Integrating Innovation and Policy for a Renewable Energy Future

Presented at the Kennedy School of Government at Harvard University

February 5, 2007

Dan E. Arvizu
Director, National Renewable Energy Laboratory

NREL/PR-100-41166

NREL Energy Efficiency and Renewable Energy Technology Development Programs

NREL R&D Portfolio

Efficient Energy Use

- Vehicle Technologies
- Building Technologies
- Industrial Technologies

Renewable Resources

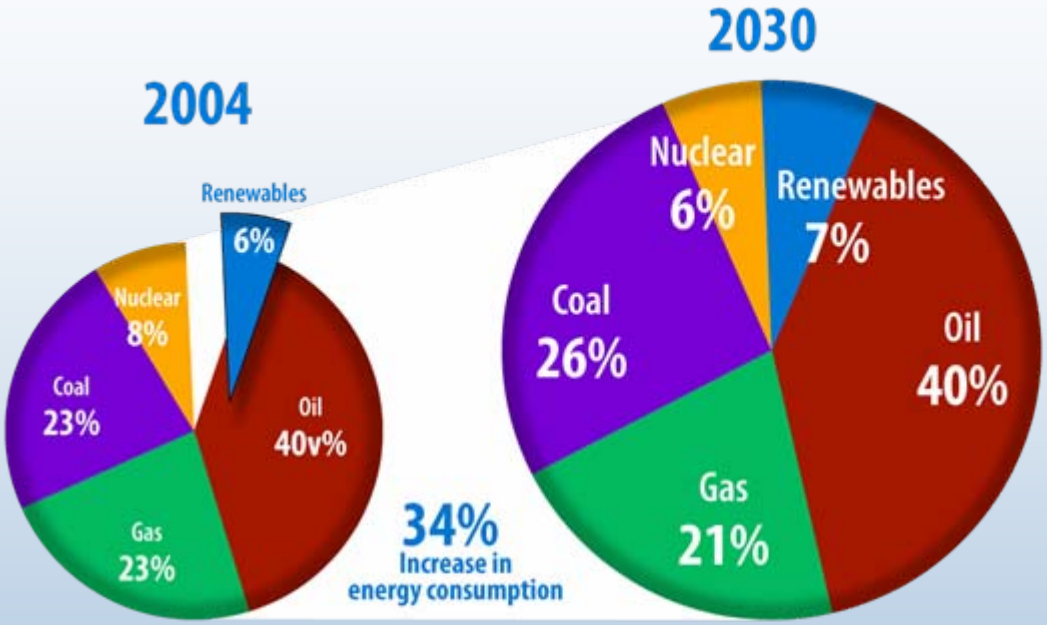
- Wind
- Solar
- Biomass
- Geothermal

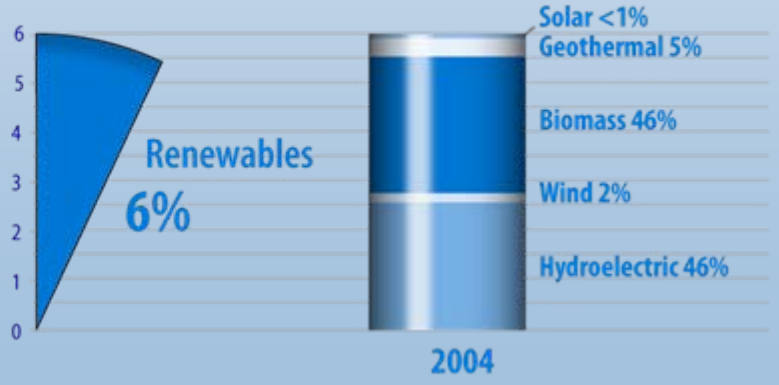
Energy Delivery and Storage

- Electricity Transmission and Distribution
- Alternative Fuels
- Hydrogen Delivery and Storage

