Disclaimer: The views expressed are those of Paul Gipe and are not necessarily those of the sponsor.

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.

Small Wind in North America The Good, the Bad, the Ugly Real Urban Wind & the Community Power Revolution by Paul Gipe

Paul Gipe, wind-works.org

Small Wind--A Checkered Past

- Poor Performance
- Poor Reliability
- Costly
- Noisy
- Magnet for Hustlers & Charlatans
- Unsafe

Paul Gipe, wind-works.org

Poor Performance

- **1/2 That of Large Turbines**

  At Best

- **Seldom Meet Projections**
- **Short Towers= Big Problem**

Holzhausen, Germany
Paul Gipe, wind-works.org

Incredible Shrinking Wind Turbine

- Air 403: 400 W
- Air-X: 300 W
- Air Breeze: 200 W
- Air Breeze: 150 W
- Measured: 125 W

Air Breeze

Wulf Test Field, Tehachapi, California

Paul Gipe, wind-works.org

Too Short a Tower
Worst Turbine Install in History?

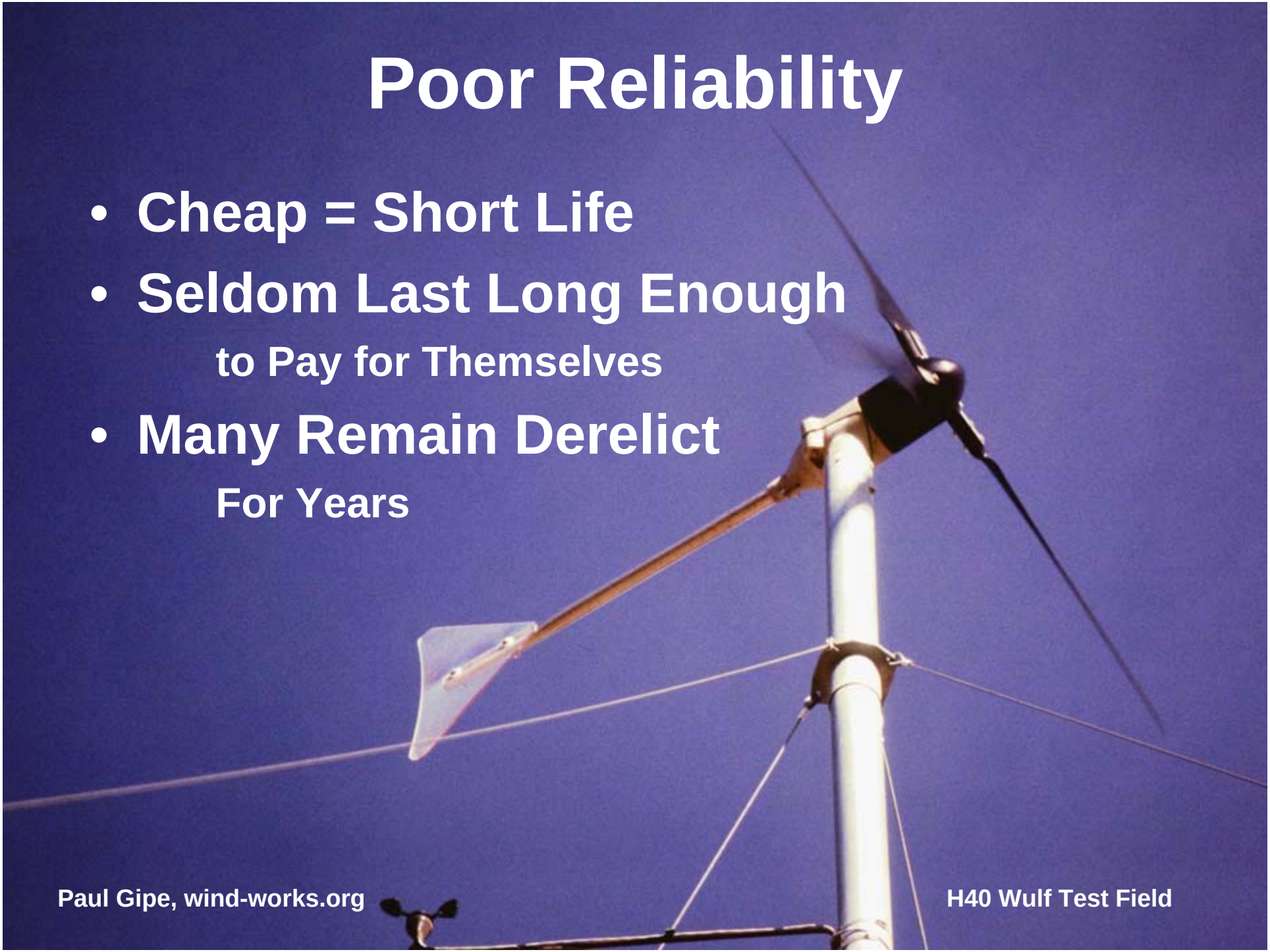
- Helix VAWT
- Seattle, WA
- If You Don't Know What's Wrong with This Picture, You Are in the Wrong Business!

Photo by Mike Nelson, WSU

Paul Gipe, wind-works.org

Poor Reliability

- **Cheap = Short Life**
- **Seldom Last Long Enough**
  - **to Pay for Themselves**
- **Many Remain Derelict**
  - **For Years**



Paul Gipe, wind-works.org

H40 Wulf Test Field

H40 4-Year Life at Wulf Test Field

- **Blade Failure**
- **Yaw Failure**
- **Insulation Failure**

Paul Gipe, wind-works.org

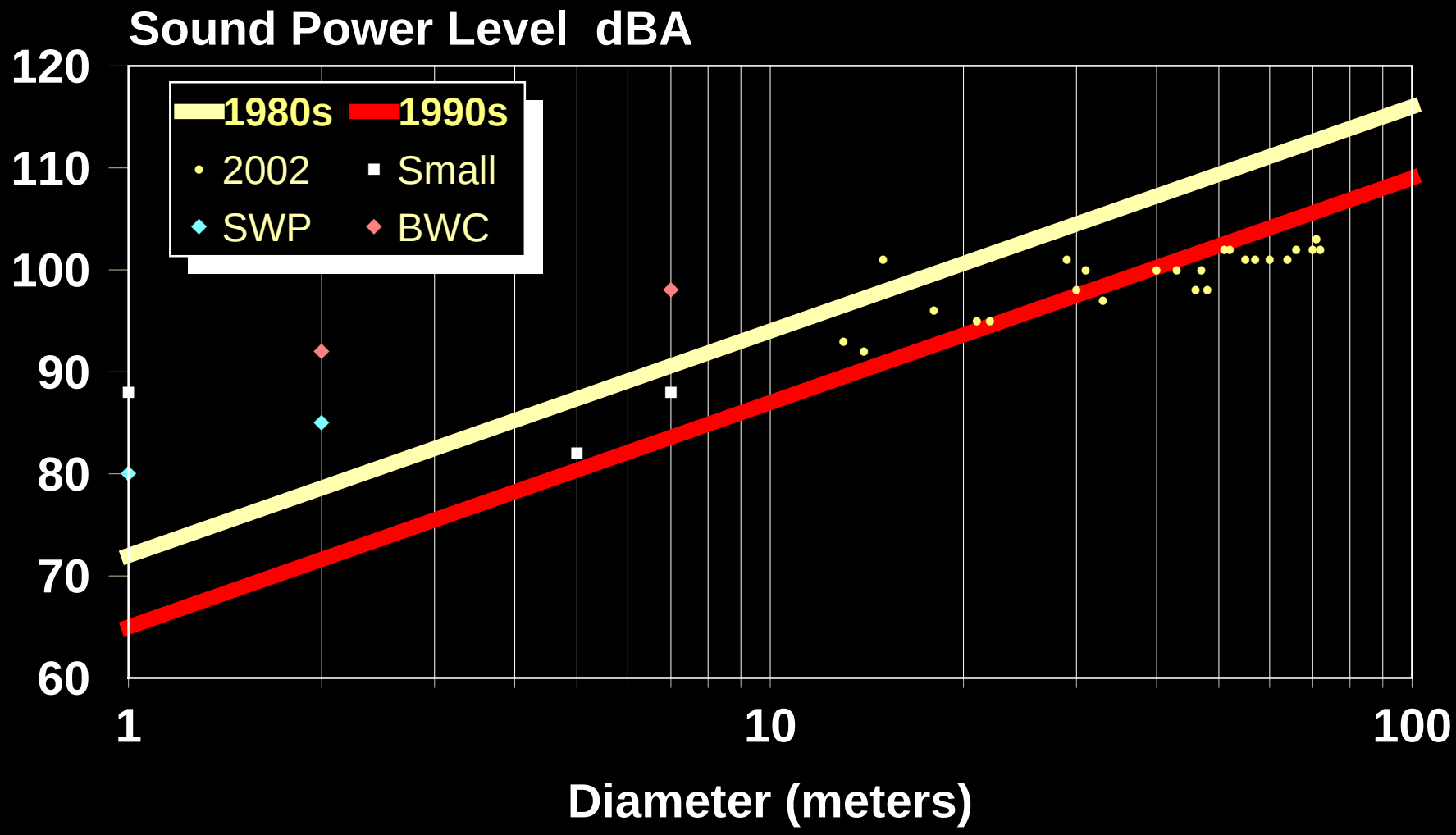
Small Wind Too Costly
3X Large Wind

Size	Low ($/m2)	High ($/m2)
Micro	1,500	2,500
Mini	1,250	2,500
Household	1,250	2,250
Small Commercial	800	1,250
Large	700	1,000

Adapted from *Wind Energy Basics: A Guide to Home- and Community-Scale Wind Energy Systems*

