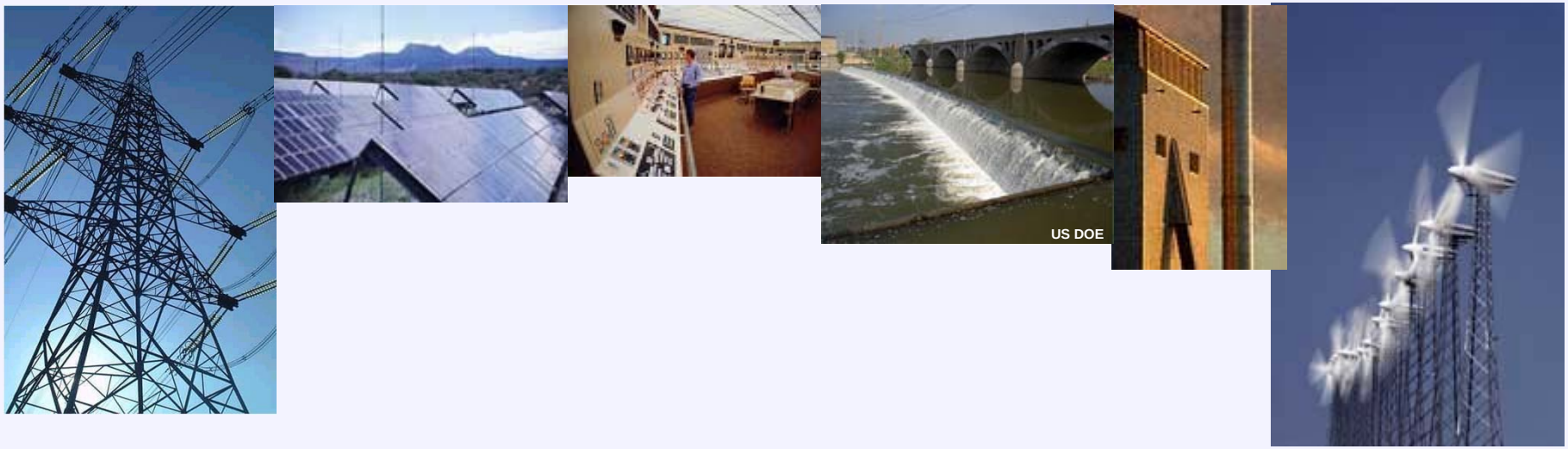


Trends and Issues in Renewable Energy

School of the Coast and Environment
Spring 2007 Seminar Series

May 4, 2007

David E. Dismukes
Center for Energy Studies
Louisiana State University

Overview of
Alternative Energy Generation

Types of Alternative Energy Generation

Hydroelectric

Biomass / Biogas

Wave Energy

Geothermal

Wind

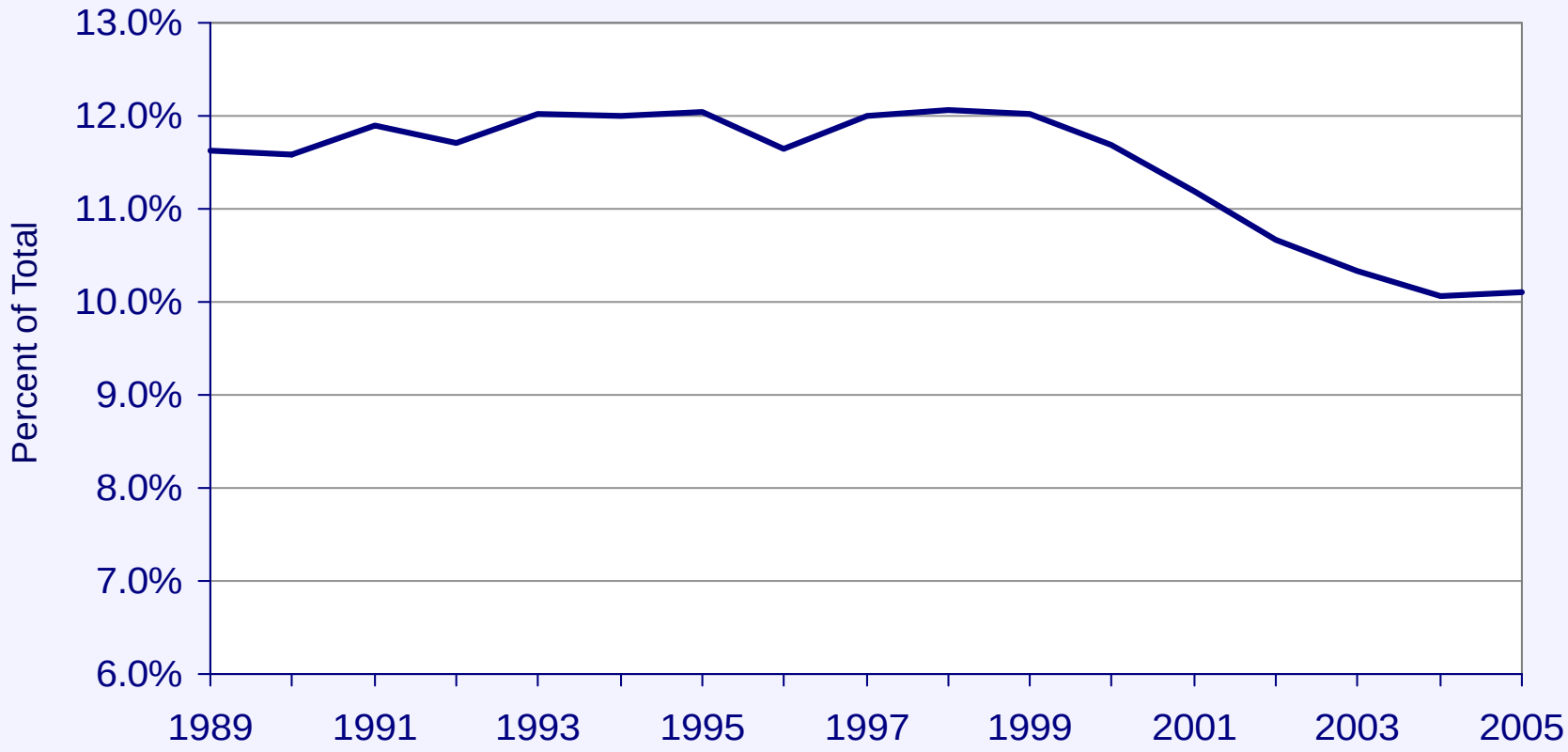
Solar

Renewable Energy Technologies

Renewable Energy Source	Generation Technology
Solar	Photovoltaic Thermal Energy Capture
Wind	Wind Turbines
Water	Hydroelectric Turbines
Ocean	Wave Energy Devices Tidal/Current Energy Turbines Thermal Energy Conversion
Geothermal	Steam Turbines Direct Use Geothermal Heat Pumps
Biomass	Combustion (direct fired, co-firing with coal Gasification / Pyrolysis
Biogas	Engine generators Combustion turbines Microturbines Fuel cells

Renewable Electricity Generation as a Share of Total US

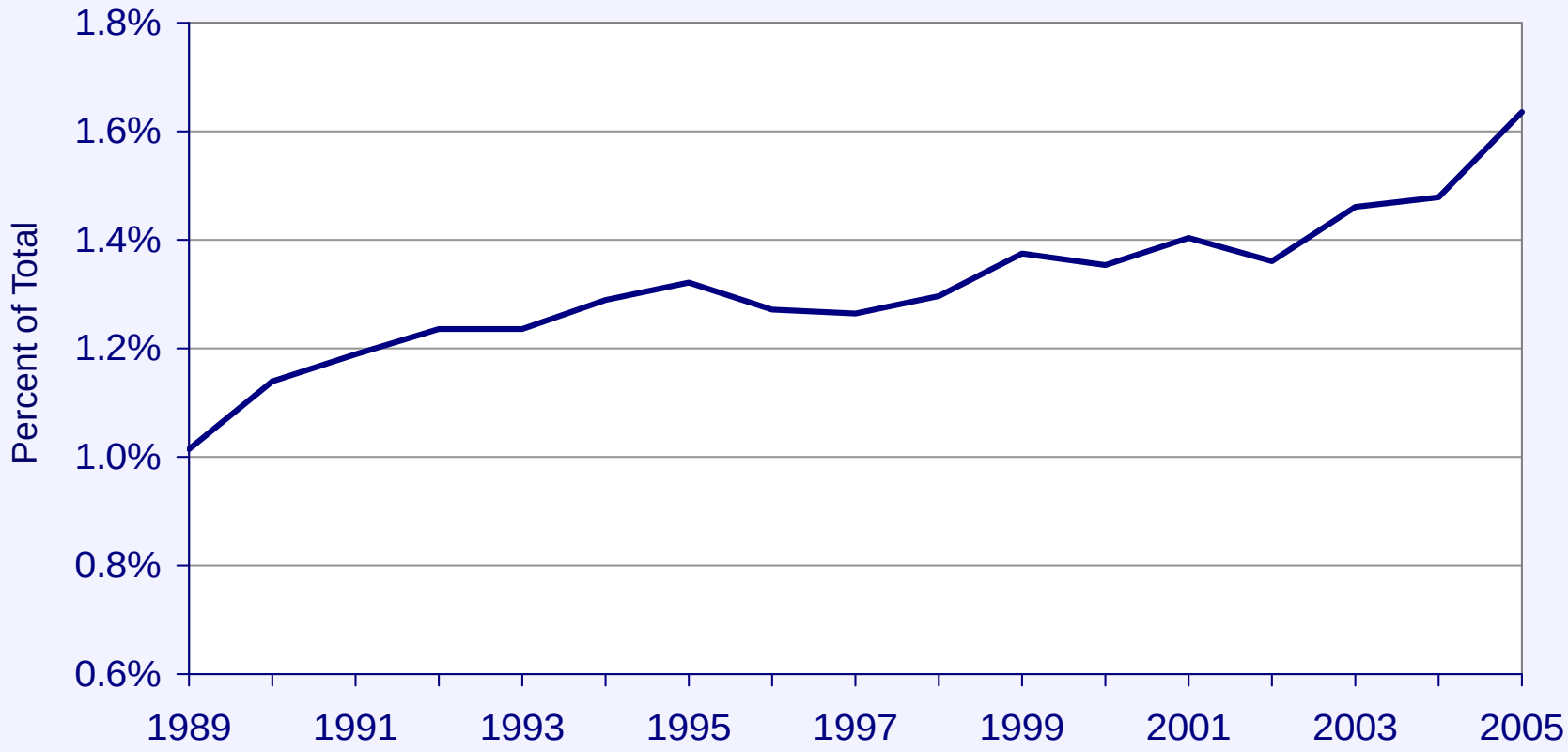
Renewable energy has fallen as a share of total U.S. power generation.



Source: Energy Information Administration, US Department of Energy

Non-hydroelectric Renewable Electricity Generation as a Share of Total US

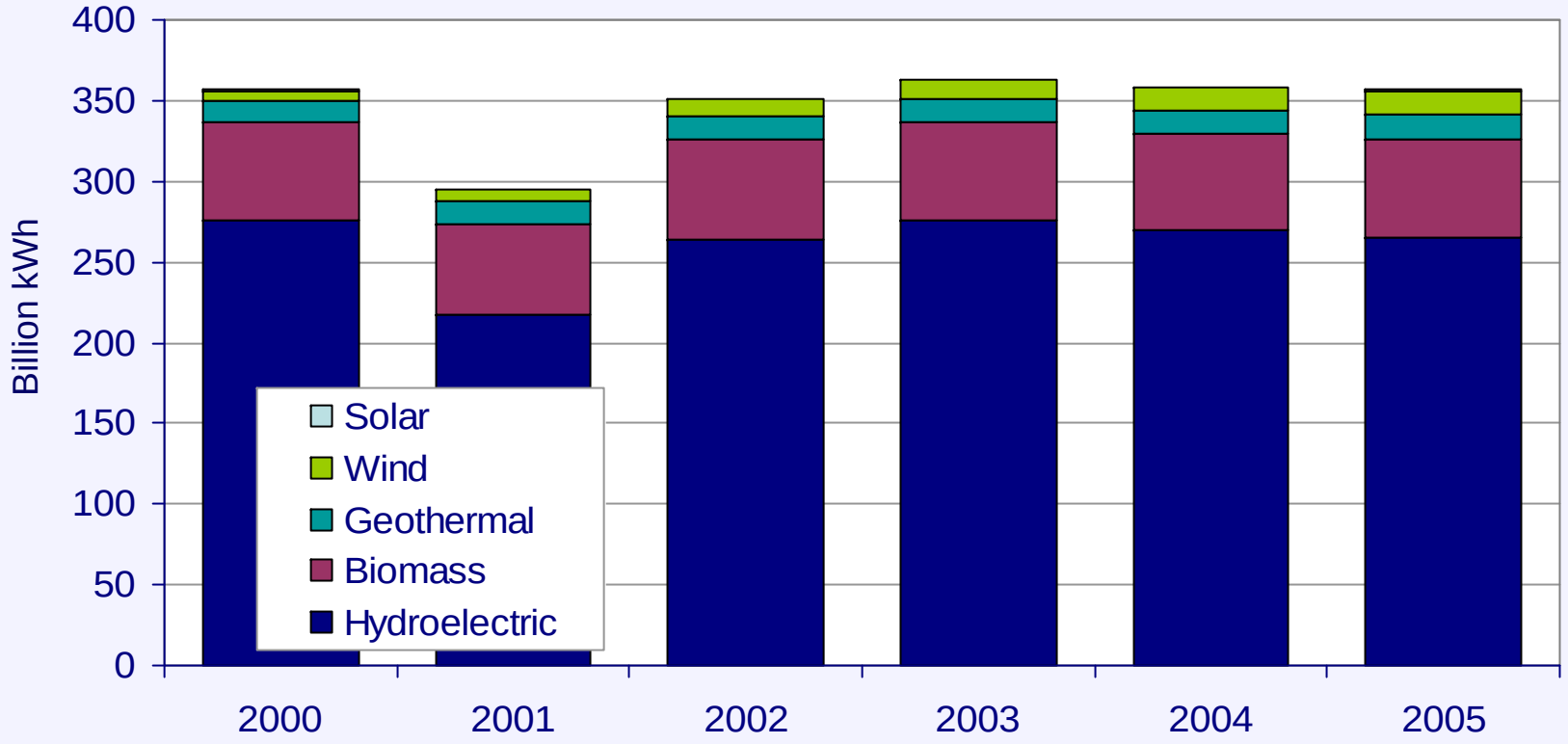
Non-hydroelectric renewable energy has increased as a share of total U.S. power generation.



