Small Wind Power
for your home, business, or farm

A Presentation to Co-op Power

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Staff Engineer

Renewable Energy Research Laboratory

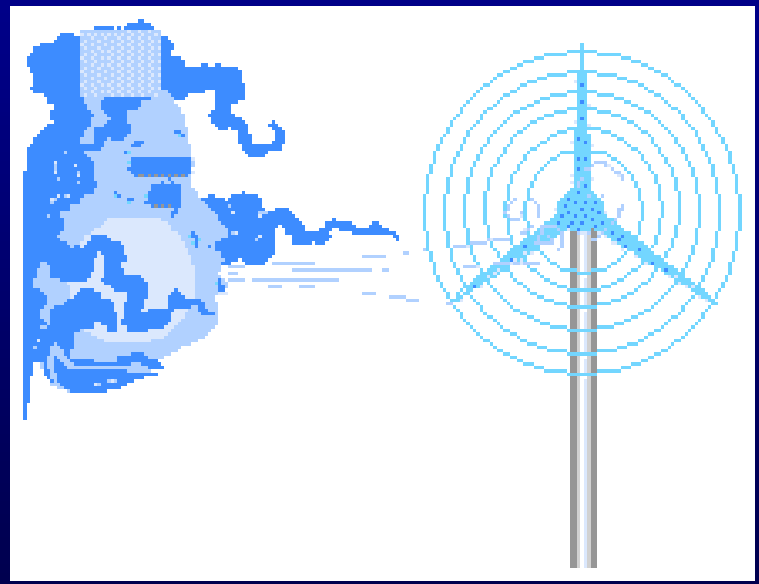
University of Massachusetts, Amherst

10 kW Bergey in Vermont

Slide Credits: NREL- Jim Green & Trudy Forsyth; Paul Gipe; AWEA

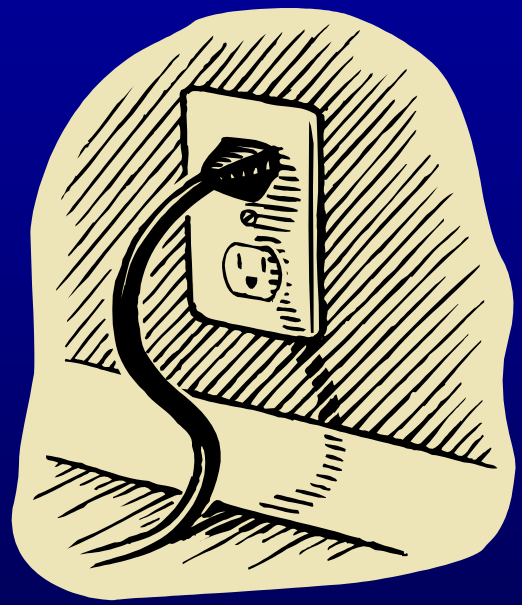
Small Wind Power: Today's Agenda

- 1. Why renewable energy? Why wind?
- 2. Technology overview
  - Available turbines
  - Noise & other impacts
- 3. Economics
  - Costs, pay-back
  - Incentives
- 4. How do I get one?
  - Siting & zoning
  - Grid interconnection
- 5. Examples ….. & Your Questions

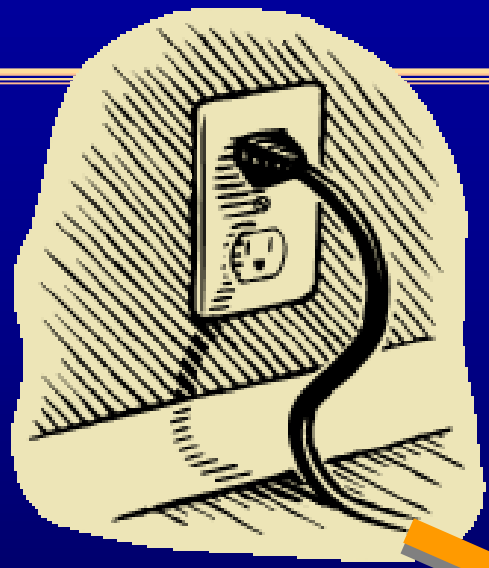


❖❖ 1. Why Renewable Energy?

- Sustainable
- Clean
- Produced locally
  - Widely available
  - Energy independence
- Reduced price volatility
- World & national policy



❖❖ 1. Why Renewable Energy?



- All energy use has impacts
  - Environmental
    - Emissions / asthma …
    - Mountain top removal, nuclear waste….
  - Economic
    - Oil imports / trade deficit …
    - Declining oil production/ Peak Oil…
    - Fuel price volatility / brown-out threats in January
  - Political
    - International security …

Many Renewable Energy Resources

- Wind energy
- Solar photovoltaics
- Solar thermal
- Biomass electric
- Biomass fuels
- Geothermal energy
- Hydropower
- Advanced Solar

Slide Source: Technology Opportunities to Reduce U.S. Greenhouse Gas Emissions, Oct 1997

Why Wind Power?

- All energy has environmental impacts
  - And economic, and socio-political…
- Wind power is one of the lowest-impact forms
  - available today

Hull's 660 kW turbine next to high school (Hull, MA)

Why *Small* Wind Power?

- Personal decisions
  vs. public policies…

…speed & level of conversion

❖❖ 2. Small Wind Technology

- Small turbines today
- What they look like
  - components
- How they work
- How much power they make

Small Wind Turbines Are Different

- Utility-Scale Wind Power,
  600 - 1,800 kW wind turbines
  - Professional maintenance crews
  - 15+ mph (7+ m/s) average wind speed
- Small, "Distributed" Wind Power
  0.3 - 50 kW wind turbines
  - Installed at individual homes, farms, businesses, schools, etc.
  - On the "customer side" of the meter
    - or off the utility grid
  - High reliability, low-maintenance
  - 9+ mph (4+ m/s) average wind speed

Small Wind Turbine Technology

- Grid – connected
  - Or battery charging
- 80- to 120-foot towers
  - Up out of turbulence
- 3 blades
- $20,000 to $60,000
  - Turbine & tower & installation
- Most common models:
  - Simple, rugged design
  - only 2–4 moving parts
  - little regular maintenance required

How big a system do I need? What size turbine?

- Electric Loads
- Power produced depends on:
  - Winds
  - Turbine
- Measuring size:
  - kW
  - Diameter
  - kWh/year

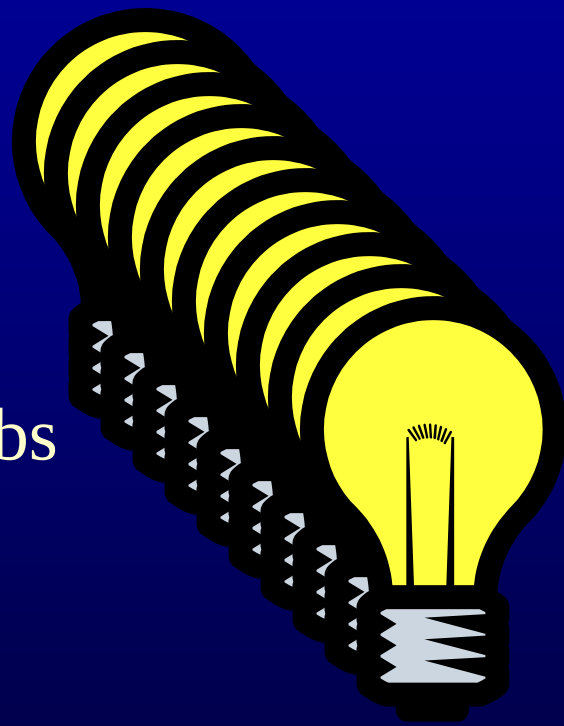
but, first, a brief diversion ...

Electricity 101:

Aren't Energy and Power the same thing?

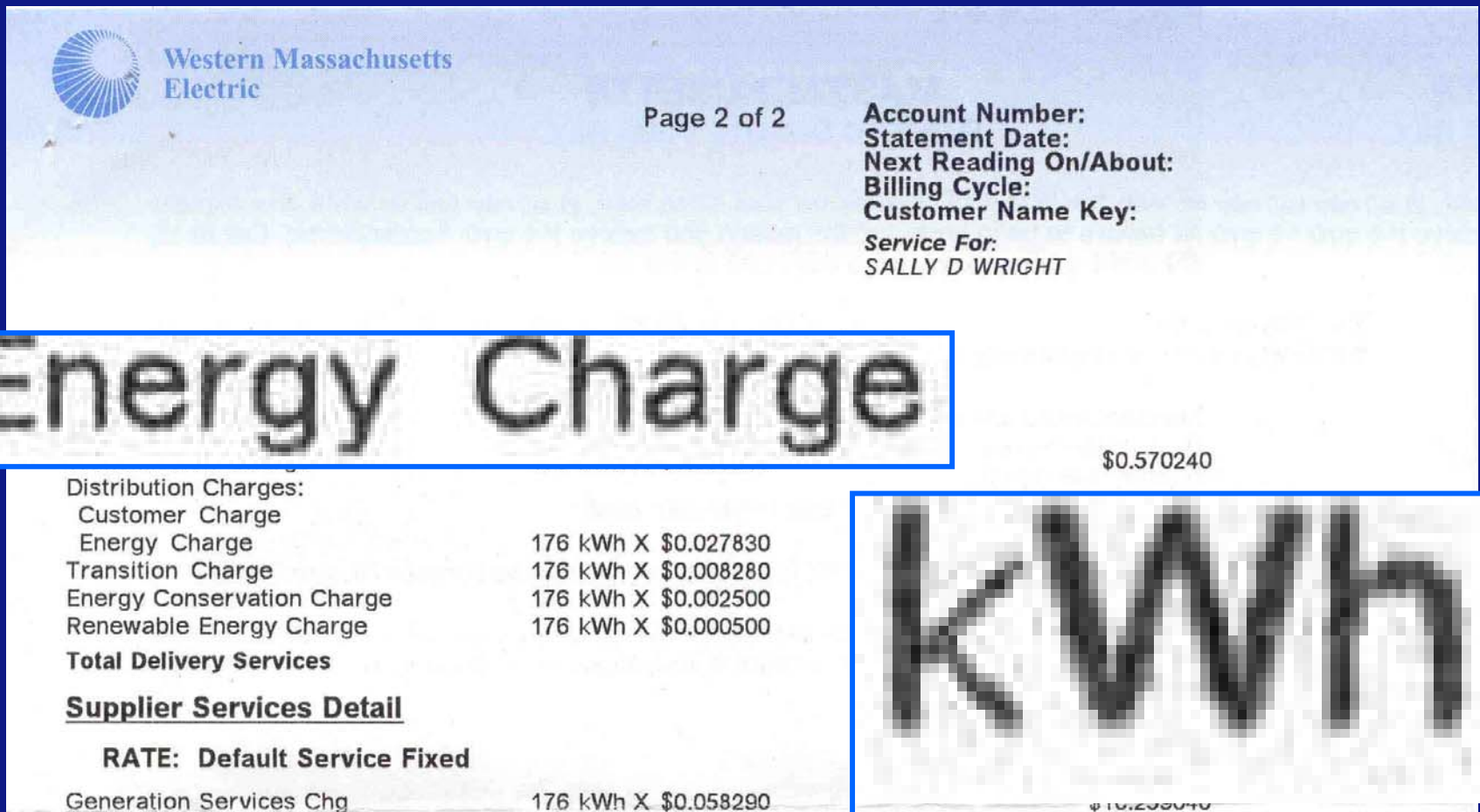
Electricity 101:
Power vs. Energy

- Power = rate
- Measured in:
  - Watts
  - Kilowatts, e.g. 10 x 100 W light bulbs
  - Megawatts = 1000 kW
  - Horsepower



Electricity 101:
Power vs. Energy

- Energy … is the quantity



Western Massachusetts Electric

Page 2 of 2

Account Number:
Statement Date:
Next Reading On/About:
Billing Cycle:
Customer Name Key:

Service For:
SALLY D WRIGHT

Energy Charge

$0.570240

Distribution Charges:
Customer Charge
Energy Charge 176 kWh X $0.027830
Transition Charge 176 kWh X $0.008280
Energy Conservation Charge 176 kWh X $0.002500
Renewable Energy Charge 176 kWh X $0.000500

Total Delivery Services

Supplier Services Detail

RATE: Default Service Fixed

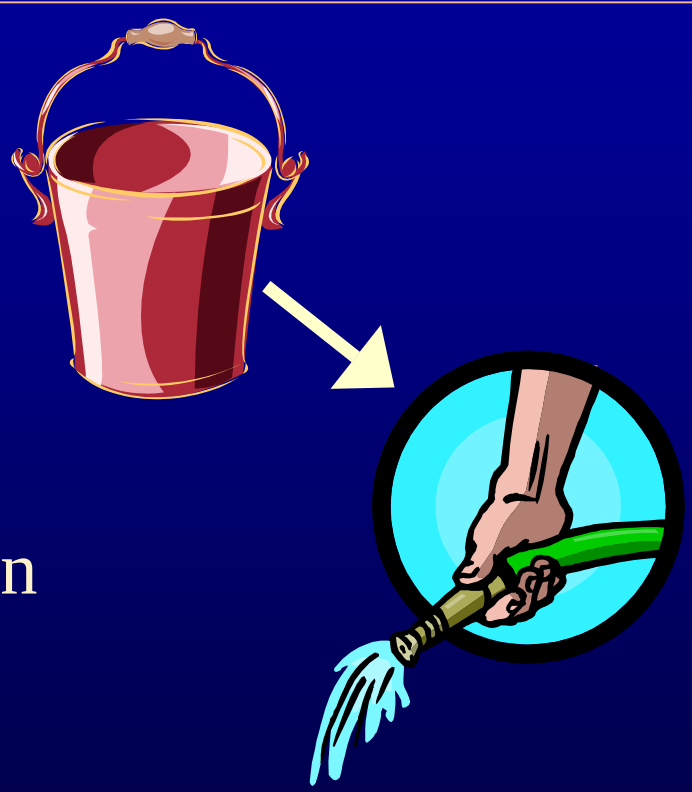
Generation Services Chg 176 kWh X $0.058290

kWh

Electricity 101:
Power vs. Energy

- "Kilowatt-hours"?
  - That sounds like a *rate*

    like miles per hour, or gallons per minute!



- Quantity → Rate

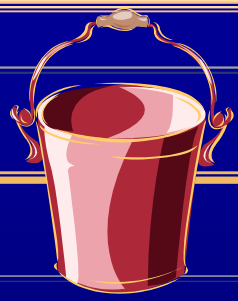
  Gallons → Gallons/min

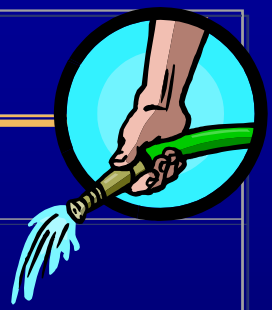
  Kilowatt * hour → kW

  ~~kW per hour~~

Electricity 101:

Aren't Power and Energy the same thing?





	Energy	Power
	Quantity	*Rate*
Unit	kWh	kW, MW
Water analogy	Gallons	Gal / Min
Car analogy -	- How far? - Gallon of gas	Engine HP
Cost example	14 ¢/kWh	$5,000/kW
Grid	Consumption & production	Installed capacity

What size turbine?

