Renewable Energy in Today's Power Markets

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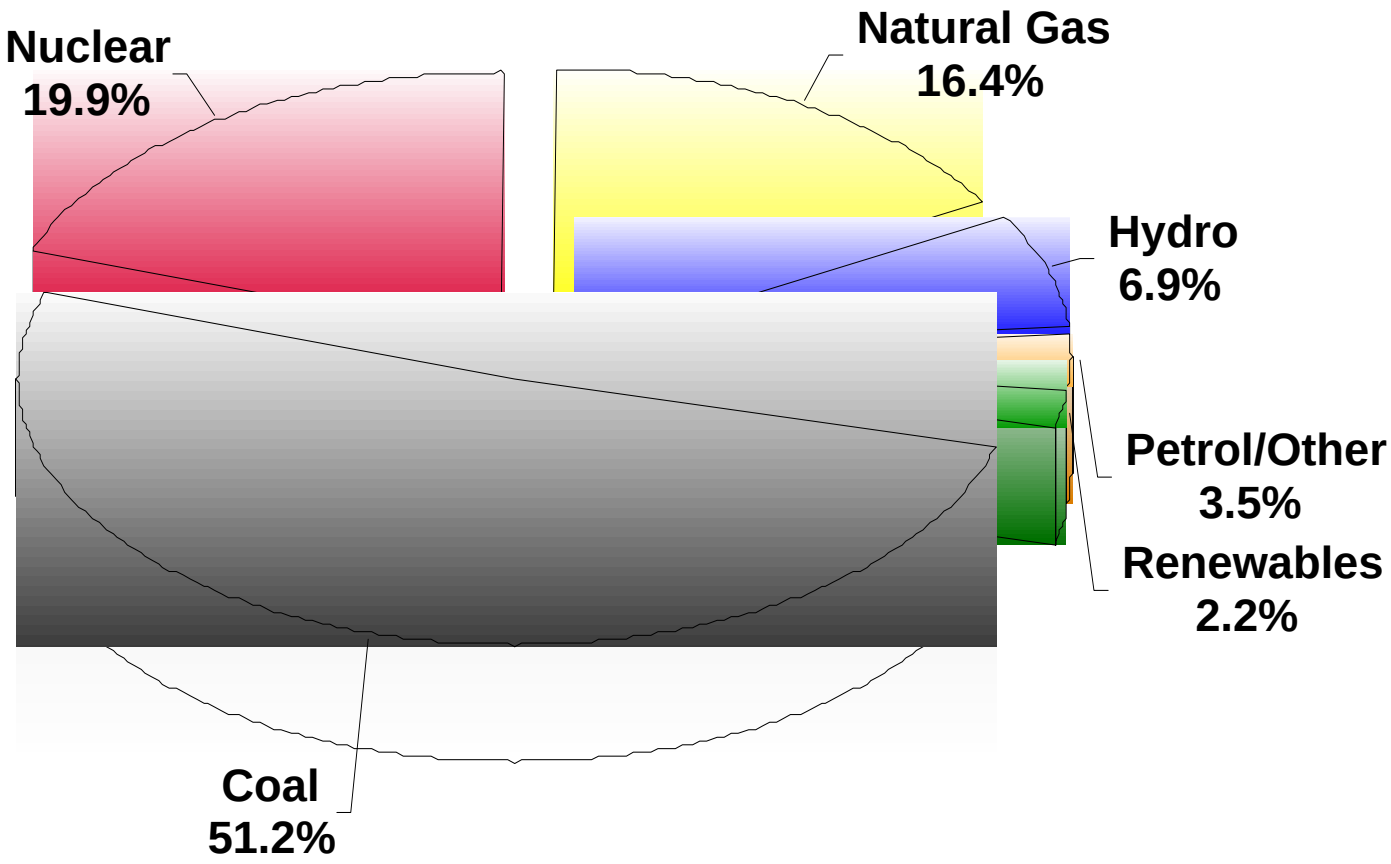
What Are Renewables?

- **Energy sources that are replenishable in nature on a regular and/or relatively short time frame.**
  - **Hydropower**
  - **Biomass**
  - **Geothermal**
  - **Wind**
  - **Solar**
- **Conversion systems employ a mix of traditional and non-traditional technologies.**
- **Generation can be base load, peaking, and “as available.”**

U.S. Power Supply Mix - 2003



Why Renewables?

- “Cleaner” energy production
- Fixed, predictable costs
- Use of local or in-state resources
- Local economic benefits
- Waste reduction
- Can be deployed in various system sizes

A Brief History of Renewables Development

- **1980s to early 1990s**
  - **"Energy Crisis" spurs search for domestic energy alternatives**
  - **Federal and state governments provide incentives for RE techs**
  - **PURPA passed in 1978, high avoided costs**

