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The Role of Municipalities in Renewable Energy Transition: Providing Drinking Water Supply of Kocaeli Province with Renewable Energy

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Abstract. The cost of electricity constitutes a significant part of municipal budgets. The decrease in renewable electricity generation costs allows municipalities to reduce their electricity costs and greenhouse gas emissions by investing renewable energy. A renewable energy transition facilitated by municipalities will positively affect and accelerate the energy transition in Turkey. In this study, the case of meeting the drinking water pumping station electricity consumption of Kocaeli Metropolitan Municipality Water and Sewerage Administration (ISU) from renewable power plants owned by ISU is analyzed. The amount of avoided emissions from renewable power generation has been calculated. 37.06% of ISU's electrical energy in the drinking water supply is consumed in drinking water pumping stations. ISU has renewable power plants with a total installed capacity of 8.50 MW. The rate of meeting the electricity consumed by the electrical energy obtained from the renewable power plants owned by ISU and the electrical energy consumed in the drinking water pumping stations is increasing. While the ratio of electricity from renewable energy sources (RES-E) to meet the electrical energy consumed in drinking water pumping stations was 19.27% in 2019, this ratio reached 31.74% in 2022 with investments in renewable energy power plants. As a result of RES-E, 32,225 tons of CO_2 emissions have been avoided.

Keywords. Renewable energy, municipality, drinking water, municipal utilities, Turkey.

1. Introduction

As a result of the increased population around the world, industrial development, and economic activities, the demand for water and electricity is gradually rising [1]. The world's electricity consumption has grown continuously in the last half century, reaching a value of approximately 28,466 TWh in 2021 [2]. Turkey's electricity consumption in 2021 was 253,034 GWh, whereas in 2022 the actual consumption was 328,674 GWh [3]. In the water sector; the amount of electricity consumed in drinking water supply, treatment and distribution constitutes 2% to 3% of global electricity consumption [4]. Almost half of this electricity is consumed by drinking water systems. About 90% of this consumption is used by the pumps located in the pumping stations [5]. Cities are responsible for about 65% of the world's energy consumption and 70% of CO_2 emissions [6]. Fossil fuels are finite resources that pollute the environment. Therefore, the interest in RES is increasing day by day [7]. Photovoltaic (PV) panels are widely used in electricity generation [8]. Since 2010, solar panel prices have fallen by approximately 90%, while global solar installed capacity has increased by over 400% [9]. Electricity expenses constitute an important part of the budget of municipalities. For this reason, municipalities make renewable power plant investments to meet their electricity demands. The decrease in the prices of PV panels has created an important opportunity for municipalities.

There are renewable power plant investments made by municipalities in Turkey. Izmir Metropolitan Municipality has invested in solar power plant (SPP). With a total of 12 SPP installed on the roofs of municipal buildings, it has reached an installed power of 1,167.40 kW. It plans an additional 510 kW SPP investment in the future. The municipality aims to support access to reliable, sustainable, and affordable energy. For this purpose; It is aimed to expand the use of energy efficiency practices, and renewable energy in all sectors and to increase electricity from renewable energy sources (RES-E) . In the 2020-2024 strategic plan, the number of preliminary studies for the establishment of renewable power plants has been determined as 4 per year. The municipality has been working towards putting into service 10 renewable power plants by 2023 [10].

Gaziantep Metropolitan Municipality has made investments in SPP and biomass power plants (BPP). The installed capacity of SPP was increased to 2 MW, and the capacity of BPP to 4 MW. The installation work of the new SPP, with an installed capacity of 27 MW, continues. It is aimed to increase the total renewable electricity capacity from 6 MW to 33 MW. In the municipality's strategic plan, goals for using RES and increasing energy efficiency were determined [11].

Diyarbakir Metropolitan Municipality generated 1,475,130 kWh of electricity in 2021 with the SPP and generated 1,247,000 TL revenue from the sale of surplus energy. In addition to the existing SPP, they have installed 669 kW and 500 kW SPP on the roofs of large municipal buildings. In the municipality's 2020-2024 strategic plan; there are goals to expand the use of RES and to reduce the effects of climate change [12].