Source: Energy Information Administration, US Department of Energy

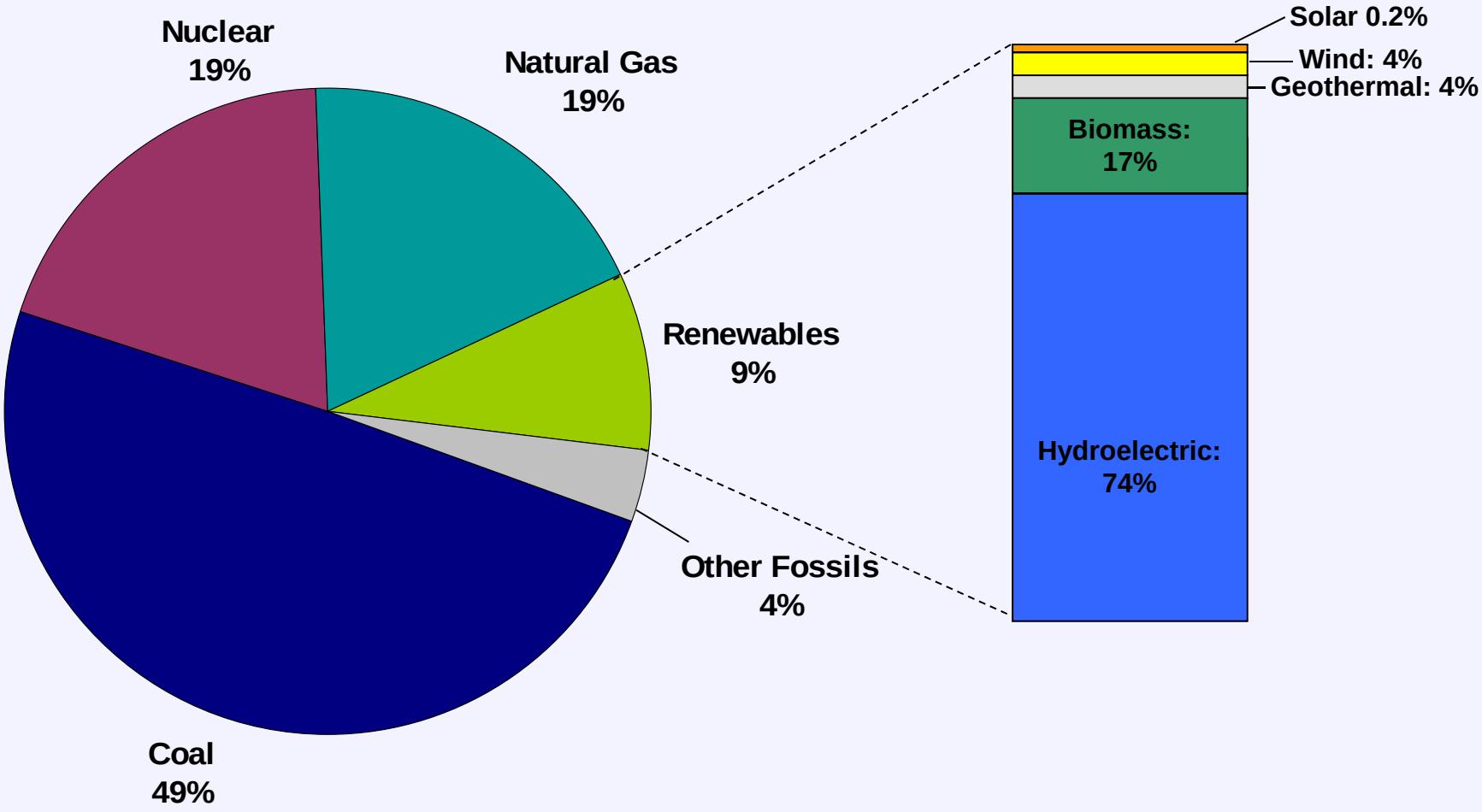
Electricity Net Generation from Renewable Energy

Current trends in renewable energy have been flat over the past several years and dominated by hydroelectric generation.



Source: Energy Information Administration, US Department of Energy

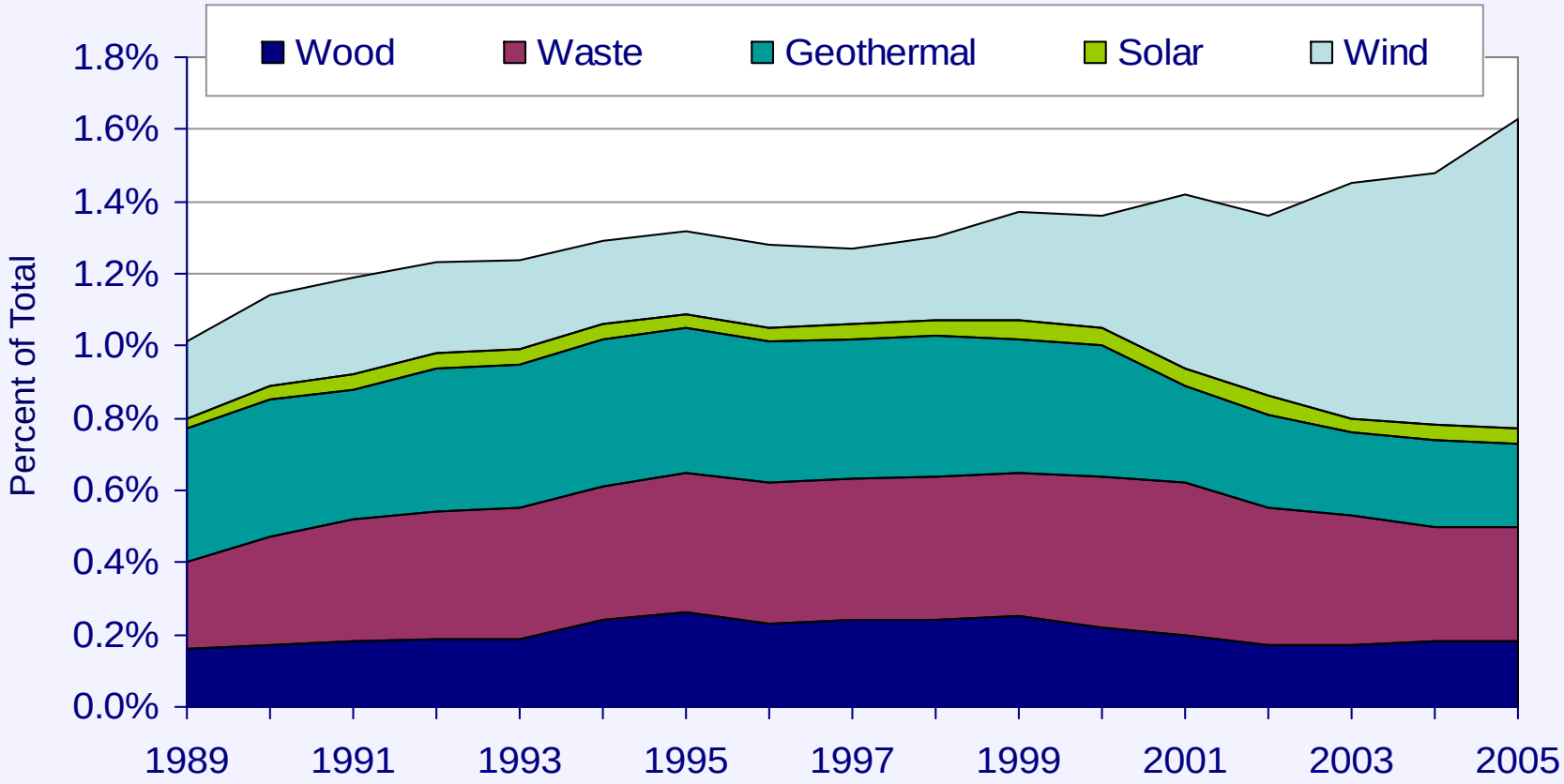
Alternative Generation as a Share of US Total, 2005



Source: Energy Information Administration, Department of Energy

Non-hydroelectric Renewable Electricity Generation as a Share of Total US

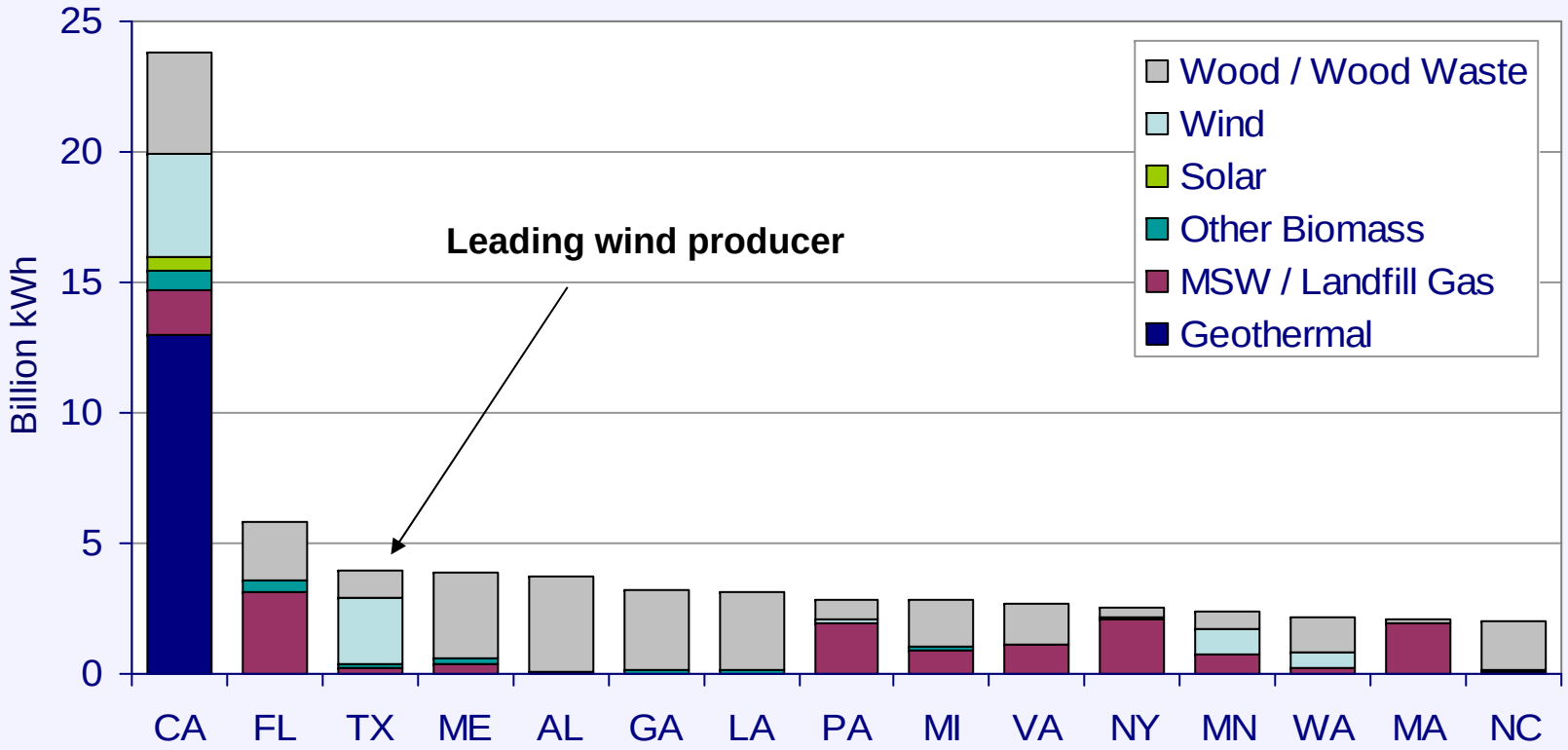
Wind energy is rapidly become the renewable energy resource of choice at the margin.



