Algorithm for Power Calculation

# Wind Energy

For the power generated from wind energy, the following formula is used for calculation (Engineering ToolBox, 2009):

**P = () = ()**

where:

* P = power (W)
* = density of air (kg/)
* A = wind mill area perpendicular to the wind ()
* v = wind speed (m/s)
* = 3.14
* d = wind mill diameter (m)

Since **air density** is not directly given in the data, we calculate it using the algorithm based on air pressure, air temperature and relative humidity (Omnicalculator.com, 2019):

* Calculate the saturation vapour pressure at dew point T, using the formula .
* Find the actual vapour pressure, multiplying the saturation vapour pressure by the relative humidity:
* Subtract the vapor pressure from the total air pressure to find the pressure of dry air:
* Input the calculated values into the following formula:

Where:

* pd is the pressure of dry air in hPa
* pv is the water vapor pressure in hPa
* RH = relative humidity
* T is the air temperature in Kelvins
* Rd is the specific gas constant for dry air equal to 287.058J/(kg)
* Rv is the specific gas constant for water vapor equal to 461.495J/kg

# Solar Energy

For the power generation from solar energy including land polar panel and floating solar, the annual solar energy output of a photovoltaic system is (Photovoltaic-software.com, 2019):

**Energy = (A \* r \* H \* PR)**

where:

* E = Energy (kWh)
* A = Total solar panel Area ()
* r = solar panel yield or efficiency (%)
* H = Annual average solar radiation on tilted panels (shadings not included)
* PR = Performance ratio, coefficient for losses (range between 0.5 and 0.9, default value = 0.75)

# Pumped Hydro Energy Storage

Refer to the research result from RE100 Group ANU, PHES is calculates as **Energy = (head \* volume \* density \* g \* efficiency)** with 2 storage-length classes including 6hours and 18hours (Stocks, 2019).

Since all the data provided by RE100 Group ANU are well-organized and calculated accurately, we decide to use the data directly which are downloaded from the official website.

More information can be found at: <http://re100.eng.anu.edu.au/global/>.

# References:

Engineering ToolBox. (2009). *Wind Power*. [online] Available at: <https://www.engineeringtoolbox.com/wind-power-d_1214.html>

Omnicalculator.com. (2019). *Air Density Calculator - What is the Density of Air? - Omni*. [online] Available at: <https://www.omnicalculator.com/physics/air-density#how-to-calculate-the-air-density>

Photovoltaic-software.com. (2019). *How to calculate output energy of PV solar systems?*. [online] Available at: <https://photovoltaic-software.com/principle-ressources/how-calculate-solar-energy-power-pv-systems>

Stocks, M. (2019). [online] Available at: <http://re100.eng.anu.edu.au/global/>