Technically: Power (*kW*), *Diameter*

Turbine	"Rating" (kW)	Diam (ft)	Tower (ft) (e.g.)
SWWP AIR-X	*0.4*	3.8'	60'
Bergey XL 1	*1.0*	8'	80'
SWWP Storm	*1.8*	12'	40'
SWWP Wh. 500	*3*	15'	80'
Bergey Excel	*7.5*	22'	80'
FL 30	*30*	43'	120'
NW100/19	*100*	63'	115'
V27 (225 kW)	*225*	89'	110'
V47 (e.g. Hull's)	*660*	154'	164'
GE 1.5SL	*1,500*	253'	197'

What size turbine?

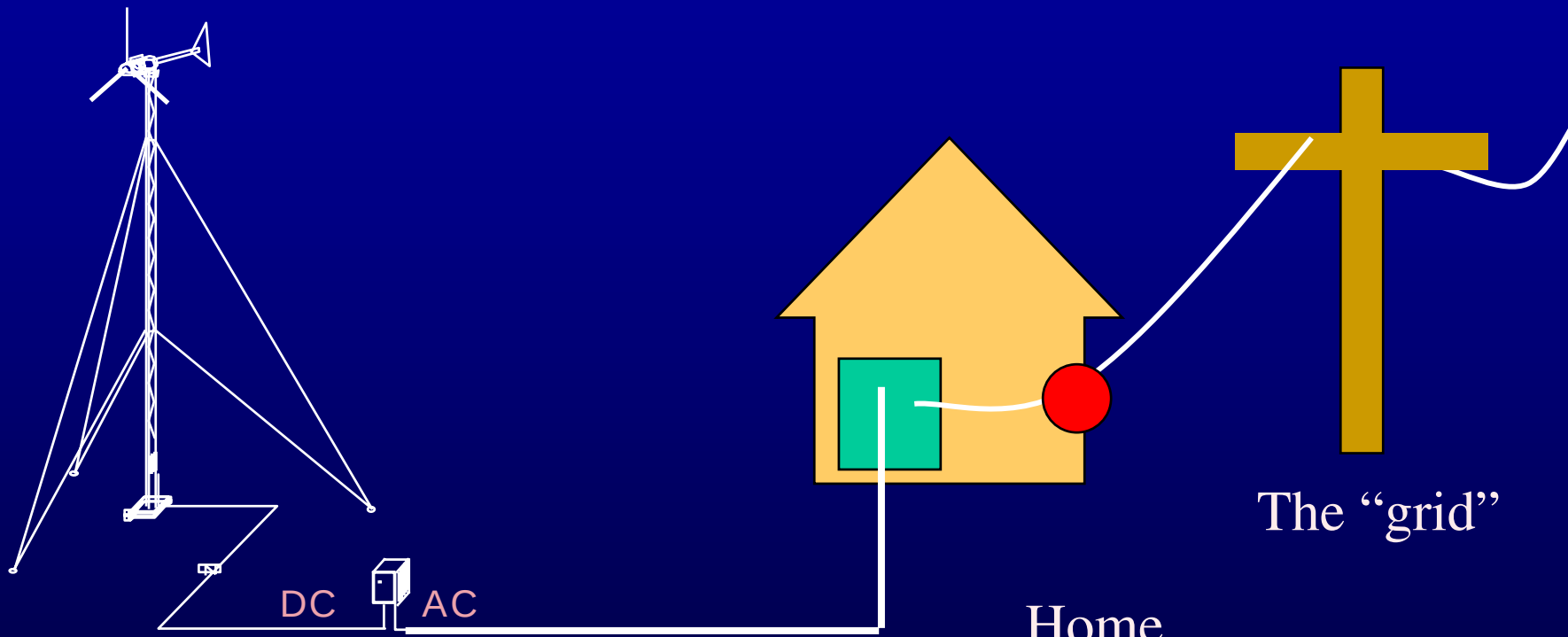
Useful: Energy (kWh/year)

Turbine	Rating (kW)	Example* of Annual Energy Production (kWh/yr)
SWWP Wh.. 500	3	6,500
Bergey Excel	7.5	16,440
Average Mass. Household	0.8 avg.	7,200
Hull's V47	660	1,500,000

- Your mileage can and will vary!
- Depends on hub-height wind speed, turbulence, maintenance, etc. Based on Mfr information, 12 mph annual mean winds (15 in Hull's case), typical tower height.

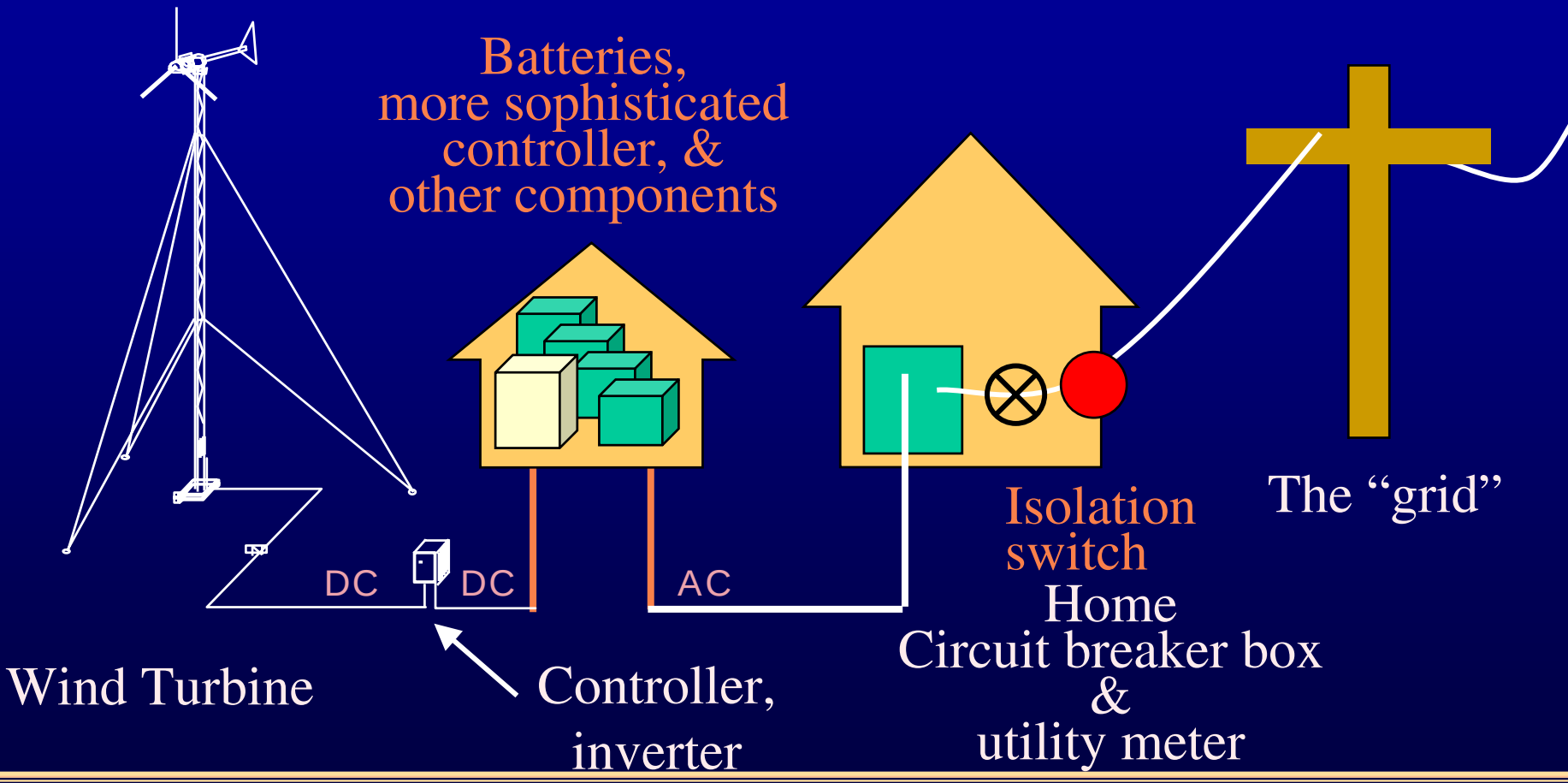
Home Energy Systems

Basic Wind System



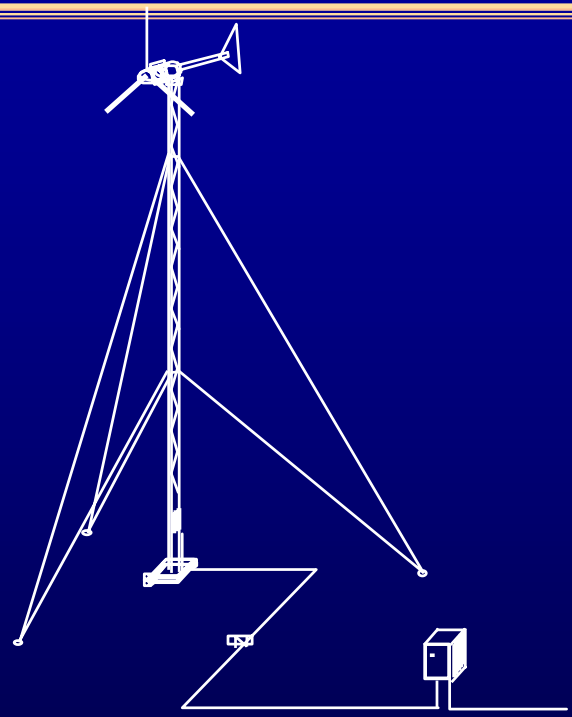
Home Energy Systems

Back-up power for utility power outages

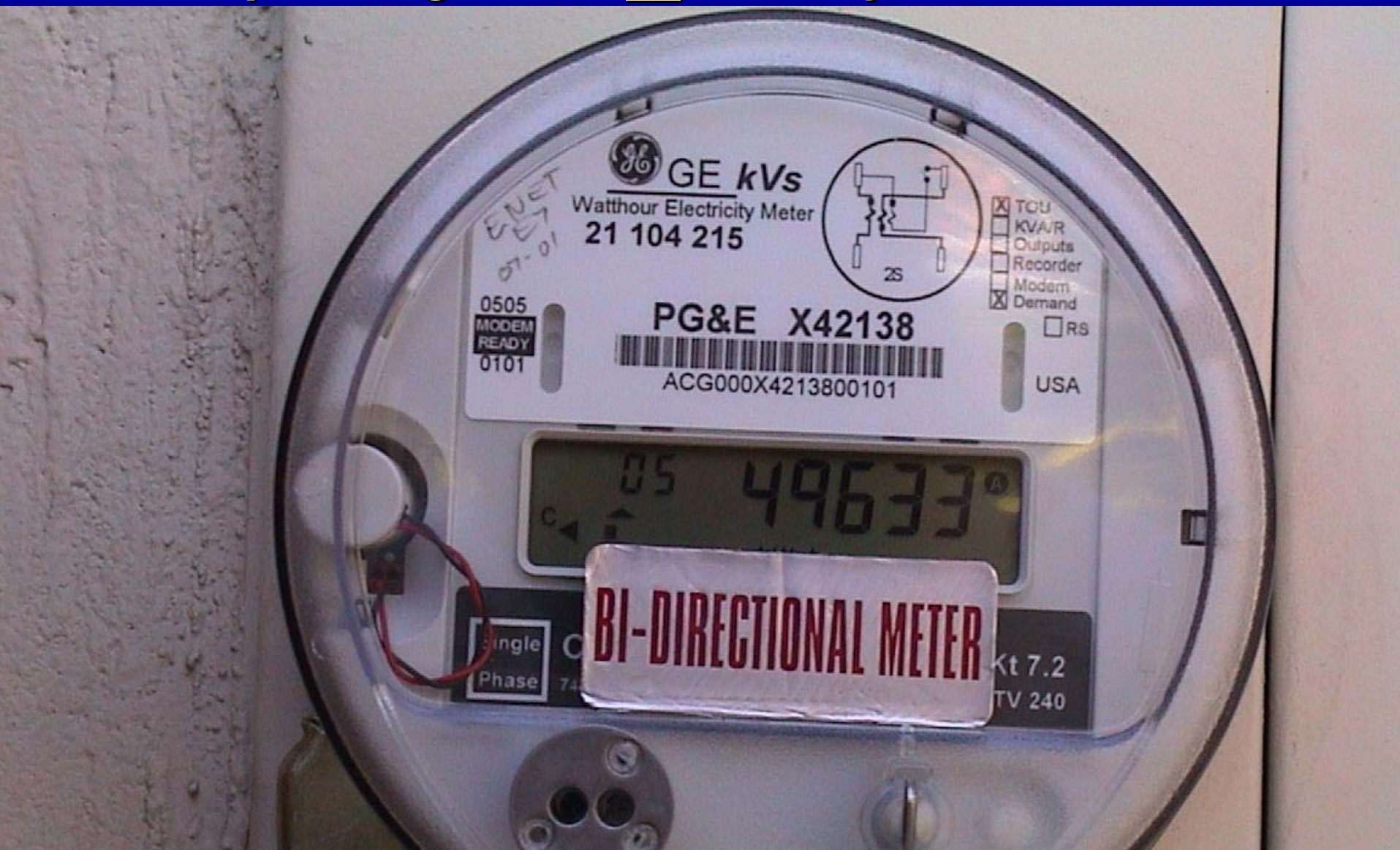


The Wind Turbine Controller

- Grid-Tied
  - "Inverter," converts the power to constant frequency 60 Hz AC
- Battery-Charging
  - DC for battery-charging
  - Regulates the battery voltage
    - to prevent over-charging
  - When the battery is fully charged:
    - Power is diverted to another load, or …
    - The rotor is unloaded and allowed to "freewheel"

