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INSIDE THIS ISSUE

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Brades, Montserrat, MSR1110

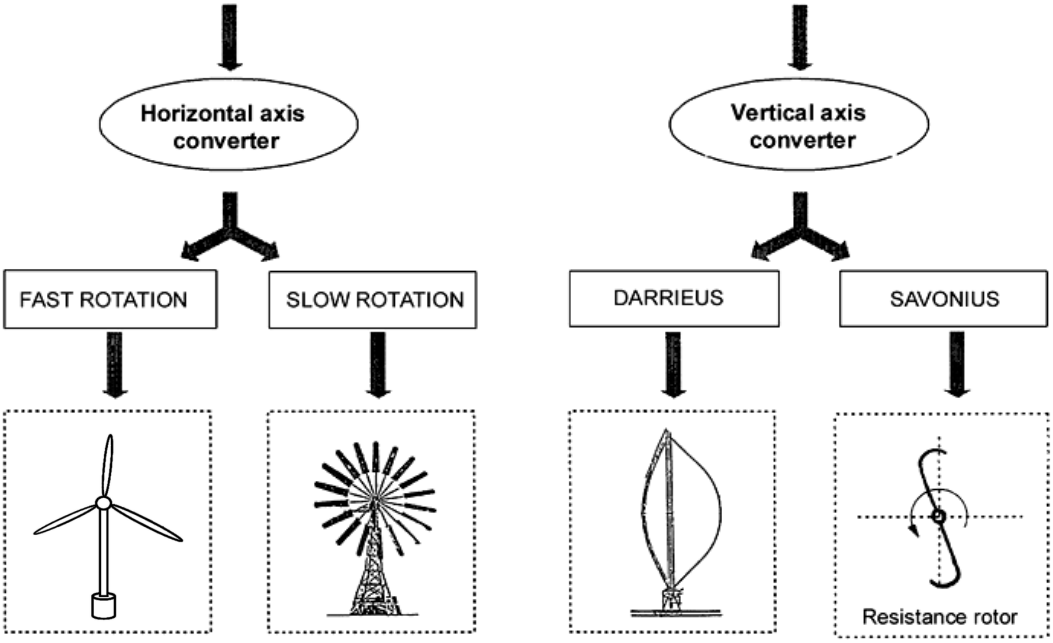
WIND TECHNOLOGY

Background

The use of wind power is one of the fastest growing Renewable Energy (RE) technologies as its capital costs decrease. Wind turbines can be installed either onshore or offshore, with global installer capacity increasing from 7.5GW in 1997 to around 564GW in 2018 [1]. Wind turbines for electricity production first emerged in the 1880s , with the first horizontal-axis wind turbine being developed in Denmark in 1891 [1].

Types of Wind Turbines

There are two types of wind turbines; horizontal-axis (HAWT) and vertical-axis (VAWT), which utilize either lift or drag forces. HAWT commonly have three blades mounted on a tower tens of feet tall. Most have a gearbox that increases slow rotations into more suitable rotations to drive the generator. VAWT have blades that are oriented and attached to the top and bottom of a vertical rotor, with the Darrieus wind turbine being the more common one [2]. VAWT have been found to be less productive than their HAWT counterparts.



