## Wind Energy and Opportunities in Virginia

***What is wind power?***

Wind power is considered a renewable energy source, as it creates electricity using the naturally occurring air flows in the earth's atmosphere. Wind turbines capture this air flow and turn it into energy. There are three major types of wind power: utility-scale, distributed, and offshore.

Utility-scale wind generally refers to wind turbines that are larger than 100 kilowatts delivered to the power grid by electric utilities to end users.[i] Utility-scale wind energy supplies approximately 8% of electricity generation in the United States.[ii] Offshore wind is also generally large in size but is built in large bodies of water. Offshore wind projects are often built on the continental shelf.

*An example of a small 400-watt turbine on a home.*

A misconception of wind power is that it must take the form of a large turbine or a spacious wind farm. However, distributed wind also exists. Distributed wind projects are defined as being 100 kilowatts or smaller but can even be as small as 400 watts.[iii] These smaller installations are typically built on residential, agricultural, commercial, industrial, and community sites. One study suggests that distributed wind systems are "technically feasible for approximately 49.5 million residential, commercial, or industrial sites, or about 44% of all U.S. buildings."[iv]

*"HAWT"*

Not only can wind turbines vary significantly in size, but also by type. The first type of turbine available for wind energy is a horizontal axis (HAWT), which is the most common type used. The blades, shaft, and generator sit on top of a tall tower and face the out towards the wind. The blades turn the shaft, but if the wind becomes too strong, the shaft is able to slow the speed down. One of the advantages of a horizontal axis is its ability to warp to the wind, which allows the turbine blades to achieve the best angle. Another advantage is the height of the tower because it allows the

turbine to reach the strongest sites for wind power. The height of the tower also allows the turbines to have a large variety of placements, such as offshore, on uneven lands, and in forested areas. Finally, these types of turbines are self-starting. One of the disadvantages of these turbines is that they are difficult to transport and install. The horizontal axis turbines can cause major problems for maintenance. Finally, there is much local opposition to these types of turbines due to aesthetics.

*"VAWT"*

The second type of turbine available is a vertical axis (VAWT), where all of the important components are close to the ground. Within vertical axis turbines, there are two different types: lift based and drag based. The photo (right) is the lift based vertical axis turbines, which are also the more efficient type. These types of turbines are easy to maintain and have lower construction and transportation costs than the horizontal axis turbines. Vertical axis turbines are most effective when placed at hilltops, ridgelines, and passes. Unfortunately, these turbines are not very efficient because the blades spin into the wind, which causes drag.

A third type of turbine is the ducted wind turbines, also known as Honeywell wind turbines, which can sit at the edge of a roof and utilizes the wind at the building's side. Wind will flow up the side of building and will be fed right into the turbine. Fortunately, the devices are generally very small. The blades are generally around 600 mm, which allows for little change in building aesthetics. These types of turbines also generally use up unused space on rooftops. One of the major advantages to these types of turbines is that they allow for on-site generation and there is no need for transmission lines. One of the disadvantages is that ducted wind turbines are only suitable for urban environments with high-rise buildings and not for homes. Another major disadvantage is that they are unidirectional, which means the wind needs to blow in the correct direction for the blades to turn.[v]

*Ducted Wind Turbine*

***Benefits of wind power***

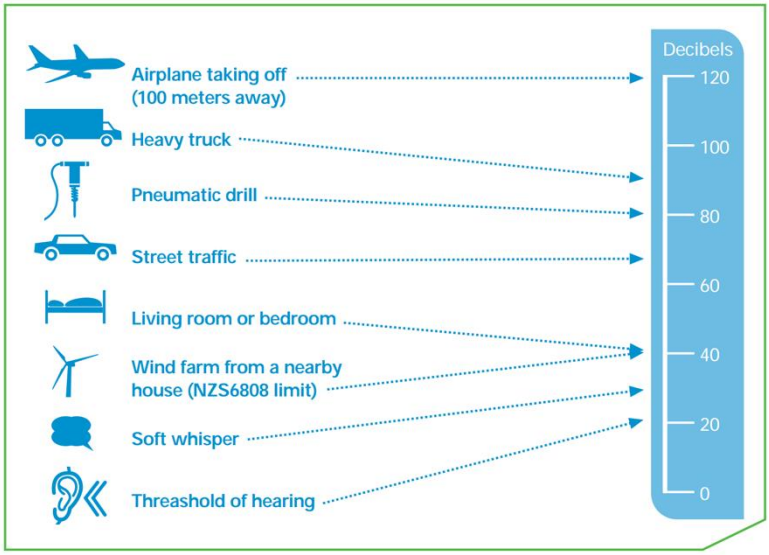
Wind energy is considered a clean and renewable form of energy. It is also a burgeoning industry that offers numerous economic benefits. The most noteworthy benefits of wind power are as follows:

1. In 2016, the wind industry supported over 100,000 American jobs – and this is in spite of how severely underdeveloped this industry is.