Source: Energy Information Administration, US Department of Energy

Top 15 States for Alternative Power Generation, 2003

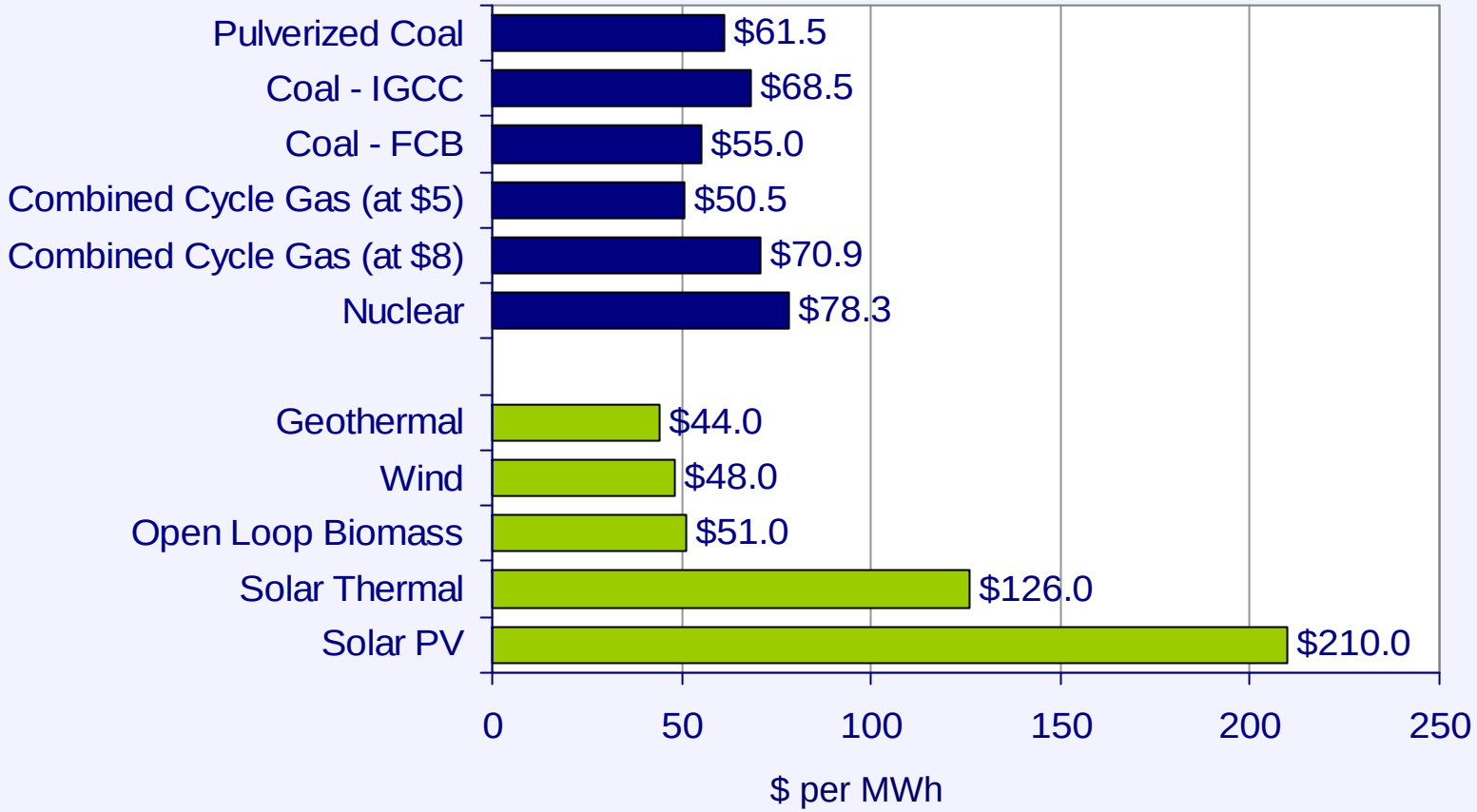
California leads the nation in renewable energy primarily because of its large geothermal resource.



Note: This excludes conventional hydroelectric generation.
Source: Energy Information Administration, US Department of Energy

National Average Levelized Generation Costs for New Plants

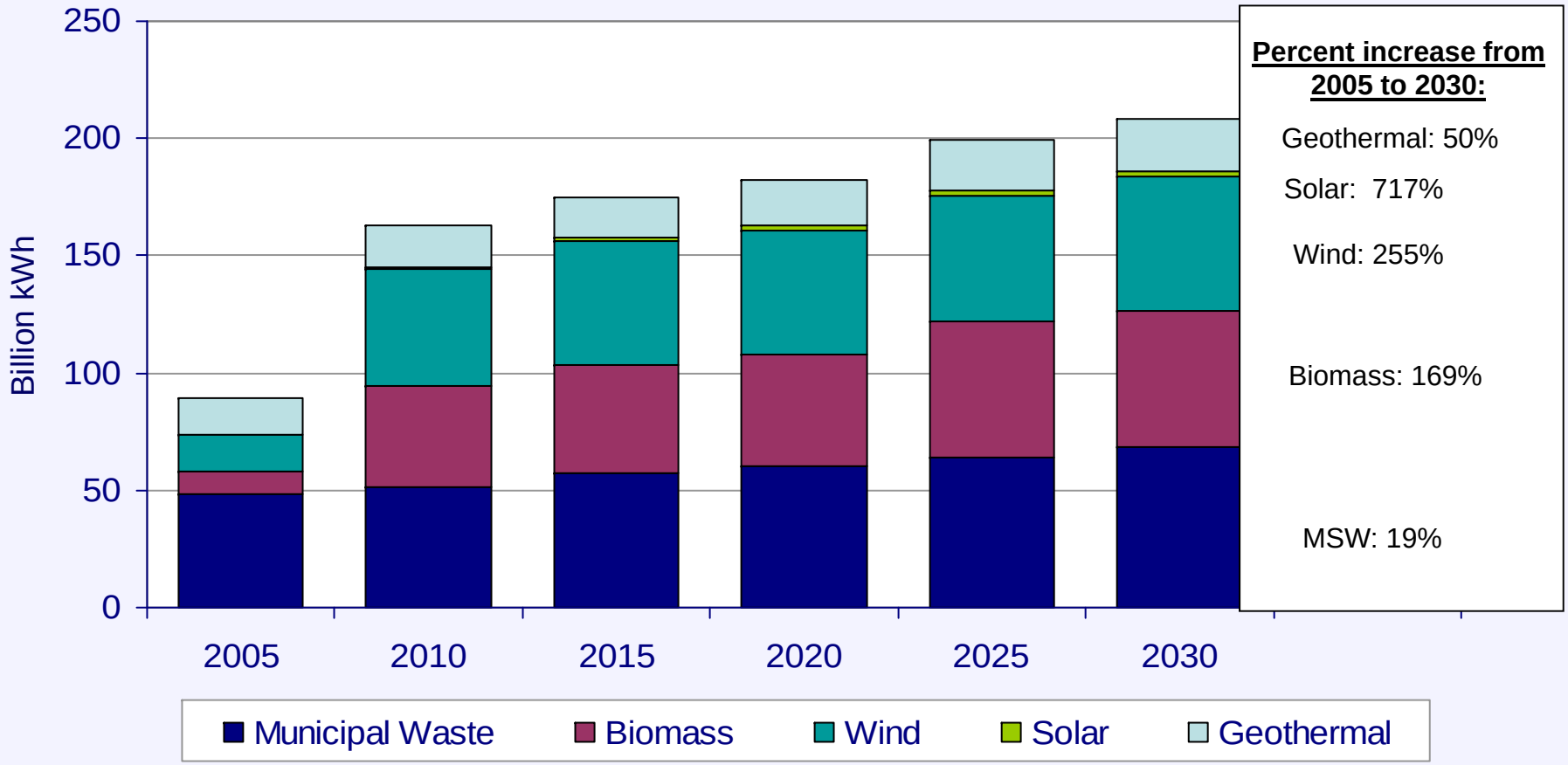
In market driven energy markets, costs drive technology development and implementation.



Source: Statement of Howard Gruenspecht, US DOE before the House Committee on Ways and Means, May 24, 2005

Projected Alternative Energy Generation

Alternative energy is expected to increase significantly in the next 25 years. Solar leads on percentage basis; wind leads on absolute basis.



Source: Energy Information Administration, Department of Energy

Projected Alternative Energy Costs, in 2003 Dollars

Costs are anticipated to fall considerably over the next several years as implementation increases.

Technology	Size (MW)	Levelized COE (cents/kWh)			
		2005	2008	2010	2017
Wind	75	4.1	3.4	3.3	2.7
Geothermal	50	5.3	5	4.9	4.5
Biomass	20	6.6	6.2	6.2	5.7
Solar PV	0.25	27.5	22.9	21.1	15.6

Source: Energy Information Administration, Department of Energy

Ranges of Investment and Generation Costs in 2002 and 2010

The key driver for renewable energy is installed costs (up-front capital investment), since fuel costs are close to zero.

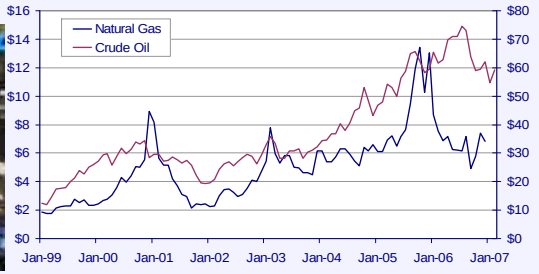
	Low Investment Costs ($/kW)		High Investment Costs ($/kW)		Low Generation Costs ($/kW)		High Generation Costs ($/kW)	
	2002	2010	2002	2010	2002	2010	2002	2010
Small Hydro Power	$ 1,000	$ 950	$ 5,000	$ 4,500	$ 2-3	$ 2	$ 9-15	$ 8-13
Solar Photovoltaic Power	$ 4,500	$ 3,000	$ 7,000	$ 4,500	$ 18-20	$ 10-15	$ 25-80	$ 18-40
Concentrating Solar Power	$ 3,000	$ 2,000	$ 5,000	$ 4,000	$ 10-15	$ 6-8	$ 20-25	$ 10-12
Biopower	$ 500	$ 400	$ 4,000	$ 3,000	$ 2-3	$ 2	$ 10-15	$ 8-12
Geothermal Power	$ 1,200	$ 1,000	$ 5,000	$ 3,500	$ 2-5	$ 2-3	$ 6-12	$ 5-10
Wind Power	$ 850	$ 700	$ 1,700	$ 1,300	$ 3-5	$ 2-4	$ 10-12	$ 6-9

Note: Discount rate is 6 percent for all technologies; amortization period is 15-25 years, and operation and maintenance costs are technology-specific.