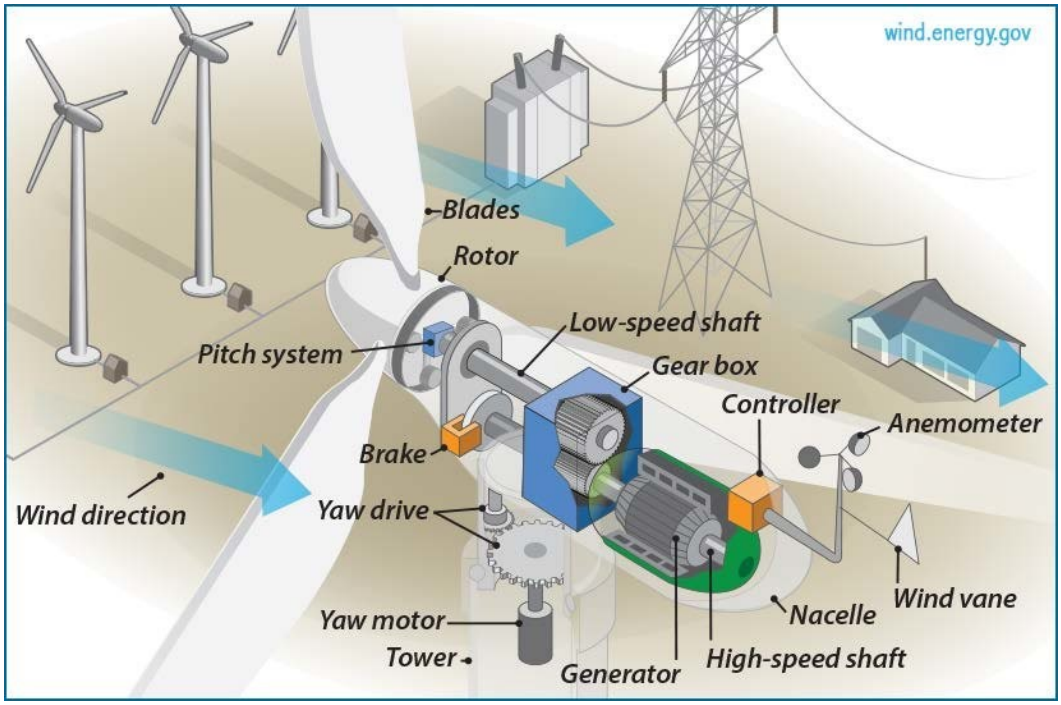
Basic Components

The design of wind turbines is continuously being improved on to achieve a greater efficiency. These improvements include changing the materials used in the construction of various parts to reduce the weight and increase the strength.

The turbine consists of three main components; the tower, the nacelle and the rotor.

- The Tower is either a steel tube or steel lattice with a ladder to access the nacelle, which is seated at the top[3]. The tower must be able to absorb heavy loads that occur due to the wind's varying strength [3].
- The Nacelle is a hollow, fiberglass shell that contains the mechanisms of the turbine. It houses the gearbox and main drive shaft and is connected by bearings to the tower [3].

- The Rotor and Blades are typically made of fiberglass, with recent improvements to reinforced carbon-fibre plastic [3]. Including carbon-fibre increases the resilience but also the price of production.



How Turbines Work

The kinetic energy created by the motion of air is used to produce electricity. The wind hits the turbines' blades, causing them to rotate. The blades are connected to a shaft that is in turn connected to the gearbox. The gearbox converts the rotor movements of 18-50rpm to about 1,500rpm, which is required by the generator [3].

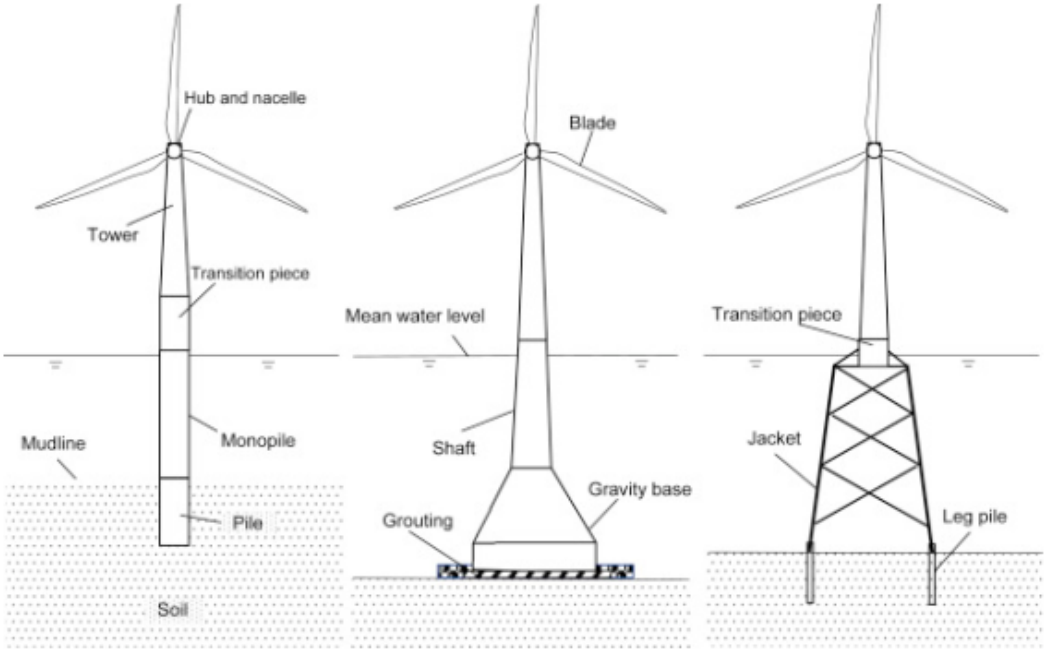
Wind Turbine Installation

Wind turbines can either be installed onshore of offshore. Onshore turbines tend to be mounted on a concrete platform, with additional land needed for access roads, substations and other infrastructure. Foundation types can be separated into three categories; shallow, deep and intermediate.