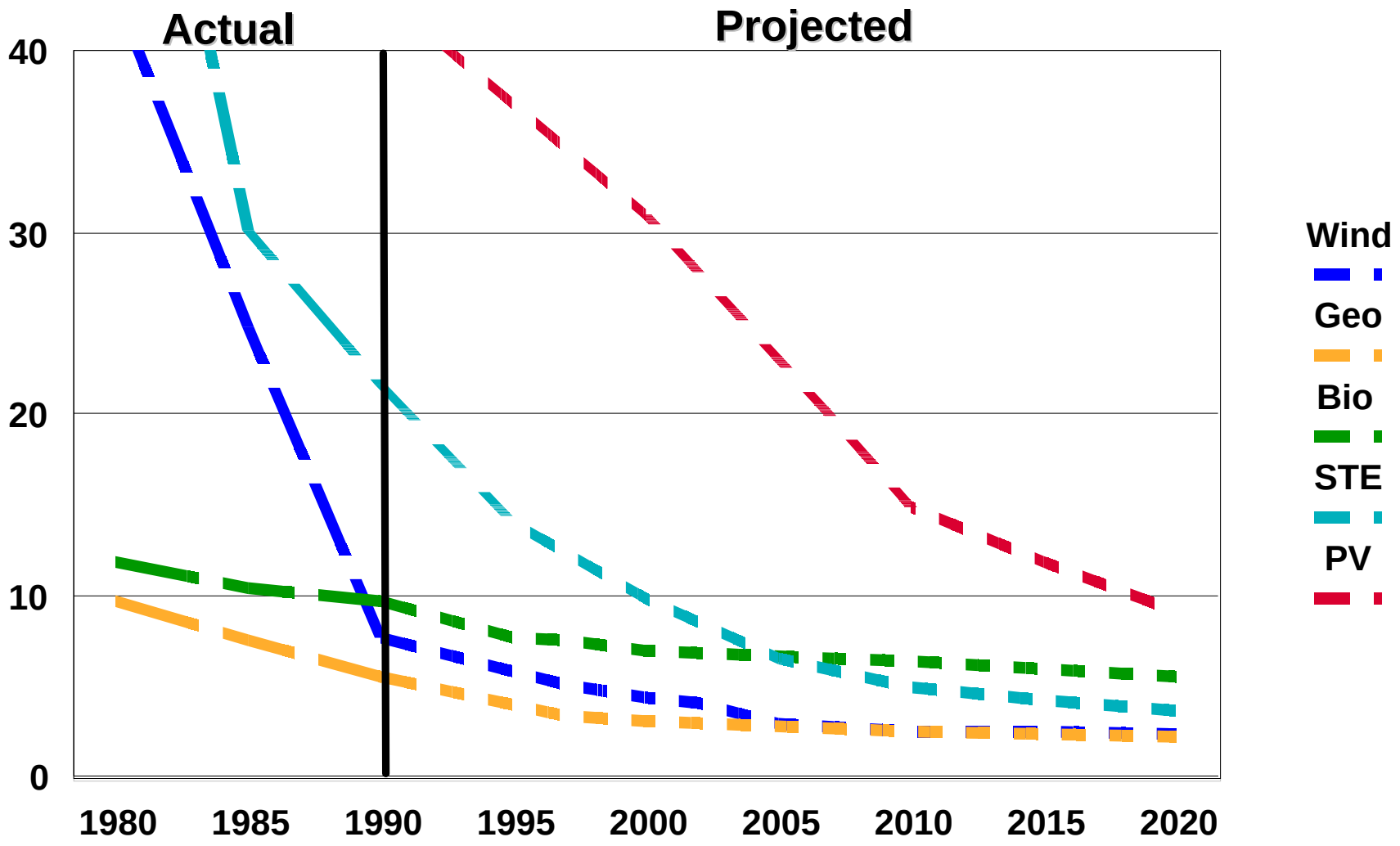
    (Under PURPA, more than 12,000 MW of non-utility-owned renewable power projects were interconnected to the grid)
  - **RD&D expenditures peak in 1981, then fall dramatically**
- **Most of 1990s**
  - **Period of lower and stable energy prices discourages renewables**
  - **Competition mantra works against "interventionist" energy policies**
  - **Steady increase in RD&D expenditures; significant decrease in 1996**
- **Late 1990s to Present**
  - **Natural gas price shocks cause reevaluation of generation mix**
  - **States take lead in adopting renewables policies**
    - **Initially to assure renewables a continued role in more competitive market; more recently to promote fuel diversity and economic development**

Current Drivers for Renewable Energy Development in the United States

- ***Financial Incentives***: **Federal production tax credit for wind, investment tax credit for solar and geothermal, and accelerated depreciation, as well as state incentives, all help lower costs and spur development.**
- ***Renewables Portfolio Standards***: **16 states have enacted RPS or other RE purchase policies, which obligate suppliers to deliver a minimum level of RE. These states represent about 35% of total U.S. load.**
- ***Renewable Energy Funds***: **15 states have created funds to financially support development of renewable energy sources.**
- ***Green Power Markets***: **Markets for voluntary purchases of "green power" have emerged: utility green pricing programs, competitive green power markets, and renewable energy certificates. Nearly 2,000 MW supported.**
- ***Market Prices***: **Some forms of renewable energy, particularly with financial incentives, can compete today on cost alone (e.g., wind at ~2-4 cents/kWh). RE sources are being increasingly viewed as a price hedge.**

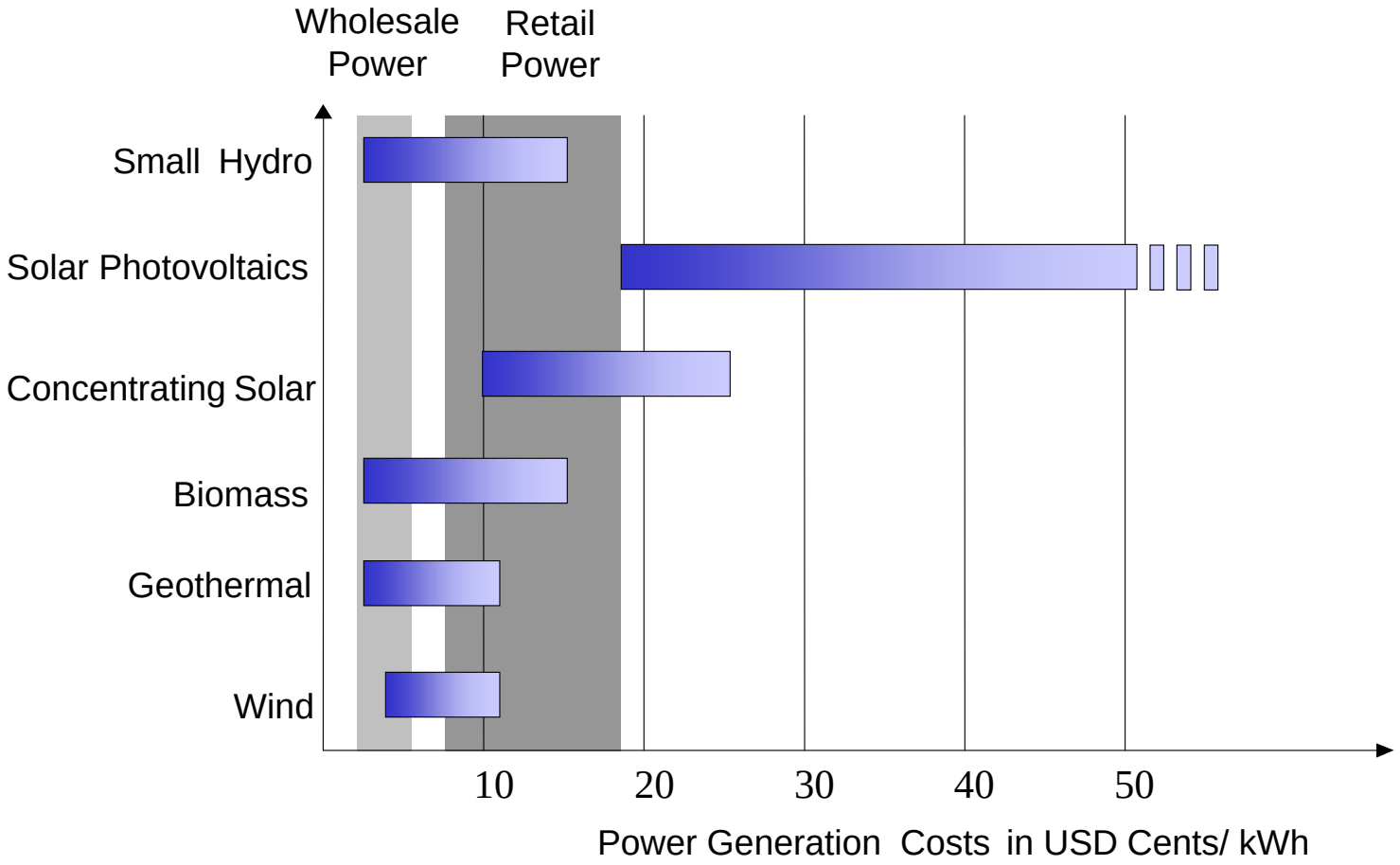
Policies can be and often are mutually supportive.

