Advancing Wind Power in Illinois
Annual Conference 2012

New Entrants and New Technology Changing Economics in the Turbine Market

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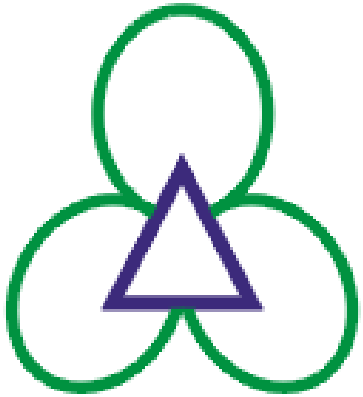

Trintek Energy Consulting, Inc.

Creating Competitive Advantage Thru Intelligent Development

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Purpose

- The Purpose of This Topic is to Examine:

❑The History of Capital Costs for Wind Turbines

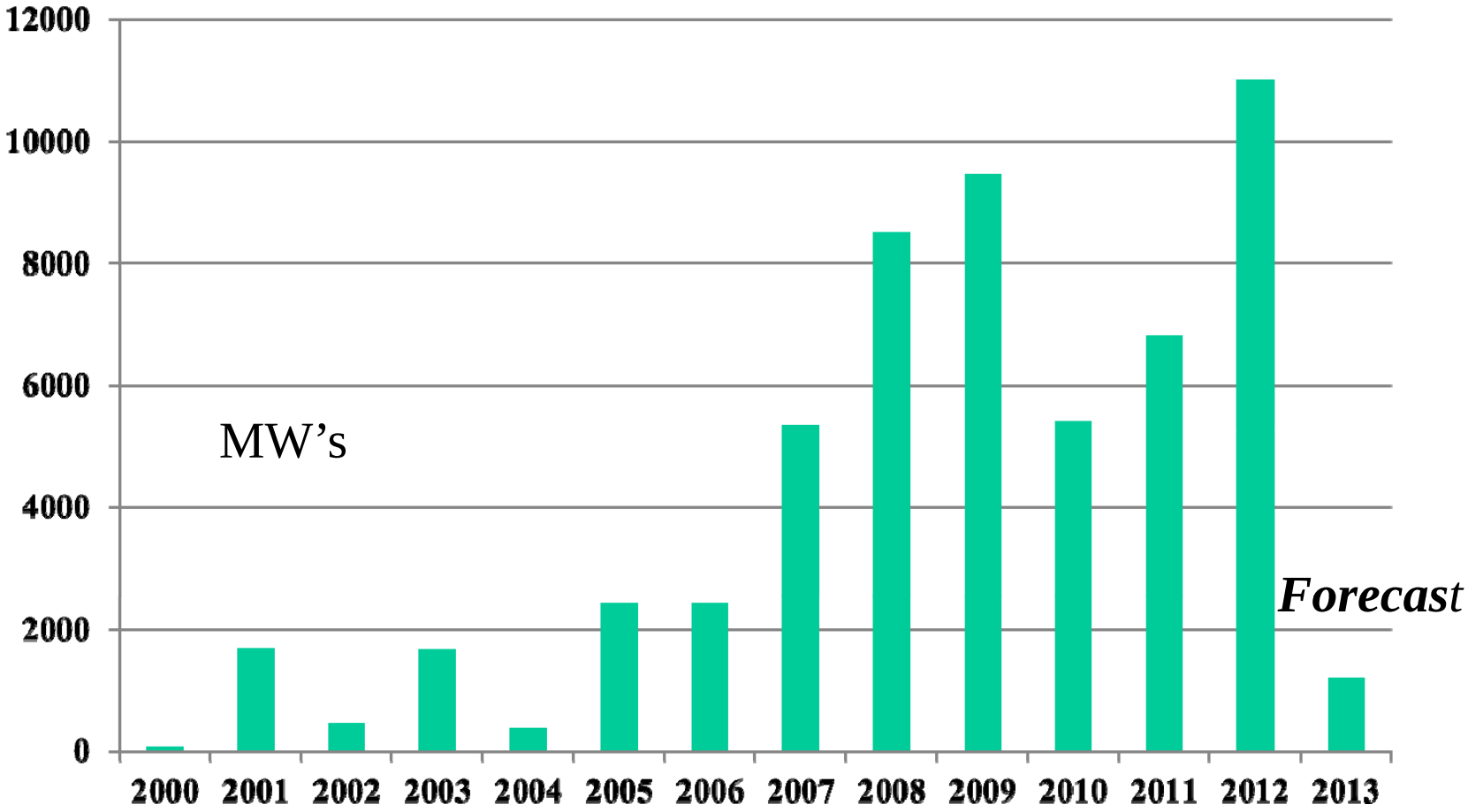
❑How the Multiple-year PTC and Enacted RPS's Created a Boom?

