CLEAN ENERGY FOR EU ISLANDS

Wind and Solar resource mapping

Gorgona, Italy

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Date: 10/10/2020

CLEAN ENERGY FOR EU ISLANDS

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The Clean Energy for EU Islands Secretariat

Who we are

The launch of the Clean Energy for EU Islands Initiative in May 2017 underlines the European Union's intent to accelerate the clean energy transition on Europe's more than 1,400 inhabited islands. The initiative aims to reduce the dependency of European islands on energy imports by making better use of their own renewable energy sources and embracing modern and innovative energy systems. As a support to the launch of the initiative, the Clean Energy for EU Islands Secretariat was set up to act as a platform of exchange for island stakeholders and to provide dedicated capacity building and technical advisory services.

The Clean Energy for EU Islands Secretariat supports islands in their clean energy transition in the following ways:

• It provides technical and methodological support to islands to develop clean energy strategies and individual clean energy projects.

• It co-organises workshops and webinars to build capacity in island communities on financing, renewable technologies, community engagement, etc. to empower them in their transition process.

• It creates a network at a European level in which islands can share their stories, learn from each other, and build a European island movement.

The Clean Energy for EU Islands Secretariat provides a link between the clean energy transition stories of EU islands and the wider European community, in particular the European Commission.

1. Glossary

Acronym	Full Name	Unit	Explanation
GHI	Global Horizontal irradiation	kWh/m²	Average annual, monthly or daily sum of global horizonal irradiation
GTI	Global Tilted Irradiation	kWh/m²	Average annual, monthly or daily sum of global tilted irradiation
PVOUT specific	Specific Photovoltaic Power Output	kWh/kWp	Yearly and monthly average values of photovoltaic electricity (AC) delivered by a PV system and normalized to 1kWp of installed capacity
PVOUT total	Total Photovoltaic Power Output	kWh	Yearly and monthly average values of photovoltaic electricity (AC) delivered by the total installed capacity of a PV system
PR	Performance Ratio	%	Ratio between specific AC electricity output of a PV system and global tilted irradiation received by the surface of a PV array (PVOUT specific/GTI)

2. Site and project description

Island description

Gorgona is the northernmost island in the Tuscan Archipelago, a group of islands off the west coast of Italy. It is known for its monastery from the Middle Ages which nowadays hosts an agricultural penal colony, currently in use. Long-stay vacation is not allowed on the island. Therefore, the number of inhabitants is rather constant throughout the year with an amount of around 150 (200 maximum) on a yearly basis.

So far, a 35 kW peak power photovoltaic farm has operated on the island but it will soon be decommissioned and replaced with a new 70 kW system as well as a storage system.

Figure 1: Location of Gorgona Island (Source: Wikipedia)

Objective of the study

This study aims at analysing the wind and solar potential of Gorgona island. The study provides the best locations for renewable energy installations considering both land restrictions and the available renewable energy resource potential.

3. Analysis on restriction areas

Gorgona and the waterbed around the island are part of the Tuscan Archipelago National Park. This is a protected area.

90% of the island is in its native state, covered with maquis shrubland, and is part of Natura 2000 as shown in Figure 2.

Environmental regulations pose restrictions on the installation of either wind or solar parks on the island. Although Gorgona is a fully protected area, the park directives may allow to build wind or solar parks in specific zones. It is recommended to contact the park administration to identify the specific zones. In this report, the entire island has been further considered for potential renewable energy project development.

A future study should identify whether cultural heritage rules apply on the buildings in the built-up area.

