Air Density and Wind Power Density at a Site

Air density from site pressure or elevation, temperature and humidity, and the wind power density at a given speed and for Rayleigh winds of that mean speed.

Method: Ideal-gas humid air density and wind power density

Input parameters

Unit system: SI

Parameter	Value	Unit
Pressure from	Site elevation (ISO 2533 standard atmosphere)	
Measured air pressure (absolute)	101.33	kPa
Site elevation above sea level	1,500.0	m
Air temperature	15.000	°C
Relative humidity (ignored below 0 °C)	60.000	%
Wind speed (or mean wind speed for the Rayleigh value)	7.0000	m/s

Calculated results

Parameter	Value	Unit
Pressure used	84.556	kPa
Air density	1.0176	kg/m³
Ratio to 1.225 kg/m³	0.83072	
Wind power density at U	174.52	W/m²
Mean power density for Rayleigh winds of mean U (6/π times)	333.31	W/m²

Notes for this case

- ρ for humid air as an ideal mixture (water vapour lowers the density slightly). Power density P/A = ½ρU³; Rayleigh winds (Weibull k = 2) carry 6/π = 1.91 times the power at the mean speed.
- Pressure from the ISO 2533 standard atmosphere at the elevation; actual pressure varies with weather by a few per cent.

Formula and method

$$\rho = \frac{(p - \phi p_s) M_{da} + \phi p_s M_w}{R_u T}, \quad \frac{P}{A} = \frac{1}{2}\rho U^3, \quad \frac{\bar{P}}{A}\Big|_{Rayleigh} = \frac{6}{\pi} \cdot \frac{1}{2}\rho \bar{U}^3$$

Variables

pressure	Pressure from	-
p	Measured air pressure (absolute)	Pa
z	Site elevation above sea level	m
T	Air temperature	K
ϕ	Relative humidity (ignored below 0 °C)	-
U	Wind speed (or mean wind speed for the Rayleigh value)	m/s
ρ	Air density	kg/m³
ρ/ρ_0	Ratio to 1.225 kg/m³	-
P/A	Wind power density at U	W/m²
$\bar{P}/A$	Mean power density for Rayleigh winds of mean U (6/π times)	W/m²

Method and standards

Air density and wind power density.

Assumptions and limits

- Ideal-gas mixture; standard atmosphere for elevation.

References

Ideal-gas humid air density and wind power density

Report details

Report reference	FCC-YA59-TVKD (the same inputs always give the same reference)
Generated	23 November 2026, 17:34 UTC
Calculator	Air Density and Wind Power Density at a Site
Method last reviewed	17 November 2026
Software release	FireCAD Calc, release of 22 November 2026
Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/environmental/wind-power/wind-air-density-power-density

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.