Foundational Science

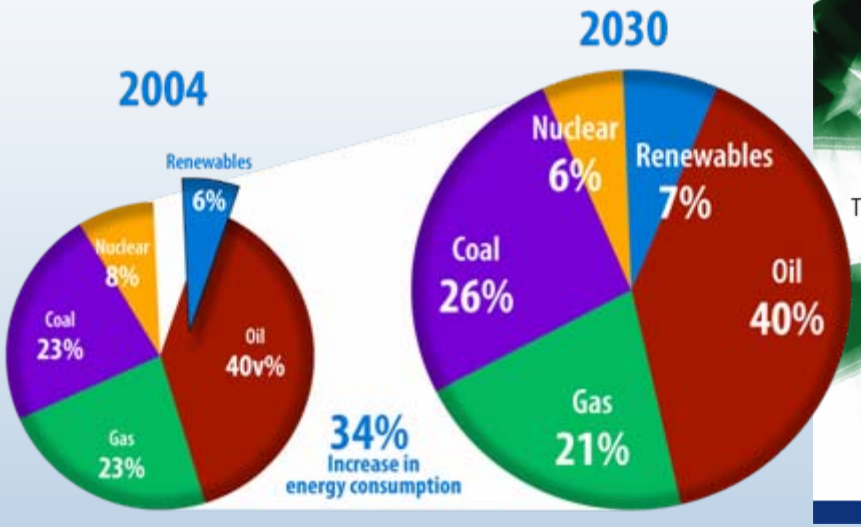
U.S. Energy Consumption and the Role of Renewable Energy

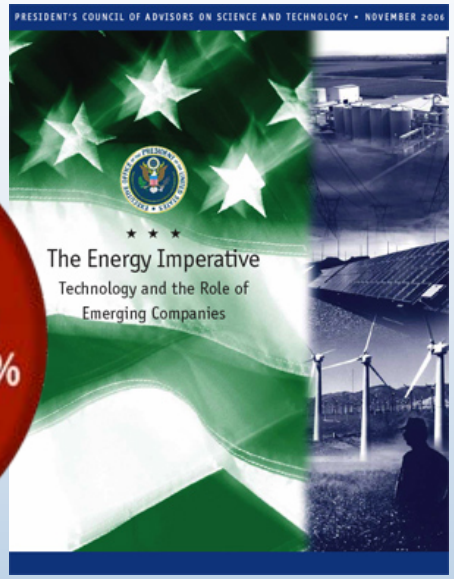




Source: Energy Information Administration, *Annual Energy Outlook 2006,* Table D4

U.S. Energy Consumption and the Role of Renewable Energy





"…in the foreseeable future, the share of non-hydroelectric renewable electricity generation in the U.S. could grow to 10% or more by 2030 and to over 20% by midcentury."

