

Wind Power

A New Crop for Canadian Farmers



A presentation to:
Canadian Farm Business
Management Council



By: David Boileau, Superior Wind Energy Inc., February 1, 2003

Outline of Presentation

- ⇒ Wind Power History
- ⇒ Wind Power Introduction
- ⇒ Wind Power Technology
- ⇒ Wind Power Market
- ⇒ The Future of Wind
- ⇒ Farming the Wind - Benefits and Impacts



History of Wind Power



Wind power has an illustrious past



- | | |
|-------------|---|
| Mid 1100s | Wind power (for milling) developed in England as response to King vesting water rights to lords |
| 1500 | Wind Power booms in Netherlands for power to drain land |
| 1850s | Centre of excellence moves to US driven by the need to pump water for irrigation |
| Mid 1800s | 25% of non-transportation energy in US from wind |
| 1889 | 77 wind mill manufacturers in the US |
| Late 1800s | 90% of Dutch industrial power from wind |
| Early 1900s | Wind power is displaced by coal for most applications but continued to pump water, particularly in the great plains |



Modern wind power began in response to energy crisis in 1970s

Late 1970s	Lobbying in response to oil crisis leads to aggressive incentives in California
Early 1980s	California wind rush in full swing
1986	Collapse of the California wind rush due to withdrawal of price incentives
Early 1990s	Led by Denmark, European governments create favourable environment for wind power
Mid 1990s	US federal incentives accelerate wind power development in US market
2001	Canadian Government announces the Wind Power Production Incentive
Today	Most developed countries have or are considering incentives to support renewable energy and wind is widely considered the most practical and competitive option



Features of Wind Power

Advantages of wind power:

- ⇒ Inexhaustible source
- ⇒ The wind is free
- ⇒ Increasingly competitive
- ⇒ Non-polluting – no green house gases
- ⇒ Quick and easy to install
- ⇒ Modular technology
- ⇒ Good match to waterpower storage and gas fired generation





Importance of Wind Speeds

Wind power increases with the cube of wind speed

- ⇒ 10% greater wind speed wind = 30% more electricity
- ⇒ 2X greater wind speed wind = 8X more electricity!
- ⇒ Must find good winds



Wind Turbine Land Use

- ⇒ Wind farms use less than 2% of the land for foundations and roads
- ⇒ 98% of land available for other uses
- ⇒ Compatible with pasture, crop, forestry, bike path, recreation, industry

How much land does it use?



Turbine Space Requirements				
	Units	m / m ² / ha	ft / ft ² / acres	
Rotor diameter (in meters):	80	m	262.47	ft
Rotor Spacing in Row:	5	rotors	5	rotors
Rotor Spacing between Rows:	8	rotors	8	rotors
Per Turbine Space Requirement:	256,000	m ²	2,755,561	ft ²
Number of Turbines installed:	5		5	
Required Area in m ² :	1,280,000	m ²	13,777,805	ft ²
Required Area in ha:	128	ha	316	acres
Number of Turbines per km ²	3.9			
Actual area taken up for turbine placement and access roads in %	1%		1%	
Area out of agricultural production	1.28	ha	3.16	acres
1 ha =	10,000	m ²		
Number ha	80	ha		
Number m ²	800,000	m ²		
1 acre =	4,046.86	m ²		
1 acre =	43,560	ft ²		



Wind Turbine Sound

- ⇒ Should be located up to 350M away from residences
- ⇒ Sound is swoosh, swoosh – not mechanical
- ⇒ Can carry on a conversation at the base of the tower
- ⇒ Sound is greatest when windy, when ambient noise is greatest too.

The Whispering Turbine



Typical Sound Levels Measured in Decibels

Threshold of Hearing	Whisper	Talking	City Traffic	Rock Concert	Jet Engine 10m away
0	30	60	90	120	150

Turbine Sound Levels Measured in Decibels

50 m from base of turbine	150 m from base of turbine	300 m from base of turbine
55-60	44-49	30-34
Equal to a clothes dryer	Equal to a quiet living room in a home	Equal to a little more than a whisper



Do Turbines Kill Birds?

- ⇒ Average turbine bird death 2.2 birds per year
- ⇒ Tubular versus lattice towers – new towers lack perches
- ⇒ Positive wildlife impact from reduced emissions

Source: www.nationalwind.org

Do Turbines Kill Birds?



Comparison of Estimates for Causes of Avian Mortality

Cause	Estimated Mortality per structure per year	Estimated Total average Annual Mortality for North America
Tall Buildings	Up to 1,500	1 – 980 million
Houses	1 – 10	100 million – 1 billion
Communication Towers	1,000	2 – 50 million
Power Lines	8/km/year in open areas up to 400/km/year in forest	30 – 174 million
Vehicles		60 – 80 million
Wind Generation Facilities	1.9 – 2.19	10 – 40 thousand
Housecats		100s of millions



Wind Turbine Aesthetics

- ⇒ Rotational speed slower on newer larger turbines
- ⇒ Larger turbines are spaced farther apart (400m)
- ⇒ 16 R.P.M. - 27 R.P.M.
- ⇒ Engineering masterpiece
- ⇒ Symbol of sustainable living

Landscapes and Wind Parks



Are turbines
ugly?



*Beauty is in the eye of
the beholder.*



Economic Impact

- ⇒ Impact on local economy
- ⇒ Manufacturing opportunity
- ⇒ CanWEA 10 x 10
- ⇒ Second largest employer in Denmark
 - Large employer in rural areas
 - Most Danish wind turbines are owned by individual farmers and/or farm co-ops.



Economic Development

- ⇒ Wind is cash crop
- ⇒ Larger return per acre than farm crops
- ⇒ Property tax assessment in rural areas
- ⇒ Rural diversification
- ⇒ Local jobs in construction, services



Economic Development

- ⇒ Canada has manufacturing skills
- ⇒ Continuous cost improvement core competence
- ⇒ Freight cost is high, so cost reduced if produced locally
- ⇒ Need sustained market to attract investment



There is plenty of wind!

- ⇒ Technically, wind resources can deliver 53,000 Terawatt hours per year - an amount which corresponds to 4 times the world's total consumption of electricity in 1998.

(Source: Wind Force 10, Edition 2000)

- ⇒ High winds are associated with seaside areas, mountain passes, some great plains areas, high lands, and the Great Lakes.

