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Disclosure: Paul Gipe has worked with Aerovironment, ANZSES, APROMA, ASES, AusWEA, AWEA, BWEA, BWE, CanWEA, CAW, CEERT, DGW, DSF, EECA, ES&T, GEO, GPI Atlantic, IREQ, KWEA, MADE, Microsoft, ManSEA, MSU, NRCan, NRG Systems, NASA, NREL, NZWEA, ORWWG, OSEA, PG&E, SeaWest, SEI, TREC, USDOE, WAWWG, WE Energies, the Folkecenter, the Izaak Walton League, the Minnesota Project, the Sierra Club, and Zond Systems, and written for magazines in the USA, Canada, France, Denmark, and Germany.

Ydby, Denmark

Advanced Renewable Tariffs For Small Wind Turbines

By Paul Gipe

Paul Gipe, wind-works.org



Small Wind Programs Overview

- The “Best” On-Grid Programs
- The Results
 - Units, MW, Performance
- Time for Change
- Proposed Feed-in Tariffs



Mick Sagrillo

Wisconsin's Small Wind Guru

- **Best Program?**
Wisconsin's Focus on Energy
- **Why?**
Subsidy Based on Performance



Wisconsin Focus on Energy

- **Subsidies**

Based on Estimated Generation Since 2003

- **Third Party Evaluation**

--for each project

- **Mick on Other Programs**

“Throwing Money [at Equipment] Doesn’t Work”

“You Give it Away That’s What It’s Worth”

If You Do Dead Turbines Become “Monuments to Failed Policy”

Wisconsin Focus on Energy

- **Evaluates Each Product**
- **Evaluates Each Site**
- **Estimates Generation**
- **Algorithm to Calculate Subsidy Amount**

Power @11 m/s

Full Subsidy @ 20% CF (Excellent WI Site)

Installed Cost (Cap 25% <20 kW)

Wisconsin Focus on Energy

Example: Skystream, 30 m Tower

Excellent Site = Most Subsidy

- **1.8 kW @ 11 m/s**
- **20% CF = 3,150 kWh/yr**
- **Installed Cost: \$17,000**
- **Subsidy = \$4,250**
- **Net Cost = \$12,700**

Wisconsin Focus on Energy

Example: Skystream, 30 m Tower

Average Site = Lower Subsidy

- **10% CF = 1,500 kWh/yr**
- **Subsidy 50% of Excellent Site**
- **Subsidy = \$2,100**
- **Net Cost = \$14,900**

Wisconsin Focus on Energy Results

- **~70 units, ~1.2 MW**
- **~2/3 of Capacity:**
 - Used Danish Turbines**
- **No Performance Measurements**
 - All Systems Have Anemometers & kWh Meters**
- **That's All--After 6 Years!**
- **Large Turbines ~500 MW**

Mike Bergey--Bergey Windpower

- **Best Program?**
California or Oregon
- **Why?**
Size of Program

Paul Gipe, wind-works.org
Tehachapi, California



CEC Emerging Renewables

- **Traditional Stepped Subsidy**
- **Two Tranches**
 - \$2,500/kW <7.5 kW**
 - \$1,500/kW >7.5 kW <30 kW**
- **Product Must be Certified to Qualify**
- **No Measurements & No Monitoring**
- **Bureaucratic & Cumbersome**
- **Zoning Restrictions**

CEC Emerging Renewables Results

- 1% of \$400 million in Subsidies in 10 years
- \$4 million in Subsidies for Small Wind



