



DOCKET

08-IEP-1B

DATE JUL 31 2008

RECD. AUG 04 2008

Wind at Community and Building/Industrial Scale

C.P “Case” van Dam

Henry Shiu

Scott Johnson

California Wind Energy Collaborative

University of California, Davis

California Energy Commission

Integrated Energy Policy Report Workshop

Emerging Technologies for the Integration of Renewables

31 July 2008



Overview

- Industry status
- System configurations and costs
- Economic considerations
- An agricultural case study
- Future opportunities





E. Mayda

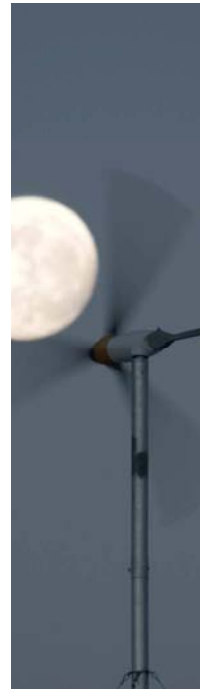
Why Wind Energy?

- Clean
 - Emission free operation
 - No waste generation
- Renewable
 - Guaranteed “fuel” availability
 - No cost volatility
- Installation
 - Rapidly deployed
- Security
 - Non-centralized installation and operation
 - No imported fuel requirement
- Economics
 - Cost effective energy
 - Local economic benefits



Wind: Big & Small

	Utility-Scale	Small / Distributed
Capacity	1 MW – 3 MW	300 W – 100 kW
Rotor diameter	60 m – 110 m	1 m – 19 m
Total height	90 m – 170 m	< 50 m
Application	Utility electricity generation (supplying the grid)	Powering nearby (on-site) electrical loads



Wind: Big & Small

Vestas V80, 1.8 MW



Source: Shiu

Southwest Skystream, 1.9 kW



Source: NREL



Small Wind Energy Systems

- Typically 100 kW or smaller
- Residential, business, industrial, agricultural applications
- On-grid, off-grid (including village power)
- Stand-alone, hybrid (e.g., with solar or diesel)