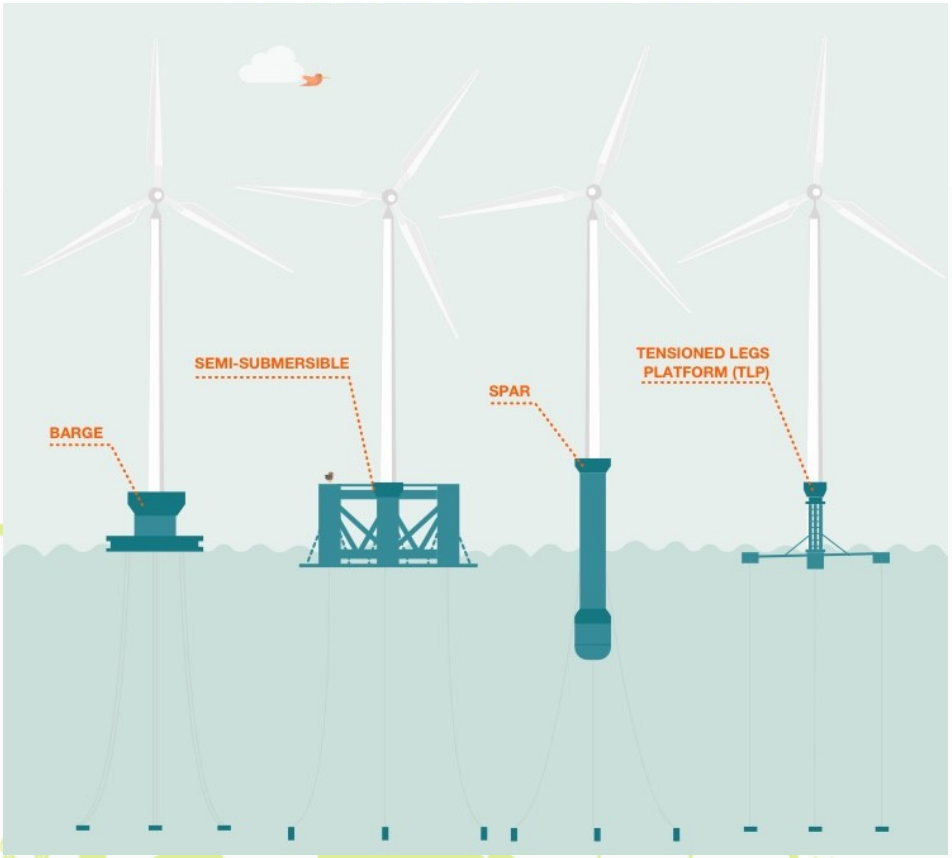
Shallow	Deep	Intermediate
Spread footings: circular, square, rectangular or	Driven piles	Rammed aggregate piers
Mats/ rafts	Drilled shafts/caissons	Stone columns
	Augercast piles	Impact piers

Table 1—Types of Onshore Wind Turbine Platforms [4]

Wind power is better offshore than onshore and this has led to an increase in a development of these types of wind plants. Offshore turbines can now be installed on platforms that are either anchored to the seafloor or floating. Anchored or Bottom-fixed turbines are attached to the seafloor and are best suited for water depths of 20-40m [5]. They are made of concrete and are substantially heavy to resist turning over. Floating turbines rely on anchoring and mooring systems to balance the different types of platforms. These include barge, spar, semi-submersible and tensioned legs platform [6].



Onshore Wind Turbine Platforms [5]



Offshore Wind Turbine Platforms [6]

