IWEC

International World Energy Conference

FULL TEXT BOOK

EDITORS
Mustafa Serdar GENÇ
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Saltuk Buğra SELÇUKLU
Şükrü Taner AZGIN



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SMALL HYDROPOWER OVERWIEW IN TURKEY

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Abstract

Although there is no legal definition in Turkey, hydropower plants with an installed capacity of less than 10 MW are widely considered as small hydropower (SHP). In Turkey, there are currently 351 SHPs in operation as of 31 December 2020. Of these, 14 are operated by the DSI and 337 are operated by the private sector; and the installed capacity of the operating SHPs is 1.662,20 MW, their total production potential is 6.279.926 GWh/year. Moreover, 38 SHPs are under construction. In addition, 613 SHP projects of 2.594.29 installed capacities and of 8.569.956 GWh/year productions potential were cancelled.

Regionally, 34.18 % of SHPs (120 SHP) are in the Black Sea Region of Turkey. 21.08 % of them (74 SHP) is located in the Mediterranean Region; 15.67 % (55 SHP) in the Eastern Anatolia Region; 13.68 % (48 SHP) in the Central Anatolia Region; 8.5 % (30 SHP) in the Marmara Region and 6% (21 SHP) in the Aegean Region(Figure 1).

This article intends to discuss SHP's in Turkey as a whole and examine the place and importance of SHP's in the sector.

Key Words: Hydropower, SHP, overview, Turkey

1. INTRODUCTION

Hydroelectric power plants (HEPP) convert the power of flowing water into electricity. The amount of energy in the flowing water determines the flow or drop rate of the water. Water flowing in a large river carries a large amount of energy, or when water is reduced from a very high point, a high amount of energy is obtained. In both ways, the water that is taken into the ducts or pipes flows into turbines, allowing turbines with arms like propeller to turn to produce electricity. Turbines depend on generators and convert mechanical energy into electrical energy. Hydroelectric power plants; it is the most important renewable energy source in terms of obtaining energy from water, creating no greenhouse gas emissions, building with local facilities, long technical life and lack of fuel costs, low operating maintenance costs, creating employment opportunities, revitalizing economic and social structure in rural areas[1].

Turkey's growing demand for energy and its dependence on foreign energy is a reality. In recent years, there has been a great trend towards hydroelectric energy in Turkey in order to meet this increasing demand and to reduce dependence on foreign markets. The most important contribution of using hydropower to the economy and the environment is to reduce dependence on external energy and mobilize clean energy sources.

Hydropower development in Turkey has been carried out for about a century for different purposes, namely electricity generation, land irrigation, water supply for domestic and industrial utilization and flood control in the surrounding area. Therefore, since its inception, the construction of water storage facilities and hydro plants has always been given priority by the Republic of Turkey.

Because of increasing concern regarding greenhouse gas emissions and global warming phenomena in recent years, there is worldwide renewed interest in hydropower generation, especially in small hydro development. Small hydro plants offers significant benefits in terms of faster deployment, distributed generation, small business opportunities, and significantly reduced concerns about regional environmental/ecological system disturbances, although their cost of energy generation is usually higher than from large hydro plants [2-4].

Turkey's hydraulic potential is 55.000 MW, and the share of hydraulic installed power, which reached 31.391 MW from 11.175 MW in 2000 as of 31 December 2020, in total installed power is about 32 %.

In cooperation with the public - private sector, 714 Hydroelectric Power Plants (public +private) with an installed capacity of 31.391 MW and a power generation potential of 108 billion kWh has been completed and put into service. From 714 facilities; 68 plants with an installed power of 13.766 MW with a power generation potential of 49 billion kWh by DSI; 646 plants with an installed power of 17.625 MW and a power generation potential of 59 billion kWh had been built by the private sector and put into operation as of December 31th, 2020 [5,6]. A very small part of the installed capacity such as about 1.662 belongs to small hydroelectric power plant and most of these small power plants are also concentrated in the eastern Black Sea region.

In this article, Small Hydropower Plants (SHPs) in Turkey are discussed as a whole and the place and importance of SHPs in the sector is examined.