❑What Factors Have Caused the Bust?

❑How Are New Entrants and New Technology Changing Economics?

❑What is the Outlook for Wind Energy and the Turbine Market?

Megawatts of Installations By Year



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Wind Turbine Prices

- Wind Turbine Prices in 2001 were $700/kW
  - ❑Includes Turbines, Transport to Site, Two Years of W&M Service

- By Year End 2009, Pricing Vaulted to $1625/kW
  - ❑ **That is More Than a 100% Increase in the Turbine Price!**
  - ❑ Terms and Conditions Also Became Very Onerous

- The Price of the Turbine is 70% of the Overall Capital Cost

- The Cure for High Prices is High Prices.

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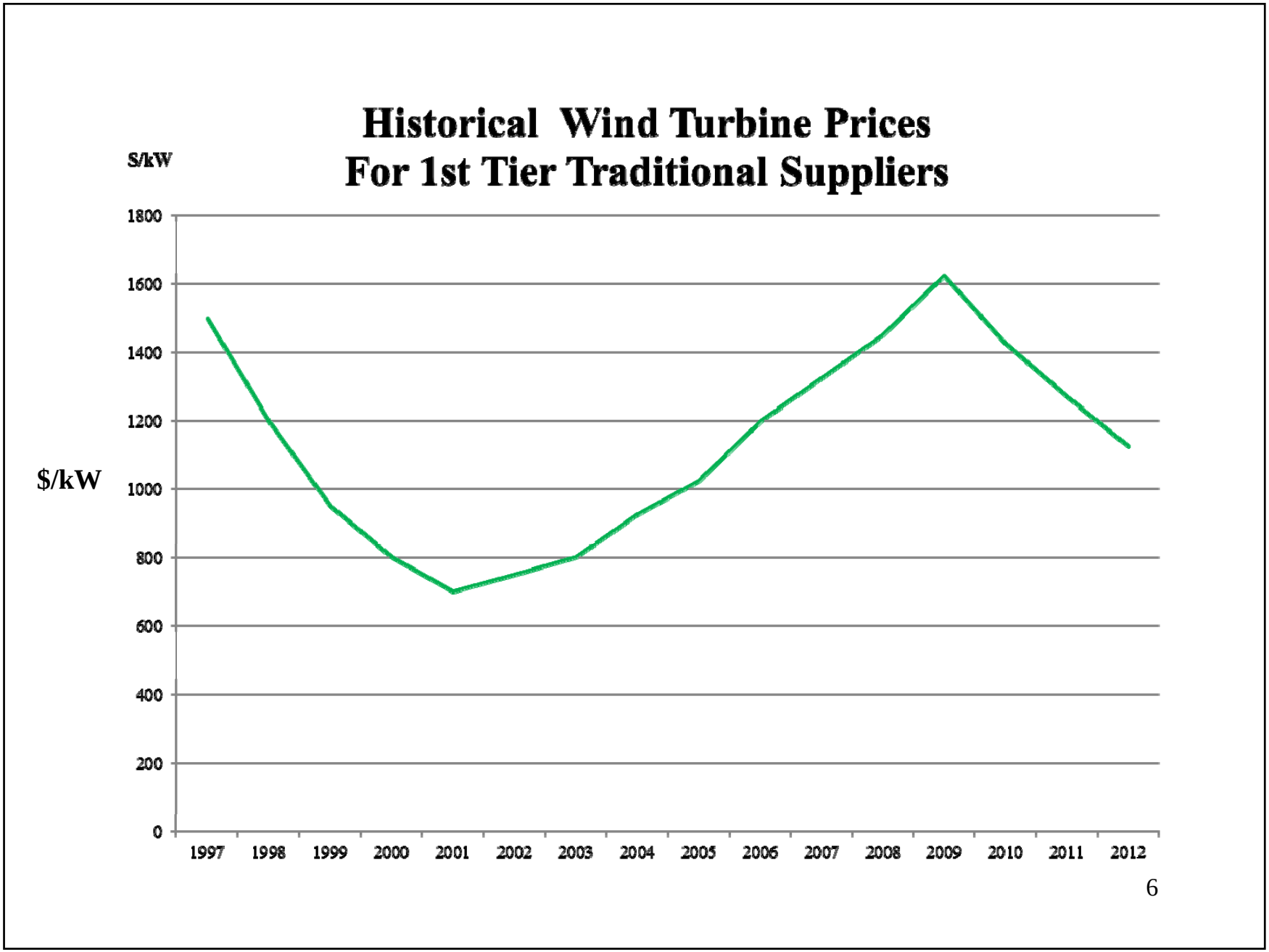
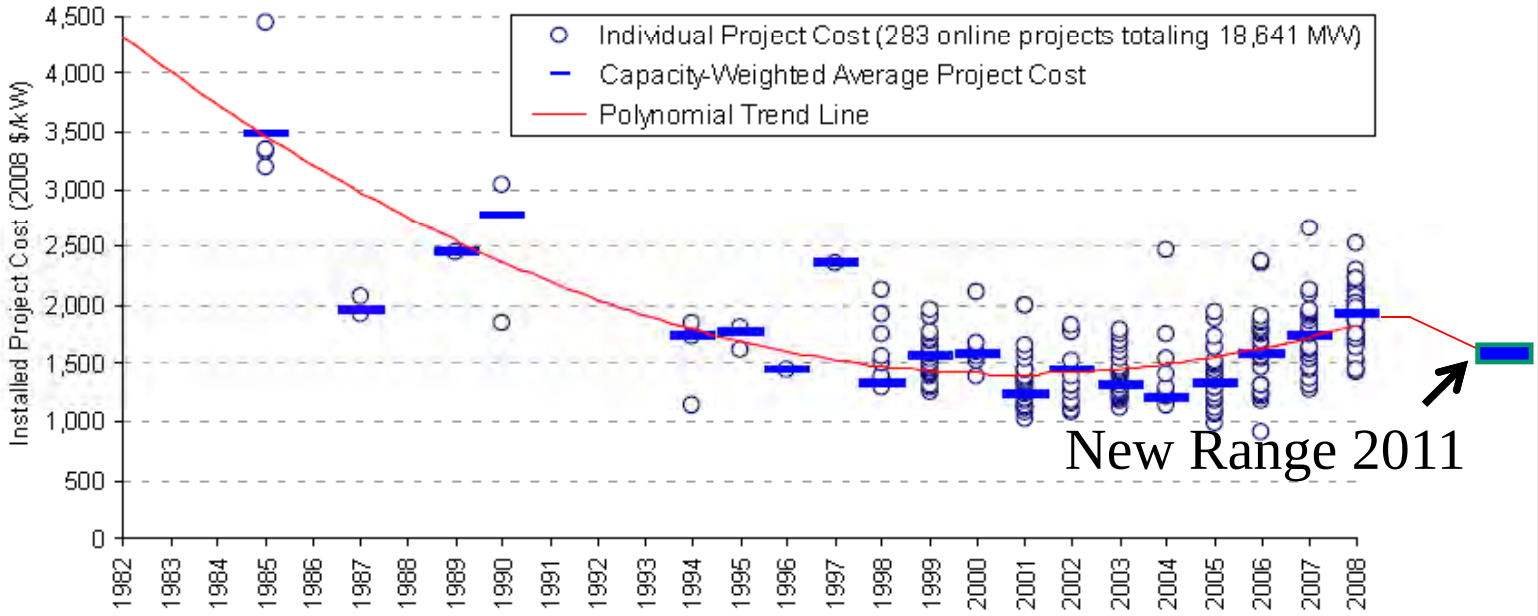