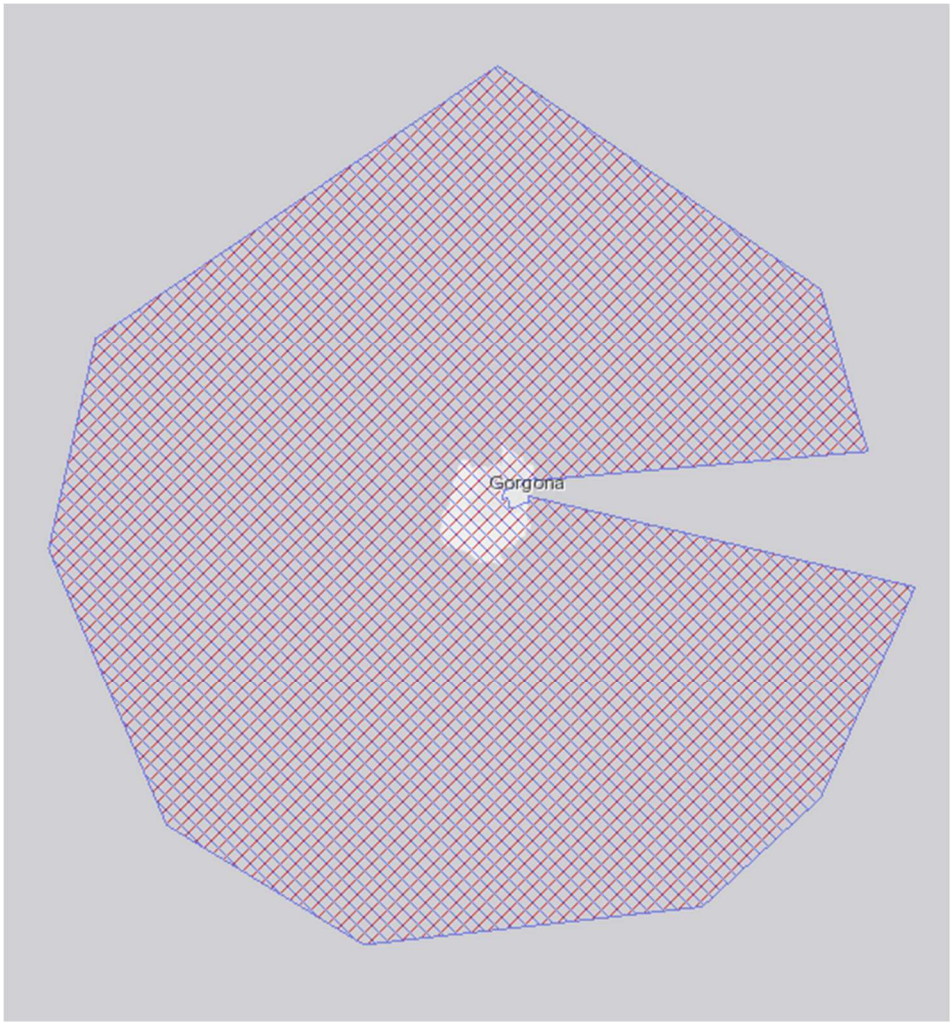

Figure 2: Restriction areas on Gorgona (Source: https://natura2000.eea.europa.eu/#:)

4. Analysis on renewable energy potential

Wind potential

For the studied area, a wind atlas has been created using the software WindPro[1]. The Wind Climate from the Global Wind Atlas[2] has been used to calculate a wind resource map of the island.

The wind speed on the island ranges between 4.0 m/s and 9.5m/s at 37.2m and between 4.8 m/s and 9.0 m/s at 55m above ground level depending on the location on the island. This is shown in the resource maps in Figure 4 and Figure 5. The wind predominantly blows from south-south-east and east-north-east where most of the energy is also available.