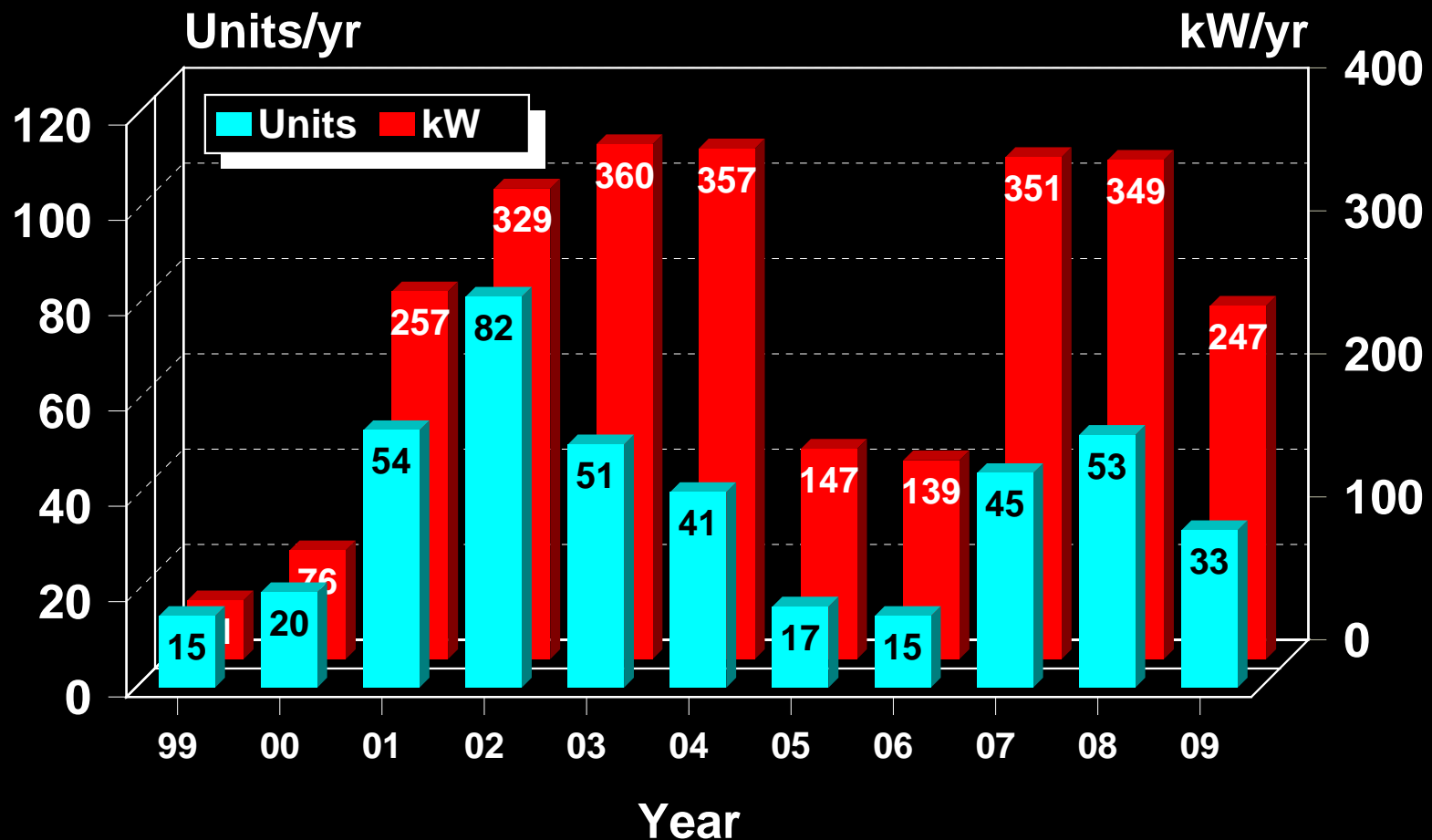
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Tehachapi, California

