first part of this century. The production costs for this oil will be higher than the costs incurred in producing conventional oil. As a consequence the rising share of unconventional oil will be a driver for higher prices. Nonetheless, there can also be price reducing effects in the case of regional overproduction. For example, the enormous amount of flowed shale oil and gas in the United States in recent years led to overcapacities in North America. It can be assumed that this phenomenon of falling energy prices will only happen occasionally and will not be sustainable.
Recent volatility in world oil prices was mainly influenced by changes in virtual demand, which is a strong indicator that OPEC lost at least part of its market power to financial institutions. It is only a matter of time before we run out of cheap oil. But

this does not automatically mean that peak oil is imminent. Data about reserves and resources prove that there will be enough oil available for many years. Especially if we find efficient technical solutions to produce unconventional oil and also cope with environmental issues.

So far oil production has always met steadily growing physical demand. If there is not enough supply to meet total demand including speculations, it is normal that this circumstances lead to price increases. However, production never decreased before physical consumption decreased which could have been an indicator for oil peak. Should the world economy be confronted with a real oil peak, the consequence will be that supply cannot be increased anymore from that point in time. The impact on the oil price would depend on whether shrinking production could still satisfy the demand. It can be assumed that under this scenario price will increase as there is a high probability that demand will steadily grow due to emerging markets and population growth.

As prices are increasingly driven more by virtual instead of physical demand, the emotional aspect in financial markets and its possible negative consequences on oil prices should not be underestimated but can hardly be verified with data. For example, the fact that we are running out of cheap oil does not mean that supply cannot meet demand anymore. An artificially initiated panic can easily lead to a hype which boosts prices in a very short time. From this perspective it would be interesting to analyze the impact of headlines about peak oil in the international media on the virtual demand and oil price.

In conclusion the following influencing factors on oil price development can be listed:

- quality of oil
- regional uncertainty of physical supply
- regional uncertainty of physical demand
- virtual demand
- lack of energy policies to harmonize demand
- environmental regulations led to a shortage of clean products
- strategic behaviors of OPEC (profit oriented versus harming the west)
- political influence
- refinery capacities
- sluggishness of oil- and energy market in general

As a consequence many different factors do have an impact on oil price but there are no indications so far that looming peak oil does already have or will have a crucial impact on oil prices in the near future. Peak oil will stay an important topic as the shortage of oil might lead to international tensions. Peak Oil will determine our future and as Aleklett proposed we need to build a substantial “crash mat” of alternative fuel production to soften the fall in conventionally produced oil [cf. Aleklett (2012), p. 36].

8 Acknowledgements

I am grateful that I participated in this MSc program about renewable energy as I could broaden my horizon in an area which is becoming more and more important in the energy sector.
Writing this master´s thesis would not have been possible without the help of several people.
First of all I want to thank the Academic Director Univ. Prof. Dr. Dipl. Ing. Reinhard Haas. He is the “soul” of this postgraduate program as he always encouraged students to think about more efficient ways to use energy. Personally I want to thank Prof. Haas for the confidence he had in me. He gave me “fruitful” hints and let me develop my own ideas without any restrictions.
A special thank you goes to my lovely spouse Christina Scharner. She encouraged me to complete the whole project even in difficult situations. Christina showed a lot of understanding and patience especially for writing this thesis on weekends in addition to my demanding job and extensive traveling for job purposes.
Last but not least I want to thank Shell and in particular my bosses who supported me by giving me as much flexibility as possible.
Overall the last months have been a fruitful life experience as it was a real challenge to coordinate this education with my profession.

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10 Annexes

Table 10.1: Energy conversion factors

	Tonnes of oil (toe)	Barrel (bbl or boe)	Megajoule (MJ)	British Thermal Unit (BTU)	Tonnes per year
Tonnes of oil (toe)	1	7.33	41868	$40 * 10^{6}$	-
Barrel (bbl or boe)	0.136	1	5712	$5.414 * 10^{6}$	-
Megajoule (MJ)	$24 * 10^{-6}$	$0.175 * 10^{-3}$	1	947.867	-
British Thermal Unit (BTU)	$25 * 10^{-9}$	$0.185 * 10^{-6}$	1.055 * 10	1	-
Barrels per day	-	-	-	-	49,8

Source: Rogner (2012), p. 437

Table 10.2: Metric system

milli (m)	10^{-3}
centi (c)	10^{-2}
kilo (k)	10^{3}
mega (M)	10^{6}
giga (G)	10^{9}
tera (T)	10^{12}
peta (P)	10^{15}
exa (E)	10^{18}
zeta (Z)	10^{21}

Source: Rogner (2012), p. 437

Table 10.3: Reserves and resources of non-renewable fuels

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

– no reserves or resources

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

Sources: BGR (2014), p. 15

Table 10.4: Crude oil 2013 by country and main regions (Mt), part 1

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

Sources: BGR (2014), p. 70

Table 10.5: Oil 2013 by country and main regions (Mt), part 2

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

Sources: BGR (2014), p. 71

Table 10.6: Crude oil 2013 by country and main regions (Mt), part 3

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

Sources: BGR (2014), p. 72

Table 10.7: Crude oil 2013 by country and main regions (Mt), part 4

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

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

Sources: BGR (2014), p. 72

Table 10.8: Distribution of crude oil resources 2013 by country and main regions (Mt)

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

Sources: BGR (2014), p. 74

Table 10.9: Distribution of crude oil reserves 2013 by country and main regions (Mt)