Historical Wind Turbine Prices
For 1st Tier Traditional Suppliers
$/kW
$/kW
1800
1600
1400
1200
1000
800
600
400
200
0
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
6

Total Installed Project Costs By Year



Source: Berkeley Lab database (some data points suppressed to protect confidentiality)

- Note: Correlation to Turbine Prices & peak Turbine Prices in 2009 at $1625/kW

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Price to Performance Ratio

Drivers for Turbine Demand

- 2005-2007 First Three Year PTC
  - ❑ Oh? Policy Visibility?

- State RPS's Grew from 22 States in 2006 to 36 states by 2011

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Factors Causing the Bust

- **Financial Crisis**
- **Lower Demand for Electric Power**
- **Lower Natural Gas Prices- Shale Development**
- **Lower Electricity Prices**
- **Unavailability of PPA's**
- **Lack of Transmission Infrastructure- Long Queues**

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Results of the Bust – Developers Go To Windfarm Jail

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New Technology

Since 1999:

- The Average Nameplate Capacity Increased by 151 Percent to 1.8 MW's
- Turbine Hub Height Has Increased by 43% to 80 Meters
- Rotor Diameter Has Increased by 86% to 84 meters
- Innovation in Scale and Economies are Likely to Continue But More Offshore Than Onshore
- Major Advances Ahead May Be More at Low Wind Speed Sites

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What Was The Impact of Technology?

- Model the Net Capacity Factor For a Piece of Land in a Certain Location Using Turbines Available in 1999.

- Then Model the Same Land in the Same Location Using Turbines Available Today.

- There Will Be Less Turbines Now and They Will Be Larger in the 2-3 MW Class vs. 750 kW or 1 MW class in 1999, and Rotor Diameter, Blade Design and Materials, Gear Boxes, and Controls Will Be Advanced.

- The Net Impact Is On the Order of 30% Improvement In Today's Net Capacity Factor vs. 1999. I.E. 32.5% vs. 25% In 1999.

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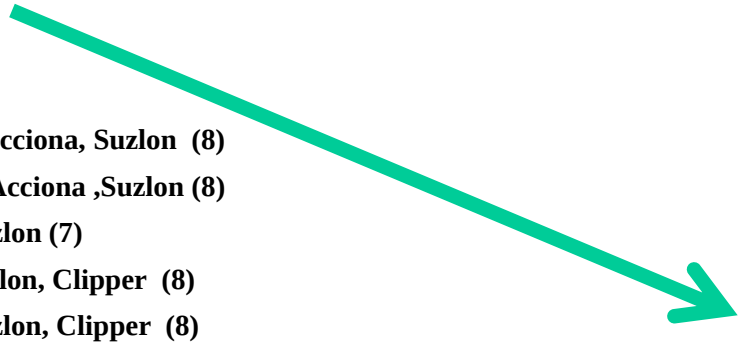
New Entrants –Full House 2009