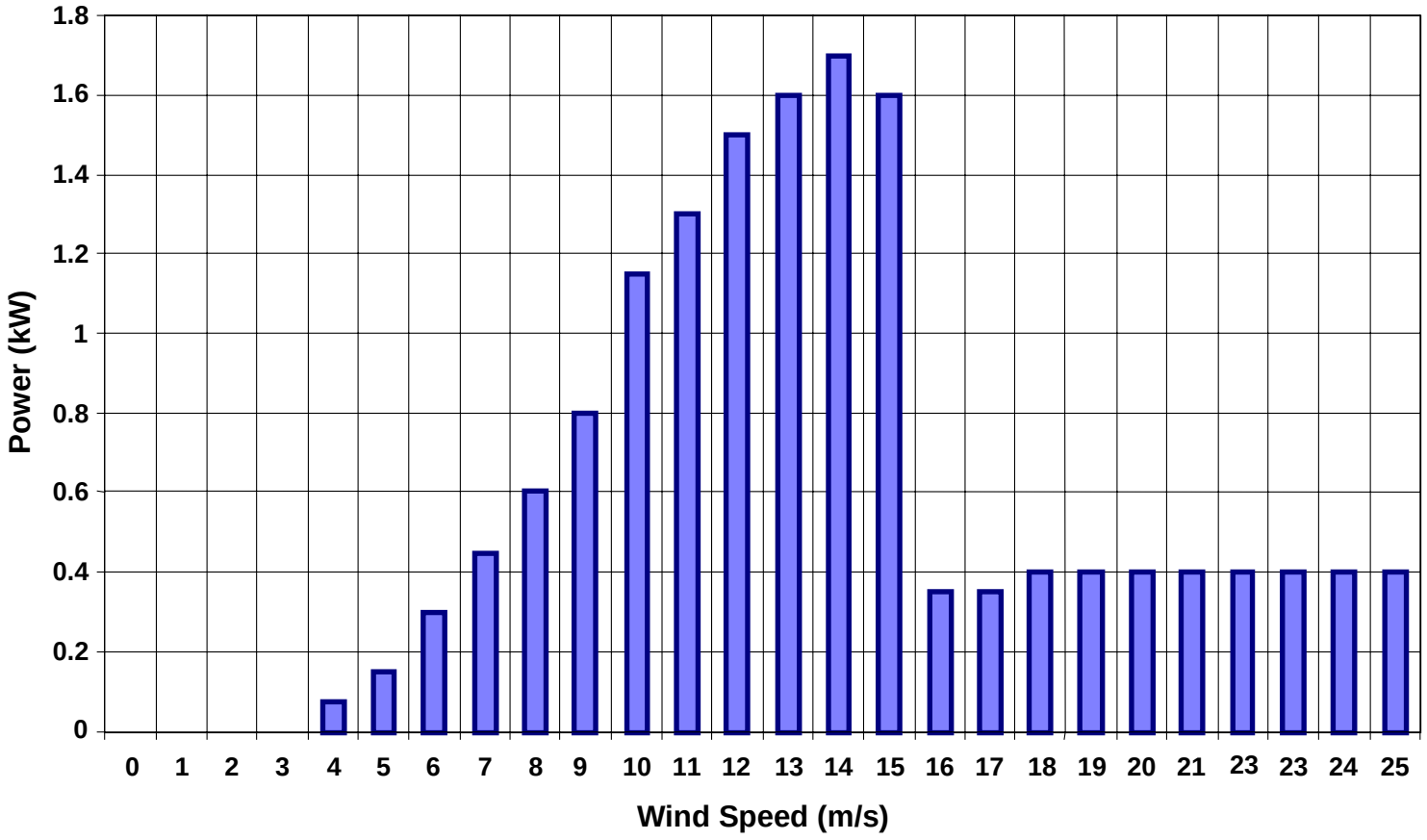


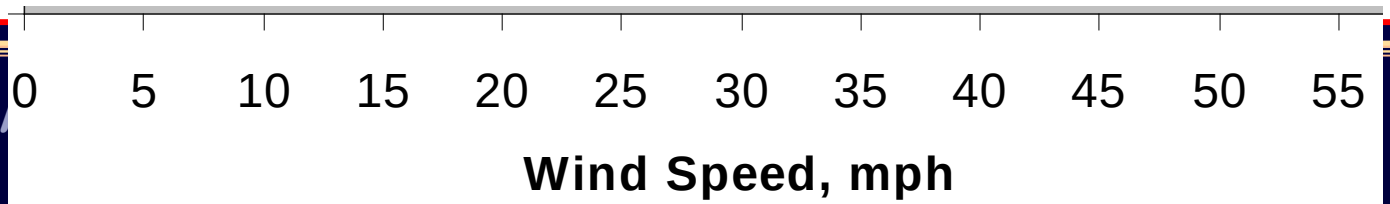
A Bi-Directional Meter –
power goes in or out of your house



Wind Turbine Power Curve

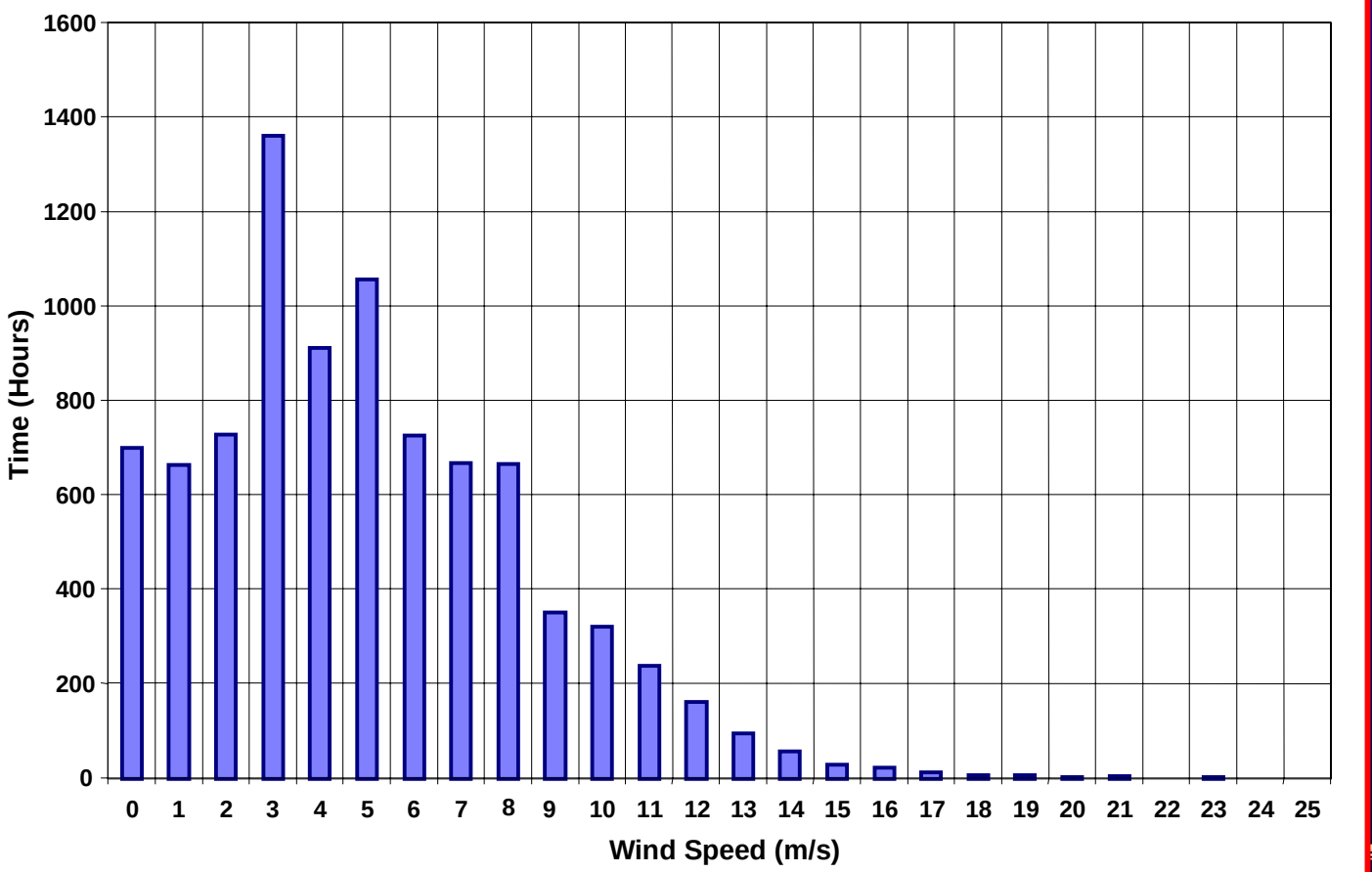
Bergey 1500 (Manufacturer's Data)





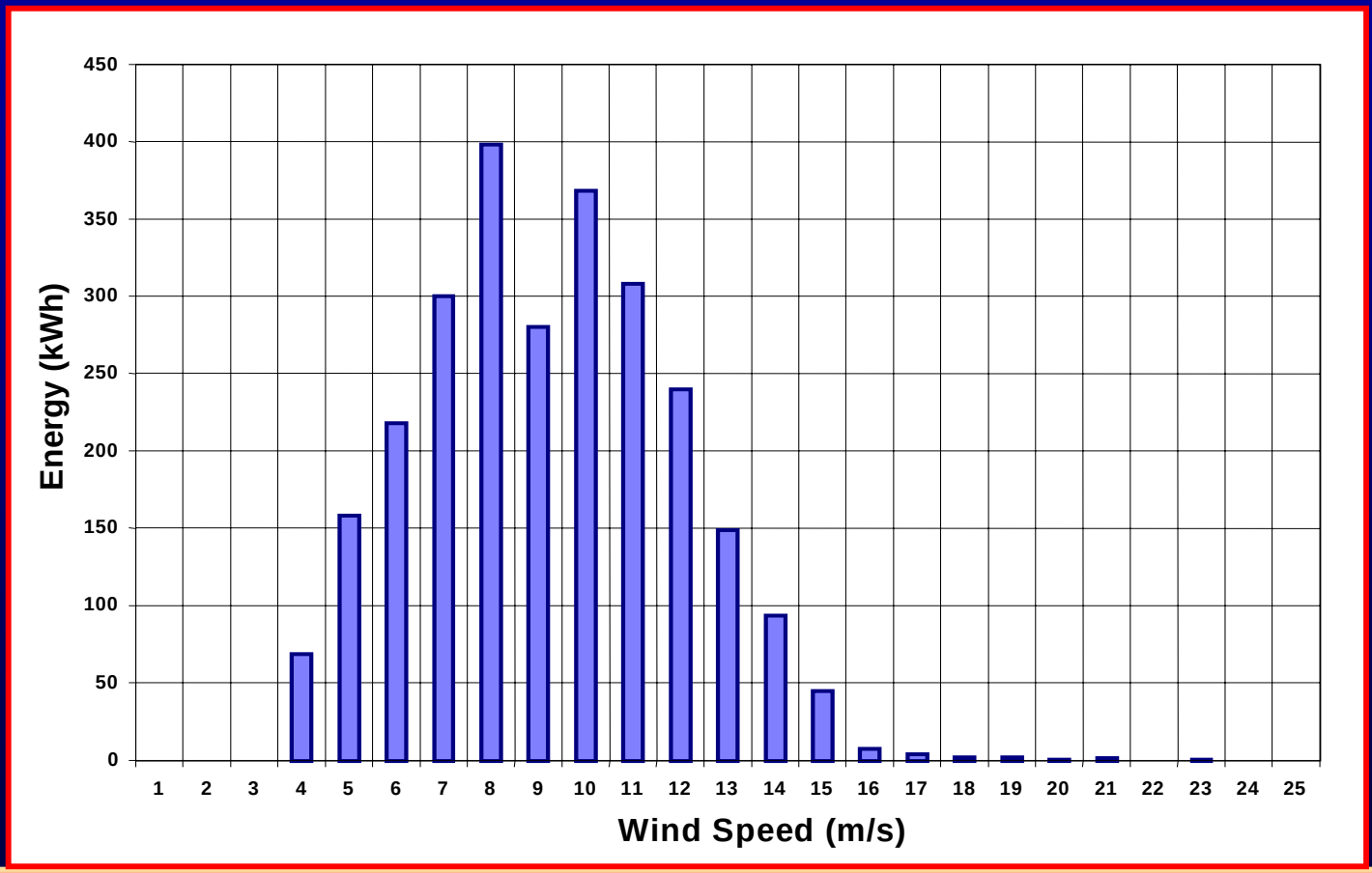
Wind Speed Frequency of Occurrence

Average Wind Speed: 5 m/s (11 mph)

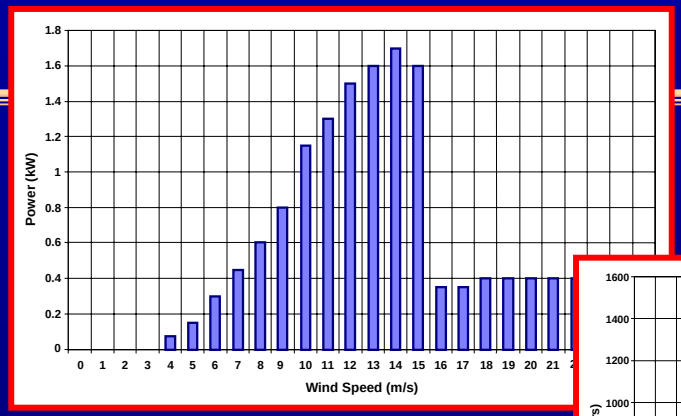


Annual Energy Production: 2643 kWh/year

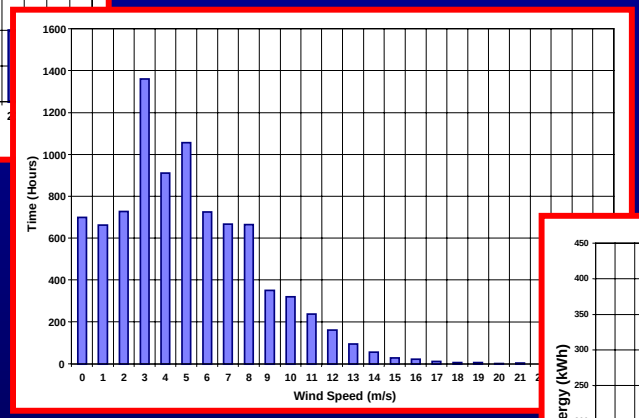
Bergey 1500 @ 5 m/s (11 mph) average wind speed