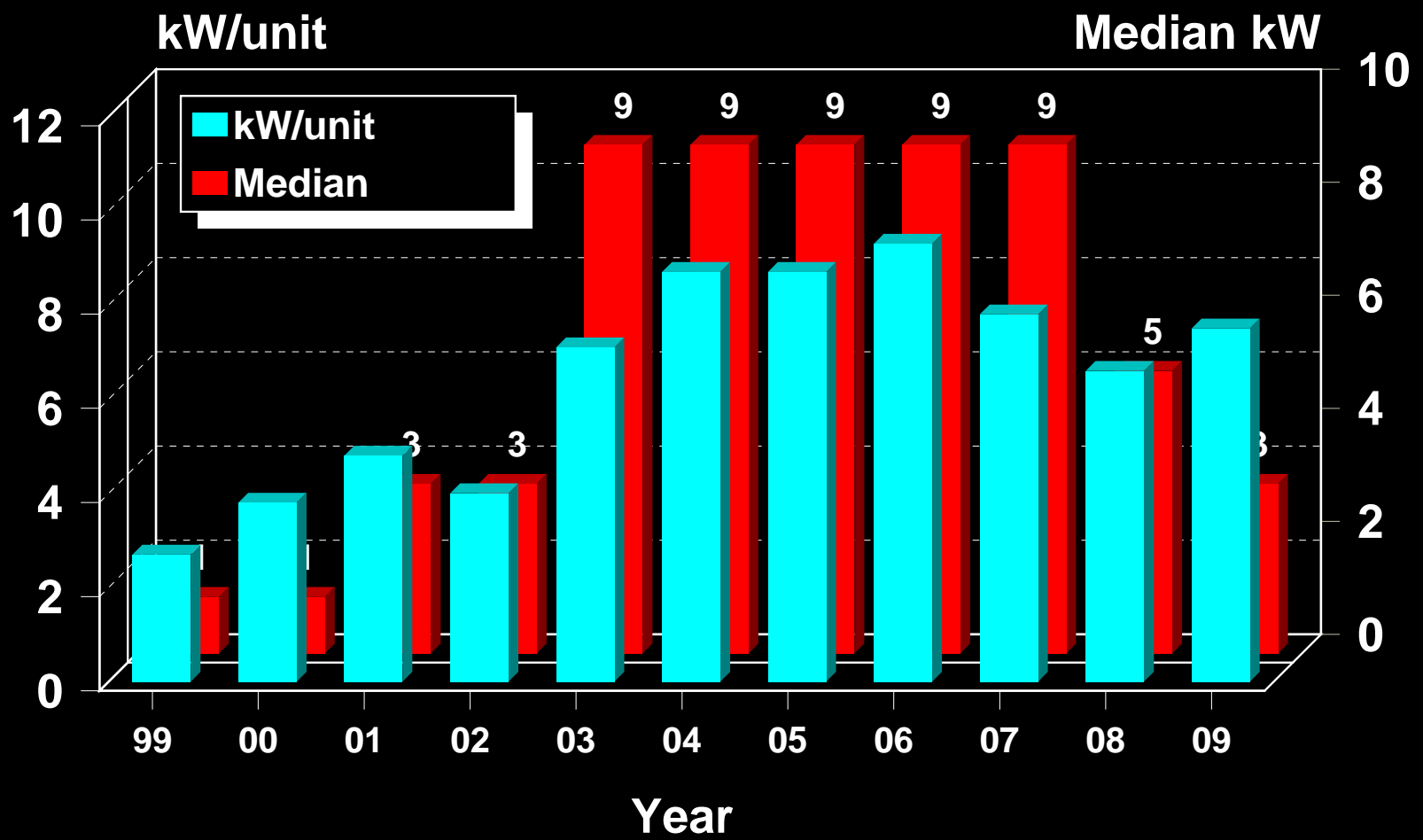
California Small Wind Program Results

- **Since 1998**
- **Total Installed: 426 units (CEC)**
- **Total Installed: 2.6 MW (CEC)**
- **Average: 40 units/yr; 250 kW/yr**
- **No Performance Data**
- **No Reports!**