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

Sources: BGR (2014), p. 75

Table 10.10: Crude oil exports in 2013 (Mt)

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

Sources: BGR (2014), p. 78

Table 10.11: Crude oil imports in 2013 (Mt)

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

Sources: BGR (2014), p. 79

Table 10.12: Crude oil production in 2013 (Mt)

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

Sources: BGR (2014), p. 76

Table 10.13: Crude oil demand in 2013 (Mt)

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

Sources: BGR (2012), p. 77

Table 10.14: Proved oil reserves history (thousand million barrels)

Proved oil reserves history (Thousand million barrels)							
Year	**Total World**	OECD	Non-OECD	OPEC	Non-OPEC	EU	Former Soviet Union
1980	**683,4**	141,0	542,4	425,4	191,0	11,8	67,0
1981	**696,5**	151,3	545,2	429,3	204,2	11,0	63,0
1982	**725,6**	150,0	575,6	459,2	203,4	10,7	63,0
1983	**737,3**	150,5	586,8	467,8	206,5	10,7	63,0
1984	**774,4**	149,8	624,6	503,7	207,8	10,0	63,0
1985	**802,6**	150,2	652,4	529,8	209,8	9,6	63,0
1986	**907,7**	149,0	758,6	636,7	210,0	9,3	61,0
1987	**938,9**	148,7	790,2	668,6	211,3	9,0	59,0
1988	**1026,7**	148,8	877,9	755,0	212,7	8,3	59,0
1989	**1027,3**	146,4	880,9	763,2	205,5	7,7	58,5
1990	**1027,5**	144,5	883,0	763,4	205,7	8,1	58,4
1991	**1032,7**	142,7	890,1	769,0	204,7	8,5	59,0
1992	**1039,3**	142,7	896,6	772,7	207,1	8,5	59,6
1993	**1041,4**	140,8	900,6	774,9	206,3	8,1	60,1
1994	**1055,6**	148,4	907,2	778,9	216,0	8,0	60,7
1995	**1065,9**	149,2	916,7	786,6	218,0	8,3	61,3
1996	**1088,7**	151,0	937,8	805,0	221,9	8,7	61,9
1997	**1107,4**	151,6	955,7	817,5	223,4	8,9	66,5
1998	**1092,9**	124,7	968,2	823,1	198,0	9,0	71,7
1999	**1237,9**	256,6	981,3	831,9	329,6	9,0	76,3
2000	**1258,1**	256,5	1001,6	849,7	331,0	8,9	77,4
2001	**1266,8**	254,8	1012,0	855,5	330,4	8,8	80,9
2002	**1321,5**	251,2	1070,3	903,3	327,9	8,0	90,3
2003	**1334,1**	247,5	1086,6	912,1	325,2	8,0	96,8
2004	**1343,7**	245,2	1098,5	918,8	324,9	7,6	100,0
2005	**1353,1**	244,7	1108,3	927,8	325,2	7,4	100,1
2006	**1363,9**	241,0	1122,8	936,1	326,5	7,0	101,2
2007	**1399,3**	239,8	1159,6	949,5	324,6	6,8	125,2
2008	**1471,6**	234,4	1237,2	1024,4	320,8	6,2	126,5
2009	**1513,2**	236,0	1277,3	1064,6	321,5	6,5	127,1
2010	**1621,6**	239,1	1382,5	1163,3	329,8	6,8	128,5
2011	**1661,8**	243,3	1418,5	1197,5	334,6	7,0	129,7
2012	**1687,3**	249,6	1437,7	1213,8	342,6	6,8	130,9
2013	**1687,9**	248,8	1439,1	1214,2	341,9	6,8	131,8

Sources: BP (2014)

Table 10.15: Production history (thousand barrels daily)

