

Comparative analysis of wind turbine options for the Isle of Ouessant (France)



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Context & Objectives



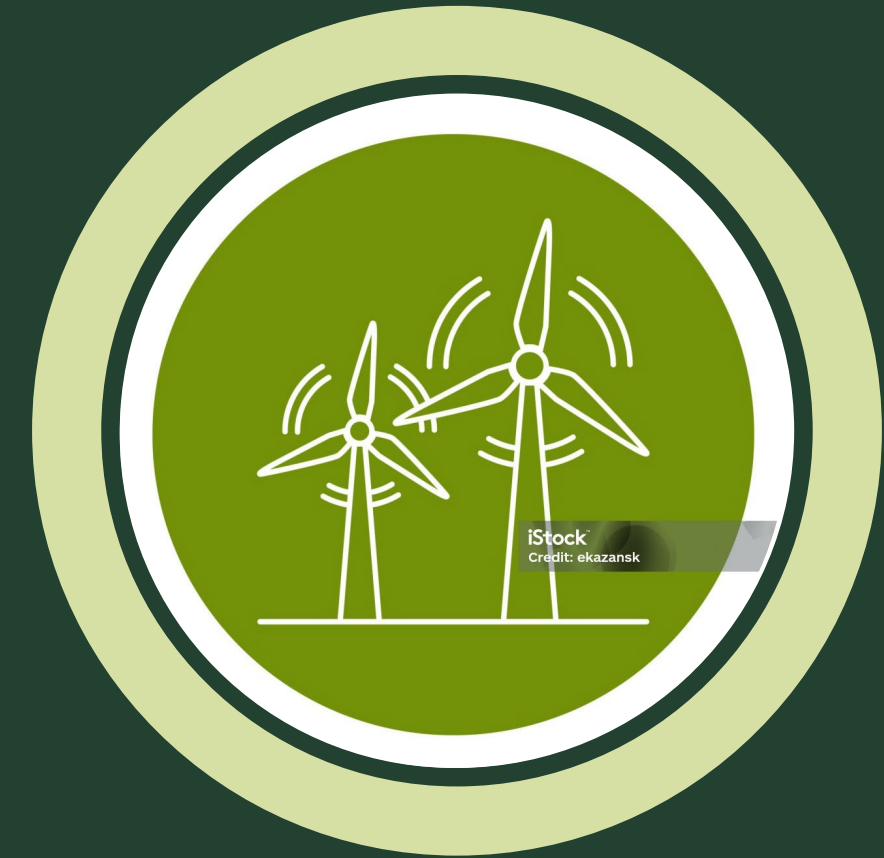
Data Analyst

Commissioned by the French
Ministry of Energy



Objective

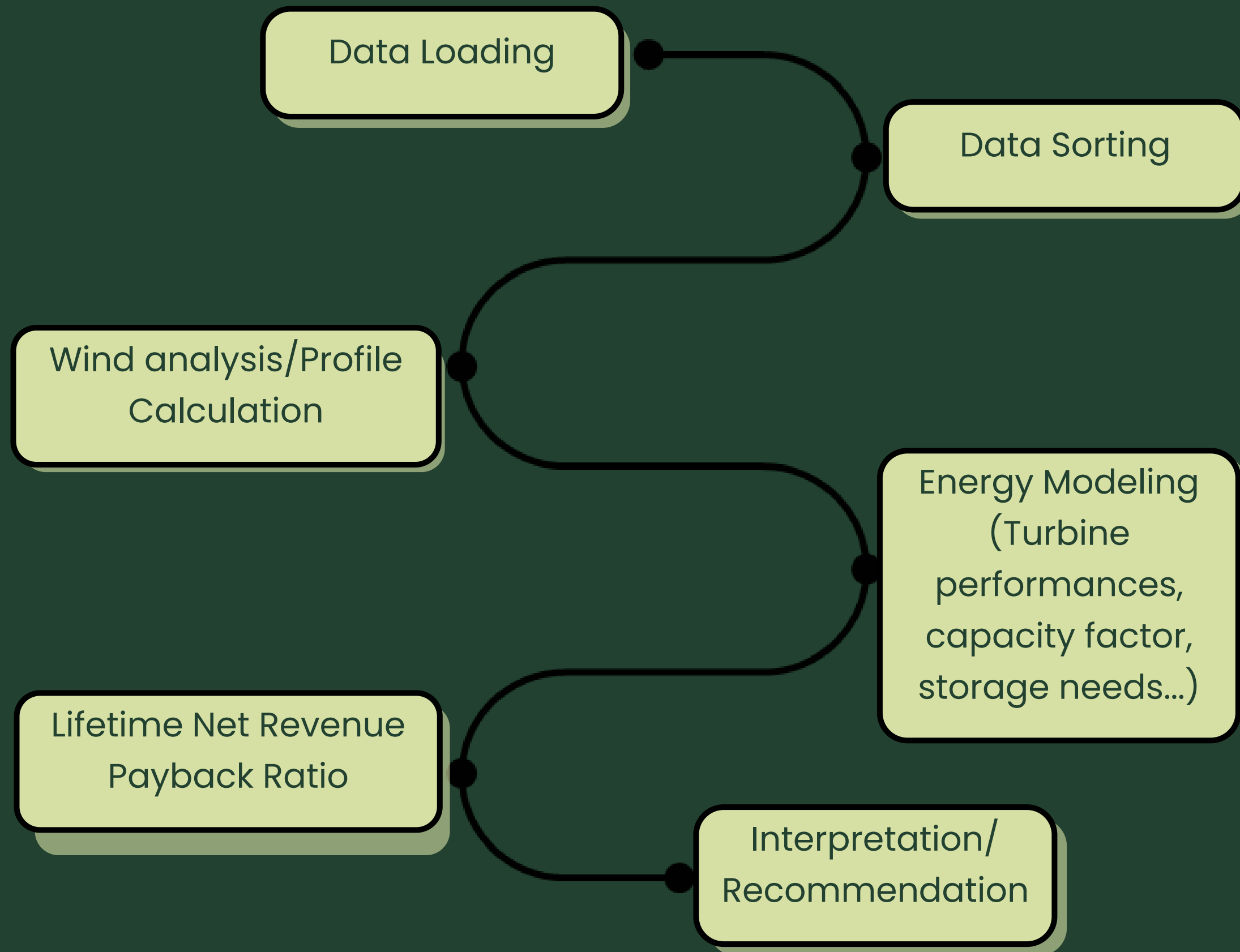
Determine the best wind turbine
option to be installed at Ouessant to
best support renewable energy
project.



Turbine candidates

Alstom ECO122
Enercon E-33
AVENTA AV-7

Method Structure

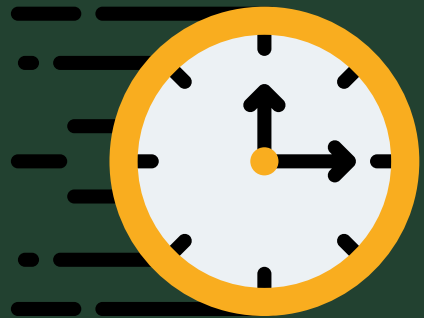


- Use of jupyter notebook in VS Code for the comparative study
- **Data:** 30-min wind measurements (2014–2024), population, turbine specs
- **Tools:** Python (Pandas, Matplotlib, SciPy), MCDA (Multi-Criteria Decision Analysis)
- **Automation:** pipeline built to run for any given dataset/year



