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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](http://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](http://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

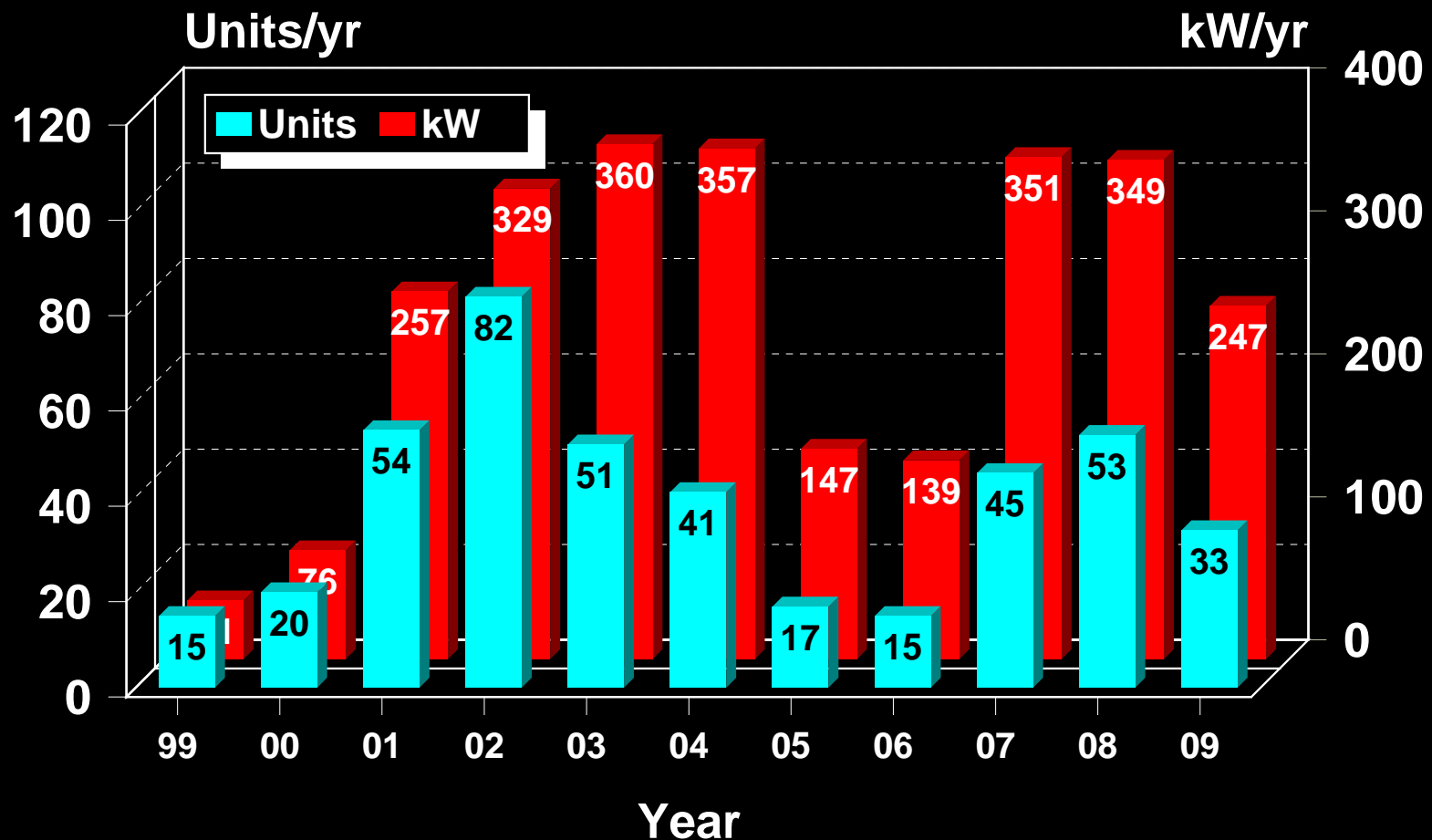


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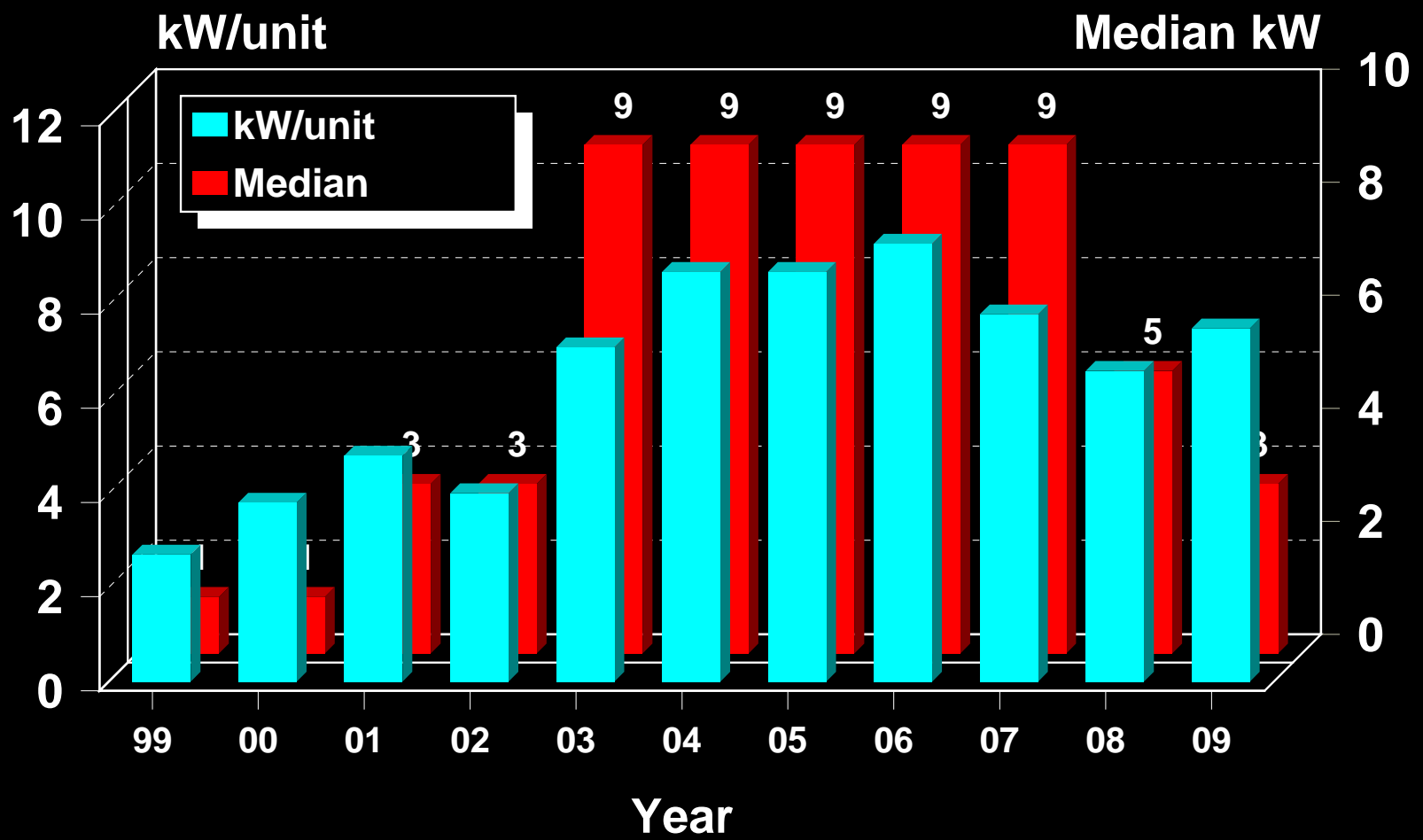
# California Small Wind Program Results