Technology





Wind Power Basics

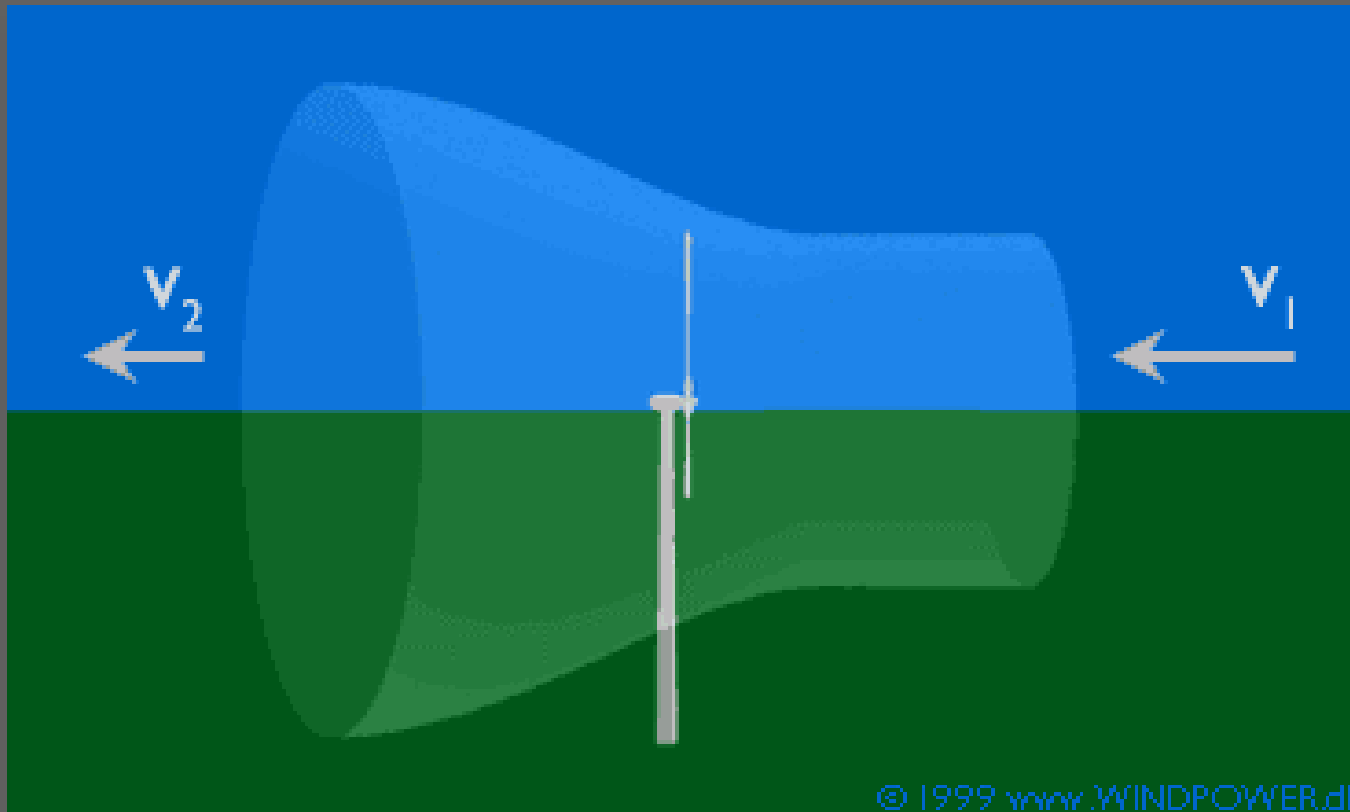
⇒ Betz Law

The maximum power that can be captured from the wind is 59% of the kinetic power in the wind

⇒ Today's turbines capture > 50% of the total power in the wind

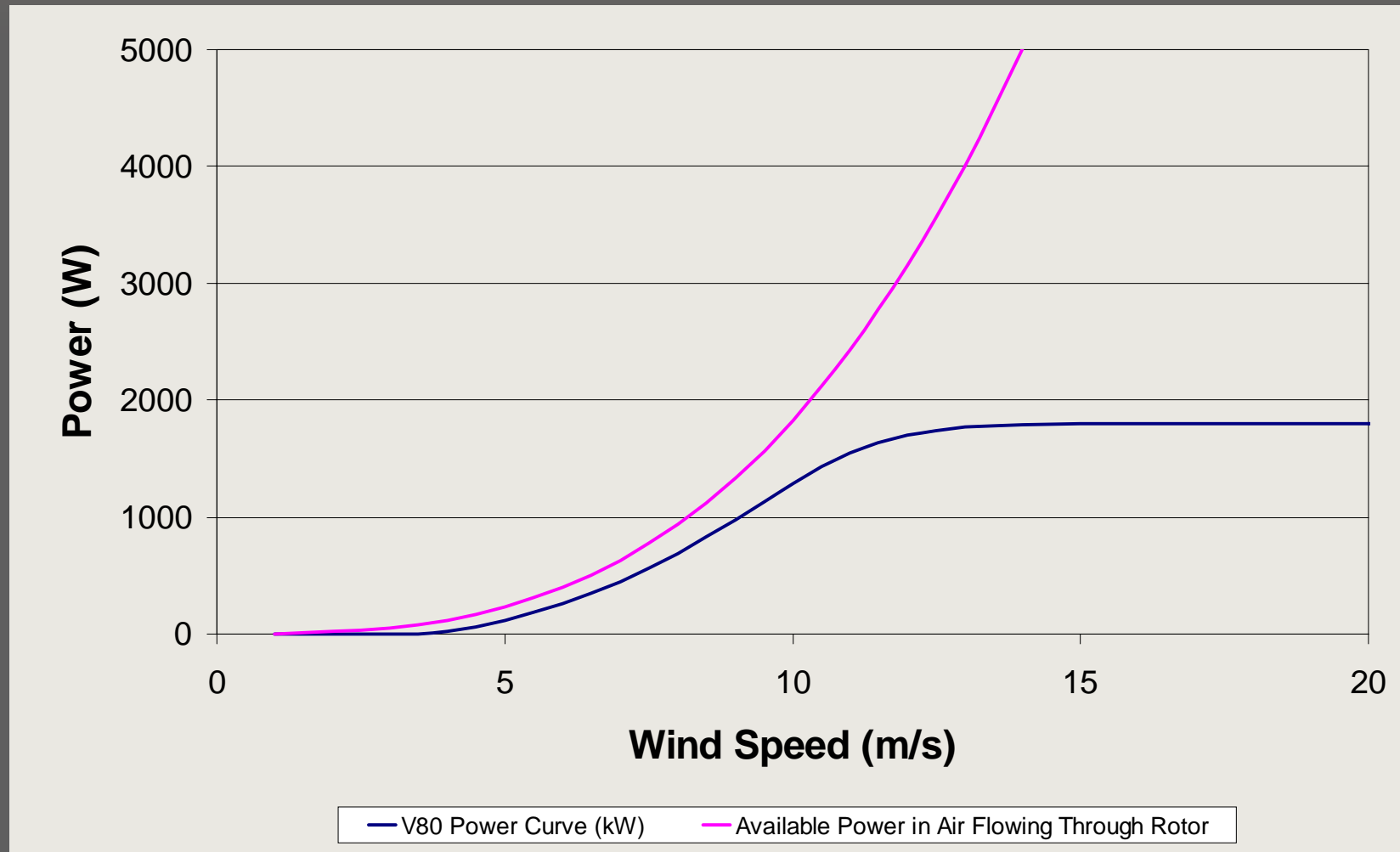
⇒ High pressure, cold air – is more dense and has more energy per cubic metre

