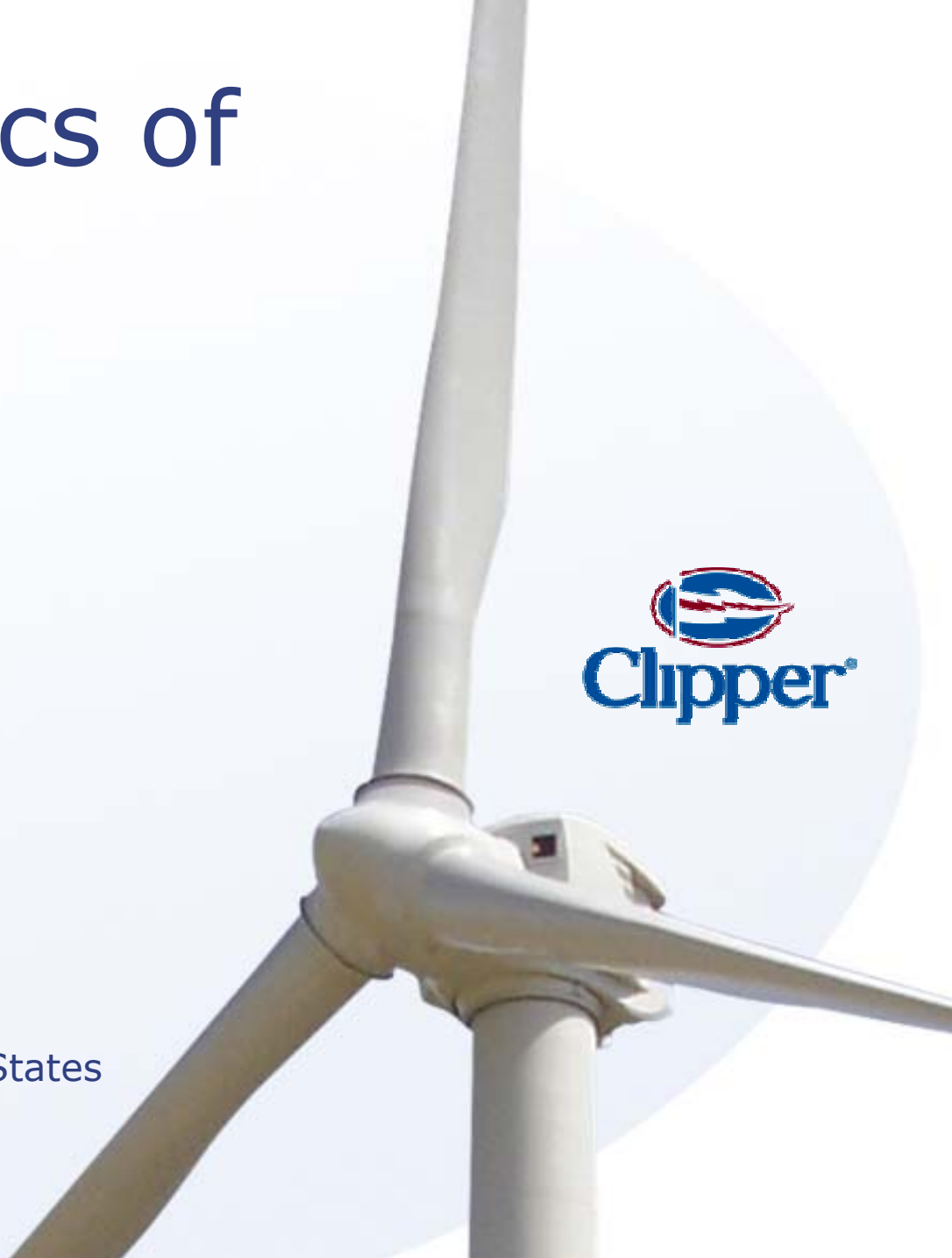
The Economics of Wind Energy



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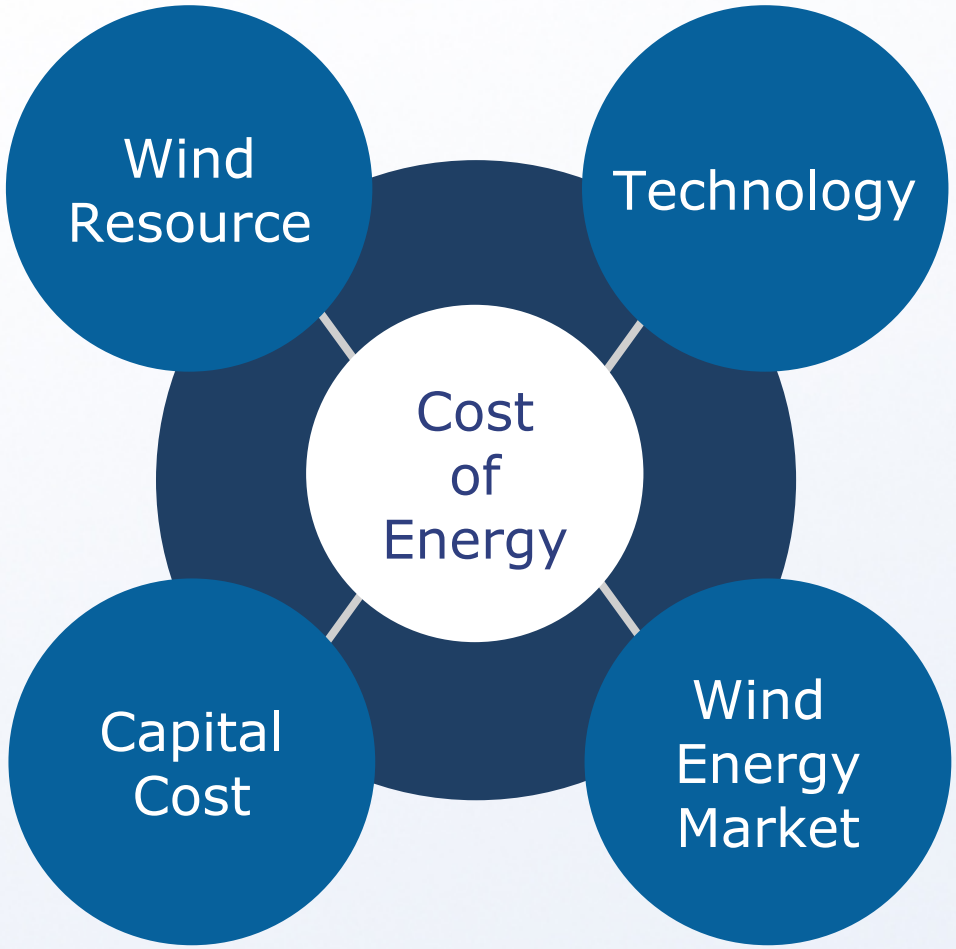
Executive Summary

Wind Energy Has Developed Substantially as a Result of the Economics of Wind

- Wind is Predictable
- Turbines are Reliable
- Long Term Energy Price Can Be Fixed