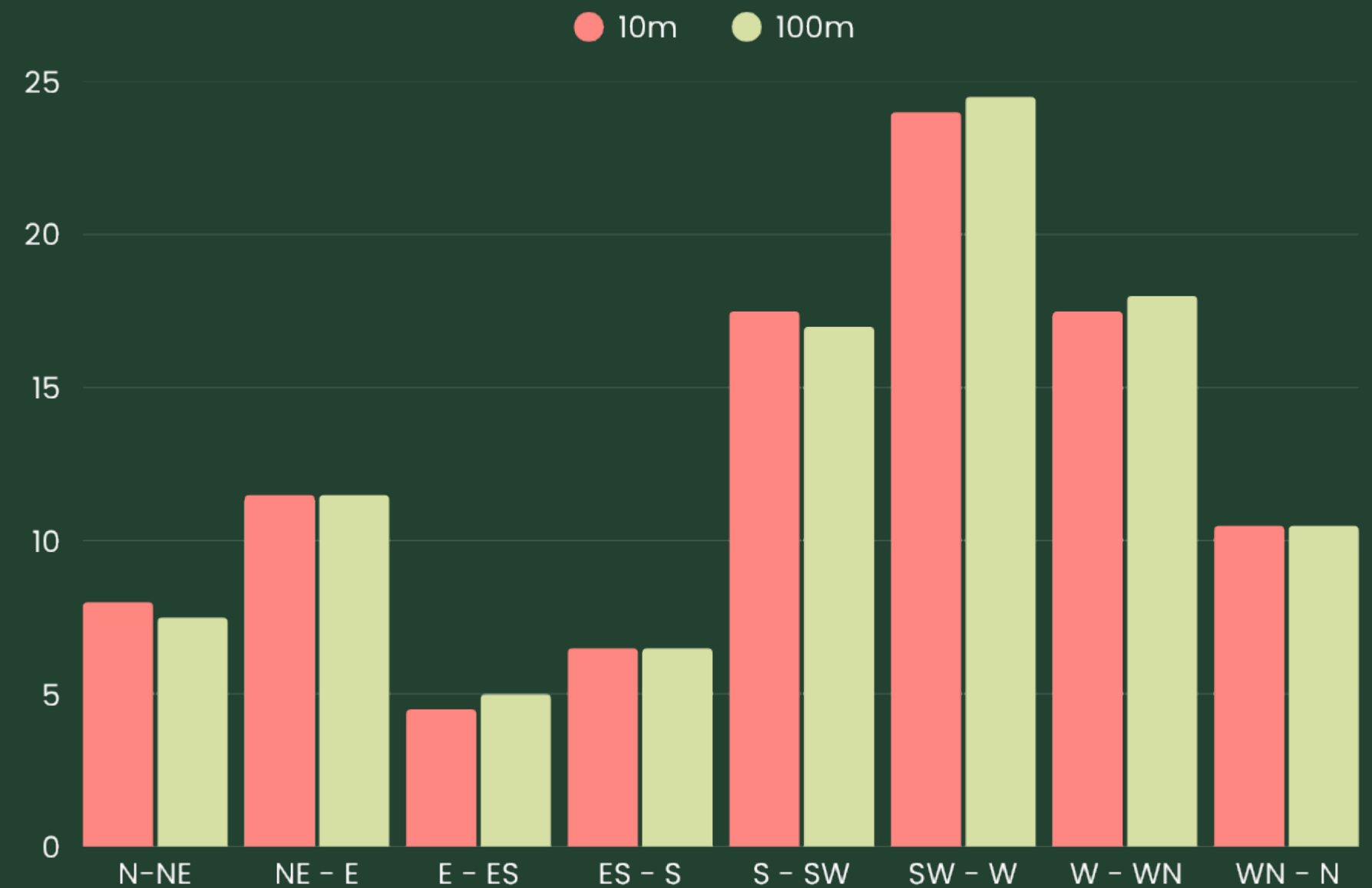
