FUTURE OF COAL AND CHALLENGES IN ENERGY FIELD

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ABSTRACT. *According to the new European Union Energy Policy from 2007, energy is an essential element for the development of the European Union. Romania is completely aligned to the European Union Energy Policy. The paper aims to show the journey of global evolution and challenges in the energetic field through the primary fossil energy carrier-the coal. In the paper both global and Romanian energy resources and the global energy consumption and coal percentage are presented. In this context the expectations and challenges faced by the energy companies in Romania are shown.*

***KEYWORDS*:** coal, energy, resources, reserves, consumption,

1. INTRODUCTION

Energy has become a strategic factor of global policy, a vital component as well as a cost factor for economic development and the progress of society as a whole, determining a series of major preoccupations worldwide. Under the circumstances of limited primary energy resources and in order to attain durability in the field, energy should be produced, supplied, and consumed more efficiently than before. In the case when changes that concern energy production, transport and consumption do not occur, all the world may face an overwhelming energy crisis in the decades to follow.

If nowadays energy laws and policies remain unchanged until 2035, world demand of energy increases with about 50% as compared with year 2007. The largest share within the increase of energy consumption until 2035 is going to be registered by the countries that are not part of the Organization for Economic Cooperation and Development (non-OECD countries), namely 84%, as compared with only 14% in the case of OECD countries [3].

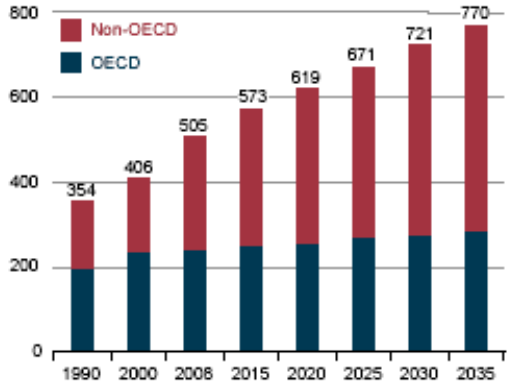

Fig. 1 World energy consumption, 1990-2035 in quadrillion Btu [9]

As regards the production of electric energy, although economic recession has decreased the consumption rate of world electric energy in 2008 and 2009, it is estimated to display a growth from 18.800 TWh in 2007 to 35.200 TWh in 2035 that is an 87%. The increase of the safety of energy supply at reasonable prices and the concern about climate changes are two of the major preoccupations and challenges of society, generally and of energy market in particular.

Production and consumption of energy determine the energy market. Consumption of energy characterized the future of world. Evidently the price of energy is recognize by rate on grows of energy consumption.

In terms of the structure of primary energy consumption worldwide, evolution and prognosis of the reference made by the International Energy Agency (IEA) highlights for the next decade rapid growth in the share of renewables and natural gas. It is estimated that about a quarter of primary energy needs globally, will continue to be covered by coal. Along with increased energy consumption will increase coal consumption. Data from the World Energy Council (WEC) shows an increase of almost 50% of global coal mining in 2005 to 1980 [12].

2. GLOBAL ENERGY RESERVES AND RESOURCES

Global energy reserves of all types are enough for the next 80 years and resources to last over one thousand years. It is known that coal reserves mean the portion of known coal resources that can be profitably mined and marketed with today's mining techniques. Coal resources are deposits that are either proven, but at present are not economically recoverable, or not proven, but expected to be present based on geological knowledge. Coal and lignite account for more than half of our which together form an even larger share of resources, shown in Figure 2 [4].

Natural gas, oil and nuclear fuels make up the remainder of total non-renewable energy reserves and resources [1]. Although abundant and – in the case of wind, solar and geothermal – practically inexhaustible, renewable energy is much harder to quantify as a resource since converting it into useful energy can be inefficient and expensive

Coal and lignite reserves are sufficient for the next 137 years at current rates of production. Unlike oil and gas, coal is widely distributed around the world with particularly large reserves in the USA, Russia and China. The distribution of coal around the word is presented in Figure 3 [3].

For this reason, coal offers a much higher level of supply security: most coal produced is used in the same country where it is extracted, which ensures the energy supply security for that country.

