Offshore Wind Energy

Offshore wind turbine energy generation has the potential to supply the U.S. and global community with enough renewable energy to balance consumption currently. Offshore wind has one of the highest potentials for energy generation technology. As the offshore wind industry grows the levelized costs of wind energy is decreasing for this technology making it competitive with other energy sources. Offshore wind can either have a floating turbine, or it can have a turbine installed into the sea floor. Offshore wind can generate more electricity than onshore wind because of the high wind speeds, and consistency of the wind. However, the oceans can be less predictable and geographic locations have different demands on the structure of the turbines. Offshore wind is important to analyze because of its capability to supply large amounts of energy with both costs and benefits. Throughout this paper I will discuss the advantages and disadvantages of offshore wind and advocate for its upscaling due to its significant potential in supplying renewable energy, while also considering the environmental impacts and equity concerns for affected groups.

Offshore wind will significantly impact the energy sector, by increasing its electricity generation share from less than 1% in 2018 to around 3-5% in 2040 shown in Figure 1. The U.S. has a potential for offshore wind capacity that is more than 4,000 gigawatts (GW) per year. Even though not all of this energy could be captured, it has the potential to supply large amounts of energy to densely populated cities in the coastal regions of the U.S. and increase renewable energy in the grid. Offshore wind in the U.S. is planned to increase to 30 GW of energy generation by 2030 and 15GW of floating offshore wind by 2030. The Biden Administration plans to scale up offshore wind by streamlining the permitting process, identifying areas where offshore wind has high potential, and investing in infrastructure. The U.S. is aiming for at least 39 GW of wind energy generation by 2040, avoiding 78 million metric tons of carbon emissions released through fossil fuel energy. Offshore wind can replace fossil fuel production, onshore wind, solar PV, and long-distance energy transmission to coastal areas. In coastal areas, offshore wind is more advantageous than onshore wind and solar PV because offshore wind has a higher capacity factor and can produce less variable energy. Offshore wind offers an energy solution to coastal communities demanding

long-distance power supply and supplies an alternative to non-renewable energy for island communities.

Offshore wind currently has a higher levelized cost of energy than most other energy sources, however the prices are continuing to decline. The LCOE for fixed-bottom offshore wind was $75/MWh in 2021 and is projected to decrease to $53/MWh in 2035. Figure 2 shows the large decreases in the LCOE for offshore wind from 2010-2021 and how renewable wind energy is becoming competitive with other energy sources. In order to become a more competitive energy source, offshore wind would need to scale up to become more reliable and therefore drive the levelized cost down even more. There are some challenges with scaling up this technology because of environmental and technical issues. Marine life can be harmed in the constructruction of offshore wind towers due to habitat distribution, displacement and collisions, and operational noise. Environmental concerns are a challenge that can slow offshore wind developments because projects need to do extensive environmental impact analysis before the project can get approved. In addition, there are technical challenges with connecting offshore turbines to the grid infrastructure. If the grid doesn't have sufficient infrastructure to connect offshore wind, this will limit the effectiveness of integration into the grid, and the transmission of the renewable energy. Offshore wind in the U.S. has created some energy justice issues with indigenous groups. In the Northeastern U.S. there is close proximity of offshore wind developments to indigenous lands without the consideration of those groups.

I recommend that offshore wind be upscaled because of its tremendous potential to supply renewable energy and offset fossil fuel use. Nevertheless, it is crucial to perform thorough environmental impacts assessments to minimize disruptions to marine habitats and biodiversity. In recent studies in the Horns Rev project in Denmark, it is shown that there may be potential benefits to marine biodiversity from offshore wind turbines by providing refuge and in this case was shown to increase the number of species in the project area. In addition, indigenous communities and other affected stakeholders should be involved in the planning process to ensure equitable and inclusive projects.