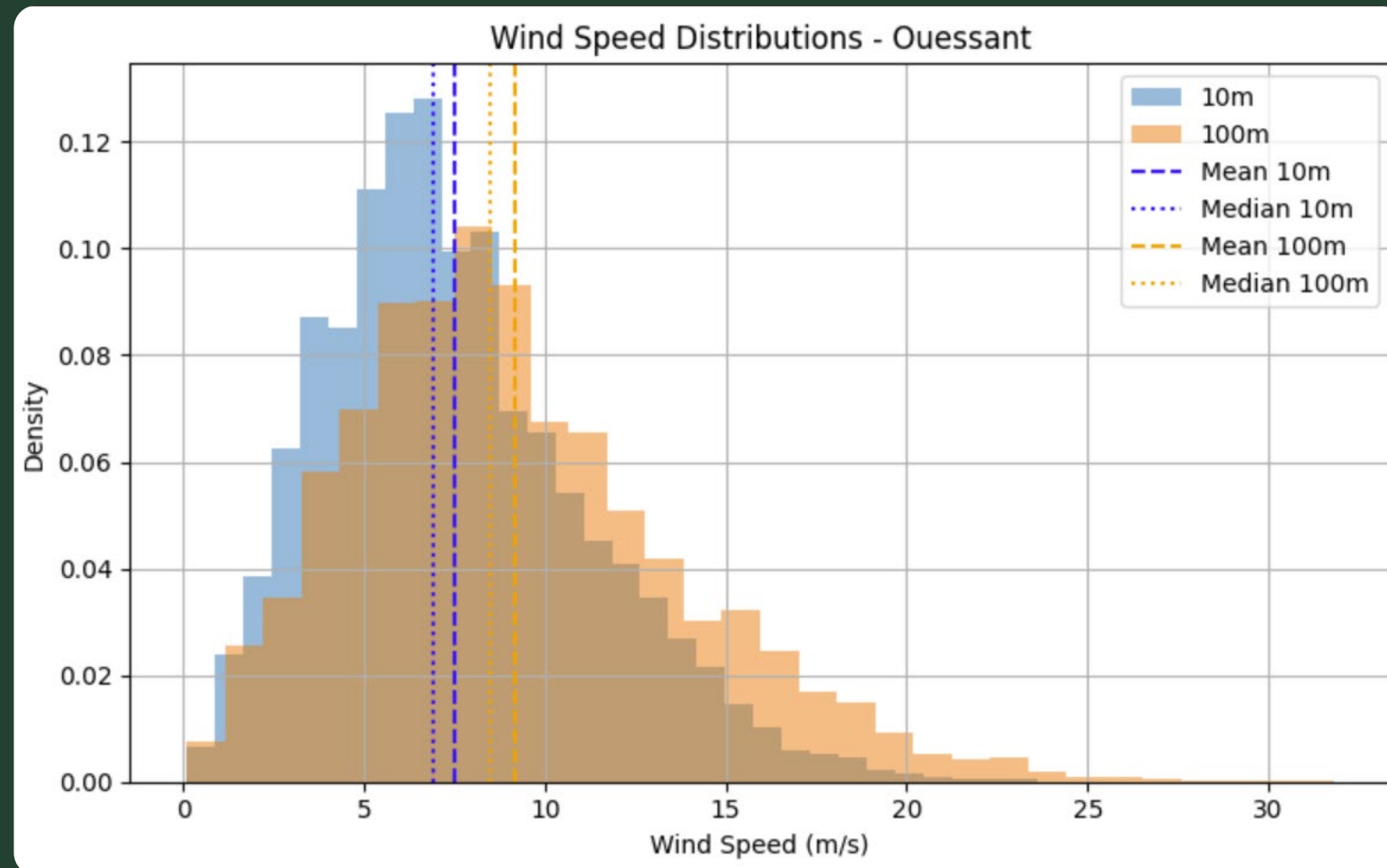
Ouessant