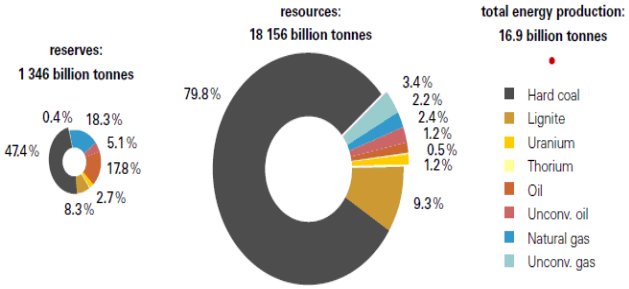

Fig. 2 Reserves and resources of non renewable fuels

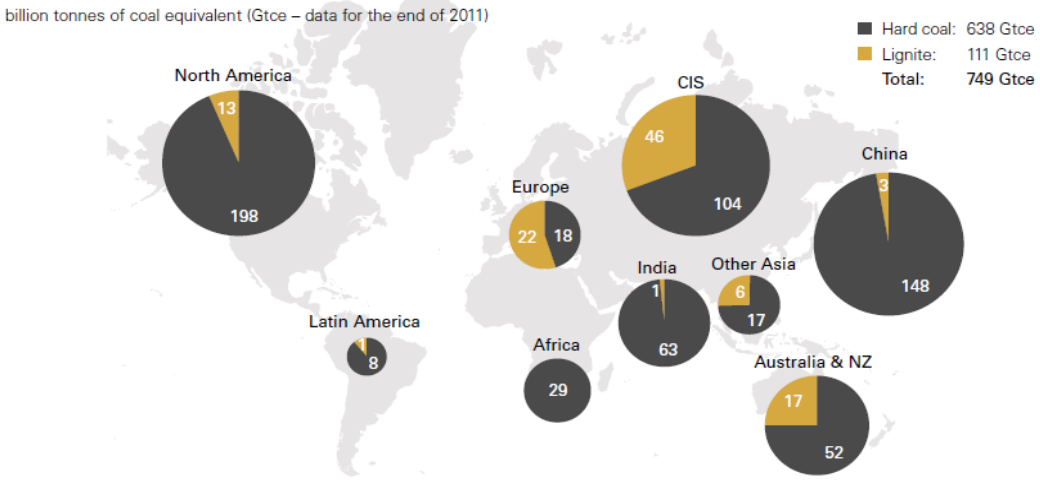

Fig. 3. Coal around the word [4]

The European Union holds only around 3% of the global energy reserves and resources (Table 1) [2]. As at the global level, reserves and resources of coal and lignite are most significant: together they account for 94 % of the EU's remaining potential [2].

Table 1. Fossil fuel reserves and resources in the EU

Gtoe (billion tonnes of coal equivalent)	Reserves		Resources	
Hard coal	16.6	43.0%	428.6	77.8%
Lignite	17.4	45.0%	93.1	16.9%
Oil	1.7	4.4%	3.6	0.7%
Natural Gas*	2.8	7.3%	20.5	3.7%
Uranium	0.1	0.3%	4.8	0.9%
Total	38.7	100.0%	550.7	100.0%

**Natural Gas includes conventional natural gas, tight gas, shale gas, coalbed methane, aquifer gas, gas hydrates.*

Some coal deposits lie near consumers and can be exploited under very favorable conditions. Some lignite opencast like the ones in Bulgaria, the Czech Republic, Germany, Greece, Hungary, Poland and Romania lie near consumers, mainly power plants, which makes the transport to be on short-distance which in turn leads to the lowest cost electricity production in Europe.

The hard coal, both indigenously produced and imported, is much less expensive than imported oil or gas and the majority of EU member states enjoy the benefits of competitive coal - fired electricity generation.

THE ROLE OF COAL IN THE EUROPEAN ECONOMY

The challenges faced by the energy world – and the coal industry in particular – are getting more complex. Global energy markets have become increasingly competitive and Europe finds itself in a race for resources and investments. Energy policies and political commitments have had to adapt in the wake of the economic crisis. US shale gas has brought cheaper coal from the US to Europe, shifting the balance in Europe between gas and coal. At the same time, global energy-related CO_2 emissions in 2012 reached a new historic high, whilst scientific consensus on the direct link between our use of energy and climate change, described in the latest IPCC report, has never been stronger, said Philip Lowe, *Director-General for Energy* from European Commission [2].