[1] https://www.irena.org/wind

[2] https://www.eia.gov/energyexplained/wind/types-of-wind-turbines.php

[3] https://www.tacticalprojectmanager.com/wind-turbine-construction

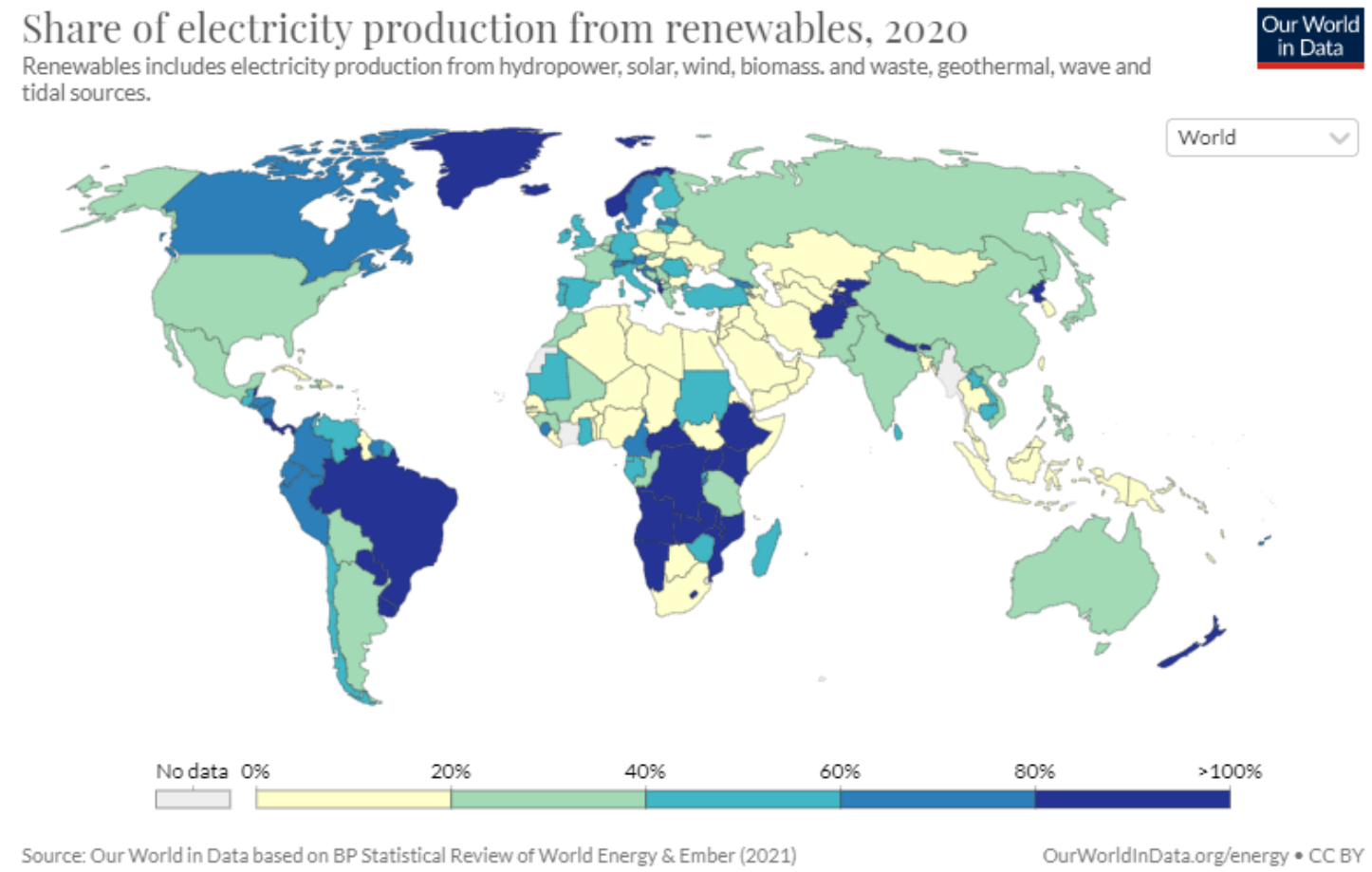
[4] http://home.eng.iastate.edu/~jdm/engr340-2011/ENGR%20340%20-%20Foundations%201%20-%20Ashlock%20-%20Schaefer.pdf

[5] https://www.sciencedirect.com/science/article/pii/S1364032120308601

[6] https://www.iberdrola.com/innovation/floating-offshore-wind#:~:text=Wind%20turbines%20can%20now%20be%20installed%20on%20these,is%20to%20achieve%20a%20green%20and%20sustainable%20planet.

GLOBAL CONTRIBUTION TO WIND ENERGY

Different forms of renewable energies (RE) are being used in the global energy mix, including electricity generation, transportation and heating. RE tend to represent a larger portion in electricity generation than the other two sections. In 2020, one quarter of global electricity was produced by RE technology [4].