Cost Trends for Renewable Power Technologies



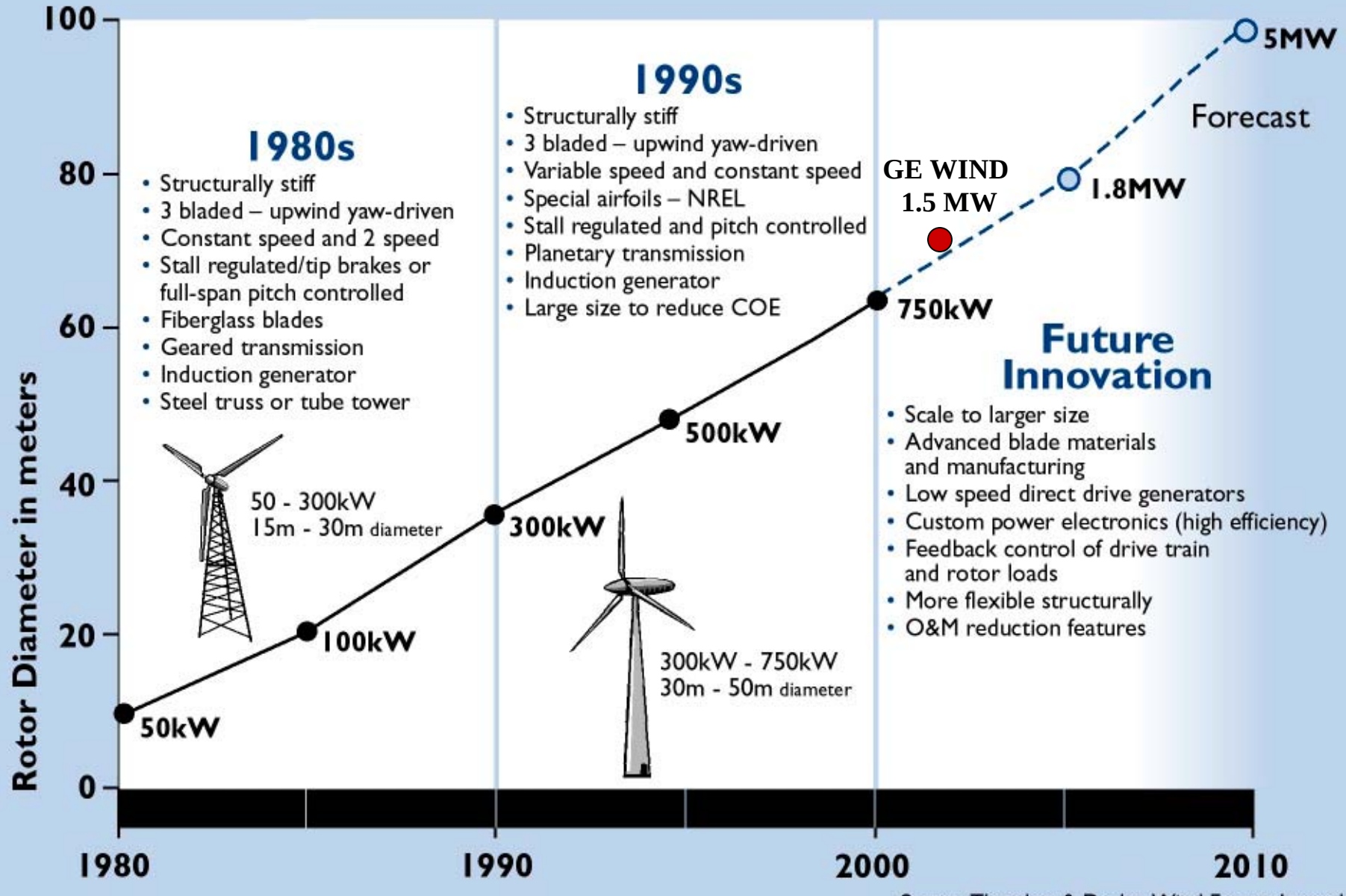
Source: DOE/EPRI

Cost Competitiveness of Selected Renewable Power Technologies



Source: International Energy Agency

The Evolution of Commercial U.S. Wind Technology



Source: Thresher & Dodge, Wind Energy Journal 1998

