



Measuring Wind Speeds for Small Turbine Sites

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Agenda

- *Wind Resource Assessment for small turbines*
- *Wind Measurements*
- *Analyzing Results*
- *Assessment for Small Turbines – budgets*
- *Why it's important*



Definitions

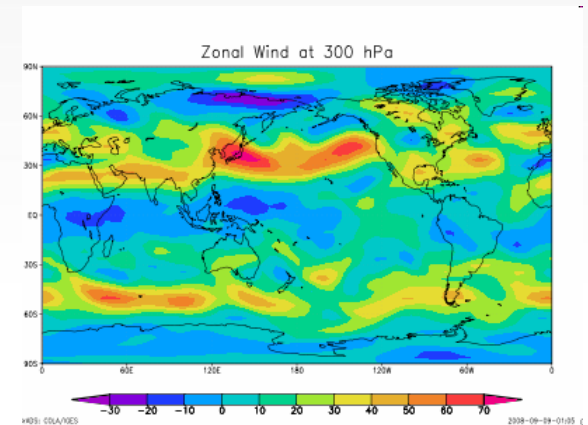
Power	Category
300 W – 15 kW	Small
15 kW – 250 kW	Community
251 kW – 1.8 MW	Utility-Scale





Wind Resource Assessment

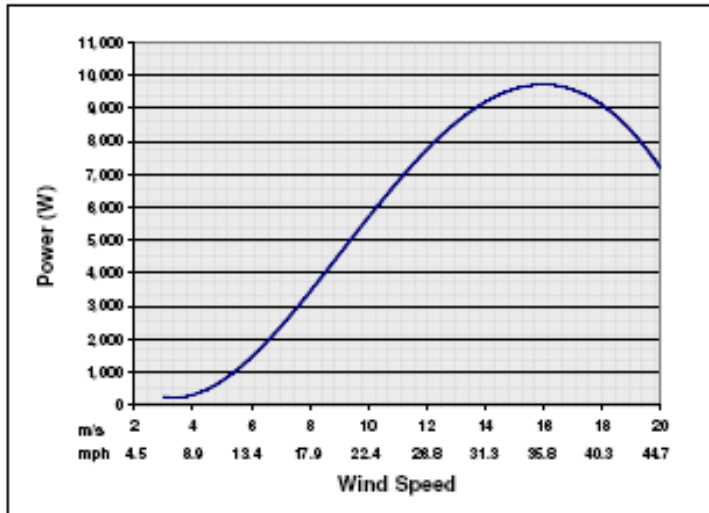
- Site Prospecting – annual mean wind speed (Atlas)
- Wind Measurements Campaign
- Results Analysis
 - Finding Best Location
 - Energy Yield Calculations





Wind Speed Measurement

Wind Power ~ (Wind Speed)³



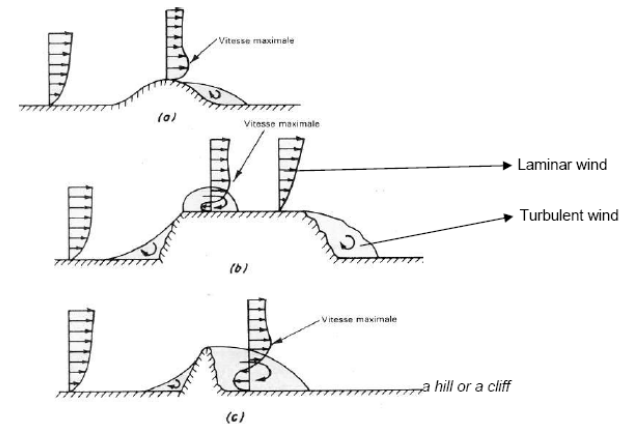
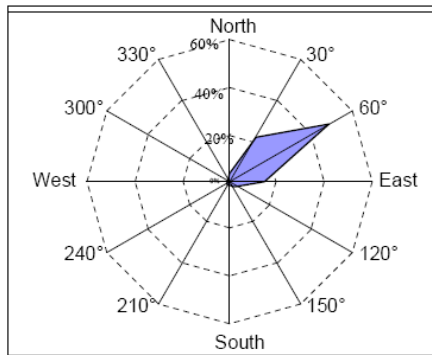
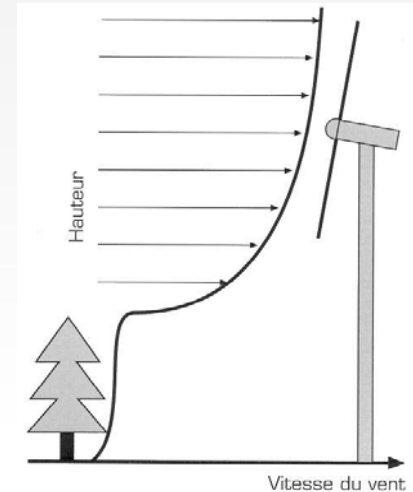
Month	Site A, 5 m/s		Site B, 5 m/s	
	Wind Speed	Energy Yield	Wind Speed	Energy Yield
Jan	2	0	3	0.2
Feb	2	0	3	0.2
Mar	2	0	3	0.2
Apr	2	0	3	0.2
May	5	1	5	1
Jun	5	1	5	1
Jul	5	1	5	1
Aug	5	1	5	1
Sep	8	3.2	7	2.2
Oct	8	3.2	7	2.2
Nov	8	3.2	7	2.2
Dec	8	3.2	7	2.2
Avg Speed	5		5	
Cumulative Power, units		16.8		13.6