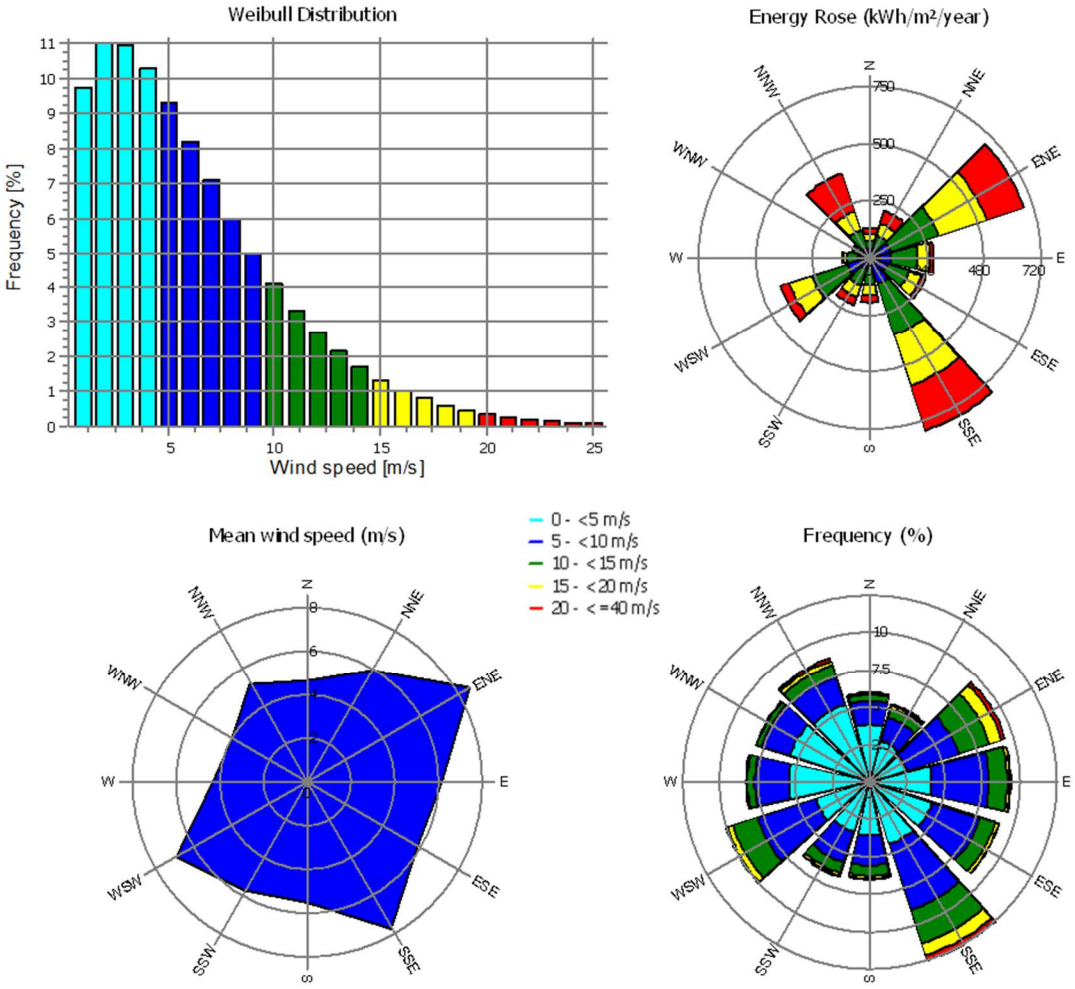

Figure 3: Wind distribution eastern part of the island

The highest wind speeds on the island are found in zones with higher altitudes, namely in the western side of the island. The island's coast is tall and rugged and has lower wind speeds. This observation is valid at both heights considered in the study. The rest of the island shows an average wind speed of 7.4m/s at 37.2m above ground level.

[1] WindPRO is a software package for designing and planning wind farm projects. It uses WAsP to simulate wind flows. It is developed and distributed by the Danish energy consultant EMD International A/S. It is trusted by many investment banks to create wind energy assessments used to determine financing for proposed wind farms.

