Wind Farm Layout: Turbines per Area, Capacity Density and Energy

Number of turbines, installed capacity and capacity density of a wind farm on a given land area from turbine size and spacing in rotor diameters, with annual energy.

Method: Array spacing and capacity density

Input parameters

Unit system: SI

Parameter	Value	Unit
Turbine rating	4.2000	MW
Rotor diameter	150.00	m
Spacing along the prevailing wind (diameters)	7.0000	
Spacing across the wind (diameters)	4.0000	
Usable site area	20.000	km²
Net capacity factor (after wake and other losses)	32.000	%

Calculated results

Parameter	Value	Unit
Number of turbines that fit	31.000	
Land per turbine	0.63000	km²
Installed capacity	130.20	MW
Capacity density (MW per km²)	6.5100	
Annual energy	364.98	GWh
Energy density (average W per m² of land)	2.0832	W/m²

Notes for this case

• Rectangular grid with cells s_aD × s_cD; edge effects, terrain, setbacks and exclusions reduce the count. Large onshore farms reach about 2–5 MW per km² overall and deliver about 1–3 W per m² of land averaged over the year.

Formula and method

$$A_t = s_a D \times s_c D, \quad N = \left\lfloor \frac{A}{A_t} \right\rfloor, \quad E = N P_t \, CF \, 8760\,h$$

Variables

P_t	Turbine rating	W
D	Rotor diameter	m
s_a	Spacing along the prevailing wind (diameters)	-
s_c	Spacing across the wind (diameters)	-
A	Usable site area	m²
CF	Net capacity factor (after wake and other losses)	-
N	Number of turbines that fit	-
A_t	Land per turbine	m²
P	Installed capacity	W
P/A	Capacity density (MW per km²)	-
E	Annual energy	J

$E/(A \cdot t)$	Energy density (average W per m² of land)	W/m²

Method and standards

Wind farm layout arithmetic.

Assumptions and limits

- Regular grid; flat site; one turbine type.

References

Array spacing and capacity density

Report details

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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-farm-capacity-density

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.