GE Energy

Current Status of Wind:
Market Update in the Context of the Economics of Wind

Mark Eilers

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Taking its place in the Mainstream

- **Reliable**

  > 95-98% availability

- **Cost effective**

  > $0.03 – $0.05 cents/kWhr – levelized with PTC

- **Stable prices**

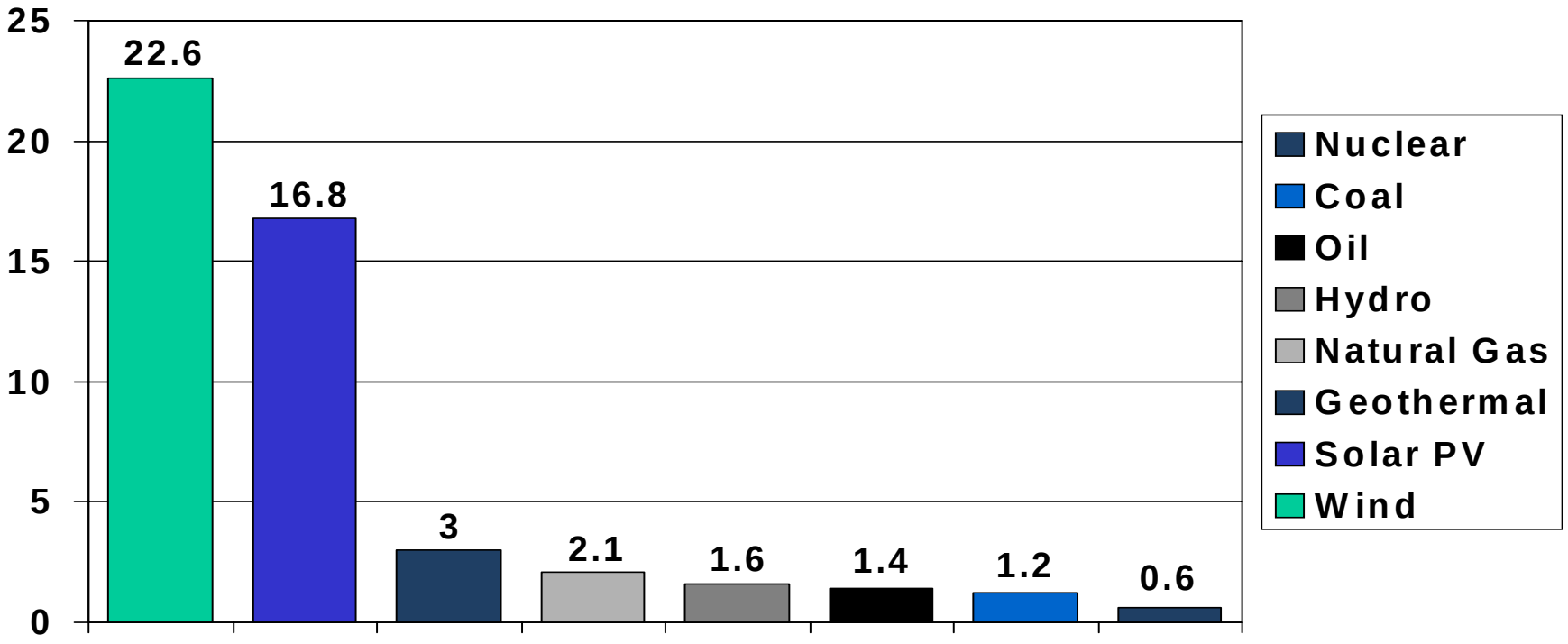
  > No fuel or environmental risks over life of the project

