THE QUESTION OF PEAK OIL

Jiří Dobrylovský

Abstract

Petroleum is the world's most important energy source and it is a key material for the chemical industry, transportation, agriculture and food industry. Its consumption is constantly growing. The oil market is experiencing large fluctuations in prices as a result of the constantly changing supply and demand. The size of oil resources is unknown, new bearings are constantly being discovered and their exhaustion is constantly a threat, a so-called peak oil - a moment, when extraction reaches its peak and begins to fall. A solution to this question largely depends on whether the oil is renewable and non-renewable resource. Two hypotheses of how the oil was formed - biological and chemical. The oldest hypothesis is chemical (Mendeleev). In the 20th century the biological hypothesis was preferred and oil was considered a fossil fuel. But the latest discoveries in space speak in favour of the chemical hypothesis, in that case oil would be unlimitedly available renewable source. On this issue depend the energetic and economical future of civilization in the following decades. In paper, I perform a qualitative assessment of the current state of knowledge.

Key words: petroleum, hydrocarbons, peak oil, Hubbert's theory

JEL Code: L71, O13

Introduction

Petroleum is the most important world energy source and fluctuations in its price have an essential influence on the global economy. Up to 2014 under the influence of the continuously growing price it seemed that disposable supplies of oil started to diminish and that human civilization was facing a threat called the peak oil. However, the collapse of oil prices by approximately 70% from mid-2014 to the beginning of 2016, resulting from whichever cause, clearly showed that the peak oil, if it really threatens us at all, does not represent any threat in the immediate prospective.

1 What is it the peak oil?

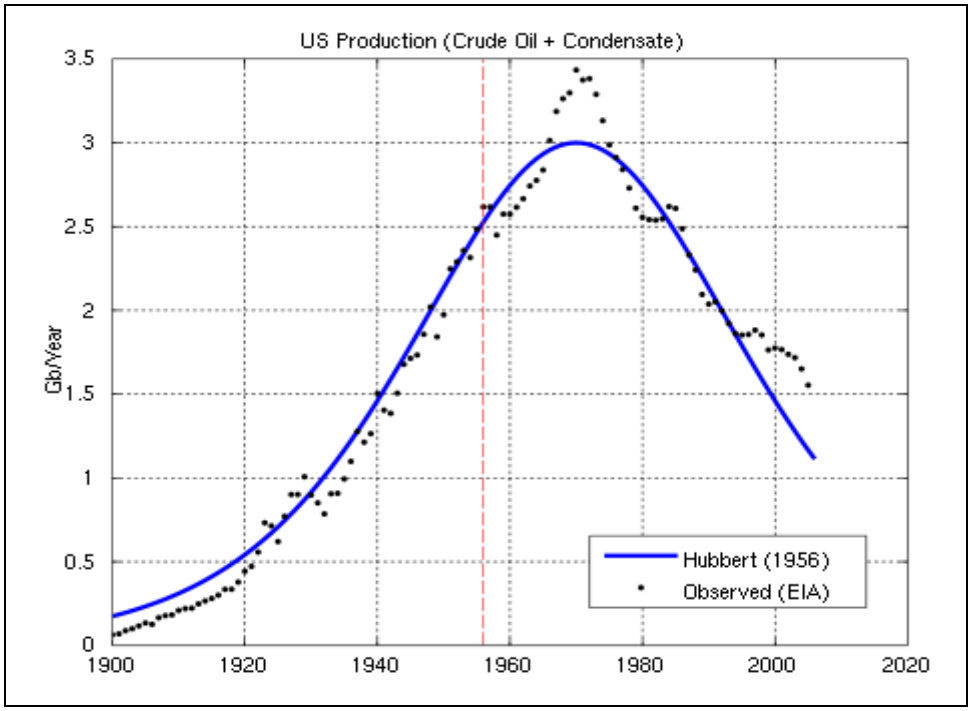
Despite the efforts to find abundant alternative sources of energy it is clear that oil and natural gas are and obviously will remain (particularly after departure from nuclear energy in a number of countries) the most important energy media for at least the next several decades. However, there are more and more frequent worries about the so-called peak oil, which is a moment when petroleum extraction (within one individual deposit, country, region or world – in this paper only the global peak oil is considered) reached the peak and from which the oil production enters the decline phase, leading to final exhaustion. A theory studying the issues of long-term predictions of consumption and exhaustion of oil and other fossil fuel is called Hubbert´s theory of the oil peak (Hubbert, 1956). This theory is based on two basic presumptions formulated by Hubbert:

1. Sources of oil are non-renewable.
2. At the moment, when approximately one half of global oil supplies is exhausted, its extraction is bound to reach its peak, after which it will start to fall.