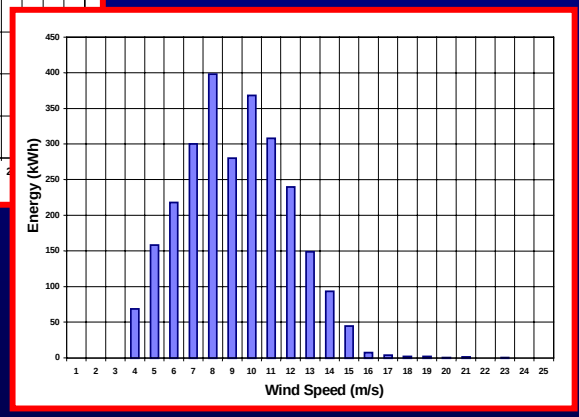
Estimation of Annual Energy Production



Power Curve

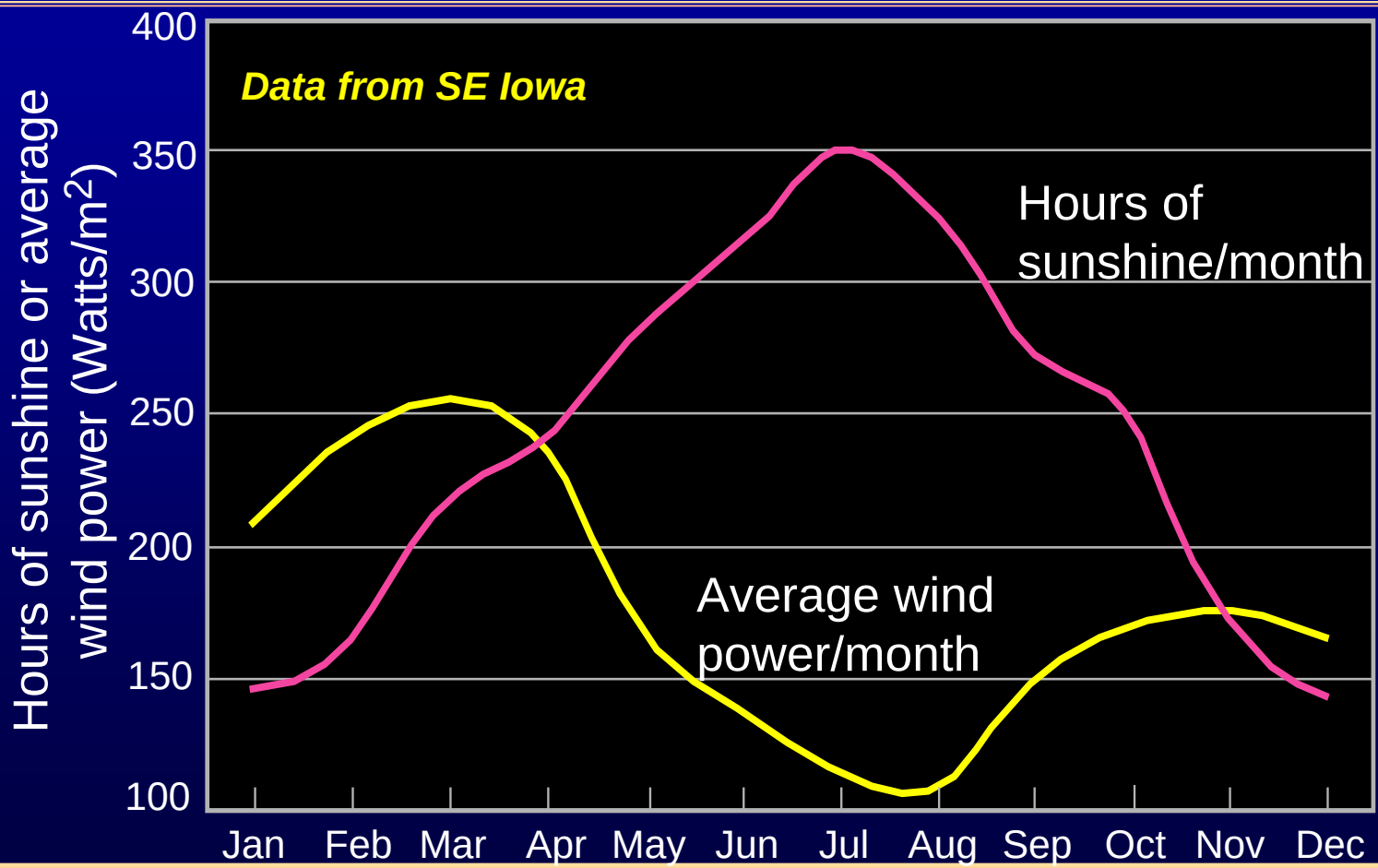


Frequency of Occurrence

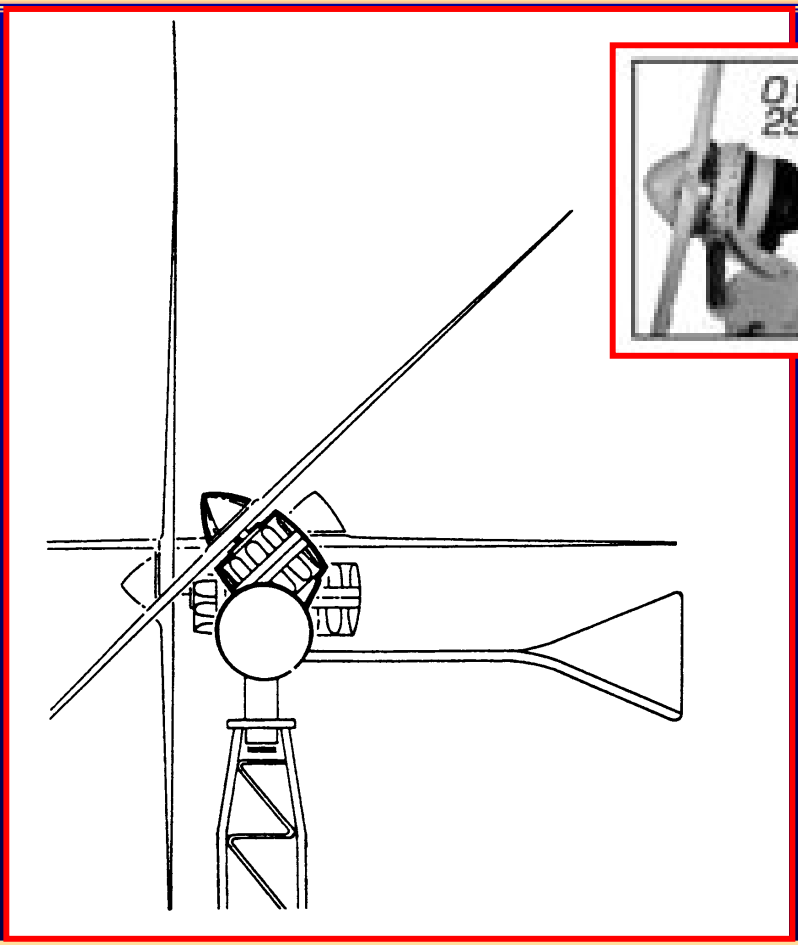


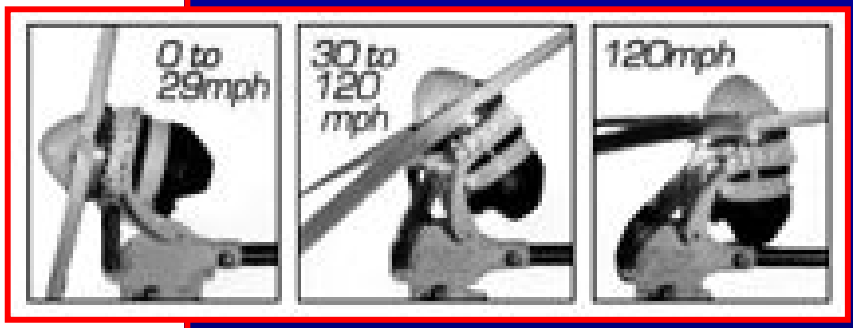
Annual Energy Production

Solar and Wind Resources are Complimentary



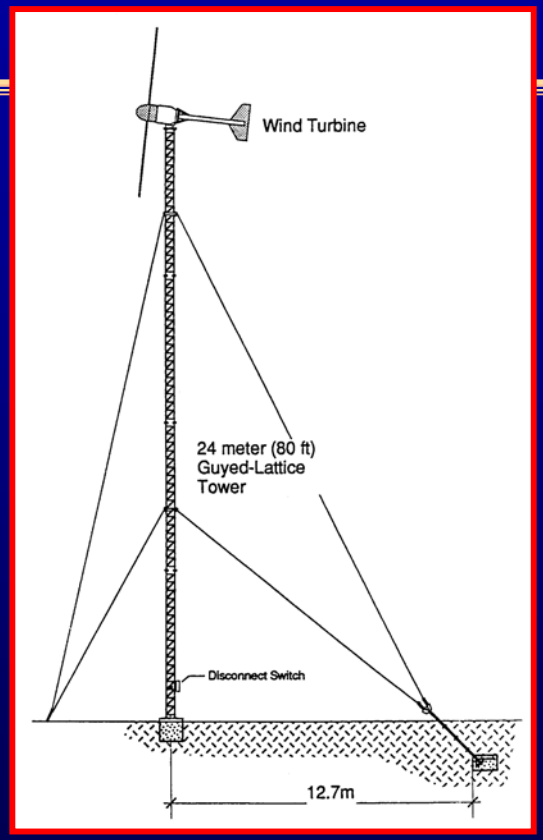
Over-speed Protection During High Winds



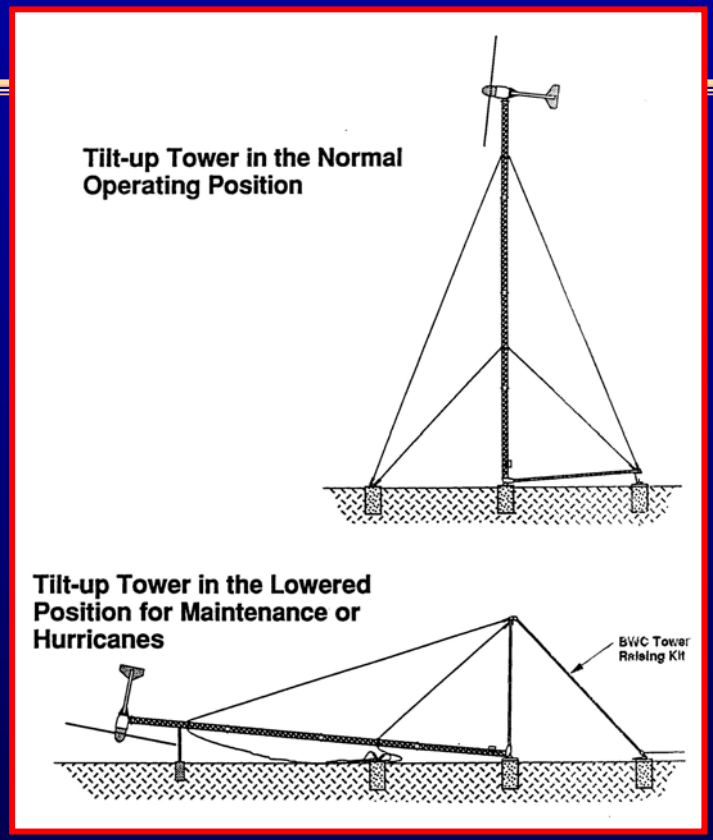


- Furling:
  - Rotor moves out of high winds
- Aeroelastic stall:
  - Blades bend out of wind

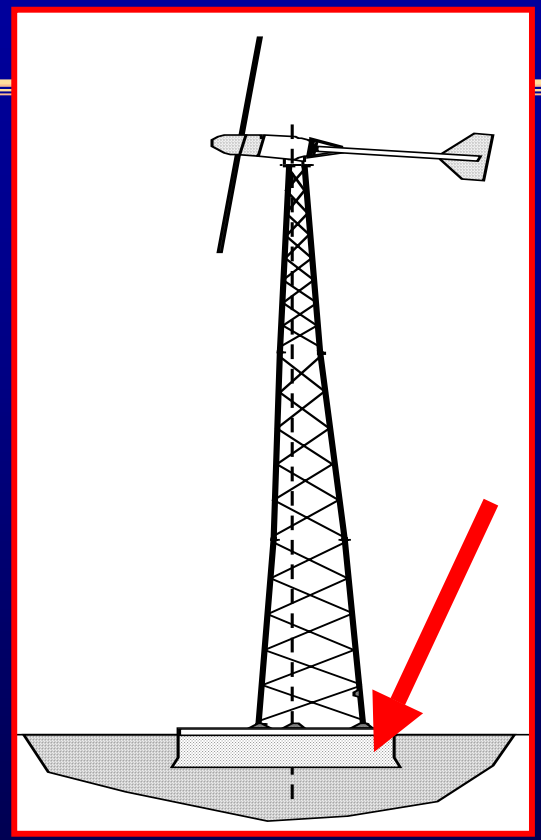
Small Wind Turbine Towers



Guyed Tower



Tilt-Up Tower



Self-Supporting Tower

Small Wind Turbines Available Today

- US manufacturers
- Imported

Bergey Windpower

Norman, OK

Want more info? Try –
www.bergey.com

Southwest Windpower
Flagstaff, AZ

Whisper 500
3 kW

Storm
(Beta testing)
1.8 kW

AIR-X
300 W

Want more info? Try –
http://www.windenergy.com/

African Wind Power

- Various models
  - 1.739 kW
- Cape Cod Regional Technical High School
  - Harwich, MA
  - installed in 2005

Want more info? Try – http://www.thesolar.biz/African%20Wind%20Power%20Wind%20Turbines.htm

Abundant Renewable Energy

- ARE110
  - 3.6 m diam
  - 2.5 kW
- ARE442
  - 7.2 m diam
  - 8.5 kW
  - Beta testing

Want more info? Try –
http://www.abundantre.com/ARE_Wind_Turbines.htm

Proven Engineering Products, Ltd.

Scotland, UK

WT600
600 W

WT2500
2.5 kW

WT6000
6 kW

- Dozen in the U.S. (2003)
- Imported by: Lake Michigan Wind & Sun, 920.743.0456

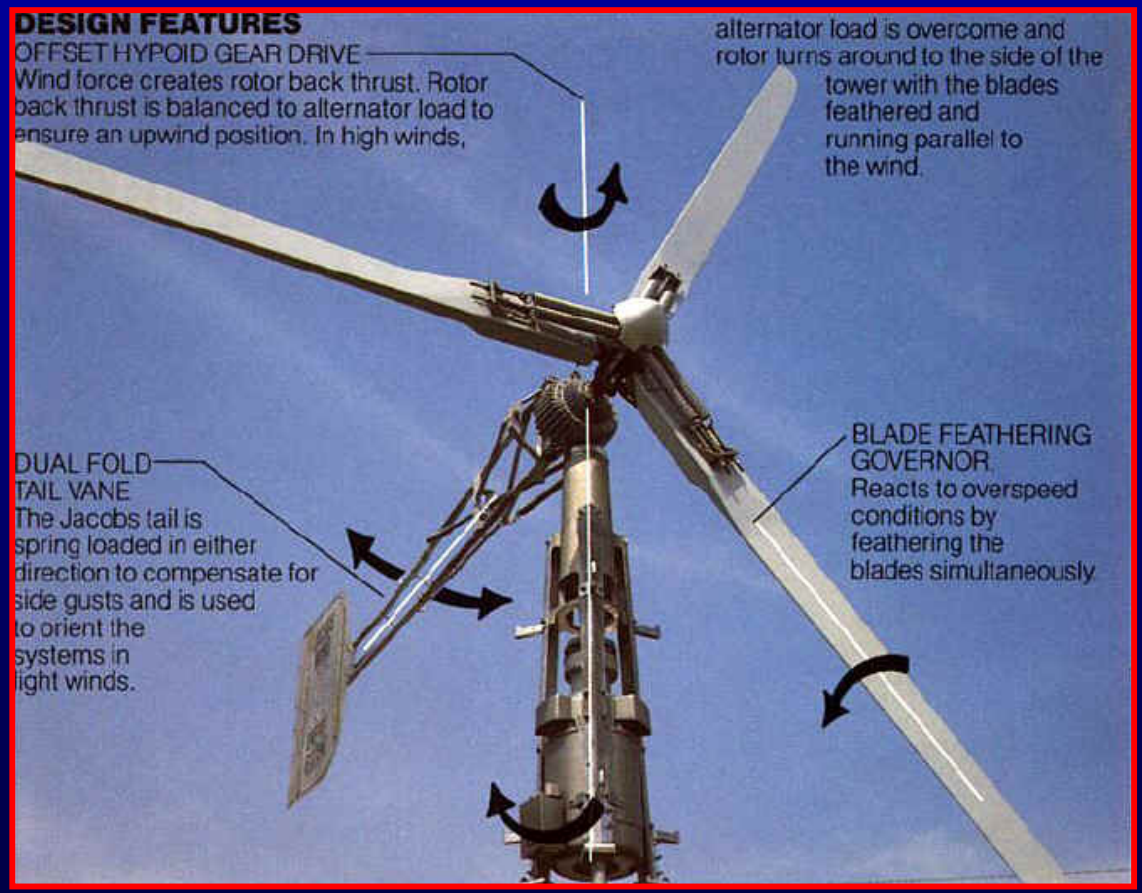
Want more info? Try – http://www.provenenergy.co.uk/

Wind Turbine Industries, Inc.