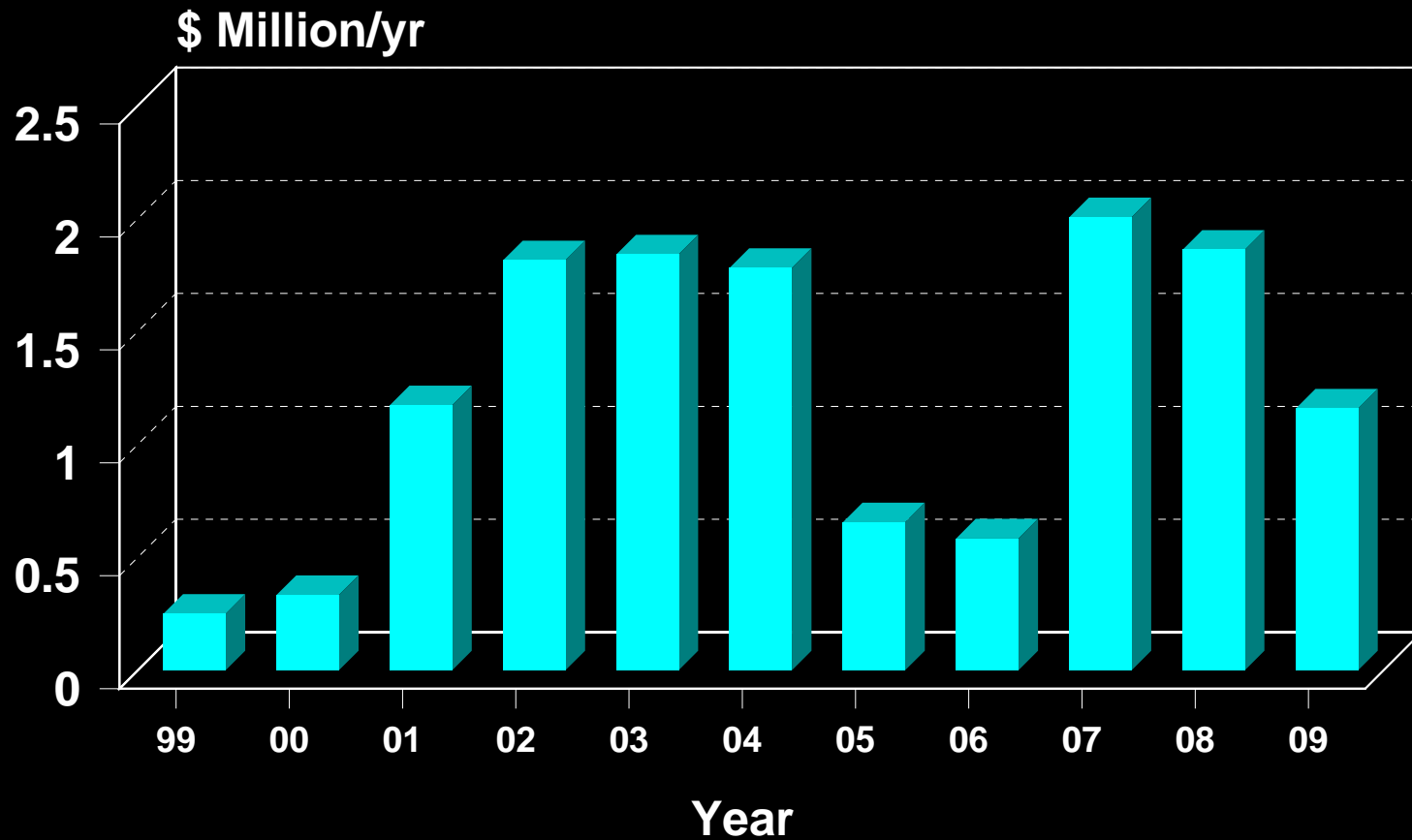
California Small Wind Program Results



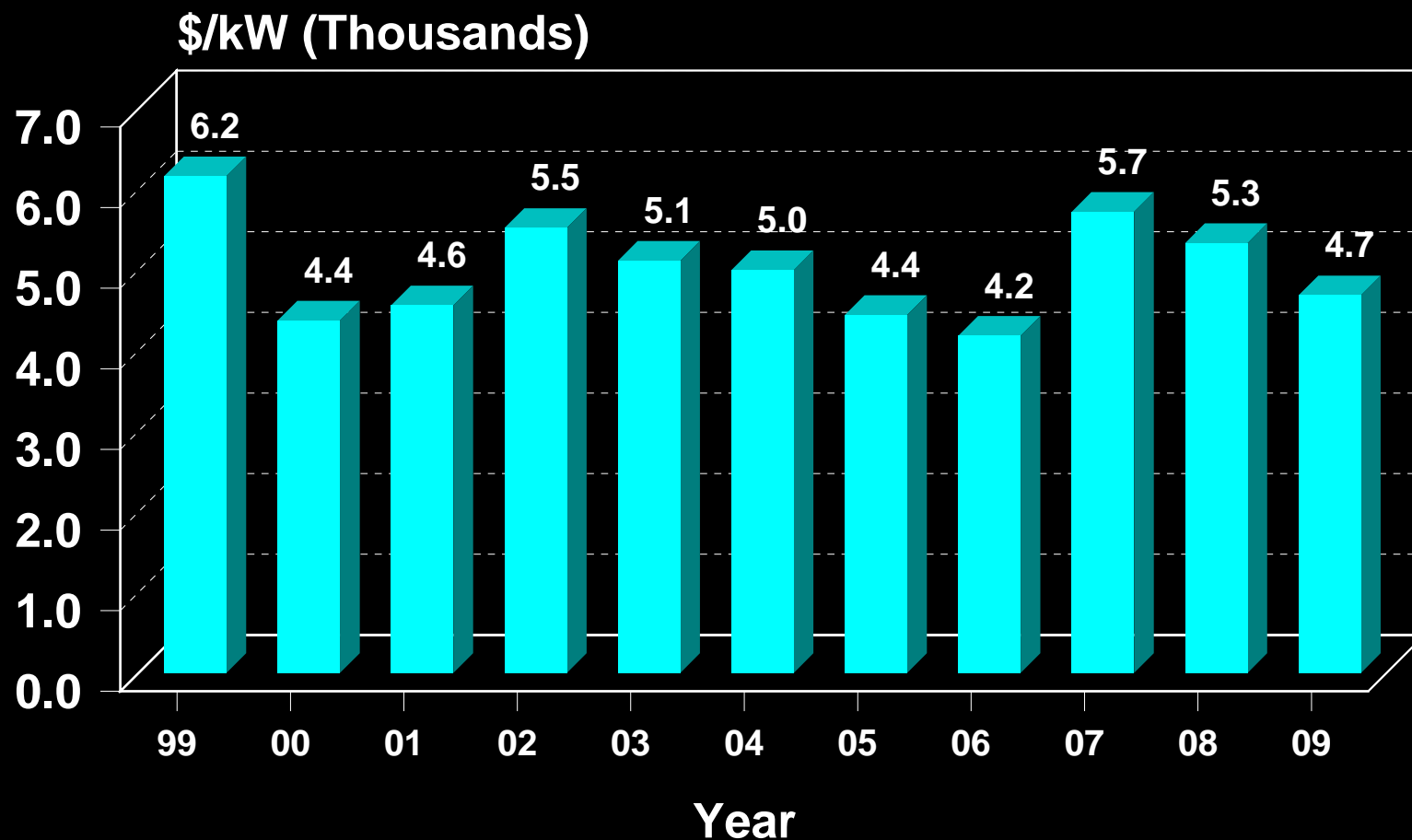
California Small Wind Program Results



California Small Wind Program Results



California Small Wind Program Results



Oregon Small Wind: Results

- **< 50 units, <100 kW in Entire State**
- **Downtown Portland Rooftop Wind**
 - 4 Skysteams**
 - Estimated Yield: 2,250 kWh/yr/turbine**
 - \$10,000/turbine**
 - Estimated Specific Yield: ~200 kWh/m²/yr**
 - Greenwashing--LEED Points**