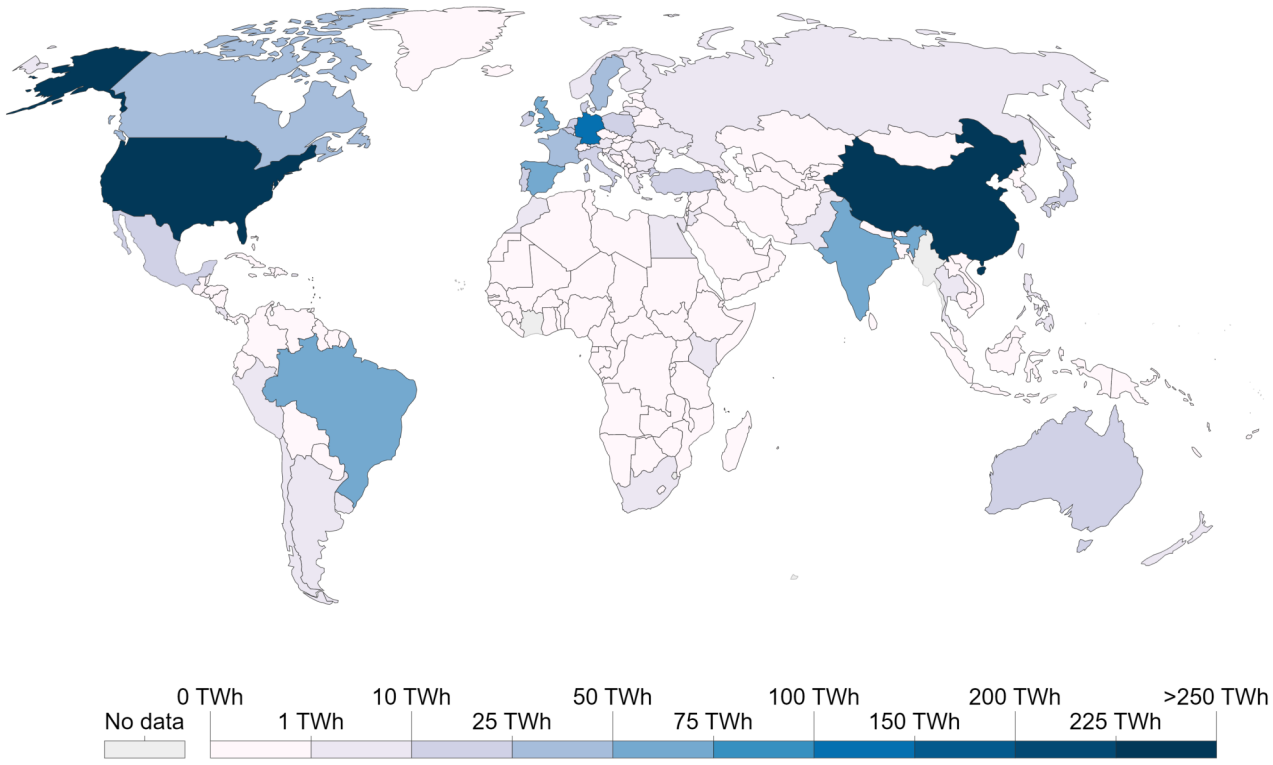


This map shows the amount of energy generated from wind in 2020, and included both onshore and off-shore wind farms. Although countries such as Germany, the US and China are producing above 100TWh, this only represents 24%, 8% and 6% of the electricity that come from wind [8].

Wind power was estimated to increase by 17%, hopefully reaching 275TWHh in 2020-2021 [7]. In 2015, there was a worldwide total of 828TWh of generated wind energy, with the US and China producing 191TWh and 186TWh respectively. In 2020, the total was 1,590TWh, and the US and China have increased their production to337TWh and 467TWh [8]. This increase is due to both countries having policy deadlines, which pushed developers to complete many installations. Over 2021, China is expected to produce 600TWh of wind energy and the US 400TWh[7].

Wind power generation

Annual electricity generation from wind is measured in terawatt-hours (TWh) per year. This includes both onshore and offshore wind sources.



Source: Our World in Data based on BP Statistical Review of World Energy & Ember (2021) OurWorldInData.org/renewable-energy • CC BY

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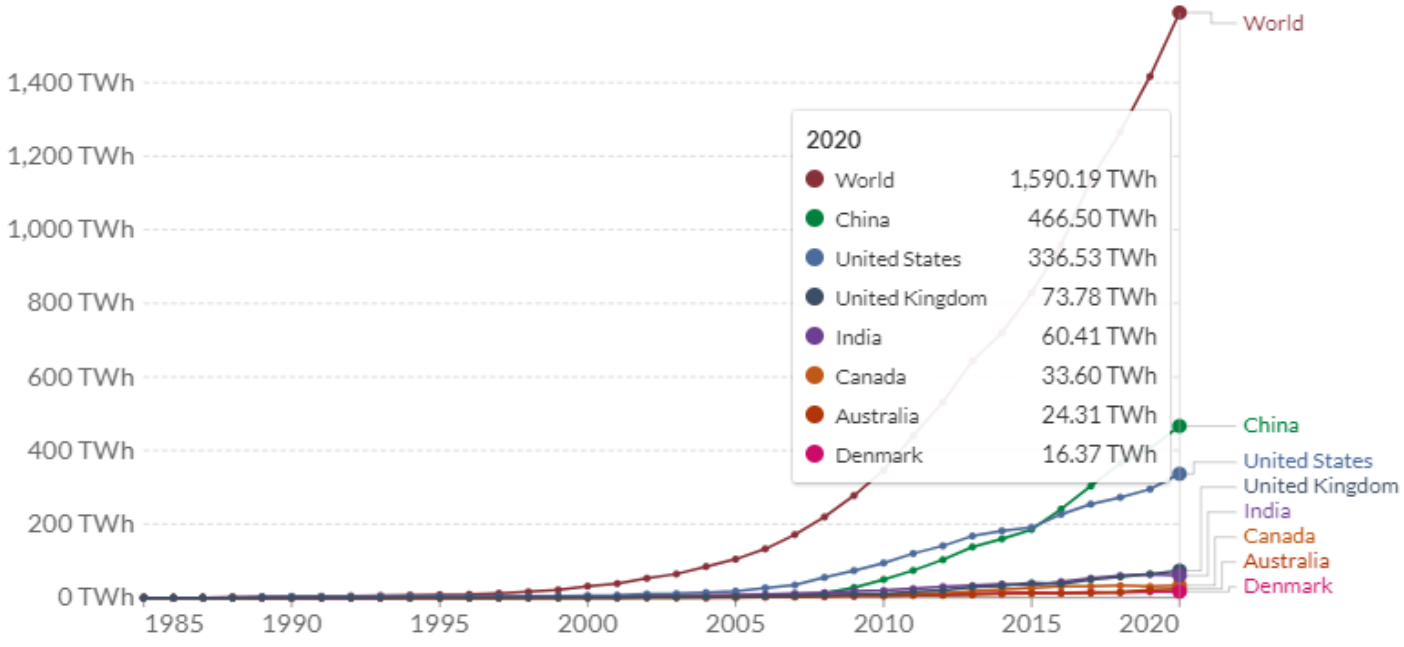