Source: Southwest Windpower



Source: Alfred University

Small Wind Snapshot

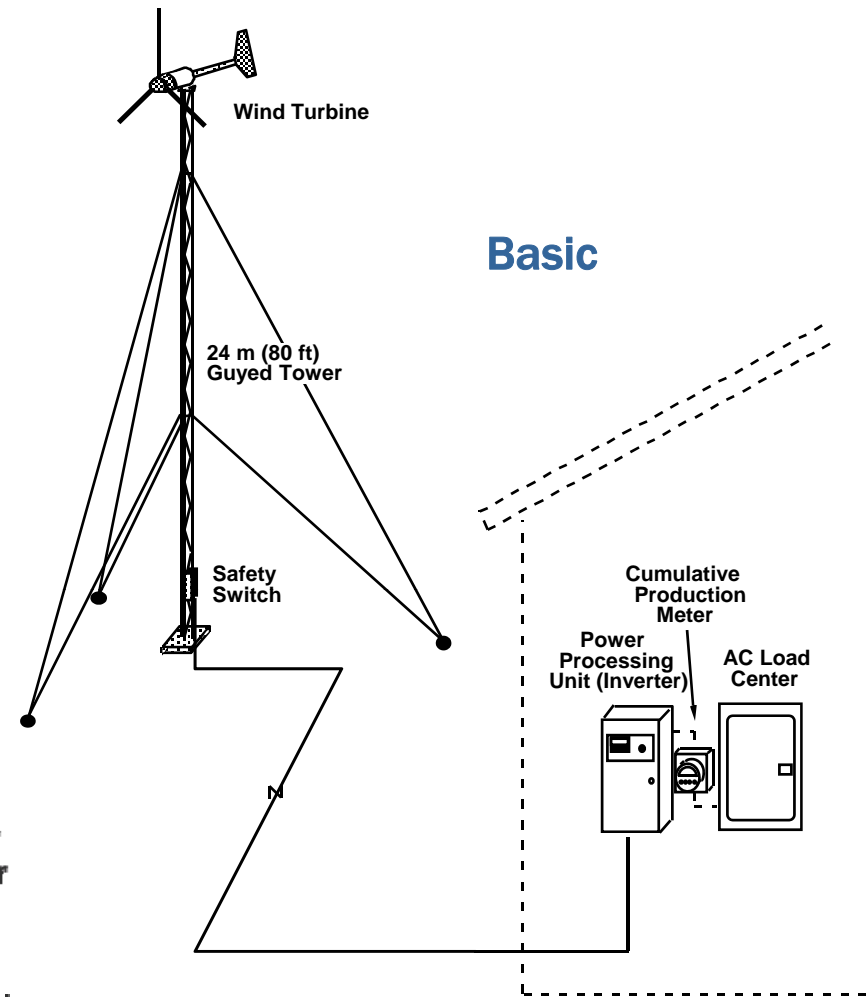
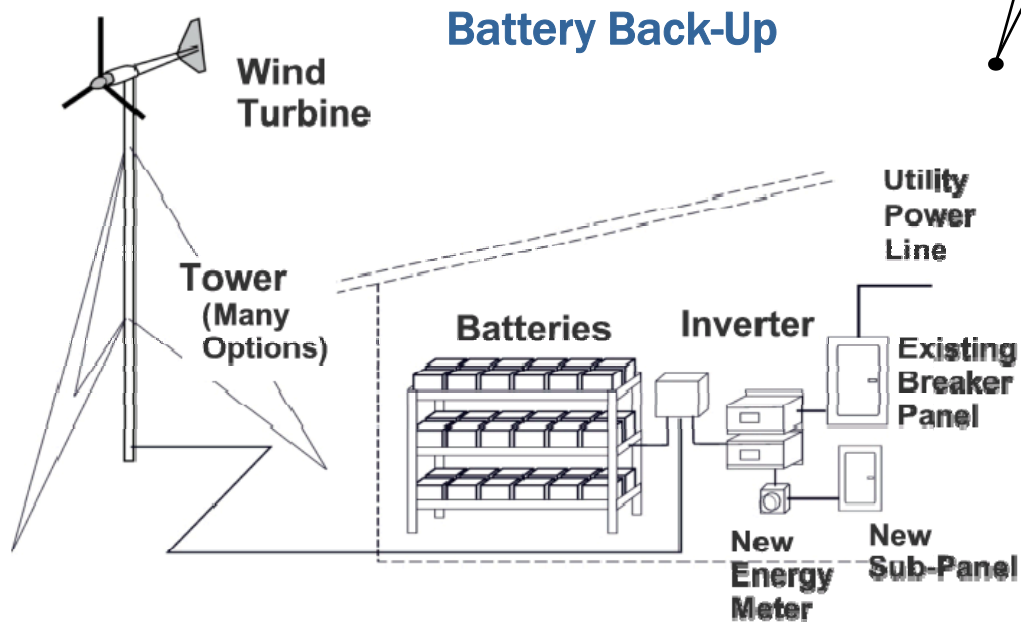
Source: AWEA, 2007

- As of 2006, there are approximately 2500 grid-connected, residential scale wind turbines (1 - 10 kW) in use in the U.S.
- Typically, small turbines are 1 to 10 kW, but range from 300 W to 100 kW
- 2006 U.S. sales
 - 6807 small turbines
 - 17.5 MW
 - \$56,082,850
 - 11% on-grid
 - 89% off-grid
 - 98% manufactured in U.S.
- 2006 Sales outside of U.S.
 - 9502 small turbines
 - 19.5 MW
 - \$61,131,500
 - 97% manufactured in U.S.
- Manufacturers
 - U.S.
 - Established: 12
 - Forthcoming: 8
 - Foreign
 - 47
 - At least 13 had sales in 2006
- U.S. market growth estimated at 14-25% annually
 - 2004: 30 MW in U.S.