Paul Gipe, wind-works.org

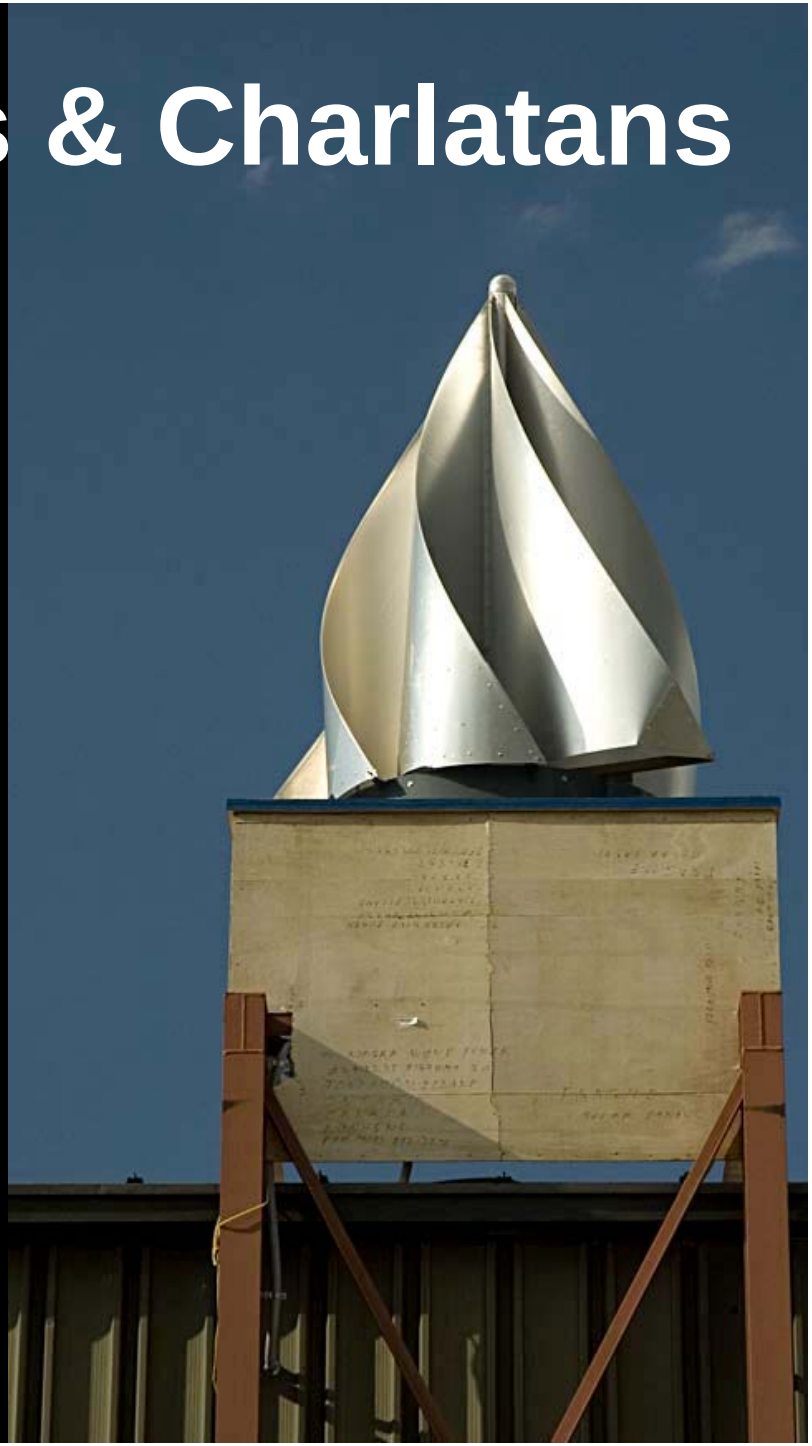
Small Wind Turbines Too Noisy



Noise Emissions: Source Sound Power Level at 8 m/s
Paul Gipe, wind-works.org

Magnet for Hustlers & Charlatans

- Ease of Entry
- Preying on Ignorance
- Pyramid Schemes
- Drag & Ducted Devices
- Fantasy Wind
- Roof Top Wind

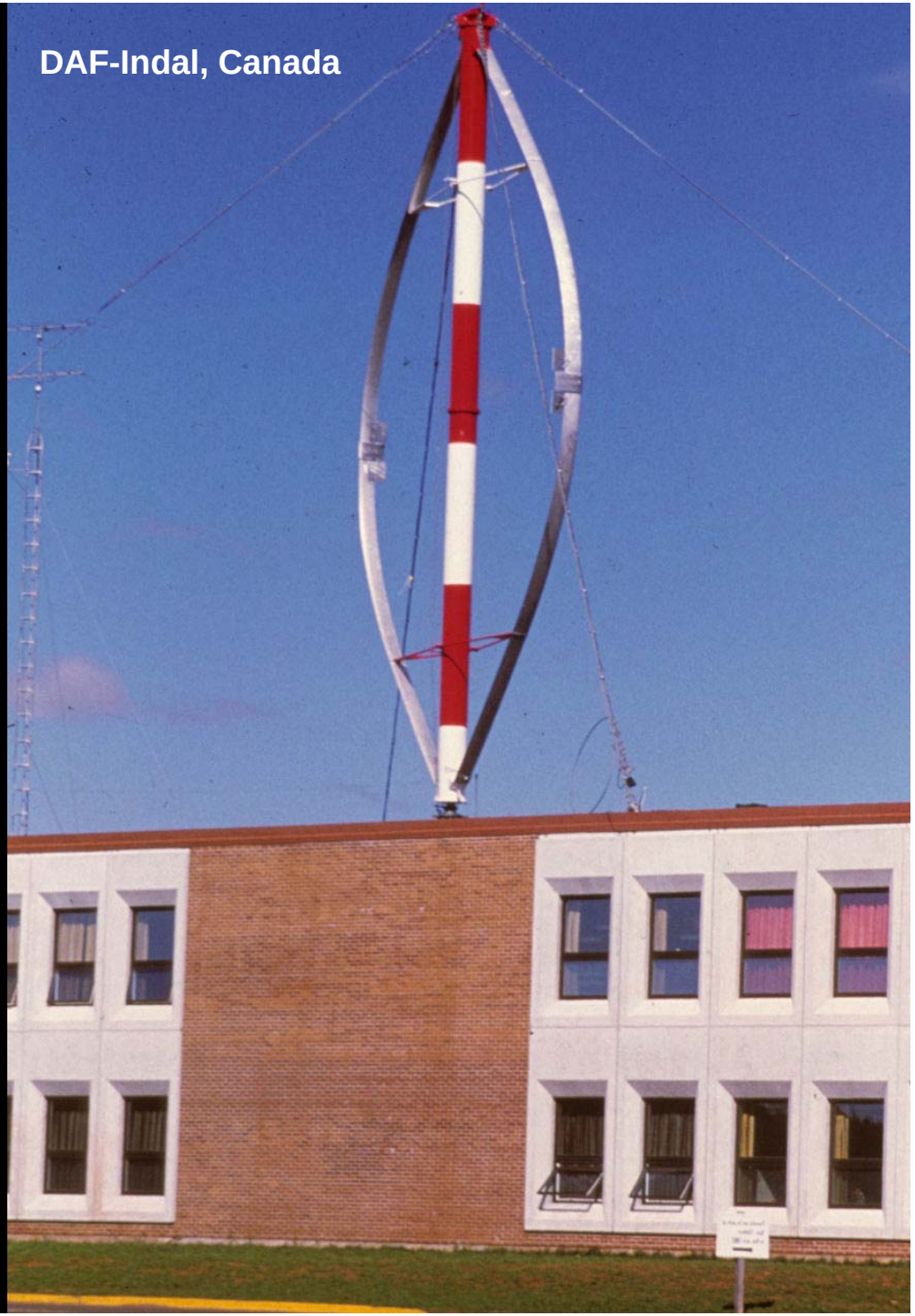


Magwind, Whitby Ontario

Paul Gipe, wind-works.org

Roof Top Mounting?

- No, Don’t Do This!
- Turbulence
- Poor Performance
  ~0 Net Energy!
- Noise & Vibration
- Safety
- Simply a Bad Idea



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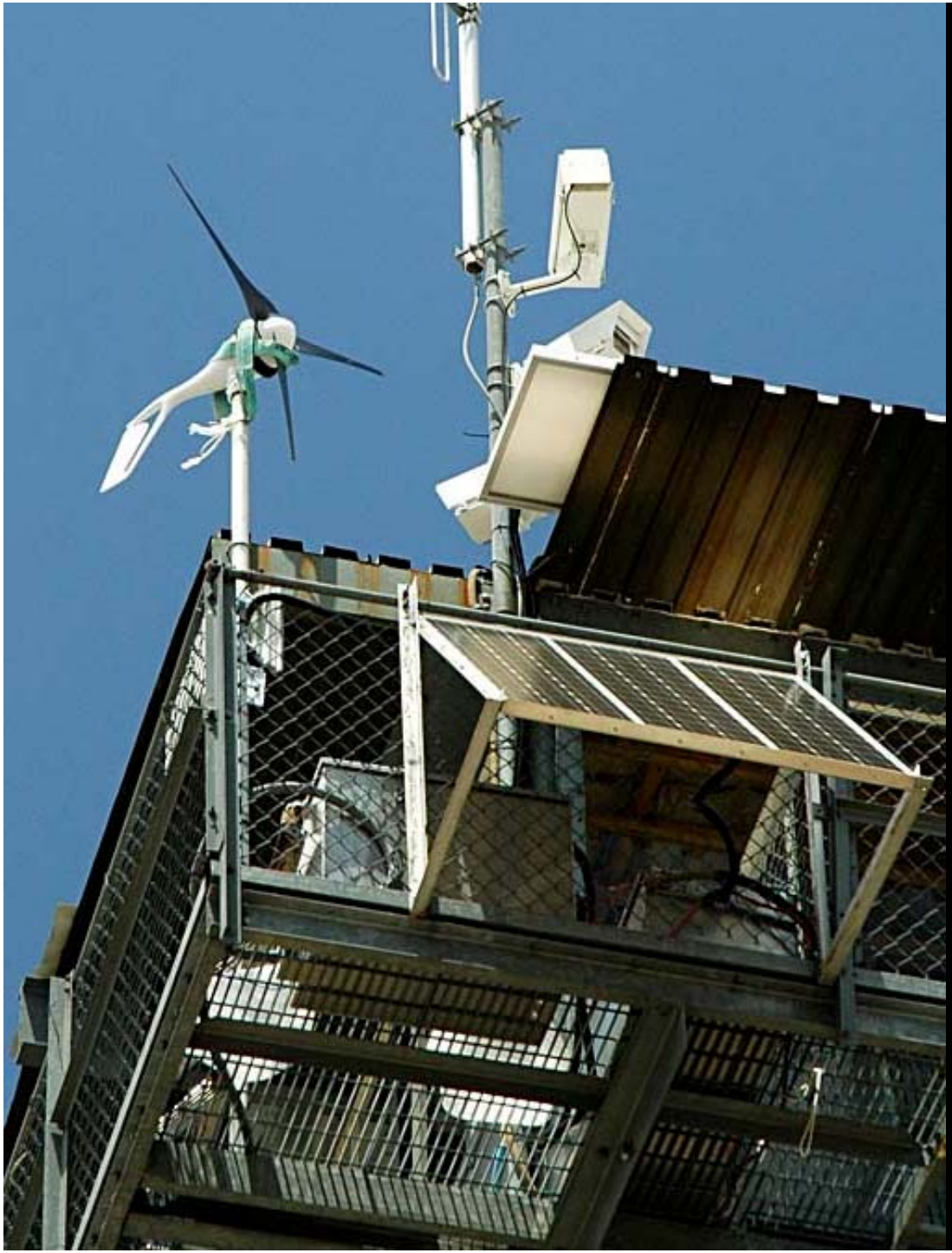
Roof Top Mounting?

- Tied Off

Paul Gipe, wind-works.org



Roof Top Mounting?