Prior Lake, MN

Jacobs
29/20
20 kW

Lots of
moving parts



Impacts: Noise

- Measured in dBA
- Background noise
  - Ambient 30 – 50 dBA
- Sound level change

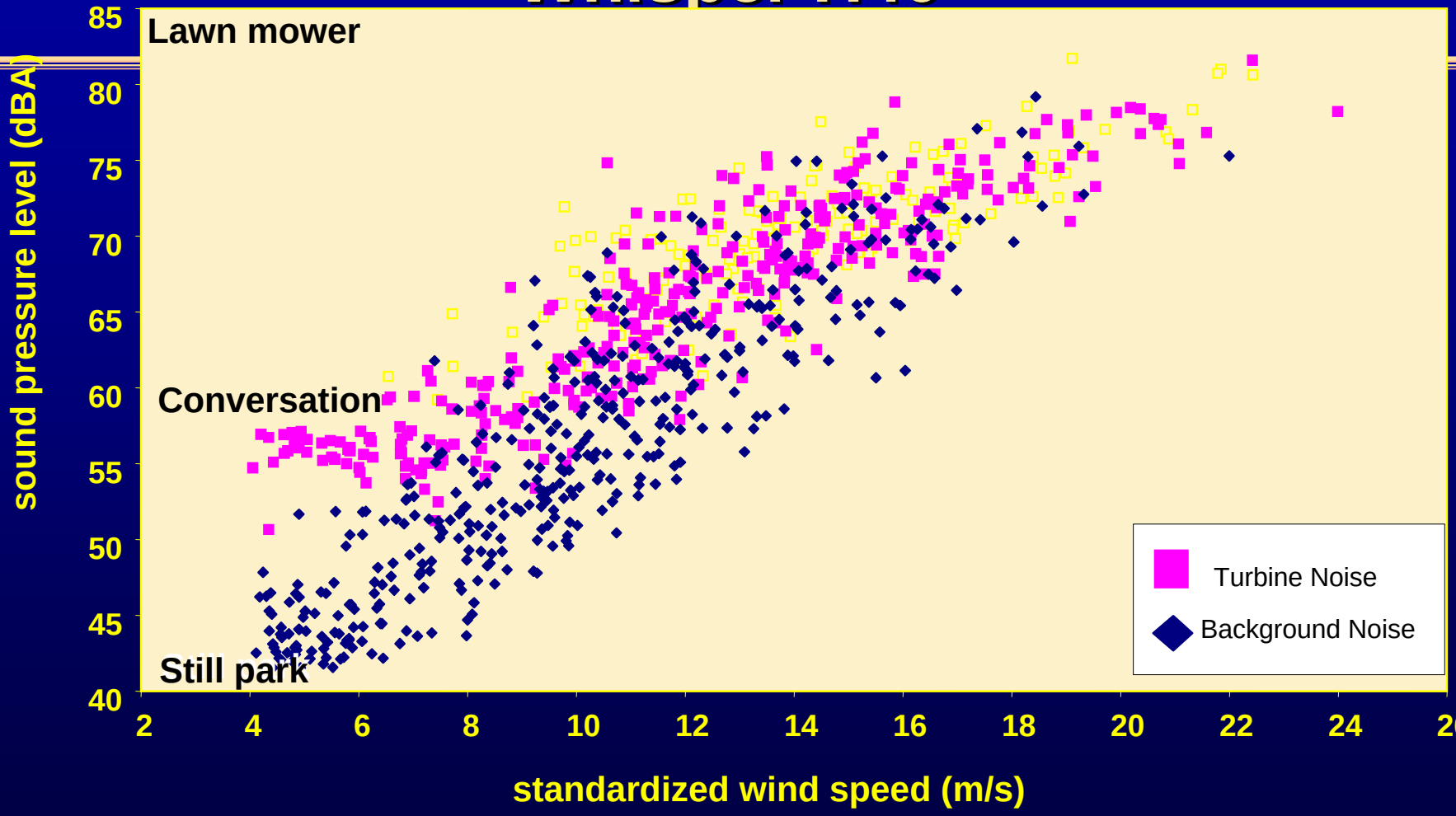
Sound Levels:

30 dBA: whisper
40 dBA: living room, still park
50 dBA: windy park
55-65: conversation
85-95: lawn mower

Level Change:

+ 3 dB: limit of perception
+10 dB: legal rise

NWTC Noise Test Data:
Whisper H40



Impacts of Small Wind Turbines: Birds?

- Reports of residential-scale wind turbines killing birds are very rare
- Other threats are greater

  than a small, unlighted wind turbine, e.g.

  – Sliding glass door

  – Car
- Historic turbines left an impression

❖❖ 3. Economics of Small Wind

- Incentives
  - Federal
  - Massachusetts
  - Costs of small wind system
- Pay-back time

Policy Options:
How can Government support Small Wind?

- Encourage Investment
  - Rebates, buy-downs, grants - Yes
  - Tax credits - Yes
  - Sales tax reductions/exemptions - Yes
  - Property tax reductions/exemptions - Yes
  - Low interest loans
- Make it easier
  - Net metering - Yes
  - Line extension / interconnect policies - Yes (latter)
  - Uniform zoning requirements - No

Want more info? Try –
http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=MA08R&state=MA&CurrentPageID=1
Or www.nationalwind.Org/pubs/strategies/default.htm

Federal Incentives

- USDA & Farm bill: support for renewables
  - Low interest loans
  - Loan guarantees
  - Grants

Want more info? Try –
http://www.rurdev.usda.gov/rbs/farmbill/2005NOFA/nofa05wind_sm.html

Mass. Financial Incentives for Residential Small Wind

- Renewable energy state income tax credit
  - 15% up to $1000
- RE equipment sales tax exemption
  - For principle residence
  - Also commercial
- Property tax exemption
- Net metering

Want more info? Try – http://www.dsireusa.org/

MTC: R.E. Trust's Small Renewables Initiative

- Rebates up to $50,000 for Installations in Mass.

Western Massachusetts Electric

Page 2 of 2

Account Number:
Statement Date:
Next Reading On/About:
Billing Cycle:
Customer Name Key:
Service For:
SALLY D WRIGHT

Delivery Services Detail

RATE: 0R1

Transmission Charge	176 kWh X $0.003240	$0.570240
Distribution Charges:		
Customer Charge		$8.530000
Energy Charge	176 kWh X $0.027830	$4.898080
Transition Charge	176 kWh X $0.008280	$1.457280
Energy Conservation Charge	176 kWh X $0.002500	$0.440000
Renewable Energy Charge	176 kWh X $0.000500	$0.088000

8.8 ¢ to the Mass. Renewable Energy Trust

Want more info? Try –
http://www.masstech.org/renewableenergy/small_renewables.htm

MTC-MRET Small Renewables Initiative

Installation Matrix for Small Renewable Initiative - Block # 2

	Technology		
	PV	Wind	Hydro
Distributed Generation	($/watt dc)	($/watt ac)	($/watt ac)
Base Incentive ($/watt)	$2.75	$2.75	$4.00
PLUS: Additions to Base			
MA-manufactured components	$0.50	$1.00	$0.75
Public Buildings	$1.50	$1.00	$2.00
Economic Target Area	$1.00	$1.00	$1.00
Back-up for Critical Loads	$0.50	$0.10	N/A
Building-Integrated PV	$1.00	N/A	N/A
Affordable Housing			
20% to less than 50 % Low-Income/ Affordable Housing (40B), or	$1.00	$1.00	$1.00
50% or greater Low-Income/ Affordable Housing (40-B)	$2.50	$2.50	$2.50
High Performance Buildings			
LEED or CHPS certified	$1.50	$1.00	$2.00
Energy Star or equivalent	$0.50	$0.35	$0.75

Mass. Incentives for Small Wind: Income Tax Credit

- Renewable energy state income tax credit
  - Personal tax credit
  - 15% tax credit for state income tax
  - Maximum of $1,000
  - Credit can be carried over if the credit is greater than one's income tax liability

Mass. Incentives for Small Wind: Sales Tax Credit

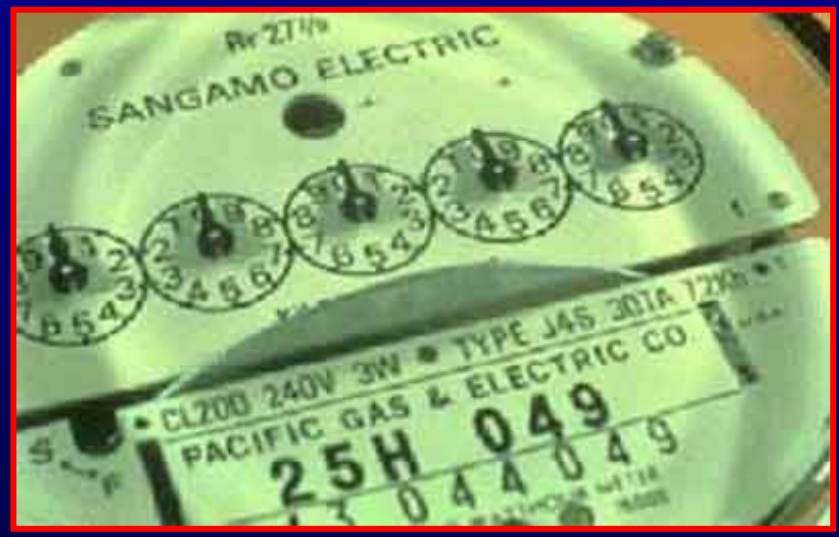
- Renewable energy equipment sales tax exemption
  - Exempts wind from state sales tax
  - Only applicable for an individual's principal residence
  - MA sales tax rate is 5%

Mass Incentives for Small Wind: Net Metering

- 60 kW maximum cap - residential, commercial industrial, utilities
- Net excess generation credited at average monthly market rate
- Law applies to distribution companies - Massachusetts Electric Company, Boston Edison company, Fitchburg Gas and Electric Light Company and Western Mass
- For more information www.state.ma.us/doer

Net Metering of Renewable Energy

- Meter sometimes turns backward
- Bill for "net" consumption/generation
- Net generation
  - Credited to next month's bill

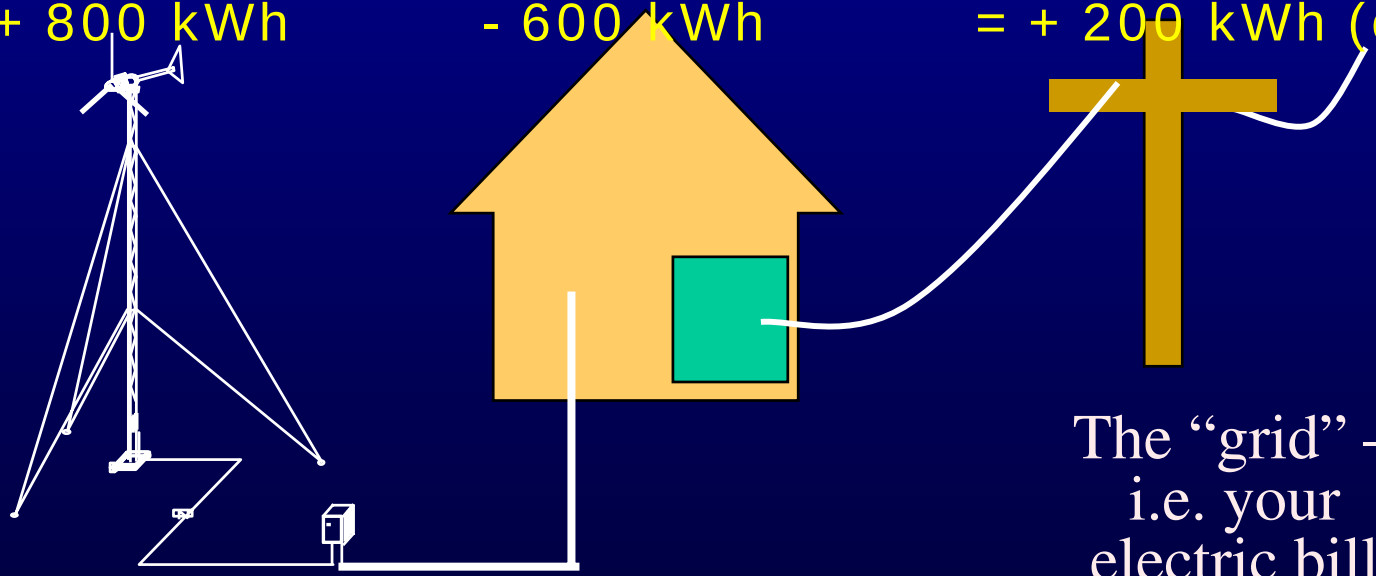


Want more info? Try –

http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=MA08R&state=MA&CurrentPageID=1

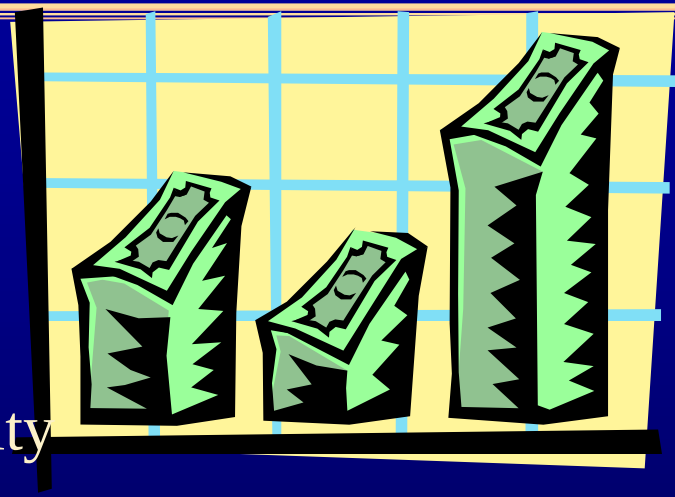
Net Metering: How it works

9am :	+ 200 watts	- 500 watts	= - 300 Watts (in)
10pm :	+ 800 watts	- 300 watts	= + 500 Watts (out)
April :	+ 500 kWh	- 600 kWh	= - 100 kWh (pay)
January :	+ 800 kWh	- 600 kWh	= + 200 kWh (credit)



The "grid" – i.e. your electric bill

Small Wind Turbine Economics

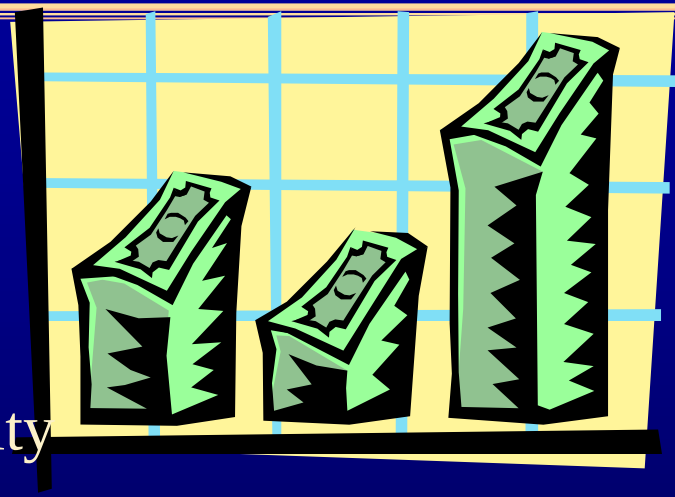


- Installed costs
  - –$2,000 and $6,000 / kW
  - –turbine, controller, and tower
  - –Cost trade-offs:
    - taller tower ➔ more energy
    - rugged/durable design ➔ longevity
- Benefits
  - – example: $10 – 40 gross savings per month
- Pay-backs: 6 – 30 years
- Equipment life-times :10 – 30 years
- Warranties : 2 – 5 years

❖❖ 3. Economics of Small Wind

- Incentives
  - Massachusetts
  - Federal
- Costs of small wind system
- Pay-back time

Small Wind Turbine Economics



- Installed costs
  - –$2,000 and $6,000 / kW
  - –turbine, controller, and tower
  - –Cost trade-offs:
    - taller tower ➔ more energy
    - rugged/durable design ➔ longevity
- Benefits
  - – example: $10 – 40 gross savings per month
- Pay-backs: 6 – 30 years
- Equipment life-times :10 – 30 years
- Warranties : 2 – 5 years

