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## Turkish challenges for low-carbon society: Current status, government policies and social acceptance



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### ABSTRACT

Turkey's rapid economic growth followed by increasing gap between domestic energy production and consumption signifies the large-scale integration of low-carbon and renewable resources into energy system. Turkey's energy demand is increasing and supplying fossil energies such as oil and gas is becoming more challenging due to the lack of domestic hydrocarbon resources. The country is facing two main issues; first, maintaining energy balance and second, handling environmental issues. Nevertheless, Turkey has substantial renewable and low-carbon energy resources with co-benefits for the country's fast growing economy and environmental sustainability. This paper aims to present a comprehensive update on Turkey's renewable and low-carbon energy sector. It reviews not only the current status of the technology, policy and economy, but also provides an insight into the social aspects as well. From a policy point of view, the paper critically discusses Turkey's energy strategy and perspectives and from the social point of view, the paper argues that there is a research gap in recent literature regarding public awareness and social acceptance of low-carbon energy technologies. Also, the future challenges for promoting low-carbon society in Turkey are discussed in terms of sustainable development and socio-environmental conditions.

### 1. Introduction

Energy consumption is an essential part of economic development in every country. In particular, developing countries are in severe need of energy supply for a sustainable and continued growth. For transition to a low-carbon energy market, the role of renewable and green energy technologies is fundamental. To this end, several factors must be taken into account including cost efficiency, technology transfer, environmental issues, and regulatory frameworks. Turkey as a developing country with a high level of reliance on imported energy supplies is in the center of attentions for utilizing new energy resources as it is blessed with considerable potentials of renewable and sustainable energy. Using cleaner types of energy and fuels will have co-benefits for the country's economic growth and environmental sustainability. Turkey has valuable potentials of renewable energy sources including hydropower, bioenergy, wind power, solar energy and geothermal energy.

A majority of research and studies on Turkey's fossil and renewable energy have investigated the technological and policy aspects without

taking into account the social and cultural dimensions. This paper aims to present an update on Turkey's renewable and low-carbon energy sector that not only reviews the current status of technology, policy and economy, but also provides an insight into the social aspects as well. From a policy perspective, the paper critically argues the lack of a comprehensive energy strategy for the future of the country; and from the social perspective, the paper points to a research gap in recent literature regarding public awareness and social acceptance of green technologies. Also, the future challenges and perspectives of Turkey's green energy and low-carbon technologies are discussed in terms of sustainable development, environmental impacts and social dimensions.

#### 1.1. CO<sub>2</sub> emission status of Turkey

Due to a high level of dependence on fossil fuels and a high economic growth Turkey's total CO<sub>2</sub> emissions has increased by 110.4% since 1990 [134]. This is the highest rate of increase in CO<sub>2</sub> emission among the Annex I countries of Kyoto Protocol. In Business

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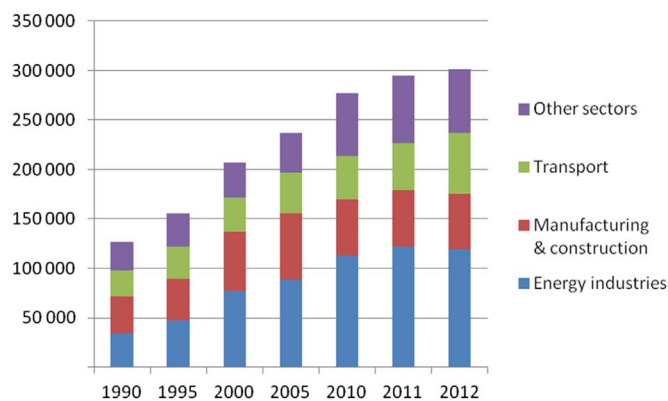


Fig. 1. Energy-related CO<sub>2</sub> emission in Turkey during 1990–2012 (thousand tonnes) [124].

as Usual (BAU) path, Turkey’s emissions will reach to 604.6 Mt in 2020 showing 151% growth compared to 2005; while the Government has set a target of decreasing emissions 11% less than the BAU path [81]. In 2012 energy sector emitted 308.6 MtCO<sub>2</sub> eq. constituting the largest portion of total Greenhouse Gas (GHG) emissions (70.2%), followed by industrial sector, agricultural sector, and waste, each with 62.8 MtCO<sub>2</sub> eq., 32.3 MtCO<sub>2</sub> eq., and 36.2 MtCO<sub>2</sub> eq. emissions, respectively [98].

