Edgar Uriel Solís Magallanes
ME Researcher
Metropolitan Polytechnic University of Hidalgo
Aerospace Engineering Master Program.

Blvd. Tolcayuca 1009
43860 Ex Hacienda San Javier
Tolcayuca, Hidalgo
México

203220042@upmh.edu.mx
www.upmetropolitana.edu.mx/oferta-educativa/MIA

Maestría en Ingeniería Aeroespacial
Programa del PNPC del CONACYT

Annual Wind Resource Assessment for an Airborne Wind Energy System

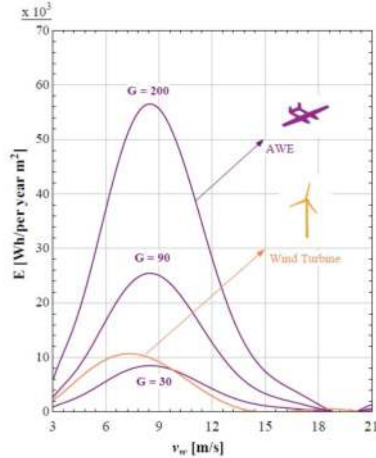
Edgar Uriel Solís-Magallanes[1], José Manuel Gallardo-Villarreal[2], Julio Valle-Hernández[1,2]
[1]Metropolitan Polytechnic University of Hidalgo
[2]Autonomous University of the State of Hidalgo

We present a methodology for assessing the wind resource available to AWE and comparing the profitability of the technology with conventional wind energy. The statistical analysis for a specific region of interest in Mexico considers the following:

- the vertical wind speed profile at 400 m above ground,
- the variation of air density with altitude,
- the influence of the flight path on the harvesting efficiency (we assume 90% to account for the misalignment of wind velocity and tether),
- the optimal reel-out speed of 1/3 of the wind velocity component along the tether,
- a pumping cycle with 80% production and 20% consumption time,
- the aerodynamic performance of the lifting device.

The diagram shows the hypothetical maximum annual energy production (AEP) per unit wing surface area for different values of the effective glide ratio. We conclude that an AWE system operated in pumping cycles can harvest more energy than a wind turbine, because it is a dynamic system that can access wind at higher altitudes. The methodology consists of the following steps:

i get hourly wind speed data from a meteorological platform or from experimental measurements,
ii cluster wind speed data in classes $v_{w,i}, \ldots v_{w,k}$ with absolute frequencies $n_i \ldots n_k$ for an average year,
iii get parameters and Weibull distribution velocities $P(V)$ and cumulated frequency $F(V)$,
iv get vertical wind speed and air density profiles,
v compute the max. specific AEP with Loyd's theory [1],
vi repeat process for a wind turbine at 150 m height.



Considering that the average wind speed is 2.78 m/s, we computed the maximum specific AEP of an AWE to be 0.362, 1.087, and 2.415 MWh for effective glide ratios of 30, 90, and 200. For a conventional wind turbine, we computed 0.493 MWh. Given the capacity factor of both technologies, this resource could be available at least 40% [2].

References:

*[1] Loyd, M. L.: Crosswind Kite Power. Journal of Energy **4**(3), 106-111 (1980)*

[2] Schmehl, R. (ed.) Airborne Wind Energy. Springer Singapore, 2018.