To deal with these challenges, EU policy makers, together with Member States, are working to find the right balance between sustainability, competitiveness and security of supply concerns, not just in our current

strategy and programmes, but also for the forthcoming EU 2030 energy and climate policy framework. These challenges also have an impact on the coal industry in Europe which has undergone a transformation. The economic arguments for coal have changed recently in its favour. Coal provides much-needed security of supply in our electricity network. After years of decline, demand for coal in the EU has started rising again, with coal imports up 7% in 2012. On the other hand, many coal plants will be faced with closure due to new air pollution limits coming into force in 2016. EU coal production will be affected by the phase out of state aid by 2018. In addition, policies to reduce greenhouse gas emissions have a particularly profound impact on the coal industry and coal-fired power generation.

In the European economy coal plays an important role. Over one quarter of our electricity comes from coal. Coal and related industries employ well over 200000 people. Balancing the benefits of coal with its environmental impact is a challenge both for the coal industry and for European policy makers.

It is known that 87% of CO_2 emissions in EU come from energy production or use, that make energy industries remain the dominant source. The only way to reconcile the use of coal with a low-carbon and efficient energy system is with greater flexibility, more efficiency and the widespread uptake of carbon dioxide capture and storage – CCS. It is important for the coal and power industries to be competitive, therefore to develop more low-carbon options for coal-fired electricity generation.

Making progress on CCS development is not just a technical and financial challenge, but also a political issue. It is necessary to cross many obstacles which need to be overcome. It is desired that the coal industry, electricity generators based coal and coal investors work together to find innovative solutions for the future of coal and to ensure that coal continues to be a useful resource in a low-carbon energy system.

The European Union is the world's third largest coal-using region, after China and North America. Each year, around 130 million tonnes of hard coal are mined and a further 210 million tonnes are imported making it the world's largest importer after China. At 430 million tonnes, EU lignite production far exceeds that from any other region. Russia, Australia, the USA and Turkey each mine around 70 million tonnes, far behind Germany which produced 185 million tonnes in 2012. Most Europeans never see a lump of coal, but they use it in their homes in the form of electricity: 27% of EU electricity production comes from burning coal and lignite in power stations. EU hard coal and lignite production and consumption for power generation are shown in Table 2 [3].

Despite these remarkable statistics, coal and lignite are not always viewed positively. They are abundant, affordable and accessible so they add to the security and competitiveness of energy supply in the EU. 88% of EU fossil energy reserves are in the form of coal and lignite. However, burning fossil fuels of any type – coal, oil or gas – releases carbon dioxide (CO_2) into the atmosphere that is thought to cause global warming and climate change. It is right that the coal industry is taking steps to reduce emissions. EURACOAL itself calls for a three-step strategy encompassing power plant modernisation to improve efficiency using technologies that are commercial today, research and development into even more efficient technologies for tomorrow and finally deploying CO_2 capture and storage in the next period.

Table 2. EU hard coal and lignite production and consumption for power generation

	EU Hard coal production		Consumption of indig. hard coal for power generation**	
Country	1-12 2013 Mt	1-12 2012 Mt	1-12 2013 Mt	1-12 2012 Mt
Bulgaria*	2.1	2.3	1.7	2.1
Czech Republic	8.6	11.4	2.8	3.3
Germany	7.5	10.8	6.4	9.8
Poland	76.5	79.2	n.a	52.0
Romania	1.8	1.9	1.8	1.9
Spain	4.4	6.1	2.9	6.5
UK	12.8	16.8	n.a	15.2
EU-27	113.7	128.5	n.a	90.8

** brown and black coal*
*** only hard coal producing countries*

In too many countries, there is a reluctance to take even the first of these practical steps as policy shifts against coal. This needs to be reversed so that the EU is not left behind in a world that is embracing coal like never before. Europe needs to demonstrate how to use coal cleanly and efficiently. There are good examples that we can be proud of and use to promote European technology. In Denmark, one can find the world's most efficient coal-fired power plants. In Germany, lignite-fired power plants that have opened in the last couple of years are the world's most flexible – perfect for balancing the increasing share of electricity from renewable energy sources under the German Energiewende. In the Netherlands, new coal-fired power plants will open shortly and ensure that the country does not become dependent on imported gas as its own North Sea gas reserves deplete. These are all good examples, but looking to Eastern and South Eastern Europe a different picture emerges [7, 9].