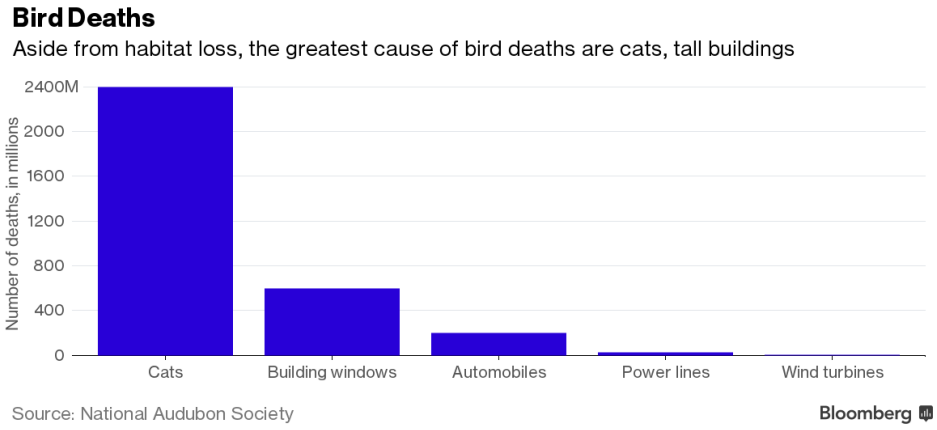
2. Wind installments require investment into the project and into the surrounding community. The last decade has seen about $14 billion of investment. These projects are often located in rural areas, which can benefit greatly from the improved infrastructure and source of employment.
3. Farmers and ranchers can invest in wind farms to help offset costs at times when growing conditions are poor.
4. Adding wind energy to a utility's energy mix can help keep rates low for consumers.
5. Wind is in abundant supply and is a renewable energy. [vi]

***Potential concerns with wind power***

Despite its numerous benefits, there remains a significant amount skepticism surrounding a robust wind industry. A common concern regarding wind energy is the noise that is produced by the wind turbines. The noise produced from turbines is the result of the wind passing over the rotating blade, which is generally heard as a swishing or whooshing noise.[vii] Wind turbines are often placed at least 300 meters away from residences, which helps to mitigate the noise emitted. Newer turbines have been able to cut back significantly on noise. At this distance, turbines generally have a sound pressure level if 43 decibels. If it is pushed back to 500 meters, the sound pressure level drops to 38 decibels. To put this in perspective, most air conditioners reach 50 decibels and most refrigerators reach 40 decibels. In many places, the ambient background noise ranges from 40 to 45 decibels, in which the noise of a turbine would be lost. As the technology of wind turbines improves, the amount of noise generated will only continue to lessen.[viii]