Bursa Metropolitan Municipality has made SPP and BPP investments. It started electricity generation by installing 2 MW SPPon the roof of metro stations and Bursaray station in the city. It also generates electricity from landfill gas (LFG). It has a LFG to electricity plant with an installed capacity of 9.8 MW. In the strategic plan of the municipality; there are goals to encourage the production of hydroelectric and solar energy in districts with alternative energy potential, and to continue to expand renewable capacity throughout the city [13].

Kütahya municipality has made SPP investments. They have installed SPP with an installed capacity of 820 kW. In 2021, it generated 1,330 MWh of electricity. The municipality's strategic plan includes the goal of increasing the installed capacity of renewable energy to meet the constantly increasing energy need, prevent environmental damage, and reduce carbon emissions [14].

Kayseri Metropolitan Municipality has invested in BPP. It generates electricity from the BPP with a capacity of 4.5 MW. In the strategic plan of the municipality; the goals include generating electricity from RES and generates electricity from LFG andfill gas[15].

Mersin Metropolitan Municipality has made SPP investments. There is SPP with an installed capacity of 18 MW. It has implemented a total of 3 MW roof-type SPP projects on the drinking water tank. In addition, it generates 50,800 MWh of electricity annually with its LFG to electricity plant with an installed capacity of 5.8 MW. It is aimed to increase the capacity of this power plant to 15 MW by 2024. With the production of LFG from municipal solid waste (MSW), the energy production of 335,000 MWh is aimed until 2024 [16].

Manisa Metropolitan Municipality has installed 4.8 MW BPP. In the strategic plan of the municipality; It aims to reduce air pollution and increase energy efficiency by generating electricity with RES. There are goal to reduce carbon emissions by making local heating [17].

İstanbul Water and Sewerage Administration (ISKI) plans to construct a floating SPP with a capacity of 570 MW, which will cover 30% of the surface of Büyükçekmece Lake [18]. The 249 kW section of the SPP was established in 2017 [19]. ISKI continues to work on obtaining the electricity it consumes from RES. In 2021, 4,792,417 kWh/year of electrical energy was obtained from SPP. ISKI aims to increase the share of renewable energy in total energy consumption from 0.24% to 6.52% by 2024 [20].

İstanbul Metropolitan Municipality (IBB) has made various investments to meet its electricity consumption with RES. IBB increased its renewable generation capacity to 18,367.8 kW by installing 259 kW SPP, 18 MW BPP, and 3 LFG plants with an installed capacity of 108.8 kW. It aims to increase the renewable power capacity to 25,000 kW by 2024. IBB aims to increase the rate of electricity consumption from RES to 15% by 2024 [21].

Ordu Metropolitan Municipality aims to create a municipality that produces its energy by utilizing RES. There is an HPP with an installed capacity of 100 kW. In addition, it is aimed to establish 4 wind power plants (WPP), each with a power of 5 MW [22]. Ordu Municipality will start the construction of a wave power plant in 2023. In this context, in the first stage, it is planned to establish a pilot plant of 4 MW [23].

Kocaeli Metropolitan Municipality Water and Sewerage Administration (ISU); consume a large amount of electricity in the supply of drinking water, distribution of drinking water and collection and treatment of wastewater. Electricity expenditure constitutes 9.11% of the budget. ISU aims to reduce electricity costs by establishing new SPP, HPP, and BPP [24].

In this study; the situation of meeting the electricity consumption of the drinking water pumping station, which is an important energy consumption item of ISU, with the electricity generated in the renewable power plants owned by ISU has been analyzed. The amount of emissions avoided by electricity generation using RES has been calculated. In this context; the electricity consumption and generation data of ISU were examined. The amount of electricity consumed by drinking water pumping stations and the amount of RES-E were compared. With the renewable energy investments made by ISU, the environment is protected, renewable energy is produced and greenhouse gas (GHG) emissions are reduced [25].