- **Grid-friendly**

  > behaves like conventional generation

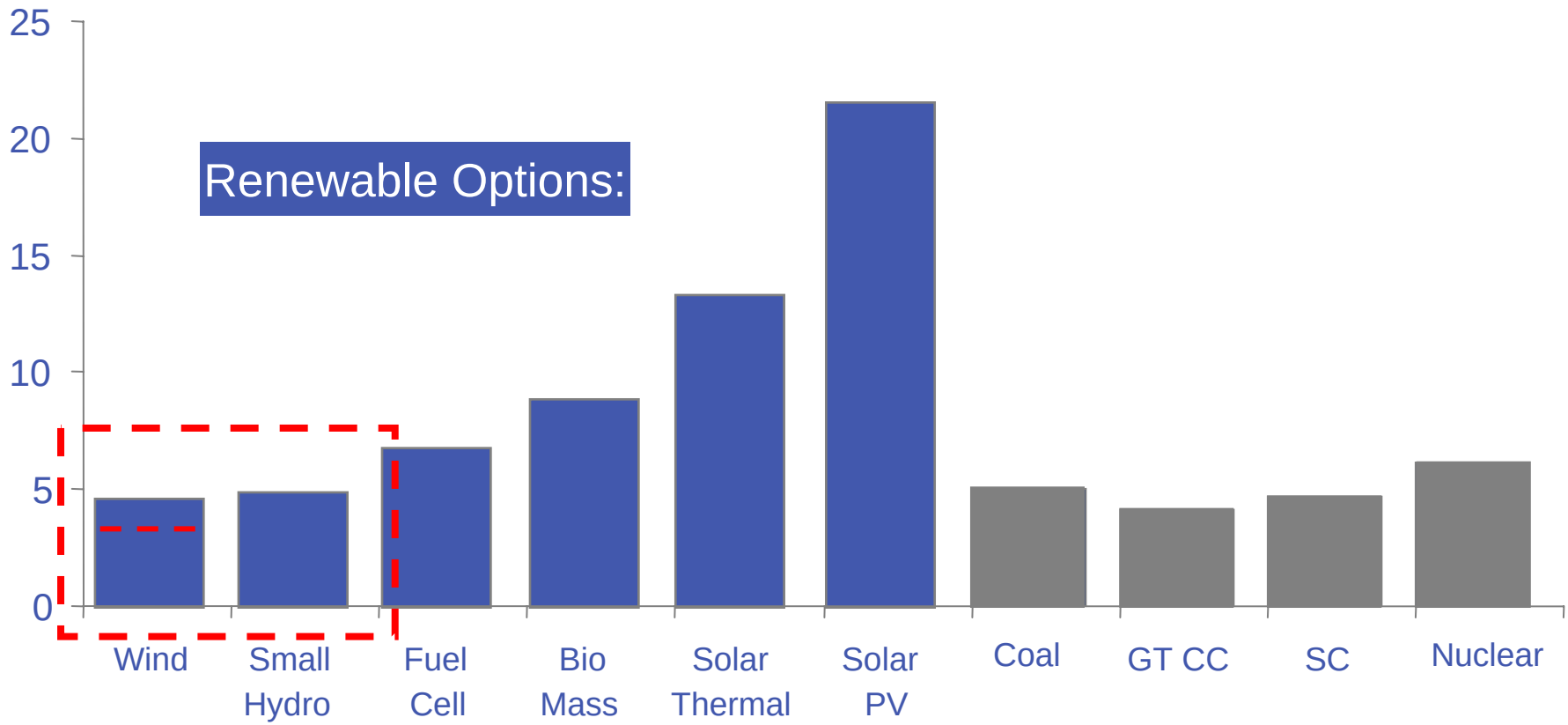
The Fastest Growing Energy Technology

Global Growth by Energy Source, Annual Average, 1990-98



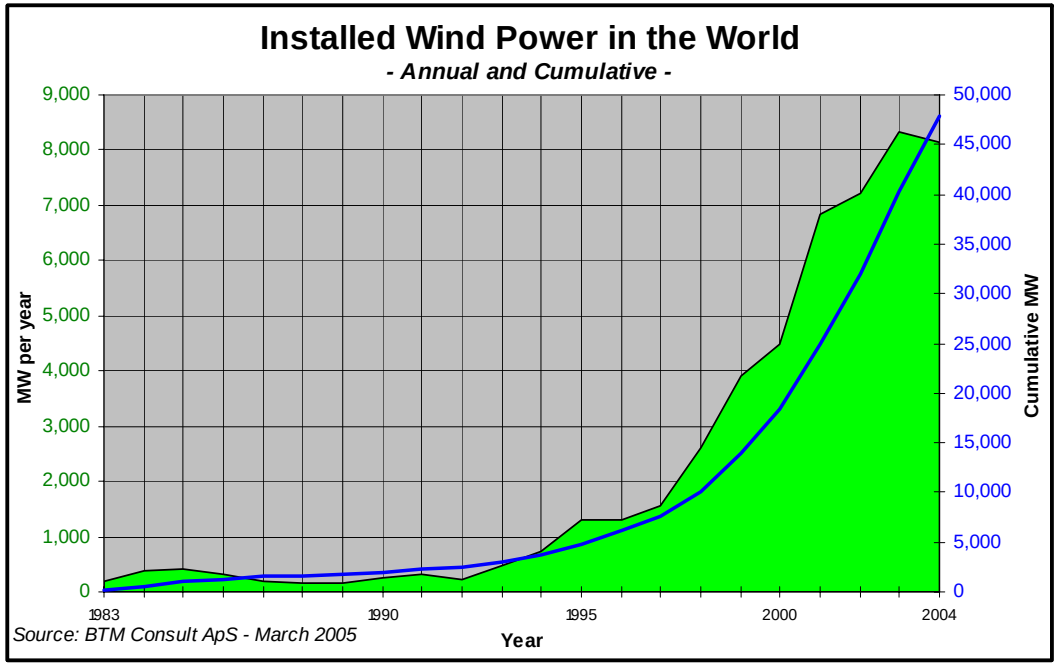
Source: REPP, Worldwatch 1999

Most Cost Effective Renewable Technology

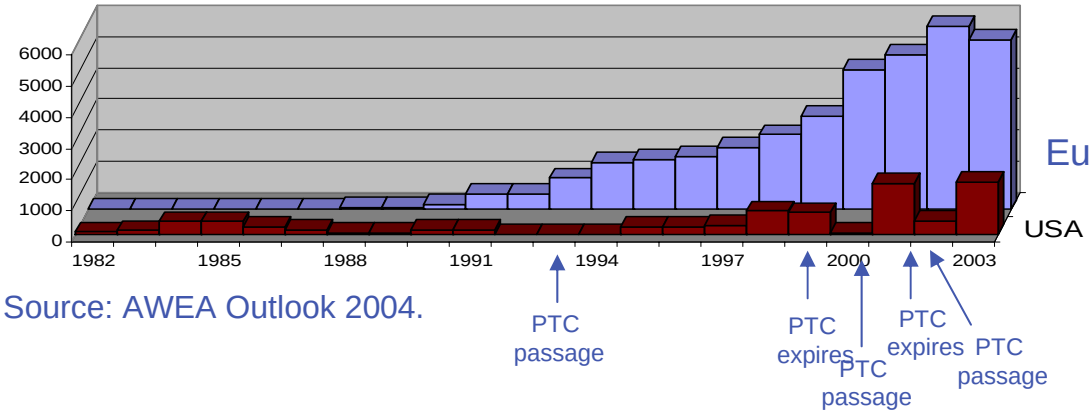


Sources: BTM Consult, WindPower Monthly, GE Energy
Biomass : Direct fueled

Current Market for Wind - Worldwide

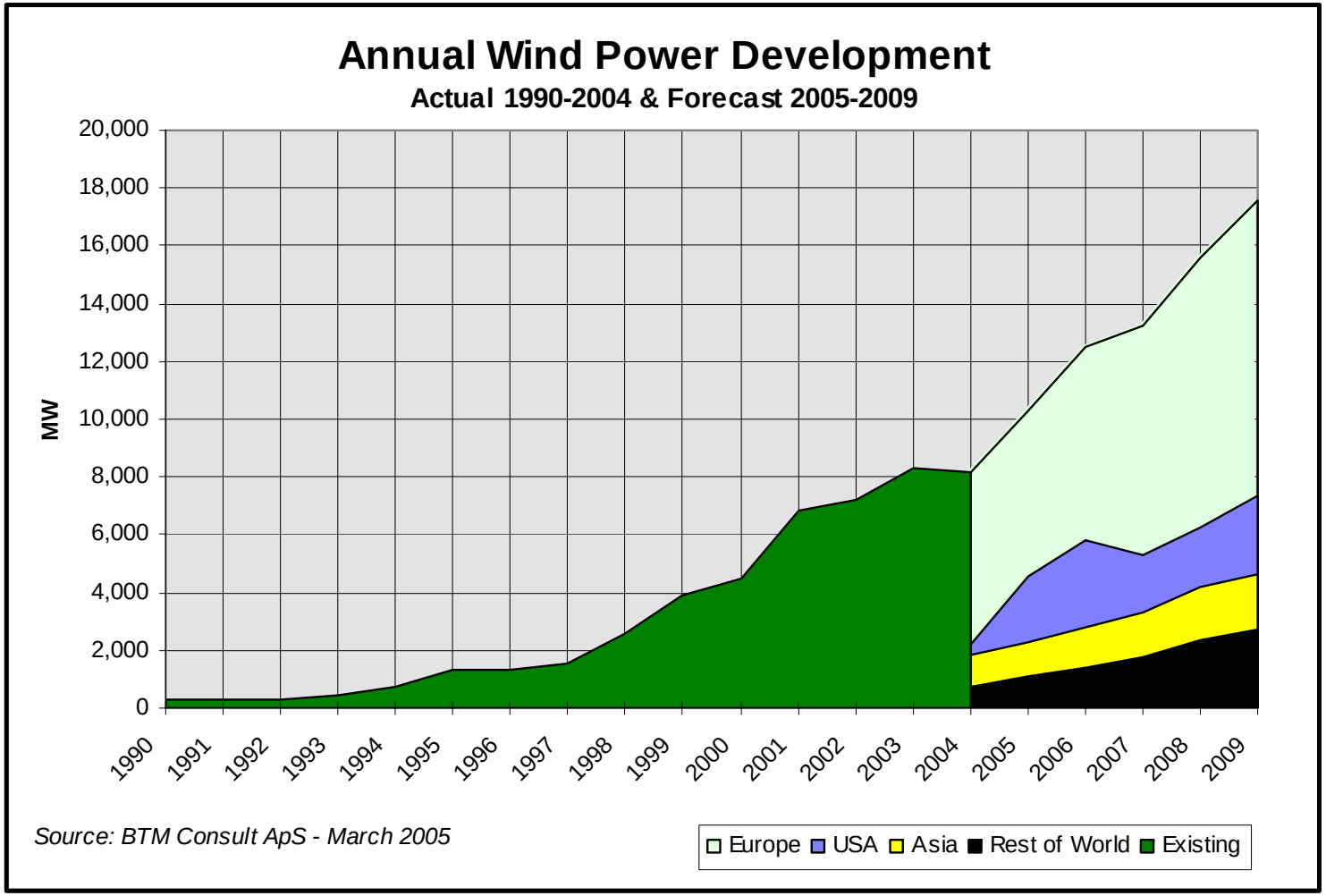


Note:
Spain has more installed wind than all of USA



Source: AWEA Outlook 2004.