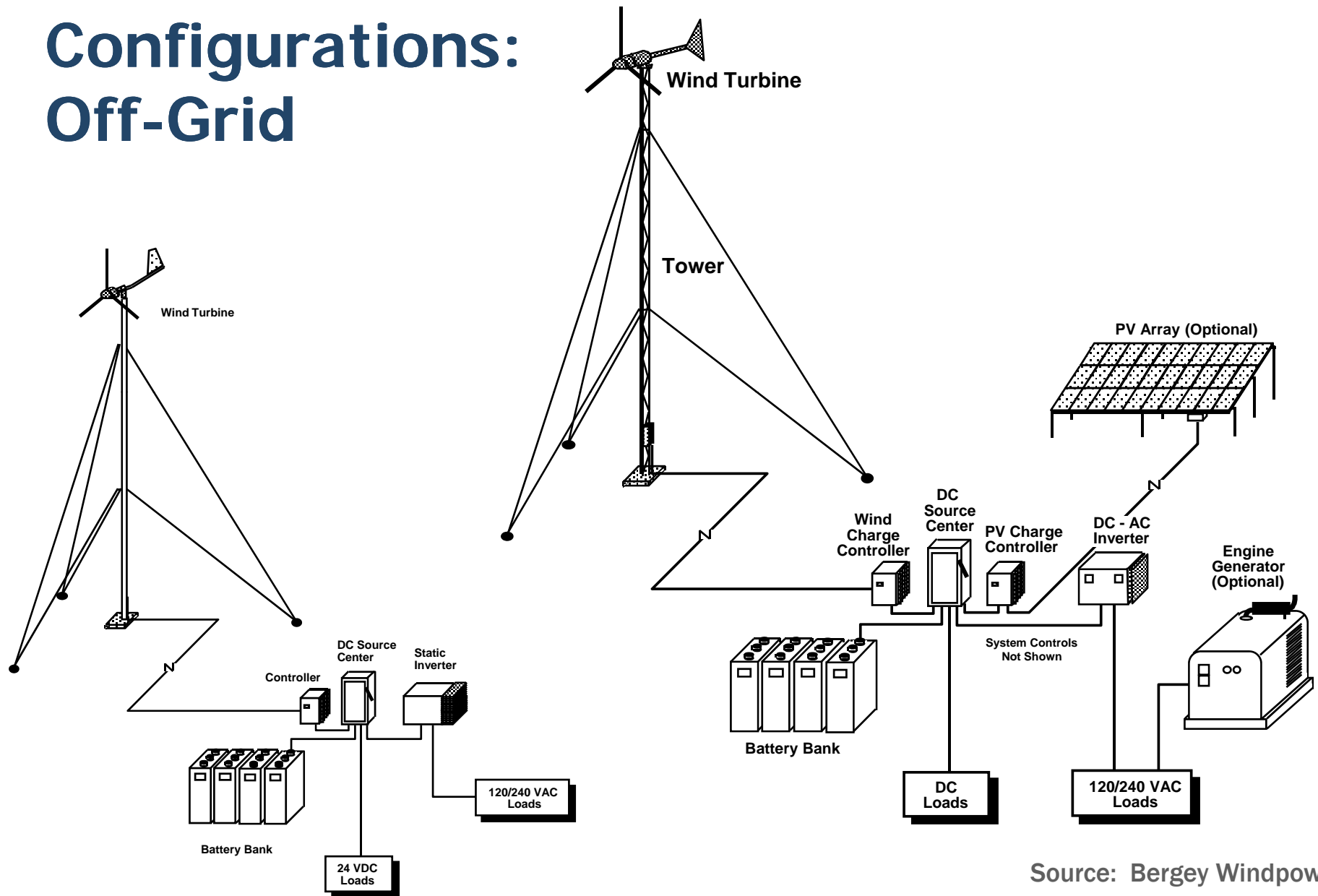
Configurations: On-Grid

- Can be hybridized with solar or another generation source
- Batteries can provide back-up power and peak shaving



Source: Bergey Windpower

Configurations: Off-Grid



Source: Bergey Windpower

Example System

- On-Grid Bergey Excel

EXCEL-S Turbine	\$ 14,900
GridTek 10 Inverter	\$ 8,000
100 ft. Guyed-Lattice Tower	\$ 6,900
Tower Wiring Kit	\$ 930
Shipping & Delivery	\$ 1,200
Foundations	\$ 2,000
Wire Run (250 ft)	\$ 1,750
Electrical Contractor	\$ 1,375
Turbine Set-Up (Inc. Crane)	\$ 1,375
Miscellaneous Costs	\$ 500
Sales Tax (7.75%)	\$ 2,385
Total	\$ 41,315

Does not include permits!



Source: van Dam



Example System

- On-Grid Southwest Windpower Skystream

Skystream 3.7 220V	\$	5,380
33' Monopole tower	\$	1,530
Hinge plate & gin pole	\$	650
Shipping & Delivery	\$	1,060
Foundations	\$	1,300
Electrical	\$	1,050
Turbine Set-Up	\$	360
Misc. Costs	\$	300
Sales Tax (7.75%)	\$	901

Total \$12,531

Does not include permits!