In the second section of this study, studies on renewable power plants investments made by local governments are examined. In the third section, Turkey's electricity generation is examined by source. Opportunities provided to municipalities regarding RES in the unlicensed electricity generation regulation were examined. In Kocaeli, the number and the installed capacity of renewable power plants owned by the metropolitan municipality and other organizations were examined. In the fourth section of the study, drinking water supply, the general electricity consumption of ISU, electricity consumption of drinking water pumping stations, and RES-Ewere examined. With the emission values, the ratio of the electricity consumed in drinking water pumping to the electricity generated was calculated. The fifth section of the study is the conclusion and recommendations section.

2. Literature Review

There are various studies examining the RES investments of municipalities. Azam et al. investigated the energy potential of solid waste in Lahore, Pakistan in their study. Solid waste management is one of the most important elements for sustainable development in cities. The amount and energy value of solid waste vary depending on many parameters such as population density, the standard of living, socioeconomic factors, per capita income, and education level. Electricity can be generated from MSW and GHG emissions can be reduced. It has been calculated that 48 MWh of energy can be produced from Lahore's 2,000 tons/day of MSW [26].

Yang et al., in their study, investigated the amount of MSW and the fuel to be produced from this waste. MSW disposal is difficult due to the ever-increasing human population. Especially in 2019, with the new coronavirus disease and the decision prohibition to leave the house, more than 6,000 tons of plastic packaging were used per day in Southeast Asian countries. They estimated that the consumption of MSW will reach 1.42 kg/person/day by 2025 and 2.6 billion metric tons by 2030. In countries that use refuse-derived fuel (RDF) instead of coal, CO_2 emissions are reduced by 40% and the amount of solid waste by more than 50% . Yang et al.determined that the cost of energy production through the gasification of RDF would be 0.05 USD/kWh [27].

Saad et al. conducted a case study in the municipality of Hammana, Lebanon. In their study, they surveyed to find the primary energy consumption in residential, business, and public buildings. As a result of the survey, they determined that their buildings have the highest GHG emissions with approximately 11,545.35 tCO_2-equivalent (eqv.) per year. They calculated that 12,292 MWh/year energy savings would be achieved by enhancing buildings' envelope and using solar water heaters, and as a result, 2,442.9 t CO_2-eqv./year GHG emissions would be prevented. In addition, they determined that the diesel generator used for the electricity of the wastewater treatment plant will be replaced with a 45kW SPP system, reducing the energy consumption by 65.25 MWh/year and the GHG emissions by 72.5 kt CO_2-eqv./year [28].

Zhong et al. examined Sweden's energy needs to be met from 100% renewable energy. Sweden's wind energy capacity is high. They calculated that the new wind power capacity needed for a 100% renewable energy production system is about twice the current wind power capacity. They found that reaching this goal would take about 20 years, considering the renewable power plant installation rate in the last 5 years [29].

Tsagkari et al. examined renewable energy projects on the Greek island of Tilos. Tilos is an island far from the mainland, powered by fuel oil and experiencing blackouts. There are unemployment and immigration problems on the island and its economy is based on mass tourism. The island's electricity demand is provided by a wind turbine with an installed capacity of 800 kW and an SPP with an installed capacity of 60 kW. It has been determined that Tilos island provides uninterrupted electricity for up to 12 hours without any energy source since excess energy has been stored [30].

Munir et al. investigated the amount of MSW in their study in New Zealand and the energy potential of these wastes. They emphasized that energy can be obtained from the MSW and that the energy deficit of the country can be reduced with the energy to be produced from MSW. They calculated that New Zealand produces about 4 million tons/year of MSW. Considering that MSW has a net energy potential of about 0.13-0.38 TEP per ton, they determined that there is an energy potential of about 0.5–1.5 MTEP/year from MSW [31].

