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The role of feed-in tariffs in emission mitigation: Turkish case

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ABSTRACT

The aim of this paper is to present the role of Feed-in Tariffs (FiTs) on GHG emission reduction in Turkey. Due to insufficient installed capacity, Turkey can only utilize 27% of its total economically viable renewable energy potential. To increase the share of the renewables, utilization of these sources has become a top priority in the overall energy agenda. Thus, new regulations and policies are introduced. These policies are expected to serve to increase installed capacities of renewable energy power plants, and reduce the CO_2 emissions intensities. Feed-in-Tariffs is considered as a promising policy to increase share of renewable energy and reduction of CO_2. However, the CO_2 emission intensity in electricity generation has not changed after the FiTs were launched, indicating that additional policies, possibly including a revision of the current renewable energy support mechanism regime, should be reconsidered.

Contents

1. Introduction

Turkey is commonly classified as an 'emerging economy', implying that the country has experienced and is expected to experience a rapid economic growth and industrialization process, which in turn is strongly correlated with electricity consumption and greenhouse gas (GHG) emissions [24,41]. This creates a dual challenge for the country. On the one hand, Turkey may face electricity supply–demand imbalances in the medium term [36]; and hence needs to increase its total electricity generation capacity. On the other hand, Turkey's CO_2 emissions from electricity generation have almost tripled in the last two decades and fossil fuel-fired electricity generation accounted for 73% of the total electricity generation in 2012 [39]. The country will eventually need to limit its carbon trajectory. In order to address these challenges simultaneously, Turkey will need to alter its current energy mix, which relies highly on imported fossil fuels.

According to Turkish Electricity Transmission Company (TETC), Turkey's electricity consumption is expected to increase annually by 6.5–7.5% until 2021 [36]; therefore the country will have to expand its total generation capacity significantly in the period ahead. With a higher share of renewables in its energy mix, Turkey

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Table 1
Turkey's renewable energy sources economic potential, installed capacity and target.

RES	Economic potential (MW)	Installed capacity (MW)	2023 Target (MW)
Hydropower	43,000	19,609	36,000
Wind	48,000	2,260	20,000
Solar	50,000	0	3,000
Geothermal	600	162	600
Total	143,600	22,031	61,600

can achieve energy supply security, lower import dependency and lower GHG emissions simultaneously. Turkey, with a consideration to above-mentioned issues, has correctly identified more effective utilization of the country's domestic and renewable energy sources as a top priority in the overall energy agenda; and adopted a rather challenging target for renewable energy deployment in 2009. The Electricity Market and Security of Supply Strategy, dated May 2009, aims to increase electricity generation from renewable energy to at least 30% by 2023. The strategy, in order to achieve this overall target, has already taken relevant policies. While the targets for renewable energy deployment are well established, the total renewable energy generation capacity lagged behind these targets. To this end, Turkey has updated existing and introduced new support schemes to incentivize renewable energy investments. The revision in Feed-in Tariffs (FiTs) was an important step taken on this front. The Government has also taken certain fiscal and administrative measures to encourage renewable energy deployment at a large scale [4].

FiTs, which may be considered a subsidy provided to the producers of electricity from renewable energy sources, is an obligation on the part of electric utilities to buy electricity from renewable energy sources at a guaranteed rate for a certain period of time [27,4]. FiTs include both policy (access to grid) and financial (guaranteed price over a period of 15–25 years) elements and are considered to be a cornerstone for renewable energy deployment [41]. FiTs are particularly successful in enhancing energy supply security and reducing emissions [27,17]. FiTs also provide protection to renewable energy producers against low wholesale electricity prices [20]. FiTs were introduced with renewable energy law in 2005. The first implementation of FiTs in Turkey, started in 2005, referred as Phase-I, and amended in 2010, referred as Phase-II.