- Tied Off

Paul Gipe, wind-works.org

Small Wind Too Dangerous

- **3 Deaths <30 kW**
  Worldwide in 30 Years
- **12 Deaths <100 kW**
  Worldwide in 30 Years

Pat Acker, 28, Bushland, TX, 1982

Paul Gipe, wind-works.org

Small Wind Turbine Tower Safety

- No Fall-Arrest System
- No Work Platform
- No Anchors
- No Training

Paul Gipe, wind-works.org

Canyon, Texas, 1979

Small Wind Turbine Tower Safety

- **Tilt-up Towers**
  - **for Micros & Minis**
  - **Always Preferable**

Paul Gipe, wind-works.org

Small Wind Turbine Tower Safety

- Person Lifts
- Fall-Arrest Systems
- Work Platforms
- Anchors
- Rotor Locking Pins
- Tower Training

Paul Gipe, wind-works.org

NREL, Colorado

Small Wind Turbine Fall Safety

- Work Platform
- Anchors
- Full Harness
- Lanyard

Paul Gipe, wind-works.org

Folkecenter, Denmark, 1997

Small Wind Programs Overview

- **The “Best” On-Grid Programs**
  - **in USA by Mick Sagrillo & Mike Bergey**
- **The Results**
  - **Units, MW, Performance**
- **Time for Change**
  - **Long Overdue**
- **Proposed Feed-in Tariffs**

Paul Gipe, wind-works.org

Mick Sagrillo
Wisconsin's Small Wind Guru

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

Paul Gipe, wind-works.org

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

Wisconsin Focus on Energy Results

- ~70 units, ~1.2 MW
- ~2/3 of Capacity:
  - Second-Hand Danish Turbines
- No Performance Measurements
- That's All--After 6 Years!
- Large Turbines in Wisconsin: ~500 MW

Mike Bergey--Bergey Windpower

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

California (CEC) Emerging Renewables Program

- **Traditional Stepped Subsidy**
  - **to Increase Volume and Lower Installed Cost**
- **Two Tranches**
- **Product Must be Certified to Qualify**
- **No Measurements & No Monitoring**

Paul Gipe, wind-works.org

CEC Emerging Renewables Results

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

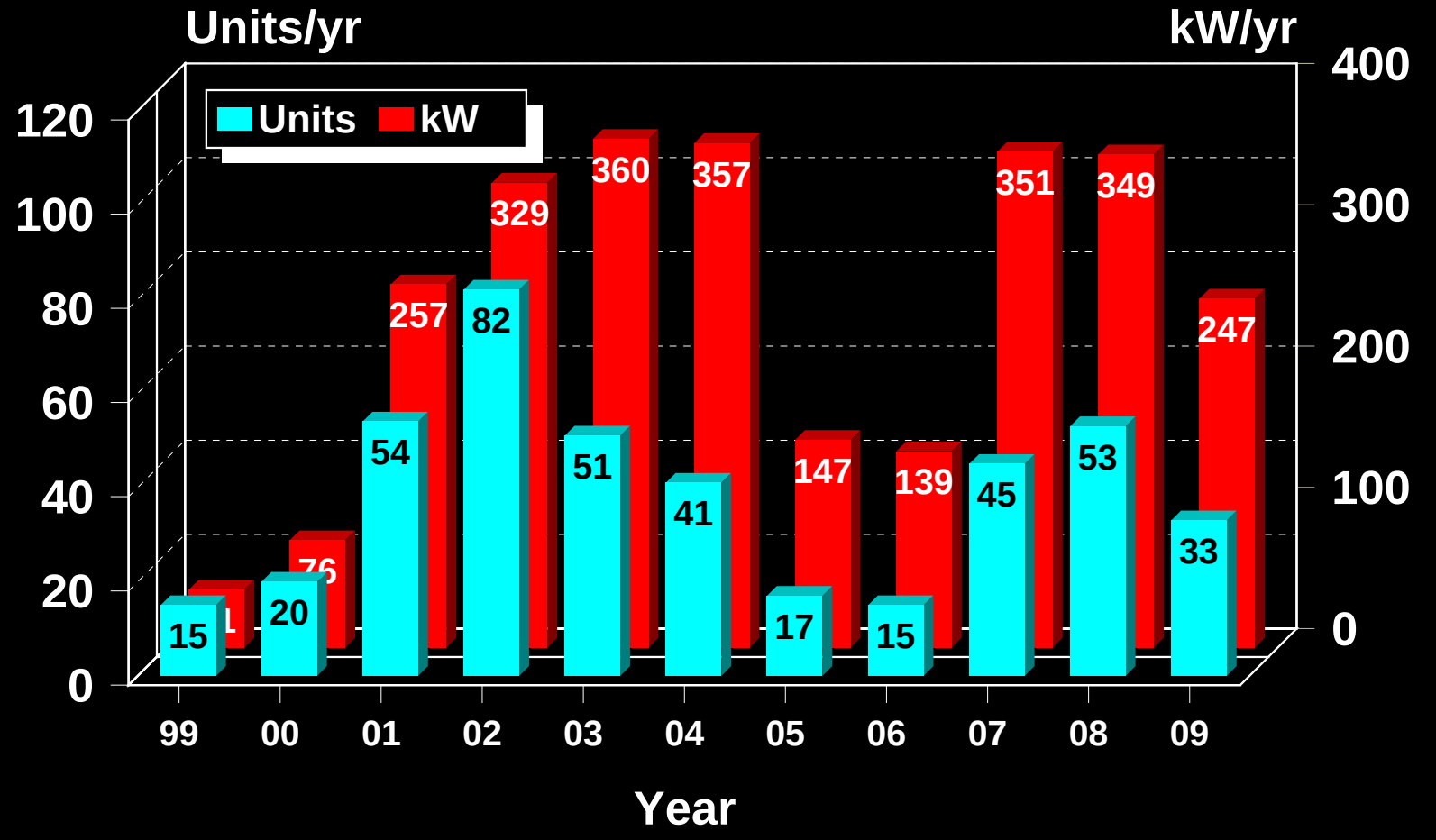
Paul Gipe, wind-works.org

Tehachapi, California

California Small Wind Program Results

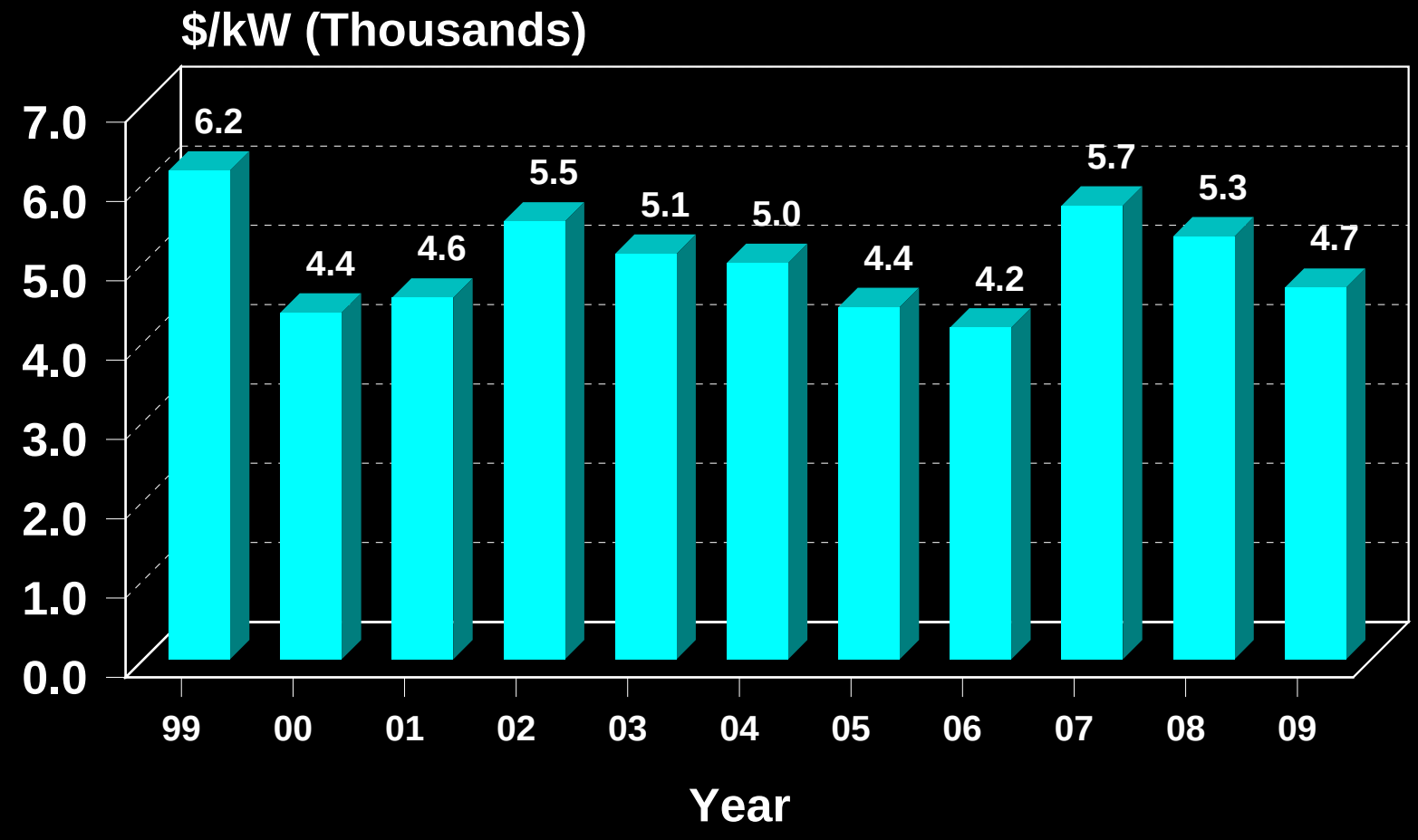
- Since 1998--12 Years
- Total Installed: 426 units
- Total Installed: 2.6 MW!
- Average: 40 units/yr; 250 kW/yr
- No Performance Data!
- No Reports!