Source: International Energy Agency

Factors Driving Alternative Energy Development

- **High Fossil Fuel Prices**

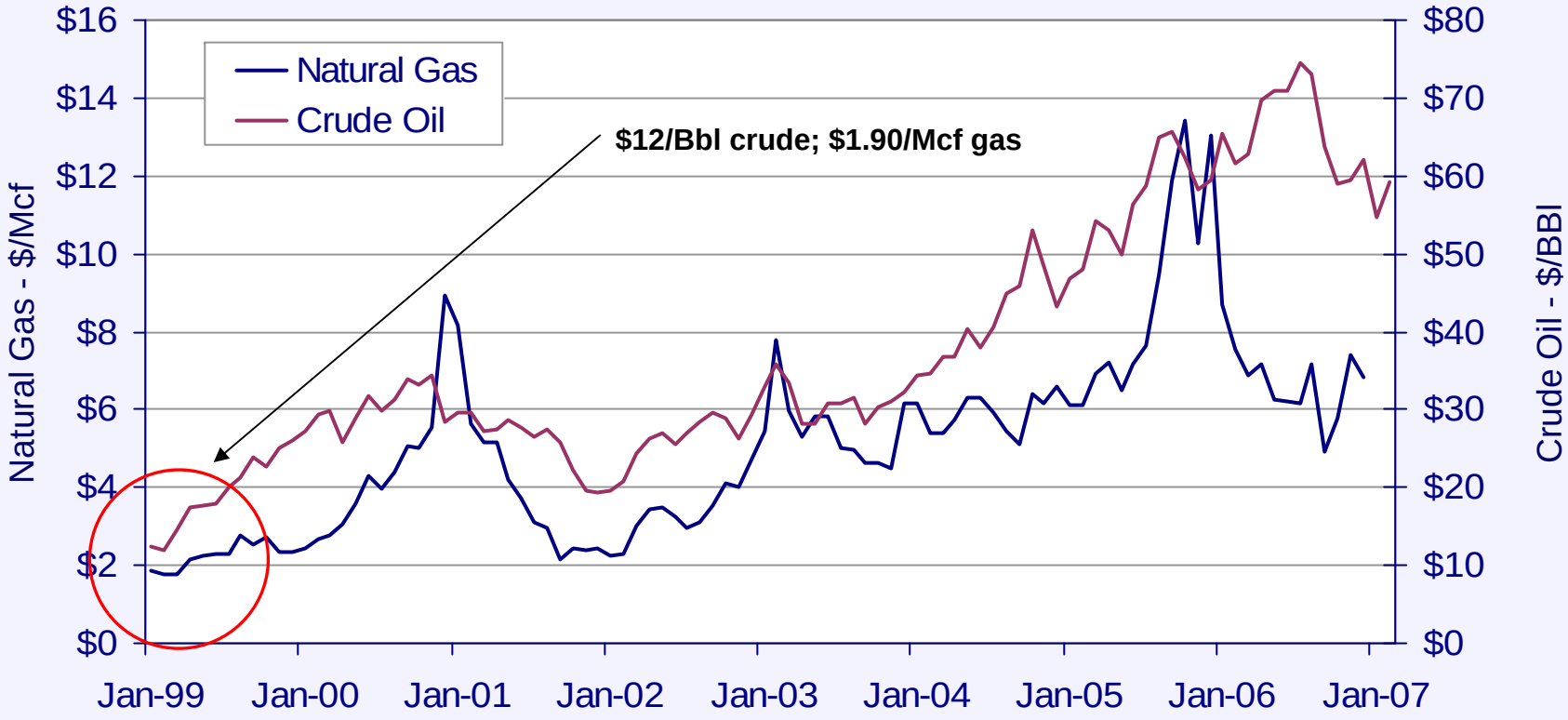


- **Energy Security**

- **Climate Change**

Recent Trends in Crude Oil and Natural Gas Prices

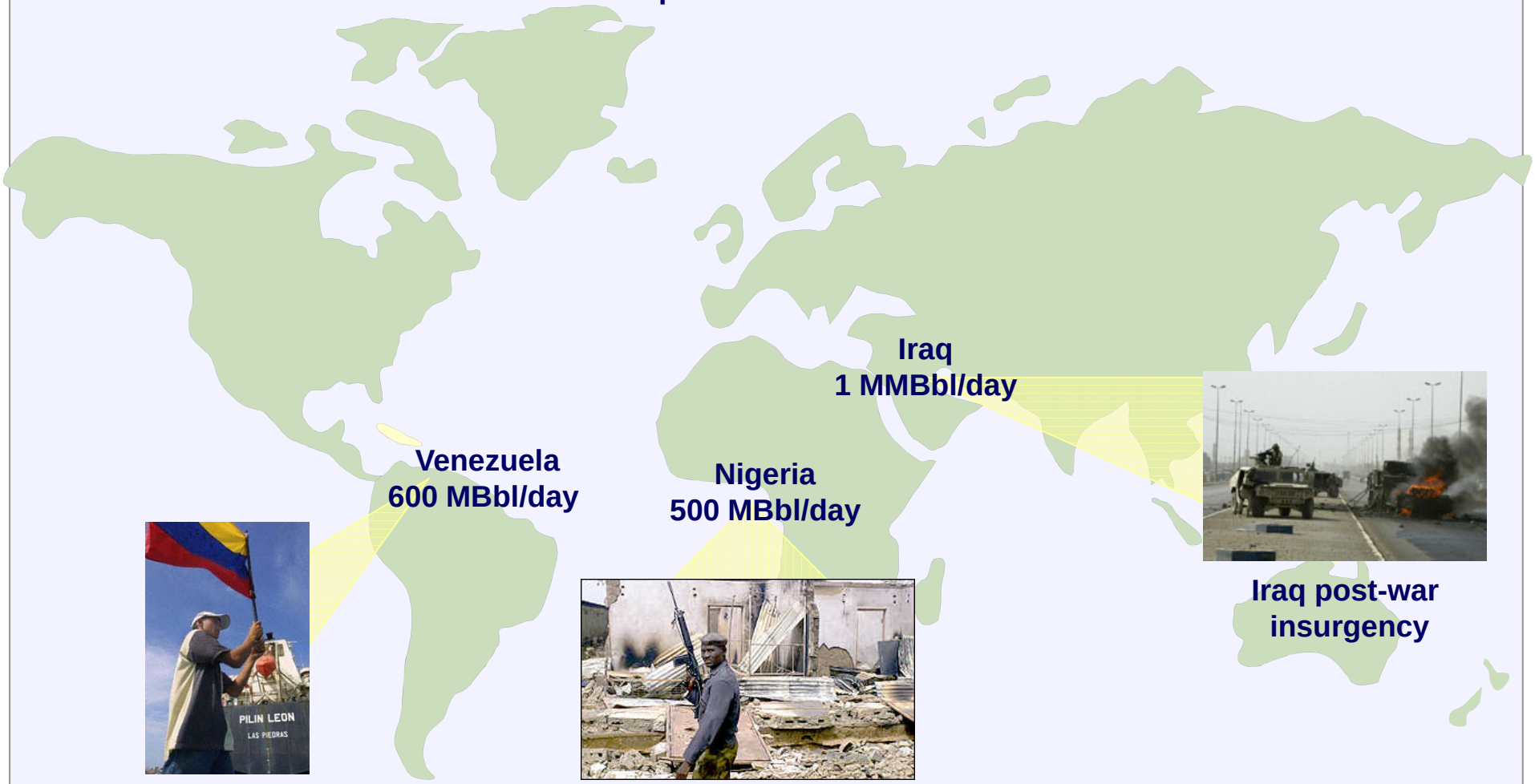
Rapid fossil fuel increases have created favorable economics for renewable resources.



Source: Federal Reserve Bank of St. Louis

Impact of Shut-in Production Worldwide

Total of Potential from Shut-in Production: 2.1 MMBbl/d
Forecast World Consumption Growth for 2006: 1.6 MMBbl/d
Forecast World Consumption Growth for 2007: 1.8 MMBbl/d



Iraq
1 MMBbl/day

Venezuela
600 MBbl/day

Nigeria
500 MBbl/day

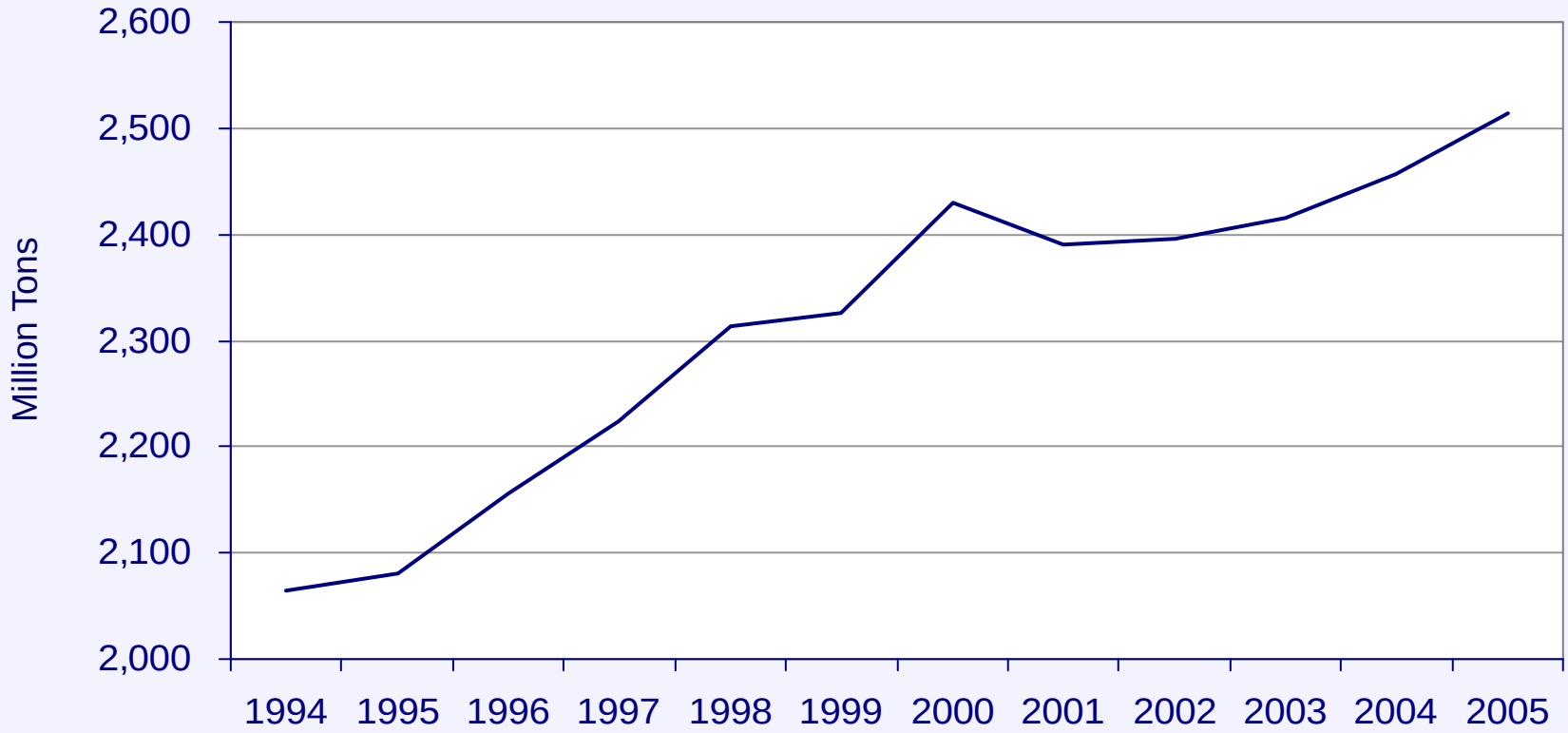
Venezuelan oil strike

Nigerian civil strife

Iraq post-war insurgency

Global Climate Change – Power Industry
Carbon Dioxide Emissions

Carbon dioxide emissions in the power industry alone have increased 22 percent since 1994.



Note: includes emissions from conventional power plants and combined-heat-and-power plants.
Source: Energy Information Administration, US Department of Energy

Global Climate Change – Policy and Legal Decisions

Recent activities have dramatically shifted the outlook for power generation.

IPCC Report

- An international network of climate change scientists has concluded for the first time that global warming is "unequivocal" and that human activity is the main driver, "very likely" causing most of the rise in temperatures since 1950.

Supreme Court Decision

Commonwealth of Massachusetts et al. v. Environmental Protection Agency et al .

- Issue: is carbon dioxide a pollutant that should be regulated by the EPA
- The EPA argued that carbon dioxide is not a pollutant; it does not have the authority to regulate
- The Court ruled that the Clean Air Act gives the Environmental Protection Agency the authority to regulate the emissions of carbon dioxide and other greenhouse gases from cars.

D.C. Circuit Court

Coke Oven Environmental Taskforce v. Environmental Protection Agency et al

- The EPA has failed to regulate carbon dioxide from new coal-fired power plants
- Likely to be influenced by Massachusetts Supreme Court decision.

19

Mechanisms Facilitating Development

- **Voluntary Markets for Alternative Energy:** renewable energy attributes are now assigned property rights and can be traded.
- **Power System Bypass:** interesting getting off the grid.
- **Federal Tax Credits:** several statutes offering tax incentives.
- **Renewable Portfolio Standards:** state-level renewable generation mandates.

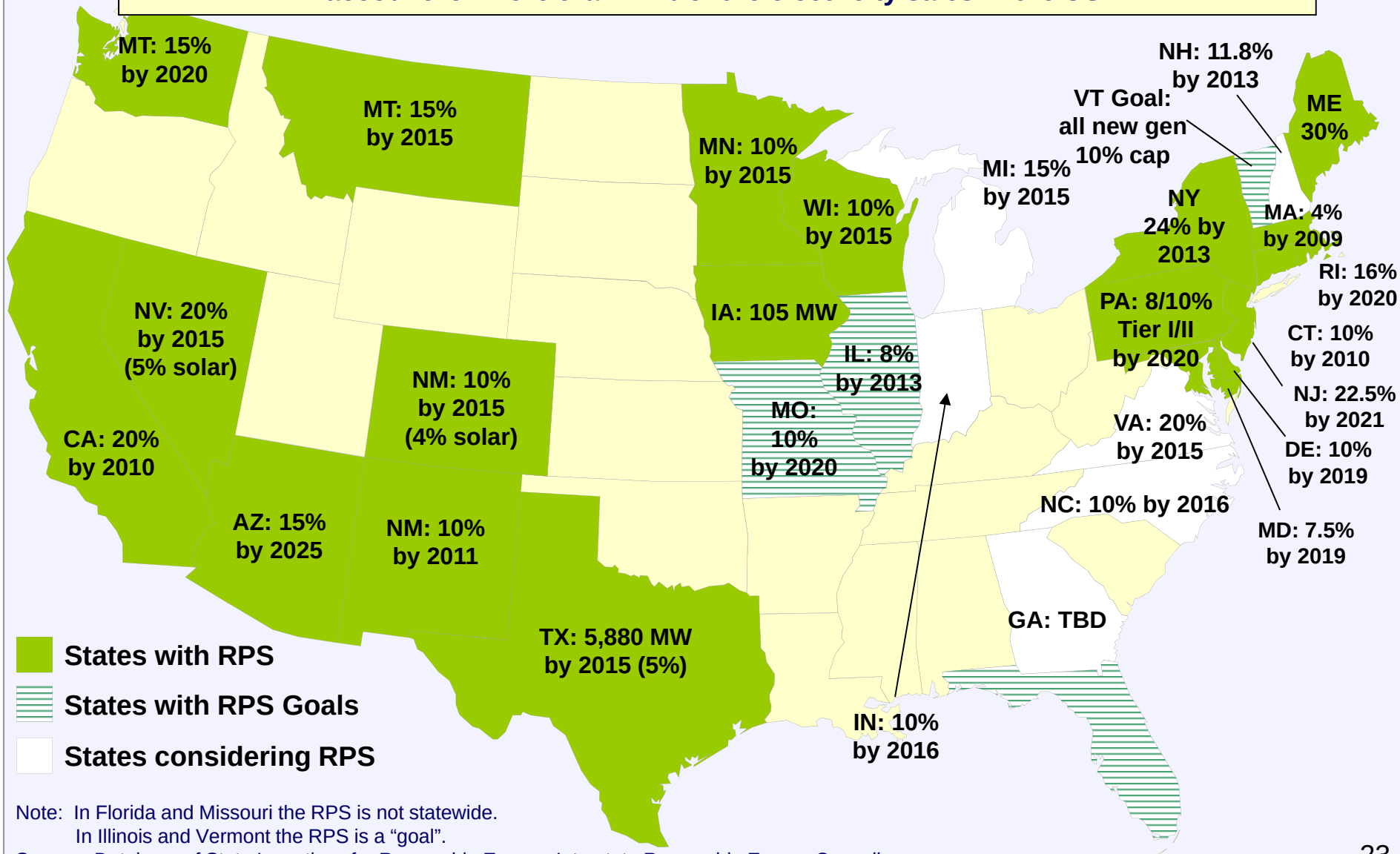
Policy Mechanisms for Alternative Energy

What is an RPS?