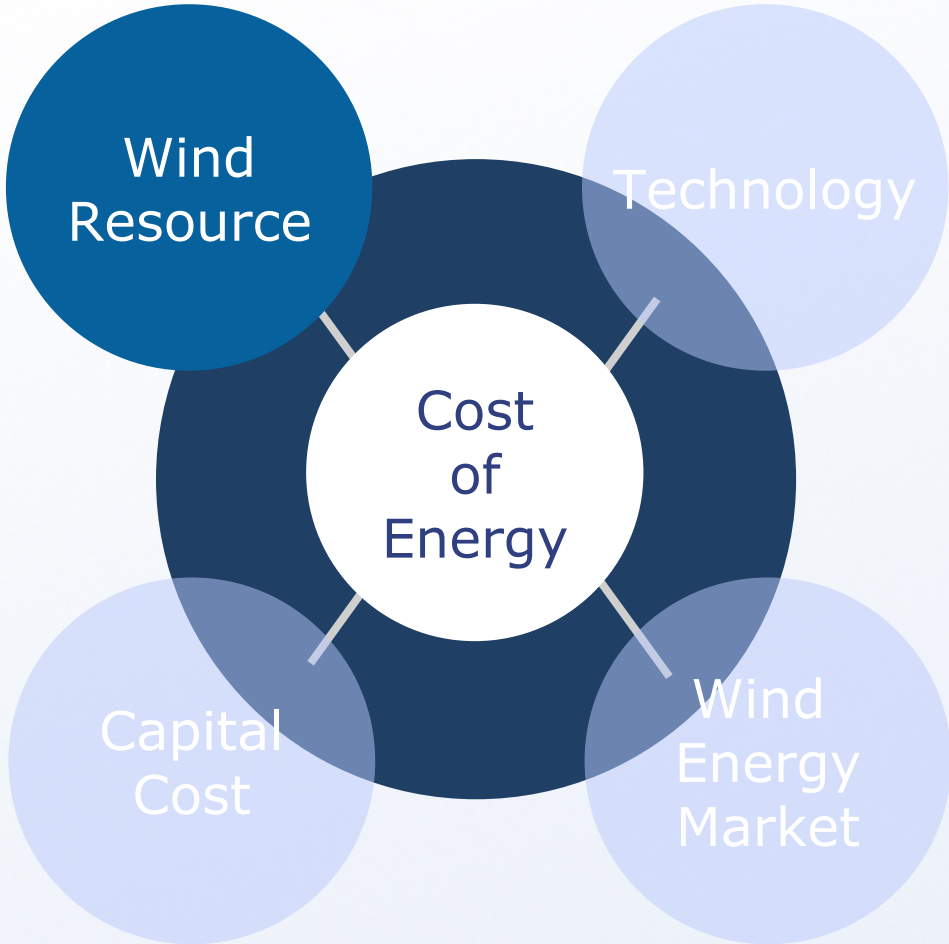
Four Drivers of Wind Energy Economics



Definitions: Cost of Wind Energy (COE)

- COE ($/MWh) = (Capital Recovery Cost + O&M)/MWh/year
  - MWh/year = Amount of Wind Resource and Productivity of the Wind Turbines
  - Capital Recovery = Debt and Equity Cost
  - O&M Cost = Turbine design, operating environment, Local Taxes, Insurance, etc.