Aboagyeac et al. examined the renewable energy potential of Ghana in their study. First, they calculated that it has an annual wind power potential of 2,000 MW with wind speeds between 9 and 9.9 m/s from the shore. Secondly, they calculated that there are 2 to 3 million tons of wood waste in the country and with the use of this amount, there is an annual BPP potential of 600 GWh. Thirdly, they calculated that there is an annual HPP potential of over 900 MW in certain areas. They found that the country's monthly average solar radiation is 4.4–5.6 kWh/m^2-day and there is a potential of 53,000 MWh of SPP per year [32].

Özcan examined the role of local governments in the energy transition and stated the activities to be carried out by municipalities. It has been determined that Turkey's renewable energy investments in cities are mainly LFG, biogas, and biomass and there are few small-capacity of SPP. 30% of the electricity in Turkey is consumed by the cities of Istanbul, Izmir, and Ankara. He examined the licensed and unlicensed renewable installed capacity of the Metropolitan Municipalities of these provinces. He examined the investments made in these cities regarding biomass, sewage sludge, LFG, solar, wind, and other RES. He stated that municipalities can contribute to renewable energy transition with their investments [6].

3. Turkey's Renewable Power Production

Renewable capacity goals by source that Turkey aims to reach by 2035 are given in Table 1 [33].

Table 1. Renewable Capacity Goals by Source (GW)

Source	Installed Capacity
Solar	52.9
Wind	29.6
Hydro	35.1
Geothermal and Biomass	5.1
Total	122.7

Turkey aims to increase its share of RES-E to 54.7% and its share in installed power to 64.7% by 2035 [33].

In Turkey, RES, and fossil resources are used for electricity generation. At the end of 2022, the total electricity generation was 326,015 GWh. Turkey's electricity production by source between 2017 and 2022 is given in Table 2 [34].

Table 2. Turkey's Electricity Generation (GWh)

Type	2017	2018	2019	2020	2021	2022
Thermal	208,307	205,217	170,374	162,378	212,977	185,503
Renewable	87,299	99,000	133,706	142,953	118,514	140,512
Total	295,606	304,216	304,081	305,330	331,492	326,015

Total energy production increased by 10.30% in 2022 compared to 2017. In this period, the rate of decrease in thermal resources was 10.95% and the rate of increase in RES was 60.95%.

The production amounts of RES used for electricity generation in Turkey between 2017 and 2022 are given in Table 3 [34].

Table 3: Turkey's Renewable Electricity Generation (GWh)

Type	2017	2018	2019	2020	2021	2022
Hydro	58,428	59,937	88,885	78,115	55,695	67,159
Wind	17,897	19,939	21,750	38,164	31,137	35,210
Solar	5,969	7,431	8,930	9,929	10,771	15,323
Geothermal	2,144	3,447	4,522	5,502	7,617	10,758
Biomass	2,861	8,246	9,620	11,242	13,294	12,062
Total	87,299	99,000	133,707	142,952	118,514	140,512

Turkey's electricity production with RES has increased by 60.95% in 2022 compared to 2017. When analyzed on a source type; it is seen that all of them increased hydro by 14.94%, wind by 96.74%, solar by 156.71%, geothermal by 401.77%, and biomass by 321.60%.

3.1. Electricity generation from renewable energy sources in Kocaeli Province

In the Regulation on Unlicensed Electricity Production in the Electricity Market, new opportunities have been given to municipalities for renewable power plants [35]. These opportunities have been given as follows;

- Municipalities will be able to sell their surplus electricity for ten years at the price of the RES support mechanism.
- Municipalities will be able to generate electricity from domestic solid wastes, wastewater treatment sludge, water and wastewater flow, up to twice the contracted power within the municipal boundaries. It will be able to establish renewable power plants without obtaining a license.

