

Lignite-fired thermal power plants and SO₂ pollution in Turkey

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Abstract

About 80% of the electric energy production in Turkey is provided by thermal power plants which use fossil fuels. Lignite, the most abundant domestic energy source, is consumed in most of these plants. Turkey has approximately 0.85% of the world's lignite reserves; however, the Turkish lignites have low calorific value and contain relatively higher amounts of ash, moisture, and sulfur. Nearly 80% of the lignite mined in Turkey is consumed in the thermal power plants since it is not appropriate for use in other types of industry and heating. In Turkey, 13 large-scale lignite-fired thermal power plants are responsible for a considerable amount of air pollution. Therefore, it is crucial to decide on the optimal place and technology for the future thermal power plants, and to equip the currently operating plants with newer technologies that will reduce amount of contaminants released into the air.

In this study, the effects of the lignite-fired thermal power plants which have an important place in the energy politics in Turkey on the air pollution are investigated. We focused on SO₂ pollution and the regions in which the SO₂ emissions were concentrated and diffused. The pollutant diffusion areas were projected and mapped based on parameters such as wind data, isotherm curves, population density, and topographic features by using Geographical Information System (GIS) software, ArcView. The contribution of the thermal power plants to SO₂ pollution was also examined.

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1. Introduction

Energy and environment are two essential and related aspects of the conservation of healthy living conditions. It is not viable to design and implement energy production and transmission plans without considering the environmental factors. Fossil fuel use, especially in electricity production, is responsible for many environmental problems. Two detrimental effects of the fossil fuel use, global warming and acid deposition, have been proven in previous studies (Kahn, 1998; Kayın et al., 1999; Joskow, 2003; Lora and Salomon, 2005). The increased environmental problems caused by the production of electricity, which is a necessity for development, have been particularly important for developing countries. Atmospheric emissions from conventional power plants have had serious adverse impacts on the

quality of local air; these countries have been forced to revise their methods of electricity production

Turkey is undergoing rapid industrialization, urbanization, and population growth. Like other developing countries, Turkey's electric power demand has been growing steadily, with an average annual growth of 9% over the past 30 years. The Ministry of Energy and Natural Resources predicts 7% annual growth until 2020. Thermal power plants (with a total installed power capacity of 20433.8 MW) are generally used to meet the electricity demand. Fifteen of these plants (9591 MW) burn coal. Most of the large-scale coal-fired power plants use domestic lignite with low calorific value and high ash, sulfur content.

Lignite, one of the most important energy sources, has intensively been used for the generation of electricity in Turkey since the 1950s. The lignite mined in Turkey is of low quality and its use causes considerable air pollution in the vicinity of thermal power plants. In the Muğla region of south-west Turkey, there are three

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major lignite-fired power plants. Some studies were carried out over a wide area around these plants to investigate air pollution and the researchers found that the emissions of SO₂ and particular materials (PM) had negative effects on the human health as well as upon the regional flora and fauna. Uslu (1991), Karagöz and Tolunay (1997) reported that the SO₂ emissions from the lignite-fired Yeniköy power plant, located in the Muğla region had significant detrimental effects on the forests near the plant. In addition, it was reported that 2770 ha of forest surrounding the Yatağan thermal power plant, had sustained damaged since 1982, when the power plant began operation.

SO₂ emission occasionally exceeds the limit values and affects the daily life especially with the contribution of fuel consumption (FC) for heating purpose in winter season in the provinces where the power plants are located (such as Kütahya, Muğla and Kahramanmaraş).

In this study, SO₂ pollutant diffusion areas were predicted that can be used as a guide to determine the locations for future energy investments. For this purpose, the areas of heaviest SO₂ pollution concentration were determined and a pollutant diffusion map was created, using SO₂ measurements from 72 regions of Turkey. Some parameters such as; wind data, isotherms, population density, and topographic features were used in the generation of the diffusion map by using the Geographical Information System (GIS) software program, ArcView.

2. Overview of energy policy and current state of electricity generation in Turkey

Modern life requires energy. The level of energy consumption is considered one criterion by which a country's level of development is measured. The levels of energy dependency and energy consumption in many developed countries are higher than those of developing countries. However, energy demand is growing sharply in developing countries that are adopting modern technologies. In these countries, most of the energy consumption is based on fossil energy sources (Sayın et al., 2005). Because of the growing economy, industry,

and population, the rate of electric energy consumption has risen in Turkey as well (Fig. 1). Electric energy consumption per person has increased by about 600% in the last 30 years and reached to a level of 1476 kWh; however, this rate is still under global average (SPO, 2000; Energy Statistics, 2003).

Turkey has been undergoing privatization of the state enterprises, price liberalization, and integration into the European and global economy. These economic changes introduced in the 1980s were responsible for economic growth of about 40% was achieved between 1990 and 2000 (Central Bank of Turkey, 2004). Turkey's population has reached 68 million and remains one of the fastest growing populations in the OECD countries. Millions of people are moving from Turkey's rural to its urban, industrial, and tourism areas. As a result of this population movement, Turkey must ensure that economic growth is sustainable, accompanied by environmental and social progress (Ocak et al., 2004).

Table 1 presents the distribution of the electric energy production according to the energy sources for the world and for Turkey in 2001. As can be seen from the table, fossil fuel-fired thermal power plants are used to meet most of the increased electric energy demand. Nearly two-thirds (64.2%) of the world's electric energy production (15 546 411 GWh) was met from the fossil fuel-fired thermal power plants. On the other hand, in Turkey, 80.2% came from the fossil-fueled power

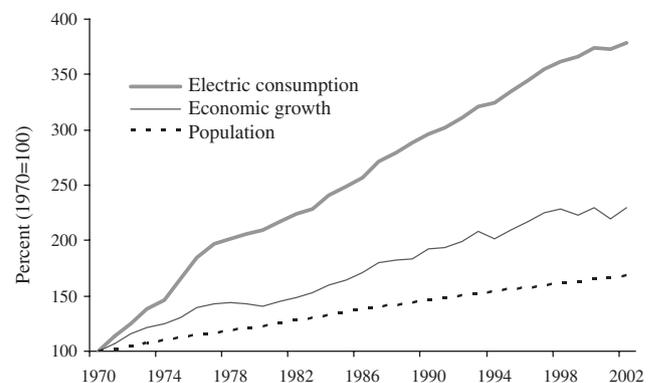


Fig. 1. Economic growth and increase in population and electric energy consumption between 1970 and 2002 (Energy Statistics, 2003; SIS, 2004a).

Table 1
The electric energy generation according to the production method (adopted from IEA, 2004)

	Fossil-fueled power station (%)				Nuclear power station (%)	Hydro-electric power station (%)	Others (%)
	Coal	Oil	Gas	Total			
World	38.5	7.5	18.2	64.2	17.1	17.0	1.7
OECD	37.7	5.9	16.7	60.2	24.0	13.5	2.2
Non-OECD	39.9	10.1	20.6	70.7	6.1	22.6	0.7
EU	26.6	5.8	17.5	50.0	33.3	13.6	3.2
Turkey	31.3	8.5	40.4	80.2	0.0	19.6	0.2

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