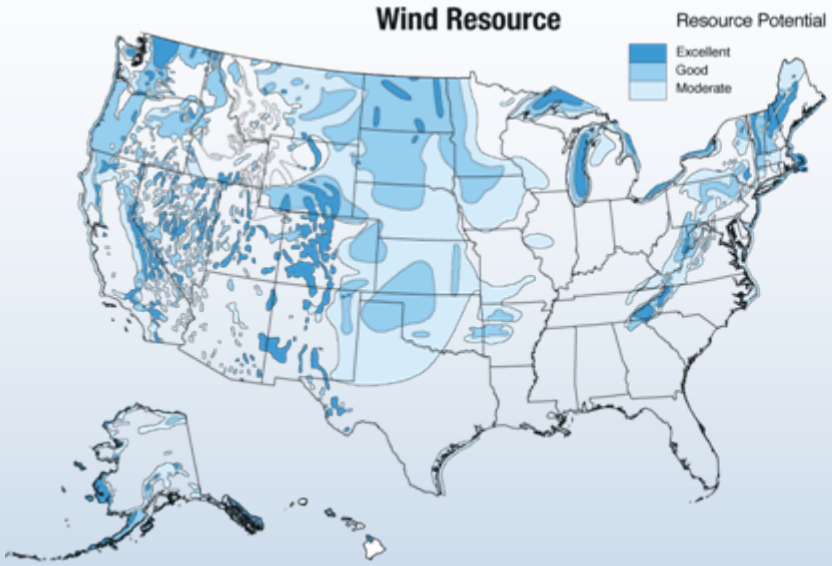
PCAST Nov 2006

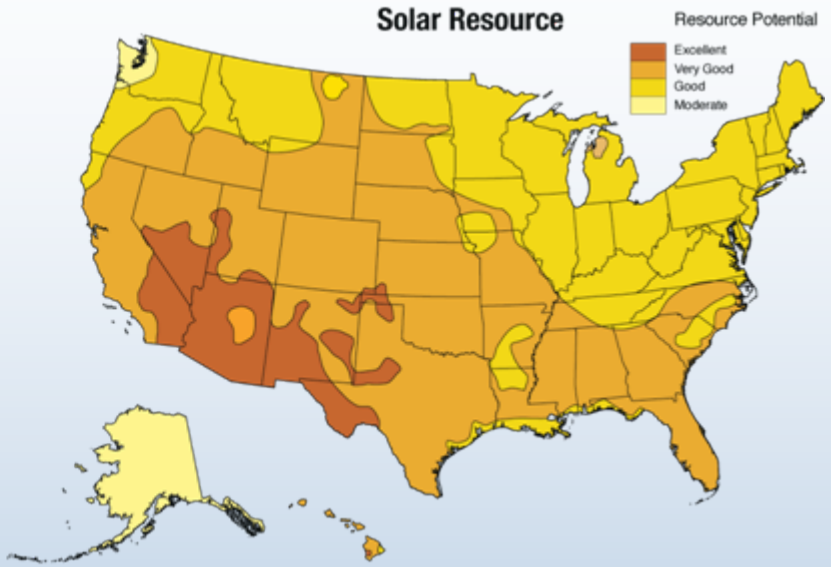
"Yes if" … not… "no because."