Future Market for Wind - Worldwide



America – Primary Market Drivers

Tax Credits

- Federal Credit (PTC)
- State Tax Payments (MN, MA)

Portfolio Standards/Goals

- 22 states and growing

Fuel Diversity

- Gas at the margin (TX)
- CO_2 exposure (heavy coal users)

Lowest Cost Resource

- IRP process decisions

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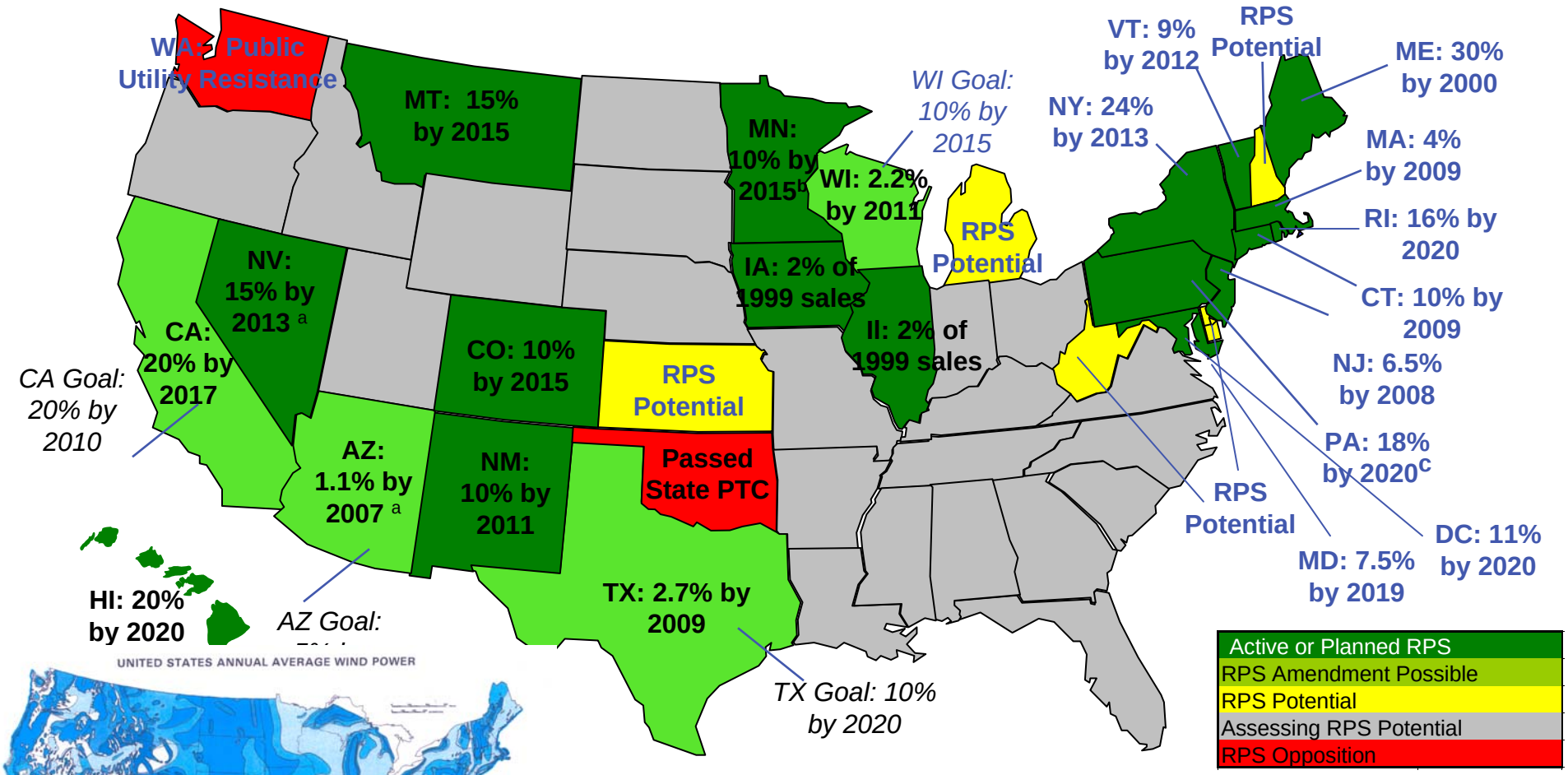
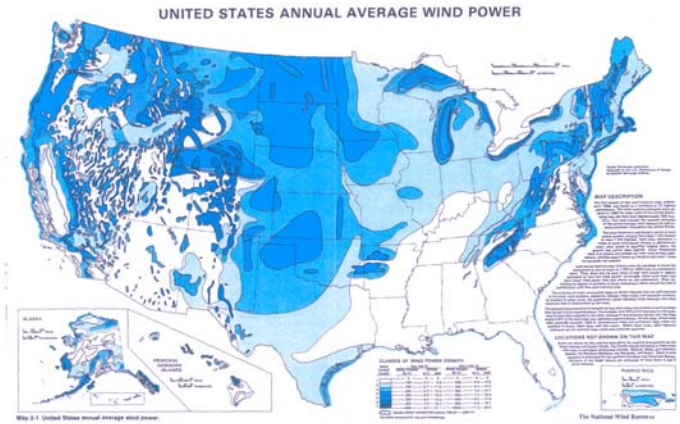
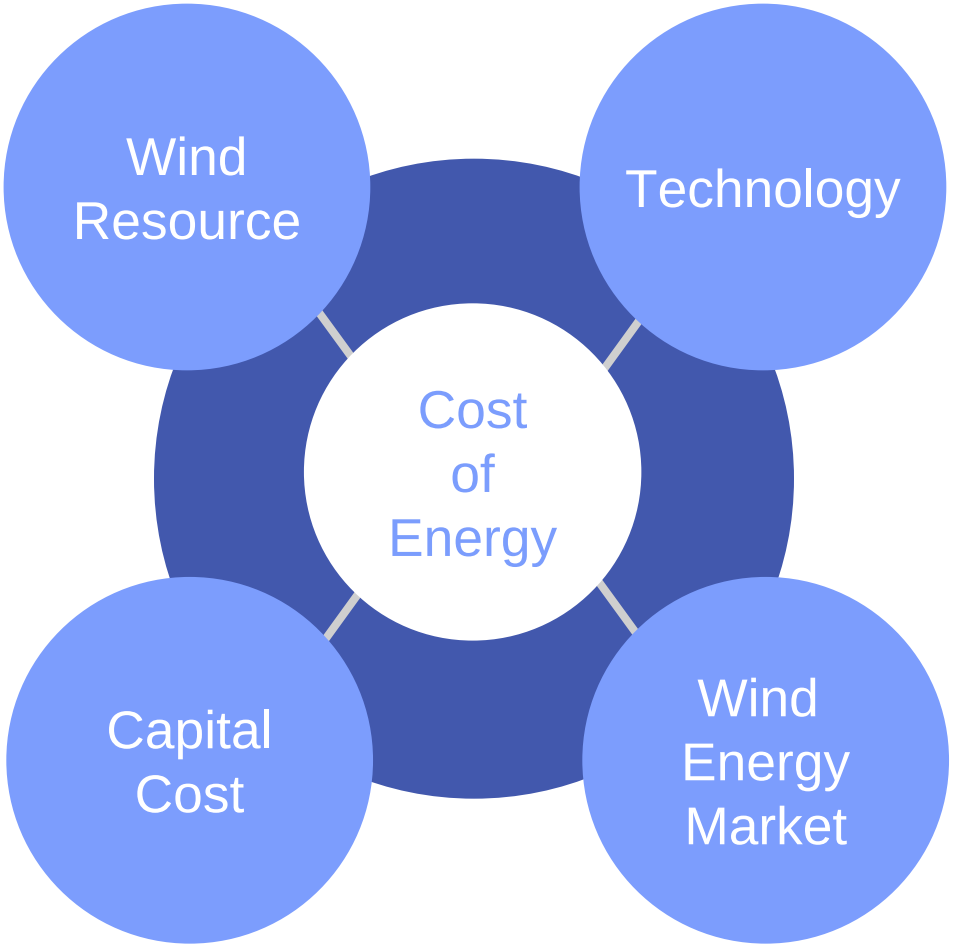
State Renewable Portfolio Standards (RPS)