A renewable portfolio standard (RPS) is a state policy that requires electricity providers to obtain a minimum percentage of their power from renewable energy resources by a certain date.

States with Renewable Portfolio Standards

Currently there are 20 states that have RPS policies in place. Together these states account for more than 42% of the electricity sales in the US.

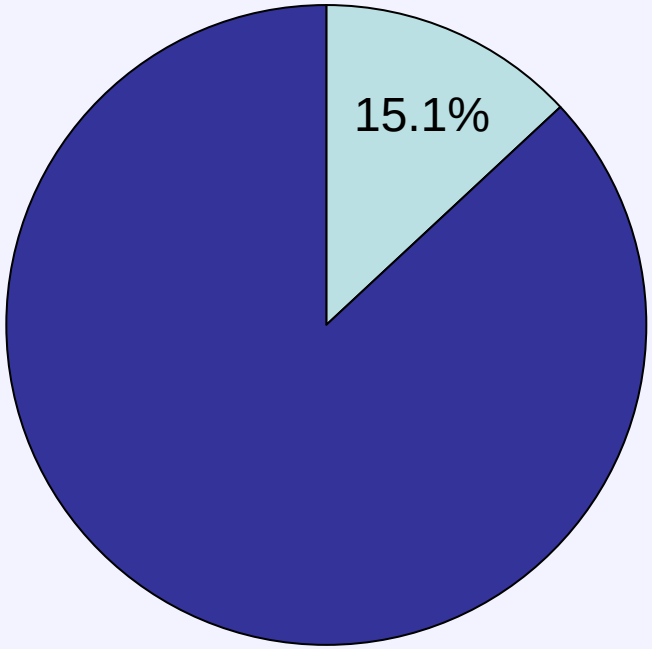


Note: In Florida and Missouri the RPS is not statewide.
In Illinois and Vermont the RPS is a "goal".

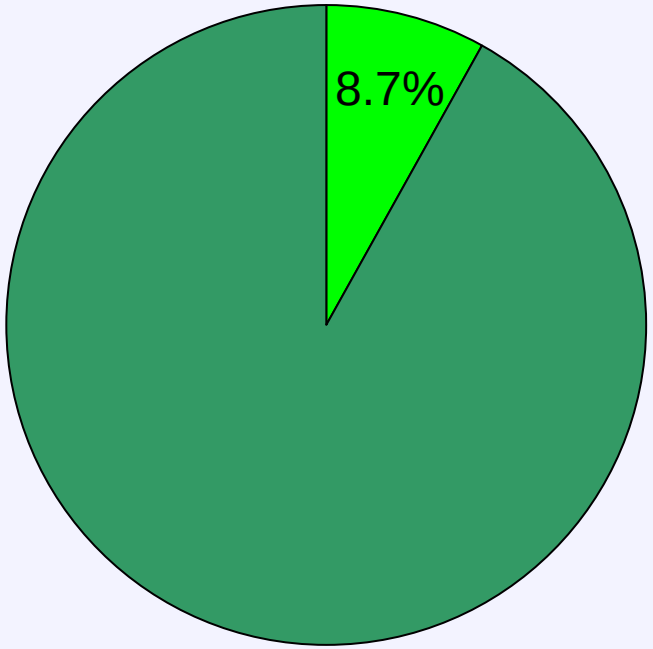
Source: Database of State Incentives for Renewable Energy, Interstate Renewable Energy Council.

Anticipated Generation from RPS Adopting States by 2025

RPS Mandated Generation as a Share of Generation in RPS States



RPS Mandated Generation as a Share of Total US Generation



Note: assumes generation growth of 1 percent per year in each state.
Source: Energy Information Administration, US Department of Energy

What is a REC?

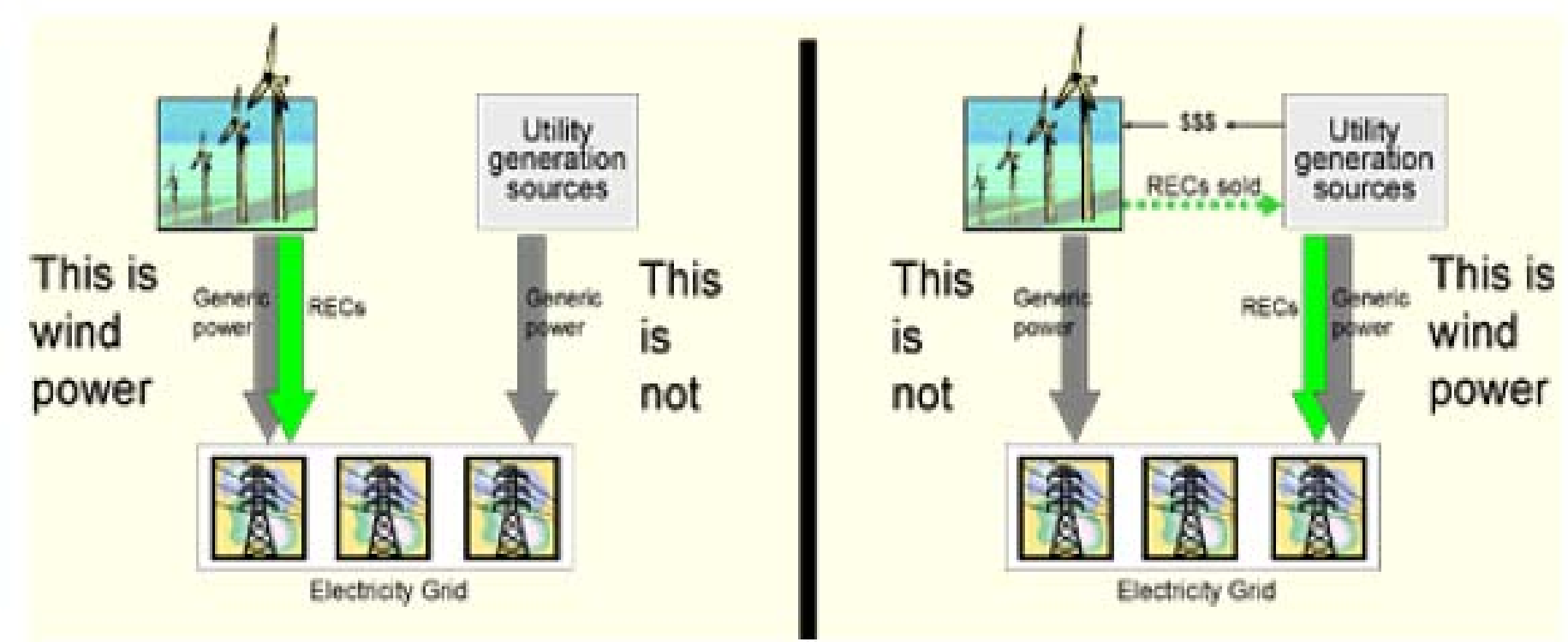
"Renewable Energy Certificates" (RECs), also known as "green tags" or "Tradable Renewable Certificates" (TRCs), are the property rights to the environmental benefits from generating electric from renewable energy sources.

These certificates can be sold and traded and the owner of the REC can legally claim to have purchased renewable energy.

Thought of as "market-based" approach to promoting renewable energy.

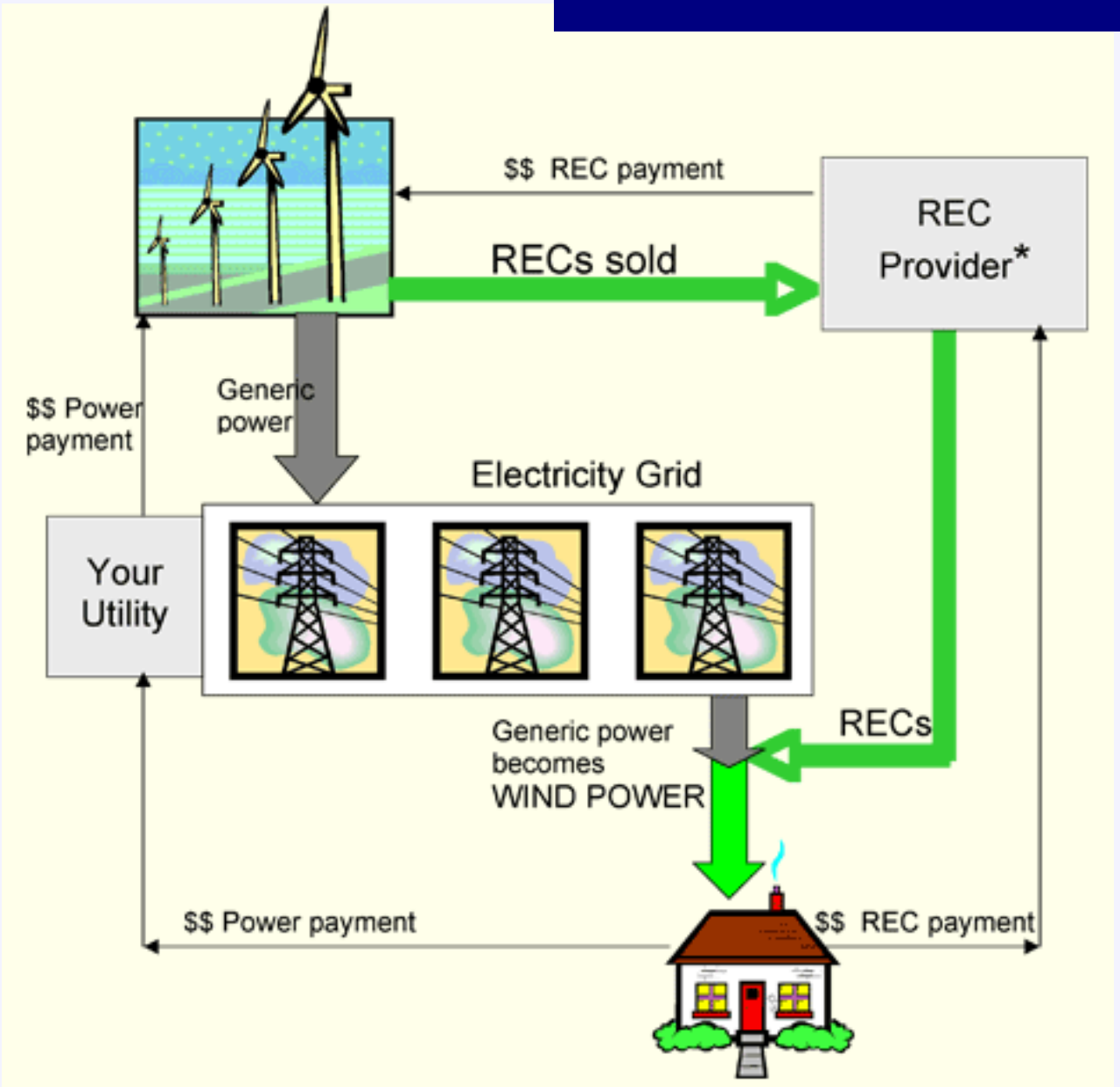
How RECs Change the Nature of "Green Transactions"

A REC creates a financial approach to facilitating renewable energy that can be distinctly different than the actual physical nature of how power is generated.