Production history (Thousand barrels daily)							
Year	**Total World**	OECD	Non-OECD	OPEC	Non-OPEC	EU	Former Soviet Union
1965	**31798,4**	10815,0	20983,4	13921,7	13019,0	698,8	4857,8
1966	**34563,2**	11478,2	23085,0	15381,4	13879,8	697,3	5302,0
1967	**37112,5**	12272,6	24839,9	16380,9	14969,6	704,6	5762,0
1968	**40430,1**	12795,6	27634,5	18250,1	16012,9	702,3	6167,1
1969	**43627,2**	13170,1	30457,1	20242,8	16818,4	698,2	6566,0
1970	**48056,2**	13952,1	34104,1	22762,1	18167,3	693,5	7126,7
1971	**50838,7**	14045,0	36793,7	24701,7	18526,5	676,7	7610,5
1972	**53661,6**	14377,2	39284,4	26392,9	19204,5	668,4	8064,1
1973	**58459,6**	14530,3	43929,3	29932,4	19862,8	673,9	8664,4
1974	**58613,4**	14055,1	44558,3	29667,3	19675,7	686,5	9270,4
1975	**55822,5**	13698,9	42123,6	26181,0	19725,5	714,0	9916,0
1976	**60410,2**	13686,5	46723,8	29589,7	20354,9	929,2	10465,6
1977	**62716,2**	14587,4	48128,9	29983,2	21723,1	1462,8	11009,9
1978	**63337,9**	15624,8	47713,1	28677,1	23130,1	1774,2	11530,8
1979	**66060,7**	16558,8	49501,9	30010,5	24244,7	2247,6	11805,4
1980	**62958,9**	17187,2	45771,6	26028,1	24814,4	2284,8	12116,4
1981	**59547,1**	17646,4	41900,7	21895,3	25391,5	2480,8	12260,3
1982	**57312,4**	18460,4	38852,0	18755,6	26227,1	2830,7	12329,8
1983	**56615,3**	18938,1	37677,2	16943,1	27268,8	3143,8	12403,4
1984	**57695,6**	19794,9	37900,6	16534,9	28864,0	3377,8	12296,7
1985	**57459,2**	20122,9	37336,2	15871,1	29570,1	3445,3	12017,9
1986	**60434,9**	19659,8	40775,1	18516,6	29515,7	3458,7	12402,6
1987	**60744,8**	19730,8	41014,0	18351,2	29786,4	3397,9	12607,2
1988	**63110,6**	19569,9	43540,7	20678,4	29883,0	3209,7	12549,2
1989	**64002,4**	18809,3	45193,2	22179,8	29568,8	2724,7	12253,8
1990	**65384,6**	18847,7	46536,9	23857,1	30004,5	2677,2	11523,1
1991	**65204,0**	19416,1	45787,9	23903,8	30869,1	2707,7	10431,2
1992	**65716,2**	19593,2	46123,0	25427,7	31178,4	2760,6	9110,2
1993	**65977,8**	19695,5	46282,4	26181,5	31638,4	2893,7	8158,0
1994	**67072,9**	20565,4	46507,5	26780,2	32934,1	3493,2	7358,5
1995	**67990,4**	20762,1	47228,3	27108,5	33620,7	3550,9	7261,1
1996	**69844,6**	21384,2	48460,4	28027,8	34678,8	3531,4	7137,9
1997	**72100,8**	21692,4	50408,4	29505,5	35256,5	3509,1	7338,8
1998	**73457,0**	21527,8	51929,2	30748,0	35354,7	3605,8	7354,3
1999	**72292,8**	21138,3	51154,5	29665,1	35110,2	3735,3	7517,5
2000	**74982,8**	21570,0	53412,8	31121,8	35829,3	3564,2	8031,7
2001	**75213,1**	21433,2	53779,9	30691,2	35831,7	3347,0	8690,3
2002	**74990,6**	21510,8	53479,8	29266,0	36159,9	3400,3	9564,7
2003	**77638,9**	21213,7	56425,2	31230,7	35878,5	3185,1	10529,7
2004	**81054,1**	20813,1	60241,0	34039,5	35600,9	2955,2	11413,7
2005	**82106,6**	19902,4	62204,2	35170,2	35101,7	2707,8	11834,7
2006	**82593,0**	19464,5	63128,5	35488,6	34786,4	2467,9	12318,0
2007	**82383,2**	19150,7	63232,5	35161,0	34419,6	2425,1	12802,6
2008	**82954,8**	18439,9	64514,9	36278,5	33852,4	2264,4	12823,8
2009	**81262,5**	18444,8	62817,7	33978,1	34015,6	2126,6	13268,8
2010	**83296,4**	18546,6	64749,8	35088,0	34650,2	1987,1	13558,2
2011	**84049,0**	18601,0	65448,0	35911,2	34529,2	1724,0	13608,6
2012	**86204,4**	19492,4	66712,0	37426,7	35122,3	1528,2	13655,3
2013	**86753,7**	20523,3	66230,4	36828,5	36062,4	1436,9	13862,8

Sources: BP (2014)

Table 10.16: Consumption history (thousand barrels daily)

Consumption history (Thousand barrels daily)					
Year	**Total World**	OECD	Non-OECD	EU	Former Soviet Union
1965	**30810,6**	23151,3	7659,3	7797,2	3314,0
1966	**33158,0**	24865,7	8292,3	8568,4	3548,8
1967	**35540,8**	26673,5	8867,3	9298,5	3866,1
1968	**38454,6**	28972,3	9482,3	10183,8	4107,3
1969	**41825,4**	31613,4	10212,1	11420,8	4376,2
1970	**45354,9**	34209,7	11145,2	12632,9	4826,4
1971	**47879,8**	35877,6	12002,3	13235,4	5126,5
1972	**51426,6**	38400,1	13026,5	14148,9	5547,1
1973	**55562,8**	41317,0	14245,9	15184,2	5981,4
1974	**54792,4**	39625,5	15166,8	14267,3	6587,9
1975	**54329,4**	38585,8	15743,7	13772,0	6911,8
1976	**57692,9**	41041,7	16651,2	14658,7	7055,1
1977	**59889,3**	42146,5	17742,8	14529,7	7375,7
1978	**62740,8**	43709,9	19030,9	15242,2	7822,3
1979	**63878,9**	44048,0	19830,9	15637,3	7967,9
1980	**61243,6**	41027,3	20216,3	14543,3	8338,2
1981	**59398,9**	38906,5	20492,4	13618,8	8442,1
1982	**57814,2**	37103,0	20711,2	12965,7	8388,4
1983	**57590,7**	36665,6	20925,1	12661,4	8273,5
1984	**58864,5**	37644,7	21219,8	12754,0	8259,5
1985	**59249,1**	37482,7	21766,4	12987,5	8374,1
1986	**60995,0**	38679,9	22315,1	13384,6	8413,7
1987	**62293,3**	39331,7	22961,6	13434,9	8455,3
1988	**64246,7**	40675,0	23571,8	13562,0	8319,8
1989	**65578,3**	41286,7	24291,6	13644,0	8323,3
1990	**66761,4**	41710,7	25050,7	13758,7	8365,9
1991	**66907,6**	41903,9	25003,8	13918,0	8030,4
1992	**67972,3**	42927,2	25045,1	13971,7	7250,1
1993	**67677,0**	43238,6	24438,3	13854,8	5748,2
1994	**69204,0**	44503,3	24700,8	13924,2	4999,8
1995	**70364,1**	45138,8	25225,3	14212,1	4465,4
1996	**71852,9**	46317,3	25535,5	14460,8	3857,8
1997	**74044,3**	47171,7	26872,7	14623,8	3842,7
1998	**74577,3**	47338,9	27238,4	14901,7	3675,6
1999	**76268,8**	48284,4	27984,5	14826,1	3654,2
2000	**76901,8**	48319,3	28582,5	14647,9	3588,3
2001	**77607,5**	48334,7	29272,8	14881,1	3675,6
2002	**78499,5**	48323,3	30176,2	14795,1	3625,3
2003	**80216,0**	48934,2	31281,8	14866,4	3814,2
2004	**83055,0**	49713,4	33341,6	15002,3	3840,4
2005	**84389,4**	50077,9	34311,4	15122,7	3829,2
2006	**85324,9**	49887,9	35436,9	15122,4	3942,9
2007	**86754,3**	49689,9	37064,4	14802,3	3992,8
2008	**86147,2**	48085,1	38062,1	14710,5	4040,4
2009	**85111,4**	46057,4	39054,0	13976,5	3887,3
2010	**87800,6**	46508,9	41291,7	13826,8	3983,6
2011	**88933,9**	46040,1	42893,8	13455,0	4293,2
2012	**89931,3**	45545,5	44385,8	12946,4	4433,5
2013	**91330,9**	45557,6	45773,3	12769,9	4559,0

