Thinking Differently: Developing a New Energy Economy

AIChE 2007 Spring National Meeting

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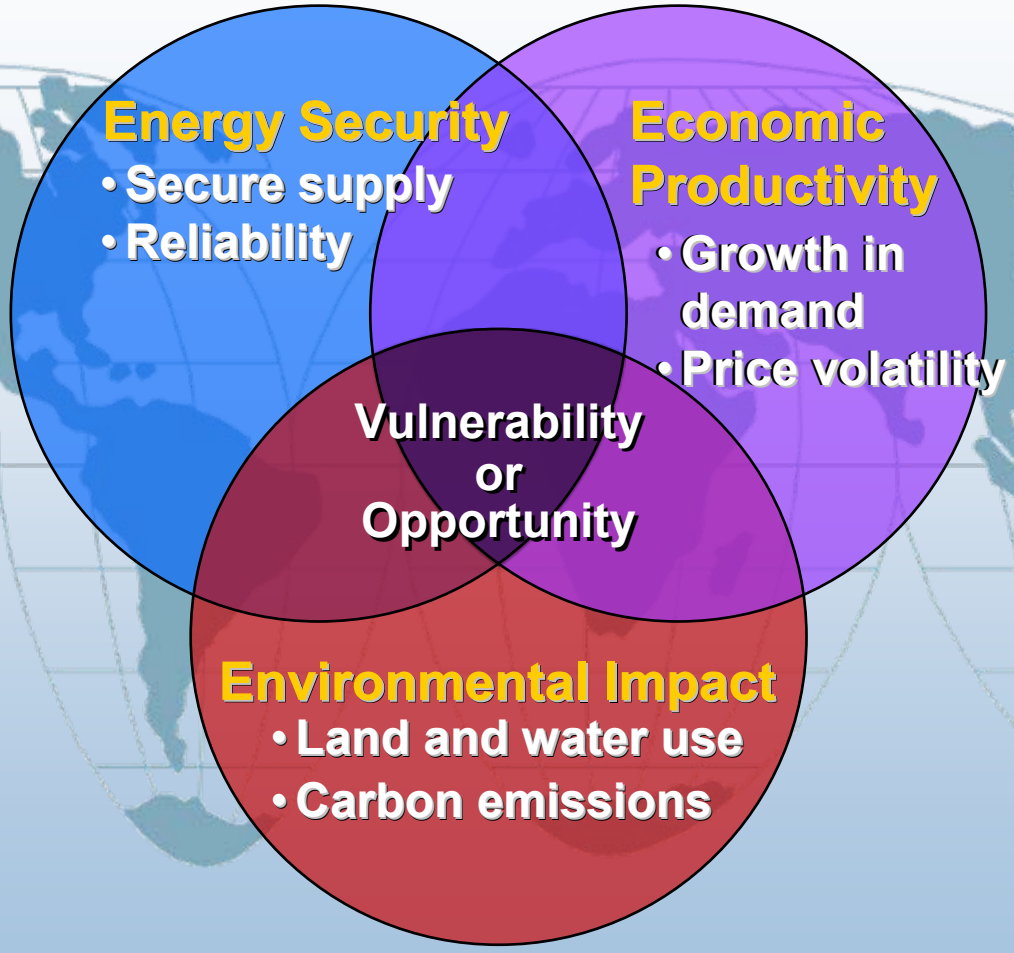
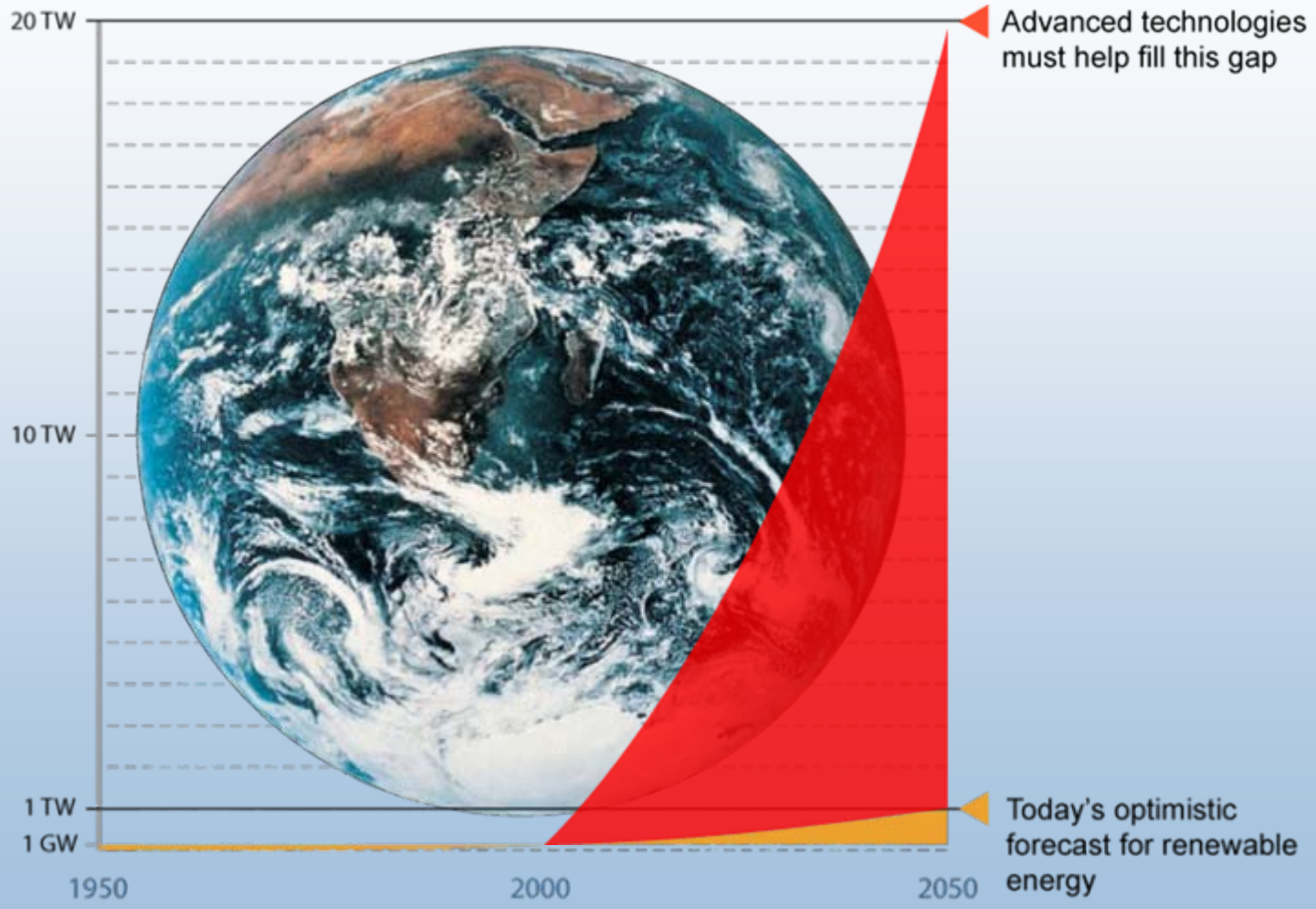
Energy Solutions Are Enormously Challenging