Newer member states have not been so lucky because the investment climate has not favoured renewal of their ageing and often inefficient coal-fired assets. The basics must be in place to support economic growth. For most countries, this means a reliable and affordable electricity supply that does not pollute the countryside. Whilst many in Western Europe can be satisfied with the progress that has been made in that direction, the same is not true across all parts of the EU.

3. PRIMARY ENERGY RESOURCES OF ROMANIA

Romania displays a varied range – yet limited in amount – of fossil and mineral primary energy resources: crude oil, natural gas, uranium, as well as an important potential of renewable resources that could be turned to good account [1].

It is mentioned in Romania's energy strategy [13], that until 2020 there are proven coal energy production deposits for the next 155 years. Almost 80 % of the country's primary energy demand is met by indigenous energy resources.

Current oil reserves are estimated at 82 million tonnes with an annual production of around 4 million tones [3].

Natural gas reserves are estimated at 109 billion cubic meters with an annual production of around 11 billion cubic meters. New offshore gas could enable Romania to become a net gas exporter by 2025 [3].

Hard coal reserves and resources are estimated at 2 446 million tonnes, of which 252.5 million tonnes are commercially exploitable within the currently leased perimeters, although as little as 11 million tonnes might be economically recoverable [3].

Proven reserves of lignite total are 280 million tonnes, with a further 9 640 million tones of resources. 95 % of lignite deposits in Romania are situated in the Oltenia mining basin and more than 80 % of these can be mined in opencast mines. The remaining lignite deposits have low economic potential, explaining why extraction in most other areas has stopped.

Romania's entire hard coal and lignite output is used for heat and power generation. At the end of 2011, the total capacity of installed generation was 20 498 MW; coal – fired power plants had a share of 28.9 % or 5 918 MW, other fossil fuel power plants 5 374 MW (26.2 %), hydro power plants 6 483 MW (31.6 %) and the Cernavodă nuclear power plant 1 411 MW (6.9 %) [13].

The main consumers of hard coal are the thermal power plants at Paroşeni (3x50 MW) and Mintia- Deva (6x210 MW) [3].

Hard coal has the advantage of ensuring a long – term supply for these power plants. Some mines will be obliged to stop their activities due to the enormous land acquisition costs and very high operational costs. More generally, some mining companies urgently need to modernize their equipment to improve performance and productivity.

Lignite mining in Romania offers some competitive advantages with the use of modern technologies and skilled labor. Reserves are concentrated in a relatively small area of about 250 square kilometers where lignite is currently mined in 19 opencast pits. These reserves provide a long - term secure supply for power plants. In order to avoid impacts on neighboring agricultural land, overburden is placed back in the excavated voids, which also helps reduce costs. The main consumers are nearby power plants, Turceni (5 unit of 330 MW), Rovinari (4 unit of 330 MW) and further to the south lies the 300 MW Craiova power plant and Isalnita (2x315 MW). The map of the distribution of hard coal and lignite in Roamnia is like in Figure 4 [3].

During 2012, the coal industry underwent major restructuring. The lignite mines and power plants were combined into the vertically integrated OLTENIA ENERGY COMPLEX to create what the Romanian government hopes will be a national champion [14].