Source: nativeenergy.com

Wholesale REC Transactions



Source: nativeenergy.com

Current Federal Tax Breaks
Corporate / Commercial

Incentive	Description
Corporate Depreciation	• Modified Accelerated Cost-Recovery System
Corporate Exemption	• Residential Energy Conservation Subsidy Exclusion (Corporate)
Corporate Tax Credit	• Business Energy Tax Credit • Renewable Energy Production Tax Credit
Federal Grant Program	• Tribal Energy Program Grant • USDA Renewable Energy Systems Improvements Program
Federal Loan Program	• USDA Renewable Energy Systems Improvements Program
Production Incentive	• Renewable Energy Production Incentive (REPI)

Current Federal Tax Breaks
Residential / Personal

Incentive	Description
Federal Loan Program	• Energy Efficient Mortgage
Personal Exemption	• Residential Energy Conservation Subsidy Exclusion (Personal)
Personal Tax Credit	• Residential Energy Efficiency Tax Credit • Residential Solar and Fuel Cell Tax Credit

Example of Tax Breaks on Project Economics (Using Straight Depreciation)

Proforma for development of 100 kW commercial solar application with REC market support only.

Proforma

	Years: 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Net Investment Year-End	$ 626,267	581,533	536,800	492,067	447,333	402,600	357,867	313,133	268,400	223,667	178,933	134,200	89,467	44,733	-
2. Average Net Investment	$ 648,633	603,900	559,167	514,433	469,700	424,967	380,233	335,500	290,767	246,033	201,300	156,567	111,833	67,100	22,367
3. Annual Generation (kWh)	131,400	131,400	131,400	131,400	131,400	131,400	131,400	131,400	131,400	131,400	131,400	131,400	131,400	131,400	131,400
4. Variable O&M ($ 2006)	$ 1,325	1,325	1,325	1,325	1,325	1,325	1,325	1,325	1,325	1,325	1,325	1,325	1,325	1,325	1,325
5. Total Cost	**$ 1,325**	**1,325**	**1,325**	**1,325**	**1,325**	**1,325**	**1,325**	**1,325**	**1,325**	**1,325**	**1,325**	**1,325**	**1,325**	**1,325**	**1,325**
6. Avoided Generation Cost	$ 14,309	14,309	14,309	14,309	14,309	14,309	14,309	14,309	14,309	14,309	14,309	14,309	14,309	14,309	14,309
7. SREC Prices	$ 630	624	617	611	605	599	593	587	581	576	570	564	558	553	547
8. SREC Revenues	$ 82,782	81,954	81,135	80,323	79,520	78,725	77,938	77,158	76,387	75,623	74,867	74,118	73,377	72,643	71,917
9. SREC After Financing Disc.	$ 82,782	81,954	81,135	80,323	79,520	78,725	77,938	77,158	76,387	75,623	74,867	74,118	73,377	72,643	71,917
10. Total Revenue	**$ 97,091**	**96,264**	**95,444**	**94,633**	**93,830**	**93,034**	**92,247**	**91,468**	**90,696**	**89,932**	**89,176**	**88,427**	**87,686**	**86,952**	**86,226**
11. Net Operating Income	**$ 53,739**	**51,526**	**49,369**	**48,210**	**47,058**	**45,913**	**44,776**	**43,646**	**42,522**	**41,406**	**40,297**	**39,194**	**38,099**	**37,010**	**35,927**
12. Depreciation - Straight	$ 44,733	44,733	44,733	44,733	44,733	44,733	44,733	44,733	44,733	44,733	44,733	44,733	44,733	44,733	44,733
13. Depreciation - MACRS	$ -	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14. Cumulative Depreciation	$ 44,733	89,467	134,200	178,933	223,667	268,400	313,133	357,867	402,600	447,333	492,067	536,800	581,533	626,267	671,000
15. Finance/Interest Expense	$ 64,863	60,390	55,917	51,443	46,970	42,497	38,023	33,550	29,077	24,603	20,130	15,657	11,183	6,710	2,237
16. Taxable Depreciation (Straight)	$ 38,023	38,023	38,023	38,023	38,023	38,023	38,023	38,023	38,023	38,023	38,023	38,023	38,023	38,023	38,023
17. Taxable Depreciation (MACRS)	$ -	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18. Income Taxes	$ (2,705)	(1,320)	68	1,460	2,854	4,252	5,653	7,057	8,463	9,873	11,285	12,701	14,119	15,540	16,964
19. Tax Credit - Carryforward	$ 201,300	201,300	201,249	200,154	198,013	194,824	190,584	185,292	178,945	171,540	163,076	153,551	142,961	131,306	118,584
20. Taxes with Credit	$ (2,705)	(1,320)	17	365	714	1,063	1,413	1,764	2,116	2,468	2,821	3,175	3,530	3,885	4,241
21. Net Income	**$ (11,124)**	**(8,864)**	**(6,547)**	**(3,233)**	**88**	**3,417**	**6,753**	**10,096**	**13,446**	**16,803**	**20,167**	**23,538**	**26,915**	**30,300**	**33,691**
22. Cash Flow	**$ 33,609**	**35,869**	**38,186**	**41,500**	**44,821**	**48,150**	**51,486**	**54,829**	**58,179**	**61,536**	**64,900**	**68,271**	**71,649**	**75,033**	**78,424**
23. Internal Rate of Return	**2.4%**														

Internal rates of return are low using REC support only

Note: Assumes a 100kW unit with a 15% capacity factor and capital cost of $6,710/kW.

Example of Tax Breaks on Project Economics (Using MACRS Depreciation)

Proforma for development of 100 kW commercial solar application with REC market support and depreciation allowance.

Proforma

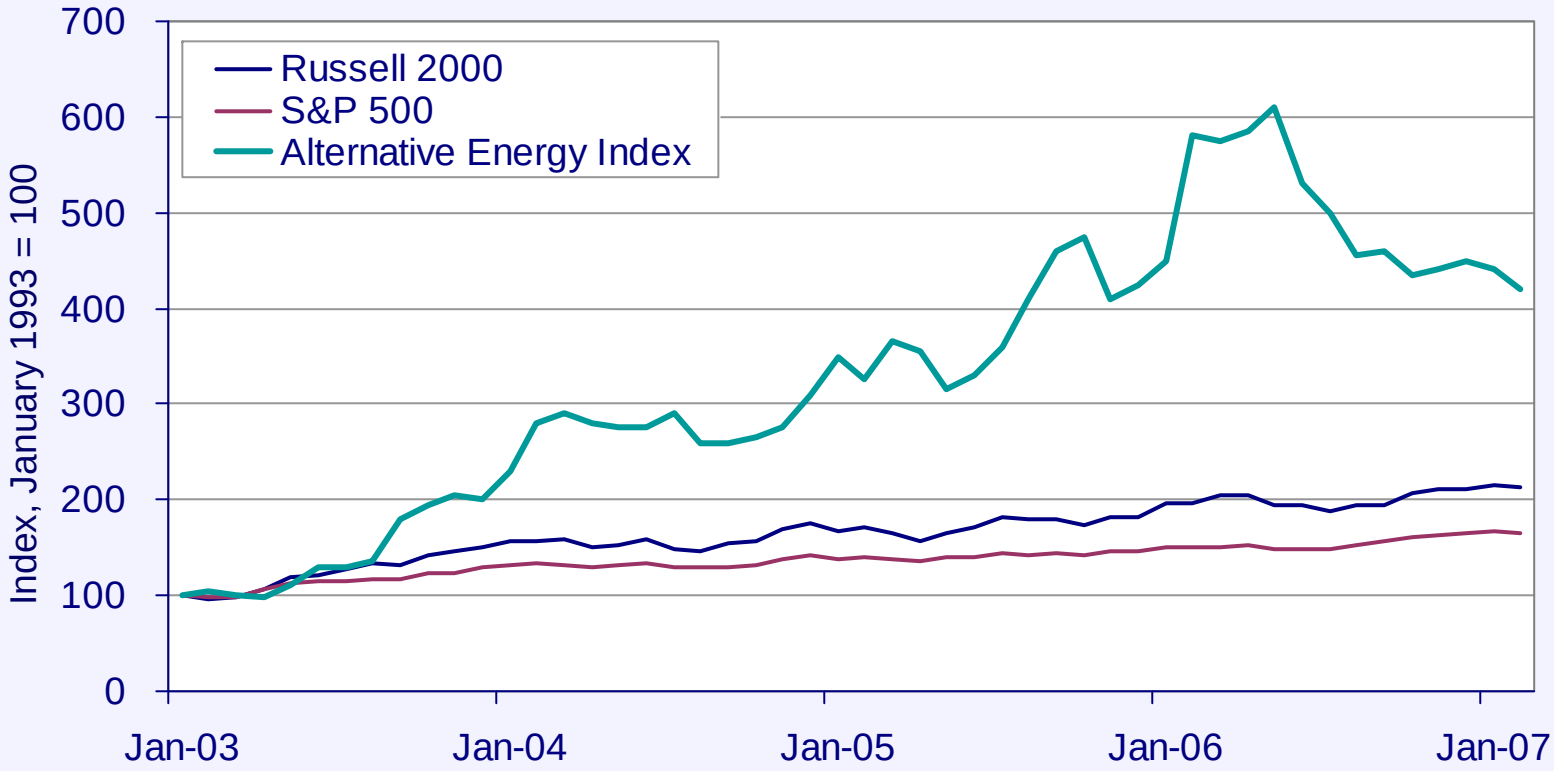
	Years: 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Net Investment Year-End	$ 536,800	402,600	268,400	134,200	-	-	-	-	-	-	-	-	-	-	-
2. Average Net Investment	$ 603,900	469,700	335,500	201,300	67,100	-	-	-	-	-	-	-	-	-	-
3. Annual Generation (kWh)	131,400	131,400	131,400	131,400	131,400	131,400	131,400	131,400	131,400	131,400	131,400	131,400	131,400	131,400	131,400
4. Variable O&M ($ 2006)	$ 1,325	1,325	1,325	1,325	1,325	1,325	1,325	1,325	1,325	1,325	1,325	1,325	1,325	1,325	1,325
5. Total Cost	**$ 1,325**	**1,325**	**1,325**	**1,325**	**1,325**	**1,325**	**1,325**	**1,325**	**1,325**	**1,325**	**1,325**	**1,325**	**1,325**	**1,325**	**1,325**
6. Avoided Generation Cost	$ 14,309	14,309	14,309	14,309	14,309	14,309	14,309	14,309	14,309	14,309	14,309	14,309	14,309	14,309	14,309
7. SREC Prices	$ 630	624	617	611	605	599	593	587	581	576	570	564	558	553	547
8. SREC Revenues	$ 82,782	81,954	81,135	80,323	79,520	78,725	77,938	77,158	76,387	75,623	74,867	74,118	73,377	72,643	71,917
9. SREC After Financing Disc.	$ 82,782	81,954	81,135	80,323	79,520	78,725	77,938	77,158	76,387	75,623	74,867	74,118	73,377	72,643	71,917
10. Total Revenue	**$ 97,091**	**96,264**	**95,444**	**94,633**	**93,830**	**93,034**	**92,247**	**91,468**	**90,696**	**89,932**	**89,176**	**88,427**	**87,686**	**86,952**	**86,226**
11. Net Operating Income	**$ 125,670**	**120,057**	**114,450**	**108,847**	**103,250**	**82,997**	**82,285**	**81,580**	**80,881**	**80,190**	**79,506**	**78,828**	**53,544**	**53,089**	**52,639**
12. Depreciation - Straight	$ -	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13. Depreciation - MACRS	$ 134,200	134,200	134,200	134,200	134,200	-	-	-	-	-	-	-	-	-	-
14. Cumulative Depreciation	$ 134,200	268,400	402,600	536,800	671,000	671,000	671,000	671,000	671,000	671,000	671,000	671,000	671,000	671,000	671,000
15. Finance/Interest Expense	$ 60,390	46,970	33,550	20,130	6,710	-	-	-	-	-	-	-	-	-	-
16. Taxable Depreciation (Straight)	$ -	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17. Taxable Depreciation (MACRS)	$ 114,070	114,070	114,070	114,070	114,070	-	-	-	-	-	-	-	-	-	-
18. Income Taxes	$ (29,903)	(25,118)	(20,330)	(15,539)	(10,744)	34,850	34,551	34,254	33,961	33,671	33,384	33,099	32,817	32,539	32,263
19. Tax Credit - Carryforward	$ 201,300	201,300	201,300	201,300	201,300	175,163	149,250	123,559	98,088	72,835	47,797	22,973	(1,640)	(26,044)	(50,241)
20. Taxes with Credit	$ (29,903)	(25,118)	(20,330)	(15,539)	(10,744)	8,712	8,638	8,564	8,490	8,418	8,346	8,275	32,817	32,539	32,263
21. Net Income	**$ 65,280**	**73,087**	**80,900**	**88,717**	**96,540**	**82,997**	**82,285**	**81,580**	**80,881**	**80,190**	**79,506**	**78,828**	**53,544**	**53,089**	**52,639**
22. Cash Flow	**$ 199,480**	**207,287**	**215,100**	**222,917**	**230,740**	**82,997**	**82,285**	**81,580**	**80,881**	**80,190**	**79,506**	**78,828**	**53,544**	**53,089**	**52,639**
23. Internal Rate of Return	**24.5%**														

Internal rates of return changed considerably

Note: Assumes a 100kW unit with a 15% capacity factor and capital cost of $6,710/kW.

Alternative Energy Stocks vs. Russell 2000 and S&P 500

Wall Street is certainly placing increasing value on alternative energy.