Must address all three imperatives

How Big is the Challenge?

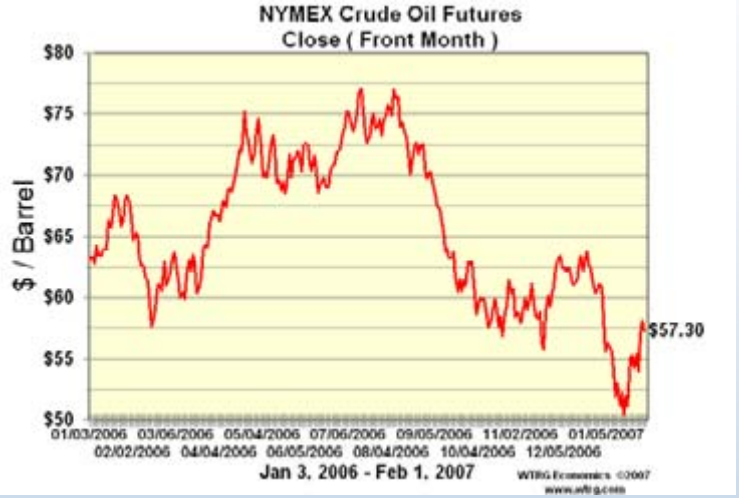


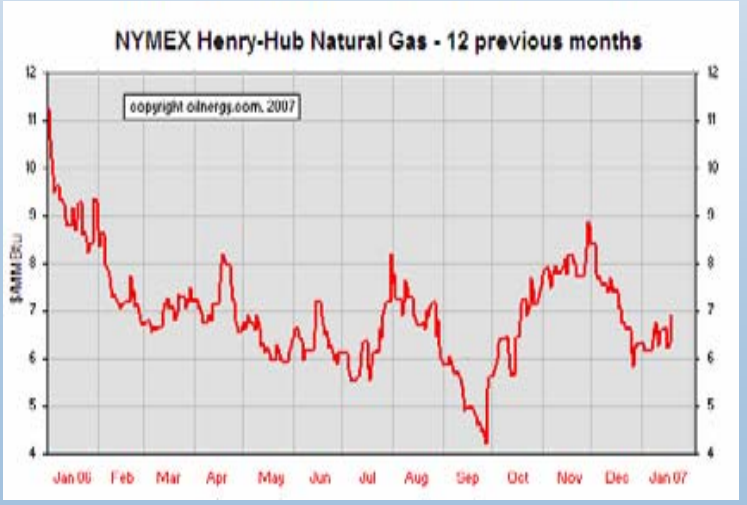
Source: Arvizu, NREL

Thinking Differently: Account for Externalities

Today's energy marketplace does not appropriately "value" certain public objectives or social goods, instead we have:

