

# Achievements in the use of Renewable Energy in Turkey's Special Environmental Protection Areas (SEPA)

## Renewable Energy in SEPA's

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**Abstract—** The objectives of the present study are to represent renewable energy usage in Turkey's Special Environmental Protected Areas (SEPA). Specific objectives are to discuss achievement in the: (i) usage of solar energy on tour boats as the primary fuel source for Dalyan Channels in the Köyceğiz-Dalyan SEPA; (ii) usage of solar energy as the main energy source for wastewater treatment plants pumping stations in the Göksu Deltası SEPA; (iii) usage of wind energy as the supplementary energy source in the Datça SEPA; (iv) usage of geothermal energy as the main heating applications in the Pamukkale SEPA and the Köyceğiz-Dalyan SEPA.

**Keywords—** wind farms; solar energy; wastewater treatment plants; geothermal energy; solar powered boats

### I. INTRODUCTION

During the past two decades environmental degradation has become more apparent. Environmental degradation is mainly due the dramatically increased impact human activities on the environment due to population, consumption, industrial activity, air pollution, water pollution, soil contamination, noise pollution etc. The environmental problems in question require long-term protective measures for sustainable development. In this context, renewable energy resources such as wind, hydro, geothermal, solar and biomass sources seem to be the most effective solution.

Turkey as an energy importing country needs to use its renewable sources. In this regard, wind and geothermal power are very attractive choices, since they represent economic, sustainable and environmental friendly options for Turkey. Due to Turkey's geography solar energy is abundant and has remarkable amount of hydro energy potential [1].

Turkey lies at the crossroads of the continents of Europe, Asia and Africa and is surrounded by the Black Sea, Mediterranean Sea and Aegean Sea, each possessing different ecological characteristics.

Various ecosystems provide shelter for thousands of animal and plant species. It should also be noted that two of the four migration routes used by the birds pass through Turkey, which makes it a highly significant ecological zone in terms of rich diversity.

The Turkish Cabinet of Ministers has declared 17 special environmental protection areas (SEPA) based on the addendum protocol of the Barcelona Convention according to the following criteria: (i) the area has endangered flora and fauna, (ii) the area is an entity together with its wetlands such as rivers, lakes, (iii) the area has archeological value, and (iv) the area provides recreational activities for the public.

Nine of the SEPA are located on the coastal regions of the Mediterranean and Aegean seas and six are located within the Turkey's interior. SEPAs are protected by a large number of existing nature conservation designations, such as the RAMSAR Convention, the Washington Convention CITES, the Bern Convention and the Barcelona Convention.

The Environmental Protection Agency for Special Area (EPASA) was established in 1989 to protect environmental values; to take all measures necessary to reverse the existing environmental problems of the areas to the maximum extent possible and designate these areas as SEPAs; to determine the conservation and management priorities for those areas; to prepare development plans and; to revise and approve existing changes and/or improvements throughout the development plans.

A site-specific management approach is needed for each SEPA, as each has its own particular characteristics within the country and the region in terms of species, habitats, historical and cultural richness and geographic properties. The objectives of the present study are to represent the renewable energy usage in special environmental protected area (SEPA) of Turkey.

Specific objectives are to discuss achievement in the: (i) usage of solar energy on tour boats as the main fuel source in Dalyan Channels in Köyceğiz-Dalyan SEPA; (ii) usage of solar energy as the main energy source for wastewater treatment plant's pumping stations in the Göksu Deltası SEPA; (iii) usage of wind energy as the supplementary energy

source in the Datça SEPA; (iv) usage of geothermal energy as the main heating applications in the Pamukkale SEPA and the Köyceğiz-Dalyan SEPA.

## II. SOLAR ENERGY USAGE IN SEPAs

### A. Solar Powered Boats in Köyceğiz-Dalyan SEPA

Köyceğiz-Dalyan SEPA is situated in southwestern region of Turkey. The area between the Köyceğiz Lake and the Mediterranean Sea is covered with four small lakes and numerous canals. The Dalyan Channel network connects lake to the Mediterranean Sea which is one of the most important reproduction areas for Mediterranean Sea turtles (*Caretta caretta*) and sheltering place for various animals. Population in Dalyan excessively increases during a tourism season. Hundreds of sightseeing tour boats (diesel) runs along the Dalyan Channel for the visitors to discover the area and observe the diverse natural life in the region. Recreational tour boats are posing a threat to the natural life in Dalyan Channel via water pollution (oil, grease, bilge etc.), noise pollution (beat-up boats, diesel engines etc), air pollution (exhaust gases etc).

The only activity allowed at Dalyan Channel is recreational boat trips. The number of official boats is 500 but with the unofficial ones this raises up to 700 boats. EPASA has put certain rules to control the boat traffic in the Dalyan Channel with max. boat length of 12m. and max speed of 5mi/hr since high speed causes loss of reeds and cause noise pollution. There exists a waste management system compromising collection, transportation and treatment of liquid (wastewaters, oil and grease) and solid wastes originating from boats.