Site Analysis



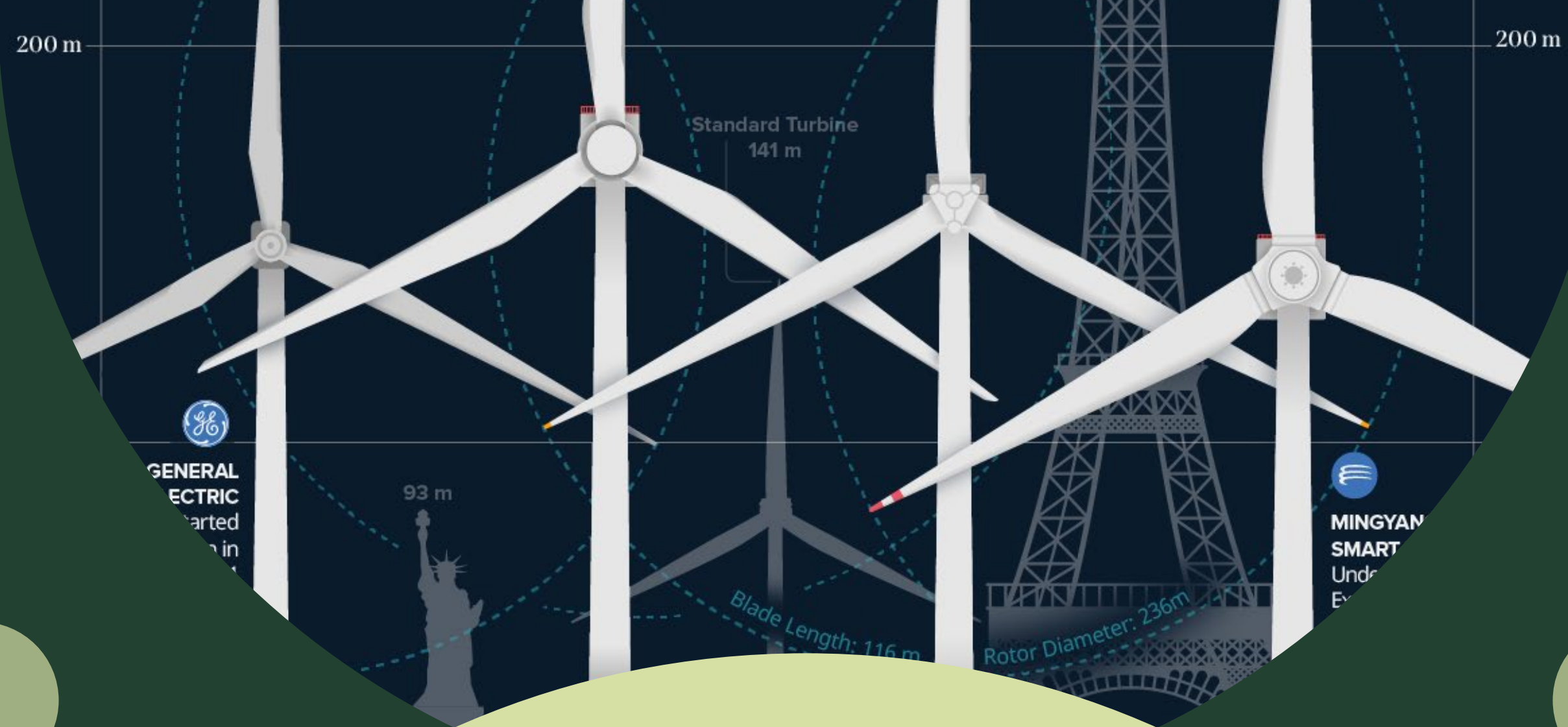
Ouessant

7



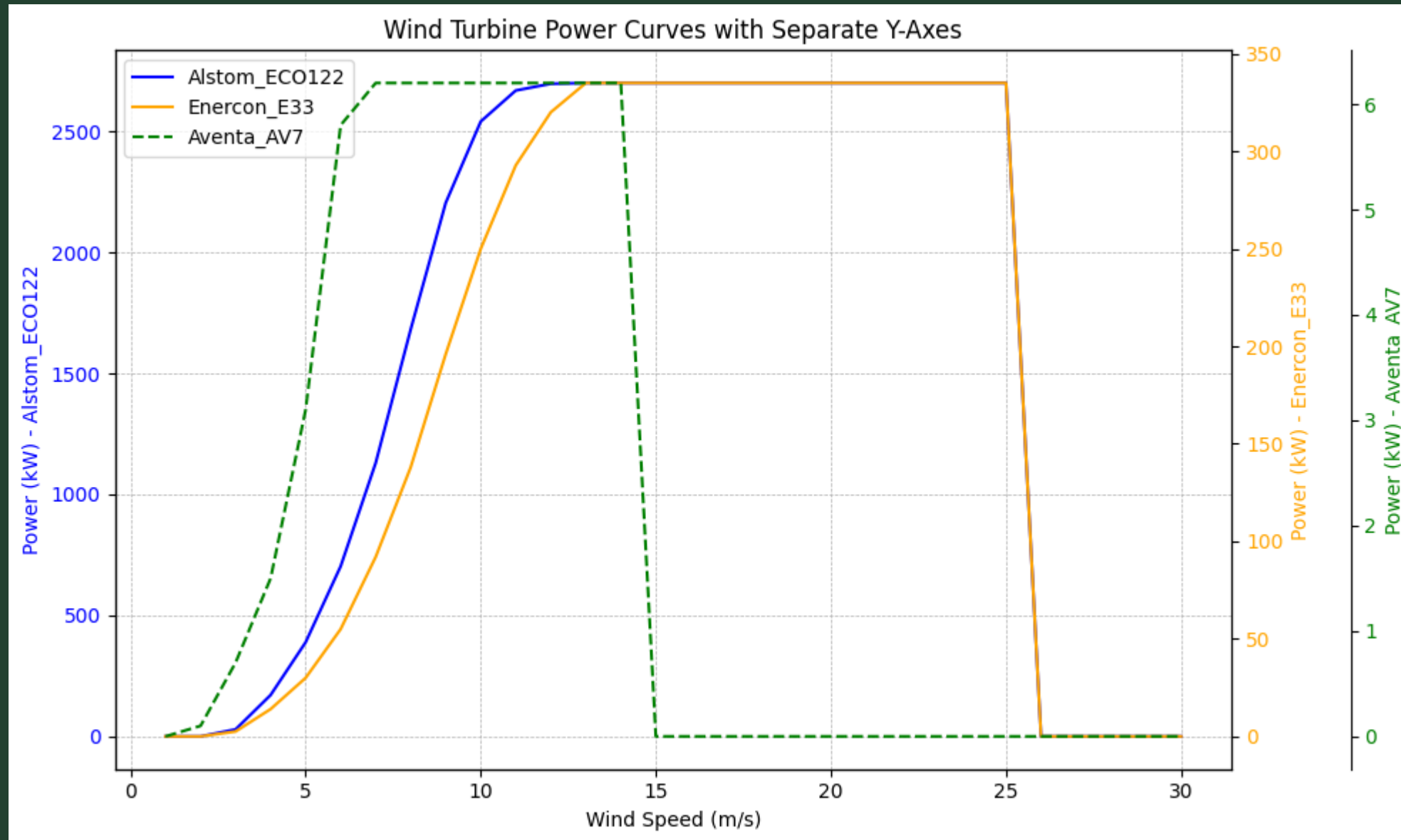
- Avg wind speed at 100 m: 9.08 m/s
- Most winds between 6–14 m/s (ideal range)
- Only 513 calm hours/year (<3 m/s)