Economics of Wind Energy



Wind Resource

Wind Energy = Wind Velocity^3

- The energy in wind varies with the Cube of the Wind Speed
- The most productive wind sites:
  - have high average wind speeds
  - are generally somewhat remote from population centers
  - integration with utility grid is generally challenging

Wind Resource

Capacity Factor=% of full power for all hours of all days
Wind Distribution X Turbine Power Curve=Gross Capacity

Gross Capacity Factor:	**40.0%**
Transformer/Line Losses/Transmission Line	-3.0%
Wake Losses	-4.8%
Control Alogorithm/Turbulence	-1.6%
Blade Contamination	-1.5%
Icing	-1.0%
Turbulence	0.0%
Turbine Availability	-3.0%
Net Capacity Factor [1]	**34.4%**
Gross to Net Conversion	86.0%

Wind Resource

Capacity Factor is a Shorthand Reference for Wind and Turbine Productivity

Approximate range of capacity factor by Region:

30-35% = Normal "Good" Wind Site

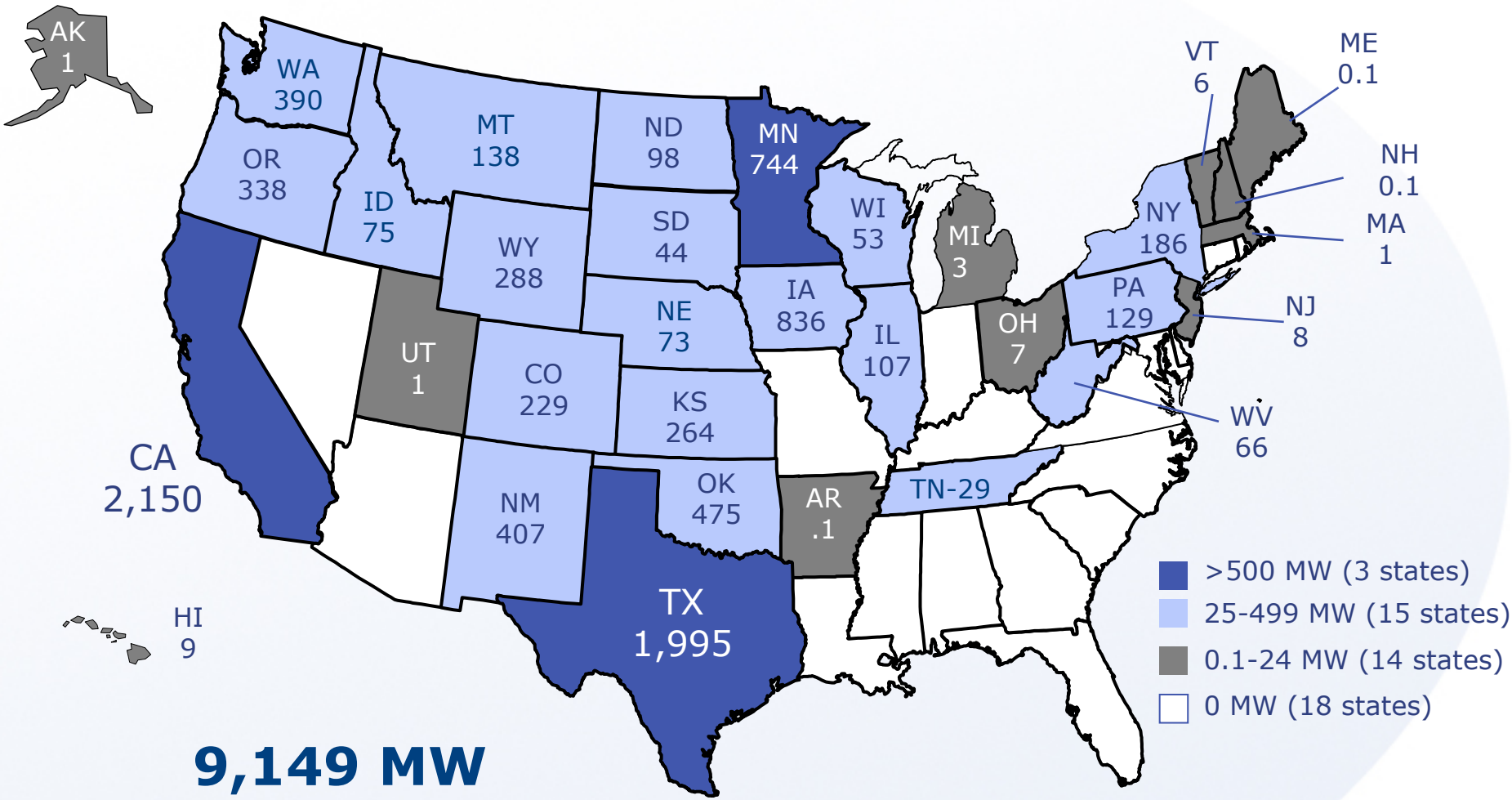
- Less production, economically viable with greater power sale rate
- Most US and Canada areas with an adequate energy market