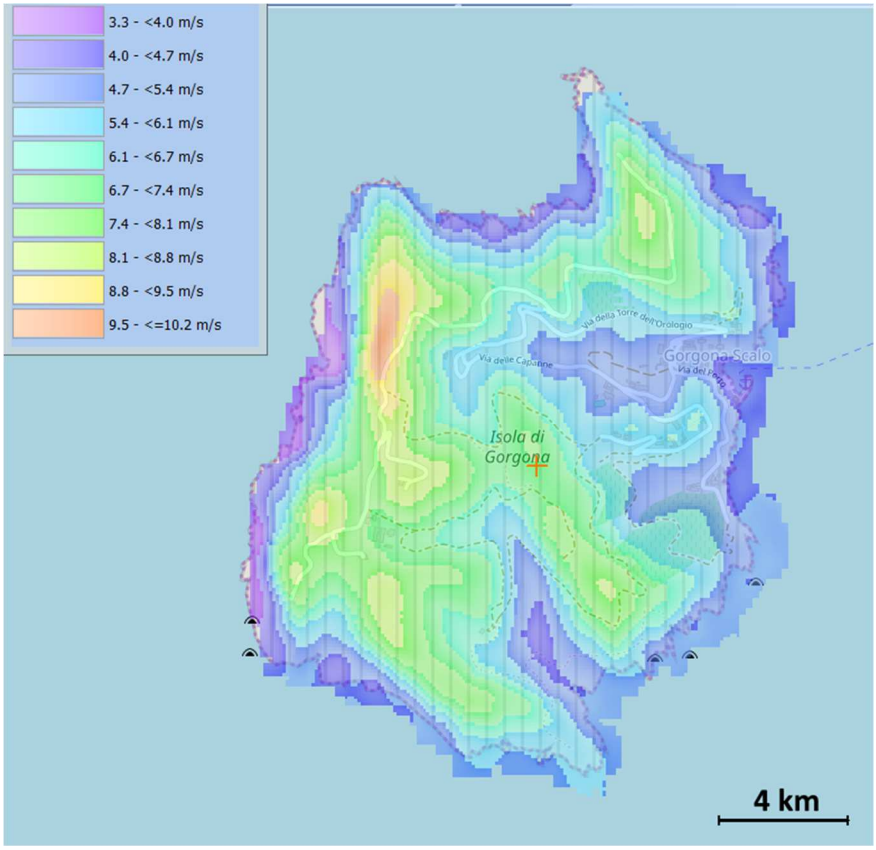

Figure 4: Mean wind speed at 37.2m above ground level [m/s]

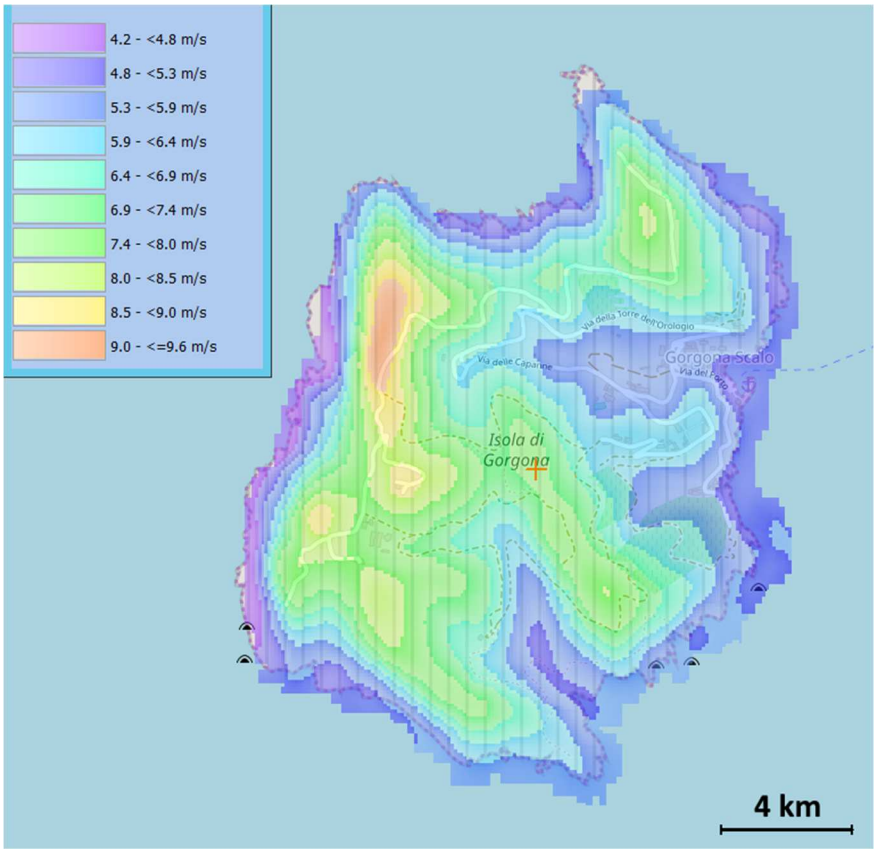

Figure 5: Mean wind speed at 55m above ground level [m/s]

A wind resource map in terms of annual production MWh/year has been generated at 37.2m above ground level based on exemplar mid-size wind turbine XANT M-24 95kW [3].

The results show that the average wind potential on the island based on the selected wind turbine type at 37.2m ranges between 123 MWh/year at the rugged coast side and 370 MWh/year on the west-side of the island with higher altitudes. Although most of the wind energy is available on the west side of the island, this area is registered as a protected area. The most suitable location otherwise would be on the heights of the penal colony on the eastern side of the island. Here the annual production is around 260MWh. However, considering the topography on site, this solution needs to be investigated further in terms of its feasibility regarding access (roads/ elevations …).