- **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!**

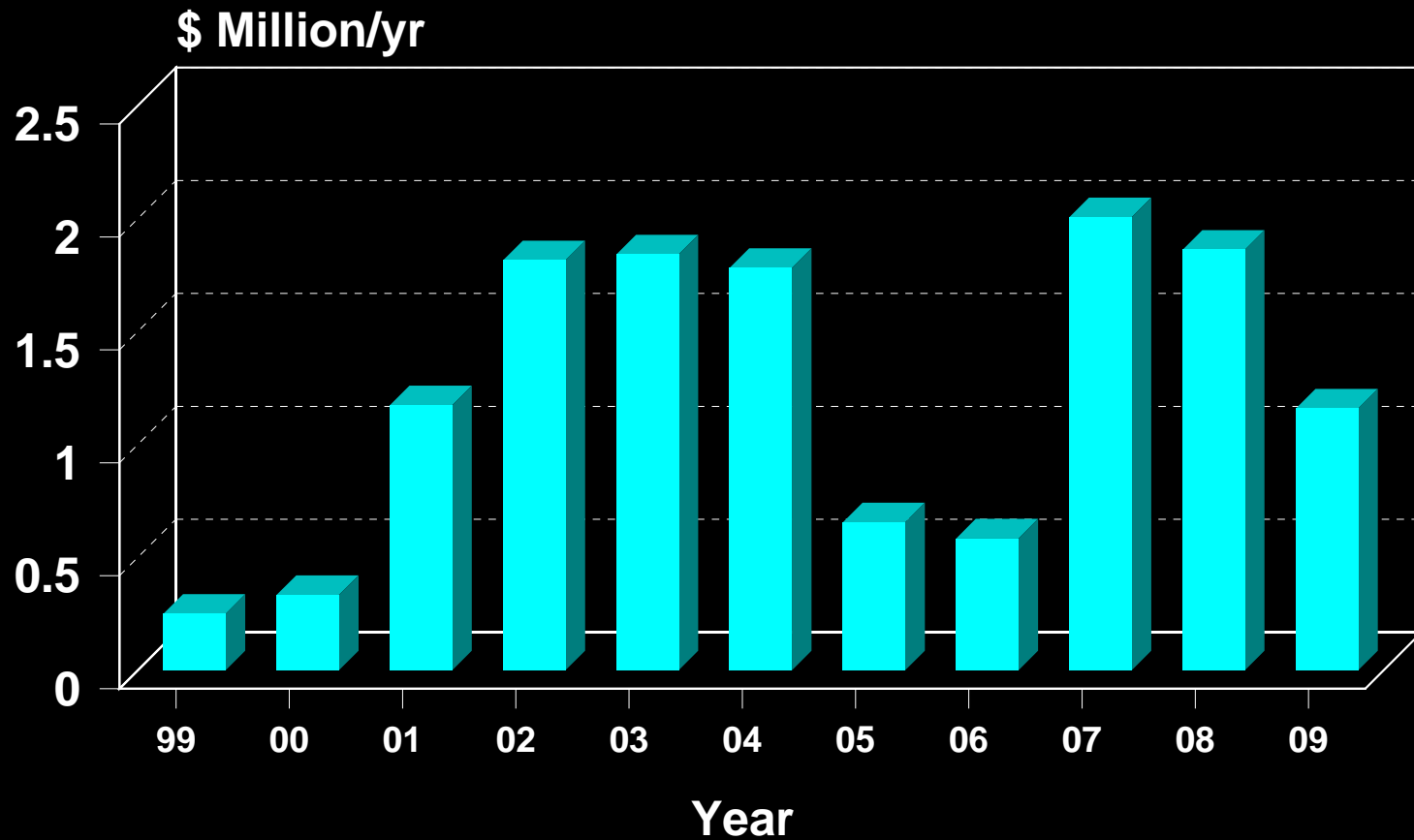
# California Small Wind Program Results



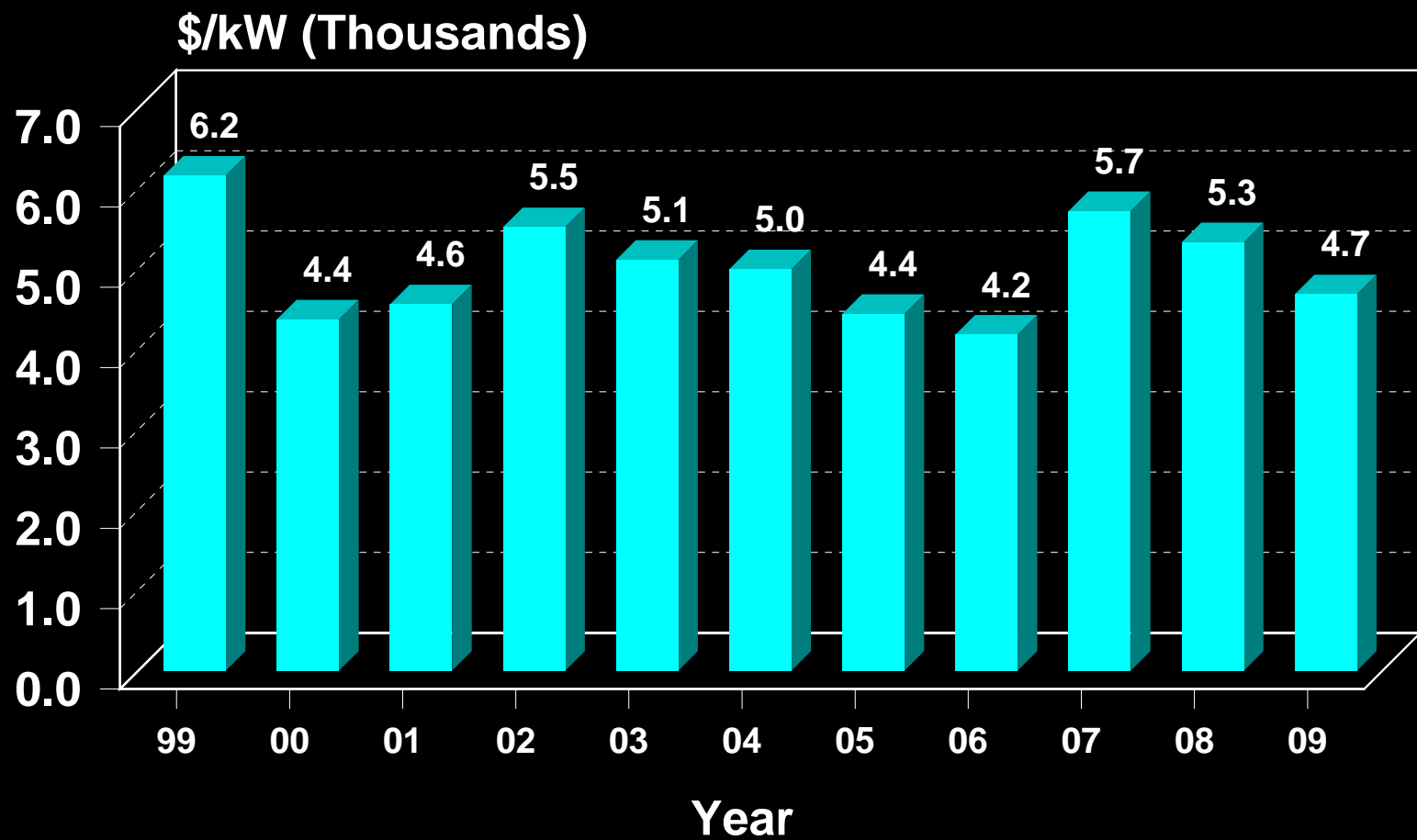
# California Small Wind Program Results



# 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/m<sup>2</sup>/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