Sources: BP (2014)

Table 10.17: Spot crude prices ($/bbl)

Spot crude oil prices ($/bbl)				
Year	Dubai	Brent	Nigerian	West Texas
1976	11,63	12,80	12,87	12,23
1977	12,38	13,92	14,21	14,22
1978	13,03	14,02	13,65	14,55
1979	29,75	31,61	29,25	25,08
1980	35,69	36,83	36,98	37,96
1981	34,32	35,93	36,18	36,08
1982	31,80	32,97	33,29	33,65
1983	28,78	29,55	29,54	30,30
1984	28,06	28,78	28,14	29,39
1985	27,53	27,56	27,75	27,98
1986	13,10	14,43	14,46	15,10
1987	16,95	18,44	18,39	19,18
1988	13,27	14,92	15,00	15,97
1989	15,62	18,23	18,30	19,68
1990	20,45	23,73	23,85	24,50
1991	16,63	20,00	20,11	21,54
1992	17,17	19,32	19,61	20,57
1993	14,93	16,97	17,41	18,45
1994	14,74	15,82	16,25	17,21
1995	16,10	17,02	17,26	18,42
1996	18,52	20,67	21,16	22,16
1997	18,23	19,09	19,33	20,61
1998	12,21	12,72	12,62	14,39
1999	17,25	17,97	18,00	19,31
2000	26,20	28,50	28,42	30,37
2001	22,81	24,44	24,23	25,93
2002	23,74	25,02	25,04	26,16
2003	26,78	28,83	28,66	31,07
2004	33,64	38,27	38,13	41,49
2005	49,35	54,52	55,69	56,59
2006	61,50	65,14	67,07	66,02
2007	68,19	72,39	74,48	72,20
2008	94,34	97,26	101,43	100,06
2009	61,39	61,67	63,35	61,92
2010	78,06	79,50	81,05	79,45
2011	106,18	111,26	113,65	95,04
2012	109,08	111,67	114,21	94,13
2013	105,47	108,66	111,95	97,99

Sources: BP (2014)

Table 10.18: Average oil price ($/bbl)