The touristic boats are equipped with diesel engines emitting particulate matter, hydrocarbons, nitrogen oxides (NO<sub>x</sub>), carbon dioxide (CO<sub>2</sub>) are frequently used due to their cheaper prices and higher combustion efficiencies. The environmental impact of usage of diesel motors in sensitive Dalyan Channels is becoming more and more destructive since emissions are localized directly on the water surface. Bilge water, oil and grease, loss of reeds, air pollutants and noise significantly affect indigenous flora and fauna like *Caretta caretta*.

A radical solution to problem faced in the Dalyan Channels is to use alternative energy generating technologies instead of diesel engines. For this purpose, new project has been initiated regarding the usage of solar powered recreational boats and central solar power unit for recharging the batteries. Electrical excitation system will be mounted on the boats and energy will be maintained in batteries. This will reduce the emission of greenhouse gases; noise caused by boats and inevitably protects biodiversity. In this proposed project, 5 of the tour boats will be converted to fuel cell powered and another 5 of them to battery powered boats as a fleet of "green tour boats". Electrical boats, instead of diesel engine, are no doubt contributed to environmental protection. Moreover

such a high-tech solution will increase the tourist attraction of the region.

The boat named Güneş 1 (Sun 1) that may lead to 9 hours of non-stop with 4.5 mi/hr speed with 12 m. long and having 12 solar panels (495 KW) collects and converts solar energy to electrical energy. In addition, 8 solar cells were also situated at the bottom of boat that stores 240 ampere energy. The boat has no bilge wastewater, oil and grease due to electromotor. This boat is the first of its kind [2]. Main problem is the cost of conversion from diesel to solar powered motors.

### B. Solar Energy Usage in Wastewater Treatment Plants

The Gökusu Deltası SEPA, a Ramsar wetland, is an important stopover for a wide variety of migratory birds. It is also one of the most important nesting areas on the Mediterranean for such sea turtle species as "*Caretta caretta*" and "*Chelonia mydas*". Furthermore, the soft-shell Nile Turtle "*Trionyx tringuis*" inhabits this region.

In order to protect the indigenous flora and fauna of the area, various protective measures have been undertaken by the EPASA. One of the main protective measures is the collection and treatment of wastewater's, for which EPASA designs, invests and constructs wastewater treatment plants. The main problem encountered by wastewater treatment plant operators is the high cost of electricity. It is well known that the highest electricity consumption occurs in pumping stations that transfer wastewater to treatment plants. In order to solve the problem, a photovoltaic system was implemented at 3 pumping stations. The on-grid type system has a capacity of 20kWp, with a total capacity of 60kWp, 276 PV panels and a total surface area of 455.40 m<sup>2</sup> [3]. This system is the one and only solar-powered wastewater treatment plant in the SEPAs, however but two further projects are about to be implemented at the Akyaka and Kulu treatment plants.

### C. Wind energy usage in SEPAs

Datça-Bozburun was declared a special environmental protection area to protect both its natural and historical richness. It is an extremely important area for its floristic diversity. Olive trees, Calabrian Cluster Pines, an endemic palm tree (*Phoenix theophrasti*), almonds, locally collected thyme, oleander, bay leaves and carob beans all represent the typical Mediterranean vegetation. Additionally, it is a crossroads between the Aegean and the Mediterranean Seas which makes it a potential revenue source in terms of yacht commerce. The peninsula is a stopover place for yacht sailors due to climate conditions and a coastline pocketed with numerous bays as a result of its hilly topographic structure.

Turkey's unique geographical character creates a regular and moderate air inflow through mountainous straits and passages. Since it is located between the colder European and warmer Asian and African

systems, a wide variety of temperature and climatic variations is achieved. Based on the examination of Turkey's Wind Atlas, it may be concluded that the regions of the Aegean, Marmara, and East-Mediterranean have remarkable wind energy potential [4].

The development of wind farms is not acceptable for most of residents due to issues such as noise pollution, visual intrusion, TV interference, and its effect on local wildlife. Involvement of the local community plays a crucial role in determining the acceptability of a renewable energy development.

The Datça Wind Farm, for example, was located away from wildlife and residential areas to prevent such impacts. It has been operated since 2008 with 37 turbines with 29.60 MW generating capacity.

#### D. Geothermal energy usage in SEPAs

Pamukkale was declared a special environmental protection area to protect the region's natural and historical assets. Thermal water sources, which constitute an important natural resource in the region, form in the Pamukkale Travertine terraces. There are 17 thermal water sources with temperatures ranging from 35-100 °C. Karahayit Geothermal Springs, on the north-west of the fault zone where the hot water sources form the Pamukkale Travertine, have made the area an important health and tourism center. The temperatures and the chemical composition of these springs consist of different qualities, causing the formation of red travertine terraces observed around Karahayit and white travertine terraces around Pamukkale. In order for the great geothermal potential around Karahayit to be of benefit within accordance to its natural balance, EPASA, the Denizli Governorship and General Directorate of Mineral Research and Exploration have been working in coordination with each other for years.