- Stable direction: mostly SW–W and W–NW (>40%)
- Exposed island with no terrain obstacles → **strong, stable and consistent** winds



Comparative study

Comparative Turbine Study



Alstom ECO122

- 89m
- 2.7 MW
- Large wind farms
- 3,3M €



Enercon E-33

- 37m
- 330 kW
- Community-scale
- 700k €



AVENTA AV-7

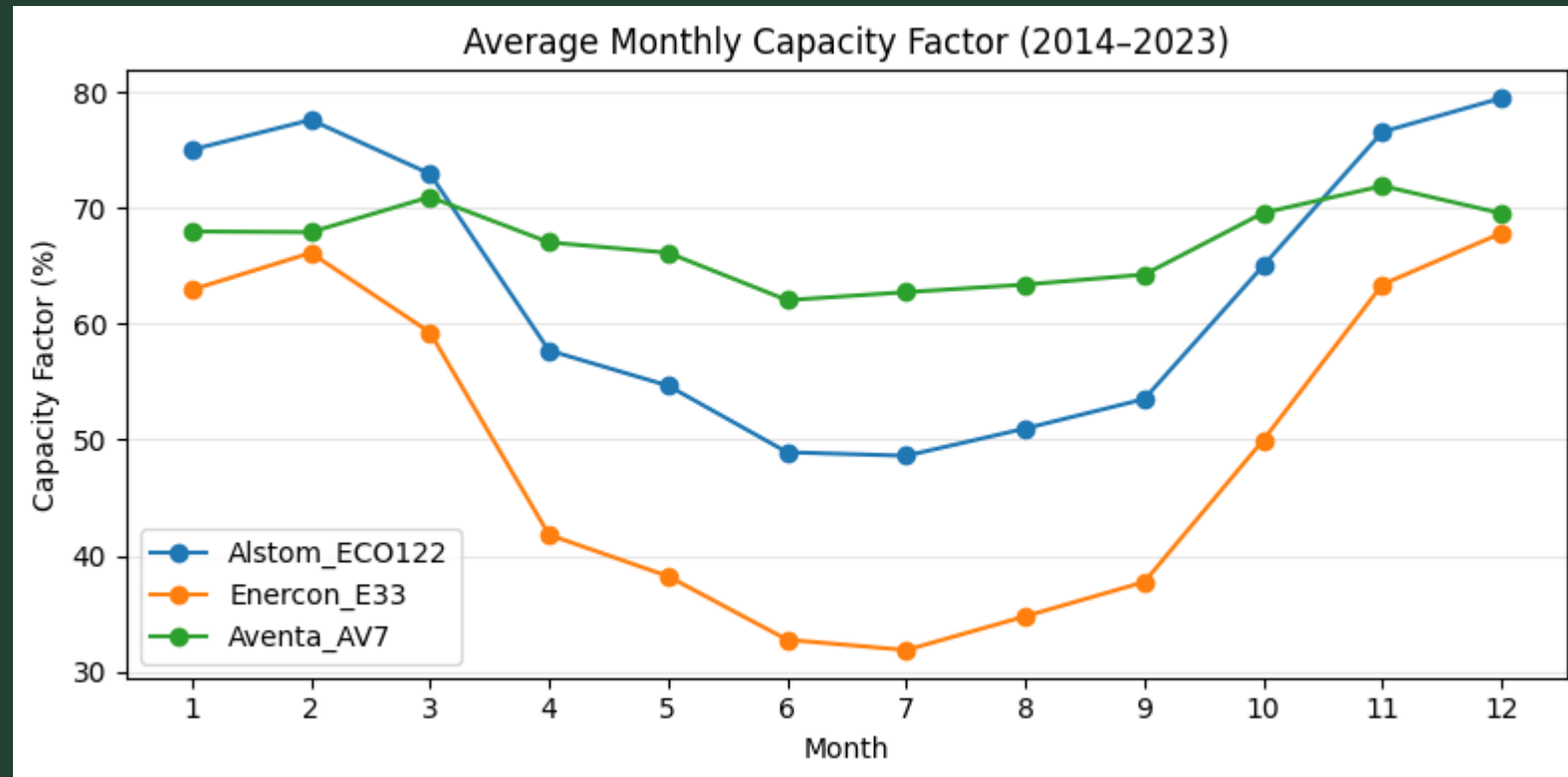
- 18m
- 6.5 kW
- Local/microgrid/ Rooftops
- 93k €