Cost of Energy Trend for Wind

1979: 40 cents/kWh

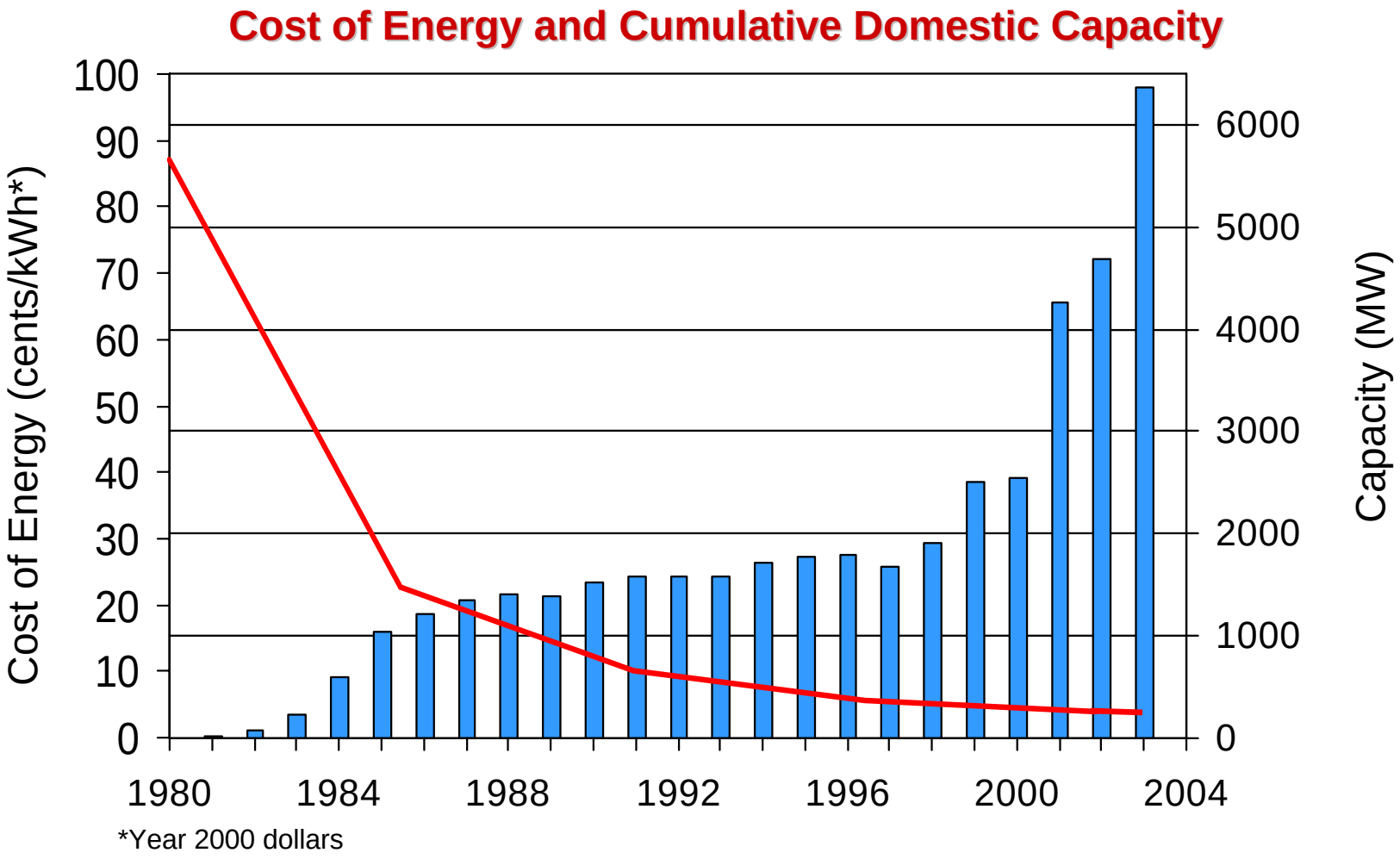
2000:
4 - 6 cents/kWh

- Increased Turbine Size and Height
- R&D Advances
- Manufacturing Improvements

2004:
3 – 4.5 cents/kWh

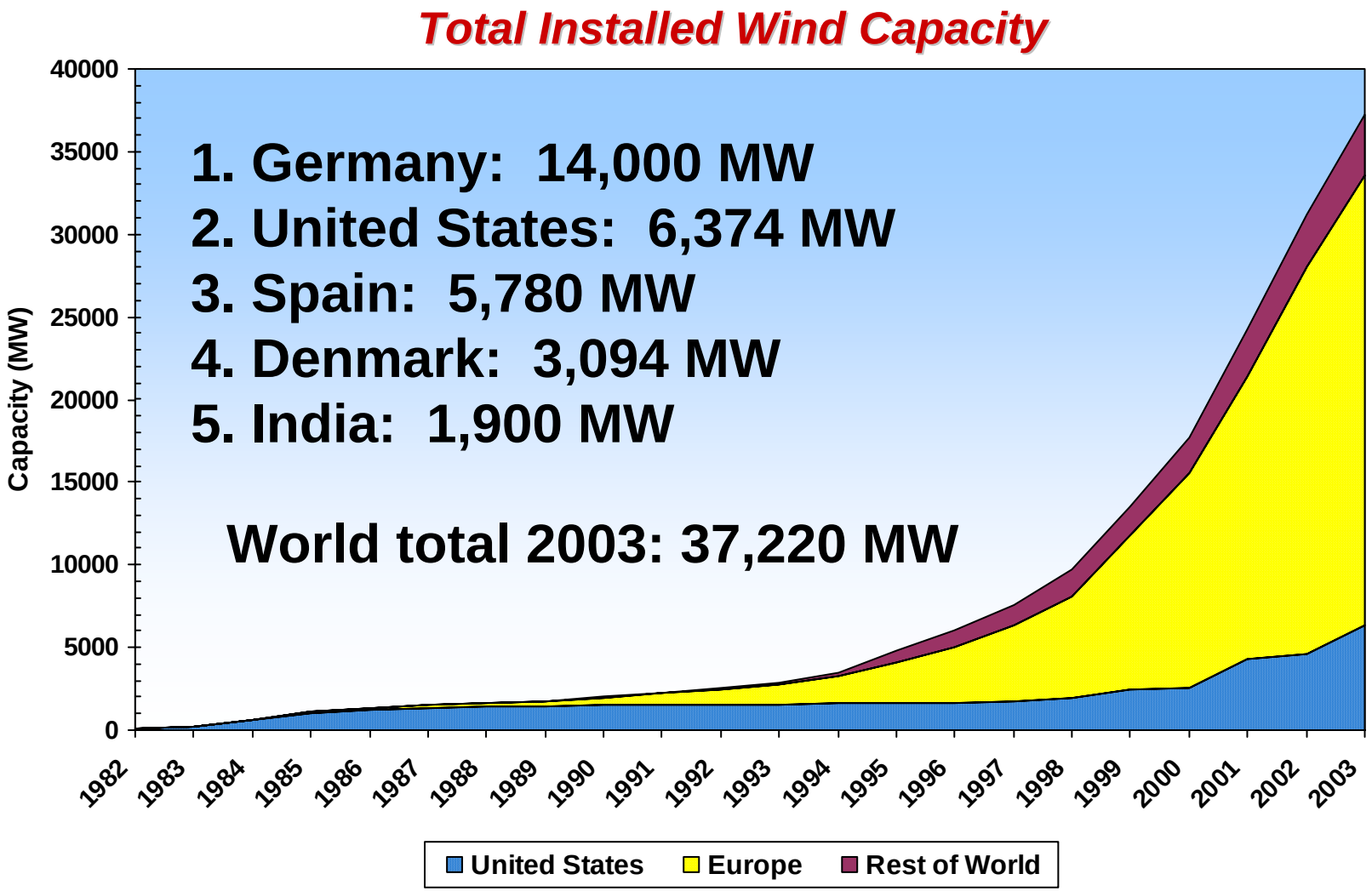
NSP 107 MW Lake Benton wind farm
4 cents/kWh (unsubsidized)