Source: Southwest Windpower



Economics

- The economics of utility-scale wind and small wind are very different
- System costs have been fairly steady at \$5 / watt (Hingtgen, California Energy Commission), 15¢ / kWh – 18¢ / kWh (AWEA)
 - Above figures do not include incentives
 - Utility-scale wind: \$1.80/W, 4¢/kWh – 7¢/kWh
 - Solar PV: 30¢/kWh (no incentives, sunny climate, source: Solarbuzz); 18¢/kWh (w/ incentives, source: SEIA); \$7.50/W (California, w/ incentives)
- Small wind systems offset the retail cost of electricity, not the wholesale cost. In California (PG&E, Oct 07):
 - Residential, single rate: 11¢/kWh – 36¢/kWh (average 16¢/kWh)
 - Residential, seasonal: 7.5¢/kWh – 35¢/kWh (average 21.7¢/kWh)
 - Residential, TOU, Summer, Tier 5: 53¢/kWh
 - Commercial, A-1: average 17¢/kWh (max 18¢/kWh)
- Net metering and incentives substantially change economics



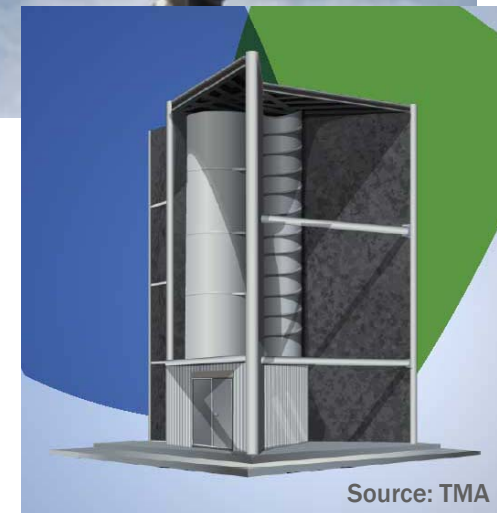
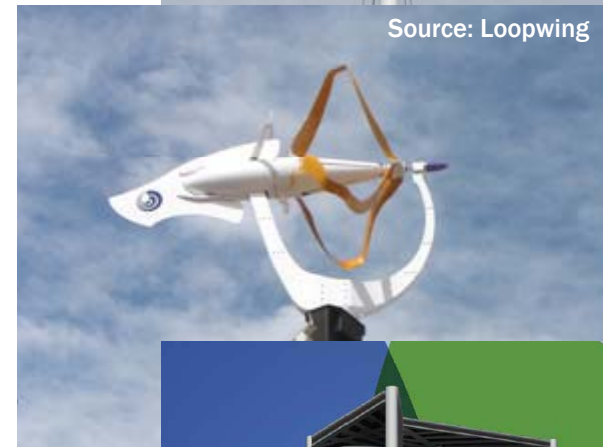
Incentive Programs

- Self Generation Incentive Program (SGIP)
 - Eligibility: Systems less than 5 MW
 - 30 kW – 1000 kW: \$1.50 / W
 - > 1000 kW: none
 - http://www.cpuc.ca.gov/static/Energy/Electric/051005_sgip.htm
- USDA Section 9006: Renewable Energy and Energy Efficiency Program
 - Grants up to 25% of project costs
 - Loans up to 50% of project costs
 - In its first three years, \$67 million of grants were awarded
 - <http://www.rurdev.usda.gov/rbs/farmbill/>
- California Energy Commission Emerging Renewables Program (ERP) Rebate
 - Eligibility
 - Small wind turbines no greater than 50 kW
 - Turbine must be on CEC approved list
 - Grid connected
 - 0 kW – 7.5 kW: \$2.50 / W
 - 7.5 kW – 30 kW: \$1.50 / W
 - > 30 kW: none
 - http://www.energy.ca.gov/renewables/emerging_renewables



Caveat Emptor

- There seems to be a new claim for a breakthrough innovation in small wind power every day
- Wind turbine designs have evolved into their current configurations for sound engineering and economic reasons
- Eligibility for California ERP rebates is one indication that a turbine is reliable
 - Compliant with standards or...
 - Demonstrated continuous operation
- Turbine certification program is under development
- “The proof is in the pudding.”
 - The best indication of a good turbine is a history of successful operation