Log Wind Profile Formula →

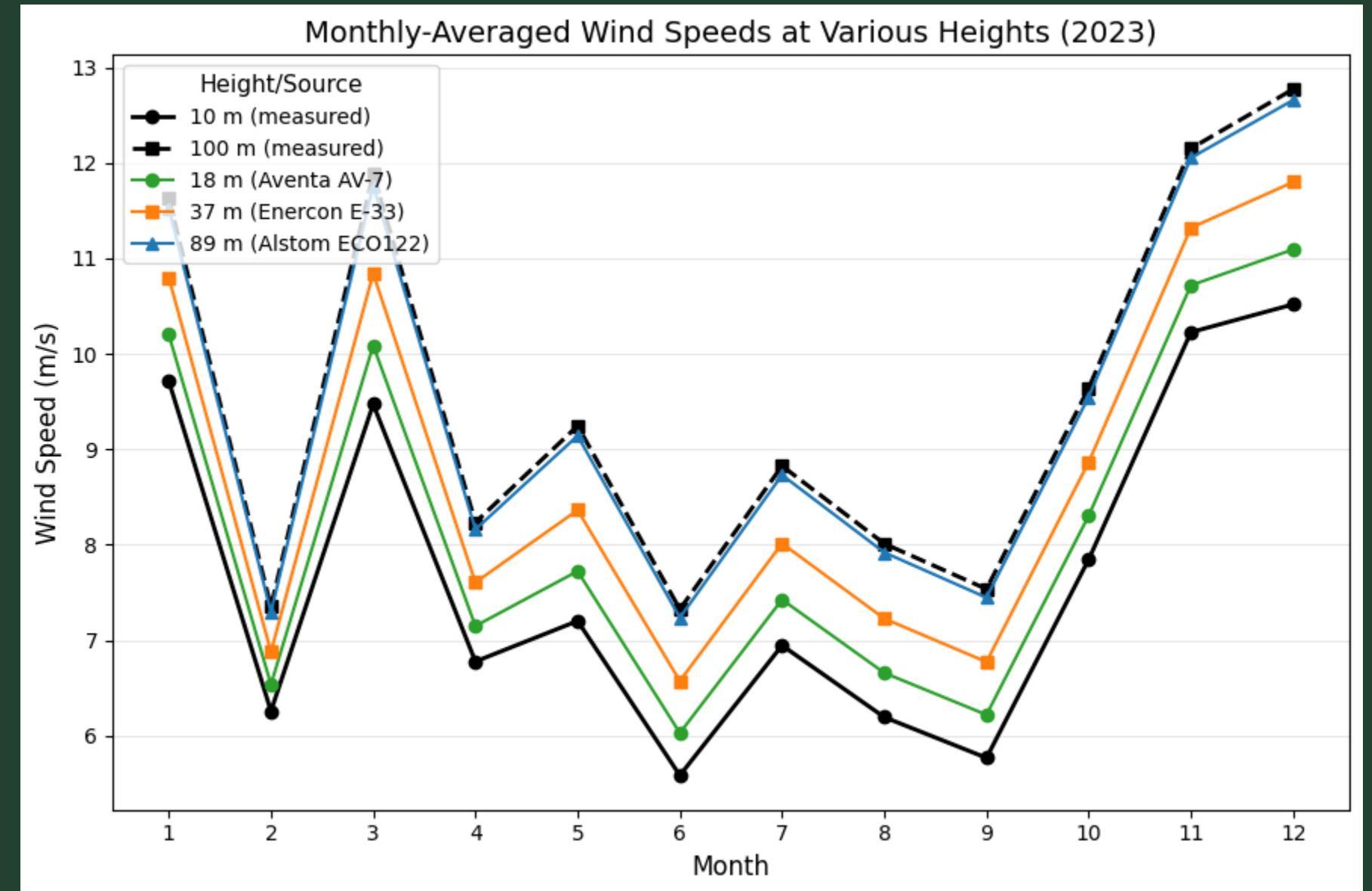
$$u(z) = \frac{u_*}{\kappa} \ln \left(\frac{z-d}{z_0} \right)$$

Annual Capacity Factors of 3 wind turbines in French Cities



$$\text{Capacity Factor} = \frac{E_{\text{year}}}{P_{\text{rated}} \times 8760}$$