Source: Our World in Data based on BP Statistical Review of World Energy & Ember (2021) OurWorldInData.org/renewable-energy • CC BY

[7] https://www.iea.org/reports/global-energy-review-2021/renewables

[8] https://ourworldindata.org/renewable-energy#wind-energy

ONSHORE VS OFFSHORE

Although onshore and offshore wind power generation share many principles, there are also many differences between certain aspects. The most obvious difference between onshore vs offshore wind is the place where turbines are to be installed. As onshore farms are installed on land, costs are much lower than offshore counterparts, which require more robust interconnections and other factors. Below are some pros and cons associated with each form of wind power generation:

Onshore

Pros	Cons
Cheaper to implement as less materials for infrastructure and installation are required and have a	Tends to require moderate to large expanses of land
Connection to the grid is easy	Require more careful wind current and speed
More companies specialize in the installation of onshore wind farms	May result in discontent due to visual and noise pollution if located near to residential arears
Potential for a relatively low maintenance cost	

Offshore

Pros	Cons
No issue pertaining to land availability as the turbines are mounted at least 200 nautical miles from the shore	Installation cost can be 20% higher due to additional infrastructure needed for anchoring and transmission of energy.
There is a higher potential for power generation due to faster and constant winds	Possible environmental impacts due to underwater noise transmission and impeding the paths of migratory bird
No visual or noise pollution	Maintenance is more expensive due to additional effects from the sea and access being restricted to helicopter access
Due to no space restrictions, these wind farms can be larger	

HISTORY OF WIND POWER IN MONTSERRAT

Montserrat is located in the Trade Winds Belt and has areas that receive 12-15mph winds throughout the year [9]. Pre-volcanic eruption, Montserrat had two wind turbines totaling 215kW[5] at St. George's Hill. Although a small amount in the grand scheme of things, this was one of the first steps taken to utilize RE for electricity generation on island. Unfortunately, the turbines are located extremely near to the volcano and suffered major damage during the eruptions. They are currently inoperable.

Wind power is still a viable RE option for Montserrat. Although a land-intensive energy source, improvements to the technology has resulted in a single turbine being rated to produce many MW of energy. There is also the potential of offshore turbine installation which eliminates some obstacles that would be encountered on land. To determine the feasibility of wind energy on Montserrat, wind speed measurements would need to be conducted at potential sites.

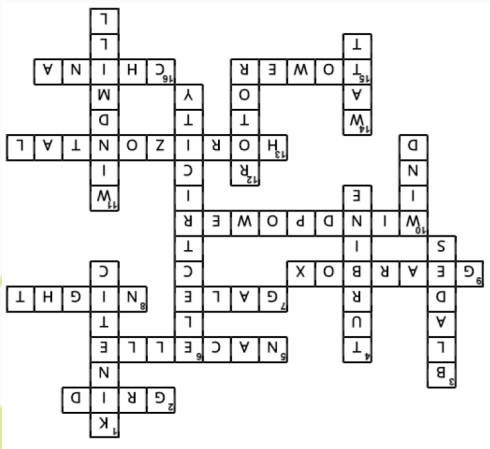
[9] https://www.nrel.gov/docs/fy15osti/64126.pdf

IMPORTANCE OF WIND MEASUREMENTS

Wind measurements are an important input for any wind energy application—determining the wind climate and establishing the power curve of the wind turbine being the most obvious tasks. The accuracy of these measurements is crucial because the energy density and wind turbine power output are proportional to the cube of the mean wind speed. Further, the instruments used must be robust and reliably accumulate data over extended periods of unattended operation. Most wind measurements are performed using simple mechanical devices, like the traditional cup anemometer. At least two anemometers arranged at different heights are used to measure this parameter.