Growth Driven by the Fundamentals:
Four Drivers of Wind Energy Economics



Cost of Wind Energy (CO_wE)

$$CO_wE\ (\$/MWh) = \frac{\text{Capital Recovery Cost + Operating Cost}}{\text{MWhrs/year}}$$

Where:

- Capital Recovery Cost = Capital + Return
- Operating cost = O&M + Warranty + Landowner + Taxes
- MWh/year = Wind Resource x Turbine productivity

Costs – Annual Operating Costs

Project Specific Costs

- O&M
- Warranty
- 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:	$1.3mm per installed MW
Capital Recovery Factor:	10%
Annual Operating Costs	$50,000 / MW / year
Energy Production	(8,760 MWh / year) x capacity factor
Production Tax Credit*	$0.01 / kWh

*1.8 cents / KWh escalating over 10 years converted to a 20-year levelized

Cost of Energy Sample Calculation

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

COE = (($1,300,000 x 0.10) + $50,000) / (8,760 MWh x 0.37)

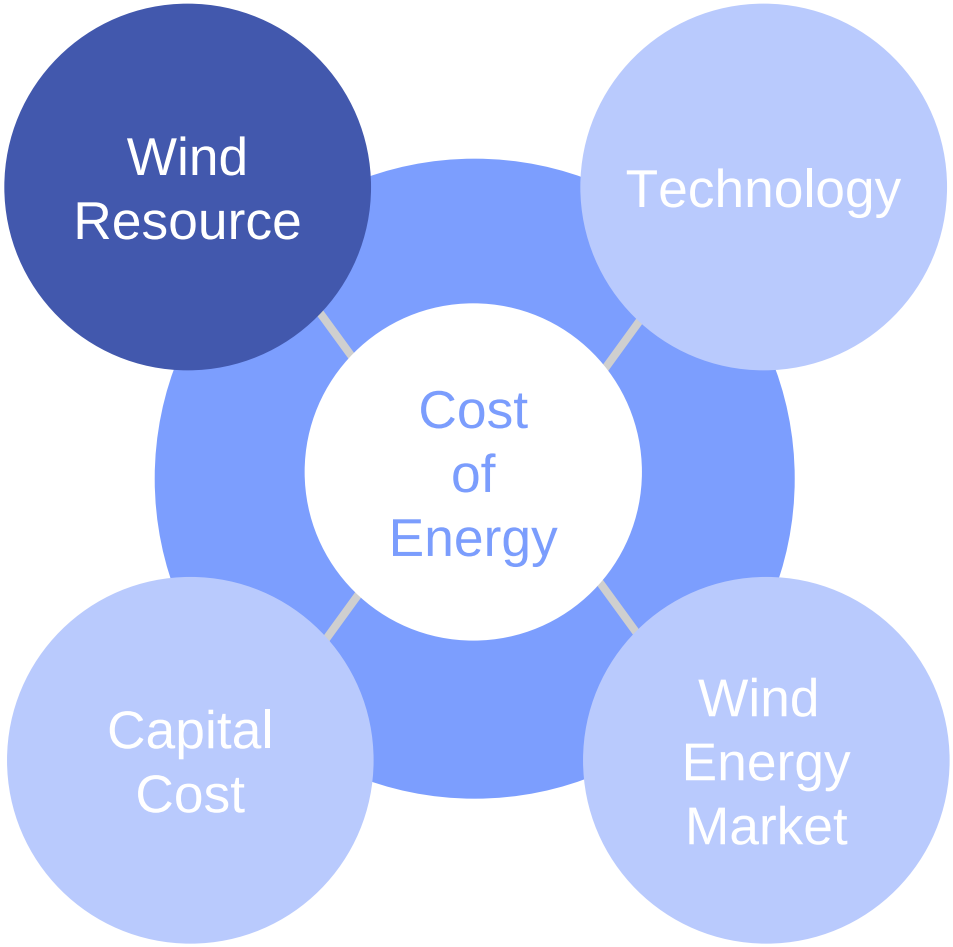
COE = ($130,000 + $50,000) / 3,241 MWh

COE = $180,000 / 3,241 MWh

COE = $55.53 / MWh or $0.055 / KWh

COE with PTC value = ($0.055 - $0.01) = **$0.045 / KWh**

Economics of Wind Energy

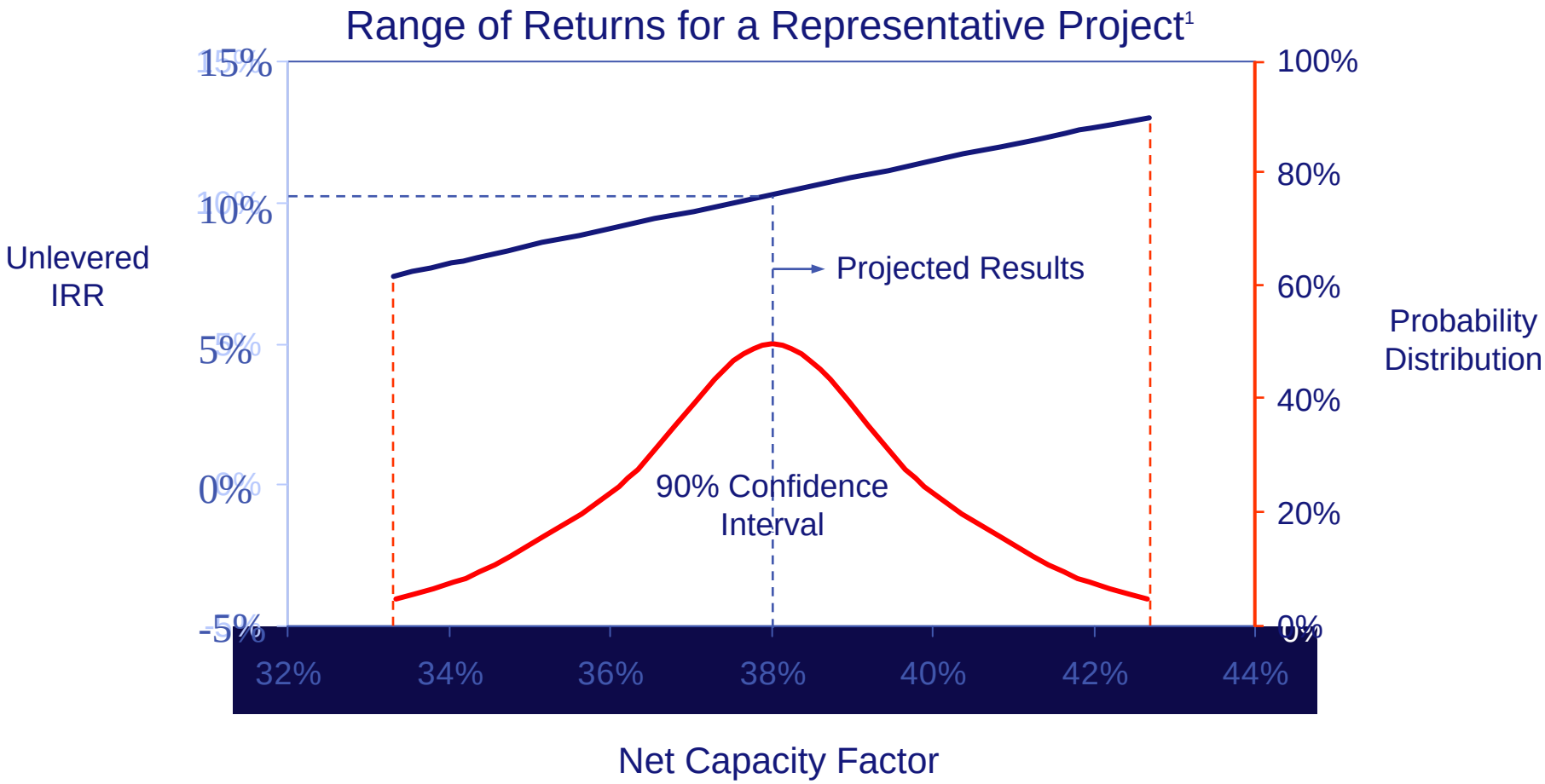


Wind Resource

Energy in wind varies with the CUBE!! of the wind speed