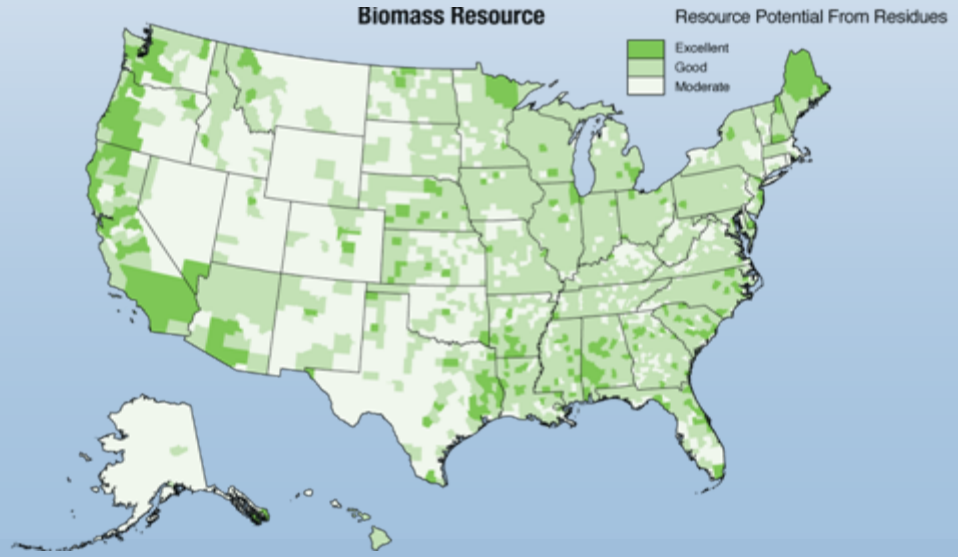
– Newt Gingrich

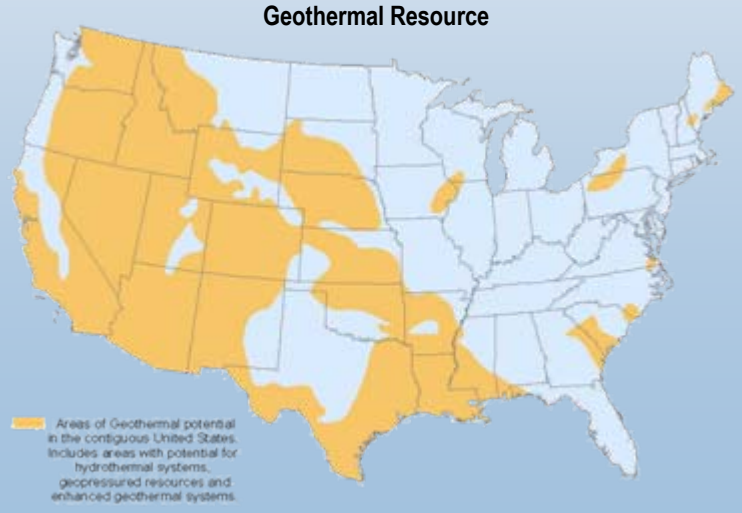
Source: OECD/IEA, 2004

National Resources

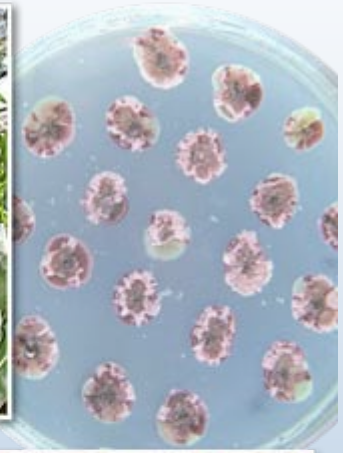


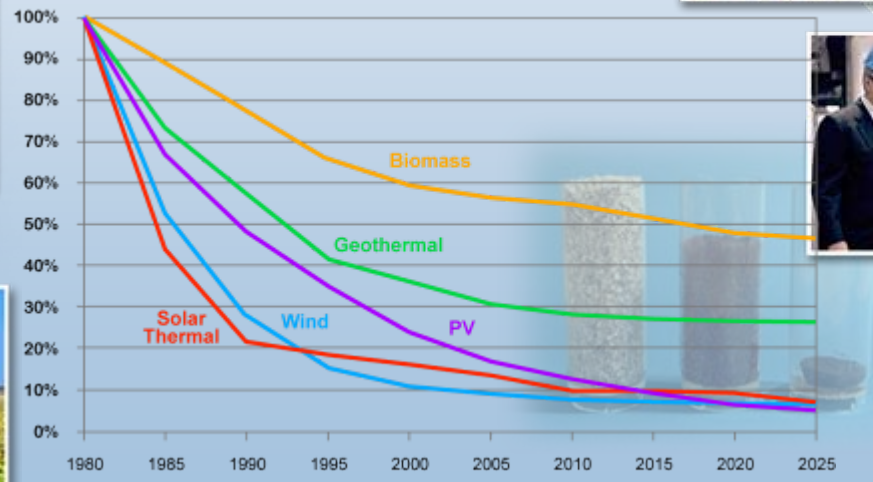






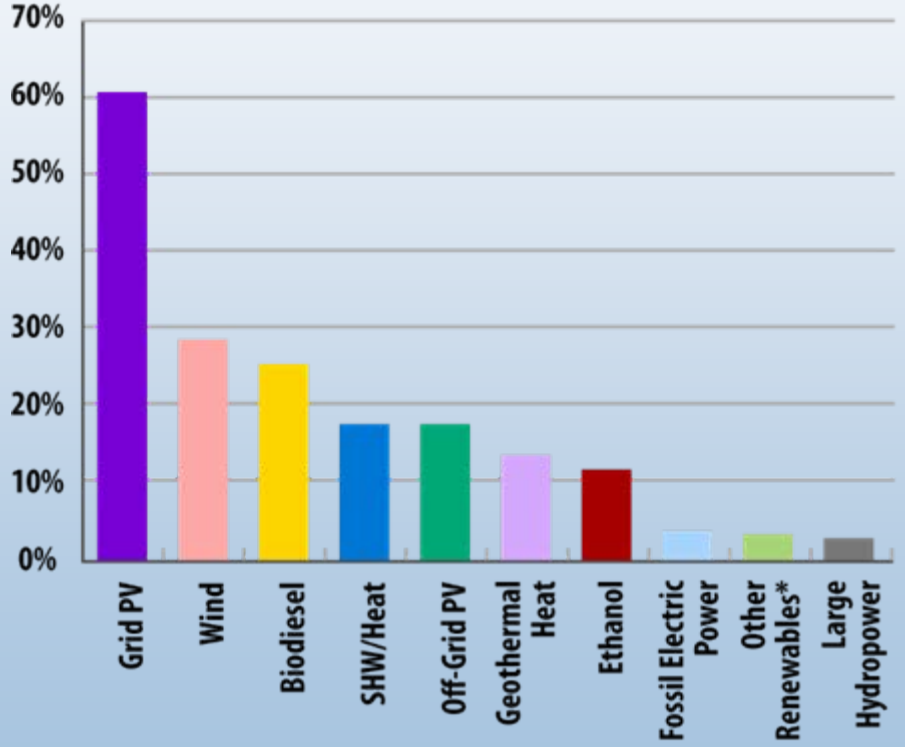
Impressive Cost Reductions