Wind turbines generate power by slowing down the wind

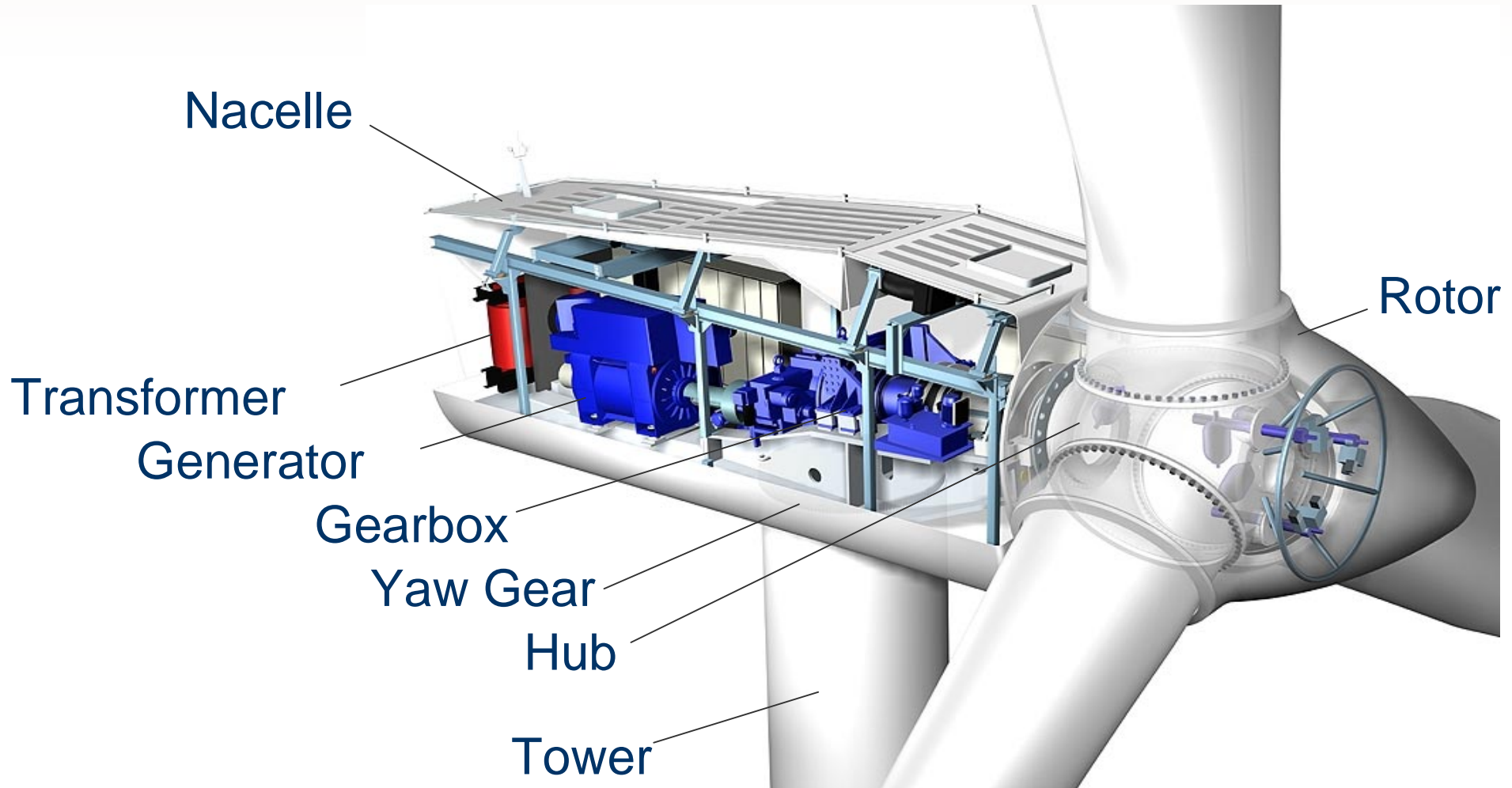


The maximum amount of energy that can be extracted is 59% of the energy in the wind.

Available power increases dramatically with the wind speed



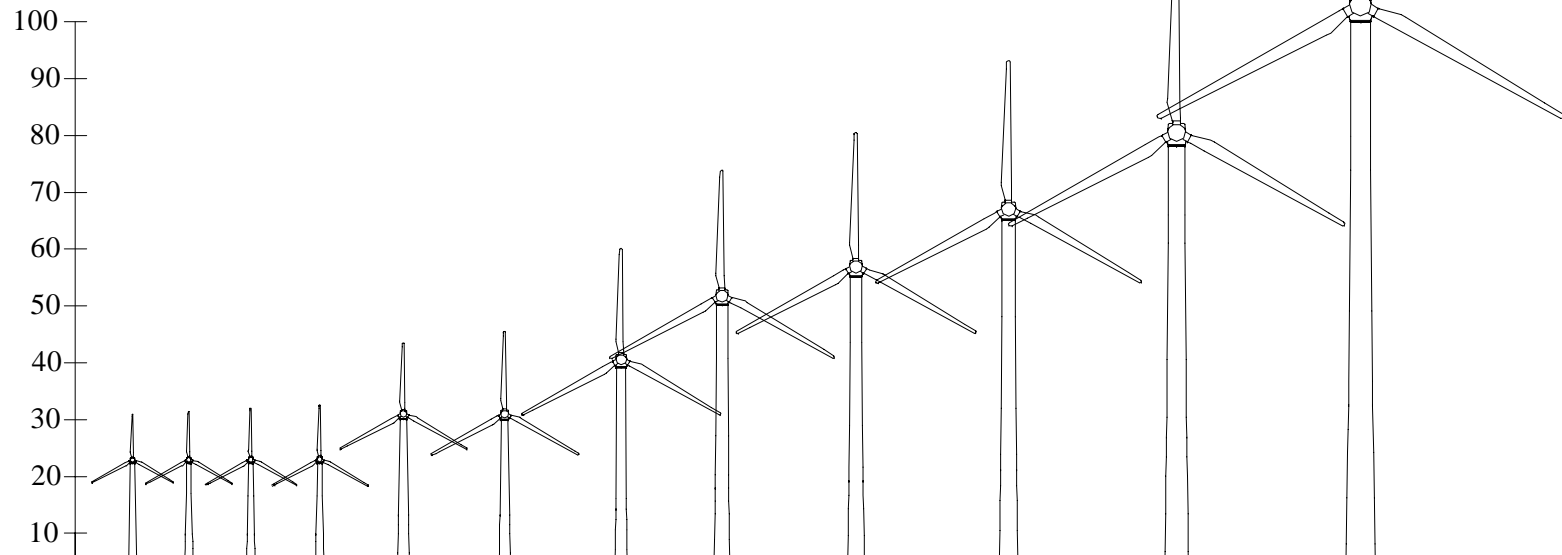
Components of a modern wind turbine generator