Wind Resource

Upper end of capacity factor:

- >45% Capacity Factor = World Class Wind site
- Characterized by consistent, predictable, strong winds
- Great Plains, Hawaii, Mountain Passes, Off-Shore Sites

Current Installed Wind Capacity (MW)



9,149 MW as of 12/31/05

Source: American Wind Energy Association

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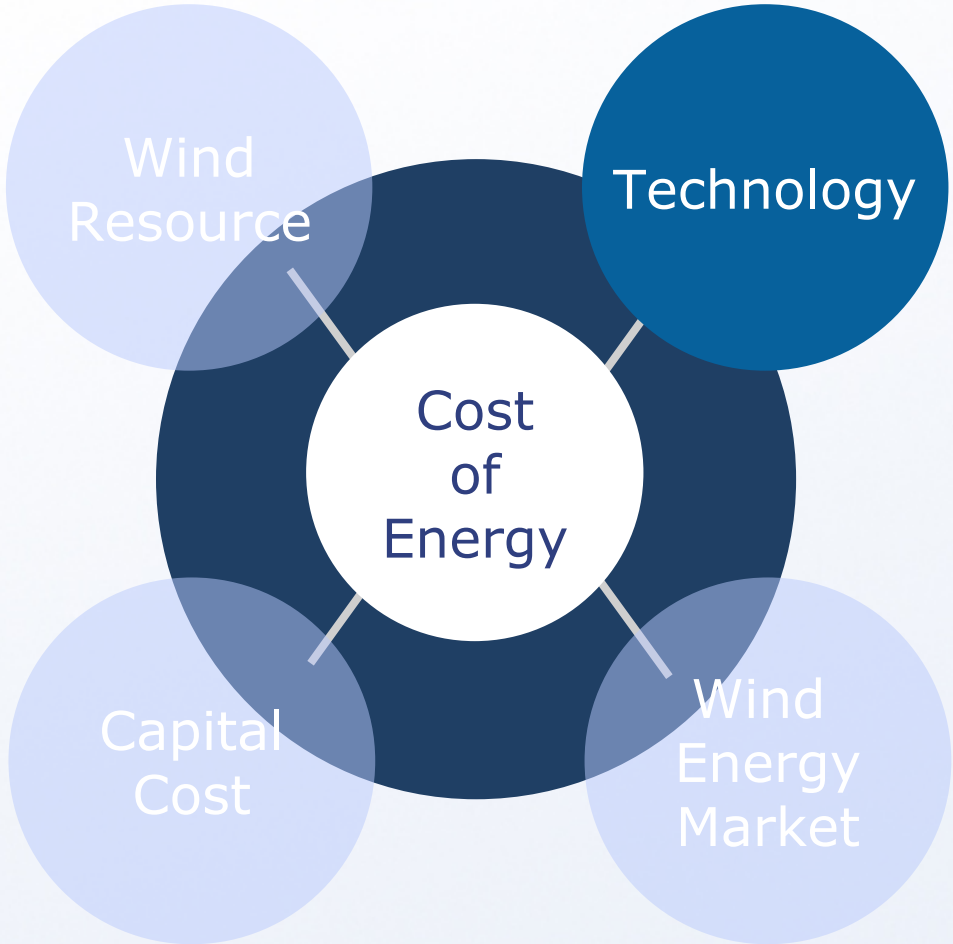
Economics of Wind Energy



20 Years of Wind Technology Development

	1981	1985	1990	1996	1999	2004
Rotor (Meter)	10	17	27	40	50	77
KW	25	100	225	550	$750	1,500
Total Cost	$65	$165	$300	$580	$730	$1,200
Cost/kW	$2,600	$1,650	$1,333	$1,050	$950	$800
MWh	45	220	550	1,480	2,200	5,600

Bottom Line: 1981-1999 = 49x the power, 11x the cost
1999-2000 = 2.6x the power, 1.8x the cost

Wind Turbine Technology

Cost of Wind Energy Has Been Reduced Over the Years as a Result of:

- Economies of Scale
  - Larger Turbines – up to MW + Size
  - Larger Plant Size – up to several hundred MW
- Technological Advances
  - Variable speed constant frequency
    - improved aerodynamic efficiency and decreased loads
  - Grid friendly power electronics
    - More wind power capacity into a given grid situation
  - Load splitting drive train
    - Lower drive train loads/ increased reliability/ lower O&M costs

Wind Turbine Technology Advances

Variable Speed Constant Frequency

Benefits:

- Lowers loads & reduces component cost
- Increases annual power output
- Enables VAR control, remote control of voltage and power factor for utility grid integration
- Stabilizes weak grids, provides utility system benefits
- Allows 60 or 50 cycle market utilization

