Wind Power Curve Air Density Correction

Equivalent reference wind speed for a pitch-regulated turbine at a site's air density, the power ratio below rated and the shift in rated wind speed.

Method: Air-density normalisation of wind turbine power curves

Input parameters

Unit system: SI

Parameter	Value	Unit
Site wind speed	8.0000	m/s
Site air density	1.0600	kg/m³
Density of the reference power curve	1.2250	kg/m³
Rated wind speed of the reference curve	11.500	m/s

Calculated results

Parameter	Value	Unit
Equivalent speed to read on the reference curve	7.6234	m/s
Power ratio below rated (stall or same speed)	86.531	%
Rated wind speed at the site density	12.068	m/s
Shift in rated wind speed	0.56817	m/s

Notes for this case

• Pitch-regulated machines: read the reference power curve at V_n = V(ρ/ρ₀)^(1/3), so the curve shifts to higher wind speeds at low density while rated power is unchanged. Stall-regulated machines: scale power by ρ/ρ₀. This is the usual power-curve normalisation method.

Formula and method

$$V_n = V\left(\frac{\rho}{\rho_0}\right)^{1/3}, \quad V_r = V_{r,0}\left(\frac{\rho_0}{\rho}\right)^{1/3}$$

Variables

V	Site wind speed	m/s
ρ	Site air density	kg/m³
ρ_0	Density of the reference power curve	kg/m³
$V_{r,0}$	Rated wind speed of the reference curve	m/s
V_n	Equivalent speed to read on the reference curve	m/s
P/P_0	Power ratio below rated (stall or same speed)	-
V_r	Rated wind speed at the site density	m/s
$V_r - V_{r,0}$	Shift in rated wind speed	m/s

Method and standards

Power-curve density normalisation.

Assumptions and limits

- Same C_P at the same tip speed ratio; no Reynolds-number effects.

References

Air-density normalisation of wind turbine power curves

Report details

Report reference	FCC-95NX-E1QX (the same inputs always give the same reference)
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Calculator	Wind Power Curve Air Density Correction
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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-power-curve-density-correction

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.