Wind Turbine Installed Cost

Example 1

Bergey Excel-S (10 kW) *(7m)*		High Cost	Low Cost
Wind turbine & inverter	**$20,900**		
Tower (80 ft guyed)	**$6,000**	$15,100	$5,400
Accessories	**$860**	$990	$800
Shipping	**$1,200**		
Installation	**$4,000**	$10,000	$2,000
Permits/Fees	**$500**	$3,500	$0
Sales Tax	**not included**	6%	-
Total	**$33,460**	$53,981	$30,300

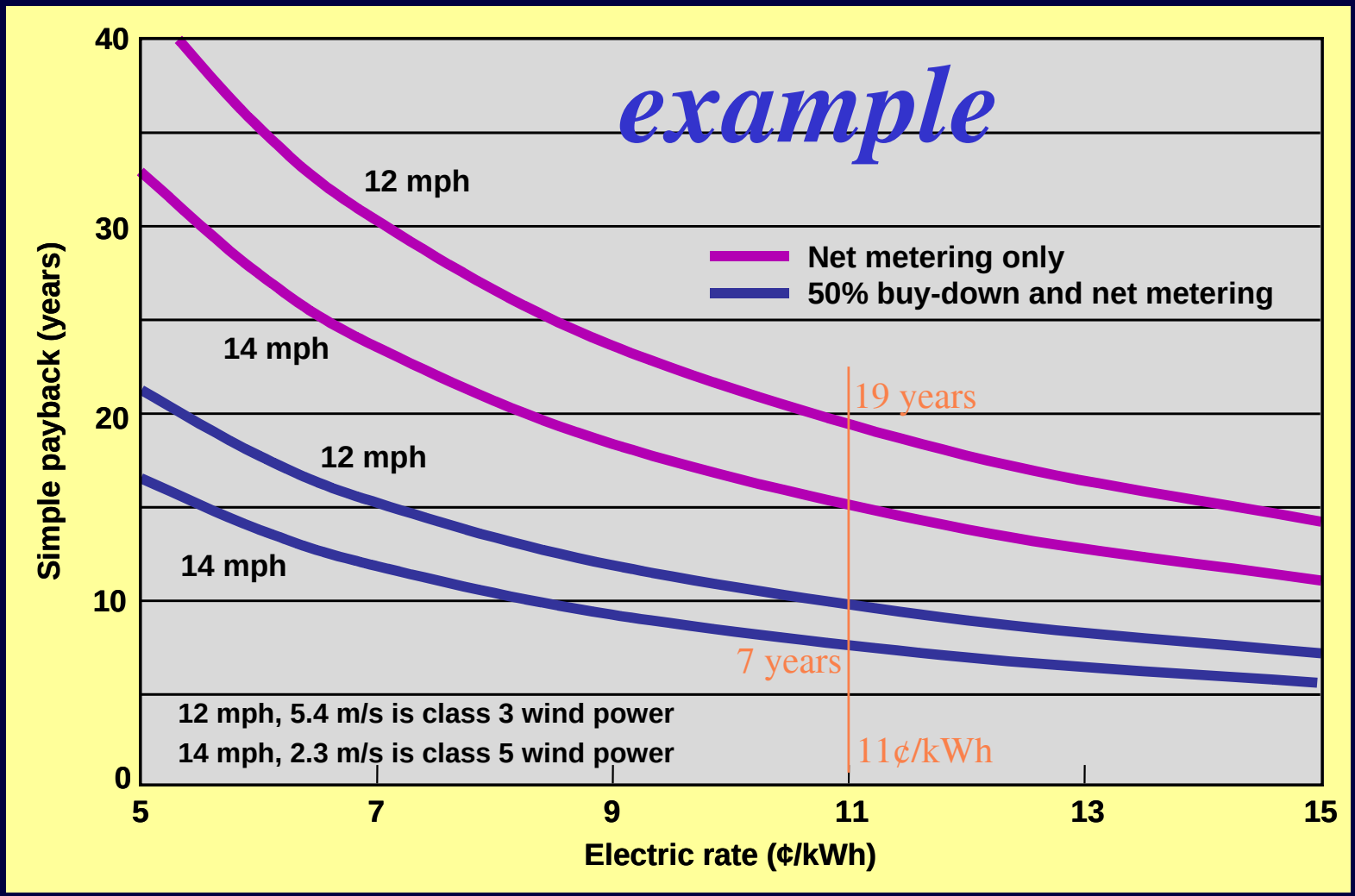
Wind Turbine Installed Cost

Example 2

Southwest Windpower
Whisper 175 (3 kW) *(15 foot, 4.26m)*

Wind turbine & inverter	**$8,950**
Tower (80 ft guyed)	**$1,920**
Battery and Containment	**$340**
Shipping	**$400**
Installation	**$2,620**
Permits/Fees	**$200**
Sales Tax	not included
Total	**$14,430**

Simple Payback:
Incentives, Wind, & Price/kWh matter



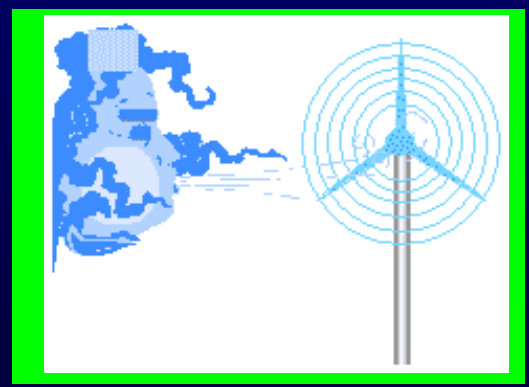
For More Information on Small Wind Economics...

- **Bergey Payback Calculator**
  www.bergey.com/Channels/1F2.htm

- **Wind Resource Atlas of the United States**
  http://rredc.nrel.gov/wind/pubs/atlas/

- **Database of State Incentives for Renewable Energy**

  www.dsireusa.org



Slide courtesy of AWEA

❖❖ 4. So you want a small wind system ….

What now?

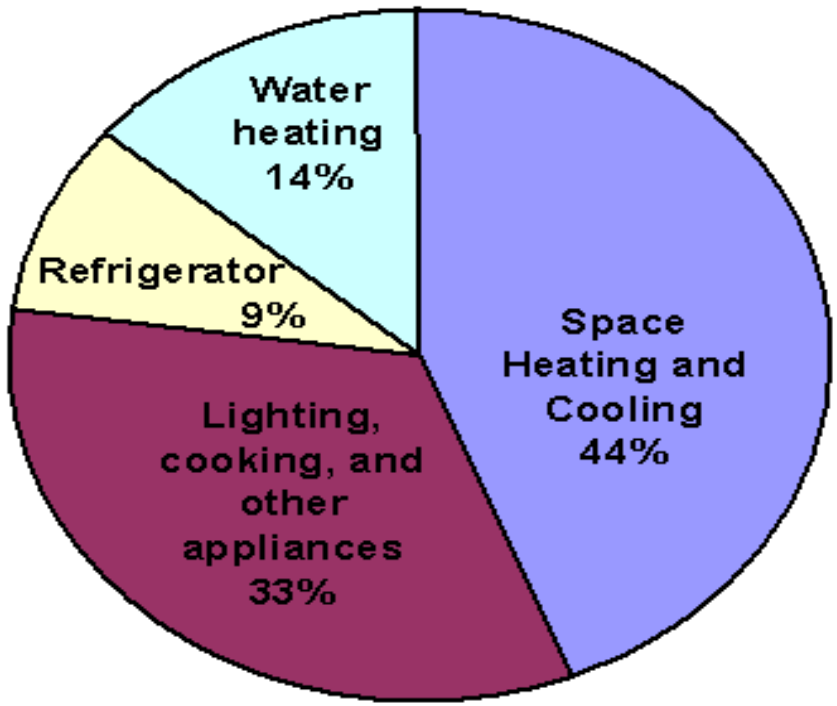
- Consider options
- Resource
  - wind speed
- Siting
- Zoning
- Interconnection

Is small wind right for you?

- Your motive
  - Clean electricity
  - Independence
  - Back up power
    - Need Batteries
- If your motive is Economics:
    - *Minimum* 10 mph (4.5 m/s) wind speed average
    - Your utility cost: >= 10 cents/kWh

Before You Buy

Economics will depend on system chosen, local wind resource, electricity costs, and how you use your wind system



Evaluate energy efficiency options first!

Approach investment as you would any other major purchase – do your homework

Slide courtesy of AWEA

Steps to deciding on Wind for your home

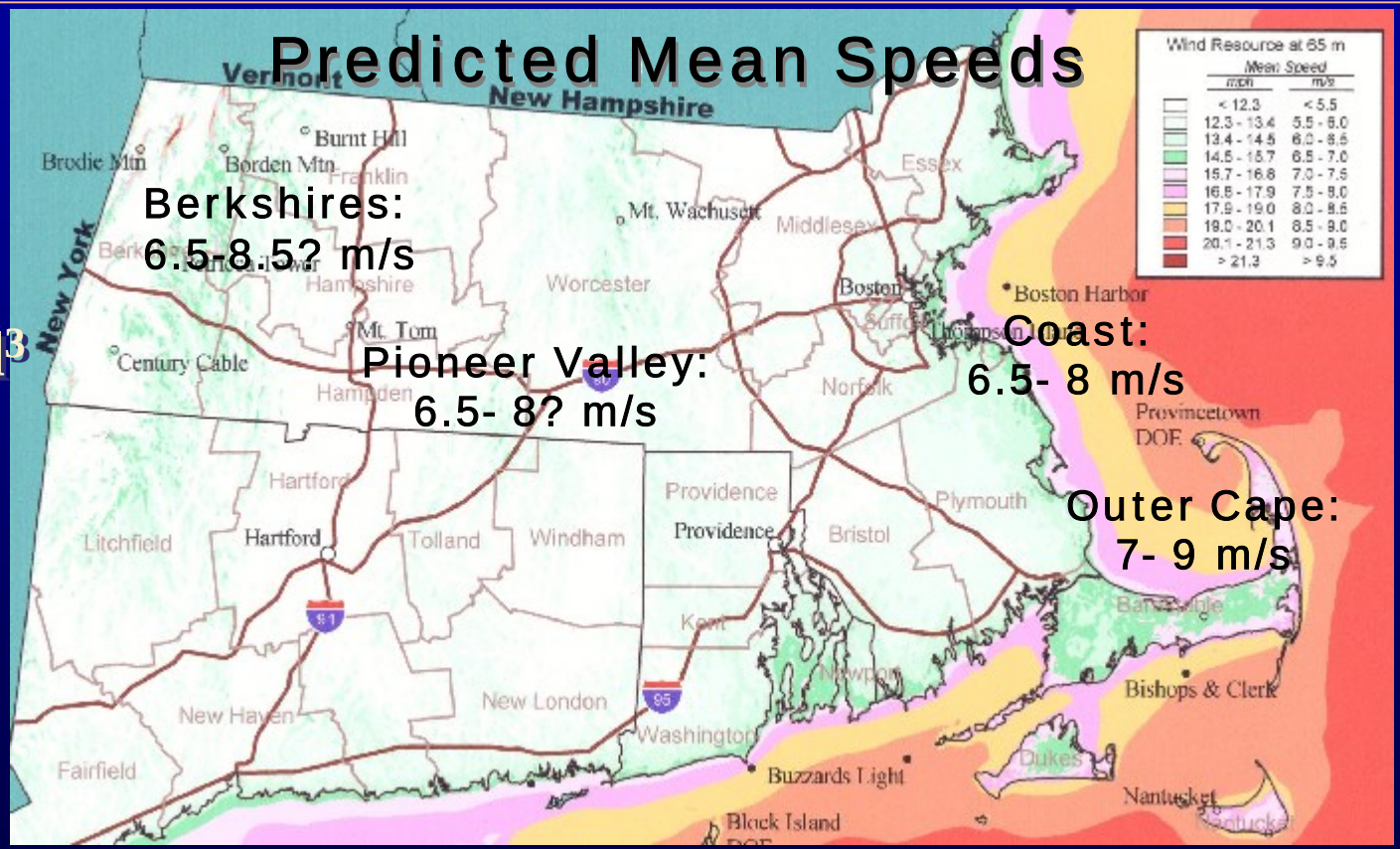
- Consider other options also
  - Conservation, Energy efficiency
  - Natural gas, propane
- Determine electricity needs
  - Both energy & power
- Determine resource
- Estimate system size, performance, and cost
- Choose machine…

Siting

- Resource
  - Speed
  - obstacles
- Space
  - Depends on zoning
  - Need >= acre
- ~1000’ from neighbors

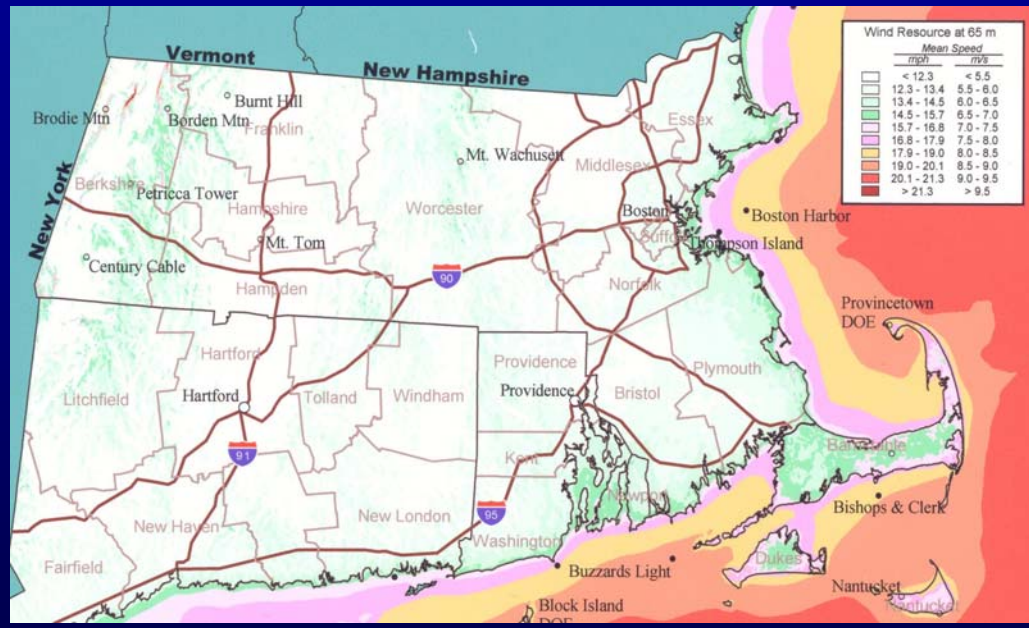
Siting:
Does Wind Speed Really Matter?