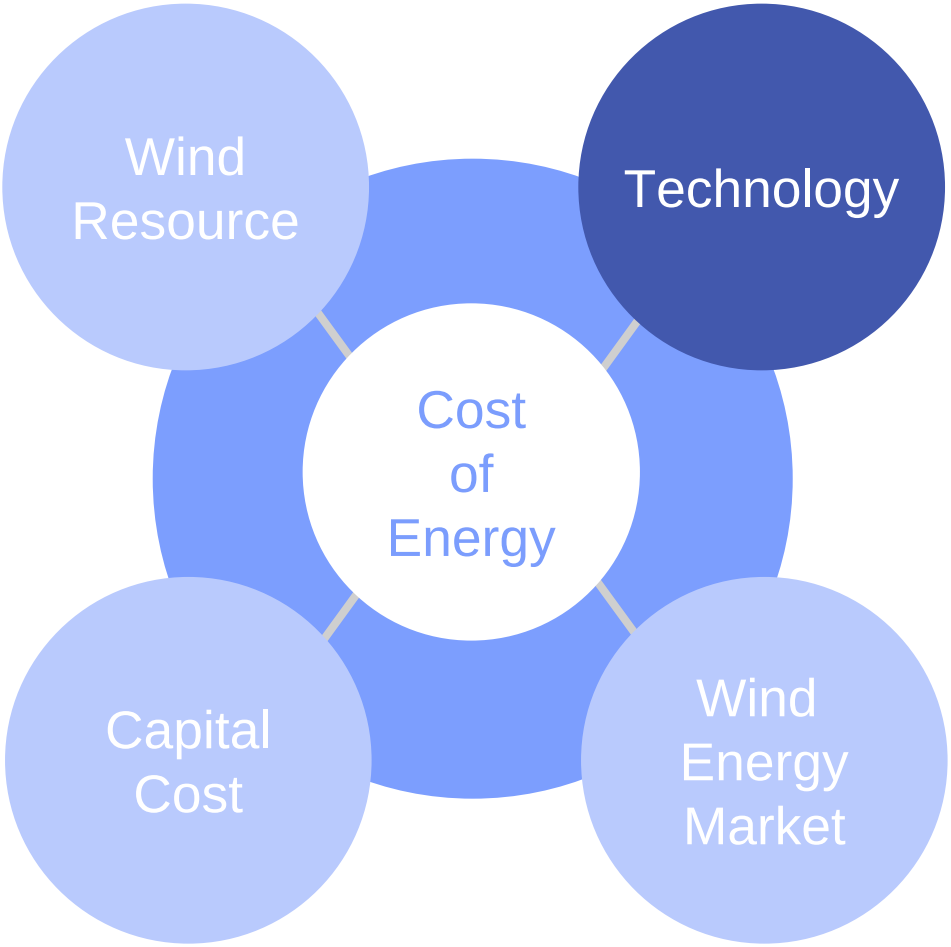
- 2 classifications – US (Class 1-7) and IEC (Class 1-3)
- Commercial wind sites today
  - medium to high wind speeds (IEC Class 1 &2)
  - remote from urban centers
- Wind determines the gross capacity factor for the site
  - Ave to Good sites – range from 25 - 35%
    - Pacific Northwest
    - Northeast
    - Mid Atlantic
  - Good to Excellent sites – range from 35 - > 45%
    - Great Plains (ND to TX)
    - Hawaii
    - Mountain passes (CA)
    - Off Shore

Variation in the Wind is Quantifiable



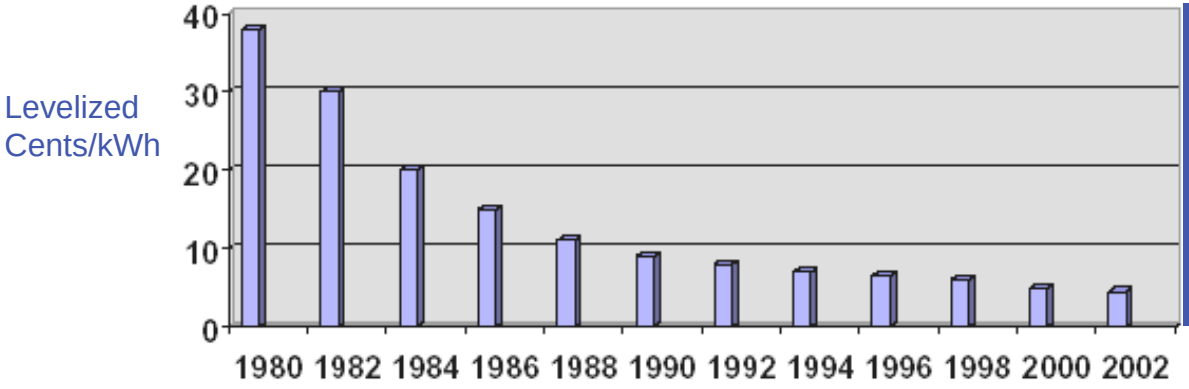
Inherently stable returns → limited downside

Economics of Wind Energy



Key Drivers for lower CO_wE

- Economies of Scale
  - Larger Turbines – up to several MW
  - Larger Plant Size – several hundred MW



80% Price Reduction in 20 Years!

- Technological Advances
  - Variable pitch blades
  - Variable speed generation
  - Increase rotor size
  - Grid friendly advances

20 Years of Wind Technology Development

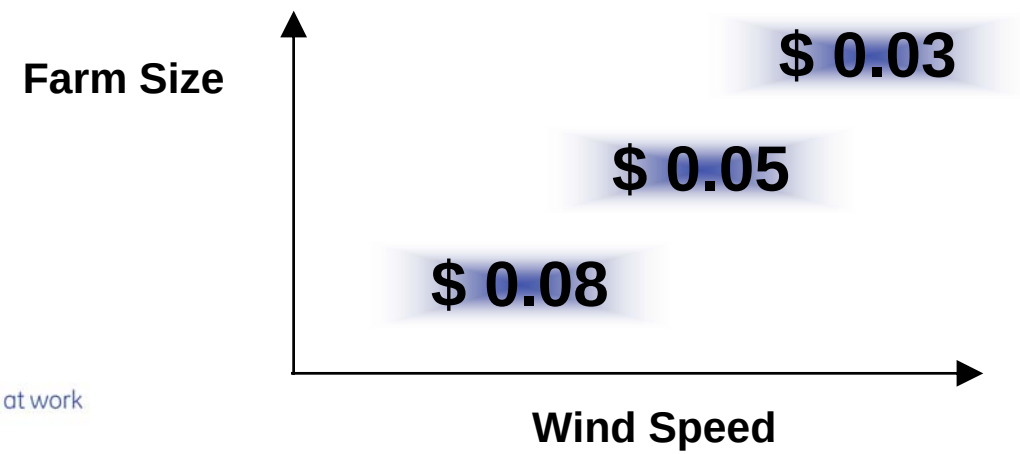
	1981	1985	1990	1996	1999	2005
Rotor (Meter)	10	17	27	40	50	77
KW	25	100	225	550	$750	1,500
Total Cost	$65	$165	$300	$580	$730	$1,200
Cost/kW	$2,600	$1,650	$1,333	$1,050	$950	$800
MWh	45	220	550	1,480	2,200	5,600