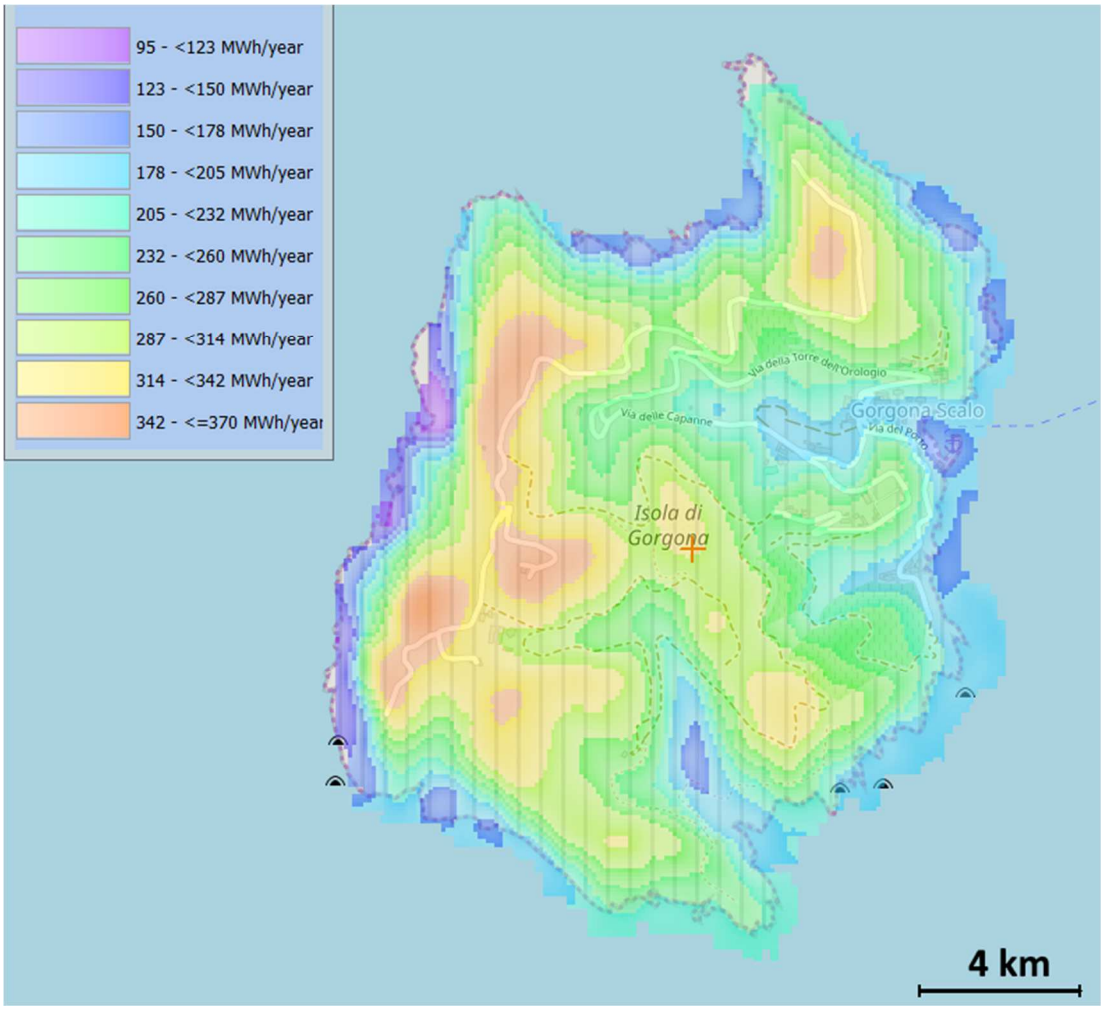

Figure 6: Annual wind production with XANT M-24 95kW @37.2m above ground level [MWh/y]

Solar potential

The potential solar power production of an area depends on the solar irradiation incident in that specific location. Solar irradiation is the incident energy per unit area over a given period of time. The study uses the global horizontal irradiation, which is the total amount of direct and diffuse solar radiation incident falling on a horizontal surface, as a measure for solar potential. It is expressed in kWh/m^2. The assessment is made using satellite data from 3E's data services[2].

[2] https://solardata.3e.eu/

The results are organized in a map showing the repartition of the horizontal solar irradiation over the island.

The results show that the average global horizontal solar irradiation on the island is rather homogenous with an average of 1,500 kWh/m². There is a slightly higher solar potential in the south of the island. According tot the information shared by the University of Livorno and the aerial imager from Google Earth (10/2019), a 35kW peak power solar farm has existed for at least 15 years on the north east coast of the island in the vicinity of Gorgona Scalo. It will soon be decommissioned and replaced with a new 70 kW system as well as a storage system.