Average Oilprice in $/bbl								
Year	Average		Brent		Dubai		WTI	
	nominal $	real 2005 $	nominal $	real 2005 $	nominal $	real 2005 $	nominal $	real 2005 $
1960	1,63	7,29			1,63	7,29		
1961	1,57	6,88			1,57	6,88		
1962		6,54			1,52	6,54		
1963	1,50	6,58			1,50	6,58		
1964	1,45	6,27			1,45	6,27		
1965	1,42	6,08			1,42	6,08		
1966	1,36	5,62			1,36	5,62		
1967	1,33	5,45			1,33	5,45		
1968	1,32	5,45			1,32	5,45		
1969	1,27	4,98			1,27	4,98		
1970	1,21	4,46			1,21	4,46		
1971	1,69	5,92			1,69	5,92		
1972	1,82	5,85			1,82	5,85		
1973	2,81	7,78			2,81	7,78		
1974	10,97	24,95			10,97	24,95		
1975	10,43	21,36			10,43	21,36		
1976	11,63	23,52			11,63	23,52		
1977	12,57	23,51			12,57	23,51		
1978	12,92	20,79			12,92	20,79		
1979	30,96	43,03	32,11	46,34	29,82	43,03		
1980	36,87	48,37	37,89	49,72	35,85	47,03		
1981	35,48	46,51	36,68	48,07	34,29	44,95		
1982	32,65	44,10	33,42	45,14	31,76	42,90	32,77	44,26
1983	29,66	41,15	29,83	41,39	28,73	39,87	30,41	42,20
1984	28,56	40,52	28,80	40,87	27,49	39,01	29,38	41,68
1985	27,18	38,98	27,33	39,18	26,46	37,94	27,76	39,81
1986	14,35	17,89	14,77	18,41	13,20	16,45	15,08	18,80
1987	18,15	20,64	18,34	20,87	16,94	19,27	19,16	21,79
1988	14,72	15,72	14,97	15,99	13,22	14,12	15,97	17,06
1989	17,84	19,17	18,22	19,58	15,70	16,88	19,60	21,06
1990	22,88	23,66	23,68	24,49	20,46	21,16	24,49	25,33
1991	19,37	20,09	20,07	20,81	16,56	17,18	21,48	22,28
1992	19,02	19,48	19,31	19,78	17,19	17,60	20,56	21,06
1993	16,84	17,09	17,02	17,27	14,94	15,16	18,56	18,83
1994	15,89	16,10	15,83	16,05	14,67	14,87	17,16	17,40
1995	17,18	15,95	17,07	15,84	16,12	14,96	18,37	17,05
1996	20,42	19,56	20,65	19,78	18,54	17,76	22,07	21,14
1997	19,17	19,58	19,09	19,50	18,10	18,49	20,33	20,76
1998	13,06	14,03	12,72	13,66	12,13	13,03	14,35	15,41
1999	18,07	19,84	17,81	19,56	17,17	18,85	19,24	21,13
2000	28,23	31,60	28,27	31,65	26,08	29,20	30,33	33,95
2001	24,35	28,71	24,42	28,79	22,71	26,78	25,92	30,55
2002	24,93	29,57	24,97	29,62	23,72	28,14	26,09	30,95
2003	28,90	32,04	28,85	31,99	26,74	29,65	31,11	34,49
2004	37,73	38,85	38,30	39,43	33,46	34,45	41,44	42,67
2005	53,39	53,39	54,43	54,43	49,29	49,29	56,44	56,44
2006	64,29	62,92	65,39	64,00	61,43	60,13	66,04	64,64
2007	71,12	65,50	72,70	66,96	68,37	62,97	72,28	66,58
2008	96,99	82,84	97,64	83,39	93,78	80,09	99,56	85,03
2009	61,76	56,49	61,86	56,59	61,75	56,49	61,65	56,39
2010	79,04	69,99	79,64	70,52	78,06	69,12	79,43	70,33
2011	104,01	84,56	110,94	90,19	106,03	86,20	95,05	77,28
2012	105,01	87,06	111,97	92,82	108,90	90,29	94,16	78,06
2013	102,00	83,00						
2014	102,20	81,40						
2015	102,10	79,80						
2016	101,90	78,30						
2017	101,70	76,80						
2018	101,50	75,30						
2019	101,40	73,80						
2020	101,20	72,40						
2025	101,50	66,30						

Source: Knoema (2013)

Table 10.19: Total world refinery capacity (thousand barrels daily)

Year	Rafinery capacity	Rafinery Throughput	Capacity Utilization	Consumption	Production
1965	**34513,6**			30810,6	31798,4
1966	**37469,1**			33158,0	34563,2
1967	**40657,2**			35540,8	37112,5
1968	**43731,3**			38454,6	40430,1
1969	**47016,2**			41825,4	43627,2
1970	**51344,4**			45354,9	48056,2
1971	**55415,3**			47879,8	50838,7
1972	**59663,4**			51426,6	53661,6
1973	**64300,5**			55562,8	58459,6
1974	**68214,0**			54792,4	58613,4
1975	**70651,7**			54329,4	55822,5
1976	**73862,9**			57692,9	60410,2
1977	**76083,1**			59889,3	62716,2
1978	**76852,4**			62740,8	63337,9
1979	**77754,4**			63878,9	66060,7
1980	**79108,8**	**59313,5**	75%	61243,6	62958,9
1981	**78057,2**	**56449,7**	72%	59398,9	59547,1
1982	**76216,5**	**54669,3**	72%	57814,2	57312,4
1983	**73806,2**	**54483,0**	74%	57590,7	56615,3
1984	**72922,8**	**55214,1**	76%	58864,5	57695,6
1985	**72758,0**	**55075,1**	76%	59249,1	57459,2
1986	**72450,3**	**57415,0**	79%	60995,0	60434,9
1987	**73081,6**	**58200,1**	80%	62293,3	60744,8
1988	**73107,8**	**59990,9**	82%	64246,7	63110,6
1989	**73665,5**	**61270,6**	83%	65578,3	64002,4
1990	**74423,8**	**61312,7**	82%	66761,4	65384,6
1991	**74047,1**	**61521,2**	83%	66907,6	65204,0
1992	**73963,7**	**61186,8**	83%	67972,3	65716,2
1993	**74435,0**	**61177,6**	82%	67677,0	65977,8
1994	**75681,4**	**61562,1**	81%	69204,0	67072,9
1995	**75953,6**	**62816,9**	83%	70364,1	67990,4
1996	**76803,4**	**64530,5**	84%	71852,9	69844,6
1997	**78629,9**	**66334,0**	84%	74044,3	72100,8
1998	**79725,7**	**66886,2**	84%	74577,3	73457,0
1999	**82212,0**	**66983,8**	81%	76268,8	72292,8
2000	**82208,5**	**68450,3**	83%	76901,8	74982,8
2001	**83183,7**	**69059,7**	83%	77607,5	75213,1
2002	**83917,3**	**68516,8**	82%	78499,5	74990,6
2003	**84182,3**	**70534,4**	84%	80216,0	77638,9
2004	**85032,5**	**72903,0**	86%	83055,0	81054,1
2005	**85875,0**	**73994,7**	86%	84389,4	82106,6
2006	**87239,9**	**74545,3**	85%	85324,9	82593,0
2007	**88446,7**	**75353,5**	85%	86754,3	82383,2
2008	**89262,1**	**74992,1**	84%	86147,2	82954,8
2009	**90836,0**	**73249,3**	81%	85111,4	81262,5
2010	**91816,1**	**75245,1**	82%	87800,6	83296,4
2011	**92191,8**	**75668,0**	82%	88933,9	84049,0
2012	**93529,0**	**75898,6**	81%	89931,3	86204,4
2013	**94928,9**	**76284,0**	80%	91330,9	86753,7