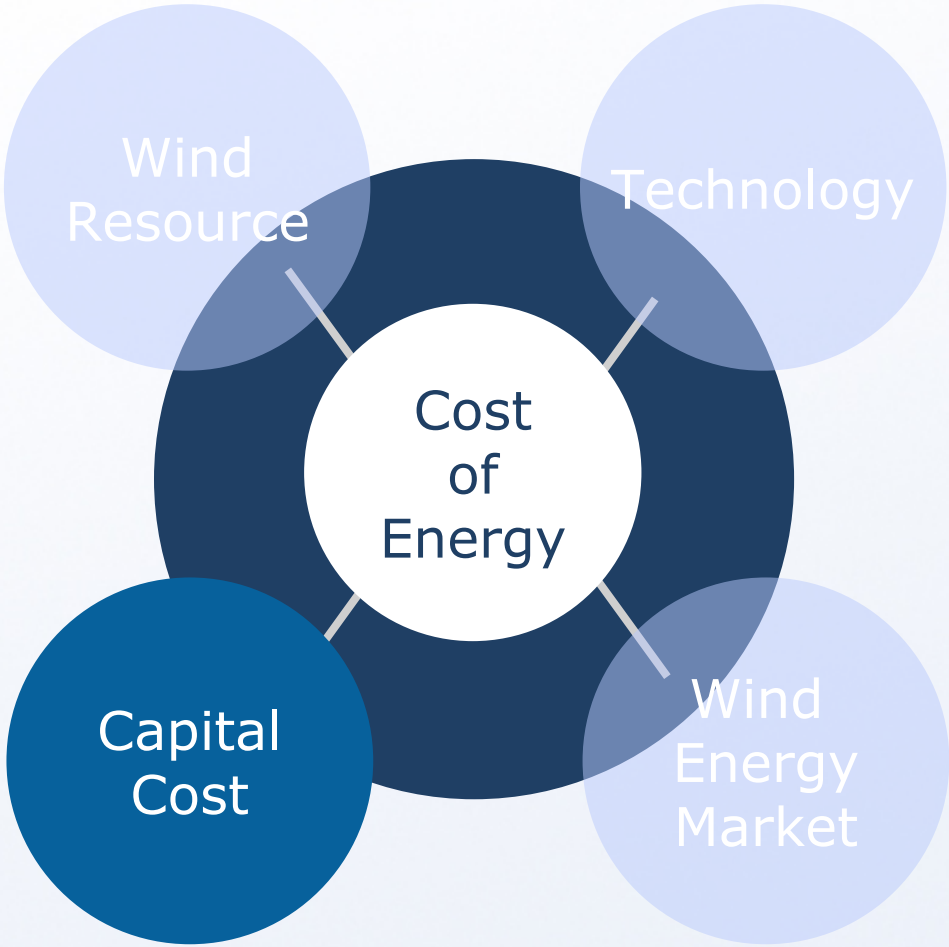
Wind Turbine Technology Advances

Load Splitting Drive Train

Benefits

- Load splitting reduces stress on gears and shafts
- Gears sizes reduced for greater manufacturing and quality flexibility due to reduces gear sizes
- Enables use of multiple generators
  - > Smaller sizes more manufacturing flexibility
  - > Partial power operation with a generator out

Economics of Wind Energy



Total Capital Costs

Approximate Installed Cost of Wind Energy Facility = $1.5 Million / MW

- Turbine (~ 70% of Total Cost)
- Transportation
- Installation and Balance of Plant
- Financing
- Legal
- Permitting
- Site Acquisition

Typical Revenue Streams (U.S.)

- Power Sale: Levelized — $.045 - $.075 / KWh
- Production Tax Credit: — $.01 / KWh Levelized
- “Green Credit” Sale: — New Market
- Accelerated Depreciation — 5-Year MACRS

Capital Structure

Construction Finance	$100% of Total Cost
Repaid by:	
• Long Term Debt:	• 50%
• Equity:	• 50%

Long Term Project Debt

- Longer Term = Lower COE due to lower debt payment amount
  - Term in years varies with certainty of power sale rate over time
  - 15 year term fixed price PPA = 15 year term loan

- Loan Amount: Lower debt service coverage ratio (DSCR)
  - = Greater debt amount
  - = Lower COE as debt cost is less than equity cost

- Long term fixed price PPA = 140% DSCR
  - Operating cash flow / debt payment = 1.40

- Market Price Energy ("Merchant") = Greater DSCR
  - – Emerging market based on higher national gas prices

Equity

- Return requirements vary with risks
- Returns are evaluated on after tax basis
  - Wind Project ~ high single digit
  - Low Cost Housing ~ mid single digits
  - Venture capital ~ X 100%