In this paper, the maximum utilization amount of renewable energy for electricity generation in Turkey by 2023 is analyzed. Current renewable energy support mechanisms, particularly FiTs, are evaluated in the context of electricity supply and demand balance and CO_2 emission reduction. There are five sections in this paper. In the next section, renewable energy potential and FiTs are explained in detail. The impacts of the utilization of renewable energy resources on electricity generation and mitigation of CO_2 emissions are evaluated in section three. The problems and alternative solution proposals related to renewable energy support mechanisms are discussed in section four. Concluding remarks and recommendations are given in the final section.

2. An overview of renewable energy potential and support mechanisms in Turkey

Turkey has a considerable renewable energy potential [23]. Table 1 reports the economically viable potential, total current installed capacity, and the Government's targets for 2023 [26]. According to the General Directorate of Renewable Energy (GDRE), the economically viable potential for hydropower, wind and geothermal are 43,000 MW, 48,000 MW and 600 MW, respectively [16]. Solar and biomass potentials are estimated to be 50,000 MW and 2,000 MW, respectively [33]. Overall, the economically viable renewable energy potential is 143,600 MW. However, Turkey can only utilize approximately 15% of the total economically viable potential of renewable energy sources in terms of installed capacity.

Between 1990 and 2012, Turkey's total installed capacity in electricity generation has increased significantly from 16,317 MW to 57,059 MW [35] (Fig. 1). The capacity increase in hydropower is from 6764 MW to 19,609 MW. Turkey ranked the second in new capacity additions in hydropower in 2012, outranked by China only [32]. In addition to hydro power, wind energy also increases rapidly so reach to 2260 MW in 2012. Geothermal energy increases steadily so its capacity as of 2012 is 162 MW. Thus, the installed capacity of renewable energy sources consists of 39% of total electricity capacity of the country. Between 1990 and 2012, Turkey's annual electricity generation increased from 57,543 GWh to 239,496 GWh. Thermal, hydro, wind and geothermal power plants generate 73%, 24%, 2.45 and 0.38% of electricity, respectively [35].

Due to potential electricity supply–demand imbalances in the medium term, the Government has correctly identified more effective utilization of the renewable energy sources as a top priority in the overall energy agenda. The Electricity Energy Market and Supply Security Strategy (dated 2009) has introduced a set of highly challenging targets for renewable energy utilization. The Strategy aims to: (i) fully utilize technically feasible and economically viable hydropower potential; (ii) increase the installed capacity of wind power plants to 20,000 MW and (iii) increase the installed capacity of geothermal power plants to 600 MW by 2023. The strategy also recognizes the importance of increase in the utilization of solar energy for electricity generation. The strategy's overall target is to generate at least 30% of the total electricity by renewable energy sources by 2023 [34].

Although economically viable renewable energy potential is high as targeted in the strategy, without appropriate renewable energy support polices, the utilization of renewable energy sources to a large extent could not be possible until the early 2000s, except for large-scale hydro power [33]. Since then Turkey has achieved significant progress in regulation and policies to encourage electricity generation from renewable energy sources [23,38,7]. Thus, Turkey established a solid legal framework and adopted several crucial policies within the sector, like the electricity market law and amendment the renewable energy law. After these regulations, FiTs became the main renewable energy support mechanism in Turkey.

2.1. Feed-in Tariffs (FiTs)

A FiT regime serves to enhance renewable energy deployment by providing power producers a long-term purchase agreement for electricity generation from renewable energy sources [9]. With these purchase agreements, a specified price is offered to power producers and this price, which is set per a unit (kWh) of electricity generation, remains valid for 10–25 years [9]. FiTs can be designed in line with different policy goals, and the rates can be differentiated by technology type, project size, resource quality, and project location [9]. Several studies show that well-designed FiTs are the most efficient and effective policies to promote renewable energy [4,24]. As shown in Fig. 2, FiTs are the most commonly used renewable energy support policies, and it was used in 97 countries/states in 2013 [32].

France, Germany, Spain, Italy, UK and Greece have benefitted to FiTs for dissemination of renewable energy. In Italy, FiTs were established in 2005 [13] and then growth in installation of RES was observed in 2008 and 2009 [10]. Italy benefitted from FiTs for both meeting energy demand and emission mitigation [10]. Similar to Italy, in Japan FiTs have had positive impacts on rising