Source: Federal Reserve Bank of St. Louis

Ongoing Challenges for Alternative Energy Development

Ongoing Challenges for Alternative Energy Development

- **Cost Issues:** what will be the nature of ongoing cost trends in light of past performance.

- **Dispatch / Availability Issues:** Ongoing challenges for renewable energy for both short term dispatch and long term planning.

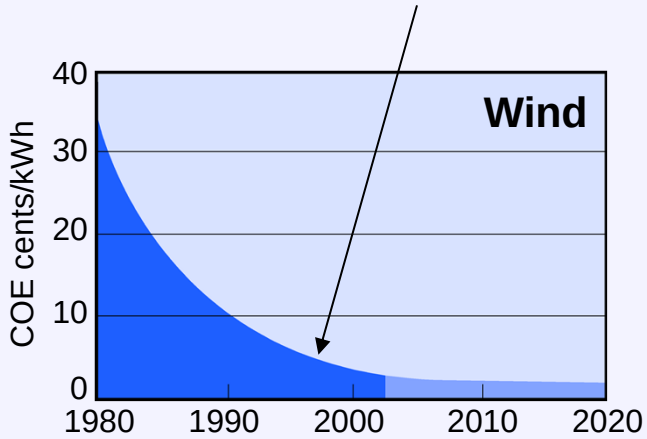
- **REC Property Right Issues:** Who owns environmental attributes of existing resources contracted to utilities.

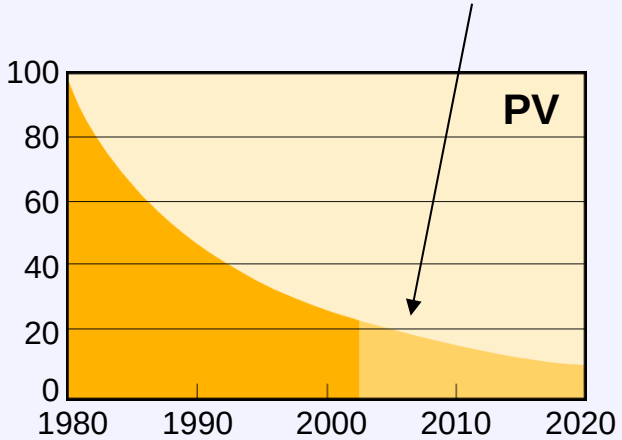
- **Regulatory / Contracting Issues:** What role does regulatory uncertainty play in the process.

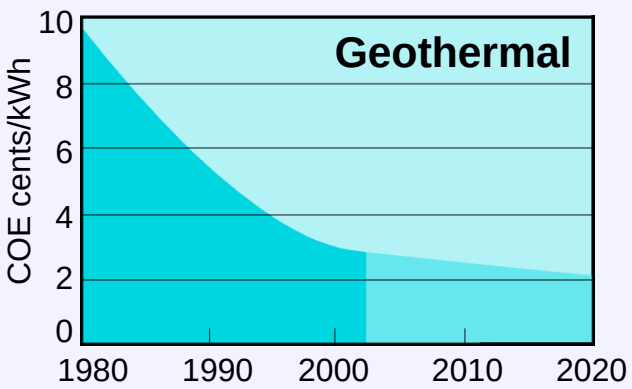
- **Regional Technical Capabilities:** National markets are efficient, but lead to regional winners and losers.

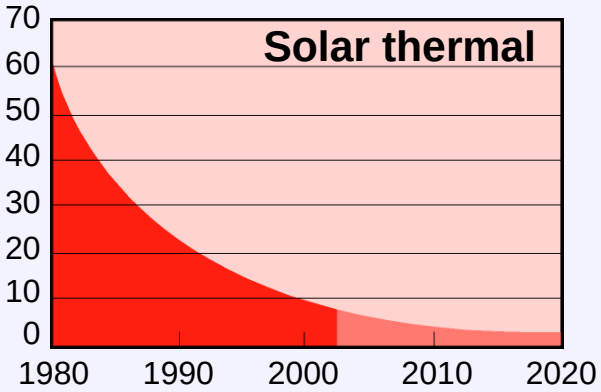
Renewable Energy Cost Trends

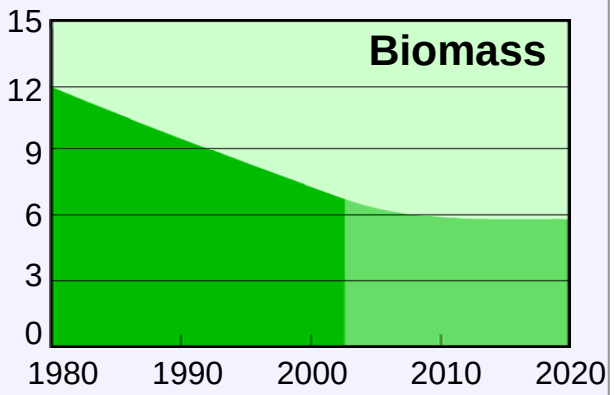
Will government support and policies reduce incentives to maintain cost efficiency trends











Levelized cents/kWh in constant $2000[1]

Source: NREL Energy Analysis Office

Dispatch and Availability Issues

Capacity Valuation

- Intermittent nature can create value/planning problem for meeting peak load.
- Can lead to less than socially optimal level of renewable resources.

Imbalance

- Wind resources have difficult time meeting most imbalance standards in wholesale markets/regional security coordination.
- FERC attempting to hold to +/- 10 percent standard. Penalties for not meeting standards.
- Can impact overall project economics or can have impact on market/system operations.

REC Property Right Issues

- RPS is forcing states to address REC ownership questions

- Uncertainty about ownership limits REC marketability
  - Critical for QF contracts – quantity and value of RECs is significant
  - Behind-the-meter projects are also eligible for RPS – if ownership not clarified, will lead to double claims

- State policy-makers are key to determining ownership
  - FERC QF ruling still subject to differing interpretations
  - Need to watch (or participate in) state regulatory proceedings
  - State legislative action may reduce appeals and uncertainty

Regulatory Issues

Rate Impacts →

- Large scale implementation.
- Costs of set-asides.
- Costs of special interests.

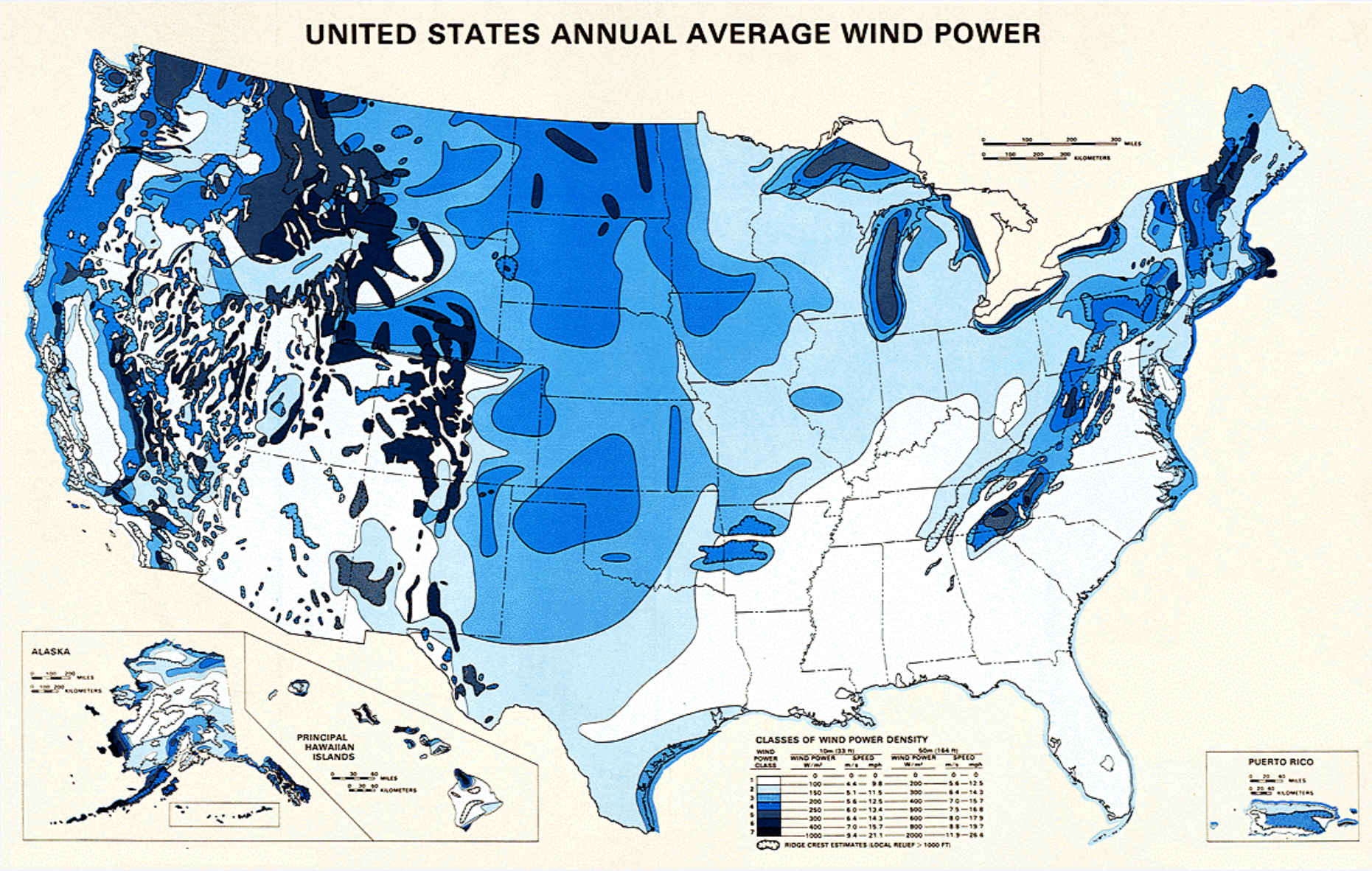
Long Term Contracting →

- Some states are finding RPS alone is not enough since many have sunset provisions creating regulatory uncertainty.
- Claims that financial community demands more certainty for favorable financing.

Technical and Performance Capabilities

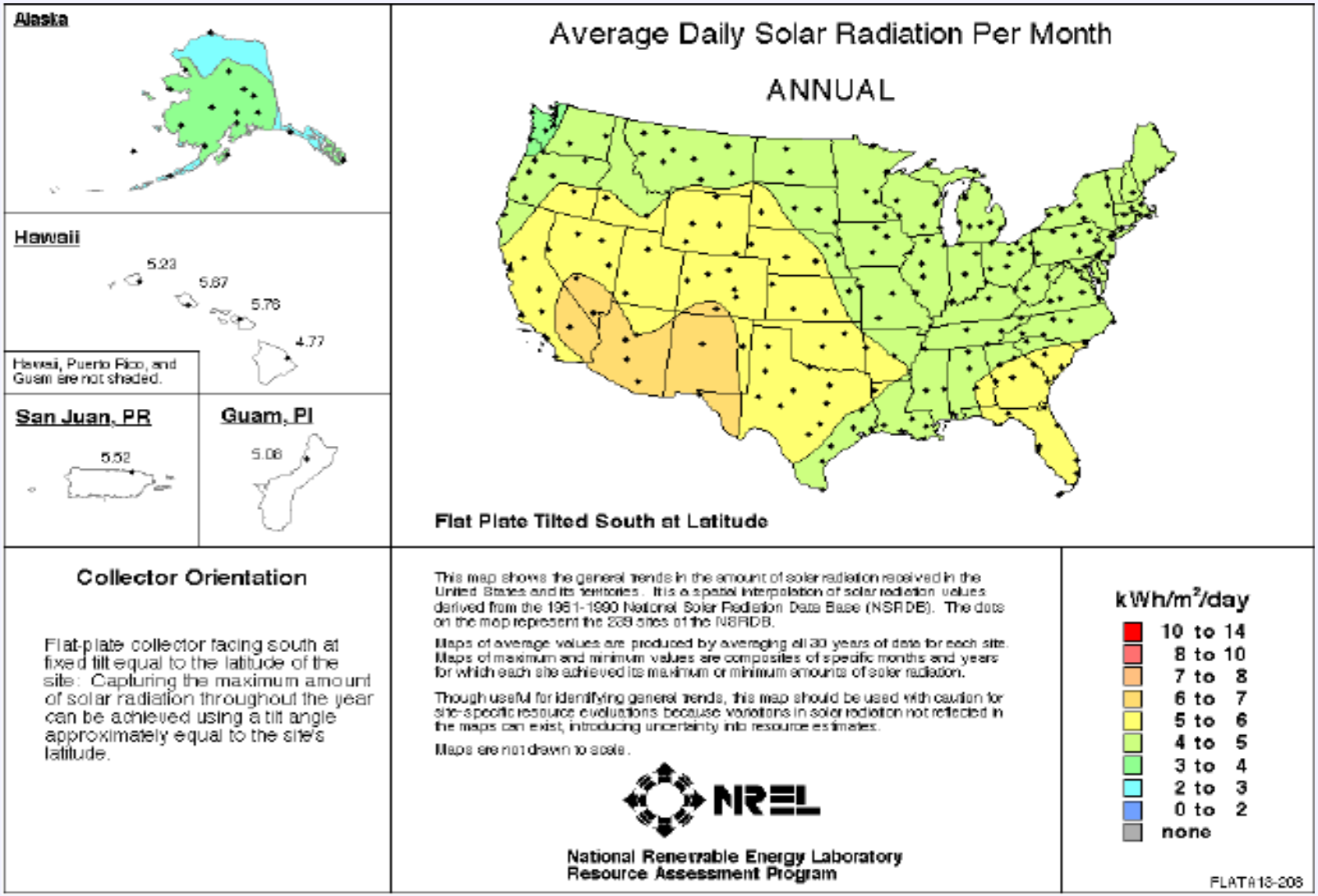
Wind	• Resources are limited • Intermittency affects cost and value
Biomass	• Cost reductions can “borrow” from allied technologies (coal, IGCC, combined cycle)
Municipal Waste/ Landfill Gas	• Resources are very limited • Site specific
Solar	• Lowest cost installation will be on new construction • Despite increasing competition, technology is expected to remain too competitive for widespread adoption