- **2001** Vestas, GE, NEG Micon, Mitsubishi, Bonus (5)
- **2002** Vestas, GE, NEG Micon, Mitsubishi, Bonus (5)
- **2003** Vestas, GE, NEG Micon, Mitsubishi, Bonus, Gamesa, Acciona, Suzlon (8)
- **2004** Vestas, GE, NEG Micon, Mitsubishi, Bonus, Gamesa, Acciona ,Suzlon (8)
- **2005** Vestas, GE, Mitsubishi, Gamesa, Acciona, Siemens, Suzlon (7)
- **2006** Vestas, GE, Mitsubishi, Gamesa, Acciona, Siemens, Suzlon, Clipper (8)
- **2007** Vestas, GE, Mitsubishi, Gamesa, Acciona, Siemens, Suzlon, Clipper (8)
- **2008** Vestas, GE, Mitsubishi, Gamesa, Acciona, Siemens, Suzlon, Clipper, Nordex , REpower (10)
- **2009** Vestas, GE, Mitsubishi, Gamesa, Acciona, Siemens, Suzlon, Clipper, Nordex, Repower (10)
- **2010** Vestas, GE, Mitsubishi, Gamesa, Acciona, Siemens, Suzlon, Clipper, Nordex, REpower, Goldwind, Sinovel (12)

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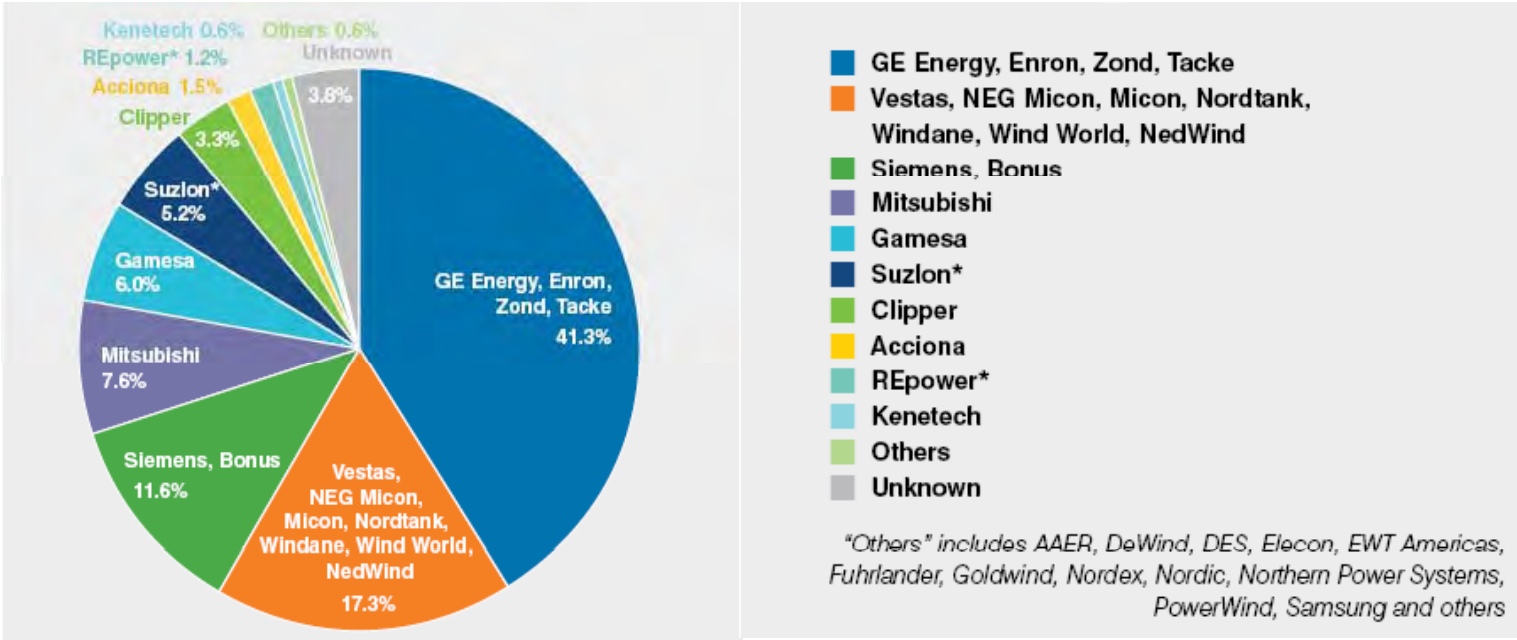
2010 Turbine Supplier Market Share- USA