2. SMALL HYDROPOWER DEVELOPMENT AND POTENTIAL IN TURKEY

The hydropower generation can be classified based on its capacity: large, small, mini and micro. As for small hydro generation, there is still no internationally agreed definition of 'small' hydro but the upper limit varies between 2.5 and 25 MW (Table 1). A maximum of 10 MW is the most widely accepted value worldwide. In Turkey, the upper limit is accepted as 50 MW. In addition, small, mini and micro-hydro plants are usually defined as plants less than 10 MW, 2MW and 100 kW, respectively. Small-scale hydro's turbine is used mostly a type of 'run of river,' so does not involve the construction of large dams and a little or no water is stored. In medium (5 m < head < 15 m) or high-head (head >15 m) installations water is carried to the fore bay by a small canal. Low-head installations (head < 5 m) generally involve water entering the turbine almost directly from the weir [7-11]. Although there is no legal definition in Turkey, hydropower plants with an installed capacity of less than 10 MW are widely considered as small hydropower (SHP).

Table 1. SHP definitions by installed capacity (MW) in various countries

Country	MW	Country	MW
Brazil	≤ 30	Armenia	≤ 30
Canada	< 50	Azerbaijan	≤ 10
China	≤ 25	Georgia	≤ 13
EU Linking Directive	≤ 20	Iraq	≤ 10
India	≤ 15	Jordan	≤ 12
Norway	≤ 10	Lebanon	≤ 10
Sweden	≤ 1.5	Syria	≤ 10
Turkey	< 10	USA	5 ≤ W ≤ 100

Small hydropower stations are typically run-of-the-river. They combine the advantages of hydropower with those of decentralized power generation, without the disadvantages of large scale installations. Advantages include low distribution costs, no/low environmental costs as with large hydro, low maintenance and local implementation and management. Power generated with small hydro station can be used for agro-processing, local lighting, water pumps and small businesses. The constructions and integration into local environments of SHP schemes typically takes less time and effort compared to large hydropower plants. For this reason, the deployment of SHPs is increasing in many parts of the world, especially in remote areas where other energy sources are not viable or are not economically attractive [12].

In Turkey, the development of small hydropower plants started in 1902. Since then many hydropower plants in rural areas have installed that were operated by municipalities, private companies and by DSI (State Hydraulic Works). In the period of 1930s, a small power plant with a capacity of 1 MW was installed in Trabzon city. The increasing demand on electricity, a number of small hydropower plants were installed from 1950s to the 1960s. A total installed capacity reached 38 MW in 1955 [13]. In Turkey, while, 279 of hydropower plants were between 0-10 MW and their installed capacity was 1490 MW until 2010 [14].

In Turkey, there are 351 SHPs in operation as of 31 December 2020. Of these, 14 are operated by the DSI and 337 are operated by the private sector; and the installed capacity of the operating SHPs is 1.662,20 MW, their total production potential is 6.279.926 GWh/year. Moreover, a total of 38 SHP is under construction of which 19 are DSI and 19 are by the private sector. The installed capacity of the SHPs under construction will be

202.66 MW, and the production potential will be 736.778 GWh. In addition, 613 SHP projects of 2.594,29 MW installed capacities and of 8.569.956 GWh/year generations potential were cancelled (Table 2) [5,6].

Table 2. SHP's potential development in Turkey

Stage of Project	Operator (Public/Private)	Quantity	Installed Capacity (MW)	Generation Potential (GWh/year)	Ratio (%)
Operation	DSI(Public)	14	42,57	145.100	0.9
	Private	337	1.619,63	6.134.826	35.8
	Total	351	1.662,20	6.279.926	36.7
Construction	DSI(Public)	19	101.83	368.389	2.2
	Private	19	101.83	368.389	2,2
	Total	38	202.66	736.778	4.4
Inspection and Project	Private	36	1.613.0	548.549	4,5
	Private(declared in Table)	34	194.68	681.382	3.2
	DSI(Prelicense-Planned)	6	31,19	94,290	0.3
	Total	76	287,17	1.325.221	8.0
Total potential(Operation-construction-inspection-project)		476	2.297,16	8.493.338	49.9
Cancelled SHP projects		613	2.594,29	8.569.956	50.1
Total potential of SHPs		1.089	4.891,45	17.063.294	100

SHP capacities between 2013 and 2021 vary. Installed capacity increased from 175 MW in 2013 to 1.156,4 MW in 2016; continued to increase to 2.961,3 in 2019; but decreased to 1.662,2 MW in 2021. The potential capacity was 6.500 MW between 2013 and 2019, and decelerated to 4.891.5 MW in 2021 (Figure 1) [15-18].

The reason for these changes is the commissioning of new projects and the cancellation of some projects. Also, this amount indicates economically operable SHPs and the described projects.