Washington State Small Wind Tariff

- **Performance-Based Incentive**
Form of Net Metering
- **But Payment/kWh on All Generation**
- **Out of State Product: \$0.12/kWh**
- **Retail Rate Offset: \$0.08/kWh**
- **Total: ~\$0.18/kWh**
- **Results: ~30 units, 30 kW**

Small Wind On-Grid Installed in USA in 2008

kW Size	Units	~MW	~\$ million*
1-10	2,825	7	26
10-20	72	1	5
20-100	87	6	23
	2,984	14	54

***At \$4,000/kW**

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Small Wind On-Grid USA 2008

- **Small Wind: 100% Net Metering**
- **AWEA: Small Wind Subsidy Needed**
 - \$2,000/kW on Top of Federal Subsidy**
 - ~50% of Installed Cost**
 - ~Equivalent to Installed Cost of Large Turbines**

Small Wind On-Grid USA 2008

- **US 2008 Commercial Investment**
~\$20 Billion
- **Small Wind On-Grid**
~0.3% of Total US Wind Investment in 2008



BWEA Small Wind Market Report On-Grid

- **<2,000 units/yr**
- **~4,500 Units Total**
- **~6 MW Total Capacity**
- **~7 million kWh/yr Total**
- **Specific Capacity:
1200 kWh/kWyr; Very Optimistic**

Britain's Energy Savings Trust Field Trials

- **Monitored 57 Turbines**
- **38 Rooftop Units, 19 Ground-Mounted**
- **Wind Speed Most Sites <5 m/s**
- **Rooftop**
 - No Rooftop Turbine >200 kWh/yr**
 - Some Rooftop Turbines Net Consumers**
 - Best Rooftop Performer <300 kWh/m²/yr**
 - Ground-Mounted Turbines ~20 CF; ~450 kW/ m² /yr**

Massachusetts Cadmus Report

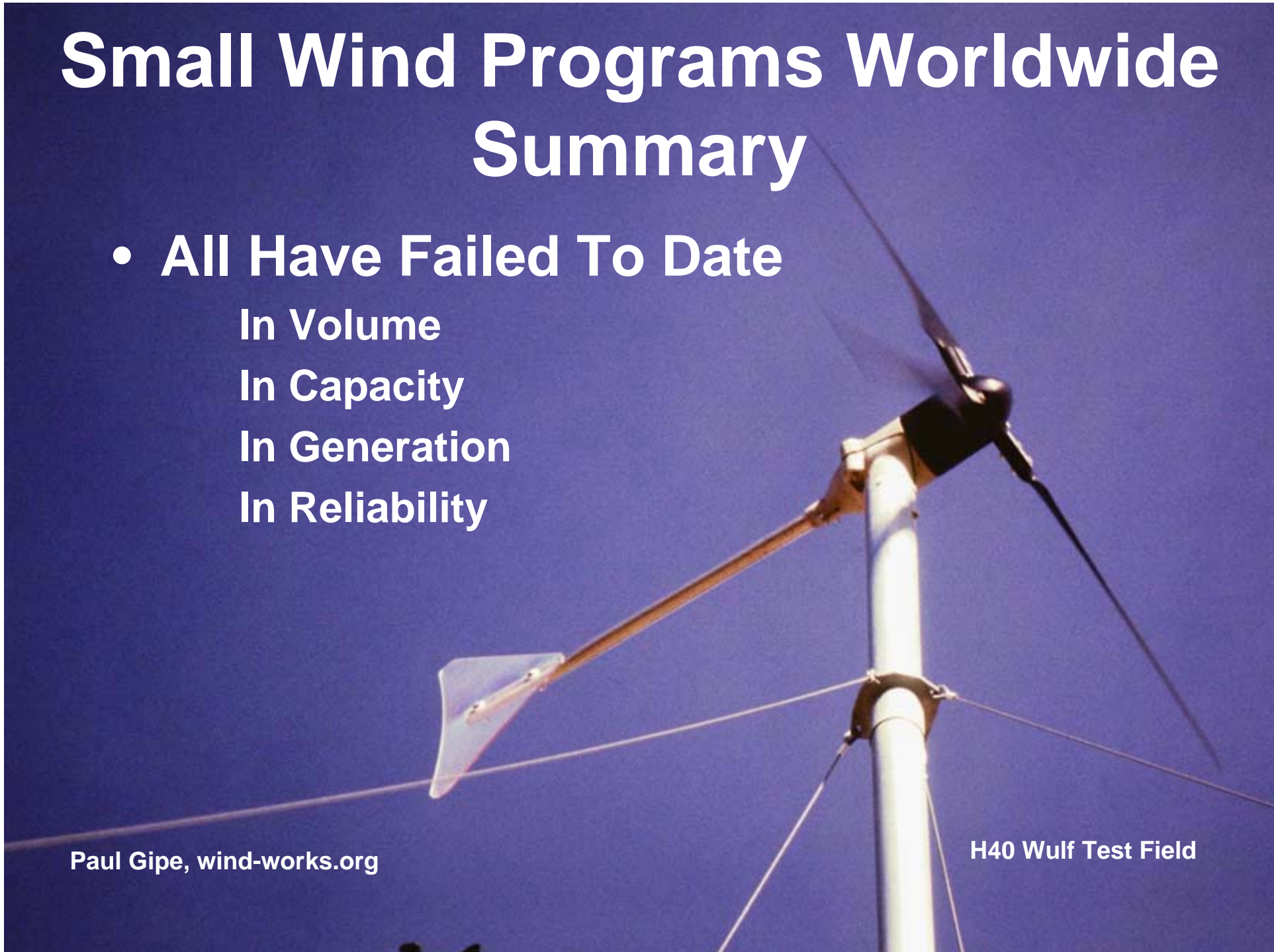
- **Monitored 21 Units**
Generation ~1/3 of Projected
- **Capacity Factor**
Best: 10-11%; Poorest: 1-4%
- **Bergey Excel**
Low: 1,300 kWh/yr; <50 kWh/m²/yr
High: 7,600 kWh/yr; ~250 kWh/m²/yr
- **ARE 442:**
9,400 kWh/yr; ~250 kWh/m²/yr
- **Ouch!**