Source- AWEA Statistics

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Economics

$/kW Price Turbine	$/kW Price BOP	$/kW Price Other	$/kW Price Total	% D/E Ratio	% IRR	% NCFactor	$/MWh PPA Price Price	10 Year Abatement Prop Tax	Exemption Sales Tax
1178	225	244	1647	64	15/12	33%	56/71*	No	Yes
1178	225	244	1647	64	15/12	41%	35/45*	Yes	Yes

Net CF of 33% = Midwest Project, Net CF of 41% = Texas Project

Assumes PTC

Assumes average transmission upgrade costs

*** Initial PPA Price and 20 Year Average Price**

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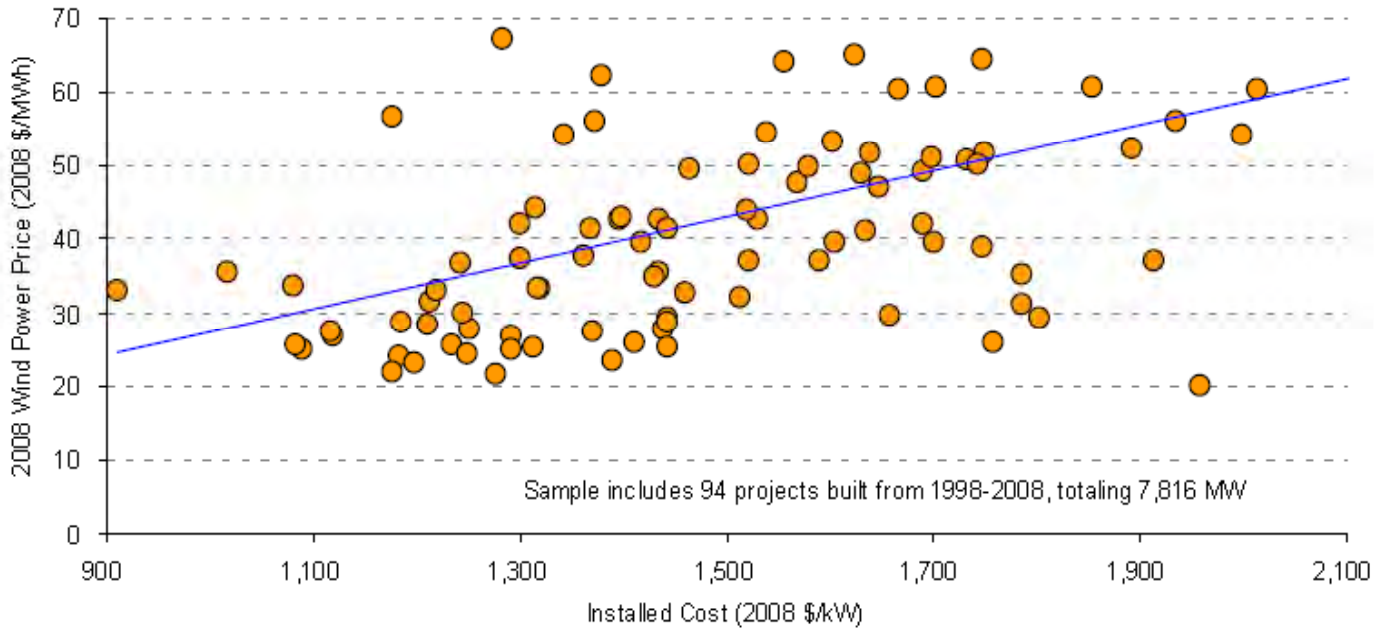
Competing with Natural Gas

- Assume a Power Price of $50/Mwh for Gas Fired Power
  - Implies $4/mmbtu long term gas price

- A Texas Project With a 10 Year Tax Abatement and Sales Tax Exemption Competes With Gas Fired Power in the $1175/kW Turbine Price Range

- A Midwest Project with a Lower Capacity Factor, and No Tax Abatement does not work at $50/Mwh—Still Needs Even Lower Turbine Prices.

