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Use of Statistical Indicators to Measure Crude Oil and Natural Gas Reserves and Production

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Abstract

Oil and gas industry is undoubtedly one of the most important industrial activities, both due to the large share of GDP and to its powerful impact on economic and social life. Substantiating decisions in this very important power engineering field is not possible without a comprehensive analysis of relevant data and information, based on a set of statistical indicators.

This paper aims to present some of the most important statistical indicators used in the analysis of reserves and production of crude oil and natural gas. Moreover, the authors provide a brief overview of the power engineering sector worldwide and in Europe, for the last years, in terms of these statistic indicators.

Keywords: *crude oil, natural gas, statistical indicators, reserves, production*

JEL Classification: *C82, L71*

Introduction

Oil and natural gas represent resources with a major impact on economic and social development, being actually, at least for the moment, the most important energy source. Products resulting from the processing of crude oil and natural gas play a key role in companies' activity and thus in people's lives, being the most traded activity in the world[1].

Like any field of social and economic life, aspects related to oil and gas industry must be measured, statistically quantified, using specific indicators to this end. Substantiation of decisions and strategies in the oil industry at both microeconomic and macroeconomic level (national, European or even global) must be based on statistical data as accurate, complete, relevant and current as possible, in order to highlight available resources and reserves, but also the production, flow or demand for oil products.

[1] Lazăr, M., Lazăr, C., *Analiză Statistico - Economică,* Economic Publishing House, Bucharest, 2012, p. 25

Even if the supply of oil products continued to grow, in absolute terms, its share in total energy production worldwide has decreased from 45% in 1973 to 35% in recent years[2].

This paper aims to highlight some methodological issues concerning the quantification of crude oil and natural gas reserves and production. In order to emphasize the role of statistical indicators specific to the oil and gas industry, the paper presents and analyzes some suggestive statistical data.

The Quantification of Oil and Natural Gas Resources

Resources or reserves of oil and gas represent a basic requirement for the development of most economic activities in any country.

The fact that these resources are unevenly distributed around the world - some countries featuring large amount of resources, others less, while others almost nothing - generates economic or military wars in order to grab areas with large amounts of oil and gas.

A distinction must be made from the outset between resources and reserves of oil and natural gas.

Resources are those quantities of oil and gas which are currently estimated in the subsoil, which may or may not be economically recovered and exploited[3].

Reserves (proved) of oil and gas are those quantities of which there is geological information with reasonable certainty that they can be exploited from known reservoirs, and under existing economic and production conditions[4].

Oil and gas reserves constitute a major component of the natural resources of the country, of national wealth. Including oil and gas resources into national wealth implies the existence of a potential which must be known with some degree of certainty[5].

The quantification of oil reserves is based on two statistical indicators:

- The volume of oil reserves (Rp), statistical indicator of moment, expressed in barrels (1 barrel = 0.1364 tons);
- The ratio (rp) between the volume of reserves (Rp) and the annual oil production (Qp):

$$r_p = \frac{Rp}{Qp} \tag{1}$$

The indicator expresses the duration in years of existence of oil reserves, while maintaining their rate of exploitation.

In the case of natural gas it was similarly proceeded, calculating two statistical indicators:

- The volume of natural gas reserves (Rg), statistical indicator of moment, expressed in cubic meters;
- The ratio (rg) between the volume of reserves (Rg) and the annual production of gas (Qg):

[2] EUROSTAT, *Agence International de l'Energie*, Luxembourg, 2005, p.75
[3] *Financial reporting in the oil and gas industry*, 2nd edition, PWC, 2011, www.pwc/energy
[4] BP Statistical Review of World Energy, 2013, p.6
[5] Anghelache, C., Voineagu, V., Mitruț, C., Isaic-Maniu, Al., *Sistemul conturilor naționale,* Economic Publishing House, Bucharest, 2007, p. 423

$$r_g = \frac{Rg}{Qg} \tag{2}$$

Using the statistical indicators mentioned above highlights very important aspects for the global economy for the sustainable development (Table 1).