Small Wind Programs Worldwide Summary

- **All Have Failed To Date**
 - In Volume
 - In Capacity
 - In Generation
 - In Reliability

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H40 Wulf Test Field



Paying Only for Performance Leads to Maturity

- **Estimates of Generation**
Better than Nothing
- **Metered kWh Best**
- **After 30 Years**
Time for Small Turbine Industry
to Grow Up



Small Wind: Time for Change

- **Wean the Industry From Subsidies**
Capital Grants & Rebates Have Failed
- **Move to Payment for Generation**
Production-Based Incentives?
Feed-in Tariffs?
- **Maturity: Facing Reality**
Acknowledging What Small Wind Costs
Higher than Large Wind--Lower than Solar PV
Standards to Protect Consumers

Small Wind Feed-in Tariffs

- **No Proof Yet**
Feed-in Tariffs Will Make Small Wind a Success
- **Worked for Large Turbines**
Feed-in Tariffs Led Way to Maturity



Existing World Small Wind Tariffs

	Years	€/kWh	CAD/kWh	USD/kWh
Portuagal	15	0.432	0.680	0.620
Italy <200 kW	15	0.300	0.472	0.431
Israel <15 kW	20	0.294	0.462	0.422
Israel <50 kW	20	0.230	0.361	0.329

Existing North American Small Wind Tariffs

	Years	€/kWh	CAD/kWh	USD/kWh
Vermont <15 kW	20	0.139	0.219	0.200
Washington Out State	6	0.090	0.147	0.120
Washington in State	6	0.309	0.503	0.410
Wisconsin, Xcel	10	0.050	0.081	0.066
Wisconsin, MG&E	10	0.046	0.075	0.061

Proposed British Small Wind Tariffs

	Years	€/kWh	CAD/kWh	USD/kWh
1.5 kW-15 kW	20	0.261	0.411	0.375
15 kW-50 kW	20	0.205	0.322	0.294
50 kW-250 kW	20	0.205	0.322	0.294

Proposed US Small Wind Tariffs

	Years	€/kWh	CAD/kWh	USD/kWh
MI <2,000 ft ²	20	0.188	0.307	0.250
MN <1,000 ft ²	20	0.188	0.307	0.250
IP&L>50 <100 kW	10	0.105	0.172	0.140

Skystream Tariff Needed Assumptions

- **\$13,500 Installed**
- **Yield from SWP Estimates***
- **Annual Reoccurring Expenses: 4%**
- **6 m/s**

*** Not Independently Verified.**



Skystream Tariff Needed Chabot Profitability Index Method

Average Weighted Cost of Capital <u>Before Tax</u>			
Equity			20%
Return on Equity	ROE		13.0%
Debt			80%
Interest on Debt			6.94%
Nominal AWCC			0.0815
Inflation			3.0%
AWCC real	t		5.0%