Power Price Vs. Total Installed Cost



Source: Berkeley Lab database

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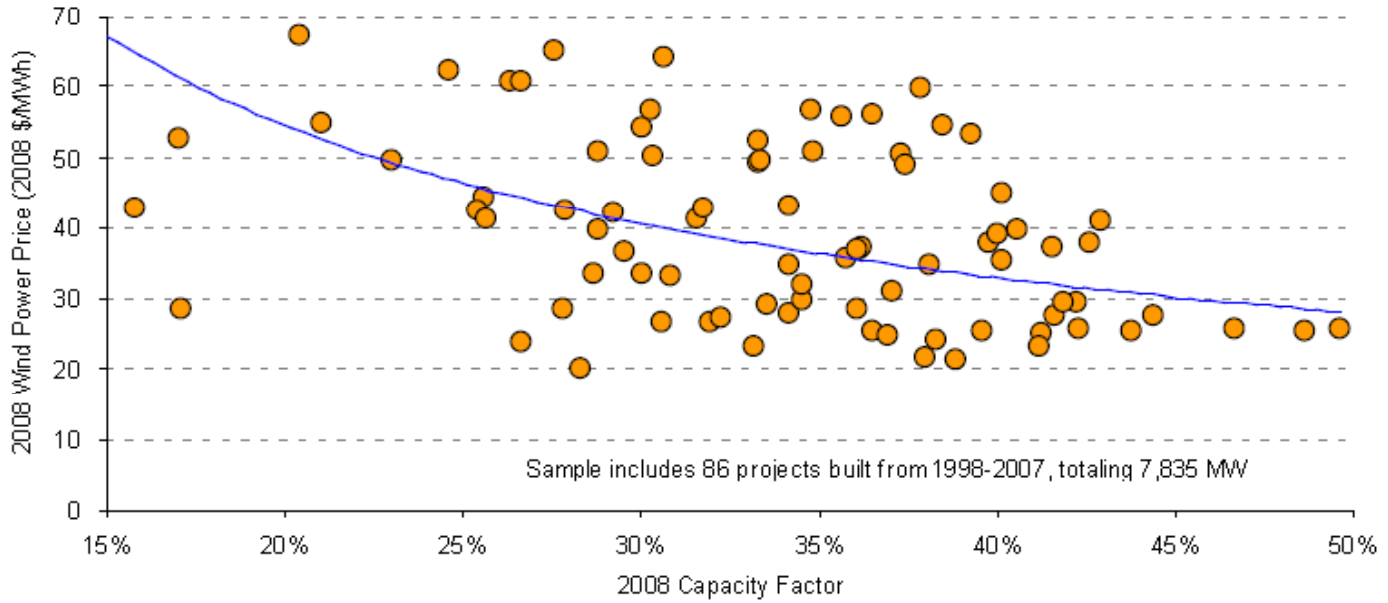
Power Price Vs. Capacity Factor



Source: Berkeley Lab database

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Outlook

- Policy Initiatives Badly Needed

- Natural Gas Prices – Killer APP, Have to Compete, Not a Short Run Issue, (Forecasts $4-6/mmbtu thru 2020+)

- Transmission Build Out- CREZ Very Helpful in Long Run

- New Technology
  - ❑ Onshore Pace Will Be More Incremental, Not Quantum
  - ❑ Industry Issue -Component Suppliers Being Hammered

- Need Better Price to Performance from Turbine Suppliers

- PPA Pricing -- ?? Have to compete with $50/Mwh Gas Fired
  - ❑ $2.00/mmbtu NG ?? Probably not sustainable.

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Got Turbines?

The Times, They are A Changing…..

And the Answer My Friend Is