Installed Wind Capacity & Cost Trends



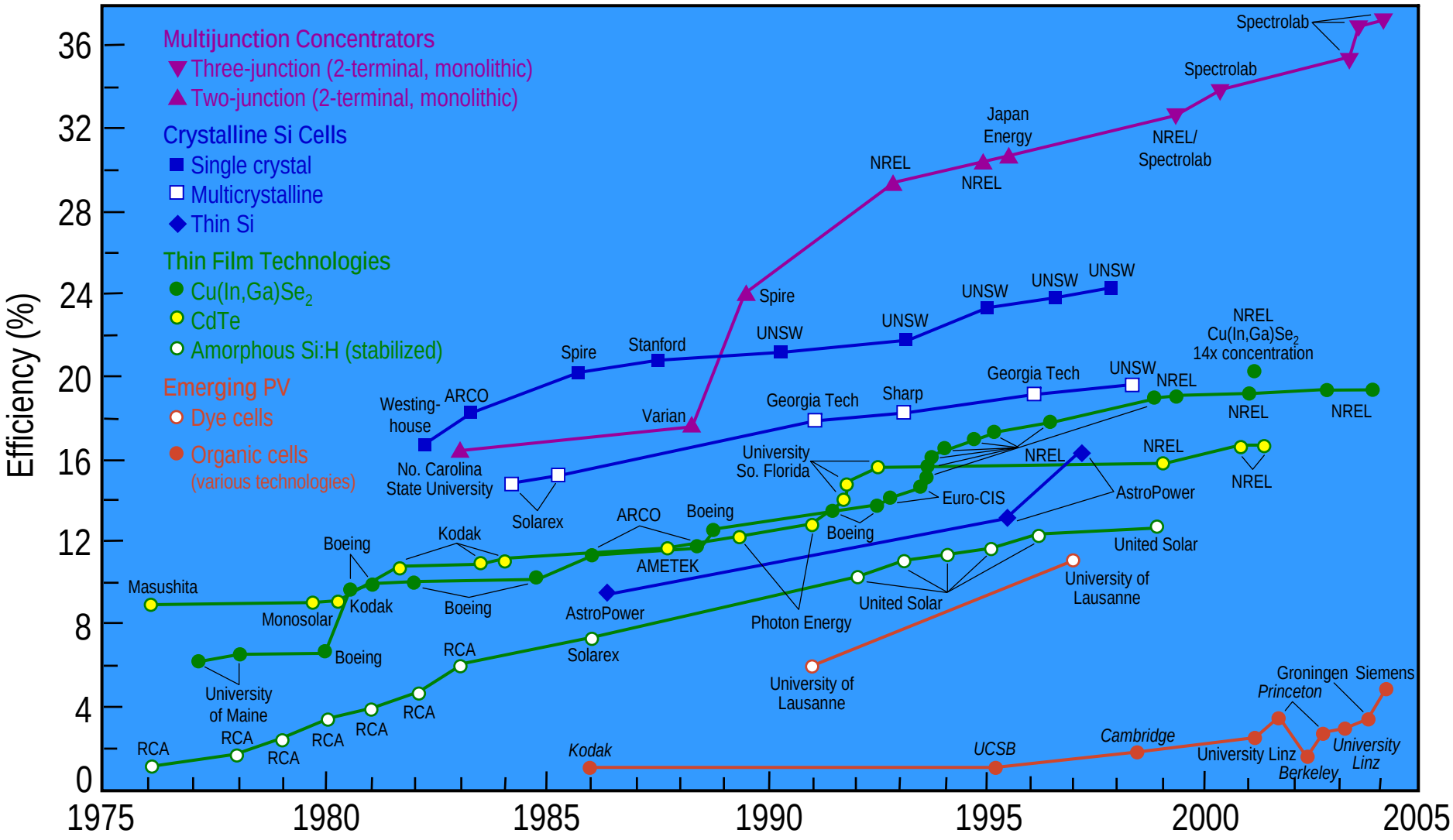
Increased Turbine Size - R&D Advances - Manufacturing Improvements