- **Yes!**
  - **Power ~ Speed^3**
  - **10% higher speed - 33% more power**



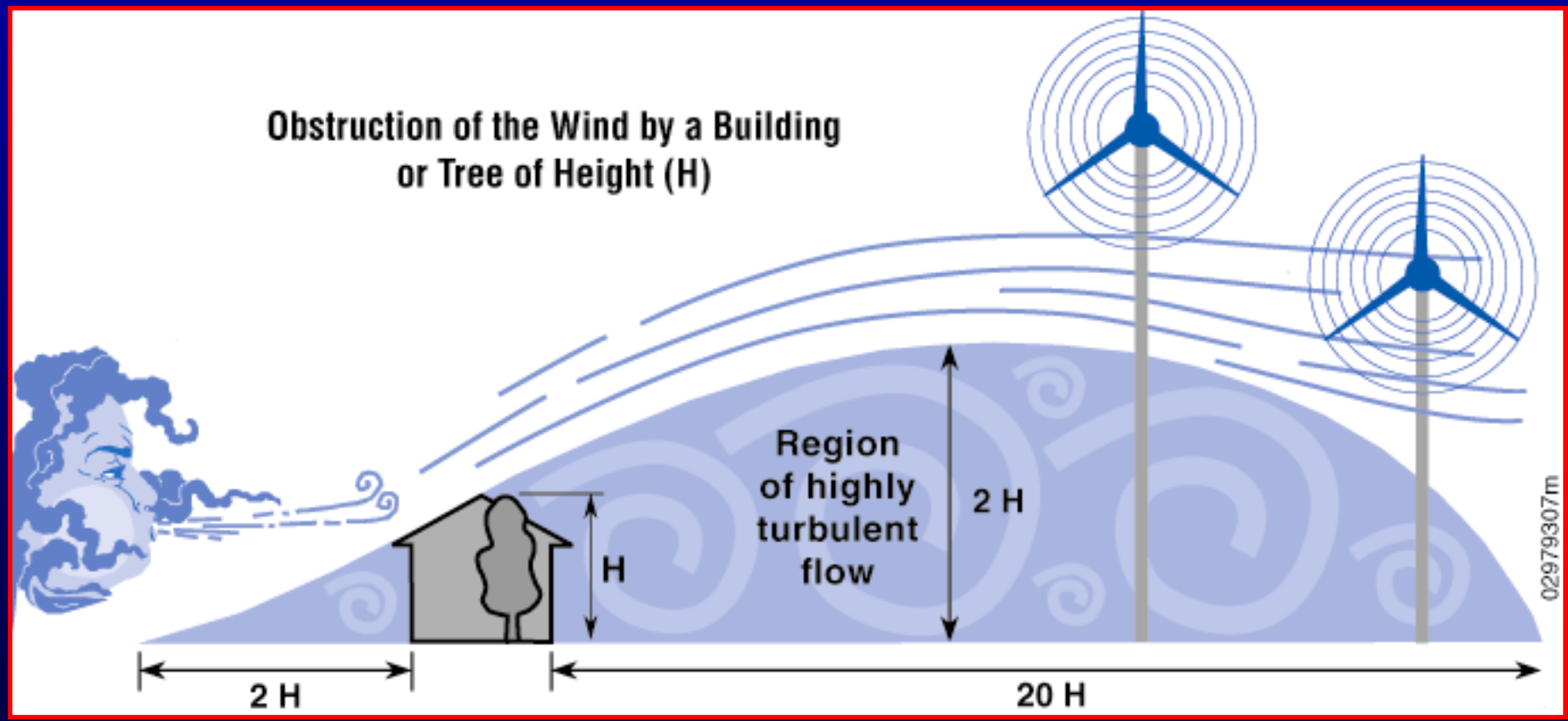
Siting:
Do I have enough wind?

- Where is Massachusetts' Wind Resource?
  - Ridges
  - Coast
  - Islands
  - Offshore
- Anemometer Tower?
  - Or micro turbine?



Want more info? Try –
http://www.awstruewind.com/inner/windmaps/NewEngland.htm

"Micro-siting" – Obstacles Matter



What about …. ?

- On the roof? – No.
  - Vibration, noise, turbulence
  - Survivability
- Used or rebuilt machines?
  - Reputable rebuilders
- Making my own?

  Or - my neighbor the inventor….
  - Survivability
  - Hugh Piggot

Grid Interconnection: The good news

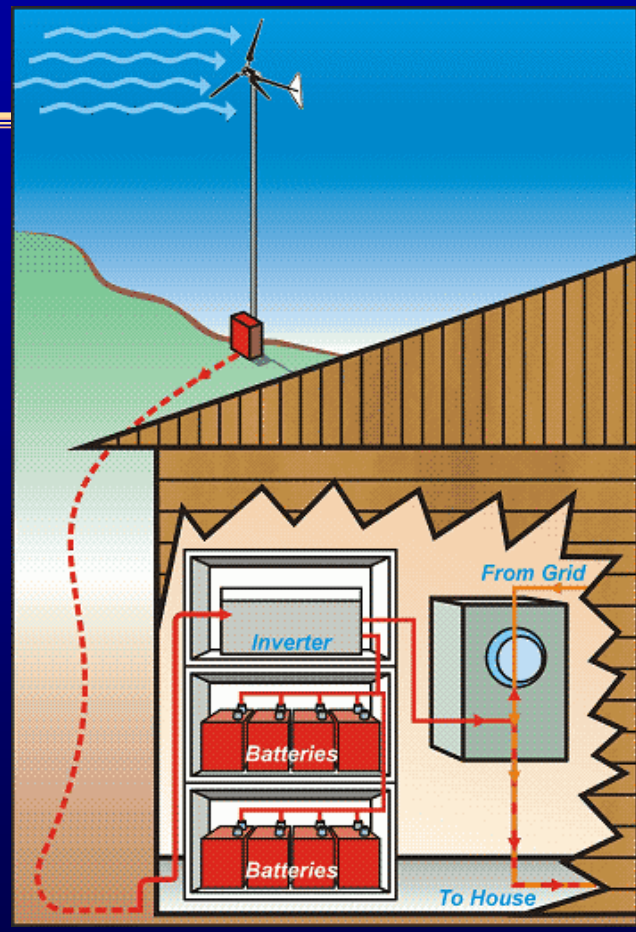
- The most common problems in utility contracts:
  - High liability insurance requirements
  - One-sided indemnity provisions
  - High customer charges
    - E.g. standby or backup charges
- Mass. law prohibits them!

Want more info? Try –

http://www.awea.org/faq/intcon_nt.html, www. Dsireuse.org

Grid Interconnection

- **Offset kWh purchase**
  - **Utility acts as "battery"**
- **Issues:**
  - **Technical & Safety**
  - **Contractual**
- **Contact your utility before hooking up**



Want more info? Try –

http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=MA08R&state=MA&CurrentPageID=1

Grid Interconnection Technical Requirements

Safety Issues

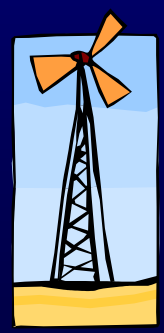
- Must meet electrical codes
- Must stop supplying power to grid during power outages

Power Quality Issues

- Must synchronize with grid
- Must match utility power's voltage, frequency and quality

Be Safety Conscious!

- Batteries & power electronic devices store energy
- Comply with the NEC (National Electric Code)
- Use good practices for climbing wind turbine towers



For More Information on Interconnection...

"Connecting a Small-Scale Renewable Energy System to an Electric Transmission System" U.S. Department of Energy Reference Brief (bibliography) 800-DOE-EREC
www.eren.doe.gov/consumerinfo/refbriefs/ja7.html

"Connecting to the Grid"
Interstate Renewable Energy Council
www.irecusa.org

Slide courtesy of AWEA

Overcoming Barriers

Small Wind 103: Siting Issues

Addressing permit requirements,
height restrictions, & environmental concerns

Slide courtesy of AWEA

Potential Obstacles

Legal issues

- City, town, or county ordinances restricting height or requiring minimum setbacks
- Building codes and covenants

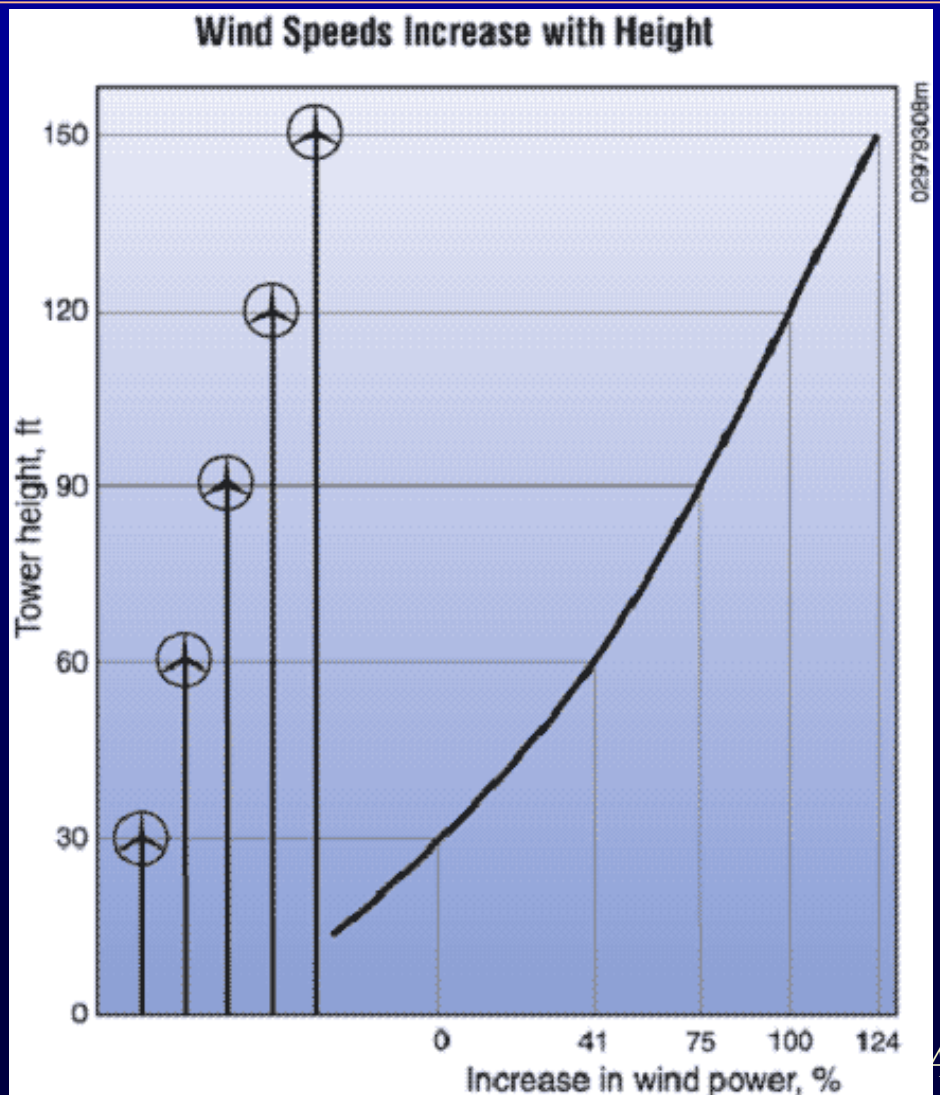
Environmental Issues

- Neighbors' concerns *(visual impact, noise)*
- Potential physical obstacles *(growing trees, planned construction)*

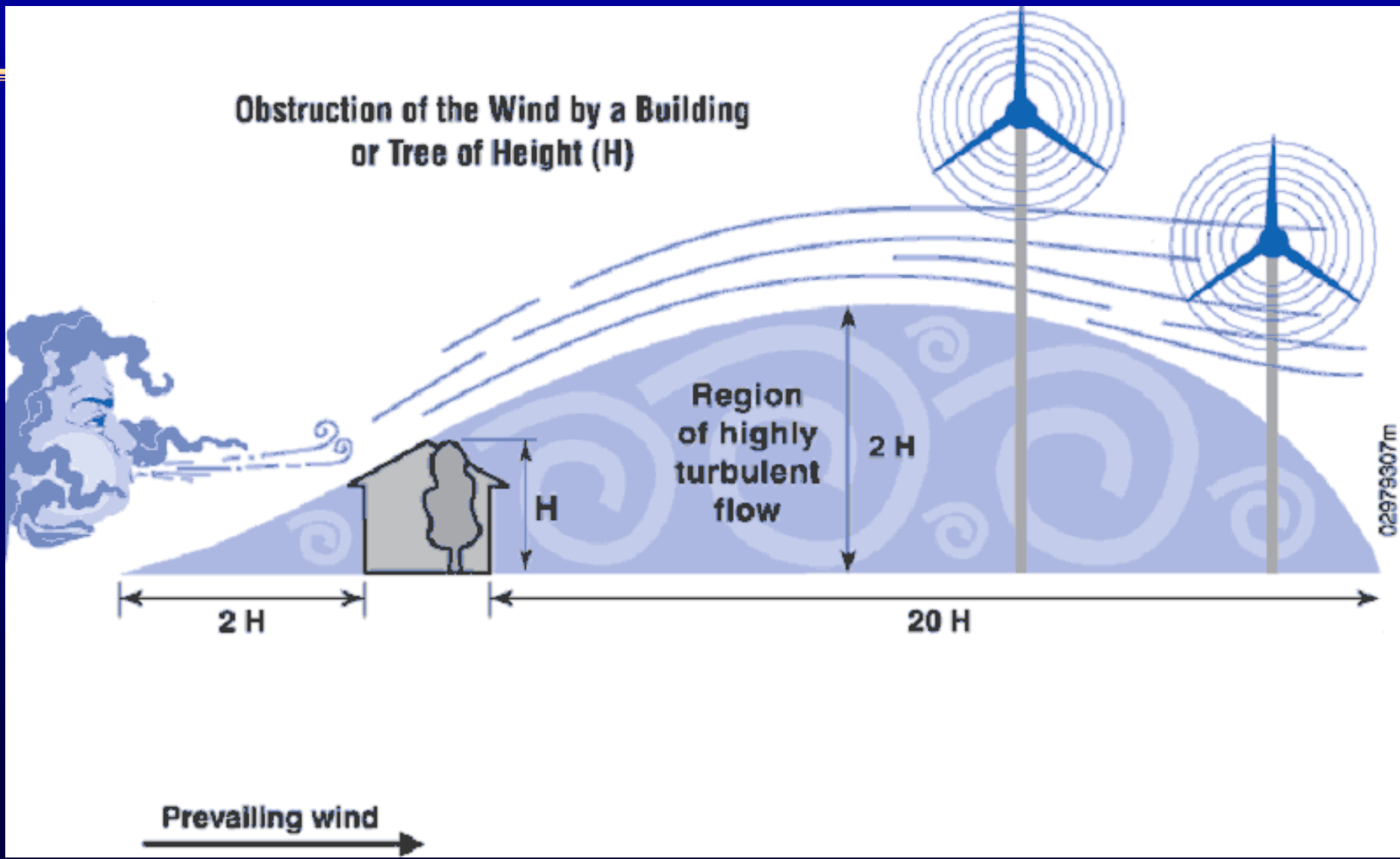
Slide courtesy of AWEA

Tower Height Matters

- Wind speed increases with height
- Small increases in wind speed result in large increases in power
- Tall towers often needed for clearance above obstacles *(turbulence)*
- May require a variance or a special use permit



Height or Distance Needed



Slide courtesy of AWEA

Noise & Visual Impact

Improved designs have made machines much quieter

- Comparable to central AC unit
- Noise levels fall sharply with distance

1 acre is a good rule-of-thumb minimum property size for a small wind installation capable of powering the whole house

Objections are less likely in a rural setting

- Spinning blades perceived as useful
- Talk to neighbors before seeking permit

Slide courtesy of AWEA

Raising Awareness Increases Acceptance

- **Emphasize the positive –**
  quiet, safe, renewable, non-polluting source of energy
- **Supply objective data –**
  expected decibel level, photographs of the equipment

- **Ask your city/county planners to designate small turbines a "permitted" use to allow 80- to 120-foot towers –**
  35-foot limits often date back to early 1900s

Slide courtesy of AWEA

Zoning:
Primarily local code

- Zoning
  - Height
  - Setbacks
    - Site plan
  - Noise
  - May require variance
    - Permitted use
    - Special use
    - Special hearing?
- Building code
  - Drawings of tower and foundations/footings
  - Engineering analysis, wet or dry stamp?
- "Approved" wind turbines (design safety)
  - Certification to national/international standards
  - Evidence of reliable one-year operation

Zoning & permitting: Federal, etc.