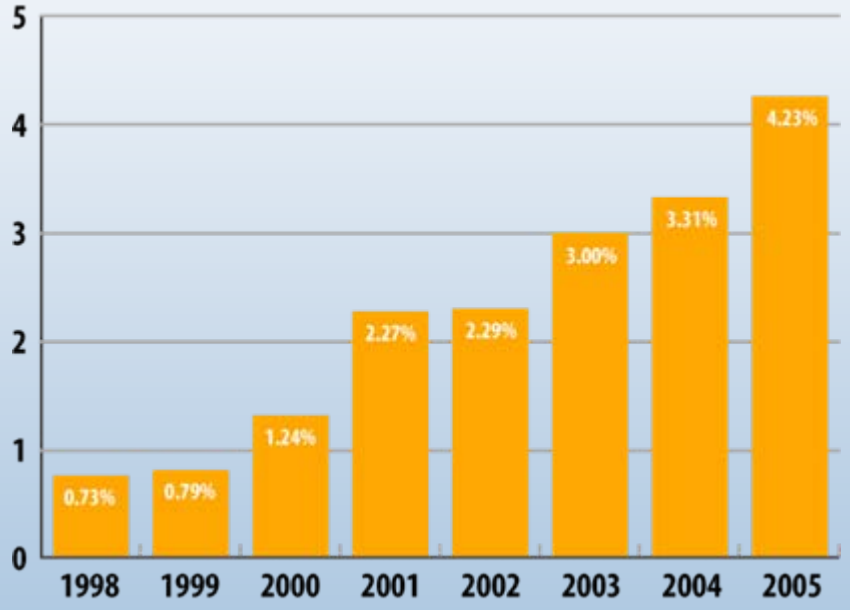


Investing in the Future

Global Renewable Energy Annual Growth Rates 2000-2004



Energy-Tech Investments Percent of Total U.S. Venture Capital



Sources:
Renewables 2005 Global Status Report, REN21
Clean Energy Trends 2006, Nth Power LLC