World Growth Market

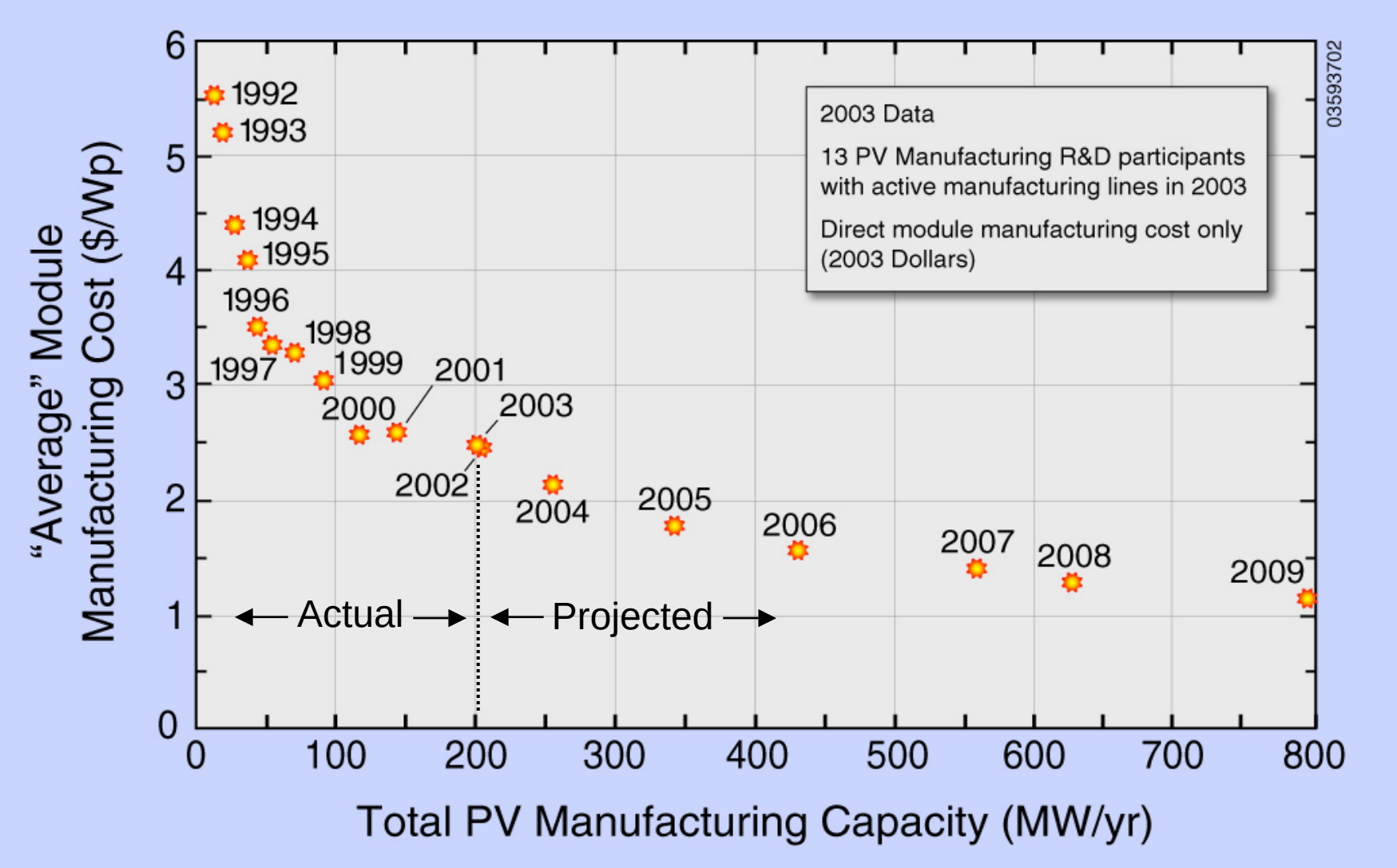


Source: WindPower Monthly

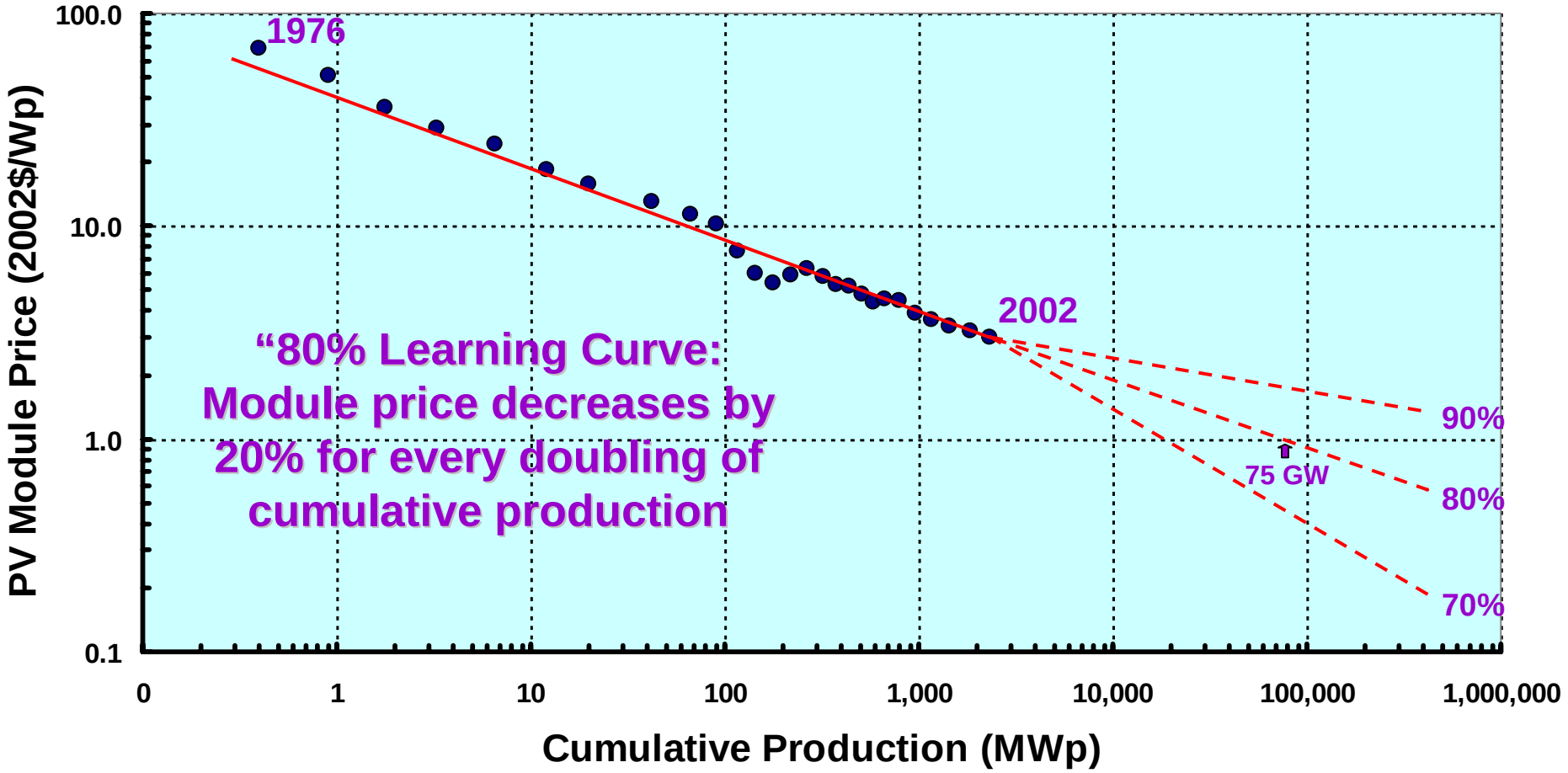
Best Research-Cell Efficiencies



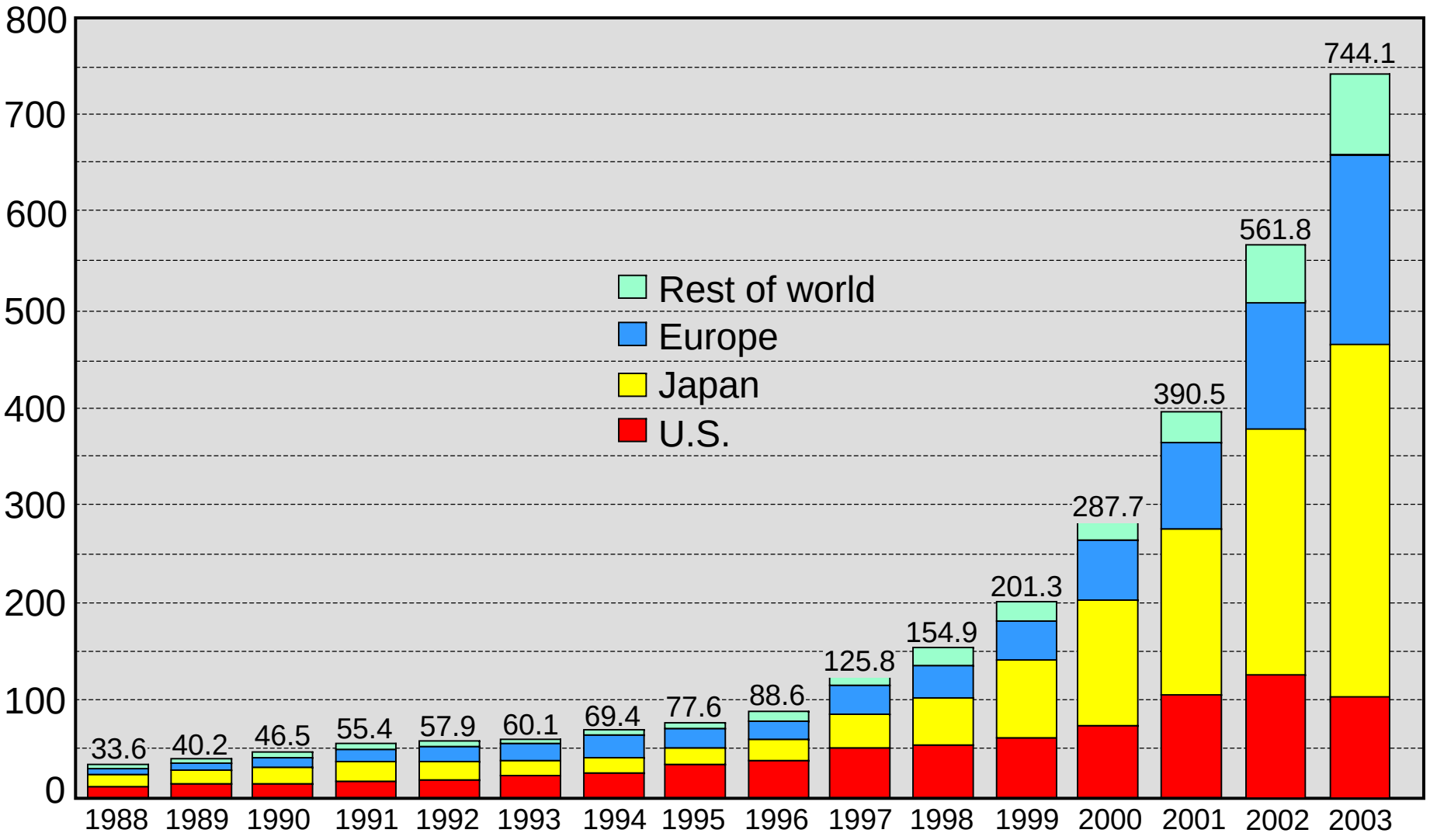
PV Manufacturing R&D Cost/Capacity
(DOE/U.S. Industry Partnership)