> Tax free bond ~ low single digit

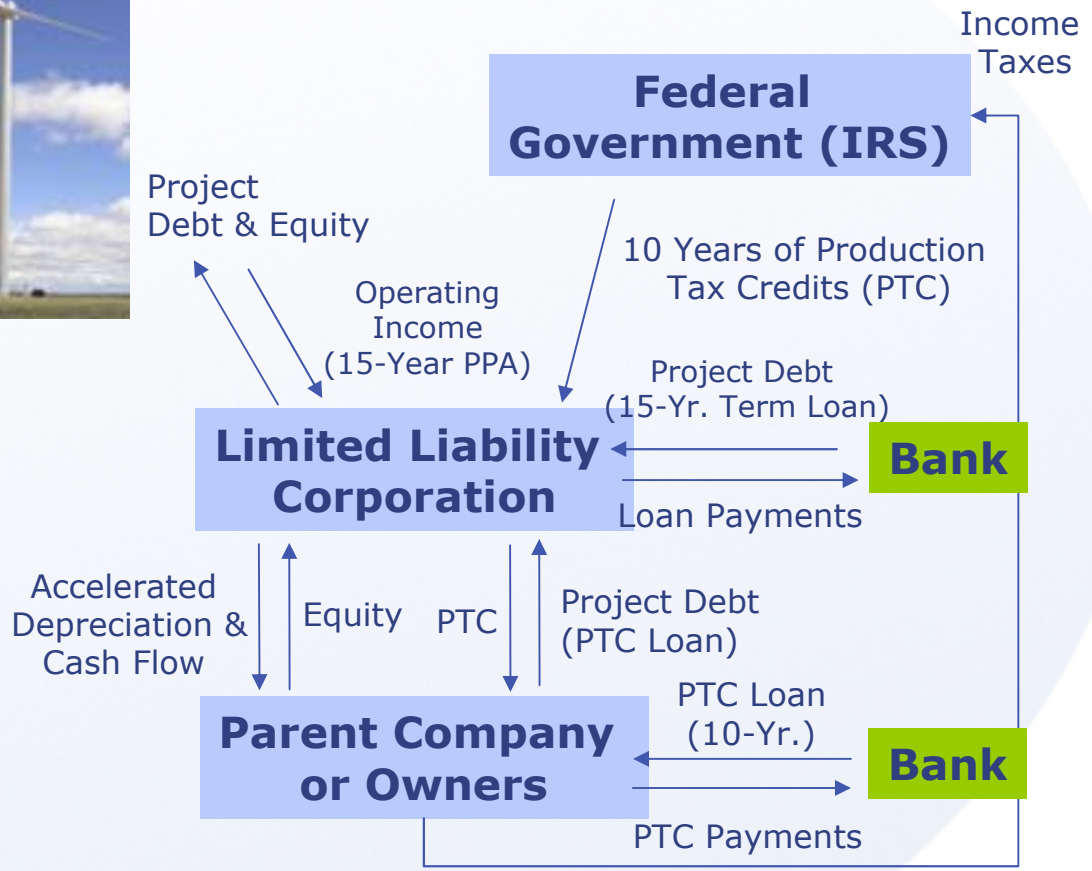
Equity

Production Tax Credit (PTC)

- Meant to "Level the Playing Field" with government assistance for other generation –
  - > Depletion allowance for fuel extraction
  - > Indemnity protection for nuclear risks
  - > Eminent Domain power for natural gas pipelines

Project Finance Structure

Wind Energy Facility
~ $1.5 Million/MW



Costs – Annual Operating Costs

Project Specific Costs:

- Operations and Maintenance
- Local Taxes
- Insurance
- Land Use Rights
- Power delivery costs
  - Interconnect
  - Transmission

Cost of Energy Sample Calculation - Example Values

Net Capacity Factor:	37%
All in Capital Cost:	$1.5MM per installed MW
Capital Recovery Factor:	10%
Annual Operating Costs:	$50k / MW / year
Energy Production:	(8,760 MWh / year) x capacity factor
Production Tax Credit:	$0.01 / kWh

Cost of Energy Sample Calculation

COE = ((Capital Cost x Capital Recovery Factor) + Operating Cost)/Energy Production

COE = (($1,500,000 x 0.10) + $50,000) / (8,760 MWh x 0.37)