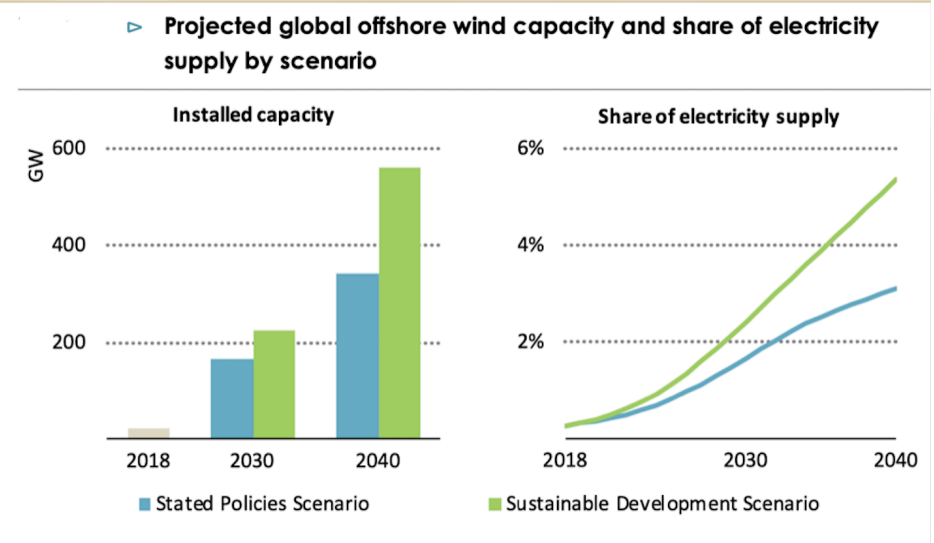

Figure 1: This figure shows the projected global offshore wind capacity and share of electricity supply by State Policies Scenario and Sustainable Development Scenario. This shows data from 2018 and projected data into 2040.

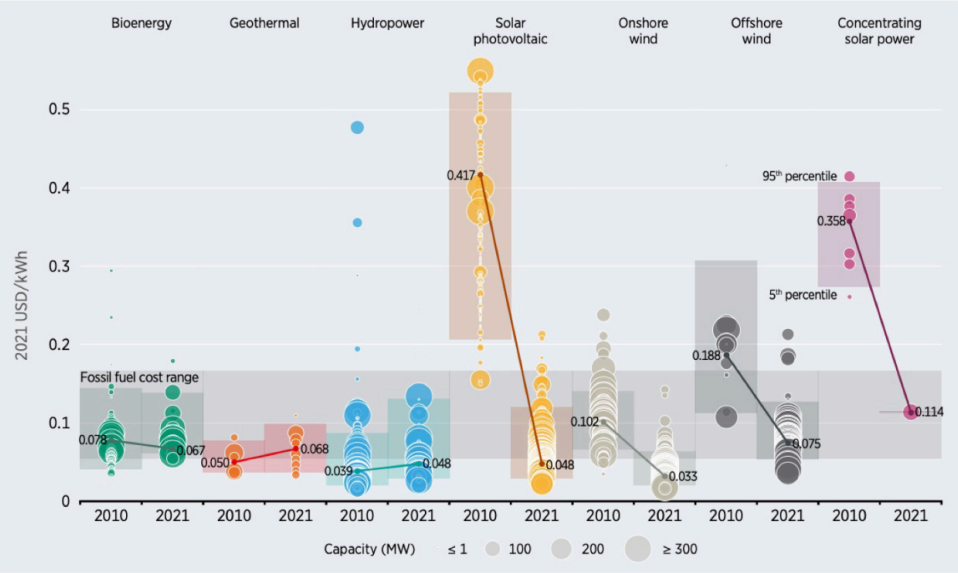

Figure 2: This figure shows the Levelized Cost of Energy for Offshore wind and comparable renewable and non-renewable energy sources. This figure also shows that in 2020 the average cost of renewable energy sources fell in the fossil fuel cost range. This demonstrates how offshore wind, and other renewables can be considered cost competitive with fossil fuel energy.

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