Monthly average wind speeds



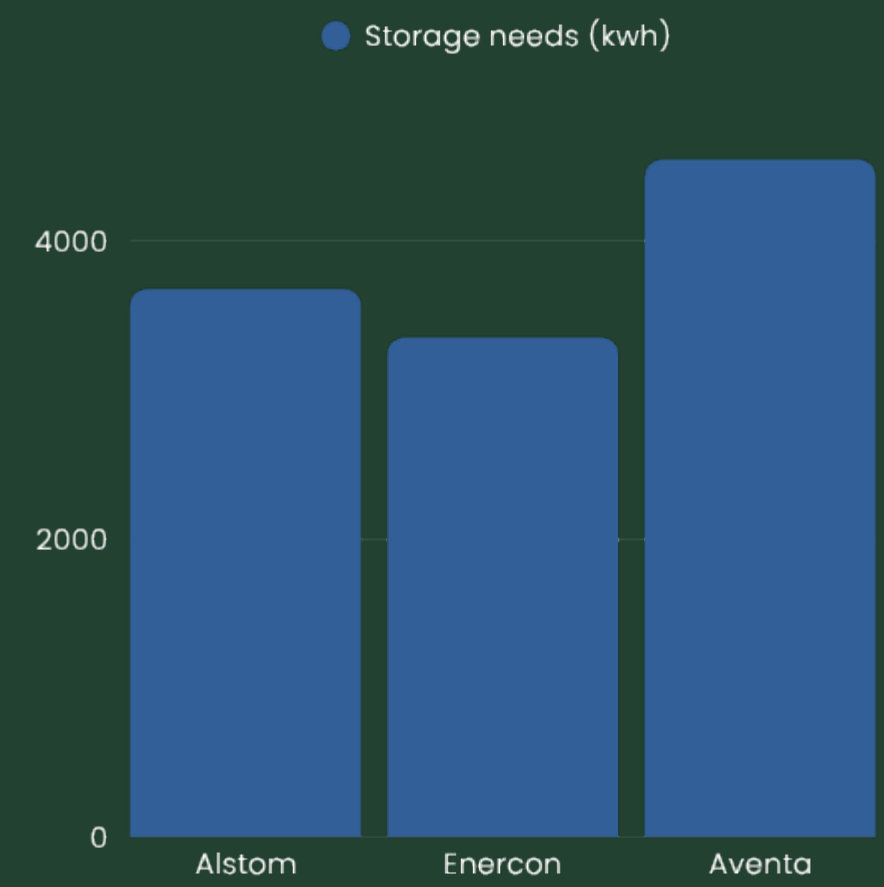
Powering the Town

Number of Turbines Needed (20142023 average annual output)

	ALSTOM	ENERCON	AVENTA
Ouessant	1	2	50

To determine the bestturbine, calculate : **price * number of turbines**
needed (for each type of turbine)

	Units Needed	Turbine Cost (€)	Installation Cost (€)	O&M Cost (€)	Upfront Cost (€)	Lifetime Cost (€)	Avg Annual Energy (kWh/yr)	Cost €/kWh (Lifetime)	Net Revenue €/kWh	Lifetime Net Revenue (€)	Net Payback Ratio
Turbine											
Alstom ECO122	1	3333000	2700000	1,620,000.0000	6033000	7,653,000.0000	15,075,633.2529	0.0254	0.1762	53,131,953.2758	6.9426
Enercon E33	2	1400000	660000	396,000.0000	2060000	2,456,000.0000	1,428,597.5245	0.0430	0.1586	9,064,210.4373	3.6906
Aventa AV7	50	4650000	325000	195,000.0000	4975000	5,170,000.0000	38,154.0621	0.1355	0.0661	2,521,858.9119	0.4878



To calculate the estimated storage needs:

- Identified turbine downtime
- grouped into gaps and measured durations
- Took 95th percentile gap as worst case
- Multiplied by average power demand to estimate required storage

Ouessant

=== Final Cost and Payback Analysis ===									
	Units	Installed Capacity (MW)	Turbine Cost (€)	Battery Cost (€)	Installation Cost (€)	O&M Cost (€)	Upfront Cost (€)	Lifetime Cost (€)	
Turbine									
Alstom EC0122	1	2.7000	3333000	548000	2700000	2025000.0000	6581000	8606000.0000	
Enercon E33	2	0.6600	1400000	548000	660000	495000.0000	2608000	3103000.0000	
Aventa AV7	50	0.3250	4650000	685000	325000	243750.0000	5660000	5903750.0000	

Lifetime Energy (kWh)	Cost per kWh (€)	Net Revenue per kWh (€)	Lifetime Net Revenue (€)	Net Payback Ratio
376890750	0.0228	0.1788	67375175.2000	7.8289
71429900	0.0434	0.1582	11297267.8400	3.6408
47692500	0.1238	0.0778	3711058.0000	0.6286

CONCLUSION

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