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

Plant Size

Economic Factors	Project A	Project B	Project C
Wind Resource	Modest	Very Good	Excellent
Project Size, MW	5-10	75	200
PPA Terms, Yrs	5	15	25
Financing Costs	Average	Average	Average
Equipment and construction	Average	Average	Average
Project Cost / kW	$1,500	$1,300	$1,200
Cost of Energy	**$0.08**	**$0.05**	**$0.03**

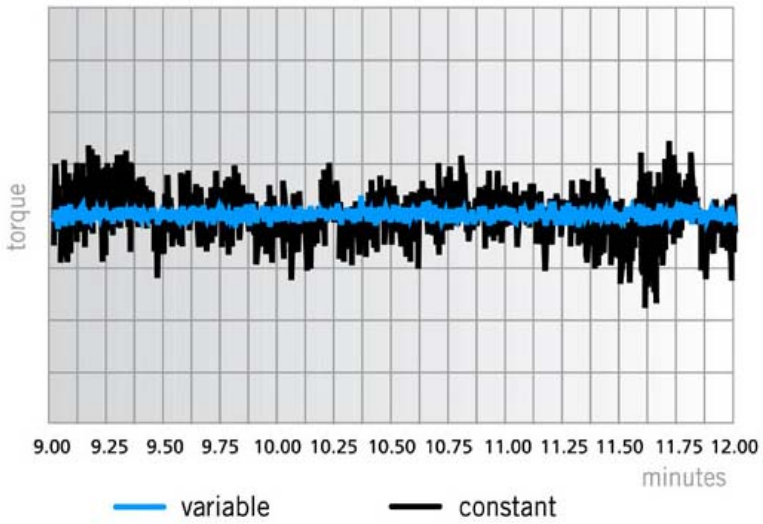
Cost of Electricity



Technology Advances

Variable Speed Constant Frequency

- Variable speed operation limits power / torque excursions
- Rotor operates at maximum Aerodynamic efficiency from cut-in to rated capacity
- Increased annual power output
- Reduces component costs



Turbine Advances

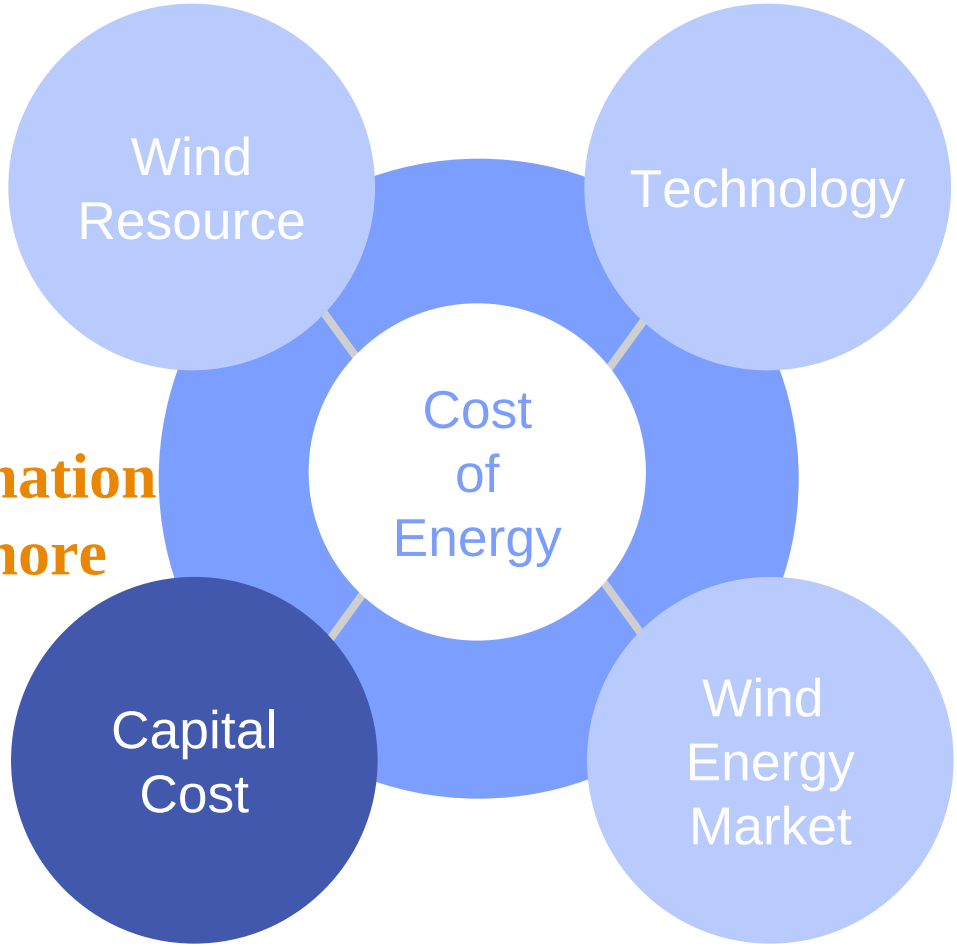
Grid friendly

- Dynamic VAR control
  - stabilizes weak grids
  - provider of valuable ancillary services to the grid
- Low voltage ride through
  - greater grid reliability
  - more annual energy sales when on the grid.

Turbine friendly

- Lowers load & reduces component cost
- Increases annual power output

Economics of Wind Energy



Following information is specific to onshore

Total Capital Costs

Installed Cost of Wind Energy Facility
Approximately $1.1 - 1.5 mm / MW

› Site Acquisition

› Permitting

›Turbine (~70% of total cost for onshore, ~50% for off shore)

› Balance of Plant (30% of total cost of onshore, ~50% for offshore)

› Erection (getting more expensive)

› Financing

› Legal

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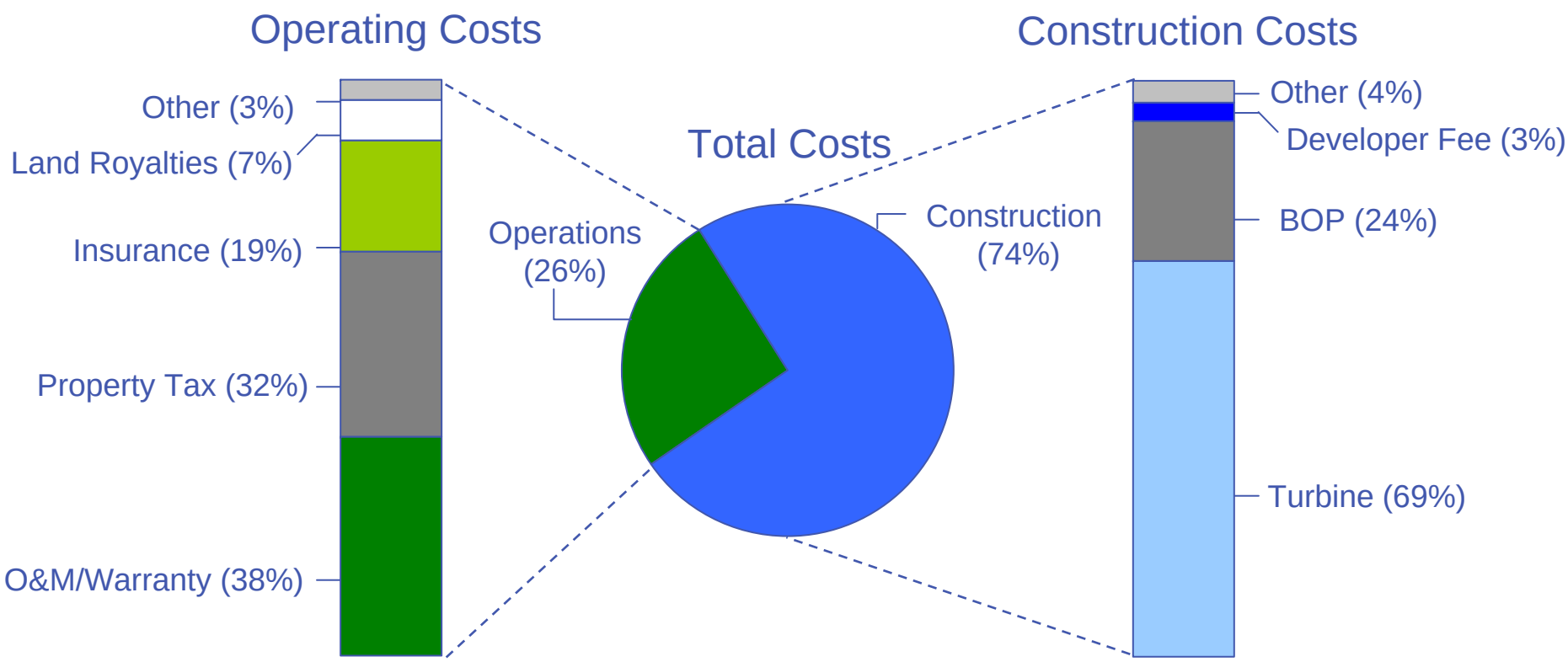
Cost Breakdown (onshore)