In other words, according to Hubert´s theory there is a certain moment from which less and less oil should be available. There is no doubt that this situation would represent a global economic (and not only economic) threat. Therefore, it is possible to ask when and if we are really threatened with this peak oil or if it is only one of many modern spectres, such as the recent phenomenon of an expected computer crash with the arrival of the year 2000 (Y2K issue) or the Mayan "end of the world" in December 2012.

It´s true that geologist Marion King Hubbert himself increased credibility of his theory substantially by his unbelievably exact prediction of the national oil peak in the USA. He made this prediction for American Petroleum Institute as a geologist employed with Royal Dutch Shell in 1956. According to this prediction oil exhaustion in the USA should have reached its peak in 1970. The exhaustion really culminated in 1971 and it has been steadily falling ever since (Fig.1).

Fig. 1: Peak oil in U.S.A.



Source: https://cs.m.wikipedia.org/wiki/Soubor:Hubbert_US_high.svg

It is also true that the national peak oil has been experienced even in other countries, including producers of global importance (beside the already mentioned USA, e.g. Libya, Venezuela, Iran, Norway and others), however, the global oil peak is still far away. This paper tries to answer the question why all these predictions, no matter how much they were based on serious analyses of the then available data, do not comply with the reality yet.

2 Disputable limits of growth

All prognosis so far, including the successful Hubbert´s one, are based on one essential, apparently obvious assumption. It is an assumption of fossil origin and therefore non-renewability of oilfields.

Regarding the fact that the world economy grows exponentially and so does the number of inhabitants of the Earth who must be fed and secured even from all other aspects, it is clear that consumption of energy sources grows exponentially, too. Should a stable disposable volume of energy sources be secured also in the future, known exploitable supplies of oil, gas, etc. should exponentially grow as well. This is, however, a major stumbling block at least according to various proponents of growth limits advocated by the most important protagonist

Thomas Robert Malthus already at the beginning of the 19th century or e.g. also by representatives of the so-called Club of Rome later in the modern period.

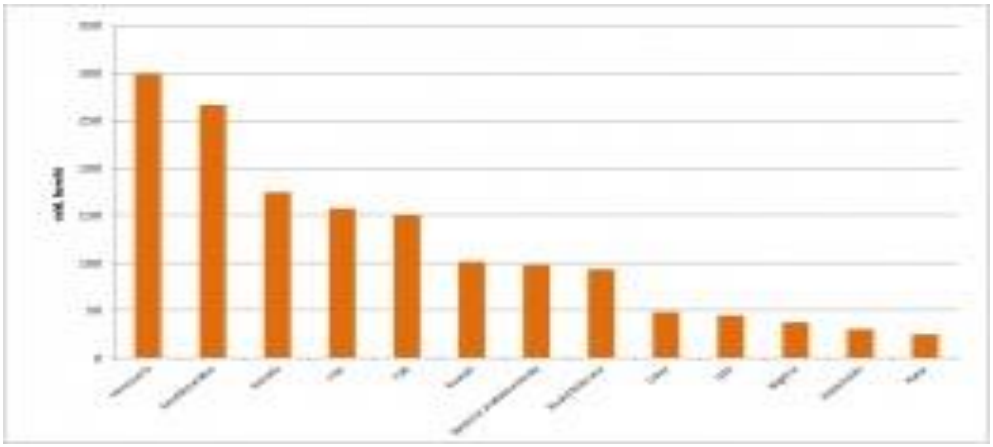
The Club of Rome as a global organization promoting so-called sustainable development and warning against potential threats of unlimited exponential economic growth was established in 1968. Since the beginning its basic publication has been the so-called "Limits to Growth" where with the help of apparently conclusive Malthusian logic it is stated that there is a threat of the Earth overcrowding, soil devastation, devastation of rain forests, elimination of biodiversity, etc. and also exploitation of energy and raw material sources of civilization. All this was said already in 1972. While we can only agree with most of the predictions and reality of the current world fully complies with them, prognosis on the depletion of raw material sources hasn´t been confirmed.