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

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

**Paul Gipe, [wind-works.org](http://wind-works.org)**

# 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/m<sup>2</sup>/yr**

**Ground-Mounted Turbines ~20 CF; ~450 kW/ m<sup>2</sup> /yr**

# Massachusetts Cadmus Report

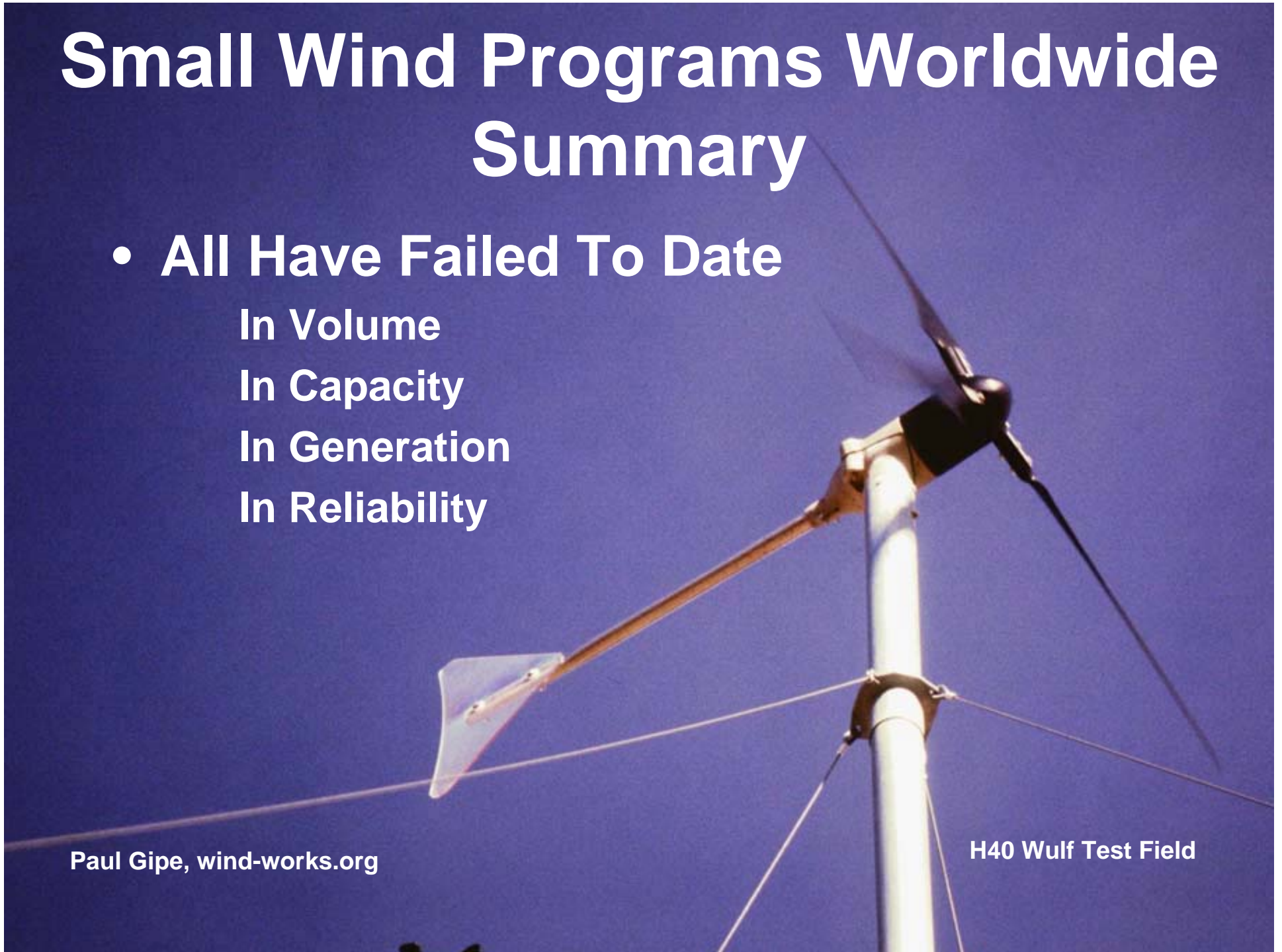
- **Monitored 21 Units**  
    **Generation ~1/3 of Projected**
- **Capacity Factor**  
    **Best: 10-11%; Poorest: 1-4%**
- **Bergey Excel**  
    **Low: 1,300 kWh/yr; <50 kWh/m<sup>2</sup>/yr**  
    **High: 7,600 kWh/yr; ~250 kWh/m<sup>2</sup>/yr**
- **ARE 442:**  
    **9,400 kWh/yr; ~250 kWh/m<sup>2</sup>/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 <sup>2</sup>	20	0.188	0.307	0.250
MN <1,000 ft <sup>2</sup>	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

<b>Average Weighted Cost of Capital <u>Before Tax</u></b>			
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%