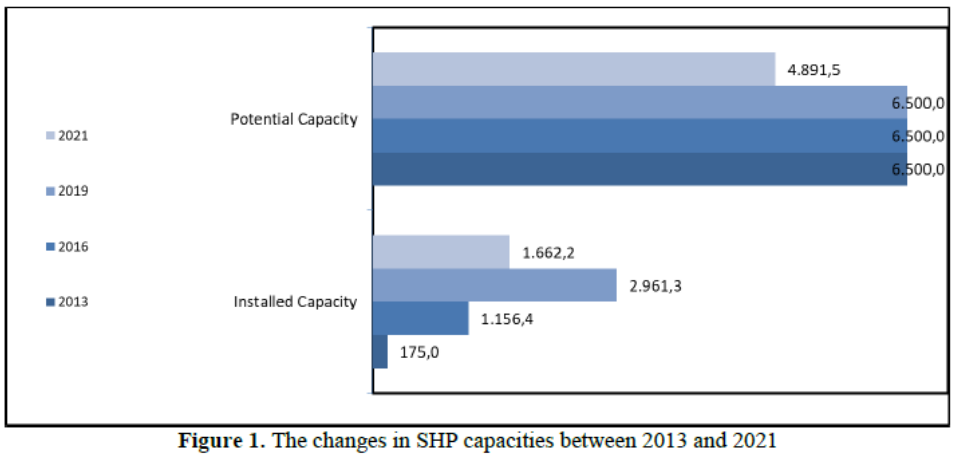


Figure 1. The changes in SHP capacities between 2013 and 2021

The regional distribution of facilities is also highly variable in Turkey. Regionally, 34.18 % of SHPs (120 SHP) is located in the Black Sea Region of Turkey. 21.08 % of them (74 SHP) is located in the Mediterranean Region; 15.67 % (55 SHP) in the Eastern Anatolia Region; 13.68 % (48 SHP) in the Central Anatolia Region; 8.5 % (30 SHP) in the Marmara Region and 6% (21 SHP) in the Aegean Region(Figure 2)[18].

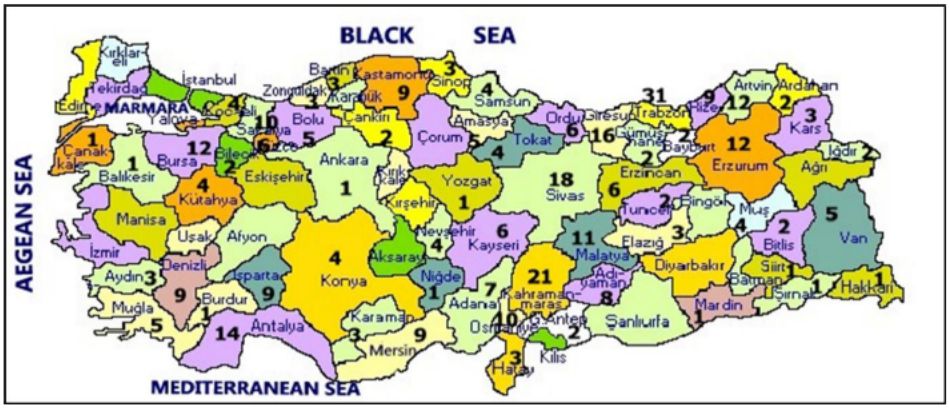


Figure 2. Local breakdown of SHPs in Turkey

From these data, it is understood that the facility is most concentrated in the eastern Black Sea region.

3. SMALL HYDROPOWER POLICY AND LICENCING PROCESS

In Turkey SHP's policy is the same as the renewable energy resources policy. Designated forested areas, land privately owned by the Treasury, or land under the disposal of the state in its entirety can be utilized for the purposes of the renewable energy generation if permission is granted by the Ministry of Agriculture and Forestry or the Ministry of Treasury and Finance. Forestry Peasant Development Revenue and Forestation and Erosion Control Revenue are not charged to the renewable energy generation facilities. Permission, lease, easement and usufruct permission fees are discounted by 85% for renewable energy generation facilities during the initial ten years of investment and operation of power transmission lines, including those under operation.

Pursuant to Provisional Article 4 of the Electricity Market Law No. 6446, for all types of generation plants (including renewables) that will be operational by December 31, 2025, transmission system usage fees are discounted by 50% for the first five years of operation. Pursuant to the Article 43.4 of the Electricity Licensing Regulation, for the facilities generating electricity from the local natural resources and the renewables, the license holders are not required to pay the yearly license fees for the first eight years following the date of completion of the power plants [19].

