Review of the Renewable Energy Generation System in Tenerife

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Background: The island of Tenerife is one of the seven canary islands and is located in the Atlantic Ocean opposite the north-western coast of Africa. In the past 20 years its population has increased from 0.7M to about 0.96M. In addition, because of the 5 million tourists visiting each year the energy system is put under pressure. Thanks to its geographical location, to make the island "greener", the government is committed to implement some actions to be energy self-sufficient and to reduce its carbon footprint as a UNESCO Biosphere Reserve. Roadmaps are set in order to produce all energy required by using renewable energy sources by 2050. In [1] A pathway to a 100% renewable energy supply for entire archipelago is presented. The renewable energy sources are mainly solar, wind power, and geothermal, with a potential for wave power exploitation. An overview of the energy scenario, with a description of the key renewable energy systems implemented in the island and the projection for future energy production is given in this work.

Technology Review

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The peak power demand in Tenerife is about 1100 MW, with an overall consumption of 3.6TWh. However, until 2013 despite the great potential for RE use, only 4% of the total power was coming from wind and solar sources [2]. Tab. 1 shows the most important technical characteristics of the installed power capacity on the island. It can be seen that back in 2013 the main power production was still coming from conventional fossil fuels. While some of the minor islands are sharing submarine connections, the electricity grid in Tenerife is mainly isolated (apart from a small interconnection with La Gomera since 2020) due to the large water depths surrounding the island, which makes locally generated energy even more attractive. Today, both solar and wind power production capacity is increased significantly, with an overall installed power of 400MW in 2019, about three times the power capacity in 2013. According to Red Eléctrica data, this record was obtained at exactly 16.20 hours. At that time, wind energy was producing 149.6 GWh, or 41.9% of the island's electricity demand [3]. On the other hand, photovoltaic solar energy reached 64.5 GWh of production to obtain 18.07% of Tenerife's demand at that time, which combined is about the 60% of the overall power demand.

Tab. 1 Summary of the power plants installed on Tenerife in 2013 [2].

Technology	No. Units	Power p.u.	Total Power	Minimum Operation Range	LCOE	Type of Fuel	Emission Rate
		MW	MW	MW	€/MWh	-	KgCO2/MWh
Combined Cycle	2	220	440	110	169	Gas Oil	650–700
Steam Turbine	3	80	240	45	165	Fuel Oil	850–900
Gas Turbine	6	35	210	8	320	Gas Oil	1200–1250
Diesel Engines	3	24	72	12	130	Fuel Oil	750–800
Wind Power	-	-	37	-	72	-	-
Photovoltaic	-	-	114	-	118	-	-

Overview of wind technology in Tenerife

Tenerife is exposed, on the one hand, to north-westerly swells generated over the long Atlantic fetch, and on the other, to the trade winds typical of these latitudes, which blow relatively constant throughout the year. Along the costal areas the wind average speed of 7-8 m/s, thus very suitable for off wind turbine installations. An example of recent installation is a wind farm in Granadilla de Abona (south coast), with seven 80-metre, 2.625MW Siemens Gamesa wind turbines, providing a total capacity of 18.375MW [4]. Let us consider that the only available turbines have the same capacity, in order to satisfy the power demand of the all island an equivalent number of (1100MW/2.625MW) about 420 wind turbines are required (assuming a power production from wind only). The key barriers to further develop the production from wind energy are the availability of space (45% of the territory is protected) and the grid penetration is limited due to weak character of the insular electrical networks. In Fig. 2, the most recent data from the Canary islands government annual statistics, is showing the trend of the overall wind power installed in Tenerife since 1985. From the graph in 2019 the overall wind power installed was about 200MW.