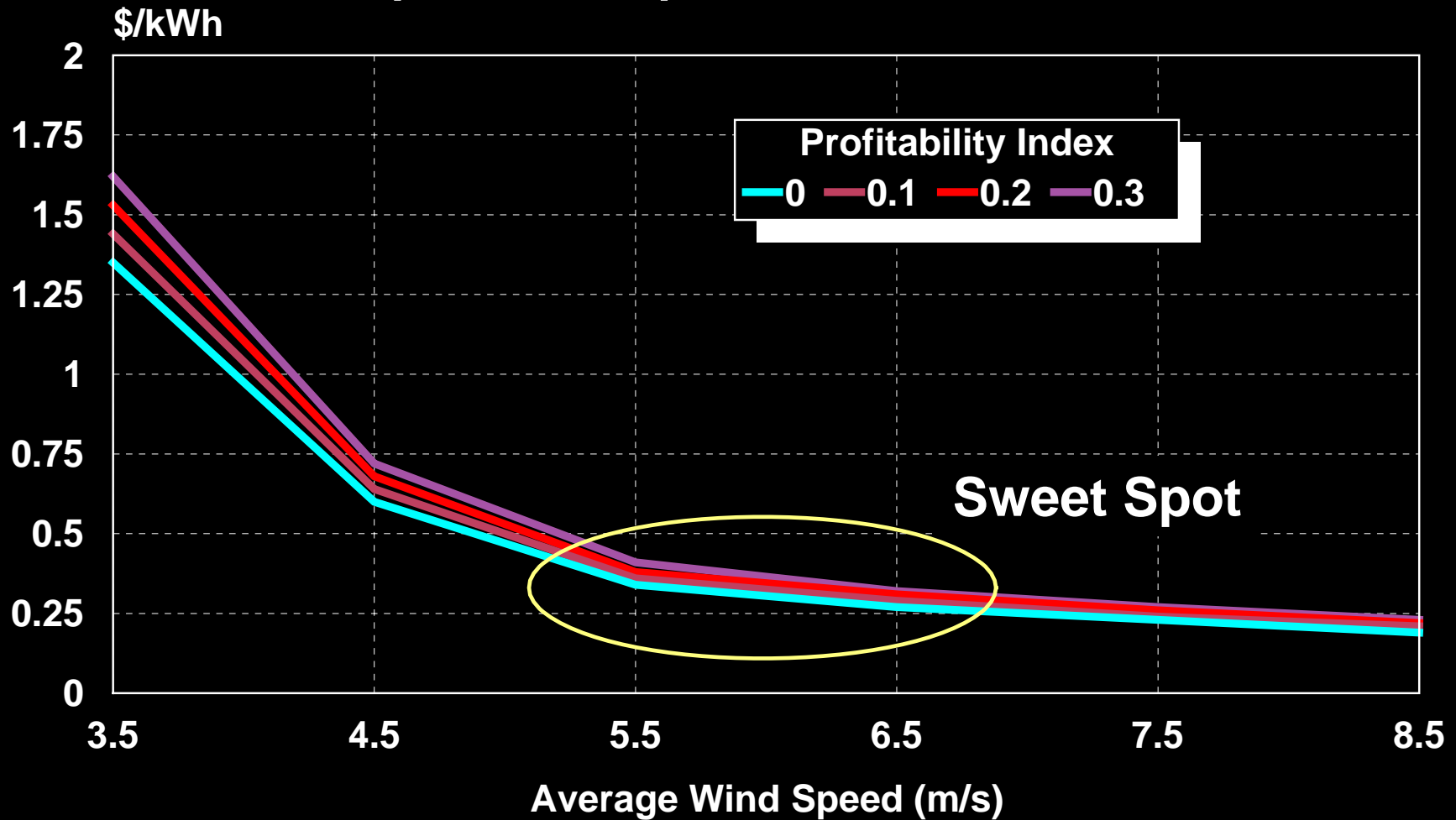
Skystream Tariff Needed

Chabot Profitability Index Method

Rotor Diameter	3.7	11	m2
Installed Cost	I	\$13,500	
Specific Installed Cost	Ius	\$1,256	\$/m2
Annual Expenses	Kom	4.0%	
Term	n	20	years
Discount Rate (AWCC)	t	5.0%	real
Specific Yield	Eas	446	kWh/m2/y
Capital Recovery Factor (n,t)	Kd	0.0802	
Profitability Index Target	PI	0.3	NPV/I
Cost of Energy	T1	\$0.406	\$/kWh
Simple Payback	SPBT	9.6	years