Sources: BP (2014)

Table 10.20: World GDP development

Year	GDP				GDP growth	GDP per captia		Per capita growth	Production	Crude Oil Production
	nominal $	nominal mln $	real 2005 $	real 2005 mln $	annual %	nominal $	real 2005 $	annual %	thousand barrel daily	annual %
1960	1.368.724.087.042	1.368.724	9.242.545.221.498	9.242.545		451	3.044			
1961	1.424.111.590.471	1.424.112	9.645.504.185.750	9.645.504	4,4%	463	3.134	3,0%		
1962	1.529.120.013.231	1.529.120	10.182.678.713.600	10.182.679	5,6%	489	3.253	3,8%		
1963	1.645.228.204.044	1.645.228	10.710.217.996.109	10.710.218	5,2%	515	3.352	3,0%		
1964	1.802.868.086.107	1.802.868	11.415.814.501.494	11.415.815	6,6%	553	3.501	4,4%		
1965	1.963.996.197.708	1.963.996	12.047.485.853.068	12.047.486	5,5%	590	3.621	3,4%	31798,4	
1966	2.129.949.355.143	2.129.949	12.756.189.399.383	12.756.189	5,9%	627	3.755	3,7%	34563,2	8,7%
1967	2.266.138.639.356	2.266.139	13.325.722.773.390	13.325.723	4,5%	654	3.844	2,4%	37112,5	7,4%
1968	2.444.239.853.755	2.444.240	14.137.493.432.375	14.137.493	6,1%	691	3.997	4,0%	40430,1	8,9%
1969	2.691.569.053.066	2.691.569	14.962.834.238.639	14.962.834	5,8%	745	4.143	3,7%	43627,2	7,9%
1970	2.954.200.298.961	2.954.200	15.601.700.374.468	15.601.700	4,3%	801	4.232	2,1%	48056,2	10,2%
1971	3.262.563.527.663	3.262.564	16.237.297.506.108	16.237.298	4,1%	867	4.314	1,9%	50838,7	5,8%
1972	3.761.789.122.564	3.761.789	17.145.438.490.221	17.145.438	5,6%	980	4.465	3,5%	53661,6	5,6%
1973	4.582.953.575.789	4.582.954	18.240.120.363.552	18.240.120	6,4%	1.171	4.659	4,3%	58459,6	8,9%
1974	5.286.058.322.172	5.286.058	18.556.341.451.627	18.556.341	1,7%	1.324	4.649	-0,2%	58613,4	0,3%
1975	5.892.063.053.532	5.892.063	18.706.117.672.789	18.706.118	0,8%	1.449	4.601	-1,0%	55822,5	-4,8%
1976	6.409.316.270.806	6.409.316	19.664.870.856.589	19.664.871	5,1%	1.549	4.751	3,3%	60410,2	8,2%
1977	7.247.798.087.944	7.247.798	20.452.772.767.984	20.452.773	4,0%	1.721	4.856	2,2%	62716,2	3,8%
1978	8.533.619.533.280	8.533.620	21.337.303.320.548	21.337.303	4,3%	1.991	4.978	2,5%	63337,9	1,0%
1979	9.914.107.353.603	9.914.107	22.220.469.896.448	22.220.470	4,1%	2.273	5.094	2,3%	66060,7	4,3%
1980	11.160.862.487.687	11.160.862	22.627.010.217.106	22.627.010	1,8%	2.515	5.098	0,1%	62958,9	-4,7%
1981	11.448.494.304.350	11.448.494	23.088.889.471.002	23.088.889	2,0%	2.535	5.113	0,3%	59547,1	-5,4%
1982	11.346.285.912.172	11.346.286	23.187.685.337.943	23.187.685	0,4%	2.469	5.045	-1,3%	57312,4	-3,8%
1983	11.600.153.941.271	11.600.154	23.810.360.453.055	23.810.360	2,7%	2.480	5.091	0,9%	56615,3	-1,2%
1984	12.038.443.031.722	12.038.443	24.912.243.515.255	24.912.244	4,6%	2.530	5.237	2,9%	57695,6	1,9%
1985	12.656.451.151.266	12.656.451	25.859.525.037.556	25.859.525	3,8%	2.615	5.343	2,0%	57459,2	-0,4%
1986	14.978.315.943.134	14.978.316	26.685.569.367.659	26.685.569	3,2%	3.041	5.418	1,4%	60434,9	5,2%
1987	17.039.086.362.685	17.039.086	27.651.824.957.065	27.651.825	3,6%	3.399	5.516	1,8%	60744,8	0,5%
1988	19.075.794.154.721	19.075.794	28.946.696.218.534	28.946.696	4,7%	3.740	5.675	2,9%	63110,6	3,9%
1989	20.018.962.922.655	20.018.963	30.039.402.573.389	30.039.403	3,8%	3.858	5.789	2,0%	64002,4	1,4%
1990	22.519.258.903.709	22.519.259	30.916.841.769.878	30.916.842	2,9%	4.266	5.857	1,2%	65384,6	2,2%
1991	23.641.409.950.599	23.641.410	31.341.551.119.193	31.341.551	1,4%	4.406	5.842	-0,3%	65204,0	-0,3%
1992	25.308.691.489.793	25.308.691	31.930.607.374.404	31.930.607	1,9%	4.645	5.861	0,3%	65716,2	0,8%
1993	25.742.585.494.456	25.742.585	32.444.888.942.753	32.444.889	1,6%	4.654	5.865	0,1%	65977,8	0,4%
1994	27.689.225.748.209	27.689.226	33.457.962.210.952	33.457.962	3,1%	4.932	5.959	1,6%	67072,9	1,7%
1995	30.642.825.528.680	30.642.826	34.432.197.122.689	34.432.197	2,9%	5.378	6.043	1,4%	67990,4	1,4%
1996	31.301.153.604.664	31.301.154	35.565.608.796.229	35.565.609	3,3%	5.416	6.153	1,8%	69844,6	2,7%
1997	31.213.034.941.087	31.213.035	36.880.738.216.278	36.880.738	3,7%	5.325	6.292	2,2%	72100,8	3,2%
1998	31.089.451.464.499	31.089.451	37.820.618.241.060	37.820.618	2,5%	5.231	6.364	1,1%	73457,0	1,9%
1999	32.240.887.780.829	32.240.888	39.097.334.528.018	39.097.335	3,4%	5.353	6.491	2,0%	72292,8	-1,6%
2000	33.284.011.609.138	33.284.012	40.761.359.957.569	40.761.360	4,3%	5.455	6.680	2,9%	74982,8	3,7%
2001	33.086.733.375.159	33.086.733	41.500.901.541.522	41.500.902	1,8%	5.354	6.715	0,5%	75213,1	0,3%
2002	34.334.649.308.100	34.334.649	42.354.964.301.926	42.354.964	2,1%	5.487	6.768	0,8%	74990,6	-0,3%
2003	38.560.126.406.383	38.560.126	43.538.255.508.657	43.538.256	2,8%	6.087	6.873	1,5%	77638,9	3,5%
2004	43.411.853.649.216	43.411.854	45.344.114.039.530	45.344.114	4,1%	6.770	7.071	2,9%	81054,1	4,4%
2005	46.964.572.241.580	46.964.572	46.964.572.241.580	46.964.572	3,6%	7.236	7.236	2,3%	82106,6	1,3%
2006	50.880.052.935.765	50.880.053	48.895.692.192.898	48.895.692	4,1%	7.747	7.445	2,9%	82593,0	0,6%
2007	57.327.852.313.281	57.327.852	50.817.645.795.354	50.817.646	3,9%	8.626	7.647	2,7%	82383,2	-0,3%
2008	62.857.999.144.162	62.857.999	51.571.302.222.075	51.571.302	1,5%	9.347	7.669	0,3%	82954,8	0,7%
2009	59.539.280.829.015	59.539.281	50.500.716.532.642	50.500.717	-2,1%	8.751	7.423	-3,2%	81262,5	-2,0%
2010	65.216.843.712.977	65.216.844	52.560.174.152.471	52.560.174	4,1%	9.474	7.636	2,9%	83296,4	2,5%
2011	72.139.587.333.087	72.139.587	54.024.630.722.813	54.024.631	2,8%	10.358	7.757	1,6%	84049,0	0,9%
2012	73.514.223.629.332	73.514.224	55.247.113.540.269	55.247.114	2,3%	10.438	7.844		86204,4	2,6%
2013	75.592.940.968.183	75.592.941	56.487.586.160.573	56.487.586	2,2%	10.610	7.929		86753,7	0,6%

