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An assessment of mining efficiency in Turkish lignite industry

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ABSTRACT

This article focuses on the mining activities of Turkish Coal Enterprises (TKI), the major lignite supplier in Turkey. First, we analyzed the lignite production and overburden removal activities of TKI from a historical perspective and then employed the Principle Component Analysis to build a mining efficiency index of TKI and investigated its historical development since the establishment of the company. We found that labor productivity and operational structure have been the most important factors, positively affecting the index. The current article makes two important contributions: (1) by using the most comprehensive data set available on TKI for the first time, and (2) by developing a Mining Efficiency Index (MEI), which can be used to analyze productivity in lignite mining activities in different countries.

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Introduction

Coal has always been an important fuel in Turkish energy system. After the oil crises in the 1970s, rising concerns about energy supply security boosted the significance of coal as a domestic source in Turkey similar to other energy import-dependent countries. Its share in overall energy consumption increased from 24.7% in 1970 to 30.9% in 1986 and then fluctuated between a low of 26.5% (in 2001 and 2005) and a high of 33.7% (in 2012).

Furthermore, the share of lignite in primary energy consumption (PEC) first increased progressively to 20.9% in 1986 and then declined to 10.2% in 2005, forming a major trough. Since then it has increased again, reaching a share of 14% in 2012. On the other hand, the share of hard coal in PEC increased steadily from 8.8% in 1978 to 16.7% in 2012. From 1977 until 2003, the share of lignite was larger than that of hard coal, yet from 2003 to 2012, Turkey consumed a total of 147.581 million tons-of-oil-equivalent (toe) of hard coal and 132.274 million toe of lignite.

The increasing share of hard coal relative to that of lignite emphasizes the growing role of hard coal in the Turkish energy system. However, this generates an important threat to the energy supply security of the country because the hard coal supply is

mostly import dependent and energy import dependency is a major problem in Turkey. In 2012, Turkey consumed 120.093 million toe primary energy of which only 25.8% (31.964 million toe) was produced domestically, 98.693 million toe was imported, and 6.866 million toe was exported, thus net import dependency on foreign energy sources was 74.2%. The hard coal import increased to 19.237 million toe, comprising 94.7% of the total hard coal consumption in 2012. On the other hand, lignite is the most abundant fossil fuel resource in Turkey and demand for it has always been met by domestic production (WEC-TNC, 1986, 1990, 1994, 1997, 2002, 2006; MENR, 2014).

On the production side, since 1976, lignite has ranked first among other energy sources (Fig. 1). Since then it increased with minor fluctuations until its local peak in 1998. Between 1998 and 2004, it decreased by 28.5% from 12.792 million toe to 9.141 million toe and then increased again to 17.860 million toe in 2012. On the other hand, hard coal production has witnessed a continuous decrease. The same is true for oil production with the exception of the 1985–1991 period. Natural gas and asphaltite production has been minimal compared to other fossil fuels with maximum productions of 931 and 567 thousand toe, respectively.

Historic lignite production and total primary energy production (PEP) are represented in Fig. 2. The two trends are parallel to each other with a correlation coefficient of 0.98. This means that PEP has mostly been driven by lignite production, whose share increased from 11.9% in 1970 to 55.0% in 2012. Therefore, lignite

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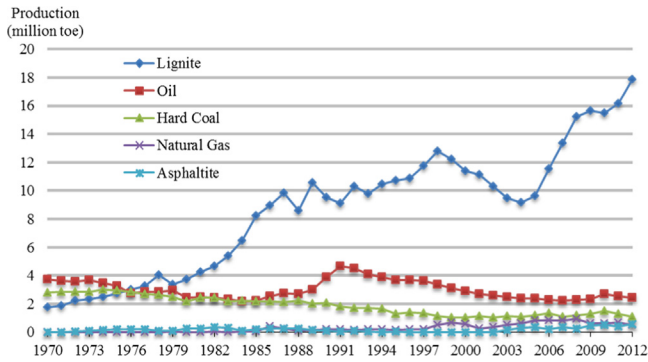


Fig. 1. Primary energy production for Turkey by energy source, 1970–2012. Source: WEC-TNC (1986, 1990, 1994, 1997, 2002, 2006); MENR (2014).

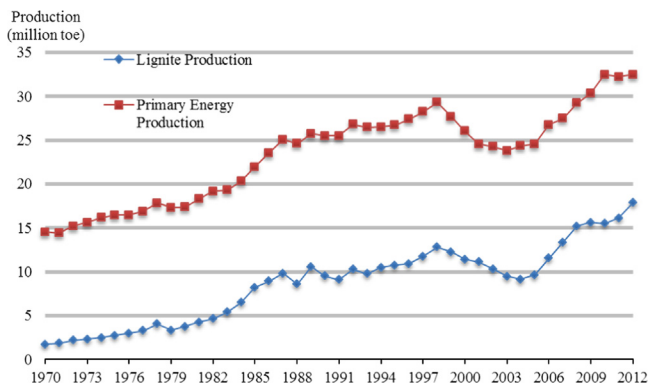


Fig. 2. Lignite production/consumption and total primary energy production, 1970–2012. Source: WEC-TNC (1986, 1990, 1994, 1997, 2002, 2006); MENR (2014).