CEC ERP Eligible Small Turbines

Source: CEC, http://www.consumerenergycenter.org/cgi-bin/eligible_smallwind.cgi

Manufacturer Name	Model Number	Description	Power Output (W)
Aerostar, Inc.	6 Meter	8,600W Wind Turbine	8,600
Atlantic Orient Canada	AOC 15/50	50,000W Wind Turbine	50,000
Bergey Windpower	BWC 1500	1,500W Wind Turbine	1,500
Bergey Windpower	BWC EXCEL	10,000W Wind Turbine	10,000
Bergey Windpower	BWC XL.1	1,000W Wind Turbine	1,200
Cygnus Wind Systems	Wind Eagle 30	30,000W Wind Turbine	30,000
Endurance Wind Power, Inc.	S-250	4,250W Wind Turbine Generator System	4,250
Endurance Wind Power, Inc.	S-250	5,000W Wind Turbine Generator System	5,000
Entegrity Wind Systems	EW15	50,000W Wind Turbine	50,000
Fortis	Espada	800W Wind Turbine	750
Fortis	Montana	5,800W Wind Turbine	5,000
Fortis	Alize	12,000W Wind Turbine	10,000
Iskra Wind Turbine Manufacturers Ltd	AT5-1	Iskra AT5-1	5,000
Northern Power Systems	NW100	100kW Wind Turbine	100,000
PacWind, Inc.	Delta I	2000W Wind Turbine	2,000
PacWind, Inc.	SeaHawk	500W Wind Turbine	500
Point Power Systems	0.8 kW	800W Wind Turbine	750
Point Power Systems	5.8 kW	5,800W Wind Turbine	5,000
Point Power Systems	12 kW	12,000W Wind Turbine	10,000
REDriven, Inc.	FD6.4-5000	5,000W Wind-Driven Generator	5,000
REDriven, Inc.	FD3.0-1000	1,000W Wind-Driven Generator	1,000
REDriven, Inc.	FD3.6-2000	2,000W Wind-Driven Generator	2,000
REDriven, Inc.	FD8.0-10K	10,000W Wind-Driven Generator	10,000
REDriven, Inc.	FD10.0-20K	20,000W Wind-Driven Generator	20,000
Southwest Windpower	AIR403	400W Wind Turbine	472
Southwest Windpower	502	500W Windseeker Wind Turbine	500
Southwest Windpower	503	500W Windseeker Wind Turbine	500
Southwest Windpower	Skystream 3.7	1,800W (2400W peak) Direct Grid-Connect Turbine	1,800
Southwest Windpower	100	Whisper 100 Wind Turbine	900
Southwest Windpower	500	Whisper 500 Wind Turbine	3,000
Southwest Windpower	200	Whisper 200 Wind Turbine	1,000
Synergy Power Corporation	S-5000 / S-8	Survivor 830W Wind Turbine	830
Synergy Power Corporation	SLG/S300	Survivor 30,000W Wind Turbine	30,000
Unitron Energy Pvt, Ltd.	UE 15	1500W Wind Turbine	1,500
Unitron Energy Pvt, Ltd.	UE 42	4200W Wind Turbine	4,200
Wind Turbine Industries	31-20	20,000W Jacobs 31-20 Wind Turbine	20,000
Wind Turbine Industries	23-10	10,000W Jacobs 23-10 Wind Turbine	10,000
Yangzhou Shenzhou Wind-driven Generator Co., Ltd	FD8.0-10K	10,000W Wind-Driven Generator	10,000
Yangzhou Shenzhou Wind-driven Generator Co., Ltd	FD6.4-5000	5,000W Wind-Driven Generator	5,000
Yangzhou Shenzhou Wind-driven Generator Co., Ltd	FD3.0-1000	1,000W Wind-Driven Generator	1,000
Yangzhou Shenzhou Wind-driven Generator Co., Ltd	FD10.0-20K	20,000W Wind-Driven Generator	20,000
Yangzhou Shenzhou Wind-driven Generator Co., Ltd	FD3.6-2000	2,000W Wind-Driven Generator	2,000



Is Distributed Wind Right Selection?