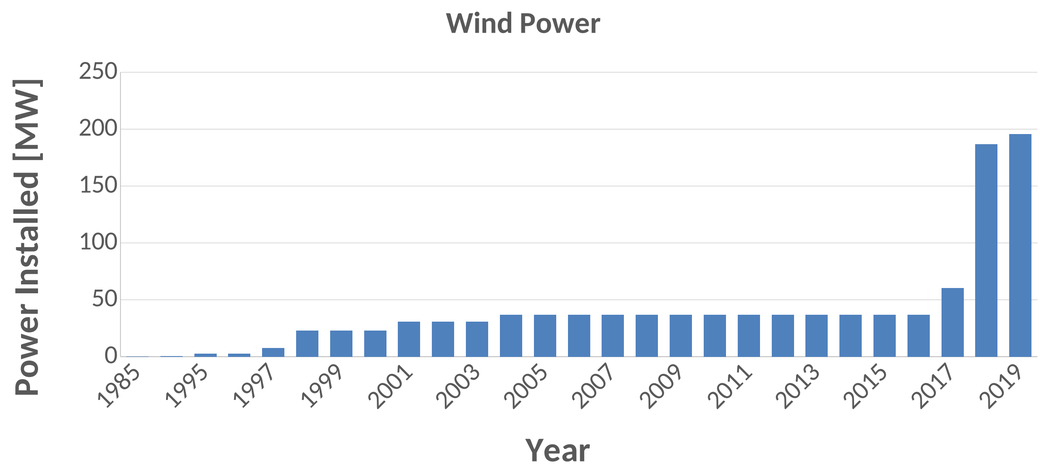

Fig. 2. Wind power installed since 1985 [6]

Overview of solar technology in Tenerife

The solar irradiation on an horizontal surface is 5.7 kWh/m², with 6.8 to 8 hours of sun per day, corresponding to 2500 – 3000 hrs/year with an enormous potential to exploit solar energy [5]. From Fig. 2 it can be noted that photovoltaic installed power has increased rapidly from 2006 to 2012 and then remained constant.

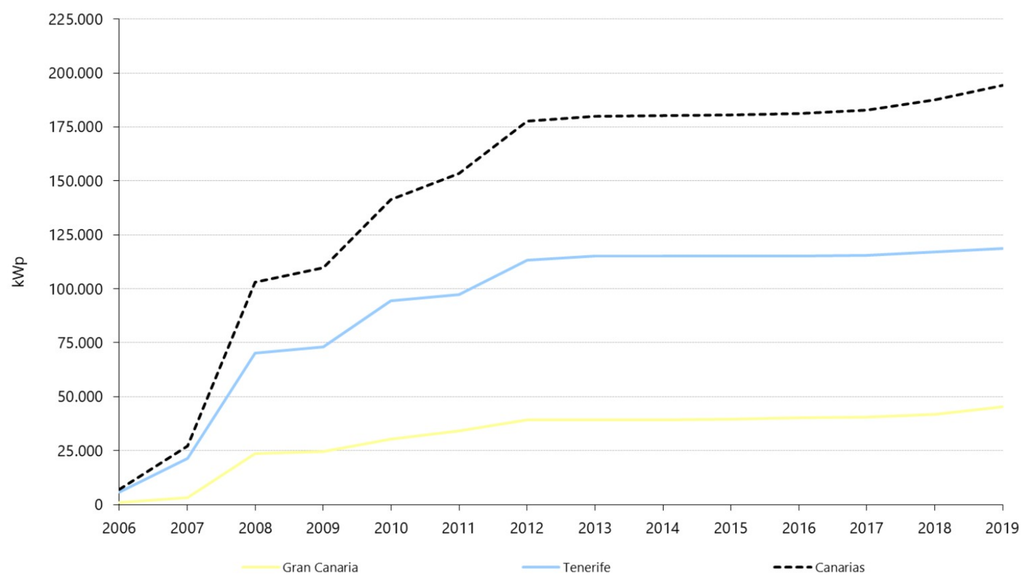

Fig. 1. Wind power installed since 2006 [6]

Potential for future expansion and Conclusions

Most RE potentials in the Canary Islands rely on solar irradiation and wind and are thus of fluctuating nature. The balancing of their temporal variation in power generation poses the major challenge to a 100% RE supply. A new project, in line with the target of the Island Council of Tenerife to cover all electricity demand with renewable energy, has been proposed for a 350 MW of production by solar alongside 1 GWh storage. The storage system would enable the management of solar power generation, adapting it to the demand curve of the island with an high level of efficiency and reliability and a low response time.

Wind energy continues to experience a good growth rate, and does not seem to be affected by regulations, which has made it the most sustainable renewable energy source.
Guidelines and roadmaps are suggesting that the wind power generation will increase, but in order to enable this further developments to the power grid are required in order to improve the carrying capability. Another factor that is slowing down the extensive installation of new renewable sources is the volcanic geography of the island with high peaks which are limiting the potential expansion.

References: [1] Hans Christian Gils, Sonja Simon, Carbon neutral archipelago - 100% renewable energy supply for the Canary Islands, Applied Energy, Volume 188, 2017, Pages 342-355, ISSN 0306-2619, https://doi.org/10.1016/j.apenergy.2016.12.023.

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[6] file:///C:/Users/ezzmd2/Downloads/AnuarioEnergeticoCanarias-2019.pdf Online. Accessed 30/01/2021. Time 00.35.

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