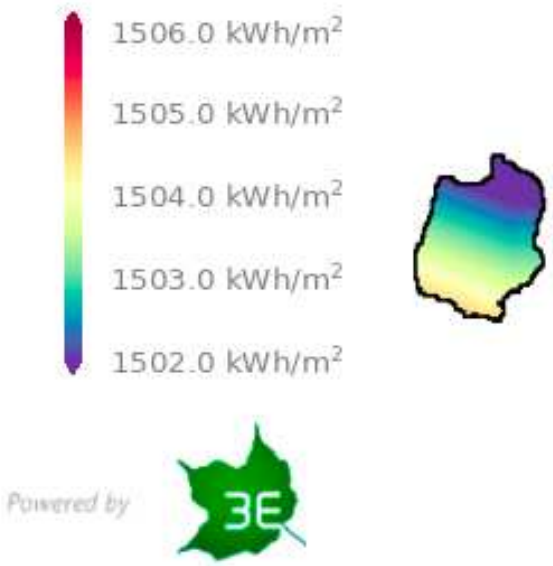

Figure 7 Horizontal Solar Irradiation distribution on Gorgona island

A preliminary assessment of the photovoltaic electricity production for the planned 70kW installation at the location of the existing solar farm has been done using SOLARGIS software.

Table 1: Coordinates of the solar farm under study

Coordinates	WGS84 DDMMSS
Longitude	43°26'00''
Latitude	09°54'24''
Elevation	77 m
Terrain azimuth	107°
Terrain slope	18°

The calculations have been done for a ground-based fix-mounted system on levelled ground. Azimuth and tilt of PV modules are homogeneous, usually facing towards the Equator and inclined at the optimum tilt to maximize yearly energy yield. The modules are fix-mounted on tilted structures aligned in rows. During low-sun angles, they may be partially shaded by preceding rows. The modules are well ventilated. This type of PV system is connected to the electricity grid through an inverter and distribution transformer, and an additional transformer may also be used. No electricity storage is considered.

The considered hypotheses are as follow:

System size	Installed capacity 70kWp
PV module type	c-SI – crystalline silicon (mono or polycristalline)
Geometry of PV module	Azimuth 180° - Tilt 33°
Relative row spacing	2.5
Inverter type	Centralized high efficiency inverter [97.8% euro efficiency]
Transformer type	High efficiency transformer [0.9% loss]
Snow and soling losses at PV modules	Monthly soiling losses up to 3.5% - monthly snow losses up to 0.0%
Cabling losses	DC cabling 2% - DC mismatch 0.3% - AC cabling 0.5%
System availability	99.5%

The theoretical estimate of solar electricity production by a photovoltaic system without considering the long-term ageing and performance degradation of PV modules and other system components is presented in the table below.

Month	GTI	PVOUT_total	PVOUT_specific	PR
	Monthly sum	Monthly sum	Monthly sum	
	kWh/m²	kWh	kWh/kWp	%
Jan	81	4,885	70	85.8
Feb	99	6,011	86	87.0
Mar	152	9,051	129	85.1
Apr	167	9,766	140	83.5
May	195	11,195	160	81.9
Jun	203	11,441	163	80.5
Jul	220	12,245	175	79.6
Aug	206	11,502	164	79.9
Sep	166	9,498	136	81.9
Oct	123	7,274	104	84.4
Nov	80	4,803	69	86.0
Dec	72	4,246	61	84.5
Yearly	1,763	101,917	1,456	82.6

5. Conclusion

In this report, the wind and solar potential of Gorgona island has been investigated.

The entire island of Gorgona, except the north-eastern part of the island in the vicinity of the penal colony, is considered as an environmentally protected area.

Although the highest wind potential of this area would be about 260MWh/year with a mid-size wind turbine of 95kW at 37.2m, the typical topography of the site makes it complicated to see a possible wind turbine installation in terms of access routes and complexity of the site.

An estimation of solar power from a 70kWp solar farm at the same location of the existing 35kWp solar farm has been assessed in this study showing an acceptable performance ratio value of 82.6% and a yearly yield of about 102 MWh/y.

References

[1] Wikipedia. Consulted on 01/10/2020. https://en.wikipedia.org/wiki/Gorgona_(Italy)
[2] Global wind Atlas. Consulted on 01/10/2020, https://globalwindatlas.info/
[3] Xant. Consulted on 05/10/2020. http://xant.com/

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