Increasing diameters have helped reduce the cost of wind power



Hub height



Name/Rotor (m)	V15	V17	V19	V20	V25	V27	V39	V44	V47	V52	V66	V80
Effect (kW)	55	75	90	100	200	225	500	600	660	850	1750	2000
Year of installation	1981	1984	1986	1987	1988	1989	1991	1995	1997	2000	1999	2000
MWh/year	217	265	301	346	481	647	1304	1581	1947	2530	4705	6768

Key technical issues for wind farms



- ⇒ Must be windy
 - Long-term average wind speed greater than 7 metres per second
- ⇒ Good wind sites typically display some of following:
 - Open country with little roughness, especially in the direction of the prevailing wind
 - High spot – speed-up effects
 - Near a body of water
 - Land/water temperature differences help to drive winds
- ⇒ No excessive turbulence
 - Can reduce turbine life
- ⇒ Access for turbine and construction equipment
- ⇒ Suitable soil conditions for construction
- ⇒ Close proximity to high voltage electrical grid

The Wind Power Market



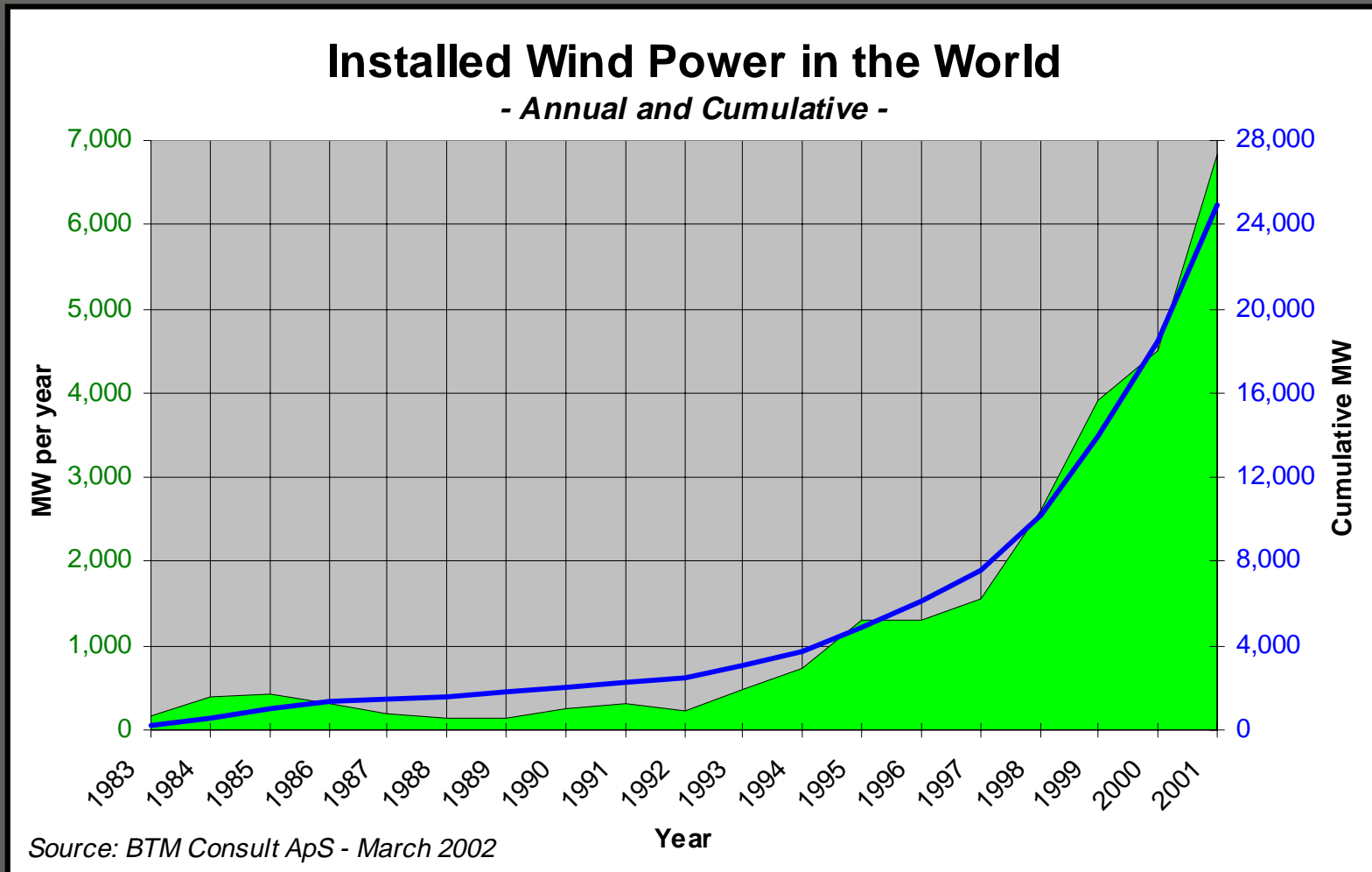
Global Market

US Market

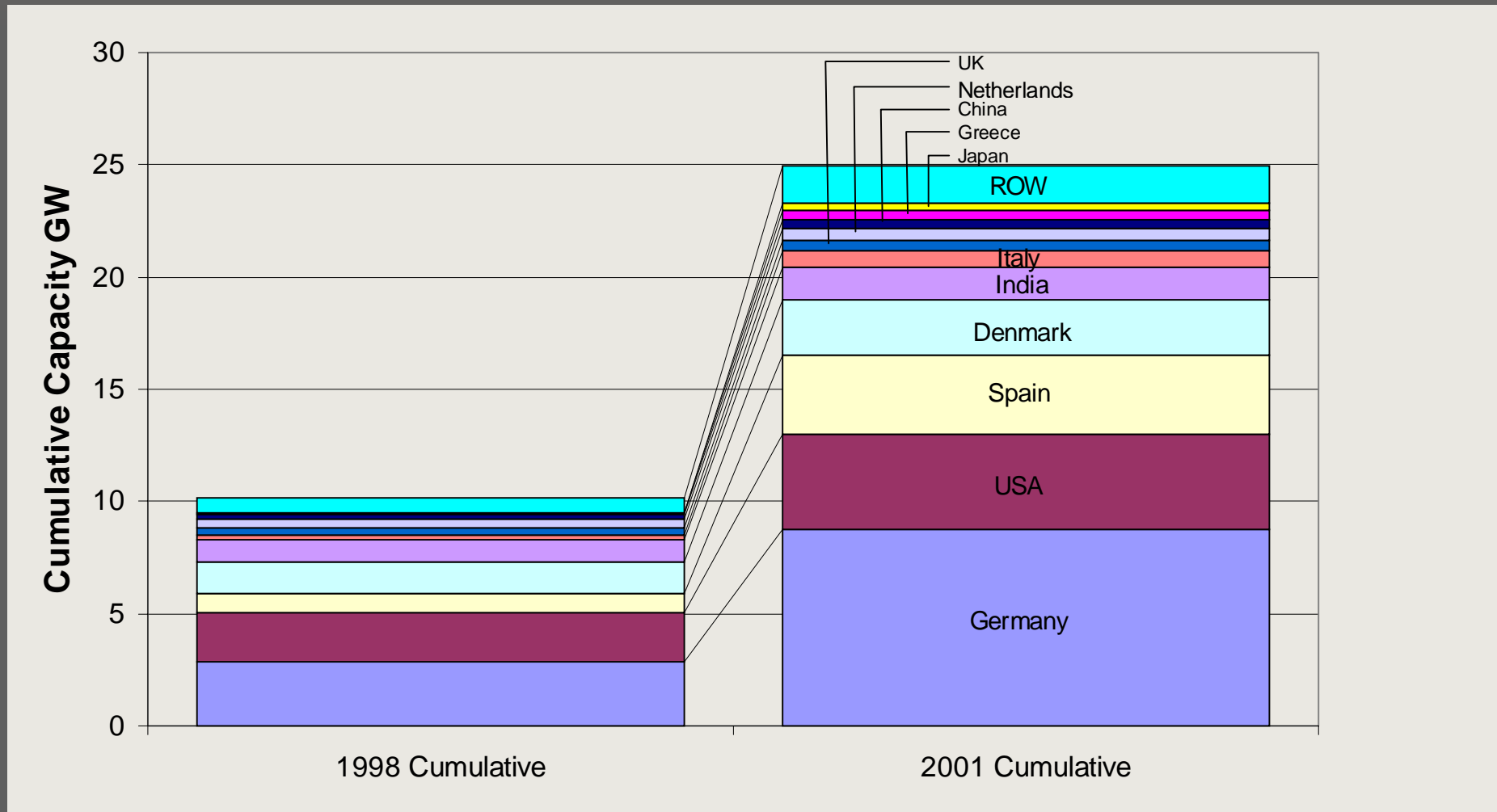
Canadian Market



Wind Power Capacity Has Grown Significantly in the Last Few Years

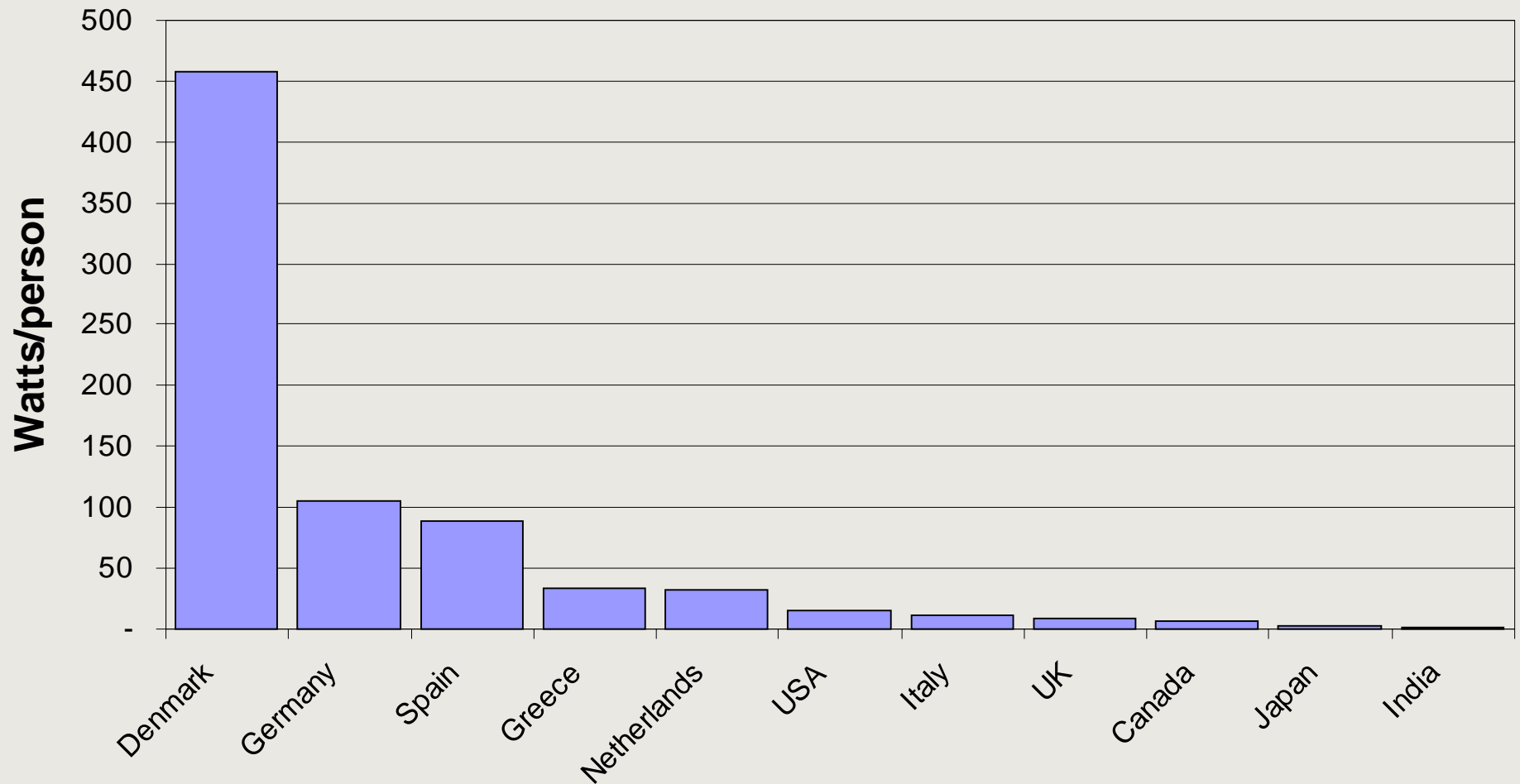


Germany, USA and Spain have 66% of Installed Capacity to end of 2001



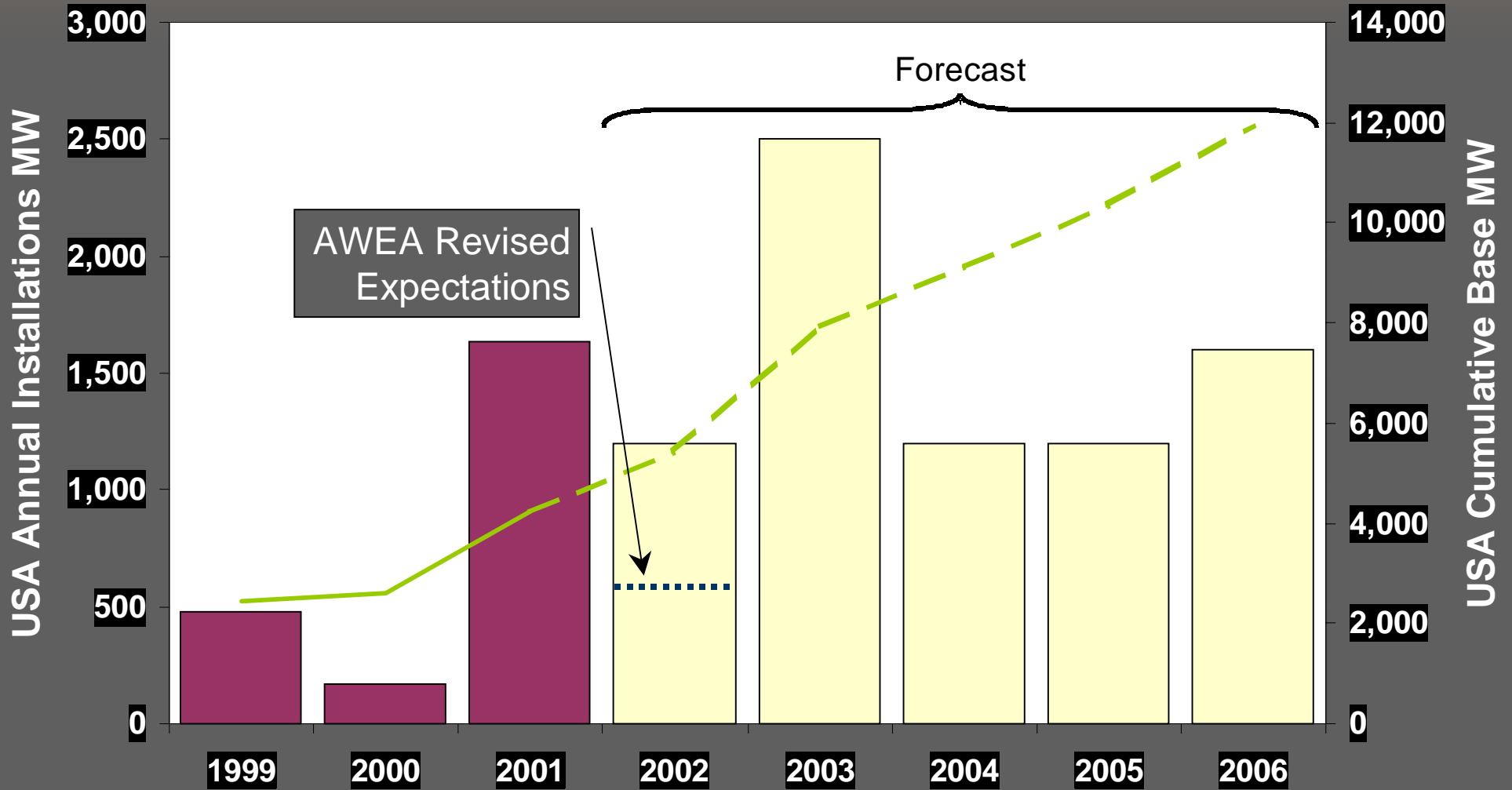
Source: BTM Consult World Market Update March 2002