California Small Wind Program Results



Paul Gipe, wind-works.org

California Small Wind Program Results



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Oregon Small Wind: Results

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

Massachusetts Performance 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^2/yr**
  - **High: 7,600 kWh/yr; ~250 kWh/m^2/yr**
- **ARE 442:**
  - **9,400 kWh/yr; ~250 kWh/m^2/yr**
- **Ouch!**

Paul Gipe, wind-works.org

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

Paul Gipe, wind-works.org

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**

Paul Gipe, wind-works.org

Small Wind Programs in USA

- **Wisconsin: Failed**
- **California: Failed**
- **Oregon: Failed**
- **Washington State: Failed**
- **USA: Failed**

Skystream, Alexandria, Indiana

Paul Gipe, wind-works.org

Small Wind Programs Worldwide Summary

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

Paul Gipe, wind-works.org

H40 Wulf Test Field

Scams, Frauds, & Flakes
How to Identify

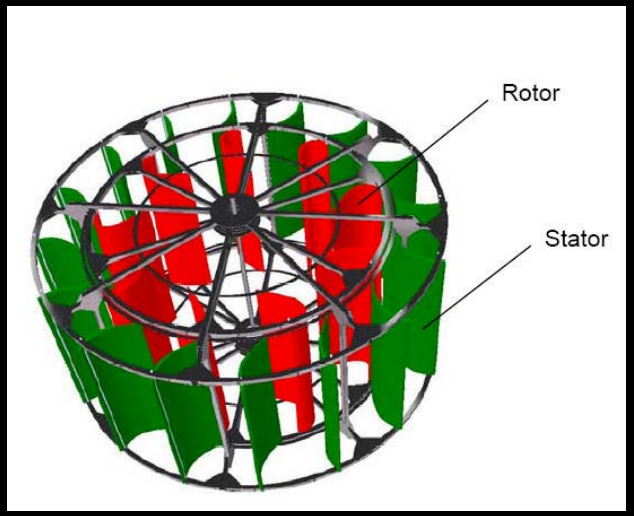
- **Heavy on Hype--Weak on Experience**
- **Fancy Web Site**
  - **Web Sites are Much Cheaper than Real Turbines**
- **Aggressive Marketing**
  - **Watch for Multi-Level Pyramid Schemes**
  - **“Get in on the Ground Floor”**
- **“New” Design, “Not Like The Others”**
  - **Often VAWTs, Squirrel Cage, Ducted (DAWT)**

Scams, Frauds, & Flakes
How to Identify

- **Patents**
  - **Rarely Mean Anything**
- **Works at Low Speeds (<3 m/s)**
  - **There's Little Power in Low Winds**
- **Silent!**
  - **Yes, Because They Seldom Do Anything**
- **Doesn't Kill Birds**
  - **Yeah, right!**

Ventilators & Squirrels in a Cage?
Gual Perpignan

- **Forget It!**
- **No Update Since 2006**



© GUAL Industrie

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Ducted Turbines (Enflo)

Paul Gipe, wind-works.org

What We've Learned after 30 Years

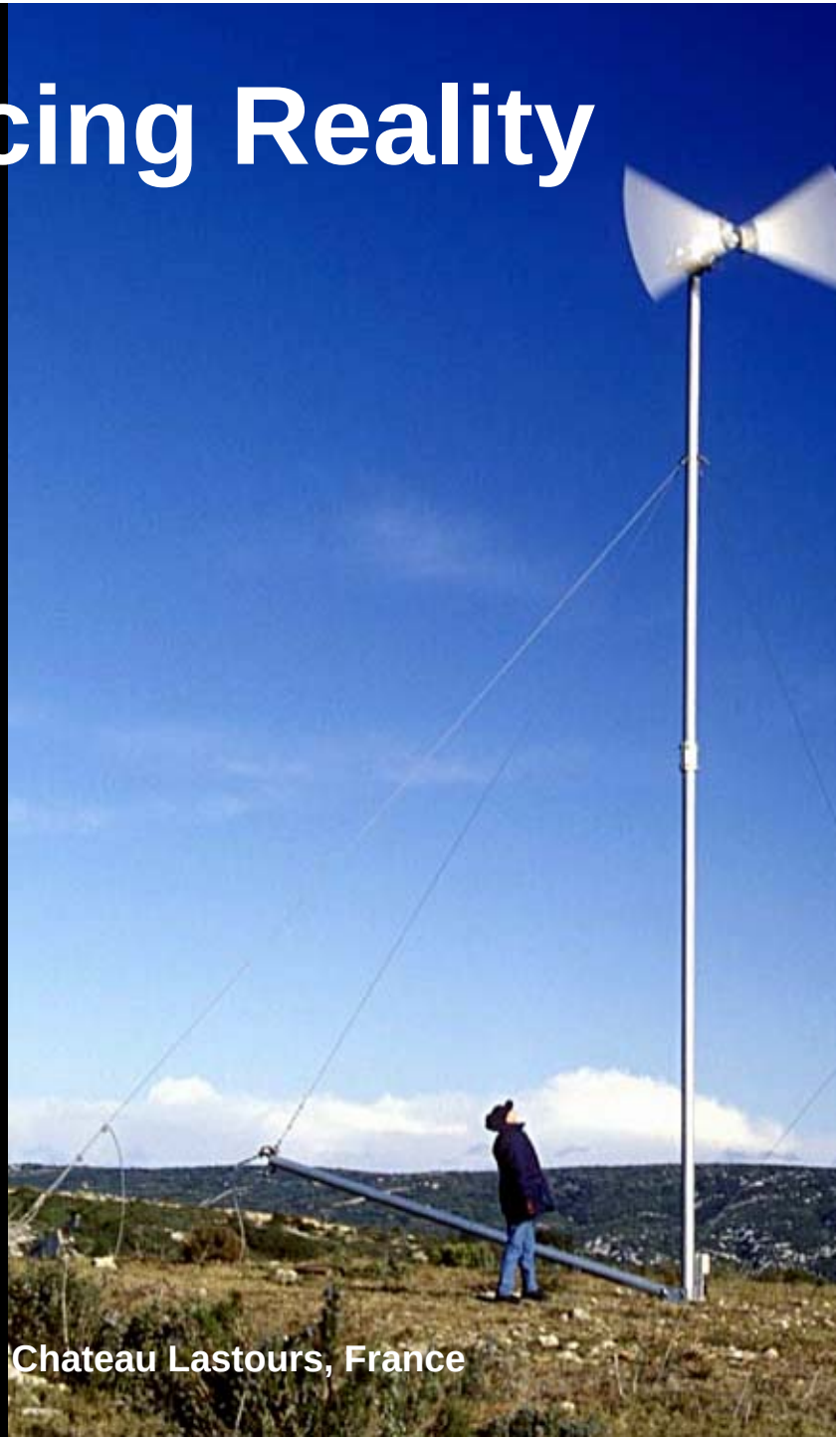
- **Always Check the Numbers**
  - **The Numbers Often Do Not Add Up**
- **Always Check the References**
  - **References Sometimes Discredited**
- **Always Google**
  - **Lots of Knowledgeable Critics on the Web**
- **Always Do Your Homework**
  - **Read a (Good) Book!**

What We've Learned after 30 Years

- No Panaceas
- No Cheap Solutions
- No Breakthroughs--No Miracles
- Numbers Matter
- Experience Matters
- Size Matters
    - Can't Get Much Energy Out of a Small Rotor

Small Wind--Facing Reality

- **Many SWT**
  - **Not Ready for Prime Time**
- **Performance Will Lag**
  - **Large Turbines**
- **Micros & Minis**
  - **for Battery Charging Only?**
- **Many New “Inventions”**
  - **Highly Questionable**



Chateau Lastours, France

Paul Gipe, wind-works.org

Small Wind: Time to Grow Up

- **Wean the Industry From Subsidies**
  - **Subsidies Have Failed**
- **Face Reality**
  - **Small Wind Costly**
  - **Standards to Protect Consumers**
- **Pay Only for Performance**
  - **Leads to Maturity**
  - **Time for Feed-in Tariffs?**

Paul Gipe, wind-works.org

Small Wind Feed-in Tariffs

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

Folkecenter, Denmark

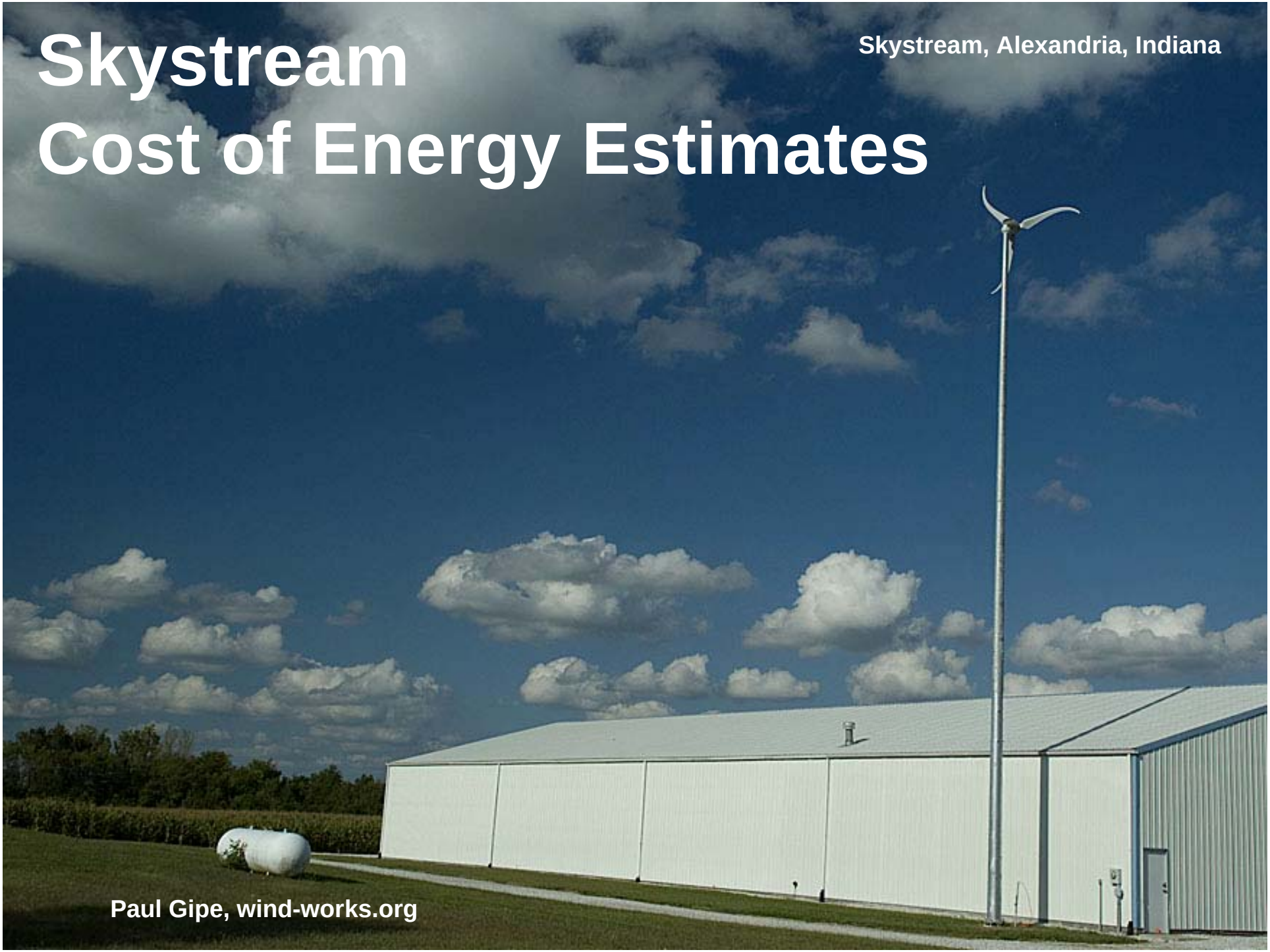
Paul Gipe, wind-works.org

Existing North American Small Wind Tariffs

	Years	€/kWh	CAD/kWh	USD/kWh
Vermont <15 kW	20	0.139	0.219	0.200

Paul Gipe, wind-works.org

Skystream
Cost of Energy Estimates



Skystream, Alexandria, Indiana

Paul Gipe, wind-works.org

Skystream Tariff Needed Assumptions

- $13,500 Installed
- Yield from SWP Estimates*
- Annual Reoccurring Expenses: 4%
- 6 m/s
- ~2 kW, 3.7 m

* Not Independently Verified.