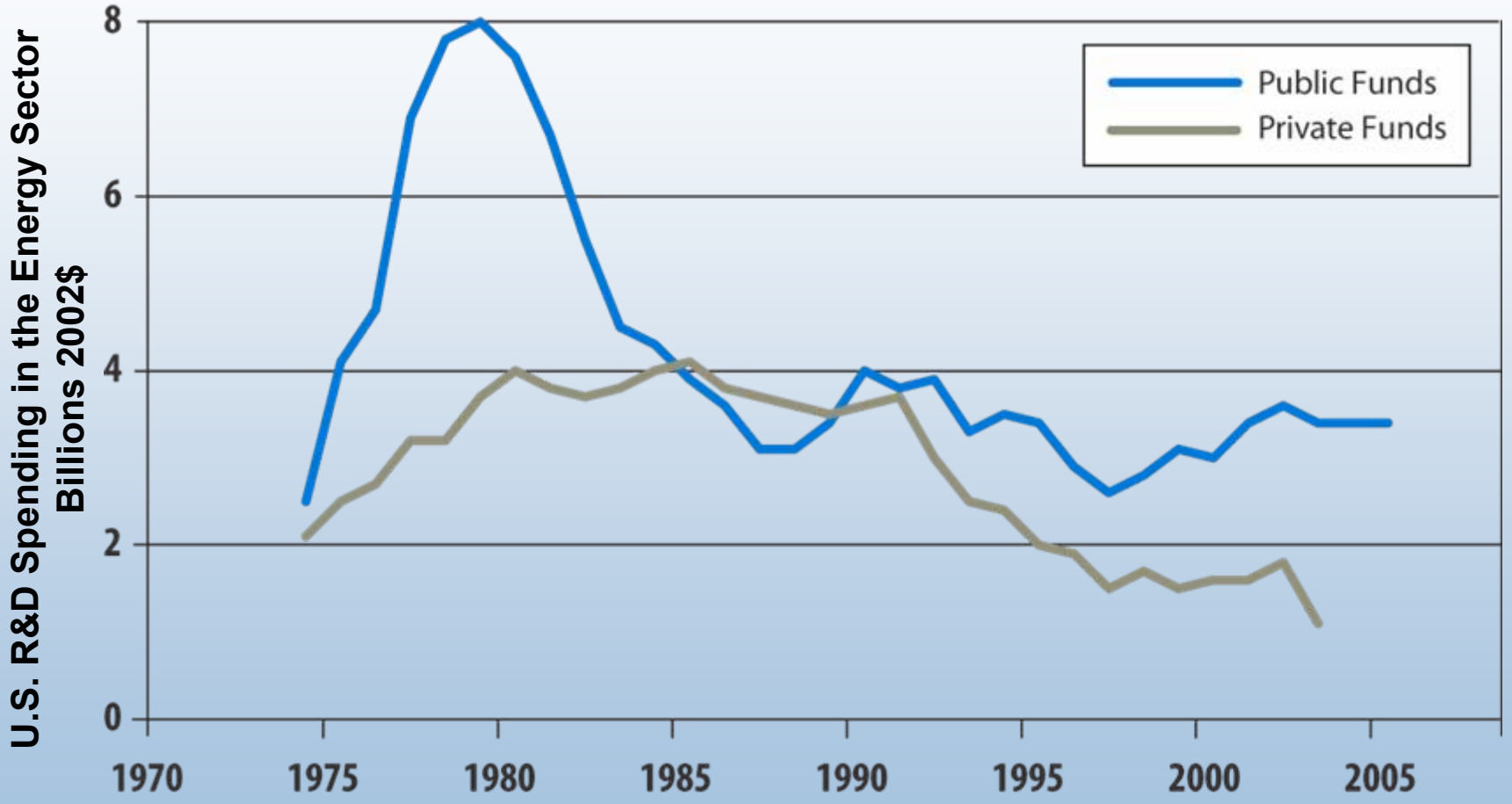
- Price volatility
- Serious environmental impacts
- Underinvestment in energy innovation