From the total energy-related CO<sub>2</sub> emissions in 2012, 39% was from energy industries, 19% from manufacturing and construction, 20% from transportation and 22% from other sectors. The rapid growth of CO<sub>2</sub> emissions is associated with the country’s rapid economic growth. Although there are few studies on the relationship between electricity generation and the associated CO<sub>2</sub> emissions in Turkey [8], emission and economic data indicate that energy-related emissions have been growing much faster than the economy [141]. Fig. 1 shows the total energy-related CO<sub>2</sub> emission in Turkey and the share of each sector during 1990–2012. Regardless of Turkey’s population growth that contributes to the total amount of emissions, the total per capita emissions also shows increasing pattern in the past two decades. CO<sub>2</sub> emissions per capita increased from 3.4 t in 1990 to 5.9 t in 2012 (Fig. 2).

### 1.2. Energy background and conditions

The first Turkish electrical generator was a 2 kW dynamo connected to a water mill in Tarsus, in 1902, and the first large power plant was installed in Silahtaraga, Istanbul, in 1913 [28]. After the establishment of the Republic of Turkey in 1923, fuels were in use primarily for heating and lighting purposes, and electricity industry was heavily dependent on foreign investment [47]. The Republic made some attempts to increase energy production during the first decade of

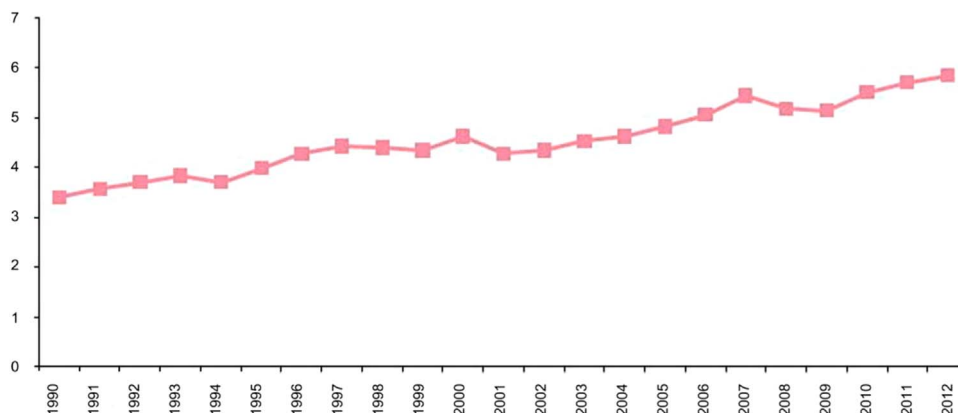


Fig. 2. CO<sub>2</sub> equivalent GHG emissions per capita during 1990–2012 (tonnes CO<sub>2</sub>-eq / capita) [124].

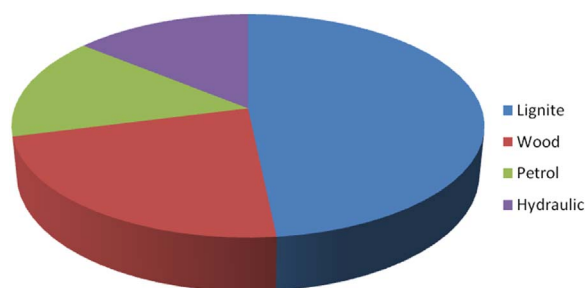


Fig. 3. Energy source share of Turkey in 1997 [110].

establishment in order to be more independent from foreigners. At the same time, foreign firms working on coal mines became nationalized and the nationalization of electricity industry was gradually happened from 1938 to 1944. In 1940 the petrol was found in Turkey by national energy companies for the first time. Thereafter and during industrialization period the energy production and consumption always followed an increasing trend, though with different rates during the time. From 1963 the government started a series of five-year development plan under which structuring the hydraulic energy and electricity were taken into account, and at the same time the Ministry of Energy and Natural Resources (MENR) which was responsible for Turkey’s energy policy was established [28]. Following that, Turkish Electricity Administration (TEK) was founded in 1970. Between 1970 and 1997 the production of primary energy sources was increased from 14,493 Btep to 27,687 Btep and the production of lignite showed the highest growth rate as indicated in Fig. 3 [110].

Turkish electricity industry was mainly dominated by TEK until the late 1990s. From 2001 Turkey started to open its electricity market to competition in order to move towards becoming an EU member, and therefore the year 2001 is considered a turning point in Turkish electricity industry [55]. In this year the Electricity Market Law came into effect as a first step towards the liberalization of the electricity market [52]. From 2001 the government started revitalization of the electricity industry with a targeting plan for achieving 100% revitalization until 2014. Fig. 4 shows the increasing gap between electricity net generation and consumption during the recent years. Currently, electricity distribution is fully in private sector’s control and the privatization of power generation assets will be completed within the next few years [65].

In Turkey, the demand for energy resources is rapidly growing due to economic growth and social development [1]. Energy is considered as an important constituent in the country’s economic and social development process. In line with the population growth, industrialization, urbanization, rising of wealth and technology advancement, energy consumption has risen severely over the past 20 years [49,68,90]. Consequently, energy production and supply at a minimum

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