The strategic aim of increasing energy production by using RES is included in the ISU 2020-2024 Strategic Plan. For this purpose, there are goals to implement renewable energy investments, prepare renewable energy projects, operate HPP, SPP, and BPP efficiently, to reduce unit energy costs in drinking water treatment and wastewater treatment processes [36]. In 2022, the population, electricity consumption, and generation values of Kocaeli province are given in Table 4 [37].

Table 4: Kocaeli Province's population, electricity consumption, and generation

	Population	Consumption (MWh)	Generation (MWh)
Kocaeli	2,118,343	12,324,572	7,658,869
Türkiye	85,279,533	328,673,568	326,014,525
Rate	2.48	3.75	2.35

2.48% of Turkey's population lives in Kocaeli and 3.75% of total electricity consumption takes place in this province. The ratio of the electricity consumed in Kocaeli to be met by the electricity generated in Kocaeli is 62.14%. There are a total of 19 renewable power plants in Kocaeli [38].
The renewable power plant types, numbers, and installed power values of the General Directorate of Kocaeli Metropolitan Municipality, its subsidiaries, and institutions other than the municipality are given in Table 5 [39].

Table 5: Renewable Power Plants in Kocaeli

Type	Plant Numbers			Installed Power (MW)		
	Municipality	Other Institutions	Total	Municipality	Other Institutions	Total
Wind	0	4	4	0	121.20	121.20
Solar	5	0	5	5.99	0	5.99
Biomass	1	4	5	0.34	14.84	15.18
Hydro	4	1	5	2.27	0.40	2.67
Total	10	9	19	8.60	136.44	145.04

The total installed power of the renewable power plant in Kocaeli is 145.04 MW. 5.93% of the installed capacity for renewable power in Kocaeli belongs to Kocaeli Metropolitan Municipality.

4. Drinking Water Supply, Electricity Consumption, and Generation

4.1. Drinking Water Supply

With "Law No. 831 on Water", the supply and administration of water have been given to municipalities [40]. In the Duties and Authorities section of "Law with number 2560 on the establishment and duties of the İstanbul Water and Sewage Administration General Directorate". Water and Sewerage Administrations have been established to carry out water and sewerage services in Metropolitan Municipalities. ISU was established and assigned to carry out these works in Kocaeli province [41].

Drinking water comes from the dam to the drinking water treatment plant with the help of pumps located in gravity or main pumping stations, depending on the location of the water source. The treated drinking water here comes from the main water tank. Afterward, according to the height of the settlement, the water is pumped into the storage tank with the pumps in the pumping stations. Electricity is used to distribute drinking water to water tanks [42]. Drinking water reaches residences and workplaces by gravity from water tanks using a service line. The flow chart of this process is given in Figure 1.

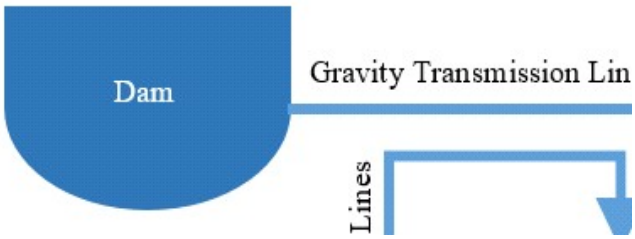

Figure 1: Water supply to consumers

4.2. Electricity Consumption

According to the 2022 census, 2,118,343 people live on the rugged terrain of Kocaeli. ISU provided 178,294,046 m^3 of drinking water to this population in 2022. For the distribution, treatment, and other processes of this water, 126,023,600 kWh of electricity was consumed. The amount and percentages of electricity consumed according to the main electricity consumption items are given in Table 6 [43].

Table 6: Electricity Consumption in Drinking Water Supply

Main Consumption Items	2022 (kWh)	%
Rainwater Pumping Stations	523,600	0.42
Drinking Water Treatment Plants	2,000,000	1.59
Building Sites and Interior Needs	2,700,000	2.14
Wastewater Pumping Stations	18,100,000	14.36
Drinking Water Pumping Stations	46,700,000	37.06
Wastewater Treatment Plants	56,000,000	44.44
Total	126,023,600	100.00

When the main electricity consumption items are examined, it is seen that the electricity consumption of drinking water pumping stations constitutes 37.06% of the total electricity consumption and consumption value is 46,700,000 kWh. The number of water tanks, their volume, and the number of drinking water pumping stations in Kocaeli by the districts are given in Table 7 [44].