- National Electric Code
  - One-line electrical drawings
  - FAA Advisory Circular AC 70/7460-2K
  - Investigate if within ~2.5 miles of runway
- FAA
  - Investigate if within ~2.5 miles of runway

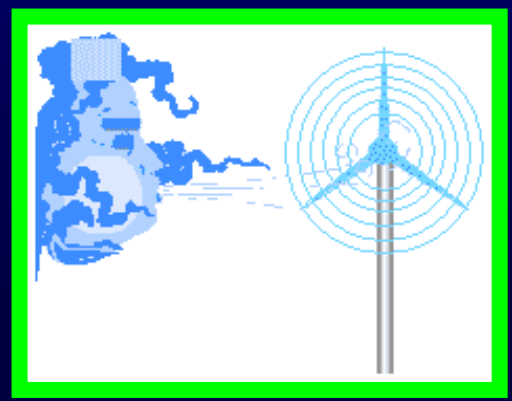
(Circular AC 70/7460-2K)

- Notice to the utility, and/or interconnection agreement
- Notice to neighbors
- TV/radio interference
  - Not a problem for wood or fiberglass blades

For More Information on Zoning Issues...

- **Legal and Safety Issues – U.S. DOE Small Wind System Installation Reference Brief**
  www.eren.doe.gov/consumerinfo/refbriefs/ja2.html

- **AWEA Advice from an Expert**
  www.awea.org/faq/sagrillo
  - *Trials and Tribulations*
  - *Keeping Hearings Under Control*
  - *Zoning Obstacles*
  - *Perceptions/Local Concerns*



Slide courtesy of AWEA

Overcoming Barriers

Expanding the Market for Small Wind Energy Systems

- **Small Wind 102: Economics**
  Making the numbers work
- **Small Wind 103: Siting Issues**
  Addressing permit requirements, height restrictions, and environmental concerns
- **Small Wind 104: Grid Interconnection**
  Reaching an agreement with your utility

Slide courtesy of AWEA

Overcoming Barriers

Small Wind 102: Economics

Making the numbers work

Slide courtesy of AWEA

Installation Costs

- Estimate $2-4/installed watt for typical system
- Smaller systems require smaller initial outlay, but cost more per watt
- Taller towers cost more, but usually reduce the payback period

A 4-10 kW system can meet the needs of a typical home

Customers paying 12 cents/kWh or more for electricity with average wind speeds of 10 mph or more can expect a payback period of 8-16 years

Slide courtesy of AWEA

Factors Affecting Payback

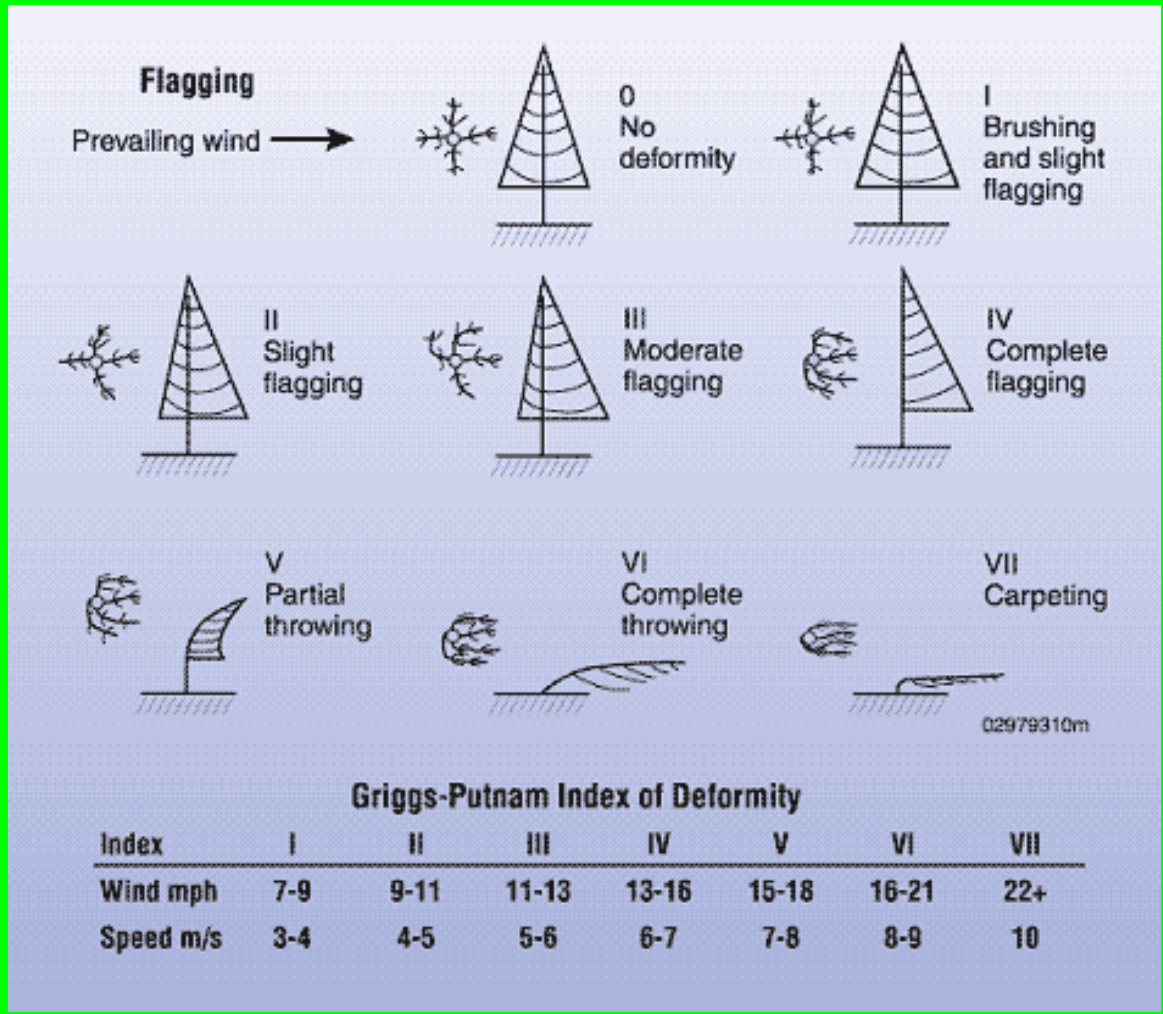
- Type, size and configuration of system
- Wind resource
- Local cost of electricity
- How wind system is used
- Rebates available, if any

If you can participate in a California-type 50% buy-down program, have net metering and average annual winds of at least 15 mph (6.7 m/s), your system can pay for itself in about 6 years

Slide courtesy of AWEA

Indirect Estimates of Wind Resource

- Review wind maps
- Obtain airport data
- Visually observe site vegetation



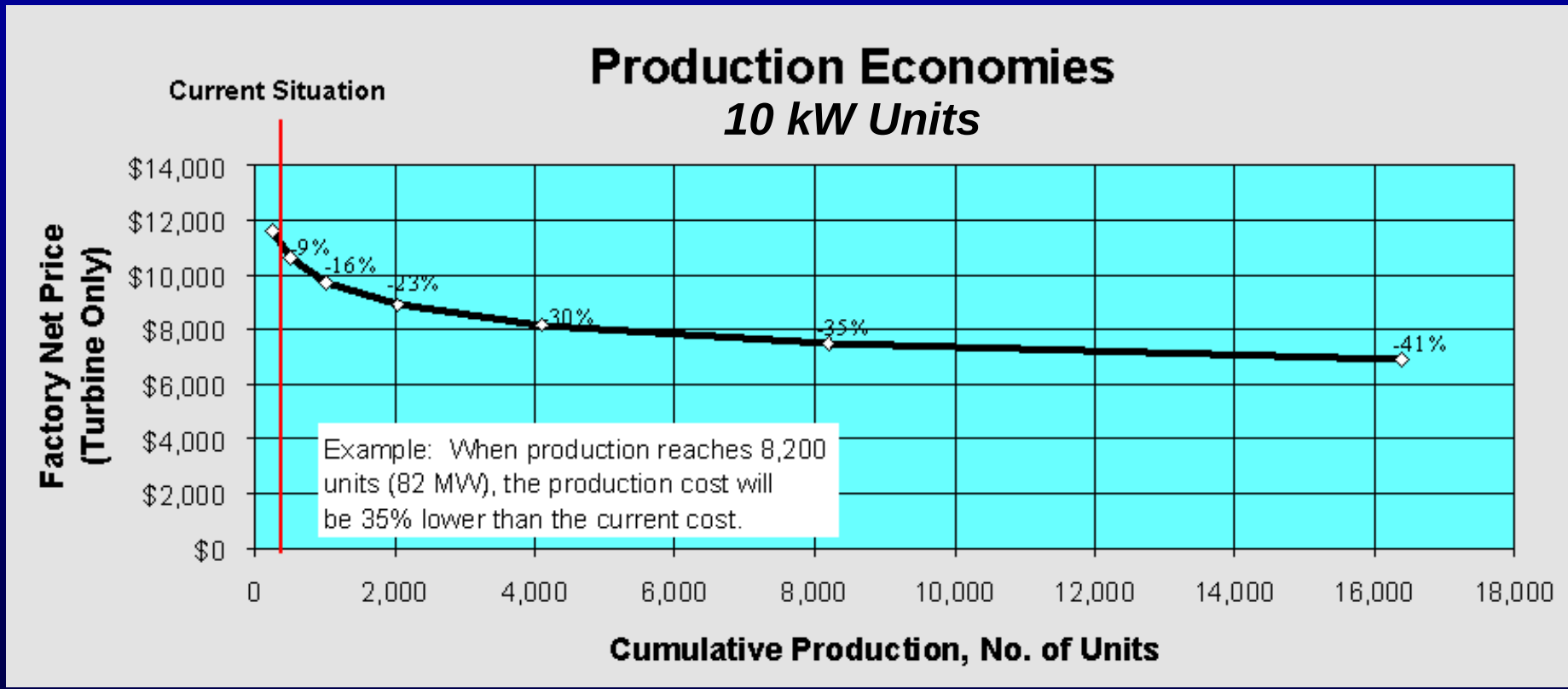
Griggs-Putnam Index of Deformity

Index	I	II	III	IV	V	VI	VII
Wind mph	7-9	9-11	11-13	13-16	15-18	16-21	22+
Speed m/s	3-4	4-5	5-6	6-7	7-8	8-9	10

See "A Siting Handbook for Small Wind Energy Conversion Systems," 800-553-6847 or www.ntis.gov/ordering.gov

Slide courtesy of AWEA

Production & Technology Improvements Bringing Down Costs



Costs for small wind turbines are projected to decrease to $1.50 / kW by 2010

Slide courtesy of AWEA

❖❖ 5. Examples

Bergey XL installation

Bergey 1 kW XL at James Madison University, Virginia Wind Energy Collaborative

Bergey XL installation

Bergey XL installation

Bergey XL installation

Bergey XL installation

AWT 3.6 meter, installed July '05
Cape Cod Regional Technical High School

Quiet

– neighbor is thinking of putting one in.

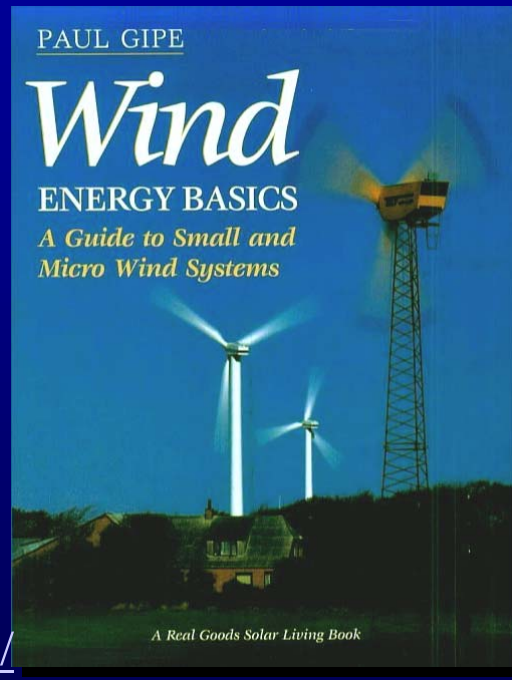
Installation, with tilt-up tower

Thanks & For more information

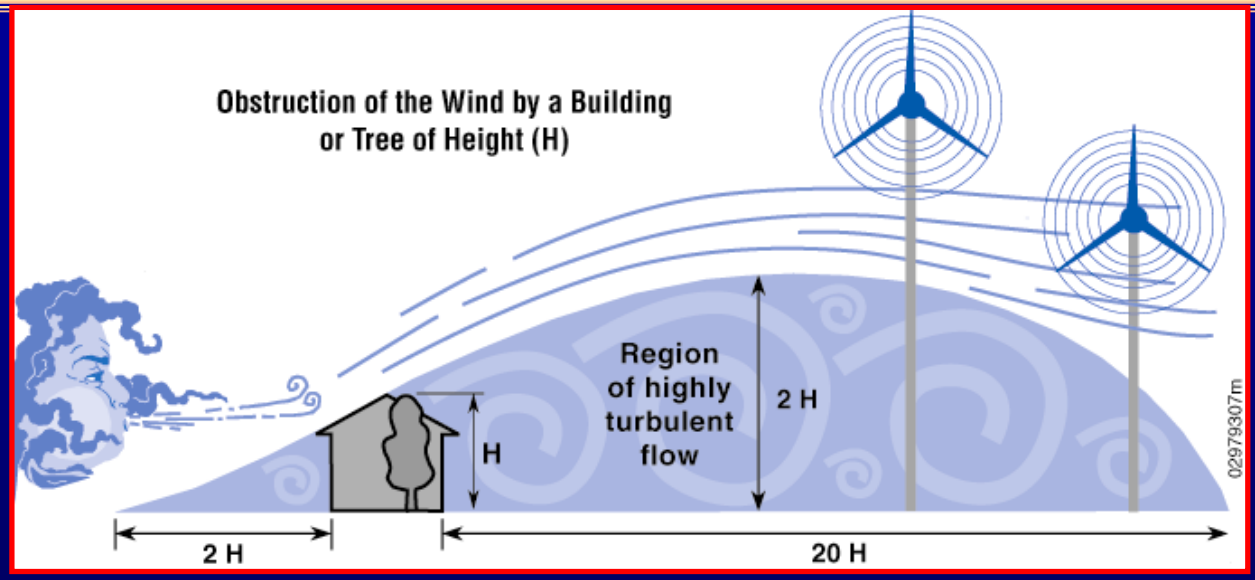
- Thanks to -
  - Co-op Power for organizing this & supporting clean energy!
  - For more information:
  - www.awea.org/smallwind/toolbox/default.asp
  - www.ceere.org/rerl/ - fact sheets & links
  - See also: links on slides for specific topics

For More Information on Small Wind

- AWEA, small wind turbine section www.awea.org
- Home Power magazine www.homepower.com
- Paul Gipe's books www.chelseagreen.com
  - Wind Energy Basics, Wind Power for Home and Business
- Mick Sagrillo's Videos and articles
  - (writes for Home Power magazine, etc.)
- Wind Powering America http://www.eere.energy.gov/windandhydro/windpoweringamerica/
- Equipment Mfrs (see links above)
- http://www.windustry.com/resources/small-scale.htm
- Interstate Renewable Energy Council & their The Small Wind Web Site http://irecusa.org/smallwindenergy/index.html



❖❖ 5. Your Questions



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