Paul Gipe, wind-works.org

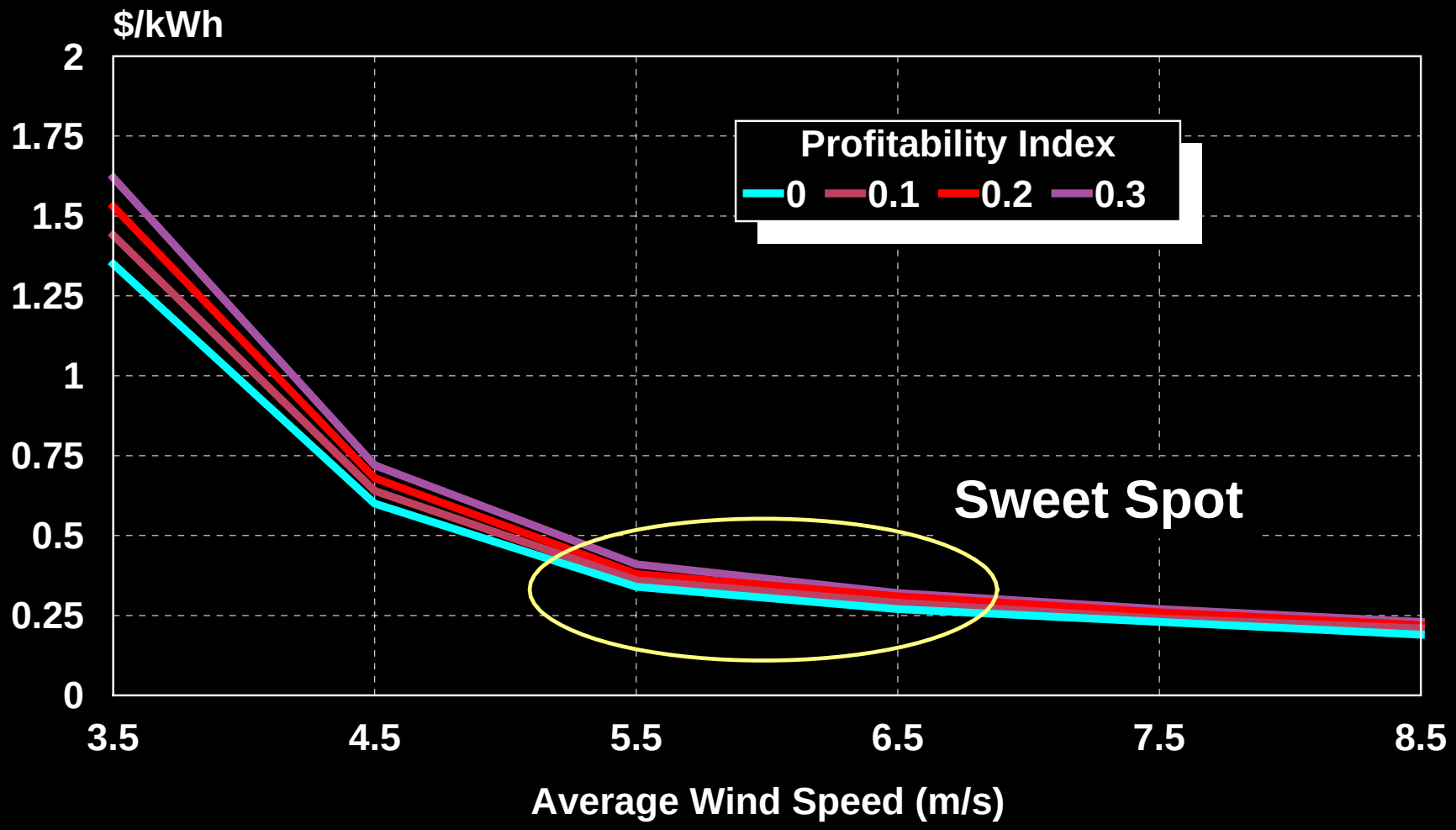
Skystream Tariff Needed
Chabot Profitability Index Method*

Average Weighted Cost of Capital		**Before Tax**
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%

***Methode TEC* by Bernad Chabot.**

Paul Gipe, wind-works.org

Skystream Tariff Needed $0.30-$0.38/kWh at 6 m/s



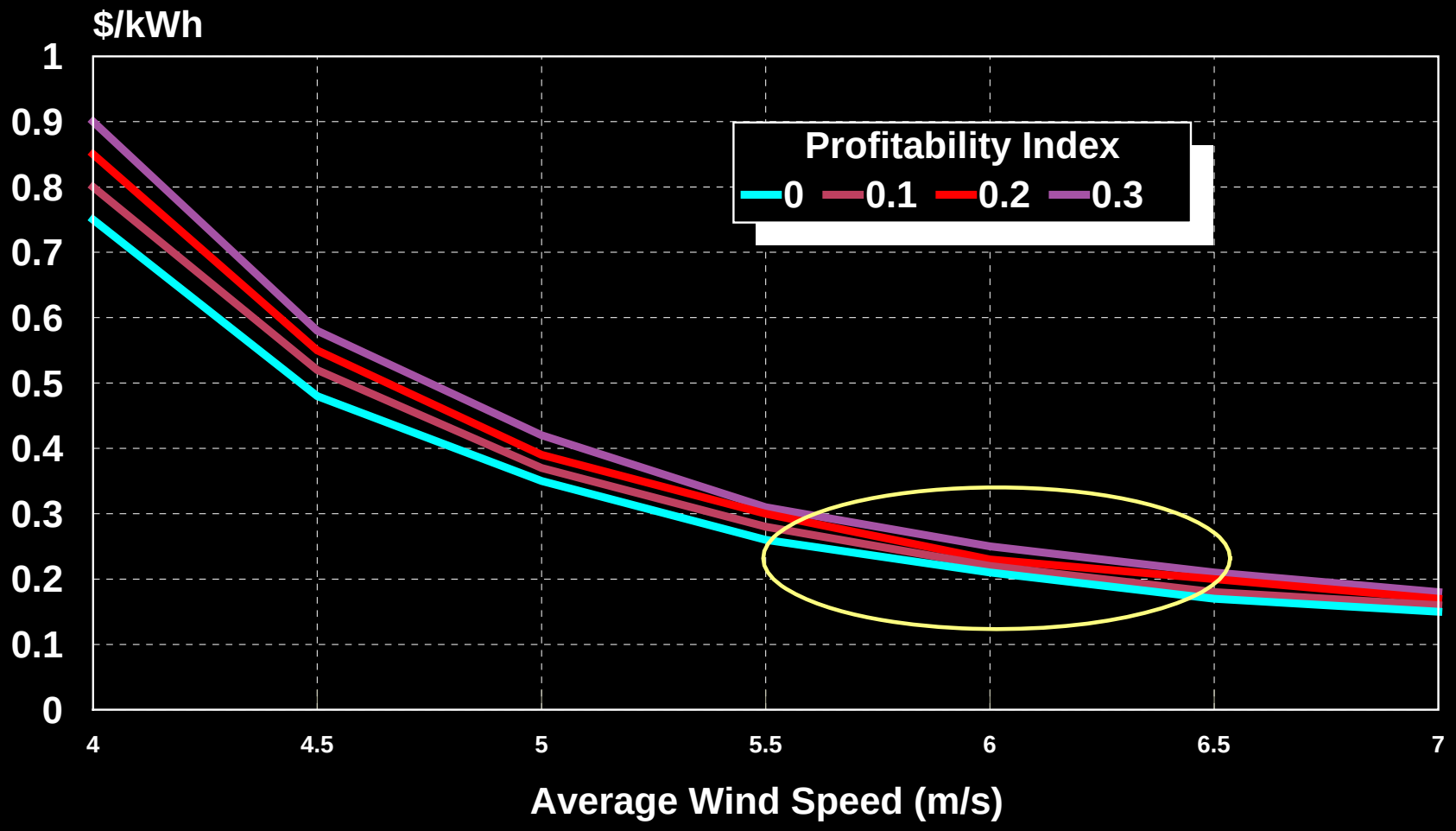
Paul Gipe, wind-works.org

Entegrity Tariff Needed Assumptions

- 15 m, 50 kW
- $205,000 Installed
- Yield from Entegrity Estimates
- Annual Reoccurring Expenses: 4%

