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Towards a higher share of distributed generation in Turkey

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ABSTRACT

In 2006, there is 8.5% distributed generation (DG) in Turkey which are generation units connected to the low and medium voltage distribution network. Out of this, 56% is industrial combined heat and power production (CHP) and 20% are renewables (RES-E), mainly runoff small scale hydro. Various technical and economical barriers have kept the DG share relatively low. This paper assesses how Turkey could increase the DG share. The methodology employed in this paper consist of a survey of the literature and legislation, combined with interviews with regulators, transmission and distribution system operators. Scenarios for DG are developed, barriers to increase the DG share are identified, DG and central generation (CG) are compared economically and regulatory measures are identified. The addition of long-run marginal transmission costs to the investment cost of new power generation units could close the long-run marginal cost difference between DG and CG. However, the share of DG is likely to stay low unless regulatory measures are taken. Moreover, a specific policy and regulation on DG is needed, the distribution grid needs strengthening, local dispatch centres need to become active and RES-E limits are needed for Turkey.

1. Introduction

Turkey is currently in a transition process from a monopolistic state controlled electricity provision to a fully liberalised market. Restructuring of the Turkish electricity market commenced with the enactment of the Electricity Market Law (EML) (EMRA, 2001). This law led to the establishment of the Energy Market Regulatory Authority (EMRA), introduction of new players in the market and unbundling of the generation and transmission corporation (TEAS) into generation (EUAS), wholesale (TETAS) and transmission (TEIAS). Distribution had been separated beforehand in 1993, when Turkish Electricity Company (TEK) was divided into TEDAS (distribution) and TEAS.

As part of the liberalisation process, Turkey has been divided into 21 distribution regions, while six portfolio generation companies are created at an average capacity of 2.7 GW each. These are planned to be privatised after commencing the distribution company's privatisation, which is planned for the second half of 2008, after amending the Electricity Market Law no.: 4628 of 2001 and after the introduction of the automatic pricing mechanism as of July 2008. In 2007, portfolio generation companies constituted 40% of total generation capacity, except for 7.5 GW hydro-electric power plants (HPPs) mainly on international rivers, 9.2 GW are privately constructed power plants with take-or-pay agreements, whereas 6.8 GW is already privately owned. Total installed capacity amounted to 40.7 GW in 2007.

Besides privatization plans, private companies are also involved in independent power generation, though the level of private investment in new generation capacity is far from sufficient to meet Turkey's rapidly growing demand.

The main objective of this paper is to access the current share of DG and to explore the possible ways to increase the share of DG in liberalising and privatising power market in Turkey as pointed out above. In this paper, DG is defined as a generation unit connected to a low of medium voltage network (<36 kV), located in the vicinity of major consumer centres. Other definitions exists as well (Scheepers, 2004), for instance including centrally generated RES-E and combined heat and power production (CHP) as well. DG, as defined in this paper, typically ranges from

Abbreviations: AP, autoproducer; BO, build operate; BOT, build operate transfer; CHP, combined heat and power production; CG, central generation; CUR, capacity utilisation rate; DG, distributed generation; EML, Electricity Market Law; EMRA, Energy Market Regulatory Authority; EU, European Union; EUAS, Elektrik Uretim AS, the state generation corporation; HPP, hydro-electric power plant; IPP, independent power producer; LDC, local distribution company; MENR, Ministry of Energy and Natural Resources; mobile, mobile plants belonging to EUAS and privately operated; η, efficiency; NLDC, National load dispatching centre; O&M, operation and maintenance; RES-E, electricity from renewable energy sources; RLDC, Regional load dispatching centre; TEAS, successor to TEK, Now broken into three companies, TETAS, TEIAS and EUAS; TEDAS, Turkiye Elektrik Dagitim AS, the national distribution system operator; TEIAS, Turkiye Elektrik Iletim AS, the national transmission system operator; TETAS, Turkiye Elektrik Ticaret ve Taahhut AS, the state wholesale corporation; TEK, Turkish Electricity Company, divided into TEAS and TEDAS; TOR, transfer of operating rights; TSO, transmission system operator; WPP, wind power plant