Table 1. The evolution of oil and gas reserves and the relationship between them and the production, worldwide in 2002 and 2012

Country	Proved Reserves, at the end of the year		Ratio R/Q in year 2012
	2002	2012	
Oil	thousand million barrels		years
United States of America	30,7	35,0	10,7
Venezuela	77,3	297,6	*
Canada	180,4	173,9	*
Saudi Arabia	262,8	265,9	63,0
Iran	130,7	157,0	*
Iraq	115,0	150,0	*
Kuwait	96,5	101,5	88,7
Qatar	27,6	23,9	33,2
Russian Federation	76,1	87,2	22,4
United Kingdom	4,5	3,1	8,8
Romania	0,5	0,6	7,4
Total World	**1321,5**	**1668,9**	**52,9**
Natural gas	trillion cubic metres		years
United States of America	5,3	8,5	12,5
Venezuela	4,2	5,6	*
Canada	1,7	2,0	12,7
Saudi Arabia	6,6	8,2	80,1
Iran	26,7	33,6	*
Iraq	3,2	3,6	*
Kuwait	1,6	1,8	*
Qatar	25,8	25,1	*
Russian Federation	29,8	32,9	*
United Kingdom	1,0	0,2	6,0
Romania	0,3	0,1	9,3
Total World	**154,9**	**187,3**	**55,7**

Data source: BP Statistical Review of World Energy, 2013, p.6 and p.20
* Over 100 years

The statistical data in the table above highlights, as previously mentioned, an uneven distribution of oil and gas reserves, for there are countries with large reserves such as Venezuela, Saudi Arabia, Canada, Iran, Iraq, Kuwait and the Russian Federation holding together nearly 75% of the world oil reserves (Figure 1).

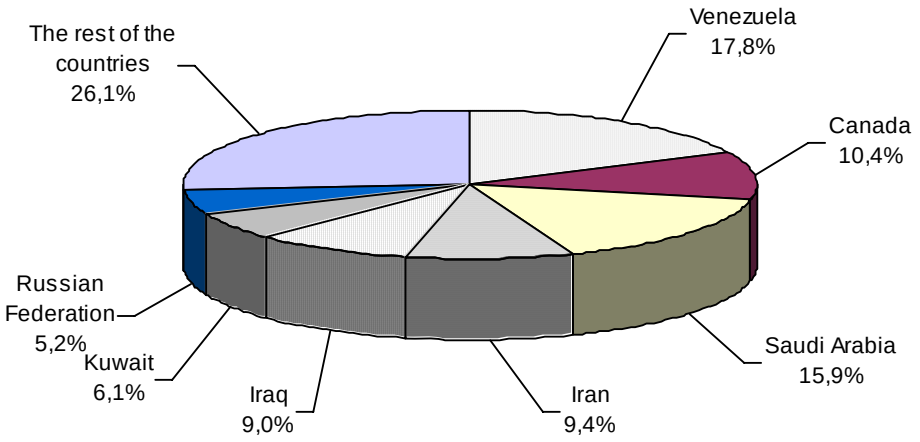

Fig. 1 Structure by countries of the global oil reserves in 2012

Data source: BP Statistical Review of World Energy, 2013, p.6

Compared to the oil reserves, the natural gas resources are even more concentrated because only three countries (Iran, Russian Federation and Qatar) own nearly 50% of the world resources (Figure 2).

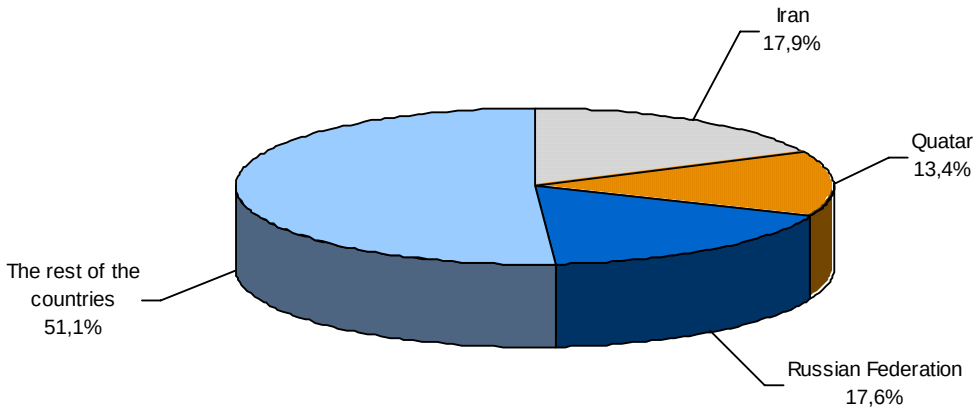

Fig.2 Structure by countries of the global natural gas reserves in 2012

Data source: BP Statistical Review of World Energy, 2013, p. 20

Romania, together with the United Kingdom and other countries unnamed in the table, are among the countries with very low reserves, both in oil and natural gas.