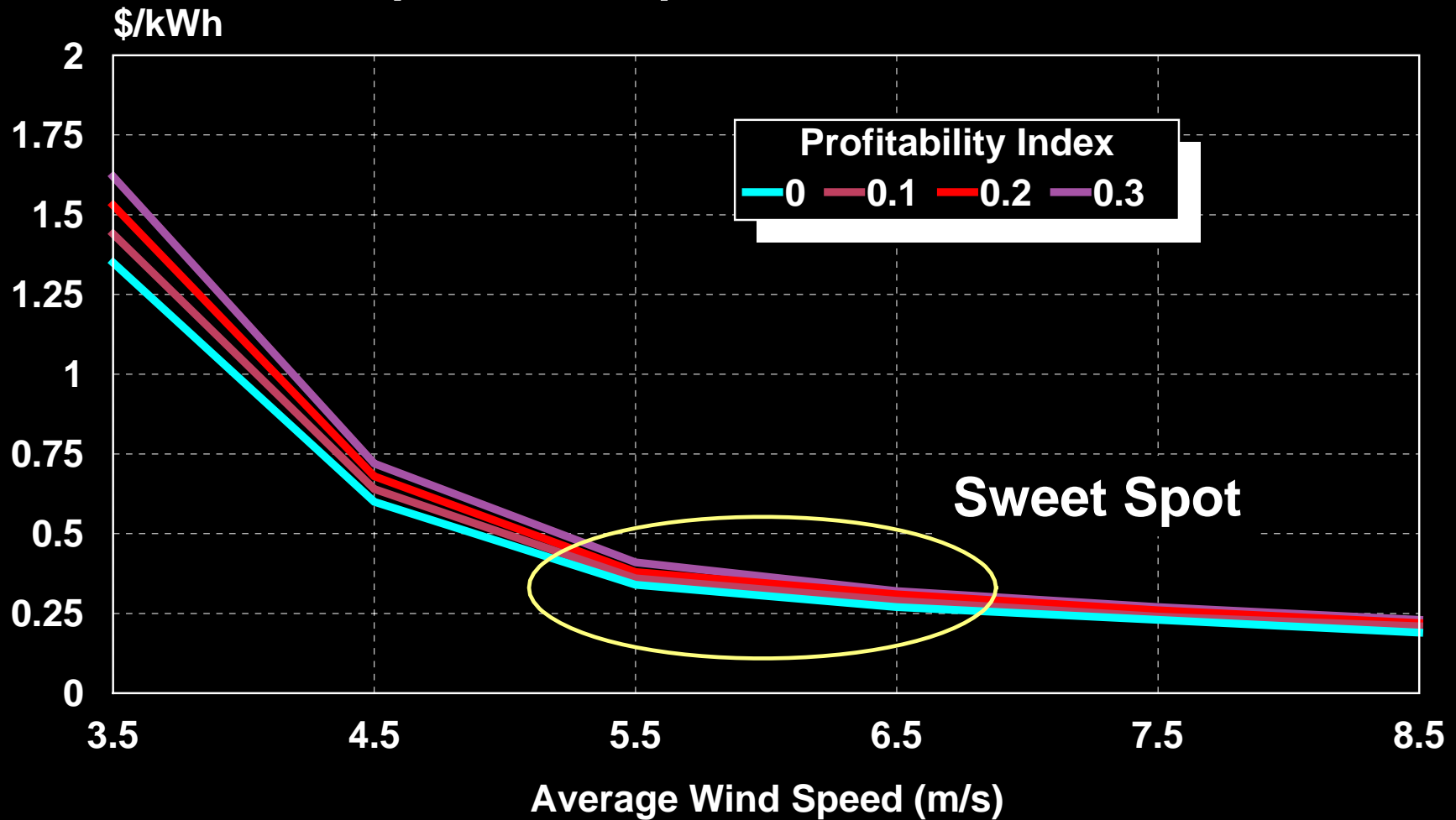
# Skystream Tariff Needed

## 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

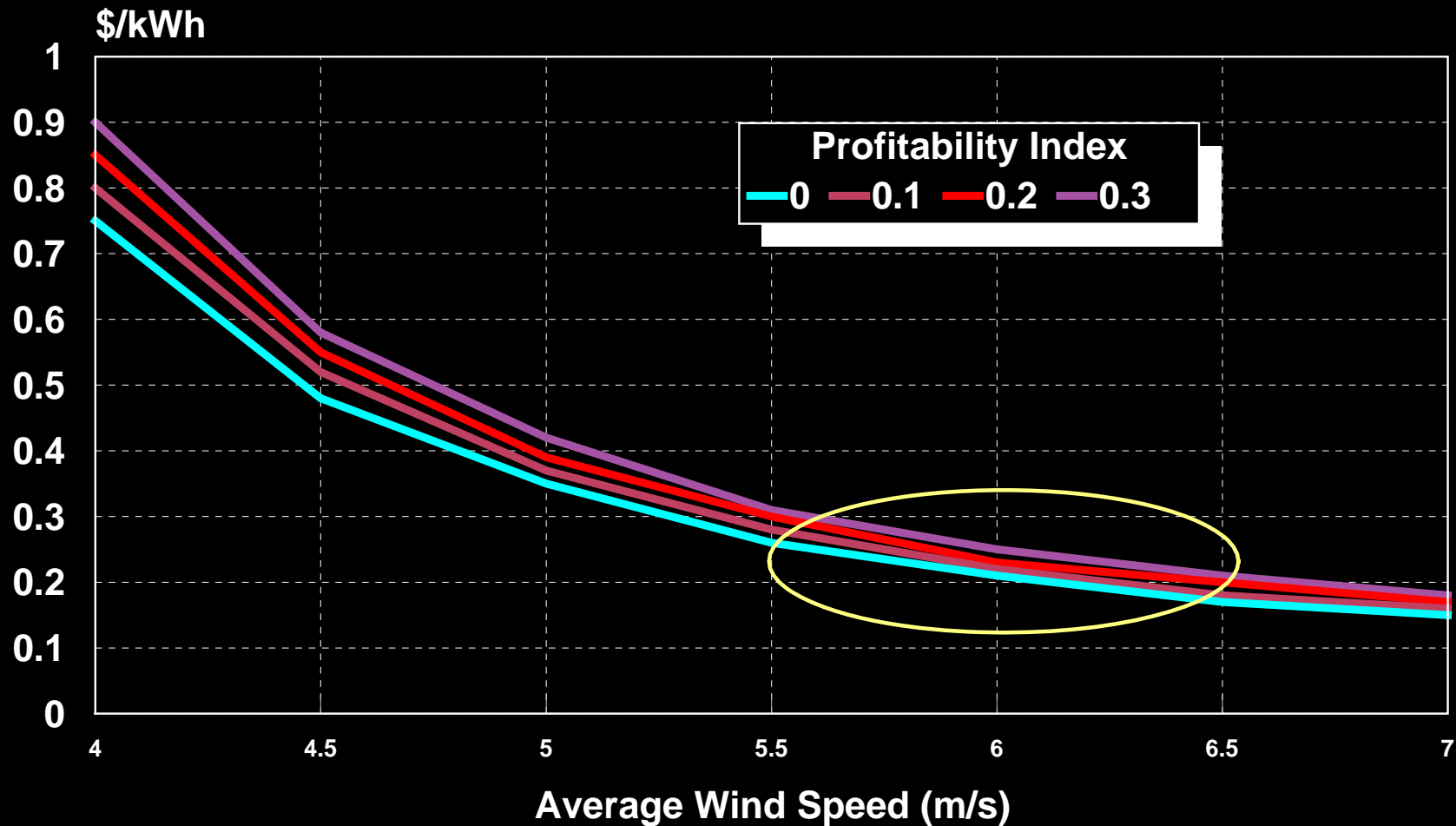


# Entegrity Tariff Needed Assumptions

- **\$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
<b>Italy</b>	<b>0.50</b>
<b>Israel</b>	<b>0.40-0.50</b>
<b>Switzerland</b>	<b>0.21</b>
<b>Vermont</b>	<b>0.22</b>
<b>Britain</b>	<b>0.30-0.40</b>

# Canadian Small Wind Tariff



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

Paul Gipe, [wind-works.org](http://wind-works.org)