*New Zealand Standard 6808:2010 Acoustics – Wind Farm Noise (NZS 6808)*



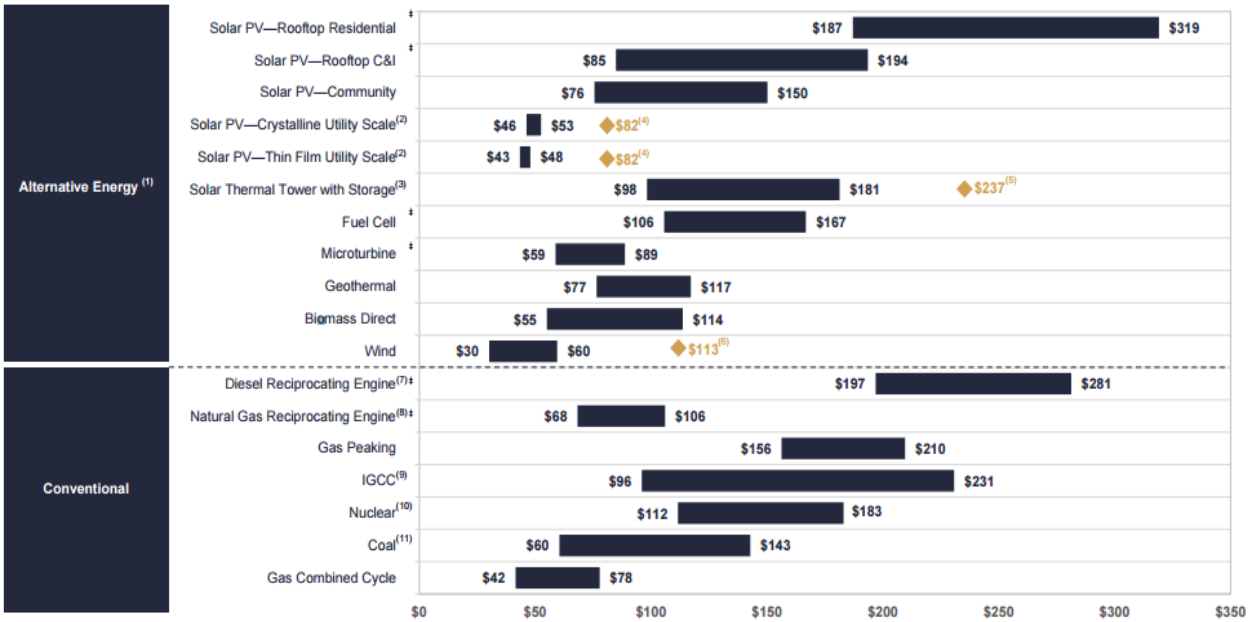

Another concern with an increased prevalence of wind energy is the impact on the bird population. This, however, is a major

misconception. The blades on the wind turbines do, unfortunately, kill some birds, but the total number of deaths is very low comparatively. The National Audubon Society compiled a list of most common causes of bird deaths (above) and the results suggest that feral and domestic cats kill far more birds than any other culprit, including wind turbines.[ix] Many efforts are currently underway to reduce this number even further by ensuring the turbine blades are visible to birds.

Some also take issue with the aesthetics of wind turbines, especially in rural and residential areas. Often individual views on the aesthetics of wind turbines will correlate with individual opinions on renewable energy. People often have a negative reaction to machinery in a rural landscape, especially when it is near one's residence. However, it is important to impress upon people that the alternatives are large, dirty coal and natural gas plants that take up more space and are much less appealing visually.[x]

***Cost of wind power***

The price of wind has declined by 66 percent over the course of the last seven years, generally due to the improvements in turbine technology. One report suggests that wind is now one of the most affordable options with respect to new electricity generation.[xi] Even at unsubsidized rates, wind is competitive with conventional generation. The range of the cost of wind power in the US is between $30/MWh and $60/MWh. The lowest costs are generally commonly found in the interior regions of the country.




*Source: Lazard's Levelized Cost of Energy Analysis - Version 11.0*

Because wind energy is derived simply from the movement of the wind, it has zero fuel costs. As a result, it is beneficial for utilities and corporate customers to sign long-term contracts in the form power purchase agreements (PPA), which allow for fixed energy costs for 20 to 30 years.

The three components included when calculating the cost of wind are the capital costs, the capacity factor, and the operating costs. As with most renewable energy projects, the capital costs are generally the most significant. In the case of wind, the turbine itself is the most expensive capital cost. It also includes the cost of construction and installation. However, because the turbine is the most significant portion of the cost, and the cost of turbines is decreasing, wind is becoming much more affordable and will only continue to do so in the future.

The capacity factor deals with the strength and quality of the wind resource at a project site. It determines how much electricity a wind project can produce, which will impact the cost of the project. As technology improves the amount of wind that can be captured and harnessed will also improve. The operating costs simply refer to the cost of delivering the electricity to the grid, and monitoring and maintenance. As these costs continue to decline and technologies improve, consumers will find that wind is quickly becoming one of the most affordable sources of energy.[xii]

***Reliability of wind power***

Grid operators have already been able to reliably integrate large amounts of wind energy into the electric system. It has reliably provided 35 percent of Iowa's electricity, over 30 percent of South Dakota's electricity, and more than 20 percent of Oklahoma's electricity. Wind energy only minimally changes the variability of the power system.