PV Module Production Experience (or "Learning") Curve

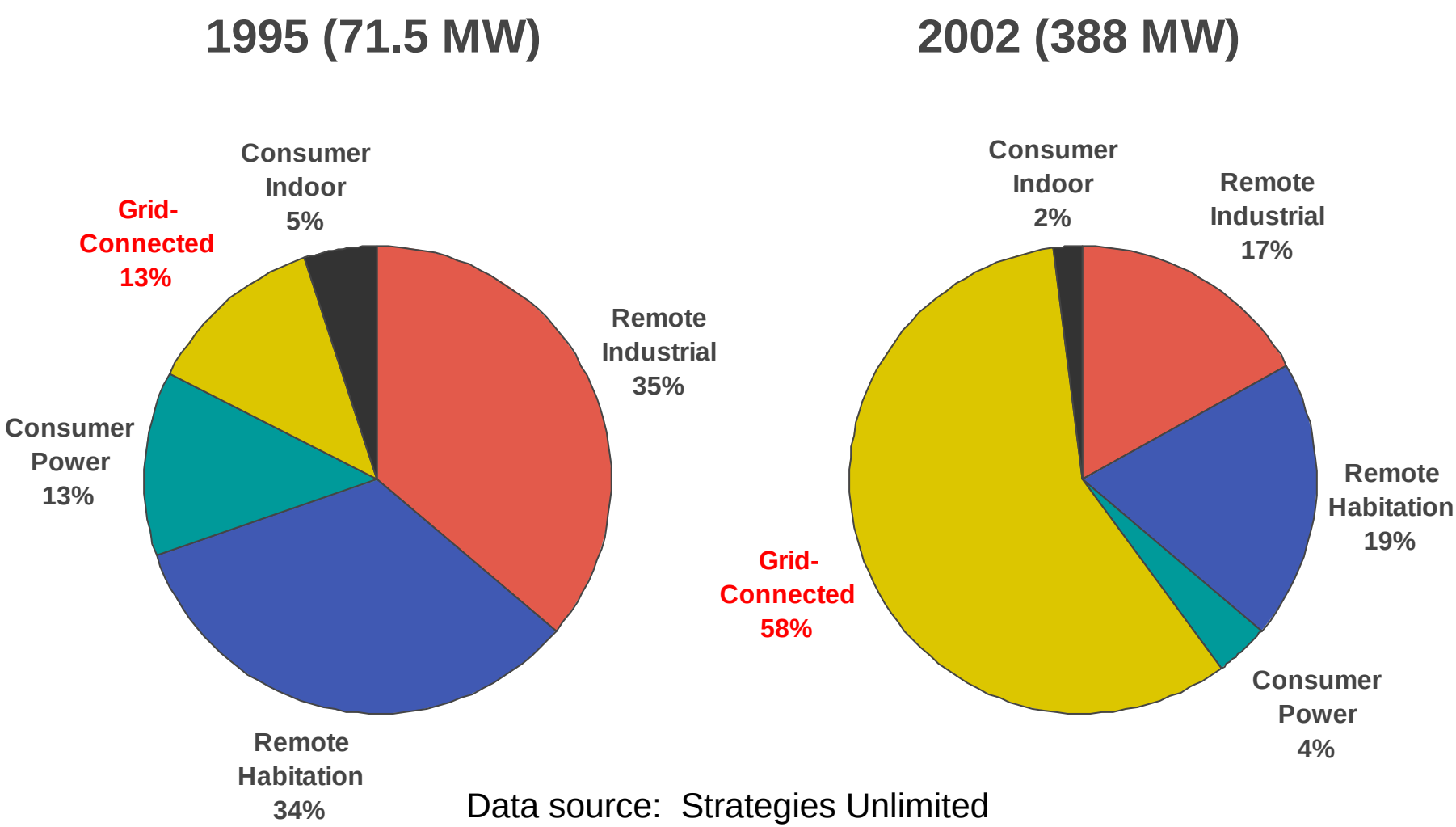


World PV Cell/Module Production (MW)