# Small Wind--What's Needed

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



Hinesburg, Vermont



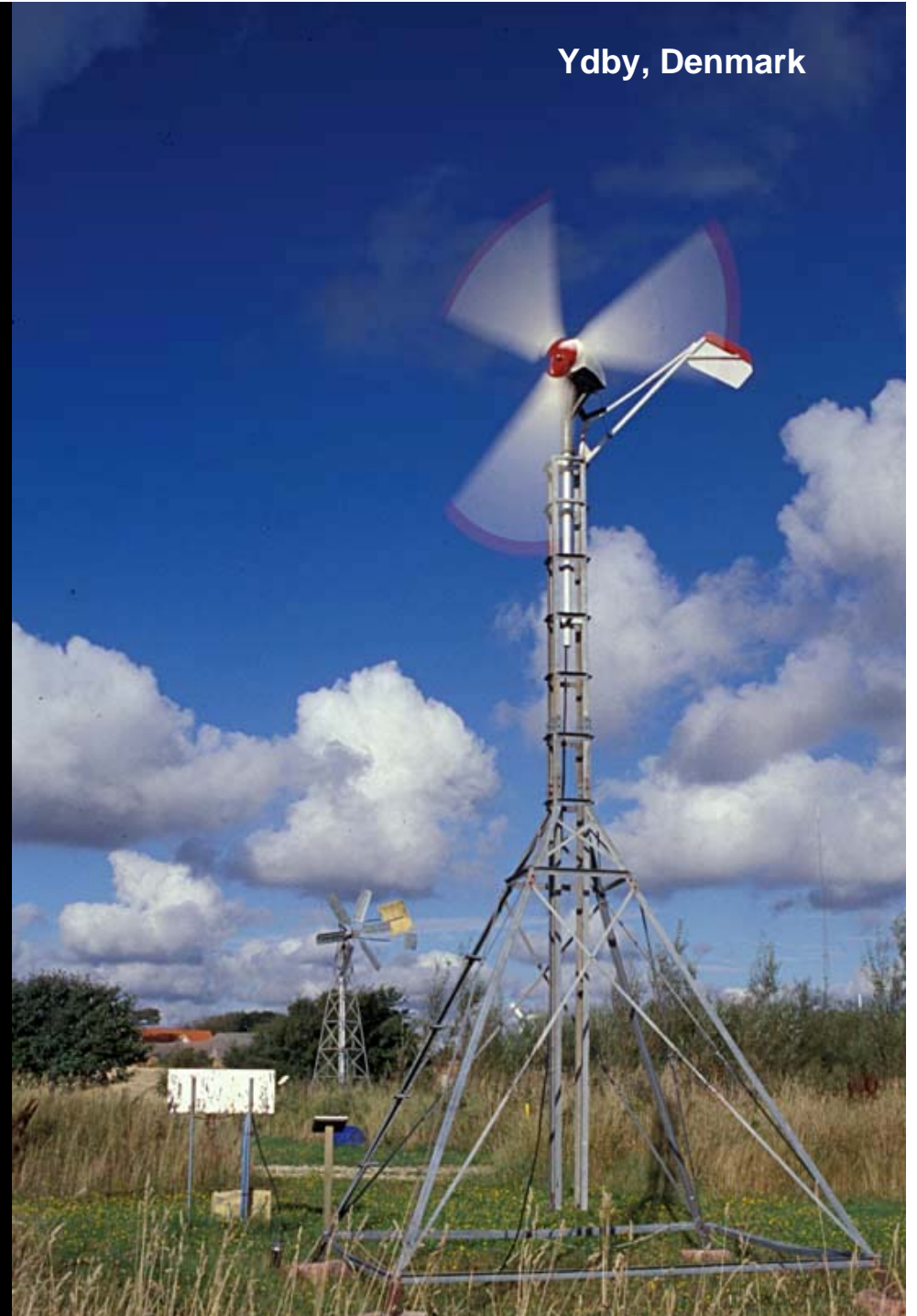
**Small Turbines  
Must Become  
as Productive  
as Large  
Turbines to  
Fulfill Their  
Promise**

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

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