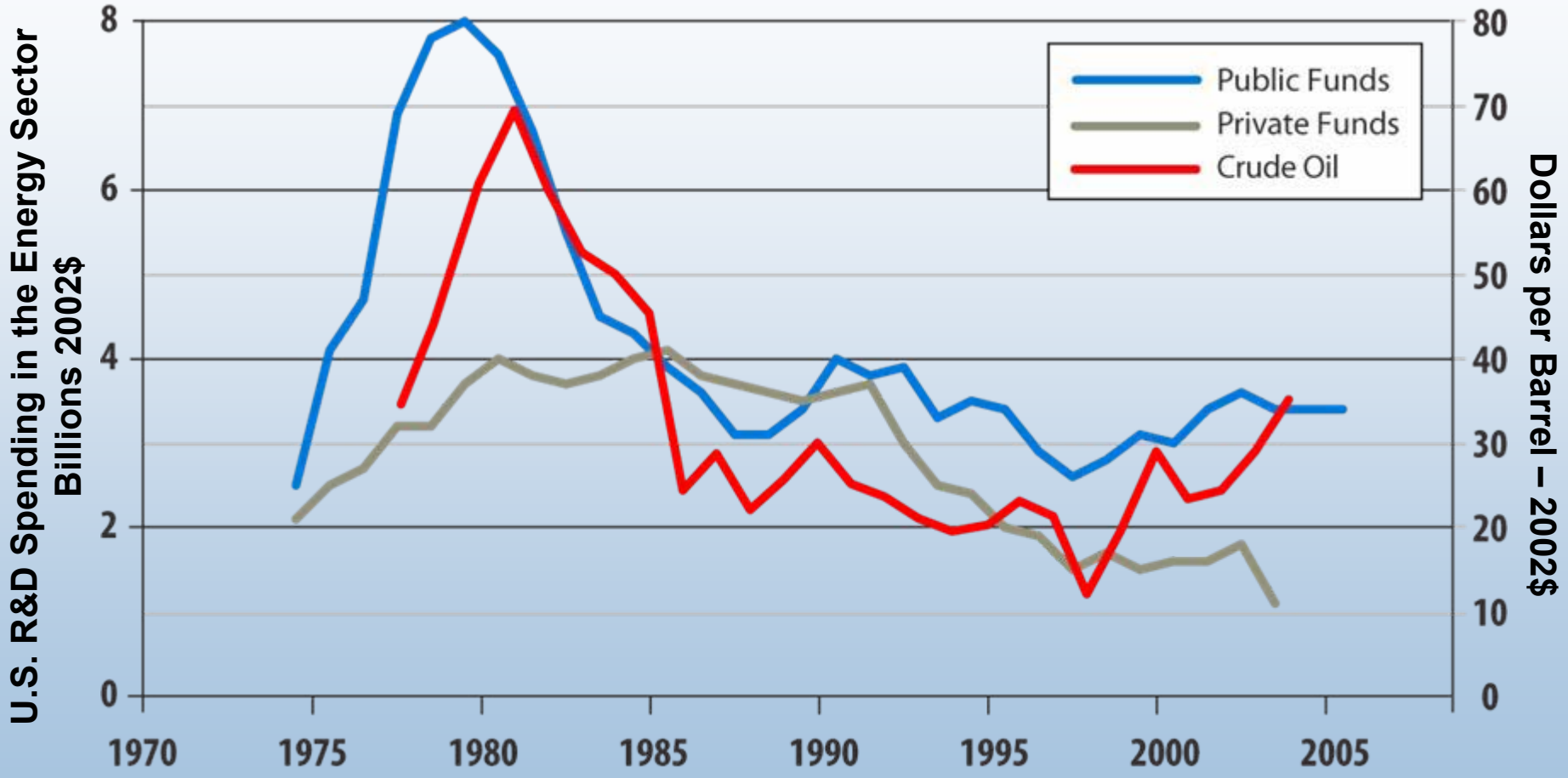
Mounting Evidence…

Declining Energy R&D Investments…



Source: Daniel Kammen, Gregory Nemet *Reversing the Incredible, Shrinking Energy R&D Budget* http://rael.berkeley.edu/files/2005/Kammen-Nemet-ShrinkingRD-2005.pdf
Table 10.3, Edition 25, *Transportation Energy Data Book* http://cta.ornl.gov/data/chapter10.shtml

Declining Energy R&D Investments… Reflect World Oil Price Movement



Source: Daniel Kammen, Gregory Nemet *Reversing the Incredible, Shrinking Energy R&D Budget* http://rael.berkeley.edu/files/2005/Kammen-Nemet-ShrinkingRD-2005.pdf
Table 10.3, Edition 25, *Transportation Energy Data Book* http://cta.ornl.gov/data/chapter10.shtml