Changes in the amount of wind tend to be gradual and predictable. In comparison, a large power plant can go offline unexpectedly at any time, which requires that operators maintain expansive reserves to accommodate such a situation. For this reason, wind is more predictable, more reliable, and less costly than many traditional energy sources.[xiii]

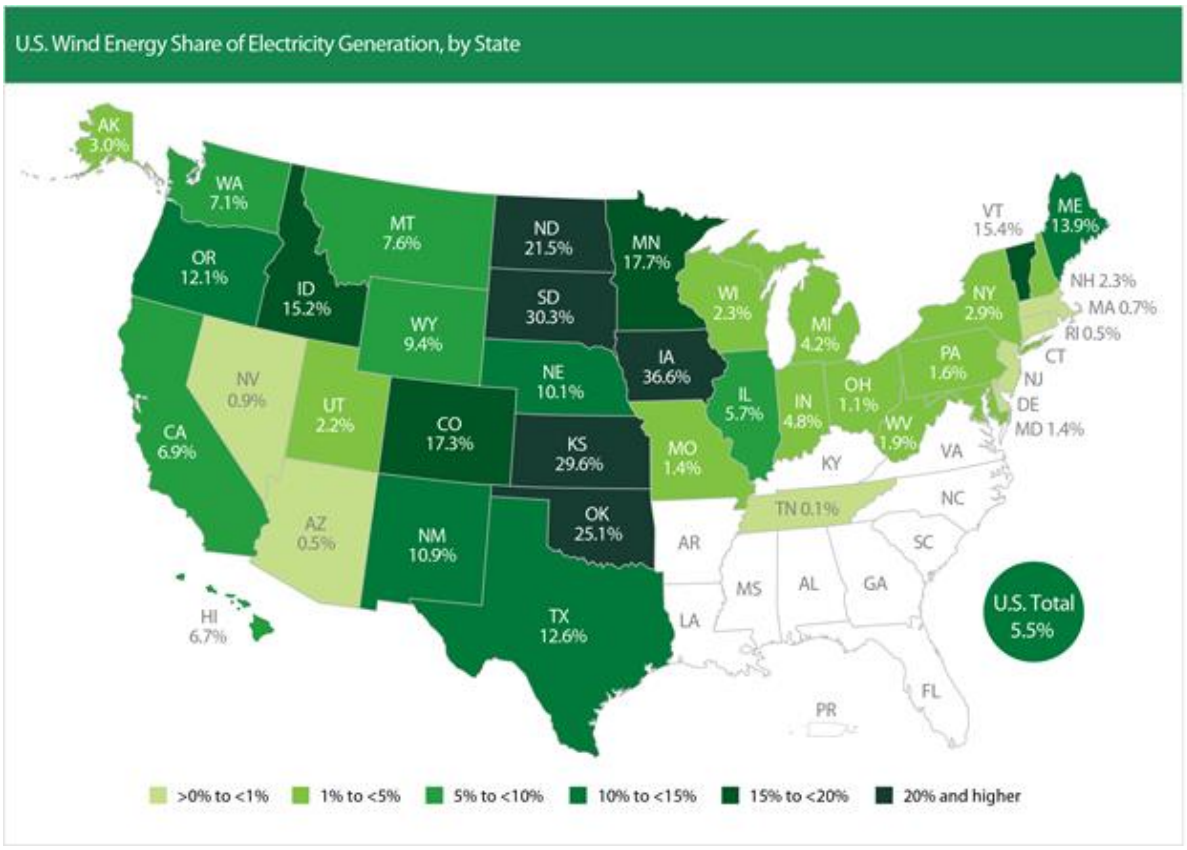
***Wind in Virginia and surrounding states***

Virginia is poised to be a leader in wind energy, however, it currently has no wind projects online. Virginia is one of a small number of states that remains completely unranked because of the negligible amount of wind energy production in the Commonwealth.

However, Virginia's neighboring states are faring far better in the progress for wind energy. Maryland currently has five wind projects, which are comprised of 79 turbines and are capable of powering 40,000 homes. West Virginia also has five wind projects and is able to power about 126,000 homes. Maryland and West Virginia have similar terrains and environmental concerns, and yet, have managed to make significant strides in wind energy.