All figures % NPV

Major Assumptions:
a) 38% Net Capacity Factor
b) PPA=2.85 cents/kWh; escalates at 2%/year after year 3
c) Incentives: 10 year PTC @ 1.8 cents/kWh 2003; 50% Bonus depreciation and 5 year MACRS
d) 90 MW project with $1.15 million/MW total cost e) $25-30K Warranty and O&M/WTG/year
f) Discount rate = 10%

Capital Structure

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

* "Monetization" of the Production Tax Credit through PTC loans typically reduces the debt to equity split to 30% equity/70% debt.

Long Term Project Debt

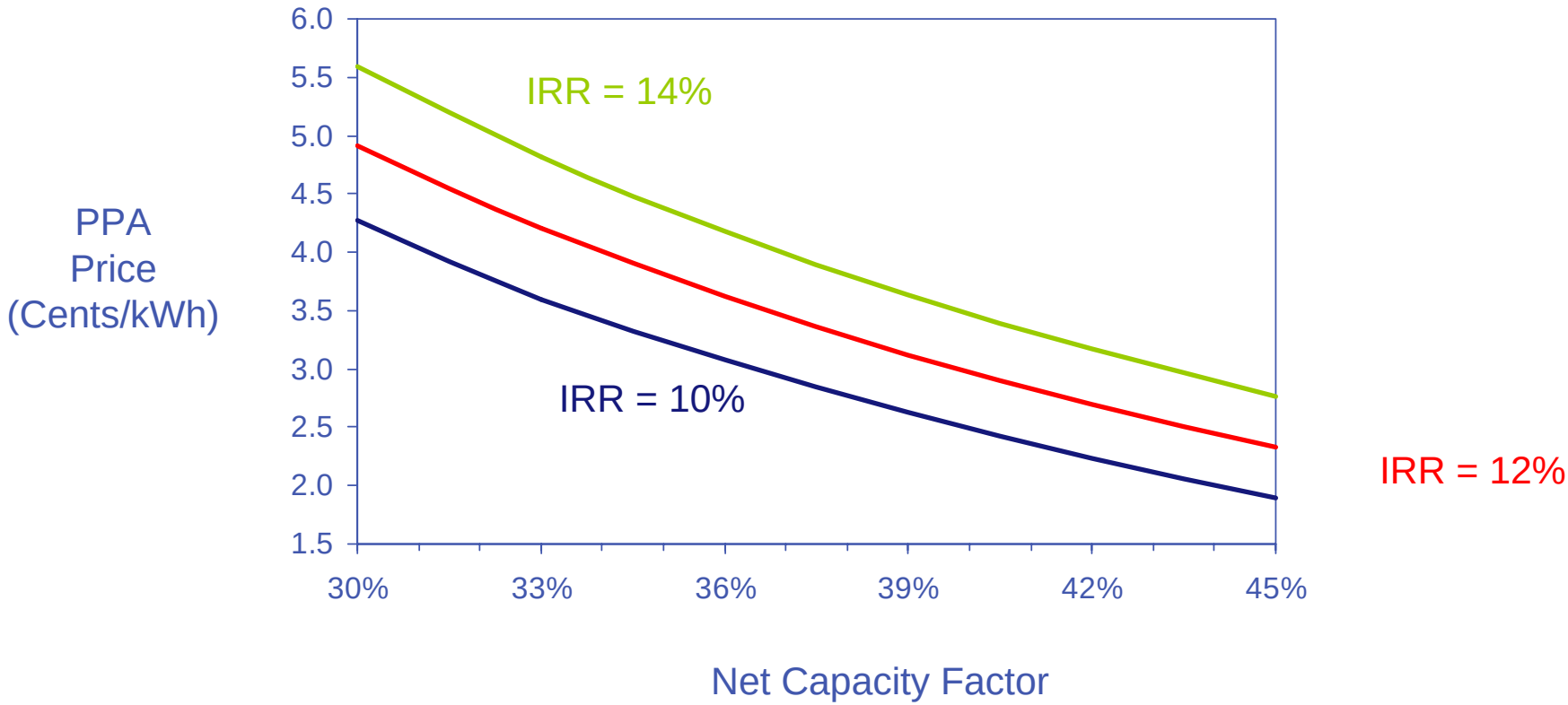
- Longer Term = Lower COE due to lower debt payment amount
  - Term in years varies with certainty of power sale rate over time
  - **Fixed rate or sale into market**

  - **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

Equity – Return Drivers

Unlevered IRR v. Capacity Factor and PPA[1]



Capacity factor and PPA are key economic drivers

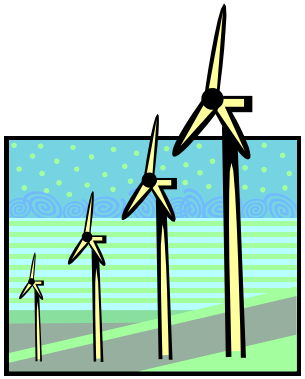
[1] Major Assumptions:
a) Incentives: 10 year PTC @ 1.8 cents/kWh 2003; 50% Bonus depreciation and 5 year MACRS
b) 90 MW project with $1.15 million/MW total cost
c) $25-30K Warranty and O&M/WTG/year
d) PPA escalates at 2%/year after year 3