Denmark has demonstrated that high penetration is possible



Source: BTM Consult World Market Update March 2002, CIA World Fact book 2002

The US Market is Growing Dramatically but Erratically

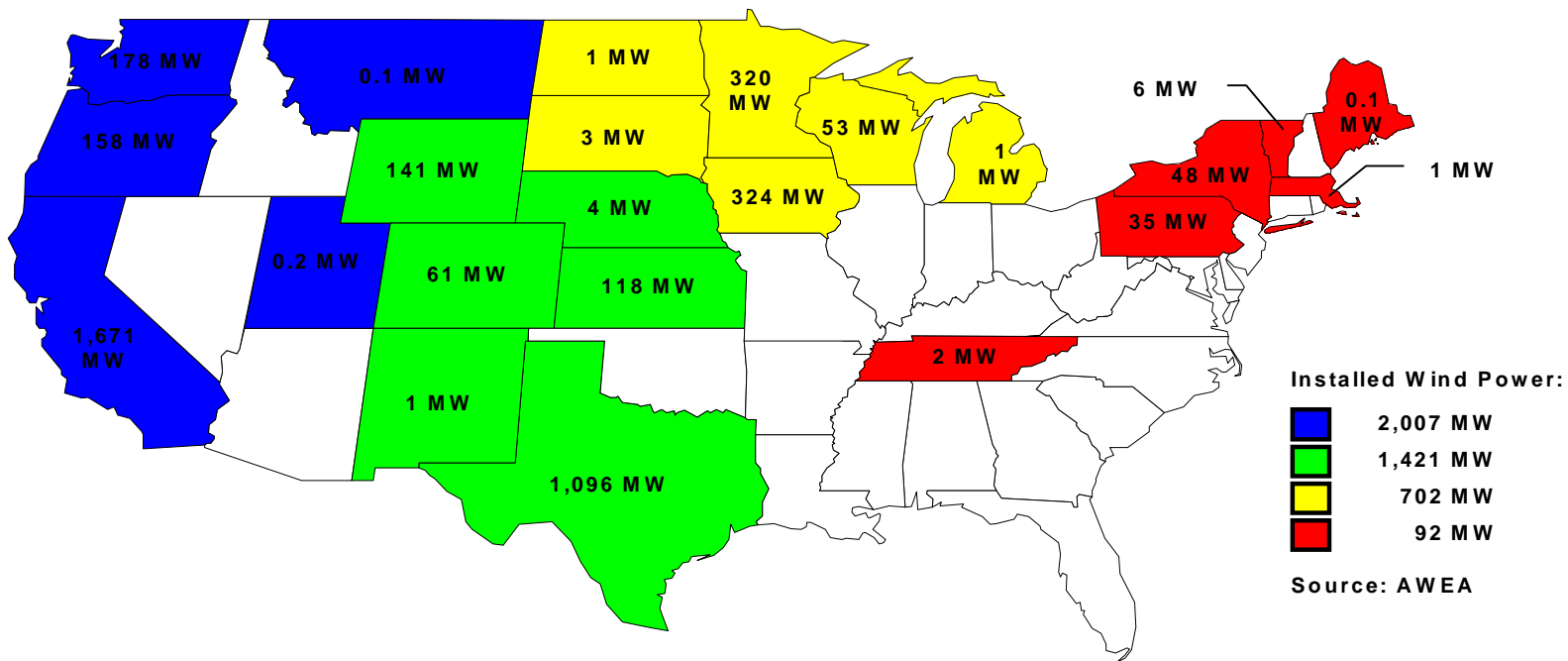


Source: BTM Consult World Market Update March 2002, AWEA

The US Market is concentrated in California and Texas



Base year 2001
Source: AWEA
Date: April 4, 2002
Author: Jesper Christensen



Key Market Drivers



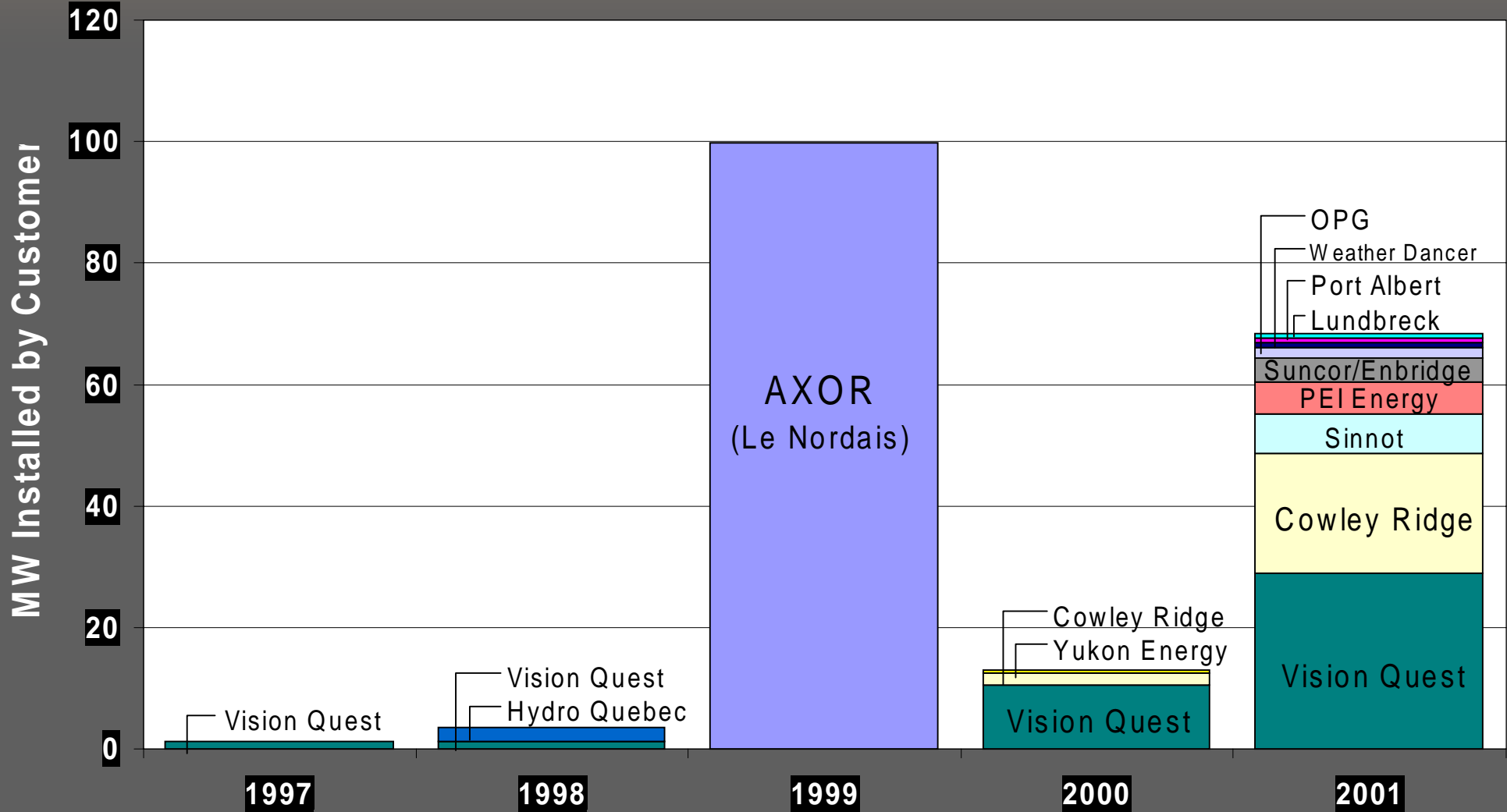
- ⇒ Federal Production Tax Credit (PTC - USA)
- ⇒ Wind Power Production Incentive (WPPI – Canada)
- ⇒ Renewable Portfolio Standards
- ⇒ Capital Tax, Property Tax, Corp. Tax, and Sales Tax Holidays (Ontario)
- ⇒ Green Power marketing programs
- ⇒ Wind energy costs are declining
 - Wind turbine technology improvements makes wind energy increasingly competitive with conventional resources in good wind regimes
- ⇒ Politicians willing to embrace homegrown energy solutions
 - Driven by the need for energy security
 - Wind energy has become mainstream with large new market entrants such as Shell, TransAlta, Suncor, Brascan and GE entering the market
 - The public is solidly behind wind energy
 - Excellent option for compliance with Kyoto protocol

