I pledge my honor I have abided by the Stevens Honor System

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Earth, Wind, and Solar

A recent analysis made by the United Nations claimed that we need to cut global greenhouse gas emissions in half by 2030 and entirely by 2040 to avoid the most catastrophic effects of climate change.[1] With this sense of urgency in mind, fossil fuel alternatives have become extremely popular, with two of the most popular forms of renewable energy being solar and wind energy, as they can be implemented nearly anywhere on Earth in place of a coal or oil power plants. Perhaps the greatest trait of both of these options is the fact that they do not produce any harmful emissions, and are very environmentally friendly. However, when the two are compared, it is questionable as to which is more practical. Solar energy as we know it today is powered by photovoltaic cells composed of three layers of uniquely doped semiconductors (typically silicon) that allow for electrons to flow when photons from sunlight break an electron off of a silicon atom, causing it to roam freely. This leaves an area of positive charge (also referred to as a "hole" in this case) where it was removed from. As a result, the free electron travels to the N-Type layer, where it is readily accepted, and contrarily, the positively charged hole travels to the P-Type layer. On the other hand, wind power is much more simplistic in its functionality. A set of blades, mounted around a rotor, catch the wind and convert it to rotational energy. This is used to spin a turbine that in turn, generates electricity. As of 2019, solar energy accounted for roughly 2% of Earth's entire energy demand, compared to wind power at about 5% in terms of total electricity generation. Solar and wind energy are actually quite similar, in that they are both classified as "variable renewable energy," meaning that their energy production is dependent on the often unpredictable conditions in their environment. Wind is not something that remains constant all the time, just like with sunlight, which can be stronger in some areas than others, and

at varying times. While this is definitely a weakness when compared to fossil fuel energy, science and engineering has allowed for significant improvements in the efficiency of both energy generation methods. Wind turbines are typically implemented in areas that have been analyzed and selected based on having the most wind on average, with offshore wind power being quite promising due to the strong tidal winds offered by our vast oceans. Similarly, solar arrays tend to be placed in areas that receive large amounts of sunlight, such as the Bhadla Solar Park in India, which is deemed as uninhabitable due to its harsh conditions resulting from the intense solar radiation. However, even in primarily windy and sunny environments, wind and sunlight tend to change their direction throughout the day, making stationary turbines and panels inefficient. To combat this, sensors are used to detect which direction the wind or sunlight is strongest, and reposition the blades or angle of the solar panels such that the maximum amount of energy is collected. Just as not everyday is windy, the sun is not always shining, and thus, energy storage methods have become of great importance when it comes to ensuring that the energy collected does not go to waste. Battery storage power stations, devised of a group of batteries, are a useful tool to combat this. Designed to store multiple hours worth of energy that can be almost instantaneously supplied in the event that immediate power is not being generated, these facilities can make the previously “variable” renewable energy alternatives much more consistent, which is necessary if they were to power the world at a much larger scale. In fact, the concept of using batteries to store excess renewable energy is becoming more of a reality as the world continues to shift towards clean energy. Tesla has been working with a lithium ion battery energy storage system that works in conjunction with their residential solar installations called the Tesla Powerwall, which can store up to 13.5 kWh of energy for later use.[2] Unfortunately, it is quite costly for such an amount of storage, ranging between $9,600 and $15,600 for a full system installation. It is worth mentioning that lithium ion batteries have been found to be quite expensive in general compared to their energy storage capacity, and many experts claim that if

we are to delve further into the field of energy storage, a better energy storage solution needs to be found. A study made by CNBC found that there are a plethora of companies working on a revolutionary solution to this issue, with new storage methods from chemical flow batteries to thermal and cryogenic systems.[3] A list of some companies working with these alternatives is included below. All in all, perhaps with these potential breakthroughs, the shift to 100% renewable energy may be even closer than expected.

Some Notable Renewable Energy Storage Companies

~ Primus Power

~ Energy Vault

~ ESS Inc.

~ Form Energy

~ Antora Energy

~ Highview Power

Sources

[1] Solomon, Caren G., Author AffiliationsFrom Massachusetts General Hospital, A. Haines and K. Ebi, R.E. Sachs and M.A. Kyle, M.A. Pacult and S. Williams, K.M. Puterbaugh, N. Andrews and Others, S. Finfer and Others, and S. S. Vege and S. T. Chari. “Climate Change - A Health Emergency: Nejm.” New England Journal of Medicine, January 17, 2019. https://www.nejm.org/doi/full/10.1056/NEJMp1817067.

[2] “Powerwall Owner Faqs: Tesla Support New Zealand.” Tesla, 2022. https://www.tesla.com/en_NZ/support/energy/powerwall/own/powerwall-owner-faq.

[3] “The Future of Energy Storage Beyond Lithium Ion.” YouTube, March 13, 2020. https://youtu.be/EoTVtB-cSps.