Although it is already almost half of a century, the announced threat of economic collapse not only hasn´t come, but whole large then underdeveloped zones on the Earth have become economic tigers in the meantime. The reason? It was explained in another publication of global importance, "Beyond the Limits", first published in 1992. It states, among others, "that during the same period (1970-1990) new fields of oil, coal and gas were found. This is the reason why although the current intensity of fossil fuel consumption is higher than in 1970 the ratio of known supplies for extraction of oil and gas have grown" (Meadows, 1995, p. 92). In other words, there is no reason to change anything with the catastrophic visions of "Limits to Growth" of 1972, they are only postponed into a not very distant future thanks to modern forms of prospection and newly discovered and opened fields.

But is this a really justified conclusion?

It is an undisputable paradox that at present there is much more disposable oil (i.e. currently excavated and not excavated but known and economically excavatable fields) than before 1990, not only from the view of absolute volume, but even relatively, after considering the steadily growing global consumption. In 1989 there were known supplies of oil for 41 years considering 1989 consumption (Meadows, 1995, p. 92), which was 66.3 million of barrels per day. On the contrary in 2013 according to statistics by British Petroleum global oil supplies were estimated at 156 billion of barrels, which would, considering 2013 consumption (approx. 91.3 million barrels per day), be enough for 54 years. Meanwhile, however, newer and newer oil fields are being found, e.g. in shelves of the Arctic Ocean, in Australia, near Madagascar, etc. see Fig.2). The situation with gas is similar.

Fig. 2: Countries with the largest proved oil supplies in the world in 2013



Source: BP Statistical Review of World Energy, 6/2013, p. 6

Several years ago, based on price development, it was still possible to claim that in the long-term horizon the steadily growing price of oil sufficiently proves that both energy sources are becoming more and more scare which results in bigger and bigger disproportion between demand and supply. Should it be like this, why would the price of oil have collapsed in 2014 and has been more or less stagnating since then (see Fig.3), while the demand for oil hasn´t been declining in any case?

Fig. 3: Price of Brent Oil in 2005-2017

Source: https://www.patria.cz/komodity/energie/IPE+BRENT/ropa-brent.html

3 Origin of oil as raw material

The explanation of this apparently incomprehensible feature can be found in an unconfirmed assumption that oil is a fossil, which means an unrenewable energy source.

Oil in general is a mixture of liquid hydrocarbons, mostly alkanes. There have been two rival hypotheses considered since the beginning of scientific investigations of this liquid. The first one, chemical or abiotic, according to which oil is a product of chemical processes in bedrocks was favoured for a long time. It was advocated among others also by Dmitri Mendeleev (1877). In the 20th century a biogenic hypothesis prevailed for many decades. It stated that oil had appeared thanks to underground metamorphosis of dead sea plankton (while coal originated from terrestrial vegetation). However, the biogenic hypothesis has never been unconditionally accepted, it could not e.g. explain, why oil fields can be found even in depths below 10km and therefore in the last half of the century the chemical hypothesis has been favoured more and more strongly again.

E.g. Sir Robert Robinson (1966) concluded that oil contains much more hydrogen and oxidizes less than it is possible with a biologically originated material.

Thomas Gold from Cornell University published an article The Deep Hot Biosphere (1992) in which he advocates abiotic origin of oil in lower layers of the lithosphere, in depths of about 200 km from hydrocarbons being stored in the depth of the Earth since the primeval accretion of the Earth and leaking up steadily. Consequently, the steadily originating oil not only fills cavities under the Earth surface, but also refills the fields which are already being extracted. In other words, oil is an unlimited and undiminishing source. He developed this idea further in a publication of the same name several years later (1999).

At the break of the 21st century J. Kenney succeeded in creating oil in a lab by an inorganic way. Kenney (2002): “There are thermodynamic reasons in the nature why complicated hydro-carbon mixtures and therefore oil either cannot emerge from strongly oxidized hydro-carbon compounds of which dead beings consist. On the contrary oil can emerge spontaneously from simple hydrocarbons (methane) by high pressures and temperatures”.

Kenney´s statement is supported by the fact that regardless of all the effort we have not managed to produce oil from vegetable material in a lab yet (so-called organic oil or also “green” oil, liquid on the base of methyl esters, has an absolutely different composition than natural oil which is, as mentioned above, a mixture of alkanes; this is the reason why the complete substitution of diesel oil by organic oil is not possible. Organic oil can be only

added to diesel oil in volumes of single digit percents, otherwise there is threat that the engine might be destroyed).