Getting to “Significance” Involves…

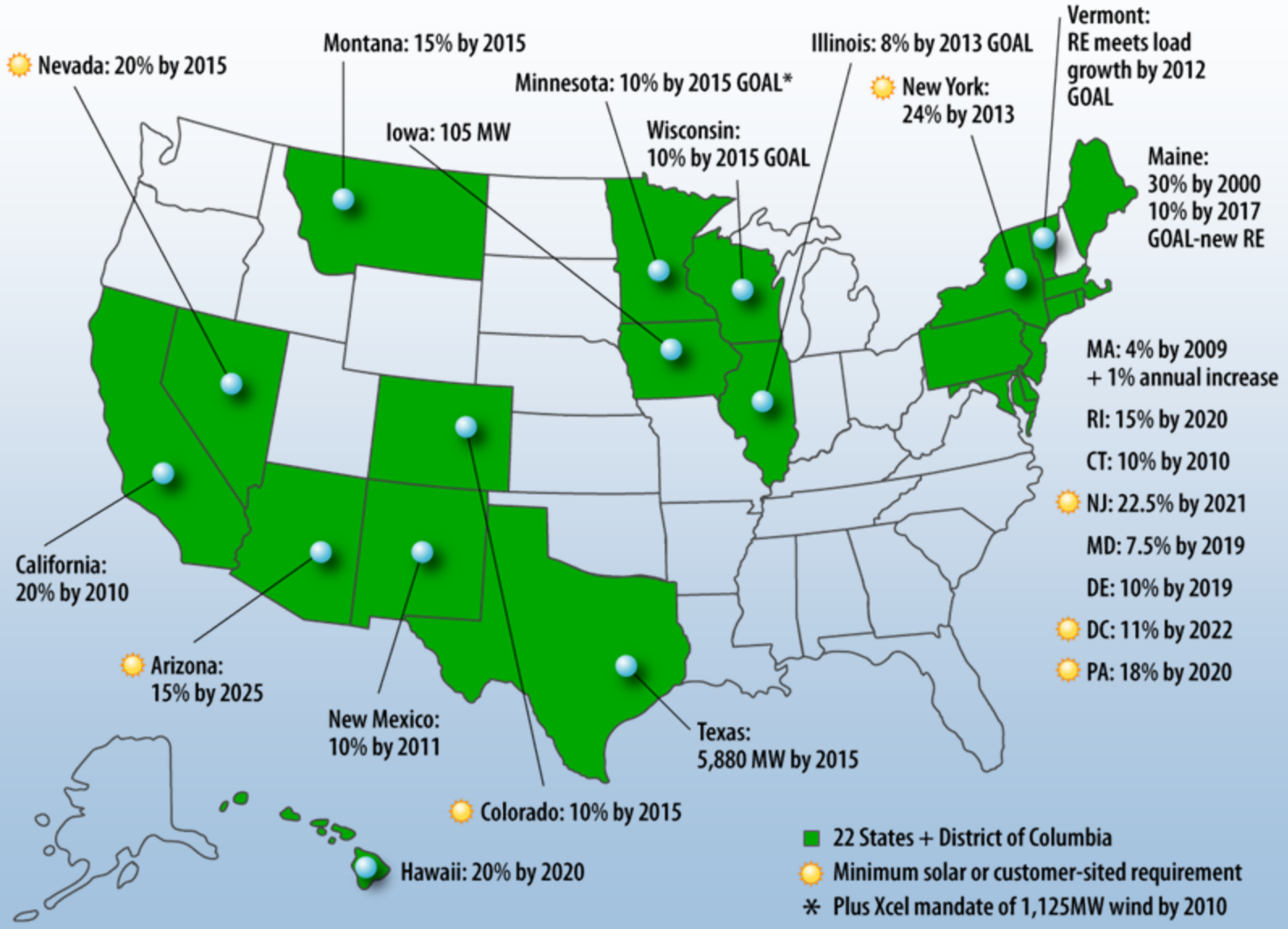
Source: NREL

Consistent Policies are Required for Long-Term Market Growth

- National goals
  - Biofuels: 30% of gasoline by 2030
  - Wind: 20% of electricity generation by 2030
  - Solar: Be market competitive by 2015 for Solar PV
- Infrastructure investments required to meet these goals, for example:
  - Biofuels: 30x30 analysis estimated infrastructure cost between $8.5 and $28.5B over 23 years

State Policy Framework

Renewable Electricity Standards



Source: DSIRE database, October 2006

Santa Fe Institute – NREL Workshop Dialogue

Development of a comprehensive framework to form a basis for a new national effort, including:

- Research
  - Technology
  - meteorology and climate, chemistry, economics, geophysics, biology (ecology, genetic engineering), political science, and human psychology
  - Understanding principle drivers, game theory approach to policy development and lock-in, U.S. leadership in international context
  - Economically, efficiently providing low carbon energy
  - Energy market completeness research
  - Theory of innovation
- Finance
  - Market completeness and opportunities for new financial instruments to mobilize capital
- Social
  - Understand complexity of social networks, decision making and “changing human behavior”
- Interaction of complex systems
  - Integrated “meta level” complex systems approach incorporating population, climate, energy, economics, agriculture


The U.S. Department of Energy's
National Renewable Energy Laboratory
www.nrel.gov
Golden, Colorado