Two critical steps to evaluate each case, best done simultaneously:

- Check ordinances and file for permits
- Perform energy production and economic analysis



Ordinances & Permitting

- Like any other structure, a wind energy system requires permits and is subject to local ordinances.
 - Usually covered in county ordinances and sometimes are found in city ordinances, too.
 - Vary significantly from location to location
 - Permitting process can be lengthy
- Example: Monterey County Zoning Ordinance 20.64.120, 21.64.120
 - Setbacks
 - Minimum of two times the total height from any property line.
 - Minimum of at least 5 times the height from any public road or highway.
 - Minimum of at least 1.25 times the height from any habitable structure.
 - Height
 - Noncommercial system shall not exceed a total height of 50 feet unless the parcel is 10 acres or larger, in which case the maximum total height may be 100 feet.
- Permitting fees
 - Vary significantly from county to county: from a few hundred dollars to several thousand.
 - Monterey County has some of the highest permitting fees in California
- Ordinances on wind energy were often drafted with little experience and may be based on incorrect or dated information.



Case Study: Irrigation in Salinas Valley

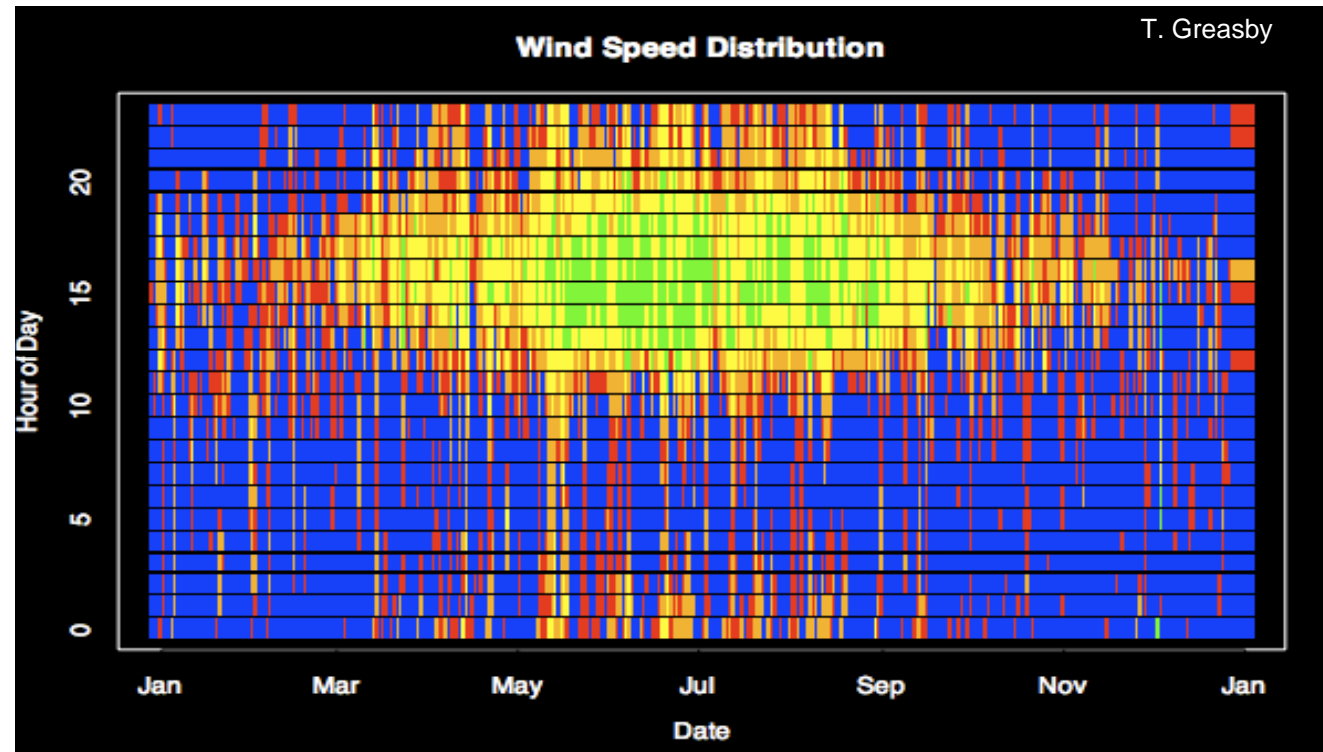
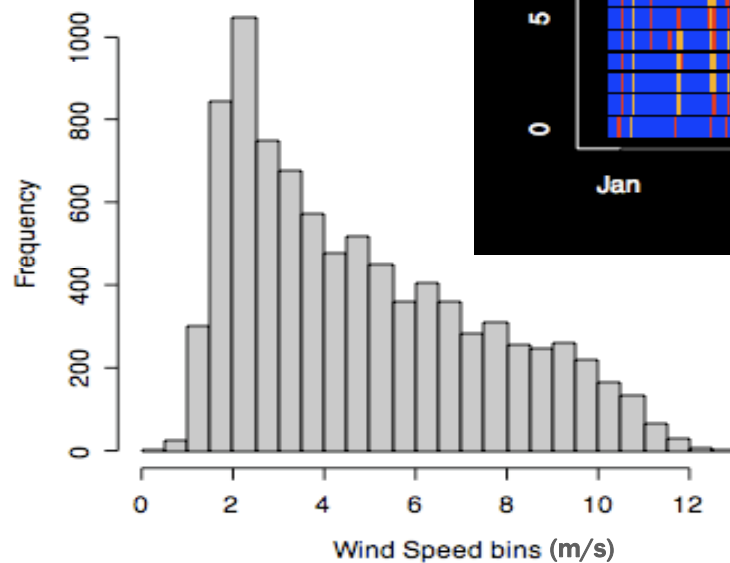
- One 450 acre ranch
 - Two wells
 - Each well requires ~ two 50kW pumps to operate irrigation system