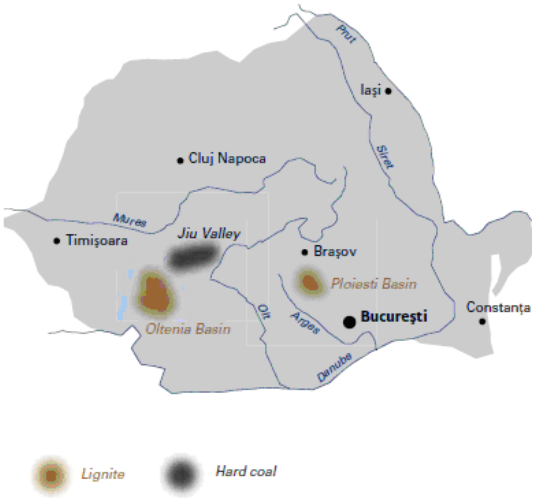

Fig. 4. Map of coal reserves in Romania

Restructuring of the hard coal sector was more problematic and was finalized only at the end of 2012 with the creation of two separate operating units under the NATIONAL HARD COAL COMPANY (CNH SA Petroşani). One will oversee the closure by 2018 of three coal mines in the Jiu Valley that are not viable (Uricani, Paroşeni and Petrila), following Council Decision 2010/787/EU on state aid to the coal industry namely, JIU VALLEY MINE CLOSURE SOCIETY. The other unit, will continue to operate the remaining four coal mines without state aid (Lonea, Livezeni, Vulcan and Lupeni), with an annual production capacity of 1.5 million tones [15]. As a result of the implementation of a solution to integrate the economically viable coal mines from Jiu Valley with the energy producers, an organizational integration, HUNEDOARA ENERGY COMPLEX any was established in 2012 in Vulcan, Romania. The company has formed after the consolidation between Energy Power Plant Deva and Energy Power Plant Paroseni in 2012, merging with the National Hard Coal Company in 2013 as a result of readjustment measures for the energy producers.

Job losses will total 2 400, leaving 5 200 employees [3].

The mines part of Hunedoara Energy Complex need to be part of an investment program to bring new technologies to maintain the capacity and ensure the pit coal production which is to be provided to the other two branches of the energy company, Paroseni and Mintia-Deva Energy power plants to produce energy.

The condition of exhaustible energy resources is as follows [7]:

- Hydro-carbon deposits are limited and show a decrease of internal production under the

circumstances of no new deposits of significant potential having been identified. Present resources represent 73.7 million tons. Yearly production of crude oil decreased from 14.7 million tons in 1976 to 5 million tons in 2006.

- Natural gas deposits are also limited, and after 1990 internal production witnessed a decline. The present deposits of natural gas represent about 184.9 billion m3. The yearly production of natural gas represented 12.3 billion m3 in 2006, namely 69% of the yearly national total consumption of natural gas.
- The identified hard coal resources of Romania represent 755 million tons out of which 105 million tons are exploitable in areas under concession.
- Romania's lignite resources represent 1490 million tons out of which 445 million tons are exploitable in areas under concession. The resources located in new perimeters which are not under concession represent 1045 million tons. Out of the deposits of 1045 million tons of lignite within the mining basin of Oltenia, 820 million tons afferent to the new perimeters are located in the neighborhood of areas under concession exhibiting the most favorable conditions of capitalization through extending concessions. Owing to the fact that lignite deposits in Oltenia includes 1-8 layers of exploitable coal, their superior exploiting requires the immediate adoption of certain regulations that could guarantee the rational exploiting under total safety conditions (minimal losses) and efficiency conditions.
- Existing and exploitable ore deposits provide the demand for natural uranium until 2017 for the functioning of two nuclear and electric units belonging to Cernavoda plant. The potential new perimeters of uranium ores cannot significantly change the existing condition so that it is necessary to adopt certain specific measures in order to provide natural uranium resources according to the demands that come out of the program of nuclear energy development.

Accordingly, at present the following estimation may be considered:

- Lignite deposits may provide their efficient exploiting for about 40 years at a production level of approximately 30 million tons per year. In the field of lignite extraction the degree of State's intervening is small and mainly consists in giving subsidies only for underground exploiting; in time such subsidies are going to be stopped.
- As regards hard coal, the decrease of perimeters and closure of inefficient mines means that at present only about 30% of the total amounts of hard coal geological deposits are now located within the perimeters under concession detained by coal mines of he Hunedoara Energy Complex. One may infer that the evolution of production costs, of supplemental costs with CO_2 emissions and the elimination of production subsidies are going to determine the important decrease of internally produced hard coal that becomes less and less competitive and determines the significant decrease of production. From an economic and energy point of view, indigene hard coal becomes a marginal source for the production of electric energy in the case it loses its subsidies. According to the national resources condition of primary energy,Table 3, established in the energy strategy (2007), , one may notice that, except for renewable energy sources, lignite is the only internal carrier of primary energy which – when it comes to resources – is able to significantly contribute to providing the demand of consumption in order to produce electric energy for the following 2 – 4 decades[13].

