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New approach to brown coal pricing using internal rate of return methodology

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HIGHLIGHTS

- We showed that brown coal is the substitute for black coal only at the time of the investment decision.
- We compiled the model used in a calculation of the economically justified price for the productive and extractive component.
- The resulting economically justified price is on a par with the current black coal price.
- The proposed methodological approach is applicable to solve similar tasks not only in the energy sector.

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ABSTRACT

Brown coal is one of the dominant local strategic raw materials in Europe, used, to a large extent, in the power-generating industry. The current situation, where the price of gas and electricity precludes the efficient use of gas sources, leads to the extraction of older sources, chiefly brown coal ones. In tandem with a turning away from nuclear power, brown coal is experiencing a renaissance and the issue of brown coal price setting is, and will be, relevant. This paper deals with a proposal of a new method for determining the base price, consisting of defining the reference fuel chain for electricity and heat production based on brown coal. It builds on the notion that the degree of risk of the involved parties should be reflected in the modified amount of revenue per capital invested. The resulting price is then an economically justified price which encourages a respect for the specific features of the market in question and set the base price of the commodity in a way that is acceptable for both the extractive and the productive components of the fuel chain.

1. Introduction

The issue of brown coal price setting is determined by the highly specific nature of the market, which – unlike the other energy commodity markets – is local, not regional (such as the overwhelming majority of the natural gas market) or global (such as oil, black coal and uranium markets). The reason for this arrangement is the fact that compared to the other energy raw materials the energy content of brown coal, in proportion to its volume, is significantly lower than that of oil or natural gas. Oil has the highest energy density with a calorific capacity of 40–45 GJ/t, translating to 35–40 GJ/m^3. Natural gas, composed primarily of methane, has an energy density equalling one thousandth of that of oil, 35–45 MJ/m^3, at atmospheric pressure. Its energy density can be increased by compressing natural gas a hundred times to 100 bar. At the same time, natural gas can be liquefied at −162 °C to achieve a calorific capacity about half of that of oil. In contrast, bituminous coal has a calorific capacity of 20–30 GJ/t, with a wide variation depending on its ash content. Brown coal then has a significantly lower calorific capacity, sometimes even less than 10 GJ/t [1].

The local nature of this commodity is also evident in the differing definitions of brown coal in the world. The definition methodologies differ across countries and organisations [2]. Different methodologies are applied in the USA (ASTM – American Society for Testing and Materials), Germany (DIN – Deutsches Institut für Normung) as well as within the UNECE (United Nations Economic Commissions for Europe). The methods differ in both the classification of coal of various calorific capacities (the UNECE defines 6 types of coal in its entire range, the DIN defines 11 types), and in the definition of the internationally applied term lignite. The UNECE defines ortho-lignite (up to 15 kJ/kg) and meta-lignite (up

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to 20 kJ/kg), whereas the ASTM defines lignite with a calorific capacity of up to 19.3 kJ/kg.

The fragmentation and ambiguity of the definitions are in themselves an illustration of the local nature of all the brown coal markets. A partial consequence of this ambiguity is the absence of a stock exchange platform for this commodity, meaning that its price cannot be determined using standard stock exchange instruments as is the case with the other energy commodities.

1.1. International brown coal market

According to the World Coal Association [3], the world-wide production of brown coal was 1041 Mt in 2011, while the global trade in brown coal in the same year was only about 5 million tonnes. In contrast, the production of black coal is more than six times greater, and the trade in black coal was 861 Mt in 2011 (see Table 1):

It is evident that black coal has a far more dominant position globally, placing brown coal on the periphery of public interest. Nevertheless, in light of the current events on the Central European energy market, i.e., a brown coal renaissance, the question of the pricing mechanism for this commodity is highly relevant. The current situation, where the price of gas and electricity precludes the efficient use of gas sources, leads to the extraction of older sources, chiefly brown coal ones. In tandem with a turning away from nuclear power, it is thus likely that European countries will return to brown coal for economic reasons and will be forced again to deal with brown coal price setting. Other reasons include the still reverberating economic crisis and the search for cheaper energies in order to keep the European economy competitive globally.