Karahayit-Pamukkale has significant potential for geothermal energy production, and much of this potential is of relatively low enthalpy that is not suitable for electricity production but is still useful for direct heating applications. The Geothermal potential of Pamukkale-Karahayit is appropriate for thermal use (at temperatures below 150°C).

The Karahayit geothermal source possesses a surface area of 10 km<sup>2</sup>, water temperature at source is 51 °C, with a usable temperature of 45 °C, the thickness of the reservoir 0.2 km and a potential of 16 M<sub>t</sub> are successfully used in thermal therapy centers [5].

This geothermal source has been irresponsibly used by houses, motels and hotels without considering re-injection for years. In order to protect thermal water from contamination and exhaustion, a new project has been initiated. The aim of the proposed project is to distribute thermal water to hotels (200.000 m<sup>2</sup>), spas, thermal resorts and thermal therapy center (with a capacity of 10,000 people/day) and re-inject it once used into direct heating in accordance with Turkish legislation.

Another geothermal source existing in the Köyceğiz-Dalyan SEPA was found, feasibility studies were conducted. Köyceğiz - Sultaniye geothermal source possesses a surface area of 6 km<sup>2</sup>, with water temperature at source of 41 °C, usable temperature of 40 °C, thickness of reservoir 0.2 km and possible potential of 5 M<sub>t</sub> will be used for direct heating purposes and thermal therapy [5].

#### E. SWOT Analysis

Table I gives SWOT (Strengths, Weakness, Opportunities and Threats) analysis for Turkey's renewable energy.

TABLE I. SWOT ANALYSIS

Strengths	Weaknesses
Remarkable progress in Turkish energy sector	Regulatory and bureaucratic difficulties High taxes Improperly recorded production rates Not fully realized potential benefits of renewable sources Insufficient policy and market tools Insufficient credit facilities for small-scale projects
Turkey's location makes it a geopolitical energy hub between Europe and the Middle East	
Advantageous climate and environmental conditions	
Remarkable renewable energy potential	
Rapidly increasing energy demand	
Ability of obtaining funds for projects from EU or other non-governmental resources	
Existence of research centers	
High educational level among local people living in Turkey's SEPAs	
Strong management ability of EPASA	
Opportunities	Threats
Perfect sector for investment	Failure to meet EU standards
Increasing public awareness	Unclear policies
New investments in renewable energy sources	Low consumer incomes
	High inflation rates

### III. DISCUSSION AND CONCLUSIONS

Approximately 60 percent of energy consumption in Turkey is supplied by imports. Thus, it is crucial to supply Turkey's energy demands from renewable resources within the country. The implementation of renewable energy technologies would reduce the existing national and global environmental problems associated with the production, transportation and use of fossil fuels. The share of renewable sources should be increased according to the different properties of geographic regions within Turkey. If Turkey does not support its non-renewable energy with renewables, its environmental quality and economic development will increasingly be endangered.

On a global scale, issues like global warming, acid rain and other pollution effects make the use of renewable sources highly attractive and non-renewable sources less and less attractive. This is valid for wind-power plants since the hazards are mainly electro-magnetic radiation and noise. On the other hand hydro-power plants have significant negative effect on the quantity and quality of rivers, habitats, ecotones, species, crops etc. and also result in significant air and noise pollution during construction. For that reason there are no hydroelectric power plants operated and licensed in the SEPAs.

EPASA's energy policy includes:

- Increasing the share of new and renewable sources (geothermal heat, solar, wind, etc.) in the SEPAs,
- Educating local people with regard to renewable energies and energy efficiency,
- Planning energy research and development activities to meet requirements and,
- Protecting both the environment and public health in energy production.

The usage of geothermal sources began in the Pamukkale SEPA and continued with the Köyceğiz-Dalyan SEPA. EPASA continues to explore new opportunities. The main utilization of geothermal energy in SEPAs is in domestic heating, greenhouses, spas and thermal resorts.

Datça Wind Farm has been operated since 2009 with 29.6 MW. An additional 12 MW is licensed in Datça-Bozburun SEPA. New locations suitable for wind farms like Saros SEPA are being searched.

Solar energy usage in direct heating has been used for a long time in the SEPAs. The usage of solar energy in wastewater treatment plants, especially in pumping stations, is however, a relatively new approach. The usage of solar-powered pumping stations in SEPAs began with a photovoltaic system designed for Arkum-Atayurt Wastewater Treatment Plant in the Göksu Deltası SEPA and will continue with two more wastewater treatment plants operating in Gökova SEPA and Tuz Lake SEPA.

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