Paul Gipe, wind-works.org

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



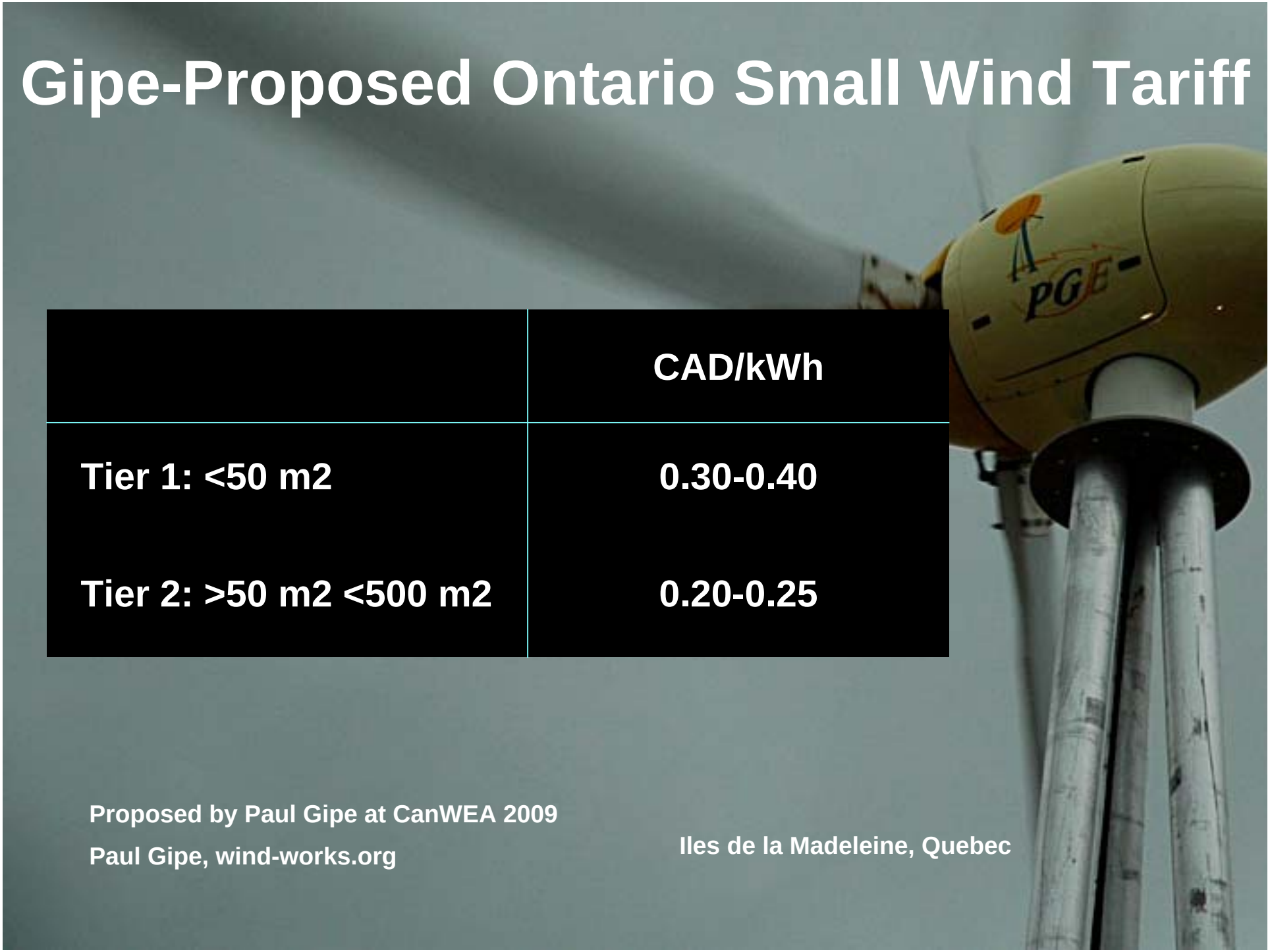
Paul Gipe, wind-works.org

Proposed US Small Wind Tariffs

	Years	€/kWh	CAD/kWh	USD/kWh
Michigan	20	0.188	0.307	0.250
Minnesota	20	0.188	0.307	0.250
Indianapolis	10	0.105	0.172	0.140

Paul Gipe, wind-works.org

Gipe-Proposed Ontario Small Wind Tariff



	CAD/kWh
Tier 1: <50 m2	0.30-0.40
Tier 2: >50 m2 <500 m2	0.20-0.25

Proposed by Paul Gipe at CanWEA 2009

Paul Gipe, wind-works.org

Iles de la Madeleine, Quebec

CanWEA-Proposed Ontario Small Wind Tariffs

	Years	€/kWh	CAD/kWh	USD/kWh
1-10 kW	20	0.390	0.550	0.530
11-100 kW	20	0.250	0.350	0.340
101-500 kW	20	0.180	0.250	0.240

Paul Gipe, wind-works.org

Mick Sagrillo's Vision of Small Wind

- Is Part of the Solution, But
- Is Not for Everyone
- Will Always be a Small Niche
- Will Never be as Pervasive as Solar PV
- Would be Helped by Feed-in Tariffs
  - To Weed Out the Junk

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

Small Wind--What's Needed

- **Compulsory Standards**
  - For Products & Installers
- **Testing**
  - with Published Results!
- **Facing Reality**
  - Small Wind's Limits
  - What Small Wind Can & Cannot Do

Paul Gipe, wind-works.org

Chateau Lastours, France

Small Turbines Must Become More Productive & More Reliable to Fulfill Their Promise

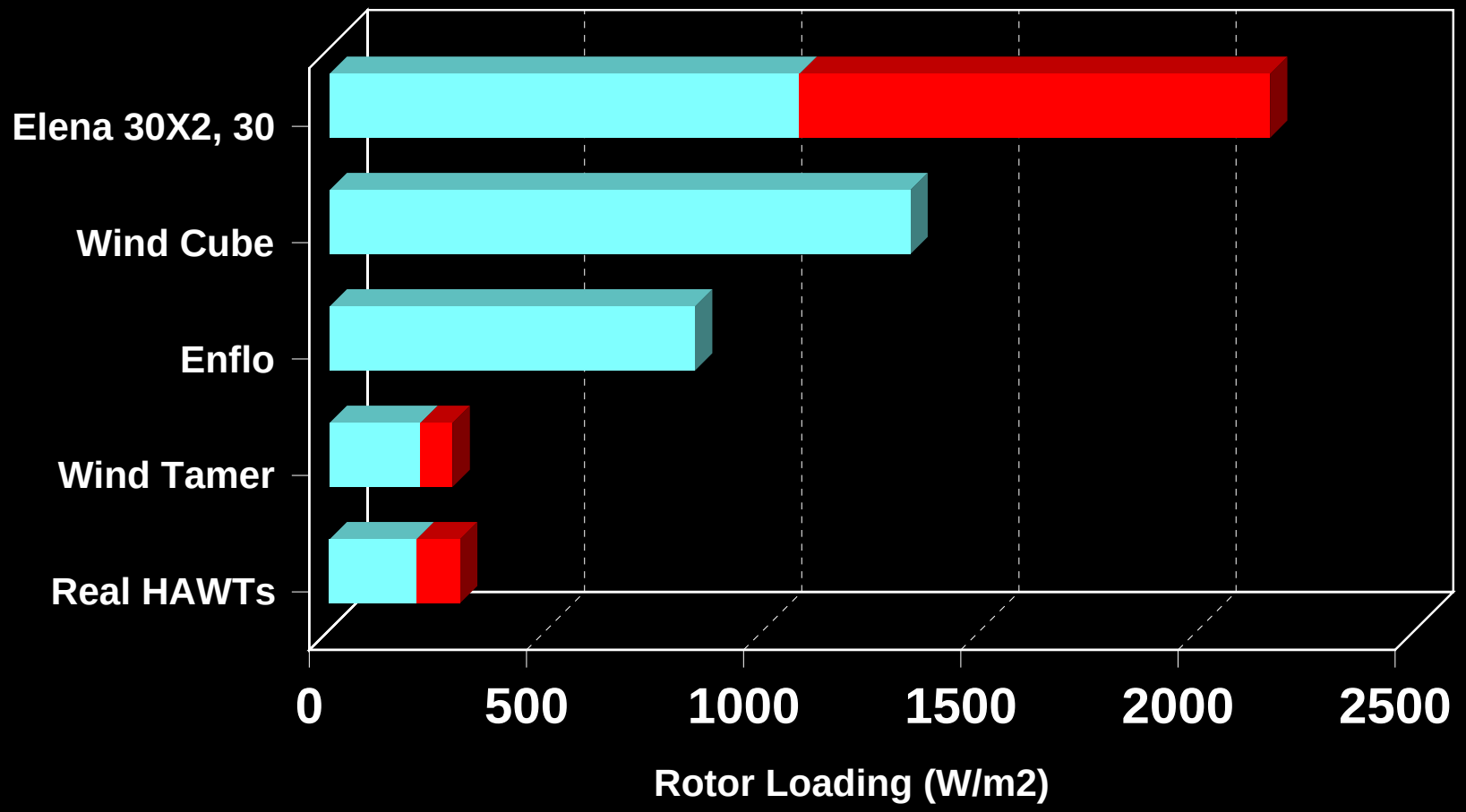
Paul Gipe, wind-works.org

Warning: Small Wind Can Easily Become a Pawn in a Bigger Game

- **Small Wind "Greenwashing"**
  - **Anti-Wind Use Small Wind to Attack Large Wind**
- **Small Wind as an Excuse for Inaction**
- **Small Wind as a Distraction**
  - **the Circus of Small Wind "Inventions"**
  - **Small VAWTs & DAWTs**

Paul Gipe, wind-works.org

Diffuser Augmented Small Wind Turbines



Paul Gipe, wind-works.org

Elena-- Mon Dieu!
”Doubling Down”

- **Double Diffusers**
- **Double Rotors**
- **Contra-Rotating**
- **~2-4 Times Betz Limit**
- **~10 Times Rational**

Maison de l’Air Annual kWh

LeMoniteur.fr

Elena 30: Maison de l'Air Poisson d'Avril?

- **Denis Baupin, Maire-adjoint (Verts)**
  - **". . . nous ne souhaitons pas détériorer son paysage" (we don't wish to spoil the Paris cityscape)**
- **Yves Cochet (Verts)**
  - **Fortunately pushed through decision to sign 2001 arrêté on wind**

Gustave Eiffel's Tower

- "Grotesque Monster . . .

  . . . A Symbol of Decadence"--Charles Garnier
- "Ungraceful Giant Skeleton"

  --Guy de Maupassant
- "Even Commercial America

  Wouldn't Want Eiffel's Tower"--Charles Gounod*

*Gounod eventually performed a "concert in the clouds" on the tower.

Excerpted from *Wind Energy Comes of Age* by Paul Gipe, 1995, John Wiley & Sons.

Paul Gipe, wind-works.org

Wind Energy is Compatible

With Most Existing Land Uses

. . . With Rural Residential

Paul Gipe, wind-works.org

. . . With Schools

Forest City, Iowa

. . . With Some Parks

Depending Upon the Level of Protection

Paul Gipe, wind-works.org

Wellington (Brooklyn), NZ

. . . With Historical Sites?