Table 7: Drinking Water Tanks, Volumes, and Pumping Stations

District	Per Item	Volume (m^3)	Pumping Stations
Başiskele	60	39,470	14
Çayırova	4	12,000	2
Darıca	1	4,000	1
Derince	39	22,145	9
Dilovası	9	13,000	4
Gebze	27	57,875	6
Gölcük	66	29,956	16
İzmit	142	66,480	31
Kandıra	133	26,780	20
Karamürsel	58	17,595	13
Kartepe	71	24,090	12
Körfez	57	19,385	25
Total	667	332,776	153

The amount of electrical energy consumed by ISU in drinking water pumping stations to distribute drinking water to settlements in the last three years is given in Table 8 [45].

Table 8: Energy Consumption of Drinking Water Pumping Station

Year	Electricity Consumption (kWh)
2019	44,700,000
2020	51,100,000
2021	46,700,000
2022	47,719,298
Total	190,219,298

When the data in Table 7 is examined; it is seen that electrical energy consumption increased in 2020 due to the increase in the amount of drinking water used due to the pandemic.

4.3. Electricity generation from renewable sources in ISU

ISU installed SPP on the Namazgâh Dam area in the Kandıra district and on the aeration ponds of the Kullar wastewater treatment plant. HPP are built on the Namazgâh dam and the Soğukpınar line. The type and installed power of these renewable power plants are given in Table 9 [46].

Table 9: Renewable Power Plants of ISU

Plant	Type	InstalledPower (MW)
Namazgâh	SPP	3.52
Kullar	SPP	1.01
Namazgâh	HPP	1.78
Soğukpınar	HPP	0.23
Soğukpınar	HPP	0.84
Soğukpınar	HPP	0.48
Soğukpınar	HPP	0.64

The total installed power value of the renewable power plants is 8.50 MW. The amount of electricity generated by these plants in the last four years is given in Table 10 [47].

Table 10: Electricity Generation from Renewable Energy Sources

Year	SPP (kWh)	HPP (kWh)	Total (kWh)
2019	5,176,780	3,438,600	8,615,380
2020	5,391,960	8,919,800	14,311,760
2021	5,458,260	10,884,730	16,342,990
2022	5,473,959	9,674,070	15,148,029
Total	21,500,959	32,917,200	54,418,159

A total of 54,418,159 kWh of electricity was generated from renewable sources in tha last four years. Of the electricity generated, 40% was from SPP and 60% from HPP. Emission values of electricity generated from SPP and HPP facilities were calculated by using combined margin CO_2 emission factors of the Turkish power grid. Avoided emission values are is given in Table 11 (Emission factor for PV: 0.6488 tCO_2 / MWh, Emission factor for HPP: 0.5552 tCO_2 / MWh) [48].

Table 11: Avoided Emissions (tCO_2)

Year	SPP	HPP	Total
2019	3,359	1,909	5,268
2020	3,498	4,952	8,451
2021	3,541	6,043	9,585
2022	3,552	5,371	8,923
Total	13,950	18,276	32,225

According to the calculations in Table 11; a total of 32,225 tCO_2 emissions have been avoided by the electricity generated by ISU from SPP and HPP within four years. The ratio of the electricity consumed in drinking water pumping stations of ISU (Table 8) to be met by the electricity generated by using RES (Table 10) is given in Figure 2.

