Energy Mix and Security Benefits of Airborne Wind Energy for Net Zero

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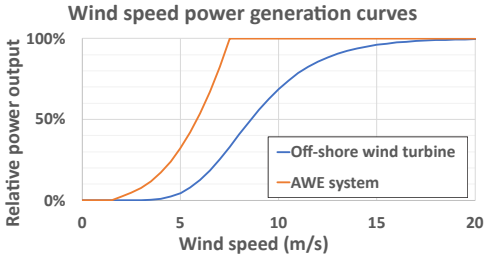
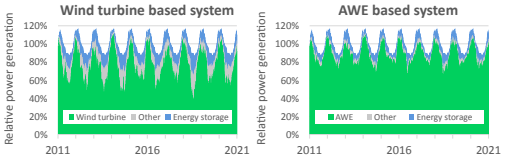
Achieving net zero requires large growth of renewable energy generation, with wind energy a key contributor in many economies. However, the output power from wind energy is subject to weather fluctuations and this is exacerbated by the low efficiencies of wind turbines at low wind speeds. An economy requires assured power generation, and therefore one that predominately uses wind energy will require substantial power generation 'over' capacity, therefore significantly increasing the total costs of its power generation system. We show that utility scale airborne wind energy (AWE) with its more sustained generation at lower wind speeds (and higher altitudes) substantially reduces generation fluctuations, and therefore substantially reduces the amount of 'over' capacity required whilst increasing energy security. We have created a demand and supply model for UK power generation using measured hourly wind data [1] for the period 2011 – 2020. The model assumes power demand is met from 3 sources; offshore wind power, other power and energy storage and assumes that wind will be used by preference if available. For both the wind turbine based system and the AWE based system, we optimised the mix of installed capacity of the 3 power sources to achieve assured supply over the 10-year period. We defined 'assured supply' as being where the energy storage remaining charge level never falls below 50% or 100 hours. For wind turbines we used the power generation curve for the Vestas V164-8.0 turbine and for AWE we used an in-house estimated efficiency curve (both shown below). The work shows that for equivalent net zero supply assurance the AWE based system requires significantly less total installed wind capacity and requires only half of the total capacity of other power and energy storage compared to the wind turbine based energy system.



Power curves for wind turbines and AWE used.



Comparison of the contribution to total power demand from wind, other and energy storage. Due to the more sustained power generation at lower wind speeds airborne wind energy requires much less contribution from other power generation sources.

References:

[1] Global Modeling and Assimilation Office (GMAO) (2015), Greenbelt, MD, USA, Goddard Earth Sciences Data and Information Services Center (GES DISC), Accessed: 7th January 2022