Canadian Market



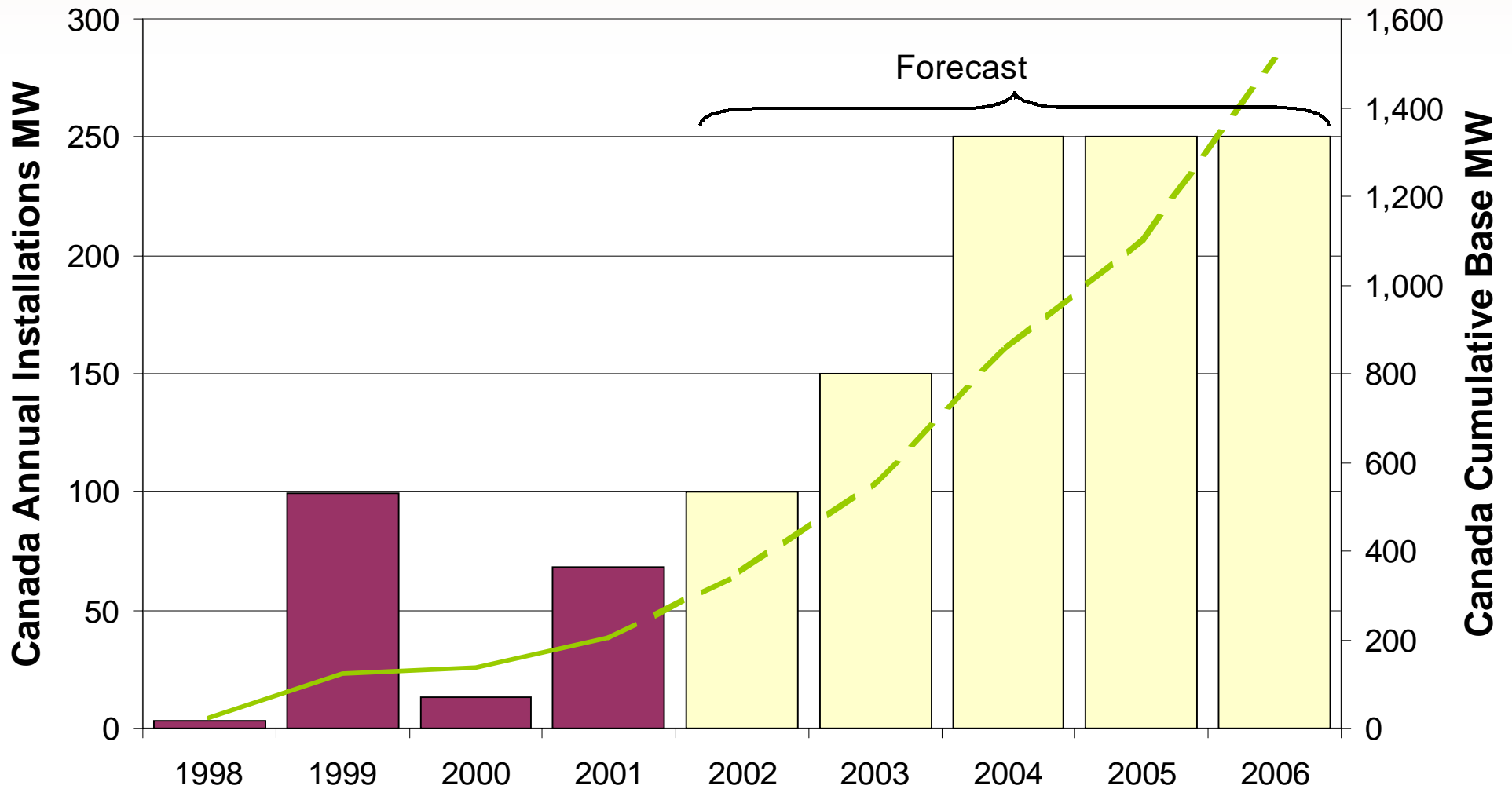
**10 MW
Huron Wind
Park near
Kincardine,
Ontario
(OPG and
British
Energy)**

The Number of Projects in Canada is Growing



Source: Canadian Wind Energy Association

The Canadian Market is Forecast to Grow Aggressively



The Future for Wind Power

In Canada
On the Farm



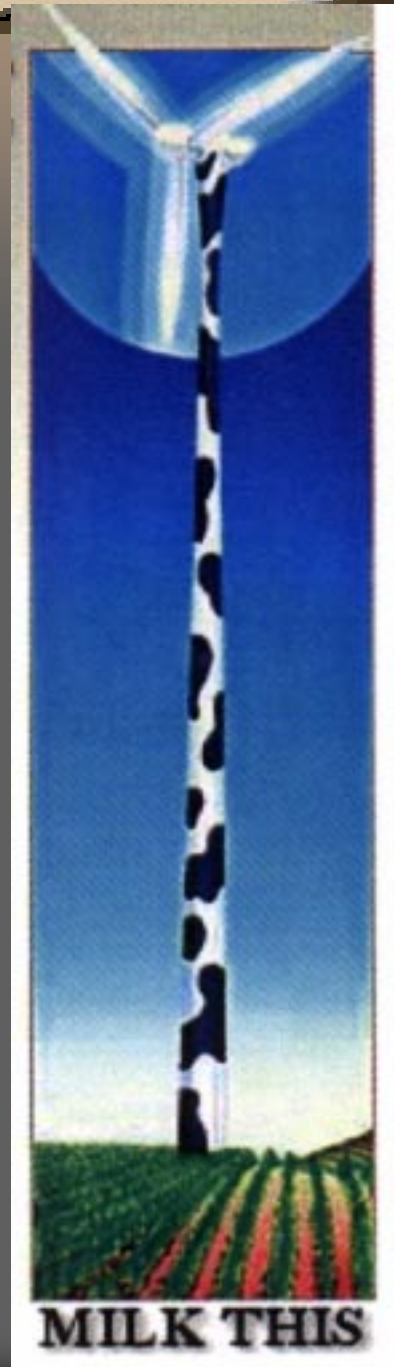
The Future for Wind Power in Canada



- ⇒ Canada has an excellent wind resource
- ⇒ With the right incentives in place 10,000 MW of installed capacity by 2010 easily achievable by industry (CanWEA goal)
 - Represents investment of \$15 Billion
 - Would result in substantial local manufacturing capacity and job creation (see CanWEA Wind Vision for Canada)
 - Would make substantial contribution towards meeting Canada's green house gas reduction commitments (15-25 million tonnes)
 - Many areas in Canada suitable for development

What's in it for farmers?

- ⇒ Royalties for landowners
 - Typically 2 to 3 percent of gross energy sales
 - \$30,000 to \$40,000 per year (assumes 10 MW installed on 100 ha parcel)
- ⇒ Fixed payment
 - Some land owners prefer fixed payment – typically \$3,000 to \$4,000 per turbine or approximately \$18,000 to \$24,000 per year
- ⇒ Improved infrastructure
 - Roads, electrical service
- ⇒ Local employment





Wind Park Impacts

- ⇒ Need to consider
 - Tile drainage
 - Interference with farm operations
 - Equipment turning radius
 - Setbacks from adjacent properties
 - Wind shadow impacts neighbour's revenue from wind

Acknowledgements



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- ⇒ For more information
 - dboileau@nwon.com
 - www.awea.org
 - www.canwea.ca
 - www.superiorwindenergy.com
 - www.windustry.org
 - www.windpower.dk - tutorial