Paul Gipe, wind-works.org

Tre Kroner Historic Park, Denmark

. . . With Tourism

Lille Havfrue, København

Paul Gipe, wind-works.org

Cleveland, Ohio

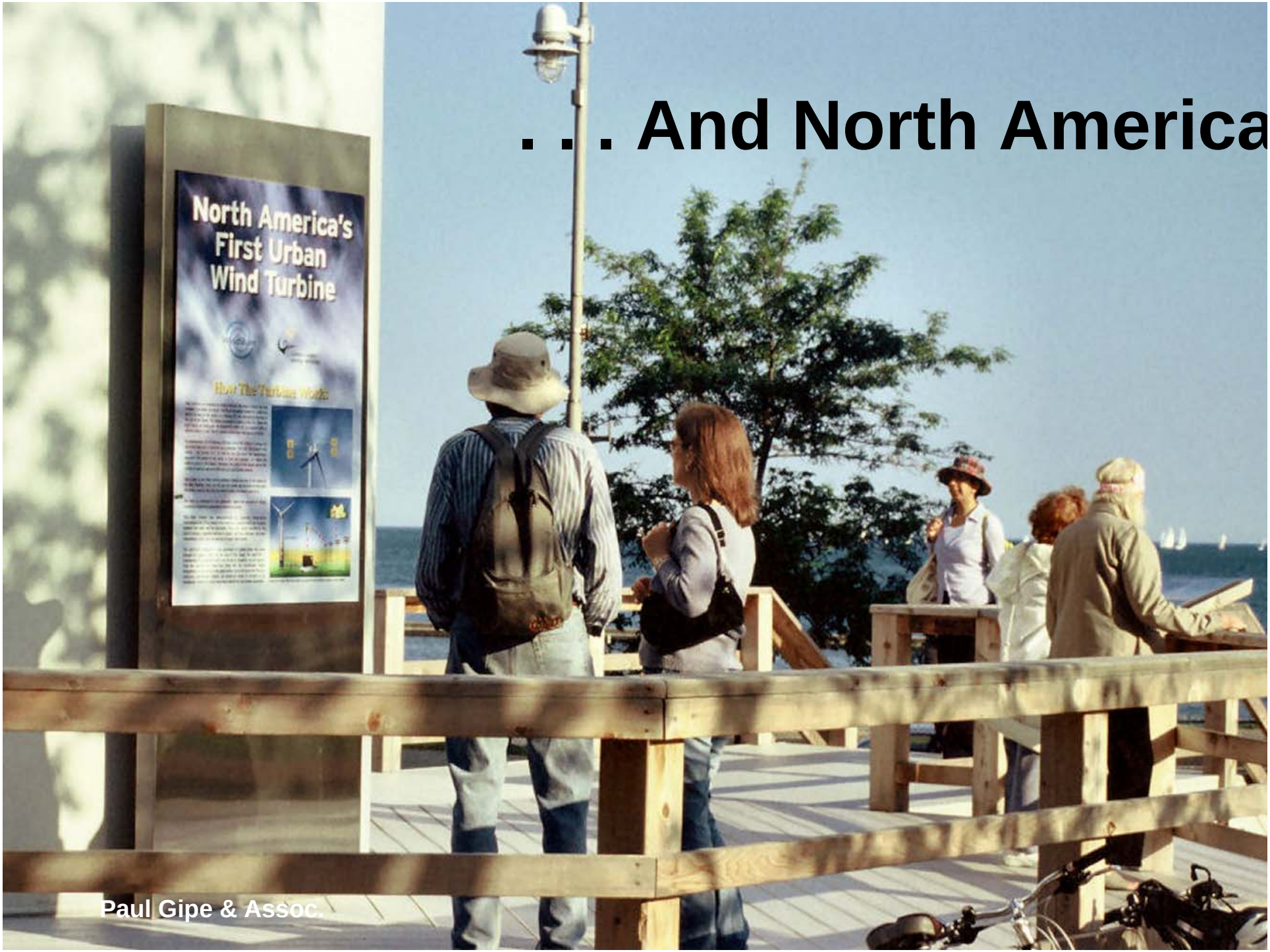
Paul Gipe, wind-works.org

Real Alternative: Real Urban Wind

- Real Turbines
- Producing Real Electricity
- Eiffel's Tower of Today

Toronto's WindShare . . . A Pioneer in Canada

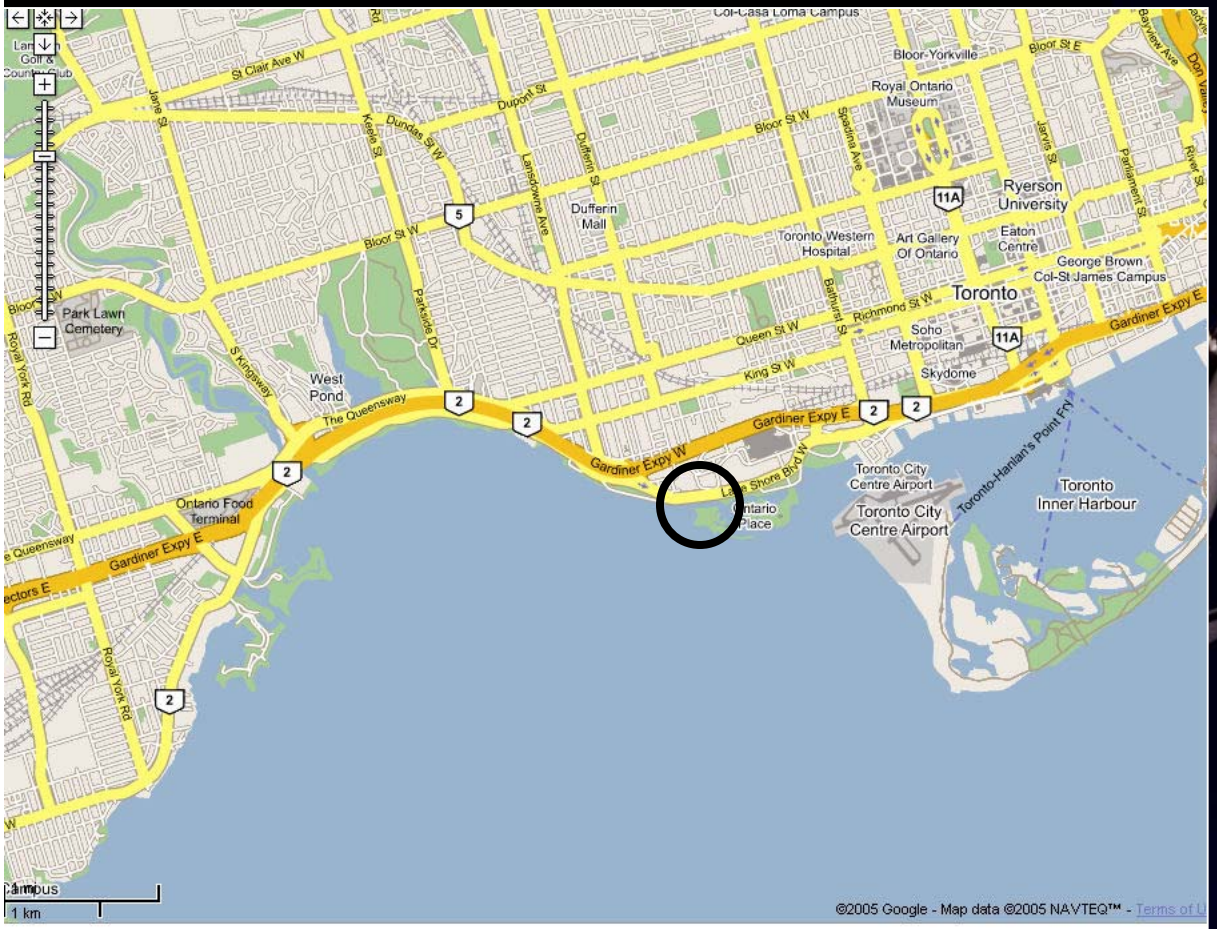
Paul Gipe, wind-works.org

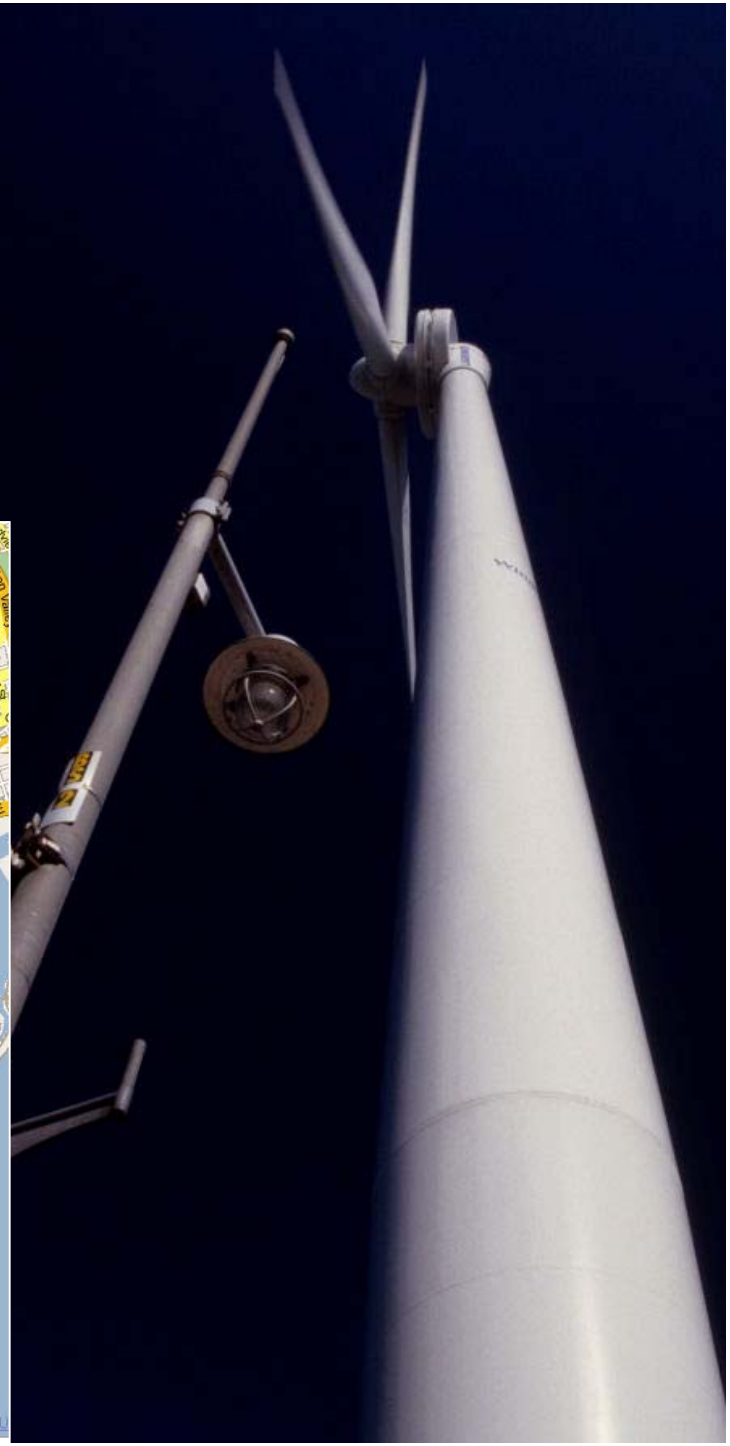


. . . And North America

Paul Gipe & Assoc.

WindShare
Toronto, Canada





WindShare
Toronto, Canada

- First Urban Turbine in N.A.
- Co-Owned
  - WindShare Co-op
    - 450 Members
  - Toronto Hydro
- Prominent Location
- Highly Visible
- Highly Popular

Paul Gipe, wind-works.org

WindShare-Toronto Hydro Expansion Plans

- ExPlace New Turbines
- Lake Wind 20 MW
- Offshore 100 MW

Paul Gipe, wind-works.org

Liberté, égalité, fraternité
The “Renewable” Revolution

- **Freedom**
  to Invest in Renewable Energy
- **Equality**
  with EdF, EoN, & Multinationals
- **Fraternity**
  with Your Neighbors in Building a Renewable Future

Freyssenet, France

Paul Gipe, wind-works.org

Strom Rebellen (Electricity Rebels)

- Democratizing Electricity Generation
- Creating Local Investment
- Creating Local Jobs
- Creating Opportunity--and Hope
- Denmark, Germany,

  Minnesota, Ontario and . . . France?