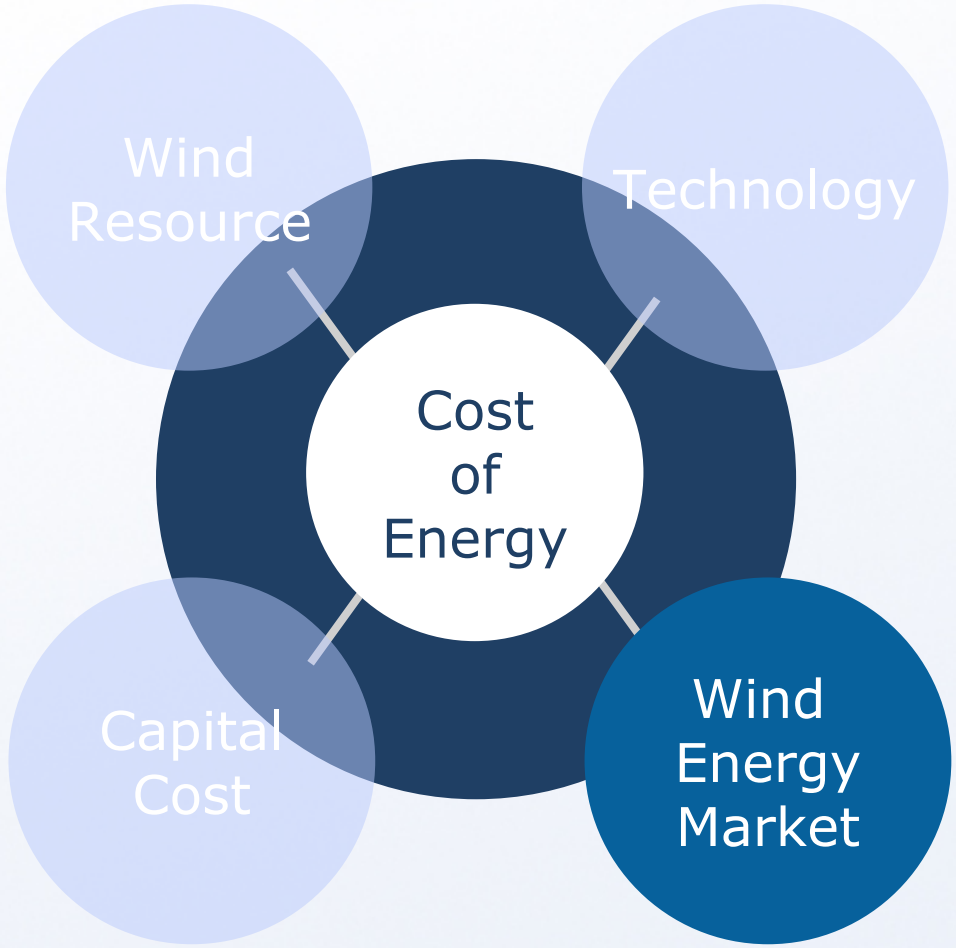
COE = ($150,000 + $50,000) / 3,241 MWh

COE = $200,000 / 3,241 MWh

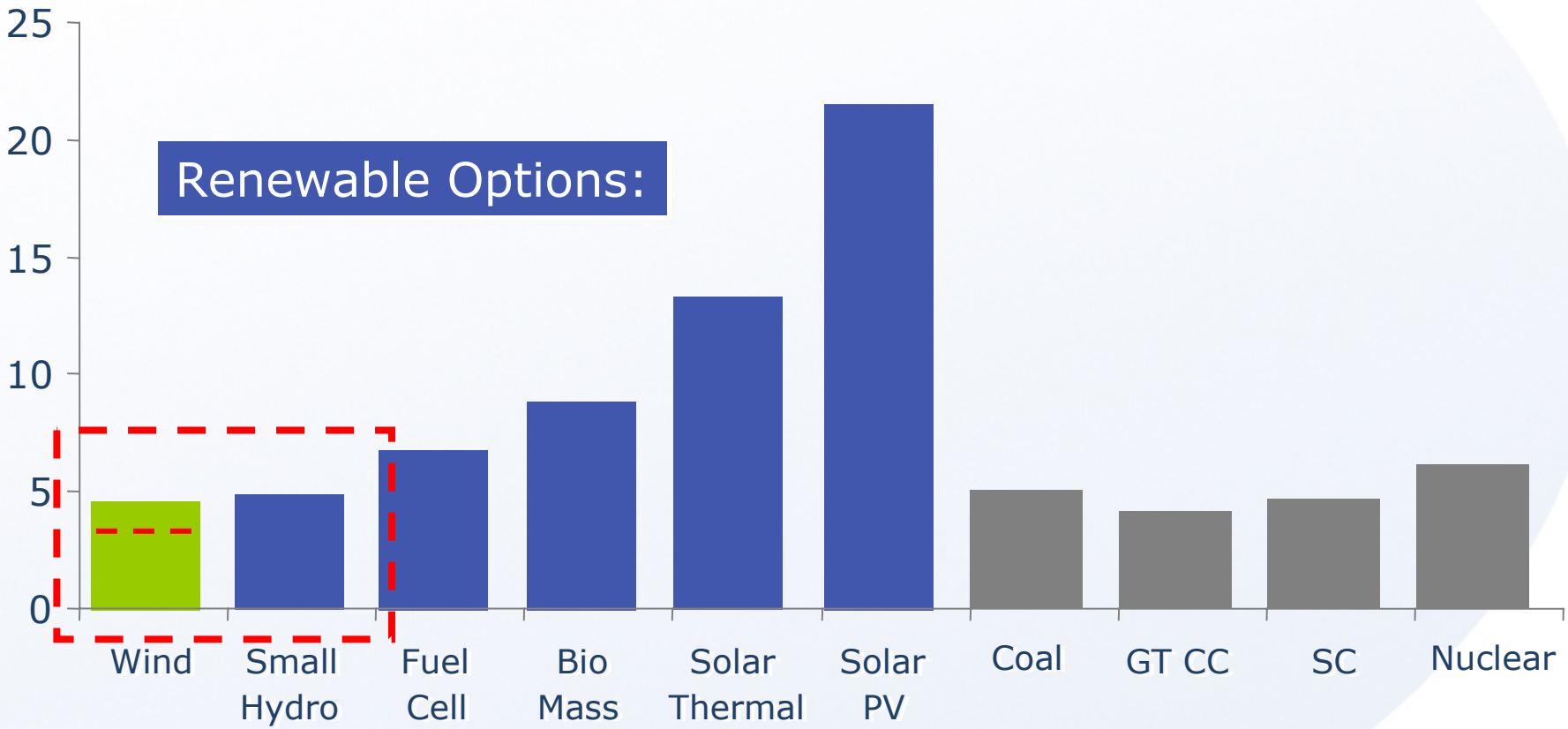
COE = $61.70 / MWh or $0.0617 / KWh

COE with PTC value = ($0.0617 - $0.01) = **$0.0517 / KWh**

Economics of Wind Energy



Wind's Cost Continues to Decline
Most Practical Renewable Technology



Sources: BTM Consult, WindPower Monthly, GE Wind Energy
Biomass : Direct fueled

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Values Associated with the Economics of Wind Power