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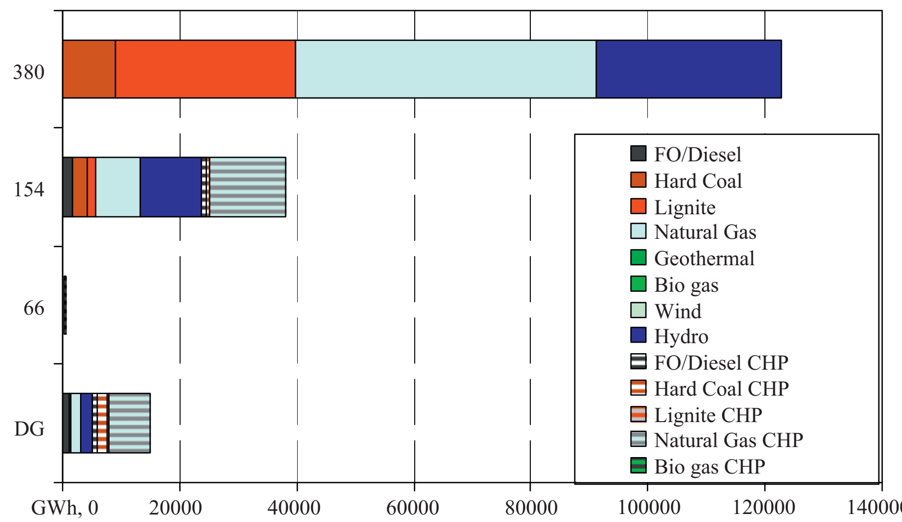

Fig. 1. Connection levels and CHP by technology in 2006. *Source:* Based on TEIAS (2007a), interviews with TEIAS and IBS compilation.

1 kW to 50 MW in capacity.[1] This contrasts with central generation (CG), which is associated with large 500–3000 MW generating plants that are usually located at a distance from where the energy is consumed.[2] The electricity is then transported through the transmission and distribution infrastructure to the customer/user (Solarbuzz, 2006).

DG has these advantages:

- "DG is attractive, not because it is efficient, but because it avoids transmission costs".
- DG units, which are small in size, can be added to the power system gradually following the gradual demand growth.
- DG units can use renewable energy.
- Some DG units are only operated during peak demand hours.

DG has these disadvantages:

- The operation cost of many small units is larger and operation and maintenance (O&M) of DG units is more complicated than central generation units.
- Fuel delivery is not always guaranteed, where truck deliveries over a distance of 80 km could add 25% to the fuel costs.
- DG technologies are relatively new and "unproven".
- Intermittent DG either needs a match with another source for dispatchability or needs additional protection and control measures (CBO, 2003; Willis and Scott, 2000).

The outline of this paper is as follows. The present situation and scenarios of DG will be presented in Section 2. From the collected information, the main technical barriers to increase the share of DG are identified (Section 3), a simple comparative economic analysis between DG and CG is performed (Section 4) and, after identifying the regulatory barriers, regulatory measures for increasing the DG share are suggested (Section 5), whereas the final Section concludes.

[1] Note that some 10 units with a capacity larger than 50 MW are connected at the distribution level (total capacity of 877 MW). These DG units were built before the regulation on the capacity level was in place.

[2] An exception to this in Turkey are BO and BOT power plants in the Marmara region, BO power plants in Ankara, and the Can lignite plant in the Aegean region. These central generation plants are located close to the main areas of consumption and they provide electricity via the transmission grid.

2. Present situation and scenarios of DG

In Turkey, 70% of generation is connected to 380 kV, 22% is connected to 154 kV, 0.3% to 66 kV and 8.5% of generation is directly connected to the distribution network, as of 2006. This latter share is the DG amount relevant for Turkey. By far, the largest contribution to DG is natural gas with 58%, followed by fuel oil and diesel with a 14% share, whereas imported coal and river runoff hydro both have a share of 11%. In 2006, the share of RES-E was 14% in total generation, out of which 12% is hydro. This means that RES-E connected via the distribution network account for a mere 1.2% of generation. Fig. 1 shows more details on connection levels by technology.

Fig. 2 presents the DG shares per generation technology and model. There are seven models of generation in Turkey, namely

1. the national generation company (EUAS),
2. mobile plants belonging to EUAS and privately operate (mobile),
3. built operate (BO),
4. built operate transfer (BOT),
5. transfer of operating rights (TOR),
6. independent power producers (IPP) and
7. autoproducers (AP).

BO, BOT and TOR are power plants with take-or-pay agreements; most of them built in the late 1990s when serious generation shortages were expected. Typically, most DG generation is undertaken by AP and IPP, with these accounting for 88% of the total. As described above, DG in Turkey mainly operates on natural gas and not on RES-E.

The introduction of CHP is also an important step towards more efficient use of energy. Fig. 1 also shows the shares of CHP in generation by technology in Turkey and shows that the majority of natural gas CHP is connected to 154 kV. Fig. 2 shows the CHP share among DG by technology and model. CHP is only found among AP and IPP, with the largest share belonging to AP. Clearly, the share of CHP in DG for natural gas is again very high, covering two-thirds of all generation. The share of CHP in total generation is 14%.

To estimate DG shares in the medium- and long-run IBS has developed two DG scenarios. In the base case, the 2006 share of DG per technology is nearly constant over time. In the high case, the 2006 share of DG grows over time for the relevant