Furthermore, following the data presented in Table 1, in some countries (Venezuela, Canada, Iran, Iraq) the oil reserves are sufficient for at least 100 years, while in other countries, including Romania, they can be exploited up to maximum 10 years.

Worldwide, both crude oil reserves as well as the natural gas can be exploited for about 50 years.

Statistical Indicators of Oil and Natural Gas Production

Quantifying the production of the industry of oil and natural gas at macroeconomic level is realized both through indicators expressed in physical units and through value indicators.

a) In the case of crude oil production:

- Annual physical crude oil production (Q_p^a), statistical indicator of moment, expressed in tons;
- Daily physical crude oil production (Q_p^z), statistical indicator obtained by reporting the annual production to the number of calendar days in a year, expressed in barrels / day;
- Physical crude oil production expressed in conventional units[6], respectively tons of equivalent oil (1 toe = 10,000 kcal / kg). This indicator is used to ensure comparability between different energy sources: oil, natural gas, coal, hydroelectric power etc;
- Value production of crude oil (QV_p), expressed in monetary units (for Romania in lei, internationally most commonly in U.S. dollars).
- Dynamic index of crude oil production ($I_{Qp1/0}$), expressed in percents and determinate according to the next relation:

$$I_{Qp1/0} = \frac{Qp1}{Qp0} \times 100 \tag{3}$$

where:
Qp1 – crude oil production realised in current period;
Qp0 – crude oil production realised in base period.

- Absolute modification of crude oil production ($\Delta_{Qp1/0}$), expressed in natural, conventional or monetary units and calculated according to the relation:

$$\Delta_{Qp1/0} = Qp1 - Qp0 \tag{4}$$

- The structure on crude oil production, by different statistical characteristics (y_{Qi}), expressed in percents:

$$y_{Qi} = \frac{Qi}{\sum Qi} \times 100 \tag{5}$$

where:
Qi – crude oil production realized at the level of a subpopulation (enterprise, region, country, continent etc.);
$\sum Q_i$ – total crude oil production (at the level of the whole statistical population).

b) In the case of natural gas production:

- Annual physical natural gas production (Q_g^a),statistical indicator of moment, expressed in natural units, respectively in cubic meters;
- Daily physical natural gas production (Q_g^z), statistical indicator resulted by the reporting of the annual production to the number of calendar days in a year, expressed in cubic meters / day;
- Physical natural gas production expressed in conventional units, respectively tons of equivalent oil;
- Value production of natural gas (QV_g), expressed in monetary units (for Romania in lei, internationally most commonly in U.S. dollars).

[6] National Institute of Statistics, Bucharest, *Romanian Statistical Yearbook,* 2013 Edition, Section: International statistics.

- Dynamic index of natural gas production ($I_{Qp1/0}$), expressed in percents and determinate according to the next relation:

$$I_{Qp1/0} = \frac{Qp1}{Qp0} \times 100 \quad (6)$$

where:
Qp1 – natural gas production realised in current period;
Qp0 – natural gas production realised in base period.

- Absolute modification of natural gas production ($\Delta_{Qp1/0}$), expressed in natural, conventional or monetary units and calculated according to the relation:

$$\Delta_{Qp1/0} = Qp1 - Qp0 \quad (7)$$

- The structure on natural gas production, by different statistical characteristics (y_{Qi}), expressed in percents:

$$y_{Qi} = \frac{Qi}{\sum Qi} \times 100 \quad (8)$$

where:
Qi – natural gas production realized at the level of a subpopulation (enterprise, region, country, continent etc.);
$\sum Q_i$ – total natural gas production (at the level of the whole statistical population).

In Table 2 some statistical data regarding the evolution of oil and gas production in the period 2002-2012 is compared globally and at the European Union level. These statistical data highlight the role of the statistical indicators presented above, in grounding strategies relating to production, consumption, trade, investment and other aspects of economic and sustainable development[7].