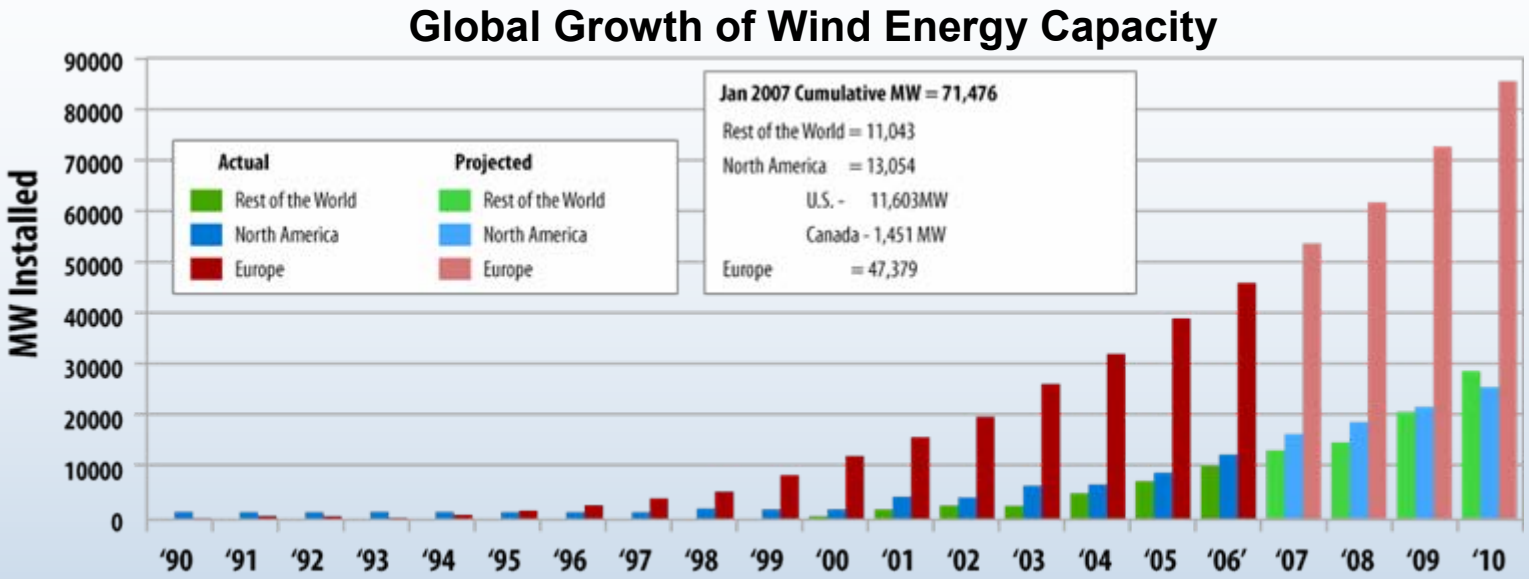
Setting the Bar Higher

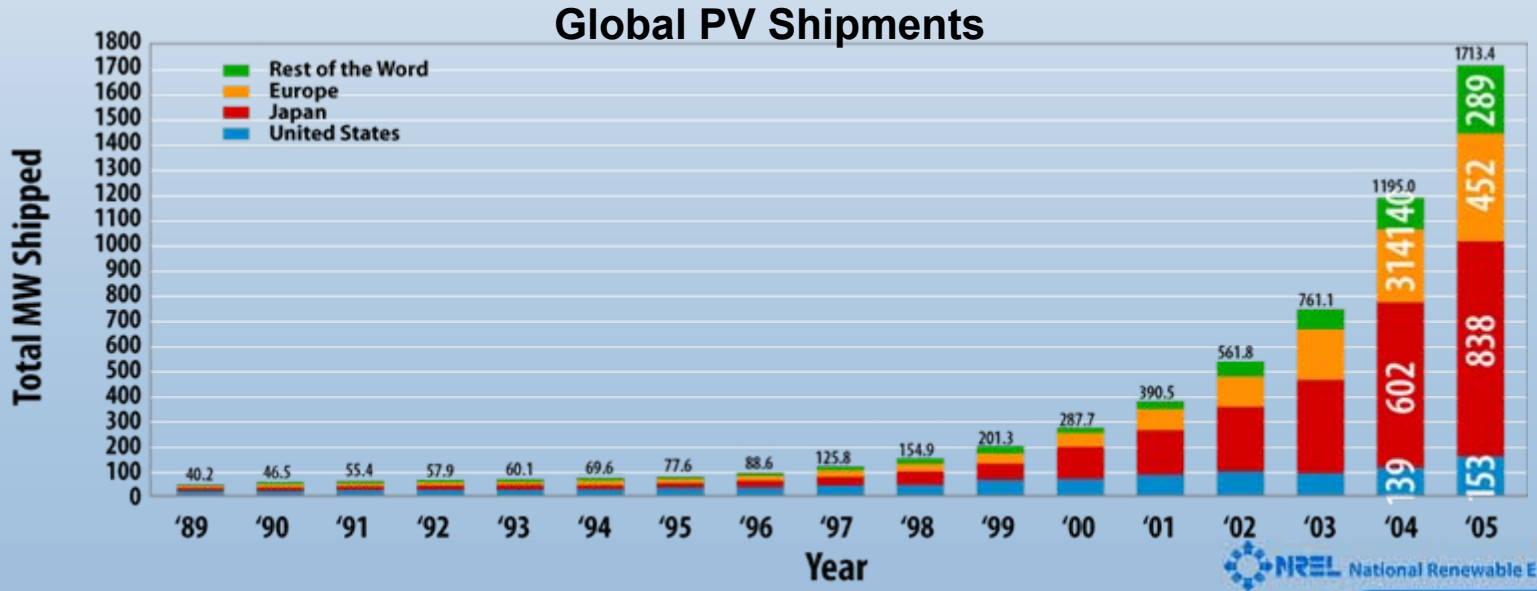
- **U.S. National goals**
  - Biofuels: reduce gasoline usage by 20% in ten years
  - Wind: 20% of total provided energy by 2030
  - Solar: Be market competitive by 2015 for PV and 2020 for CSP
- **Challenge goals**
  - 25% of nation's energy supply from renewable sources by 2025
  - Others…