Source: World Bank (2014)

Table 10.21: Total world population part 1 (thousands)

Year	Total population (thousands) Estimates	Total population (thousands) Medium	Total population (thousands) High	Total population (thousands) Low	Total population (thousands) Constant
1950	2525779	2525779			
1951	2572851	2572851			
1952	2619292	2619292			
1953	2665865	2665865			
1954	2713172	2713172			
1955	2761651	2761651			
1956	2811572	2811572			
1957	2863043	2863043			
1958	2916030	2916030			
1959	2970396	2970396			
1960	3026003	3026003			
1961	3082830	3082830			
1962	3141072	3141072			
1963	3201178	3201178			
1964	3263739	3263739			
1965	3329122	3329122			
1966	3397475	3397475			
1967	3468522	3468522			
1968	3541675	3541675			
1969	3616109	3616109			
1970	3691173	3691173			
1971	3766754	3766754			
1972	3842874	3842874			
1973	3919182	3919182			
1974	3995305	3995305			
1975	4071020	4071020			
1976	4146136	4146136			
1977	4220817	4220817			
1978	4295665	4295665			
1979	4371528	4371528			
1980	4449049	4449049			
1981	4528235	4528235			
1982	4608962	4608962			
1983	4691560	4691560			
1984	4776393	4776393			
1985	4863602	4863602			
1986	4953377	4953377			
1987	5045316	5045316			
1988	5138215	5138215			
1989	5230452	5230452			
1990	5320817	5320817			
1991	5408909	5408909			
1992	5494900	5494900			
1993	5578865	5578865			
1994	5661086	5661086			
1995	5741822	5741822			
1996	5821017	5821017			
1997	5898688	5898688			
1998	5975304	5975304			
1999	6051478	6051478			
2000	6127700	6127700			
2001	6204147	6204147			