as a major domestic energy source in the Turkish energy mix will be of significant importance for decreasing the burden of energy import dependence, and its share of PEC should be increased from the current value of 14.8% through an emphasis on the exploration and production. Yet, it is well known that lignites emit much higher GHGs (Greenhouse Gases) compared to other fossil fuels and their improper use causes severe local and global environmental degradation. The authors of this article are of the opinion that domestic lignites have a significant role to play in the energy systems of countries, such as Turkey, which are energy import dependent, provided that they are used in an environment-friendly manner by employing Clean Coal Technologies (CCT).

In Turkey, the exploration and production sector of the lignite industry is dominated by state-owned companies such as the General Directorate of Mineral Research and Exploration (MTA), the General Directorate of Turkish Coal Enterprises (TKI), and the Electricity Generation Company (EUAS). While MTA is a governmental institution established to conduct reconnaissance, appraisal, and exploration of coals among other minerals, TKI and EUAS are responsible for lignite production and electricity generation, respectively. Since it was established in 1935 MTA has been involved in various activities in the Turkish lignite industry such as geological mapping, geochemical analyses, geophysical studies, and exploratory drilling. With the establishment of TKI in 1957, some of these activities were transferred to TKI. TKI was initially responsible for all types of coal deposits of Turkey but later hard coals were transferred to Turkish Hard Coal Enterprises (TTK) after its establishment in 1983 (Ediger et al., 2014).

From 1957 to 2010, the majority of lignite production in Turkey was carried out by TKI, such that it was responsible for 73% of lignite produced. However, the share of the private sector and other public companies in lignite production decreased to 42.6% in

2010 from 84.3% in 1984. As a result of the step-by-step transferring of the lignite fields feeding coal-fired power plants to EUAS between 1989 and 2000 (such as Kangal in 1989, Elbistan in 1995, and Cayirhan in 2000), EUAS became the second largest lignite producer in Turkey after TKI. By 2010, EUAS was the public company with the largest lignite reserves in Turkey. EUAS was formed in 2001 when the Turkish Electricity Generation and Transmission Company (TEAS) was divided into three separate entities, each responsible for electricity generation, transmission, and trading.

This study focuses on TKI's mining activities given that it has been the major lignite supplier since 1957. The data used in this study is taken from Ediger (2014) unless otherwise stated. Firstly, we analyzed mining activities of TKI from a historical perspective and then we built a mining efficiency index of TKI and investigated how efficiently the company had operated since its establishment. Finally, we have concluded that labor productivity and operational structure have been the most important factors affecting the efficiency index. Although TKI's operational efficiency has increased significantly over time, this trend was severely disrupted in 2002–2003, possibly as a delayed response to the economic crisis Turkey experienced in 2001. The current article makes two important contributions: (1) by employing the most comprehensive data set on TKI for the first time, and (2) by developing a mining efficiency index for TKI, Turkey's major lignite supplier.

The structure of this article is as follows: *TKI's lignite production* reviews TKI's historical lignite production while providing detailed explanations of production by its enterprises and fields; *Overburden removal* analyzes overburden removal activities carried out in TKI fields; *Mining efficiency index* is dedicated to the analysis of the historical efficiency of TKI's exploration and production activities; and *Conclusions and policy implication*, finally, concludes with policy suggestions.

TKI's lignite production

Corporation's overall production

Turkey's cumulative coal production between 1957 and 2010 was 1853 million tonnes of which 89% (1649.3 million tonnes) was lignite, 10.2% (188.4 million tonnes) was hard coal, and only 0.8% (15.6 million tonnes) was asphaltite. During the same period, TKI was responsible for a cumulative 1425 million tonnes of coal of which 1245 million tonnes were lignite and 180 million tonnes hard coal.¹ Approximately 75% of Turkey's cumulative lignite production in the same period was carried out by TKI. As shown in Fig. 3, TKI's run-of-mine lignite production curve increased to 45.7 million tonnes and reached its peak in 1994. After this high, two other significant peaks in 2000 and 2008 were reached between 1995 and 2004, and 2004 and 2010 with values of 43.0 million tonnes and 45.9 million tonnes, respectively.

The peak of 2008 is the historic high point of TKI's run-of-mine lignite production. The company's salable production in this horizon followed a path that is parallel to the run-of-mine production and both curves got closer in some periods. For instance, in 1957 only 23.7% of run-of-mine lignite production was salable, this ratio gradually increased up to 90.8% in 1981. It remained above 90% until 2002, yet after 2003 it declined falling to 74.4% in 2010. In aggregate, 85% of 1.42 billion tonnes of run-of-mine production were supplied as salable production between 1957 and 2010.

¹ Please note that TKI also produced hard coal until TTK was established in 1983.

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