Skystream Tariff Needed

\$0.30-\$0.38/kWh

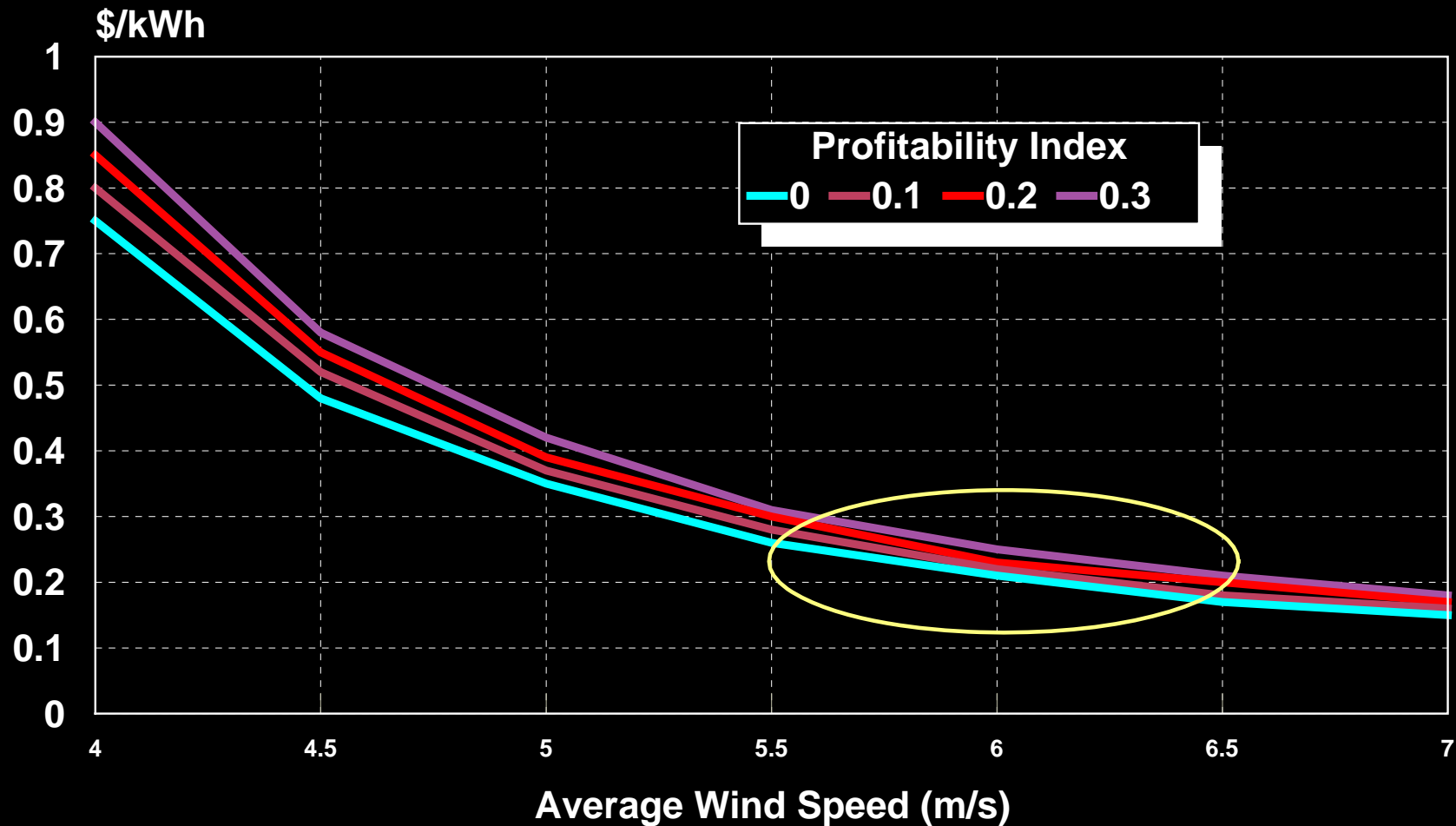


Entegrity Tariff Needed Assumptions

- **\$205,000 Installed**
- **Yield from Entegrity Estimates**
- **Annual Reoccurring Expenses: 4%**



Entegrity Tariff Needed \$0.20-\$0.25/kWh at 6 m/s



Small Wind Tariff Summary

	CAD/kWh
Italy	0.50
Israel	0.40-0.50
Switzerland	0.21
Vermont	0.22
Britain	0.30-0.40

Canadian Small Wind Tariff



	CAD/kWh
Tier 1: <50 m ²	0.30-0.40
Tier 2: >50 m ² <500 m ²	0.20-0.25

Olivier Krug--Krug Wind France's Largest Small Wind Installer What's Needed

- **Compulsory Standards**
For Products & For Installers
- **Inform Public**
About What Small Wind Can & Cannot Do
- **Adapt Zoning to Tall Towers**
- **Right to Connect**
- **Move to Feed-in Tariffs**
No More Subsidies, Grants, Tax Credits

Small Wind--What's Needed Informed Consumers

- **Demand Better Products**
Less Susceptible to Hustlers & Charlatans
- **Know What They're Buying**
- **Know What to Expect**
Published Performance Tests
- **Know What is Being Delivered**
Metering a Must

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Small Wind--What's Needed

- **Standards & Certification**
For Products & Installers
- **Testing**
with Published Results!
- **Facing Reality**
Small Wind's Limits



Hinesburg, Vermont



Small Turbines Must Become as Productive as Large Turbines to Fulfill Their Promise

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**The Small Wind
Industry Needs
Advanced
Renewable
Tariffs or it Will
Remain
Insignificant**

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Ydby, Denmark



**Now Available
from
Chelsea Green**

WIND ENERGY BASICS

**A Guide to Home- and
Community-Scale Wind
Energy Systems**

SECOND EDITION

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