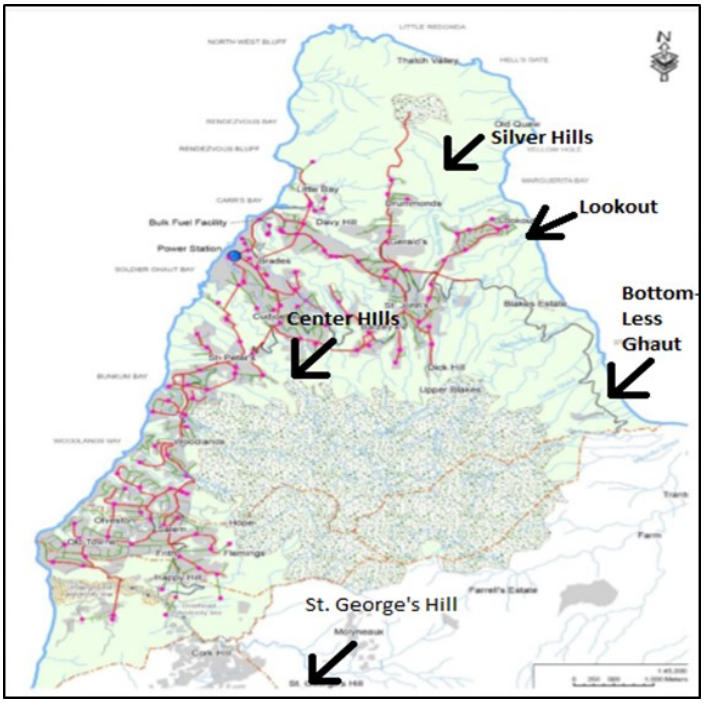
The behavior of these is fairly well understood and the sources of error well known—but sometimes neglected. Wind measurement data would be collected and averaged over 10-minute intervals by a data logger, and then transmitted through the GSM / GPRS communication for further analysis. For the design of a wind power station it is necessary to carry out continuous measurements for at least 12 months without interruption.

Wind measurements are an essential tool for determining the profitability of a wind farm project. The first major step towards the successful implementation of a wind energy project is an accurate assessment of the wind at the potential wind farm construction site, which is best conducted by a professional. Once collected and analyzed, it will provide an idea of the potential of the project for third-party investors or loan providers. Wind direction is also a needed measurement and is assessed by weather vanes. In addition to speed and wind direction data, terrain and surface roughness are investigated, as well as temperature, pressure and humidity to determine the density of the air flow.



SUMMARY OF DESKTOP WIND STUDY

The Montserrat Sustainable Energy Plan – Initial Programme of Action 2016 – 2020 addresses growing concerns regarding the dependence of the country on imported fossil fuels for its energy needs. The transition can be achieved by maximizing the use of indigenous resources and integrating them into the island's energy mix to improve energy security and achieve lower energy costs. Currently, less than 4% of the electricity produced on the island is generated from an indigenous source of energy.