1.2. Differences between black and brown coal

Due to the specificity of brown coal and the fact that it's not common to utilise it worldwide, we consider it appropriate to emphasize the differences between brown and black coal. The differences mainly lie in the different fuel parameters which affect the specific requirements related to power plants. These key parameters can include (see Table 2):

It is common to use brown coal in power plants with the calorific value of about 10–12 MJ/kg, which is significantly different from black coal. Different parameters entail specific demands on plant technology. It can be stated that the calorific value has a significant influence on the required amount of fuel burned, and thereby on the shipping cost. The content of volatile matter is the amount of gaseous substance which is released during the combustion of coal. This means that the brown coal burns at a high flame and combusts easily. On the other hand, it is more difficult to burn it out completely which, amongst other things, is to the detriment of the efficiency of the plant. The combustion chamber also has a different shape compared to those used for black coal.

Ash and water contents form a ballast substance which is particularly burdensome for coal transport. The water content in the brown coal is closely related to the drying of the fuel before pulverization. So the type of mill and pulverizing fineness depends on the water content. Generally, the black coal is pulverized to double the fineness of the brown coal. There are, therefore, different types of mills as well as the fuel and air facilities, owing to the different quantity and quality of burned coal. This relates particularly to the pulverized coal boilers, which are in the majority worldwide.

The various types of coal (for example, even a similar type with a similar calorific value) have a different temperature of softening, melting and flowing. Due to potential ash layers on the surface of the chamber, black and brown coal are not easily interchangeable. Brown coal is the substitute for black coal only at the time of the investment decision. During the plant operation black coal is no more the substitute because of the aforementioned different parameters. The plant technology is always modified to the specific coal parameters. Moreover, the expected service life of plants is around 40–50 years and any reconstruction would result in writing off previous investments.

2. Current methods for pricing energy commodities

Similar to the oil and natural gas markets, black coal also makes significant use of long-term contracts [8]. This is mainly due to the high investments in the energy industry and the fact that both producers and consumers need guarantees of return on investment in their projects. The prices of energy commodities even for long-term contracts are determined chiefly on spot, forward, option or futures markets. It makes no difference whether we speak about oil [9,10], natural gas [11] or black coal [12,13]. Due to their energy contents, these energy commodities have a different position from that of brown coal. Relatively adequate space [14–17] has been dedicated to price predicting and analysing the trends in these commodities, but the studies do not deal with base pricing. This is logical because the price of these commodities is determined by the market. The base price refers to a price that enters the calculation of the price of a long-term contract and is indexed in the proceeding years based on the inflation trend, electricity prices and so on. It can therefore be identified as the price P_0 at the time T_0.

In the case of a non-vertically integrated extractor–consumer chain, the brown coal price is determined exclusively by long-term contracts, thus mostly determined by the consumer's and the supplier's negotiating power. Therefore, we are left with a situation where there is no vertically integrated chain. If not, the situation can be complicated by additional factors that distort the market environment. Needless to say, a vertically integrated enterprise may only be profitable through producing, or even selling, its electricity or heat. This pricing is rarely discussed amongst the well-informed public. Yet, a non-vertically integrated chain logically has to suffer from disputes concerning the legitimacy of pricing the commodity. For this method of brown coal utilisation, there occurs the problem of the non-existence of a public anonymous market from which the price for the contracts could be derived.

2.1. Methods for pricing brown coal

The only publically available methodology for pricing brown coal that deals with base pricing is the one proposed for the Turkish setting [18]. The principle of this approach is the definition of a maximum acceptable price from the point of view of the power

Table 1
Top coal producers. *source*: World Coal Association.

Brown coal production in 2011				Black coal production in 2011			
German	176 Mt	Australia	69 Mt	China	2831 Mt	Australia	199 Mt
China	136 Mt	Poland	63 Mt	USA	849 Mt	Russia	178 Mt
Russia	78 Mt	Greece	59 Mt	India	509 Mt	Kazakhstan	98 Mt
Turkey	74 Mt	Czech Republic	43 Mt	Indonesia	373 Mt	Colombia	80 Mt
USA	74 Mt	India	41 Mt	South Africa	250 Mt	Poland	65 Mt
Global production			1041 Mt	Global production			6637 Mt