Table 1. The situation of national primary energy resources

Fossile fuel	Reserves						Yearly estimated output
	Reserves		Exploitable under concession		Within new perimeters		
	Million tons*	Million. tep	Million tons*	Milllion tep	Million tons*	Million. tep	Million tons*
Hard coal	755	422	105	38,8			3,3
Lignite	1490	276	445	82,4	1045	133	32
Crude Oil	74	72	n.a	n.a	n.a	n.a	5,2
Natural Gaz	185	159	n.a	n.a	n.a	n.a	12,5
Nuclear energy	n.a	n.a	n.a	n.a	n.a	n.a	n.a

*natural gas exclusively expressed in billion cubic meters

4. COAL IN GLOBAL ENERGY CONSUMPTION

Global consumption of commercial energy, has totalled 19 billion tonnes of coal equivalent (Gtce) in 2012 [11]. The coal, with a 29 % percentage, was ranked of the second after oil, as one of the major sources of primary energy Coal production has more than doubled since 1980 and, according to the IEA, coal could replace oil to become the most important source of energy within the next five years [10].

For power generation, coal plays a major role in both developed and emerging economies. In 2012, 41 % of global power generation was based on coal: 38 % hard coal and 3 % lignite (Figures 5).

World coal production reached 7.8 billion tonnes in 2012: 6.9 billion tonnes of hard coal and 0.9 billion tonnes of lignite. In turn, the production of hard coal

comprised 5.9 billion tonnes of steam coal and 1.0 billon tonnes of coking coal [7].

There are some very large consumers of coal which tend to dominate the global picture. On an energy basis, the European Union is the world's fourth largest consumer of coal after China, the United States and India. It is noteworthy that in 2012, China's annual coal production grew by an estimated 130 million tonnes, this being almost identical to the EU's total hard coal production. Nevertheless, at 433 million tonnes, the EU remains the world's largest lignite producer by a wide margin.

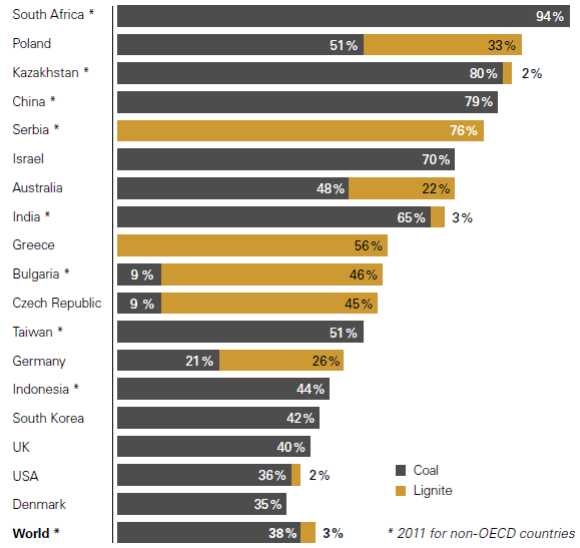

Fig. 5 Share of coal - fired power generation in selected countries, 2012 * [11]

Two thirds of all coal produced worldwide is delivered to power plants, or 90 % in the case of lignite. Other major customers for hard coal are in the iron and steel sector, chemical fertiliser manufacture and the process heating market, including cement works, paper mills, food processors and other industries. Coal today plays a lesser role in the heating of buildings, except in several eastern European countries, Turkey, China and North Korea. That said, coal - fired district heating and cooling as well as combined heat and power are important in Scandinavian countries.

5. CONCLUSIONS

The coal industry, from extraction to power generation, represents a completely secure value - added industrial supply chain, creating economic wealth and prosperity in the EU.

Beyond Europe, the technologies developed by the European mining and power plant equipment suppliers also contribute to improving the efficiency of coal production, preparation and use in other regions of the world.

Coal today plays a lesser role in the heating of buildings, except in several eastern European countries, Turkey, China and North Korea. For power generation, coal plays a major role in both developed and emerging economies.

Romania's entire hard coal and lignite output is used for heat and power generation.

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