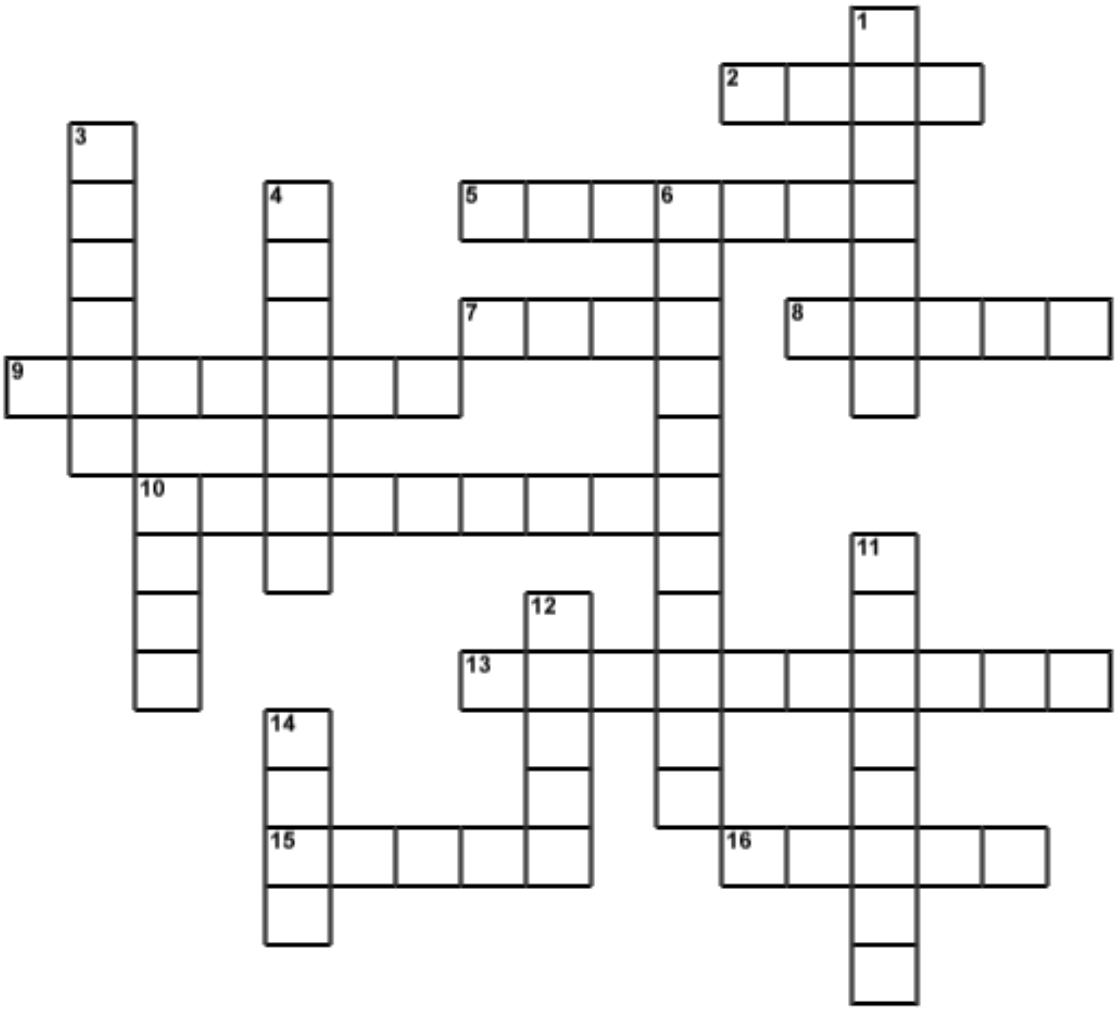
To aid with the diversification of the island's energy mix, the Energy Unit conducted a desktop wind study that used the Renewable Energy Space Analytics Tool (RE-SAT) to simulate the installation of four wind turbines rated at 1000 kW each to the existing energy infrastructure. RE-SAT is a project funded by the UK-Space Agency and led by the Institute for Environment Analytics, in collaboration with the United Nations Development Programme and the Government of 6 Small Island Developing States (SIDS).

Using RE-SAT and the weather data that the RE-SAT team gathered from the MVO and the John A. Osborne Airport, five locations with a high potential for a wind farm development were chosen. These areas were located in Silver Hills, Center Hills via Barzeys, Lookout, Bottomless Ghaut and St. George's Hill.

To choose a location that would be the most viable, various factors were investigated. The factors are as follows:

- Accessibility- Ease of getting to the proposed location, ease of transporting necessary equipment to the location (such as turbine blades and other parts).
- Costs- Cost of creating access roads to sites, costs of getting electricity from the site to a main junction point.
- Land Acquisition- One or more of the proposed locations are not Crown Land and therefore would need to be acquired.
- Production- Based on the wind energy production simulations that were conducted, four locations showed good power production while one location (Bottomless Ghaut) produced less than the other locations.
- Relative Risk- Some areas are high risk, such as the St. George's Hill and Bottomless Ghaut Areas due to their proximity to the volcano.
- Levelized Cost of Energy- which is a measure of the average net present cost of electricity generation for a generating plant over its lifetime.

The locations were then ranked and given a score based on the factors seen above with the outcome of this ranking suggests that Center Hills is the most viable location for development. Further investigation and data collection will be needed to verify if this is the best and only location for the installation of a wind farm.



Across:

2. An electricity transmission and distribution system.
5. Hollow shell that contain the mechanisms of the turbine.
7. Strong wind
8. Wind power can be used day or _____.
9. Used to increase rotational speed of the rotor shaft.
10. Type of Renewable Energy
13. A _____ axis turbine is the most common.
15. The base structure that supports the wind turbine rotor and nacelle.
16. This country is one of five top wind power producers.

Down:

1. Wind energy is what kind of energy?
3. What turns to make energy?
4. Wind _____ creates energy
6. Wind turbines create _____
10. Air in motion.
11. A mill operated by the power of the wind
12. The blades turn the _____.
14. A measure of unit for power.