Getting to "Significance" Involves…

Source: NREL

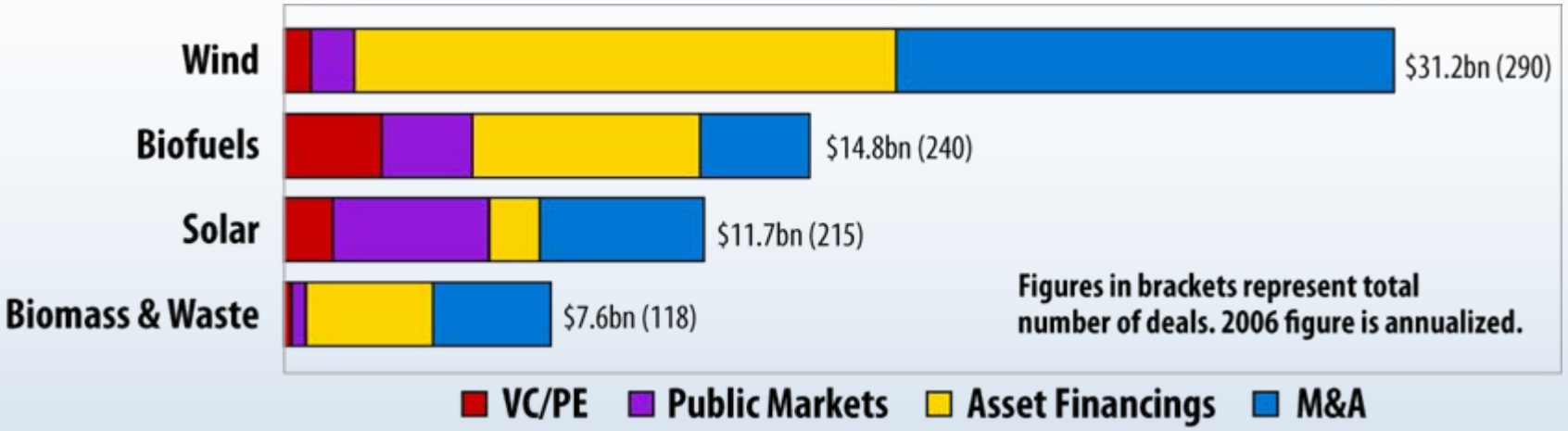
Global Markets are Growing Rapidly



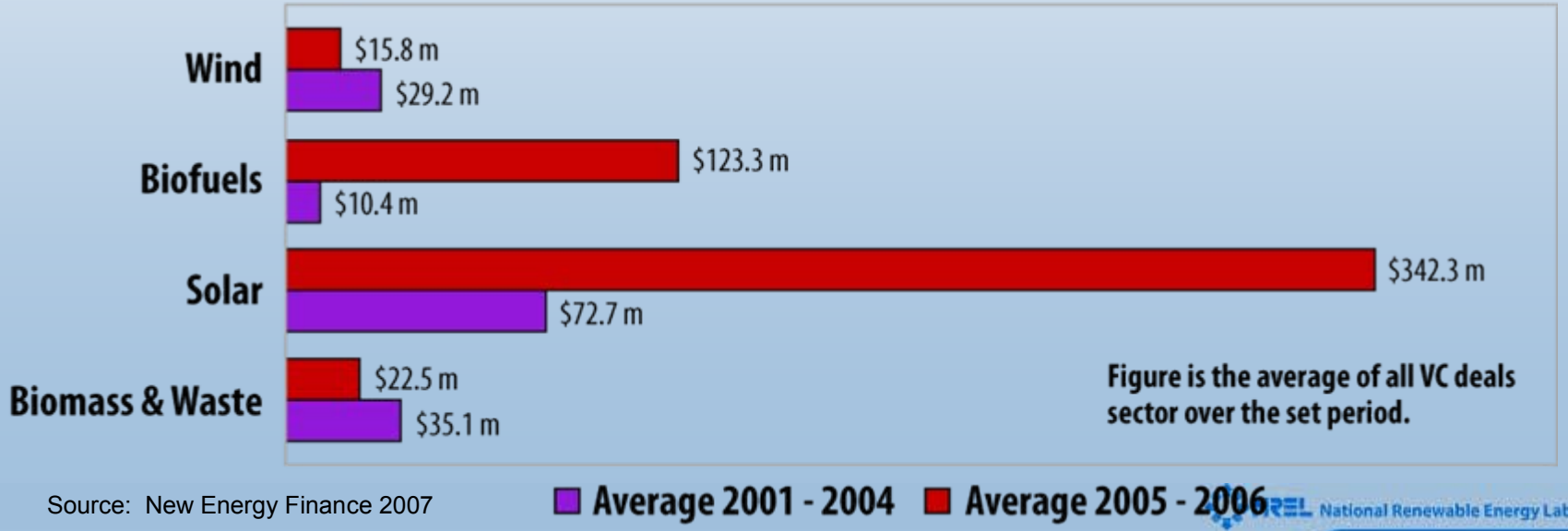


Money Is Flowing Into the Sector