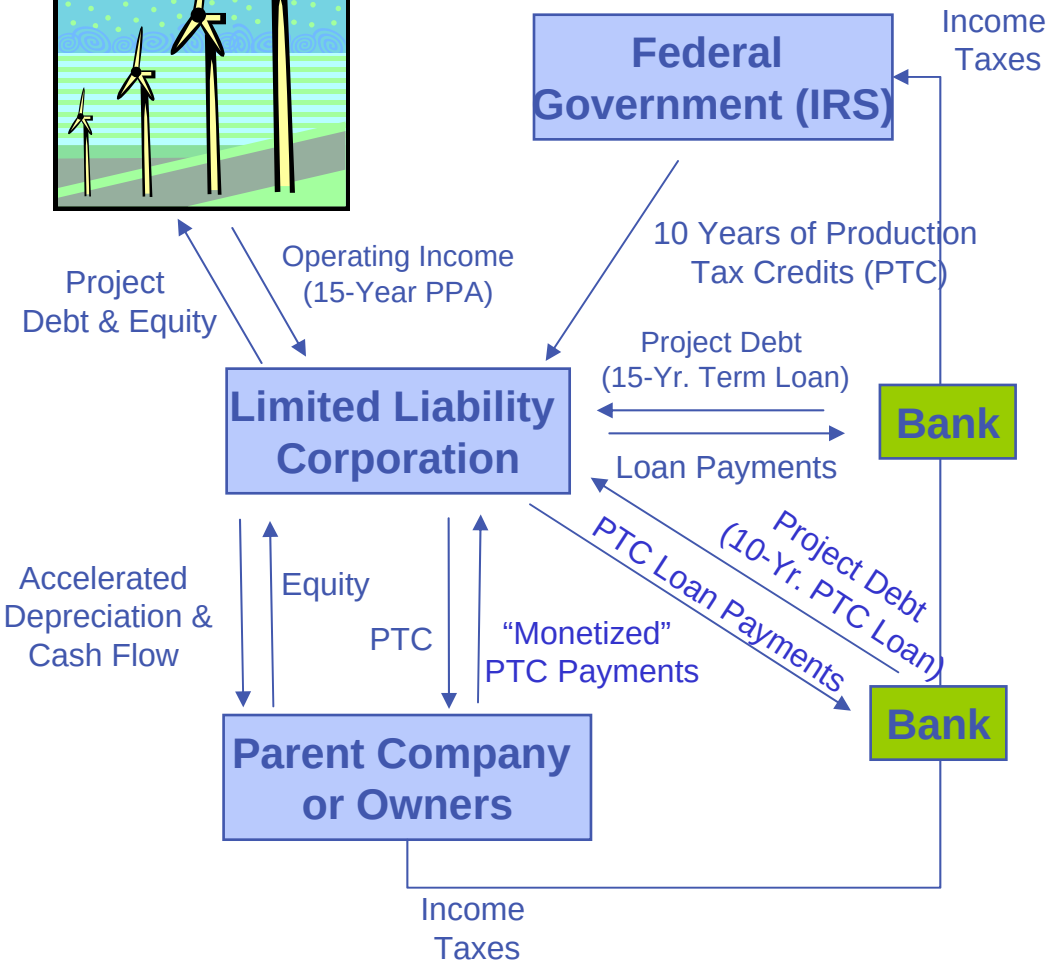
Equity - Returns Comparison

- Return requirements vary with risks
- Wind investment risks are low
- Returns are evaluated on after tax basis
  - Wind Project ~ 8-10 %
  - Housing ~ single digits
  - Venture capital ~ 50% +
- Production Tax Credit (PTC) improves after-tax return to equity with a lower PPA price

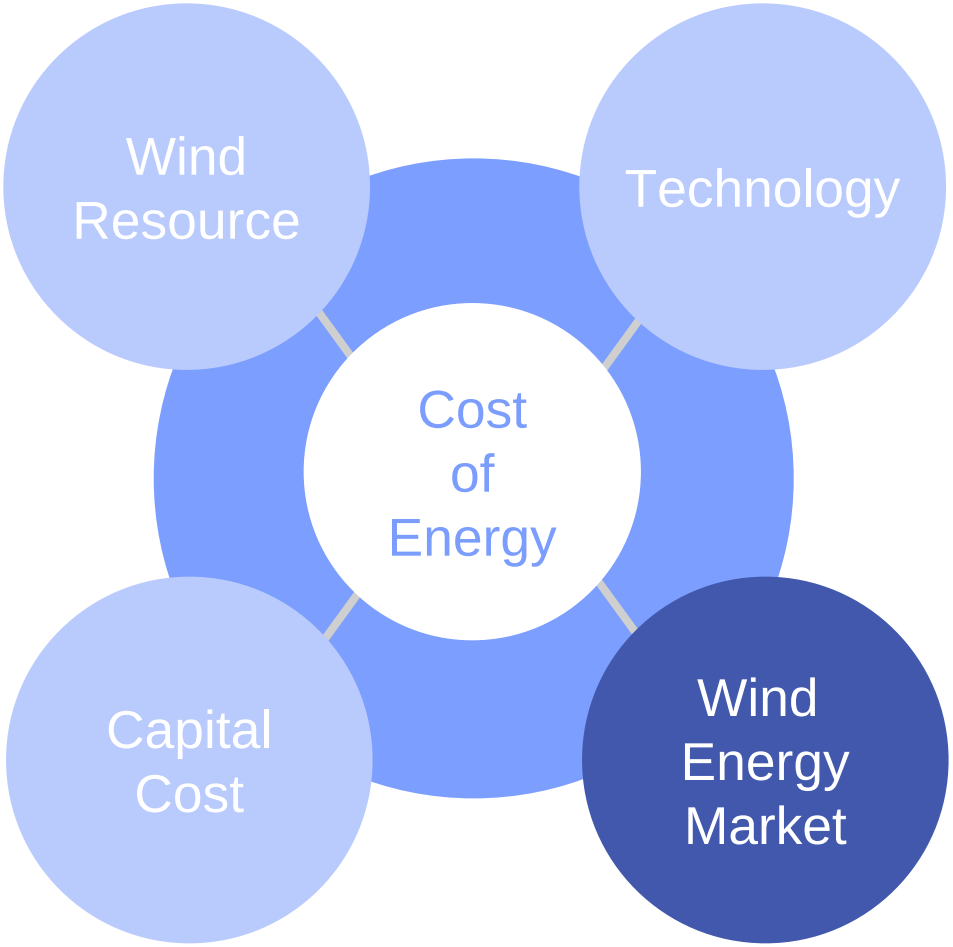
Project Finance Structure

On-shore
Wind Energy Facility
~ $1 ,200/kW





Growth Driven by Fundamentals
Wind Energy Market



Wind Energy Value Streams (US)

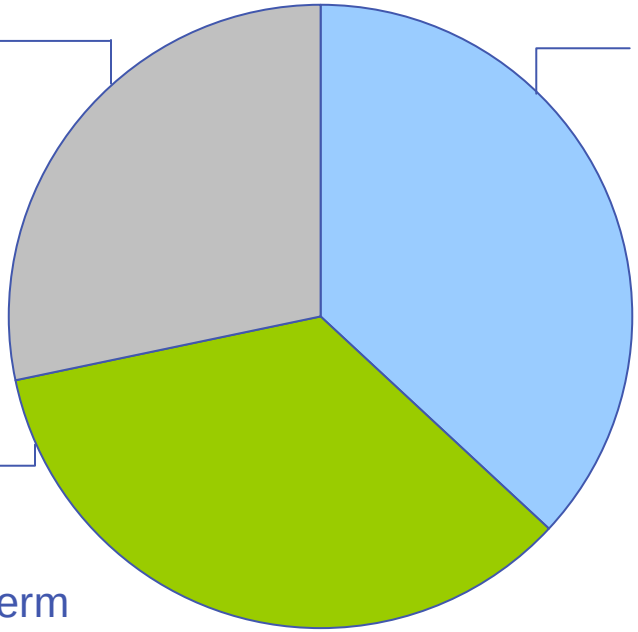
- Power Sale: $.035 - $.055 / KWh Levelized
- Production Tax Credit: $.018 / KWh after tax
- Renewable Attribute: Cash, Regulatory compliance,
- Mitigate future Carbon risks
- Accelerated Depreciation 5-Year MACRS

Wind Energy Value Streams (US)

% NPV Value of Equity Cash Flows[1]

Operations (28.3%)
- 20 year term

Production Tax Credit (36.9%)
- Requires tax appetite
- 10 year term



Depreciation (34.8%)
- Requires tax appetite
- Predominantly 5 year term

Equity cash flows require tax appetite
5 yrs – 60% 10yrs – 85%

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d) 90 MW project with $1.15 million/MW total cost
e) $25-30K Warranty and O&M/WTG/year
f) Discount rate = 10%

Summary: Wind Market is Strong and Growing

Economic Fundamentals Drive Growth

Wind is Reliable

- Wind resource is statistically predictable
- Today's wind turbines technology is reliable

Wind is economically sound and prudent

- Energy costs are fixed long term
- There is no fuel cost risk
- Wind energy COE is competitive in today's energy market

Local, national and world governments and the public are demanding cleaner, less risky energy technologies

Thank you!

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