The answer to the question how inorganic methane appeared in the depth of the Earth must be searched in astronautics (which revealed huge lakes of non-biological methane on Saturn´s moon Titan), in astrology (which detected simple and more complex hydrocarbons in interstellar molecular clouds) and also in terrestrial oceanography, which found huge stocks of so-called methane hydrate (CH_4 x 5.75 H_20) leaking from the Earth depths and crystallizing on the sea beds. In other words, the universe is full of hydrocarbons (hydrogen is the most widespread element and carbon the fourth most widespread one in the universe) and under suitable conditions existing in the depths of Earth lithosphere oil can emerge from them in a natural way.

Conclusion

Regardless if a chemical or biological hypothesis on the origin of oil is confirmed or not, the earthly economy doesn´t need to worry about final extraction of this energy source. In case of biological oil the peak oil will be reached sooner or later, but thanks to currently proved oil fields and new technologies for its extraction (hydraulic fission, oil sands refining) it will definitely not happen before 2070. By that time, however, oil as the most important energy medium will undoubtedly have been long replaced.

This already happens to a considerable amount now, because oil consumption grows much more slowly than it would respond to the huge expansion of China and other countries. In contrast to exponential growth in extraction performed up to the Yom Kippur war in 1973 resulting in the first oil shock, currently the growth in oil exploitation follows rather a logarithmic curve, a definitely concave one. It is not possible to explain why it is so in several sentences, but it is obvious that basic causes can be seen in the growing efficiency of oil and oil products utilisation (e.g. decreasing fuel consumption of cars) and in substitution of oil as energy raw material by other sources of energy (solar energy, wind, a dramatic increase in utilization of nuclear energy in China and in other countries). Hence the curve depicting exploitation of oil by far more reflects the changing type of returns to production function. Up to the mid-1970s, when more easily accessible oilfields with oil flowing almost without any help were exploited, increasing returns were applied, but with the need of switching to more demanding extraction, diminishing returns started to prevail.

In case of abiotic oil and natural gas there is no need to worry about any peak oil in however distant the future at all. There will be no turning-point catastrophe, after which the global economy would collapse, with unpredictable consequences at once. In the extreme we can expect only further application of the law of diminishing returns. Consequently, from a certain moment oil and gas will become more and more expensive energy sources and one day their utilization will not be worth it and they will be naturally replaced by other sources as in the case of biogenic oil – the substitute may be fusion of heavy hydrogen, utilization of metallic hydrogen or anything else.

However, this doesn´t mean that all worries can be left behind. Even with the optimistic option in mind human civilisation has more than enough problems.

Acknowledgment

This article is provided as one of the outputs of the research project of the Faculty of Business Administration IP 300040 „Competitiveness “.

References

1. BP Statistical Review of World Energy, 6/2013. https://www.laohamutuk.org/DVD/docs/BPWER2013report.pdf
2. Foucher, S. (2007). *Hubbert US high.* Commons wikimedia.
3. Gold, T. (1992). *The Deep Hot Biosphere.* In: Proceedings of the National Academy of Sciences, U.S.A., pp. 6045-6049.
4. Gold, T. (1999). *The Deep Hot Biosphere.* New York: Springer.
5. Hubbert, M.K. (1956). *Nuclear Energy and the Fossil Fuels*. San Antonio: American Petroleum Institute.
6. Kenney, J.F., et al. (2002). *The thermodynamic stability of the hydrogen-carbon system: The genesis of hydrocarbons and the origin of petroleum.* In: Proceedings of the National Academy of Sciences, U.S.A., pp. 10976-10981.
7. Kohout, P. (2011). *Finance po krizi.* Praha: Grada Publishing.
8. Meadows, D.H., Meadows. D.L., Randers, J., Behrens, W.W. (1972). *Limits to Growth: A Report for the Club of Rome's Project on the Predicament of Mankind*. New York: Universe Books.
9. Meadows, D.H., Meadows. D.L., Randers, J. (1995). *Překročení mezí.* Praha: Argo.

10. Mendělejev, D.I. (1877). *L´Origine du petrole.* In: La Revue Scientifique, France, pp. 409-416.
11. Robinson, R. (1966). *The Origins od Petroleum*. Nature, s. 212, pp. 1291-1295.
12. https://www.patria.cz/komodity/energie/IPE+BRENT/ropa-brent.html

Contact

Jiří Dobrylovský
University of Economics, Prague
W. Churchill Sq. 4, 130 67 Prague 3, Czech Republic
dobrylov@vse.cz