Technical Challenges -- Wind Resources



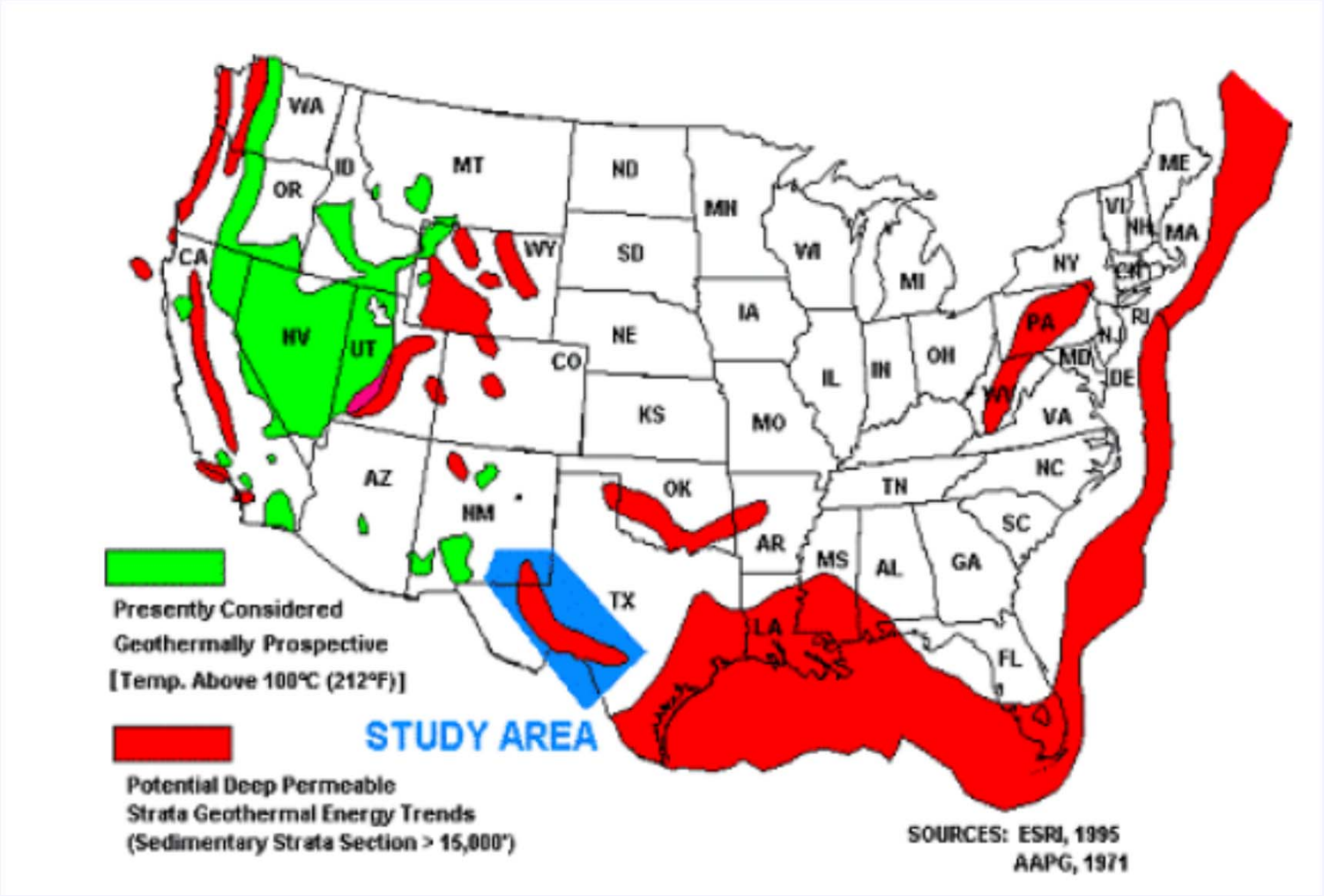
Source: NREL Energy Analysis Office

Technical Challenges -- Solar Resources



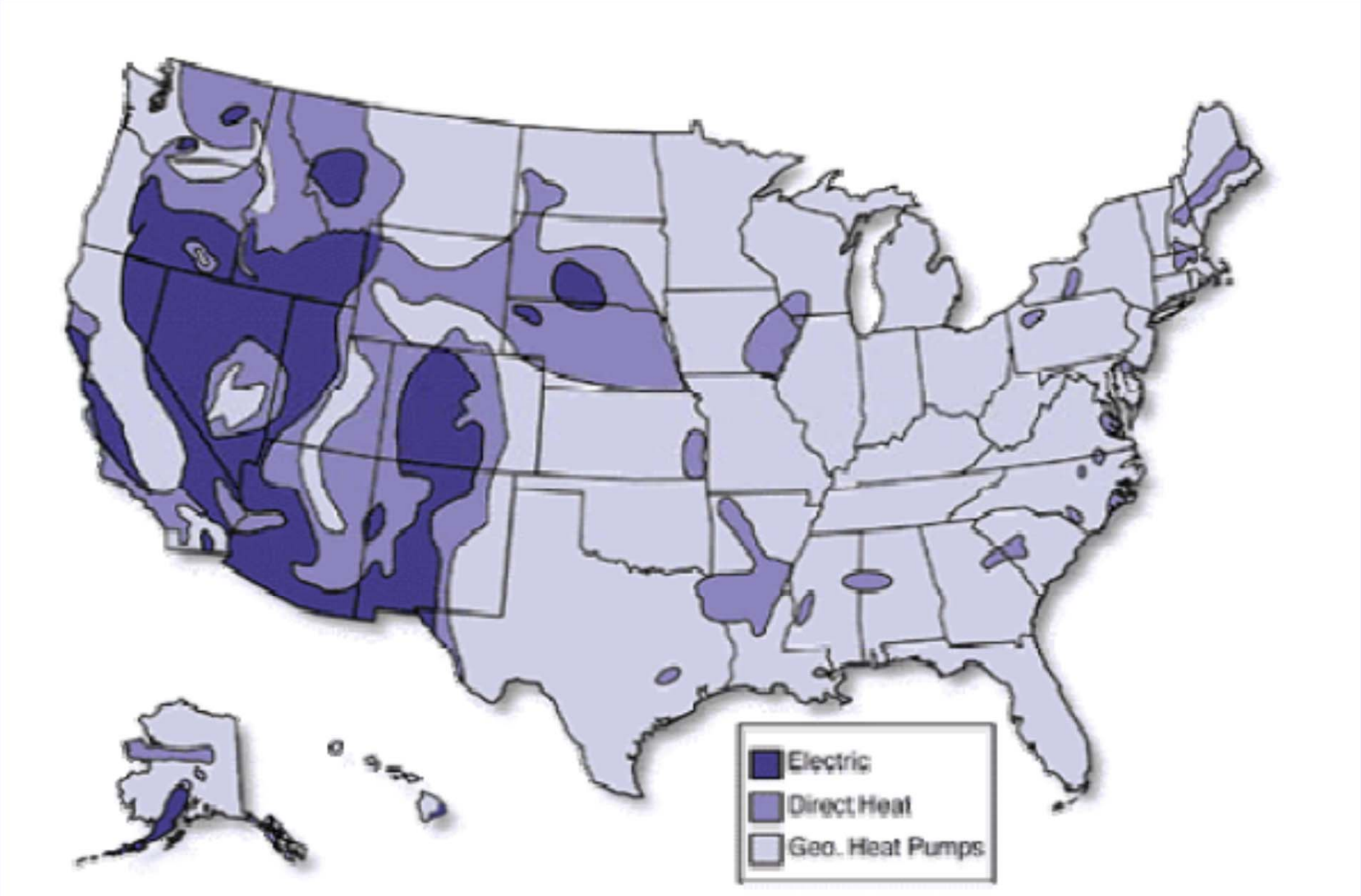
Source: NREL Energy Analysis Office

Technical Challenges -- Geothermal Resources



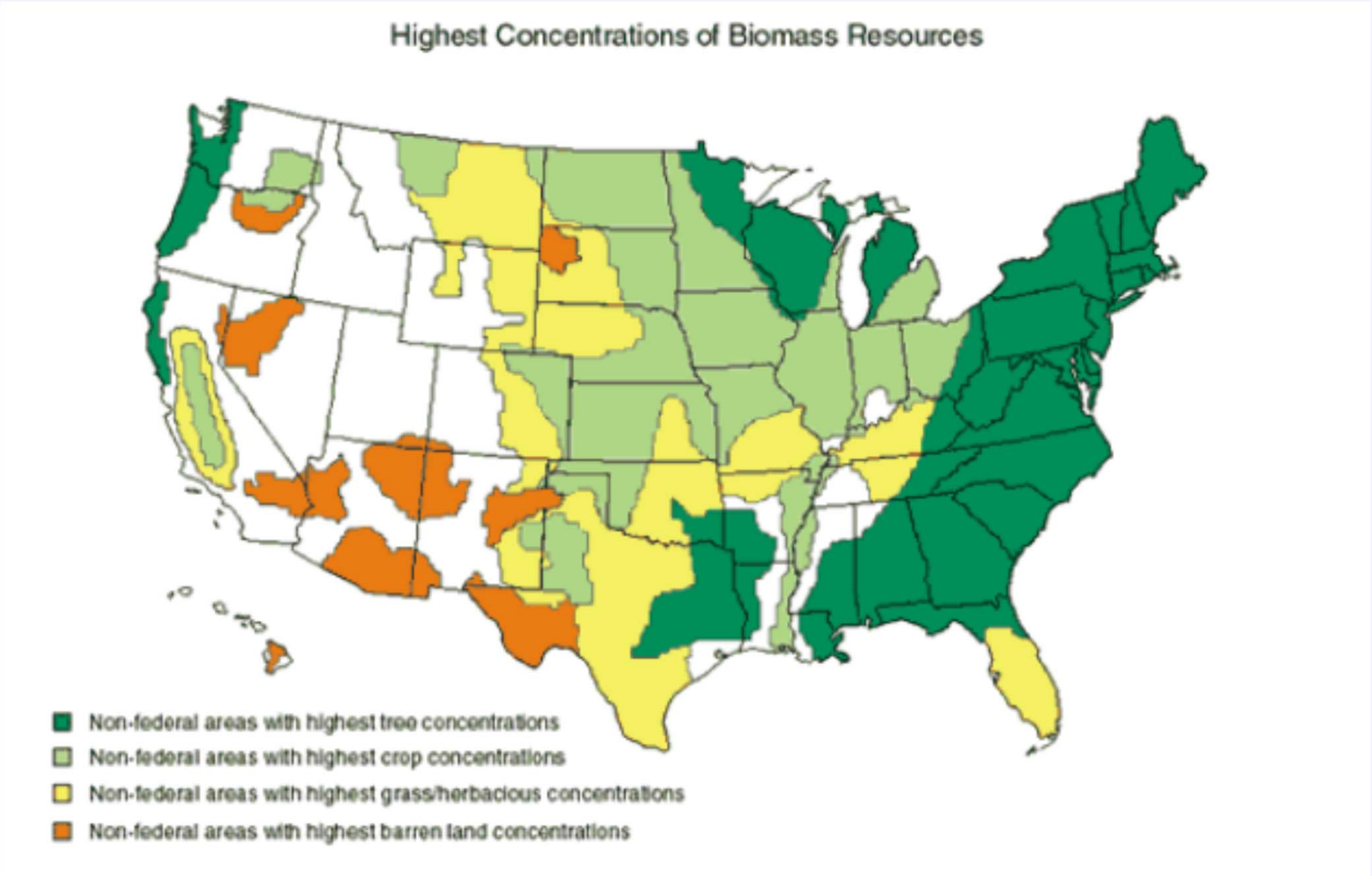
Source: NREL Energy Analysis Office

Low Temperature Geothermal Resources



Source: NREL Energy Analysis Office

Biomass Resources



Source: NREL Energy Analysis Office

Conclusions

Current Federal Tax Breaks
Residential / Personal

Opportunities

- Cost characteristics have improved
- Fossil resource prices are high and anticipated to remain high
- Considerable State and Federal Policy Support

Challenges

- Technologies need to continue to develop cost efficiencies in the face of generous supports
- Regulatory uncertainty
- Financial and contracting issues

Questions, Comments, & Discussion

dismukes@lsu.edu

www.enrg.lsu.edu