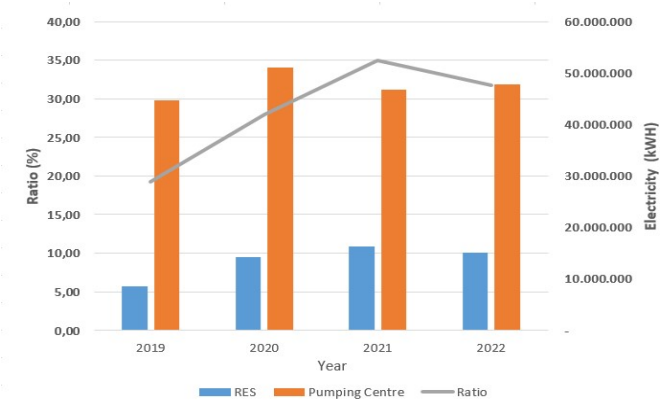

Figure 2. Meeting the Electricity Consumed in the Drinking Water Pumping Station with RES

The amount of electricity used in ISU's drinking water pumping stations increased in 2020. It is thought that the effect of the pandemic is causing this increase. The ratio of the electrical energy produced by using RES to cover the amount consumed at the drinking water pumping station was 19.27% in 2019, 28.01% in 2020, 34.92% in 2021, and 31.74% in 2022. Compared to 2019, the rate of meeting the amount of electrical energy consumed in drinking water pumping stations by using RES has increased by 64,71.

5. Conclusion and Recommendations

The costs of renewable power plants continue to fall. Municipalities can generate electricity from RES and improve their budgets. RES-Ewill also reduce GHG emissions and Turkey's foreign energy dependency.

There are a total of 19 renewable power plants in Kocaeli. The total installed power of these plants is 145.04 MW. In Kocaeli, 5.93% of the renewable power plants belong to the Metropolitan Municipality. As of 2022, the rate of meeting the electricity generation and consumption of Kocaeli province is 62.14%.

ISU aims to realize renewable energy investments, prepare additional renewable energy projects, operate HPP, SPP, and BPP efficiently, reduce unit energy costs in the drinking water treatment process, and reduce unit energy costs in the wastewater treatment process.

Kocaeli province has a rough terrain located around the Gulf of Izmit and generally, the settlements are at +300 elevation with sea level. For this reason, ISU carries out drinking water distributions by using pumping stations. 37.06% of the total electrical energy consumed to distribute drinking water is consumed in drinking water pumping stations.

ISU generates electricity with the HPPs that it has installed on the dam sites and the SPP it has installed on the aeration pools of the wastewater treatment plant. ISU has a total of 8.50 MW renewable power plant capacity , of which 4.53 MW is SPP and 3.97 MW is HPP. Of the electricity generated, 40% was generated from SPP and 60% from HPP.

The ratio of RES-E to meet the electrical energy consumed in drinking water pumping stations was 19.27% in 2019, 28.01% in 2020, 34.92% in 2021, and 31.74% in 2022. Compared to 2019, the rate of meeting the amount of electricity consumed in drinking water pumping stations by using RES has increased by 64.71%. In 2022, 13,006,704 TL income was obtained from electricity generation [49].

ISU has avoided a total of 32,225 tCO_2 emissions in the last four years with the electricity it has generated from SPP and HPP. In 2019-2022, ISU generated a total of 21,500,959 kWh of electricity from SPP and a total of 32,917,200 kWh of electricity from HPP in the same period. The amount of avoided emissions is calculated as 13,950 tCO_2 for SPP and 18,276 tCO_2 for HPP, totaling 32,225 tCO_2.
It is necessary to benefit more from RES in Kocaeli. For this purpose; SPP can be installed on the aeration pools of 22 wastewater treatment plants in Kocaeli. SPP production efficiency will increase as the water in here keeps the solar panels cold.

The main clean water resources of Kocaeli are Yuvacık and Namazgâh dams. In the dam, water is lost by evaporation on summer days. To reduce this and to use these surfaces efficiently, SPP can be installed on the dam water surfaces. Thus, SPP cooling will also be provided. In addition, SPP can be installed on municipal service buildings, warehouse buildings, sports facilities, parks, and bus stations.

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