2006 Investment and M&A – By Sector and Asset Class

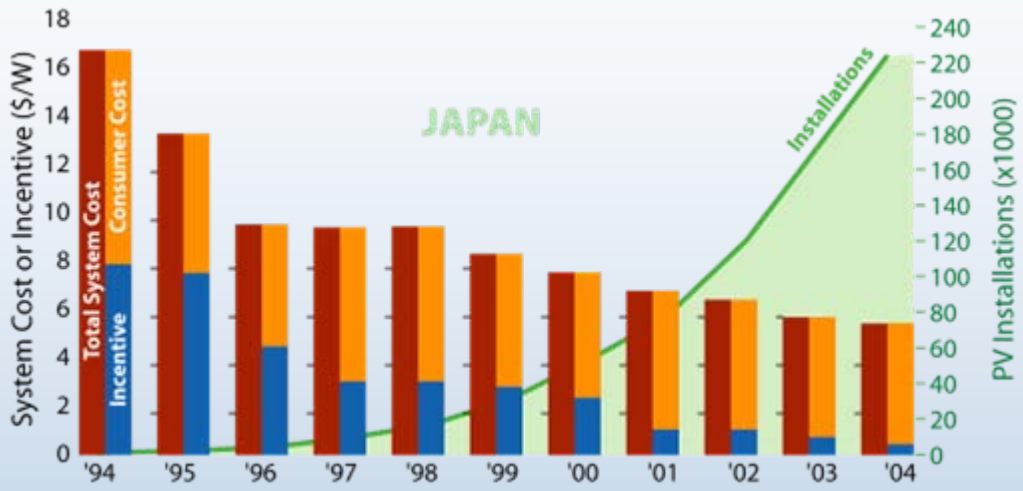


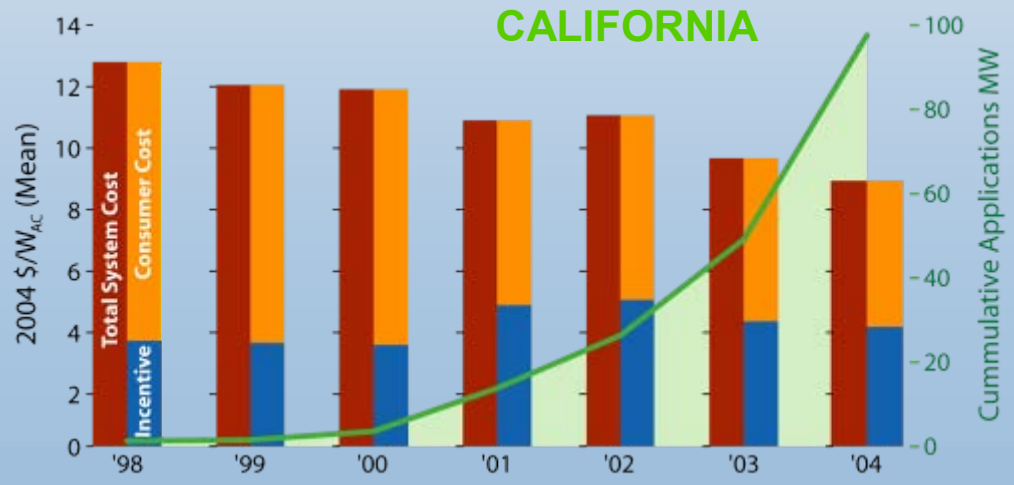
Annual VC Investment Volume – 2001-2004 Compared With 2005-2006