Wind Power Factors

Factor	Issues to be addressed
Vertical Wind Shear	<ul style="list-style-type: none"> Depends on <i>roughness</i>, local obstacles Tower height must be adjusted
Wind Direction	<ul style="list-style-type: none"> Obstacles must be avoided from the dominant wind direction
Turbulence	<ul style="list-style-type: none"> Shorter WT Lifecycle More frequent inspections required





Finding Correlation

- Even 1 year direct measurement is not enough
- 10-15 years data required
- Reference site – nearest meteorological station (up to 40 km)

$$V_{\text{site}} = f(V_{\text{ref}})$$

- Analyze synchronized Data between reference site and proposed site (daily basis)
- Monitoring Campaign Duration becomes shorter (minimum 3 months)



Small Turbines – Low Budget

Measurement Campaign Budget:
5%-10% of the project budget

Wind Project Budget

vs.

Measurement Campaign Costs

Installed Power	Project Budget
1 kW	\$3,000
3 kW	\$8,000
10 kW	\$24,000
17.5 kW	\$40,000
50 kW	\$100,000
2 MW	\$3.6 M
100 MW	\$150 M

Mast Height	Number of Sensors (anemometer+ vane)	Campaign Duration	Uncertainty	Cost estimated
6 m	1	3 months	12%	< \$1,000
12 m	2	3 months	10%	\$2,000
40 m	3	1.5 – 2 years	< 5%	\$35,000



Wind Assessment Advantages

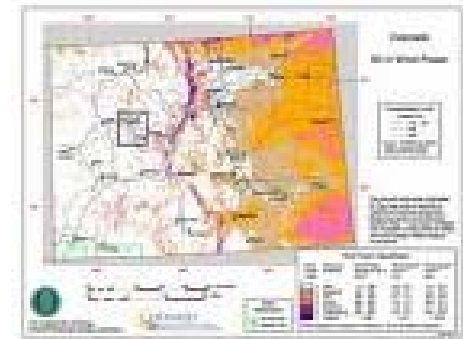
- Reduce Financial Risks
- Maximize Energy Production
- Increase Turbine Lifetime
- Avoid Disappointment





Key Success Factors

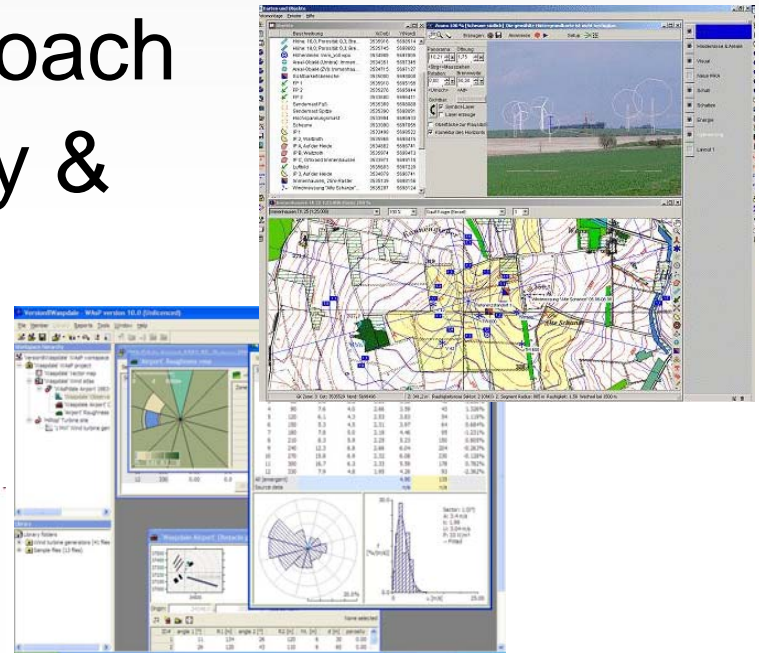
- Online Wind Resource Atlas of Israel
 - NOABL – UK
 - NREL – US
- Consolidated data from different sources (IMS, MNI, Electric Company etc.)
- Easy access to historical meteorological data





Clean Electric Services

- End-to-end Wind Assessment
- Customer-oriented approach
- Expertise in meteorology & engineering
- Independent unbiased consulting



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Q&A

Thank You!

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