Fortunately, there are a few projects currently in the works for Virginia. The Rocky Forge Wind Project is in the process of being built in Botetourt County and is anticipated to be 75 MW in size. This is enough to power an estimated 20,000 homes in Virginia. It is also projected to bring more than 150 new jobs to Botetourt County and significant local spending throughout the construction of the project. Wind projects in rural areas can be especially advantageous because these projects allow farmers to diversify by investing in a drought-resistant "crop."[xiv]

Additionally, Dominion Energy is in the process of building an offshore wind project in Virginia. There will be two 8 MW turbines 27 miles off the coast of Virginia Beach. This project, however, is not expected to start producing electricity until the year 2020.[xv] Projects such as these are demonstrative of two things. First, that wind projects take a time to get online. Virginia is already falling behind the rest of the country in terms of wind power production, and unless some there is some legislative change and investment in the near future, it will only continue to trail most other states. Second, there are communities in Virginia who are supportive of these projects, as they have the potential to bring with them significant economic benefits.




*Source: American Wind Energy Association*

***Conclusion***

Wind energy was once regarded are prohibitively expensive and not sufficiently efficient. This paradigm has since shifted, and wind has become an abundant resource that the Commonwealth can no longer afford to ignore. Wind is now inexpensive, reliable, and accessible. It is clear that Virginia has underutilized wind and other renewable resources and will continue to do so unless significant change is made.

[i] AWEA (2018). *Wind 101: the basics of wind energy*. [online] Available at: https://www.awea.org/wind-power-101 [Accessed 20 Jun. 2018].
[ii] WINDExchange (2018). *WINDExchange: Utility-Scale Wind Energy*. [online] Available at: https://windexchange.energy.gov/markets/utility-scale [Accessed 20 Jun. 2018].
[iii] AWEA (2018). *Wind 101: the basics of wind energy*. [online] Available at: https://www.awea.org/wind-power-101 [Accessed 20 Jun. 2018].
[iv] https://www.energy.gov/eere/wind/distributed-wind
[v] *Types of Wind Turbines and Associated Advantages - Thermal Systems*. [online] Available at: http://me1065.wikidot.com/types-of-wind-turbines-and-associated-advantages [Accessed 24 Jun. 2018].
[vi] AWEA (2018). *Wind 101: the basics of wind energy*. [online] Available at: https://www.awea.org/wind-power-101 [Accessed 20 Jun. 2018].
[vii] Windenergy.org.nz. (2018). [online] Available at: http://www.windenergy.org.nz/store/doc/Sound_and_Wind_Turbines.pdf [Accessed 20 Jun. 2018].
[viii] Kellner, T. (2018). *How Much Noise Does A Wind Turbine Make? - GE Reports*. [online] GE Reports. Available at: https://www.ge.com/reports/post/92442325225/how-loud-is-a-wind-turbine/ [Accessed 18 Jun. 2018].
[ix] AWEA (2018). *The Truth About Wind Power.* [online] Available at: http://www.aweablog.org/the-truth-about-wind-power/ [Accessed 18 Jun. 2018].
[x] Nexus Media. (2018). *The Aesthetics of Wind Energy – Nexus Media*. [online] Available at: https://nexusmedianews.com/the-aesthetics-of-wind-energy-7a610c1e5b0a [Accessed 20 Jun. 2018].
[xi] Lazard. Lazard's Levelized Cost of Energy Analysis – Version 11.0. [online] Available at https://www.lazard.com/media/450337/lazard-levelized-cost-of-energy-version-110.pdf [Accessed 24 Jun. 2018].
[xii] AWEA. *The Cost of Wind Energy in the U.S.* [online] Available at: https://www.awea.org/falling-wind-energy-costs [Accessed 19 Jun. 2018].
[xiii] AWEA (2018). *The Truth About Wind Power.* [online] Available at: http://www.aweablog.org/the-truth-about-wind-power/ [Accessed 18 Jun. 2018].
[xiv] Rocky Forge Wind. *Rocky Forge Wind Project Profile*. [online] Available at: http://www.rockyforgewind.com/frequently_asked_questions [Accessed 18 Jun. 2018].
[xv] *Dominion Energy. Five Things to Know: Dominion Energy's First Offshore Wind Project.* [online] Available at: https://www.dominionenergy.com/library/domcom/pdfs/electric-generation/renewable/wind/cvow-five-things.pdf?la=en [Accessed 20 Jun. 2018].