Energy Cost Summary (2007)

	Well 1 (AG-1B)	Well 2 (AG-5B)
Energy Use	100,445 kWh/yr	139,740 kWh/yr
Energy Charge	\$0.15/kWh	\$0.05-0.16/kWh
Energy Cost	\$15,140	\$10,750
Monthly Demand	98 kW	93 kW
Demand Charge	\$4.20-\$6.08/kW	\$4-10/kW
Demand Cost	\$4,760	\$11,400
Total Cost	\$20,110	\$22,450



Wind Resource



Wind data found at nearby CIMIS station.

- Wind speed adjusted for height difference 8 ft. to 120 ft.



Wind Turbine

- Entegritty EW15
 - Rotor Diameter: 15m
 - Rated Power : 50 kW
- Tower Types & Footprint
 - Lattice: 20.5' x 20.5' x 5"
 - Monopole: 22' x 22' x 5"
- Common Heights
 - 80', 100', 120'
 - +20' = +\$7500
 - Monopole is significantly more expensive.



Economic Analysis

Well 1 (AG-1B)

COE		\$0.15073 /kWh	
		Entegry EW15	
Rated Power	50	kW	
Turbine Cost	\$215,000		
SGIP (Incentive)	\$75,000		
USDA (Incentive)	\$53,750		
Final Cost	\$86,250		
Energy Usage	100,445	kWh/yr	
Energy Production	70,020	kWh/yr	
% of Energy	70	%	
Energy Cost Savings	\$10,554	/yr	
Simple Payback	8.2	yrs	

Well 2 (AG-5B)

Season	Peak	COE
Summer	OnPeak	\$0.1637
	OffPeak	\$0.0550
Winter	OnPeak	\$0.0611
	OffPeak	\$0.0509

Energy Usage	Energy Charges	Energy Production	Energy Cost Savings
27,189	\$4,450	25,850	\$4,230.87
81,651	\$4,490	27,360	\$1,504.53
19,319	\$1,180	10,520	\$642.56
12,370	\$630	6,290	\$320.35
139,740	\$10,750	70,020	\$6,698

Energy Usage
Energy Production
% of Energy
Energy Cost Savings

Simple Payback

139,740 kWh/yr
70,020 kWh/yr
50 %
\$6,698 /yr

12.9 yrs

Possible ways to increase savings:

- Peak demand shaving to reduce high demand charges
- Energy storage options (batteries, water towers)



Looking Ahead

- We believe that wind energy deployment at community and distribution levels in California would yield benefits for everyone
 - Reduced electricity needs and costs
 - Reduced emissions
- California is well situated to maximize the benefits of wind energy at community and building/industrial scale:
 - Wind resource
 - Net metering (up to 1000 kW)
 - Rebate programs (CEC ERP, SGIP, etc.)
- Hurdles facing distributed wind energy deployment:
 - Local ordinances and permitting requirements
 - Permitting fees
 - Equipment verification (certification)





- Case van Dam
cpvandam@ucdavis.edu
- Henry Shiu
hjshiu@ucdavis.edu
- Scott Johnson
sjohnson@ucdavis.edu
- California Wind Energy Collaborative
<http://cwec.ucdavis.edu/>