Source: *PV News*, March 2004

Shift in Mainstream PV Applications

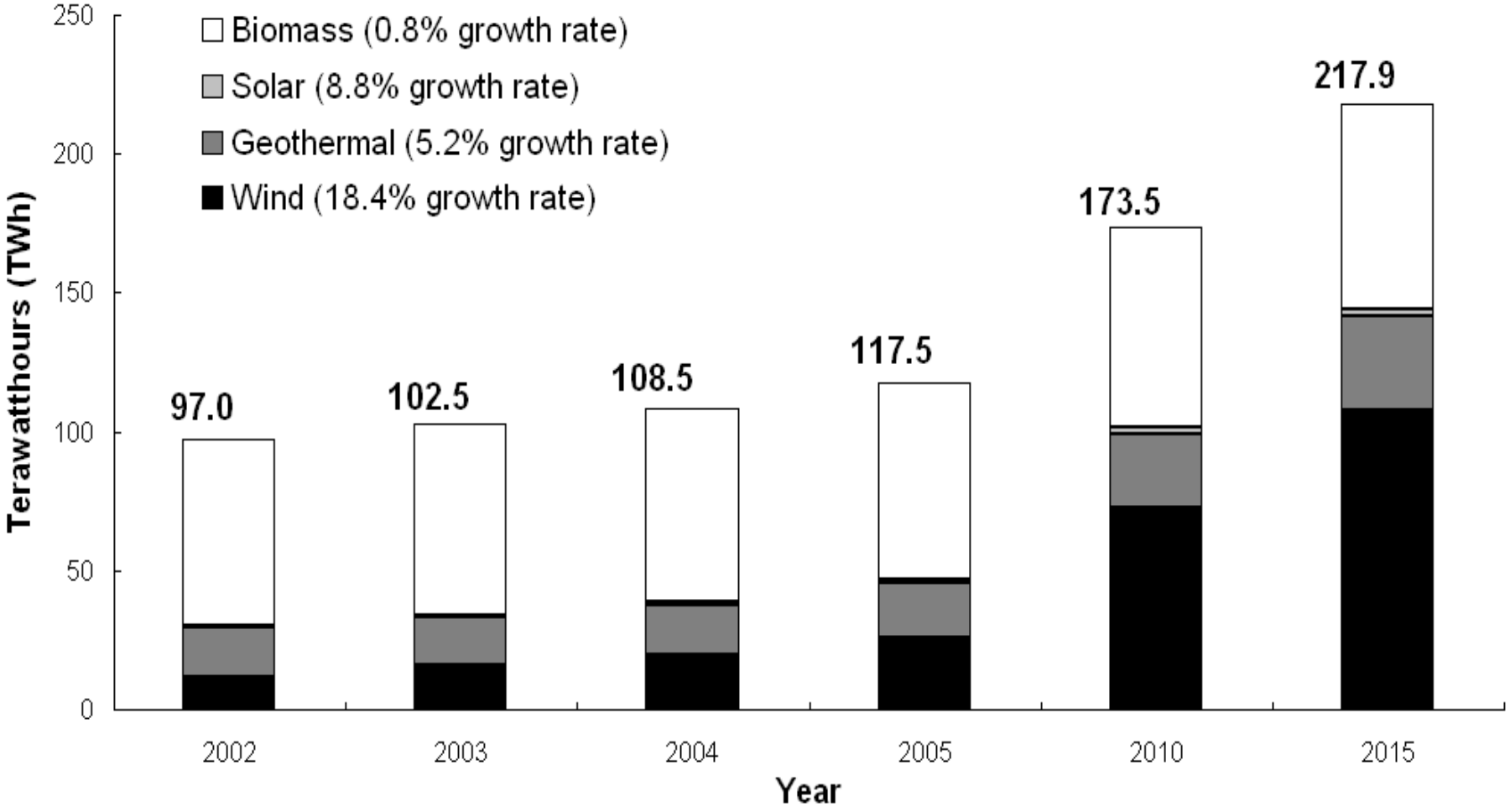


Data source: Strategies Unlimited

Some Other Factors

- **Net metering and non-discriminatory interconnection rules for customer-owned renewables systems.**
- **Transmission capabilities to tap more remote resources.**
- **Addressing intermittency of some RE technologies but not a major issue until intermittents become a significant fraction of the generation mix.**
- **Consumer education needed for voluntary green power markets to be more successful.**

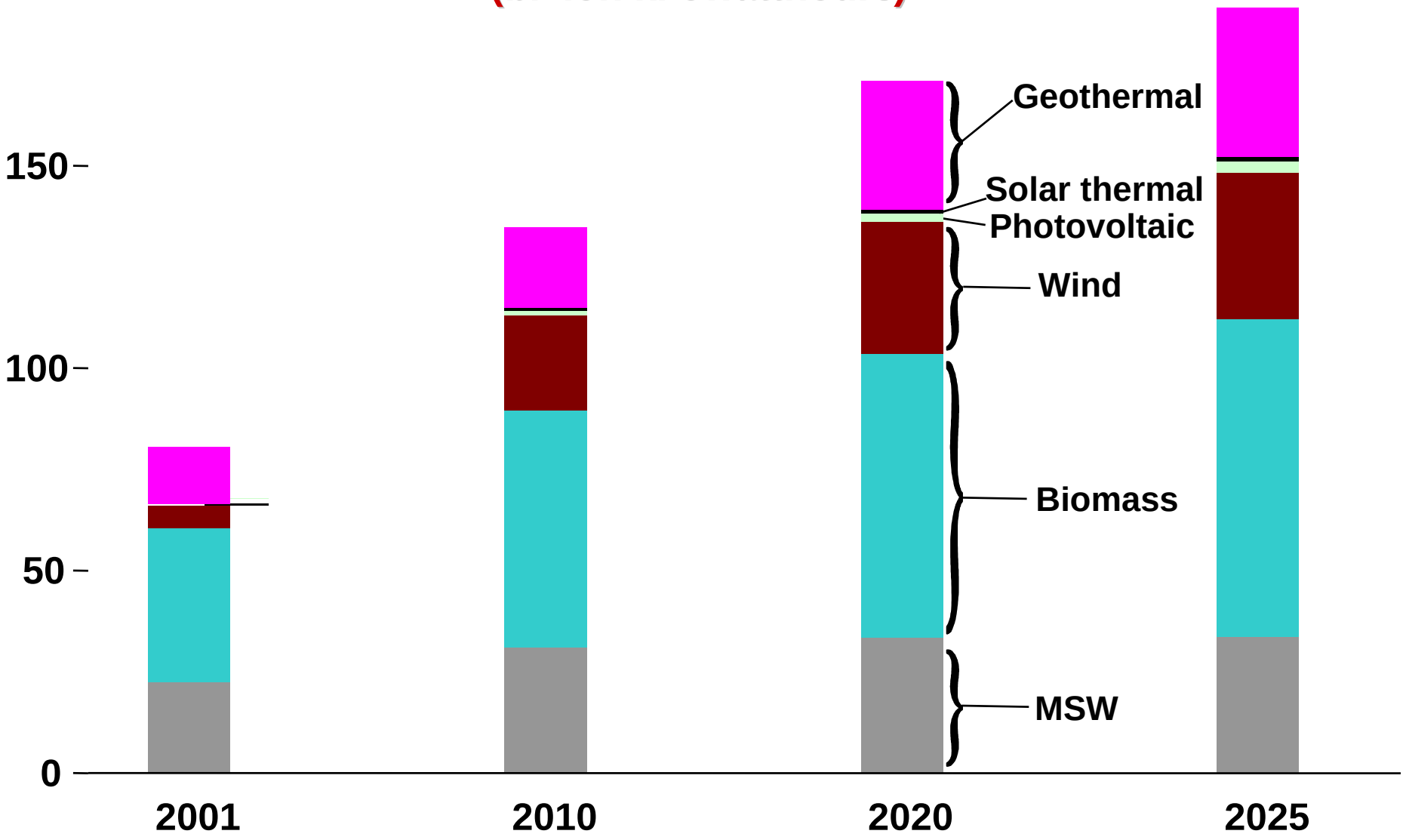
Platts National Forecast for Renewable Power Generation



EIA Projected Renewable Electricity Generation

By Energy Source, 2010, 2020, and 2025

(billion kilowatthours)



Concluding Remarks

- RE technologies are likely to continue historical improvement in cost and performance from a combination of RD&D and increased market deployment.
- In the absence of a more aggressive federal approach to deployment, state policies will continue to lead the way.
- RPS and SBC policies establish minimum public support levels for renewables supply or investments.
- Green pricing programs allow customers to support higher levels of renewables development through voluntary purchases.
- Financial incentives compliment other policy approaches by lowering production costs.
- Combinations of policies are likely to achieve the best outcomes.