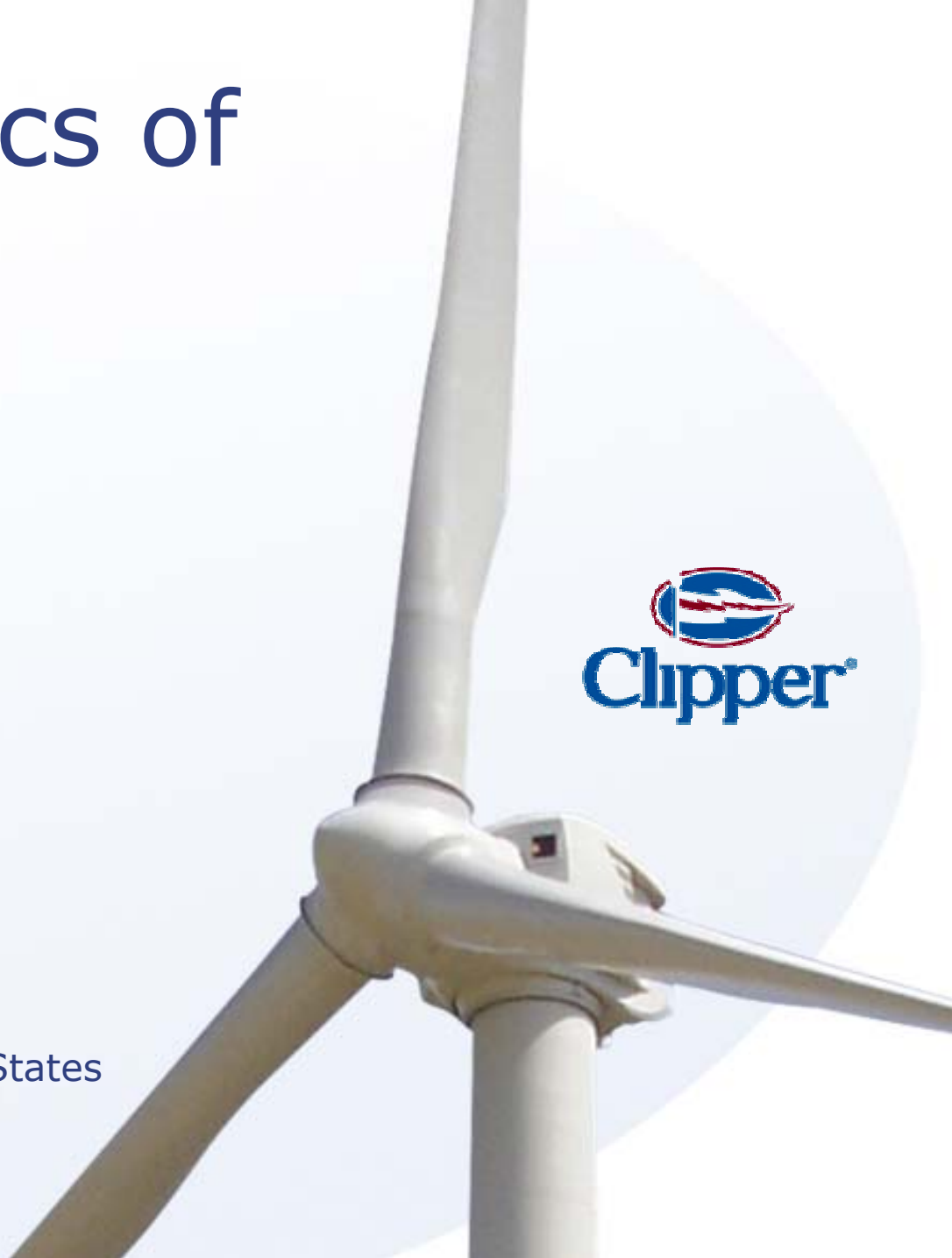
- Energy Sale
- Tax Credit
- "Green" Credit / Emissions Credit
  - Cash
  - Regulatory compliance value
- Unpriced Values
  - Hedge value
    - Fuel costs increase risk cost
    - Pollution / CO2 tax risk
  - Fuel diversity value

Summary

Economics of Wind are Reasonably Certain and Highly Favorable:

- Wind resource is statistically predictable
- Today's wind turbines technology is reliable
- Wind energy costs are fixed long term
- Price of wind energy can be fixed over a long term
- The price of wind energy is competitive in today's energy market
- Renewable initiatives or requirements will accelerate development of wind energy
- Stable long term government policy is needed for wind energy to provide all it can to the US and Canadian economies

The Economics of Wind Energy



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