Source: United Nations (2012)

Table 10.22: Total world population part 2 (thousands)

2002	6280854	6280854			
2003	6357992	6357992			
2004	6435706	6435706			
2005	6514095	6514095			
2006	6593228	6593228			
2007	6673106	6673106			
2008	6753649	6753649			
2009	6834722	6834722			
2010	6916183	6916183	6916183	6916183	6916183
2011		6997999	7005845	6990091	7000956
2012		7080072	7099195	7060800	7087375
2013		7162119	7195452	7128540	7175187
2014		7243784	7293436	7193795	7264004
2015		7324782	7392233	7256925	7353522
2016		7404977	7491548	7317958	7443680
2017		7484325	7591455	7376732	7534493
2018		7562760	7691842	7433217	7625822
2019		7640245	7792683	7487359	7717525
2020		7716749	7893904	7539163	7809497
2021		7792209	7995412	7588606	7901696
2022		7866580	8096973	7635840	7994136
2023		7939877	8198227	7681247	8086853
2024		8012143	8298744	7725329	8179918
2025		8083413	8398226	7768450	8273410
2026		8153677	8496528	7810753	8367375
2027		8222927	8593734	7852162	8461882
2028		8291193	8690073	7892550	8557084
2029		8358519	8785904	7931693	8653165
2030		8424937	8881519	7969407	8750296
2031		8490456	8976991	8005663	8848582
2032		8555068	9072335	8040470	8948122
2033		8618774	9167728	8073723	9049070
2034		8681569	9263363	8105297	9151589
2035		8743447	9359400	8135087	9255828
2036		8804406	9455928	8163037	9361911
2037		8864437	9552994	8189105	9469936
2038		8923515	9650657	8213223	9579980
2039		8981607	9748954	8235322	9692105
2040		9038687	9847909	8255351	9806383
2041		9094744	9947554	8273280	9922929
2042		9149769	10047891	8289099	10041855
2043		9203741	10148867	8302810	10163225
2044		9256636	10250406	8314429	10287094
2045		9308438	10352435	8323978	10413537
2046		9359140	10454937	8331464	10542678
2047		9408741	10557888	8336913	10674665
2048		9457241	10661193	8340384	10809639
2049		9504640	10764741	8341959	10947755
2050		9550945	10868444	8341706	11089178
2051		9596160	10972268	8339667	11234079

Source: United Nations (2012)

Table 10.23: Total World population part 3 (thousands)

2052	9640298	11076210	8335875	11382642
2053	9683379	11180246	8330391	11535079
2054	9725430	11284360	8323279	11691613
2055	9766475	11388551	8314597	11852474
2056	9806530	11492815	8304385	12017879
2057	9845615	11597175	8292677	12188055
2058	9883762	11701686	8279513	12363257
2059	9921012	11806426	8264932	12543753
2060	9957399	11911465	8248967	12729809
2061	9992942	12016837	8231648	12921685
2062	10027657	12122575	8212996	13119635
2063	10061562	12228754	8193018	13323915
2064	10094674	12335457	8171714	13534780
2065	10127007	12442757	8149085	13752494
2066	10158579	12550696	8125154	13977354
2067	10189402	12659304	8099939	14209652
2068	10219473	12768617	8073434	14449658
2069	10248787	12878668	8045626	14697638
2070	10277339	12989484	8016514	14953882
2071	10305146	13101094	7986122	15218723
2072	10332223	13213515	7954481	15492520
2073	10358578	13326745	7921618	15775624
2074	10384216	13440773	7887560	16068398
2075	10409149	13555593	7852342	16371225
2076	10433385	13671202	7815996	16684501
2077	10456949	13787607	7778573	17008650
2078	10479893	13904823	7740157	17344127
2079	10502280	14022865	7700850	17691408
2080	10524161	14141742	7660738	18050975
2081	10545553	14261440	7619872	18423304
2082	10566461	14381937	7578294	18808875
2083	10586905	14503211	7536062	19208190
2084	10606904	14625233	7493241	19621763
2085	10626467	14747972	7449881	20050116
2086	10645602	14871398	7406029	20493805
2087	10664298	14995473	7361717	20953379
2088	10682524	15120135	7316957	21429362
2089	10700238	15245312	7271750	21922277
2090	10717401	15370937	7226104	22432681
2091	10733987	15496956	7180035	22961181
2092	10749980	15623324	7133570	23508429
2093	10765365	15750001	7086740	24075112
2094	10780130	15876949	7039575	24661936
2095	10794252	16004122	6992097	25269619
2096	10807703	16131467	6944323	25898887
2097	10820442	16258925	6896258	26550468
2098	10832420	16386426	6847901	27225092
2099	10843579	16513895	6799241	27923498
2100	10853849	16641244	6750256	28646425

Source: United Nations (2012)