As regards the realization of small hydropower projects, firstly, the projects are studied and then posted on website in order to be applied by companies. Companies wishing to apply within the specified period submit to the projects published on the website. The applicant companies submit the required documents to DSI. Afterwards, candidate companies are invited to the DSI meeting in order to bid. As a summary, Hydroelectric Energy Department studies feasibility reports for planned hydropower projects, and taking their rant ability into considerations posts the economically feasible ones on its website for a bid meeting. After the meeting, the company that will carry out the project is decided. In the next process, the company prepares a detailed feasibility report and submits it to DSI for approval. After completion of the process of environmental impact assessment, water usage rights agreement between DSI and companies is signed. The company moves to the construction phase. Through construction phase of the project, Hydroelectric Energy Department supervises its construction and inspects it. After the completion of the project, Hydroelectric Energy Department with some other DSI departments makes a pre-final inspection [19,20]. If the plant passes that inspection, it is commissioned and will be granted permission to electricity (Figure 3).

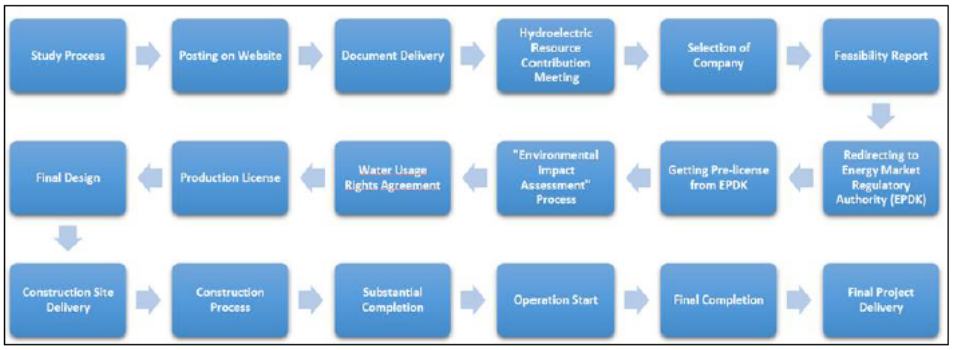


Figure 3. The process of the hydropower project

In Turkey, all market activities must be licensed. For each facility, to be granted a separate license is an obligation. Before granted a license, all generation facilities have to apply for a pre-license during which site related works such as land permission, environmental effect analysis etc. stated in the electricity market legislation have to be accomplished by pre-license holder company. Small scale generation plants using renewable sources up to 5 MW and micro-co-generation plants have been exempted from obligations for receiving a license and establishing a company. And generation facilities for municipal waste disposal facilities also are an exception.

4. CONCLUSION AND RECOMMENDATIONS

Turkey utilizes diverse energy sources to meet its electricity demand. Even though fossil power plants occupy a major part of energy generation (about 57% of the total installed capacity), renewable energy sources such as hydropower, wind, geothermal and solar power are also significant contributors to meeting the energy demand of the country. Among these renewable energy sources hydropower accounted for 26 % of electricity generation in 2020.

National targets for 2023 based on renewable energy sources according to national energy policies and strategy documents are determined as 38.5 % in renewable energy. When these targets are analyzed, it can be said that the target of increasing electricity generation from renewable sources to at least 30% in the National Energy and Mining Policy has already been exceeded. It has been observed that the target of increasing the share of all renewable energy sources in total electricity generation to 38.8 % in the 11th Development Plan is exceeded as of the current situation.

In most of the sites of small-hydro plants the primary requirement of the local communications agricultural land as their survival depends upon it. Therefore, many of small hydropower plants are normally operated to serve customer in remote area. When electricity and water are available able, the living standards will be enhanced by better education, internet, job opportunities, communication and others facilities. Also, they create job opportunities in rural areas addressing prevent migration to other places [21].

Over the past years SHP installed capacity has steadily increased. However, SHP still has to face barriers of different types as legal, social and environmental issues. Legally, Renewable Energy Law No. 5346 applies to small hydropower or hydropower production facilities having a reservoir area less than 15 km2 making no limitation regarding installed capacity. This guideline encourages the private sector to move towards investment in large hydropower systems for the potentially higher profits. Socially environmental reactions of public opinion against hydropower facilities could affect the investors, due to wrong or inappropriate site selection, exclusion of stakeholders, and unplanned basin management. And environmentally Turkey is among the countries most affected by climate change or variability. Therefore, SHP investments are adversely affected due to the decrease in surface waters.

By eliminating all these negative factors, it is possible to construct and operate small hydroelectric power in a sustainable sense within a certain plan.

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