Table 2. The evolution of oil and gas production worldwide and in the European Union in the period 2002 – 2012

Year	Oil - million tones -		Natural gas - trillion cubic metres -	
	Total World	European Union	Total World	European Union
2002	3602,7	158,0	2523,9	227,6
2003	3734,3	147,9	2620,7	223,6
2004	3905,5	137,5	2691,6	227,3
2005	3943,1	125,6	2780,0	212,0
2006	3963,3	114,4	2880,1	201,3
2007	3950,4	113,1	2943,2	187,5
2008	3991,8	105,7	3054,0	193,3
2009	3890,6	99,1	2969,3	174,3
2010	3977,8	92,5	3192,3	177,8
2011	4018,8	80,8	3291,3	157,9
2012	4118,9	73,0	3363,9	149,6

Data source: BP Statistical Review of World Energy, 2013, p.10 and 22

The data presented in the table above highlights an increasing trend in the global production of oil and natural gas, reflected in a supplement of 14.3%, respectively 33.3% (Figure 3) in the period 2002 – 2012.

[7] Houjeiri, H., Brandt, A., *Oil Production Greenhouse Emissions Estimator,* OPGEE v1.0, User guide & Technical documentation, Stanford University, 2012, p.33

In the European Union, however, we notice a negative trend in production throughout the period under review, registering a drastic reduction in oil production by 53.8% and by 34.3% in the natural gas.

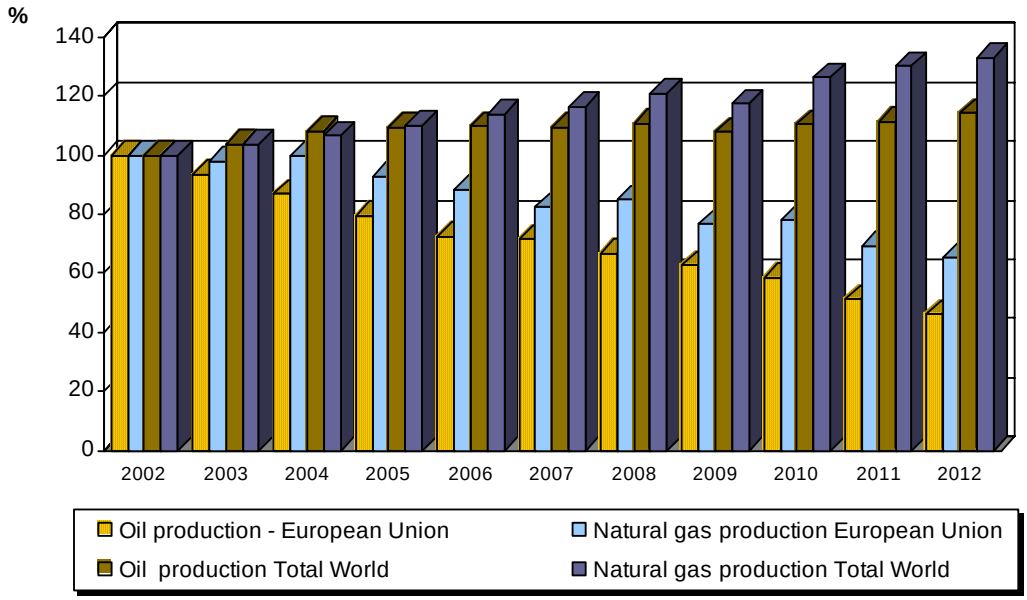

Fig. 3 The dynamics of the production of oil and gas worldwide and in the European Union in the period 2002 - 2012 (1990 = 100)

Data source: BP Statistical Review of World Energy, 2013, p.10 and 22

The chart clearly shows not only the opposite direction but also different rates of development of oil and gas production of the European Union compared to the world.

Conclusions

Using a clear, well-defined, relevant, flexible and current system of statistical indicators is absolutely necessary for the characterization of the oil and gas industry. These indicators should highlight all the aspects of this particularly important power engineering field, starting with those of the existing reserves and their dynamics, the annual and daily production, expressed both in physical and value units, the distribution of reserves by country or region, the consumption of energy worldwide but also by countries, domestic and international trade of oil products.

This paper presented only a few of these indicators, respectively only those which characterize the reserves and the production of oil and natural gas, without reference to the products resulting from their processing.

However, the little statistical information presented has managed to outline an overview on oil and natural gas reserves, currently available worldwide, their uneven distribution by country and the period for which it is estimated these reserves will last, taking into account the evolution of the production of these products.

Moreover, the data on the evolution of production of oil and natural gas showed a moderate tendency to increase worldwide and a significant reduction in the European Union.

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