Paul Gipe, wind-works.org

François Pélissier, Erélia

- Le Haut des Ailes, Lorraine
- 32 MW
- Objectives
  - New Jobs Locally
  - New Opportunity Locally

Paul Gipe, wind-works.org

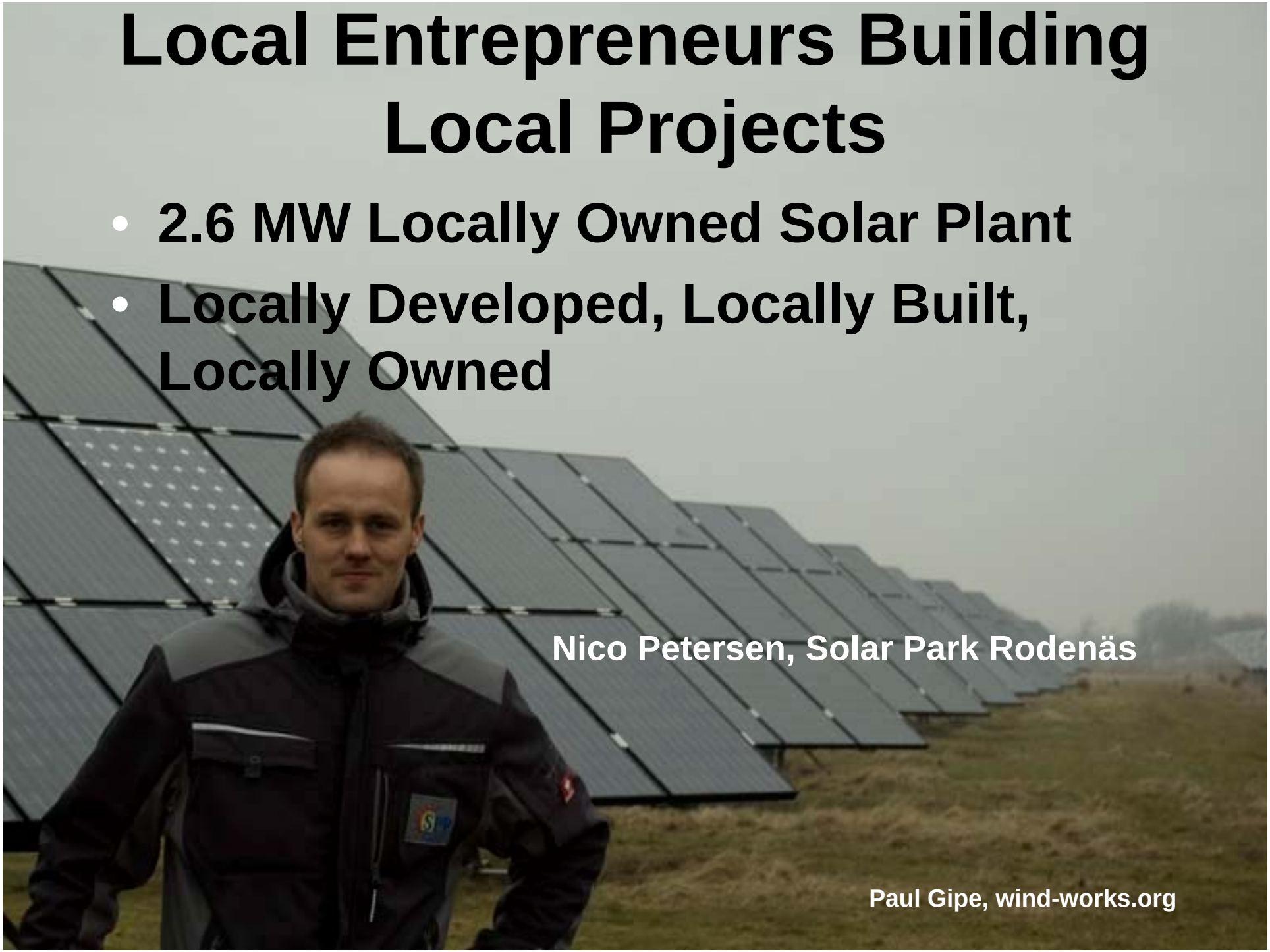
Local People Helping Local People
Hans-Heinrich Andresen

- Manages 16 Wind Farms
- in 16 Villages
- All Locally Owned
  - 15 Owners in Smallest
  - 400 Owners in Largest
- Now Planning Their Own Transmission Line

Paul Gipe, wind-works.org

Local Entrepreneurs Building Local Projects

- 2.6 MW Locally Owned Solar Plant
- Locally Developed, Locally Built, Locally Owned



The Farmers of Friedrich-Wilhelm Lübkekoog

- 1990 First Locally-Owned Wind Farm
- First Repowering (w/ Bigger Turbines)
- 2009 Added 30-50 kW each Solar PV

Ontario's Green Energy Act

The Most Progressive Renewable Energy Policy in North America in ~~Two~~ Three Decades

Paul Gipe, wind-works.org

Goderich, Ontario

Ontario's Green Energy Act

- **Changes Public Policy on Electricity**
  - **Includes Industrial & Environmental Policy**
- **Gives Renewables Priority**
  - **In Utility Procurement & System Design**
- **Targets Industrial Development**
- **Targets Job Creation**
  - **Goal: 50,000 Jobs in 3 Years**

Paul Gipe, wind-works.org

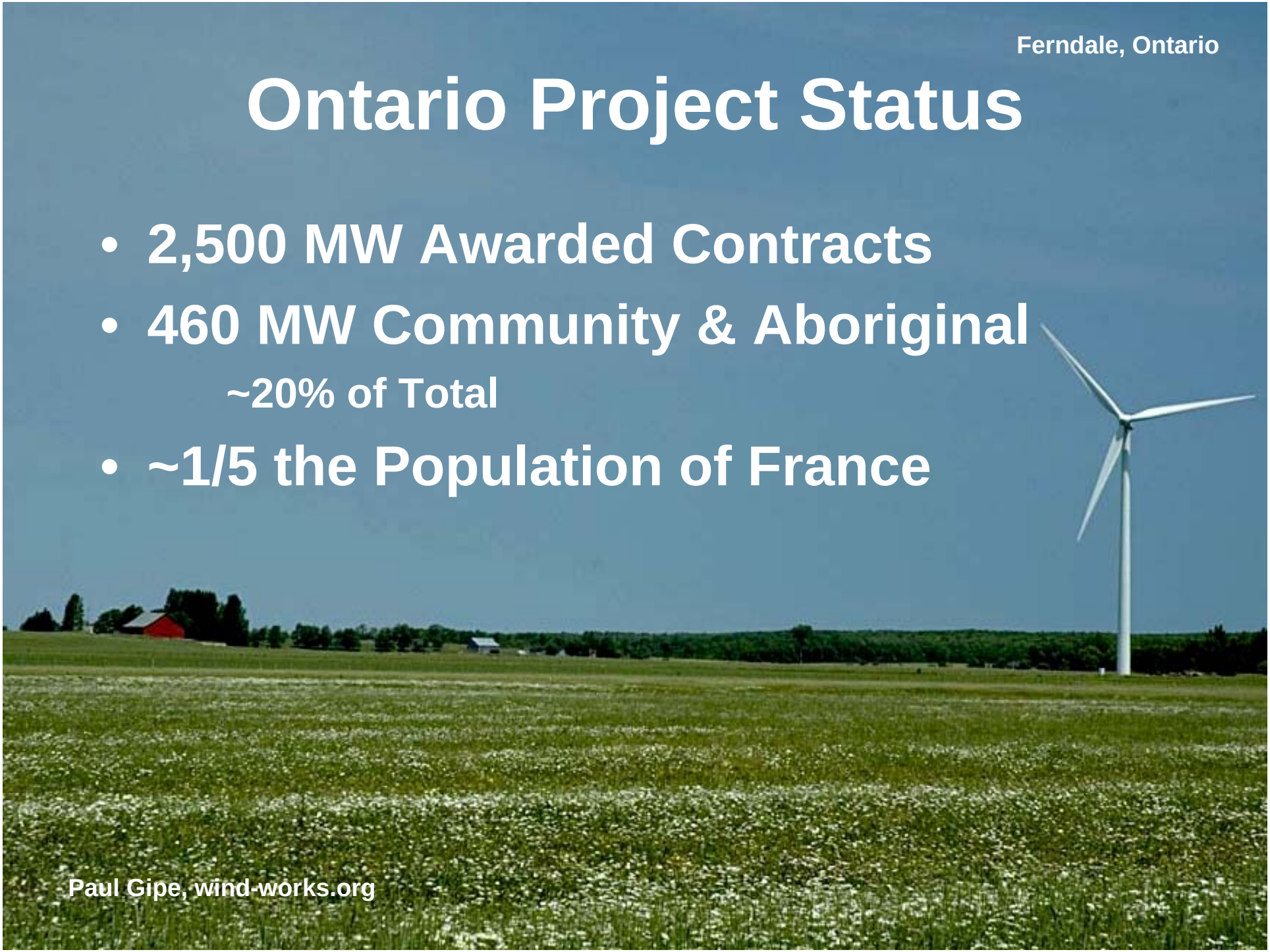
Ontario's Feed-in Tariffs

- **First Offshore Wind Tariffs in NA**
- **First Aboriginal Bonus in NA**
  - **$0.015 CAD/kWh Bonus**
  - **Total: $0.15 CAD/kWh (€0.105/kWh)**
- **First Differentiated Solar PV Tariffs**
  - **5 Tranches or Classes**
- **Best Wind, Solar, & Biogas Tariffs in NA**
  - **Competitive Internationally**

Ontario's Feed-in Tariffs

- **No Subsidies or Grants**
- **Costs Borne by Consumers**
  - **Not Taxpayers--More Egalitarian**
- **Community Wind Bonus**
  - **Individual Farmers Quality**
  - **$0.01 CAD/kWh Bonus**
  - **$0.145 CAD/kWh (€0.10/kWh)**

Paul Gipe, wind-works.org



Ontario Project Status

- 2,500 MW Awarded Contracts
- 460 MW Community & Aboriginal
  - ~20% of Total
- ~1/5 the Population of France

A Modest Proposal for Community Power *en France*

- **Create Community Power Tariffs**
- **Target: 2,500 MW (5X Ontario)**
- **Find Sites in *Paris &* Île-de-France**

  Wind, Solar, Landfill Gas, Biogas
- **Install a Modern "Eiffel Tower"**

  with a "Viewing Platform" if You Must

Paul Gipe, wind-works.org

German Municipal Landfills

- Sources of Generation
- Sources of Revenue

Hamburg, Germany

Paul Gipe, wind-works.org

Hamburg Municipal City Landfill

- Wind
- Biogas
- Solar PV

Hamburg Landfill, Germany

Paul Gipe, wind-works.org

“Nothing is as powerful as an idea whose time has come.”
-- Victor Hugo
Paul Gipe, wind-works.org
*"Il n'est rien au monde d'aussi puissant qu'une idée dont l'heure est venue." Victor Hugo
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Move From
A Culture of Consumption
to
A Culture of Conservation
--Ontario Premier Dalton McGuinty
Paul Gipe, wind-works.org
Montfort, Wisconsin

Move From
A Nation of Consumers
to
A Nation of Producers

Paul Gipe, wind-works.org

Lackawanna, New York

Gaspé Peninsula, Quebec
No Time for Half-Measures
No Time to Lose
Paul Gipe, wind-works.org

We Need A Lot More Wind . . .

. . . A Lot More Solar

. . . A Lot More Renewable Energy
Technology for Life*
*from N.F.S. Grundtvig, Danish Theologian
Paul Gipe, wind-works.org

Renewable Energy The Revolution Has Begun!

www.wind-works.org

Manawatu Gorge, New Zealand