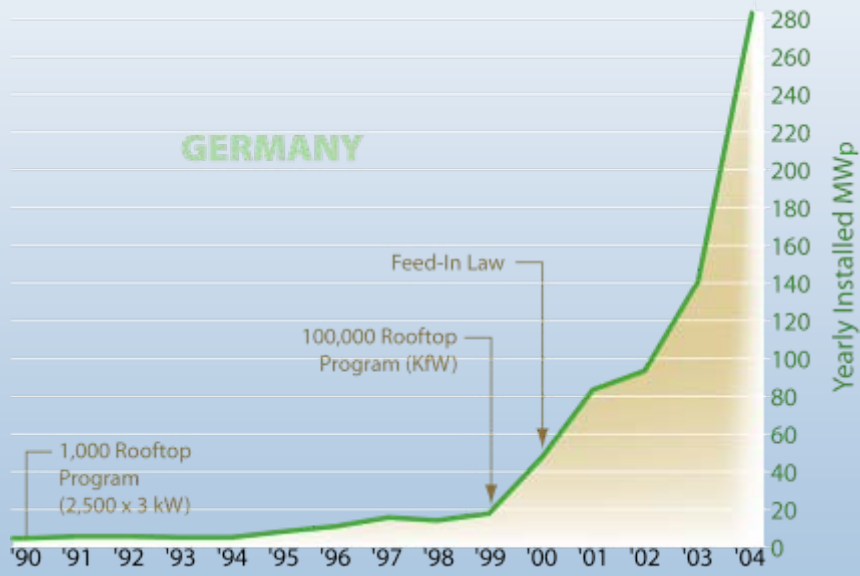


Source: New Energy Finance 2007

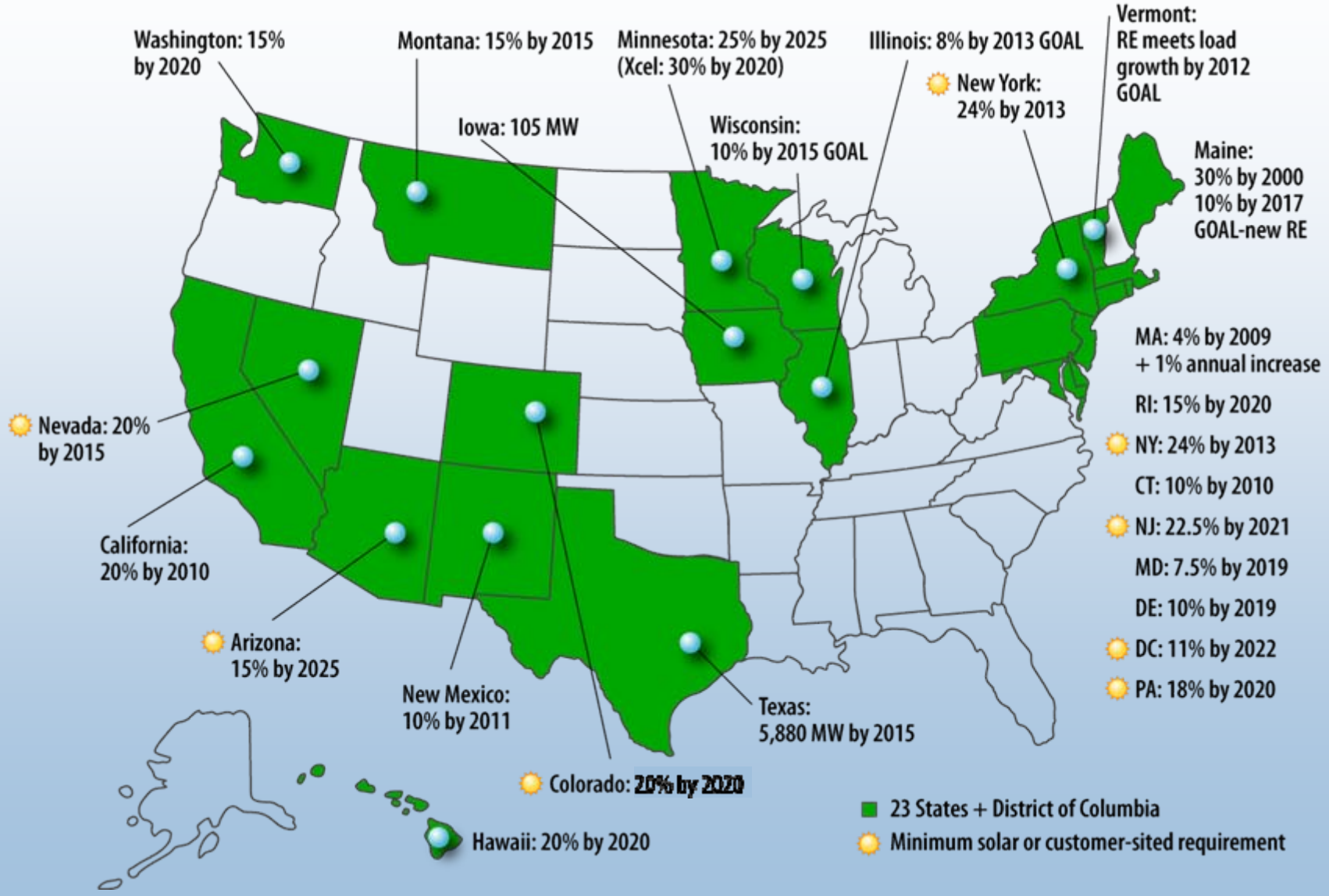
Worldwide Markets Have Driven Cost Reductions – Solar PV Example





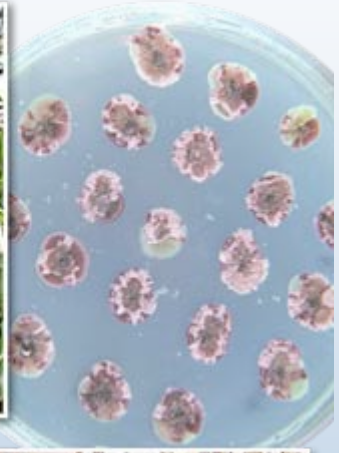


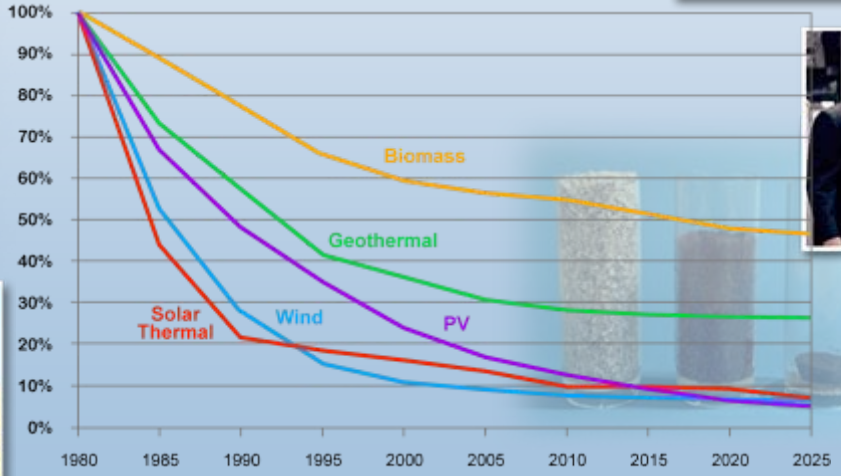
State Policy Framework
Renewable Electricity Standards



Source: DSIRE database, March 2007

Past Investments Have Yielded Impressive Cost Reductions

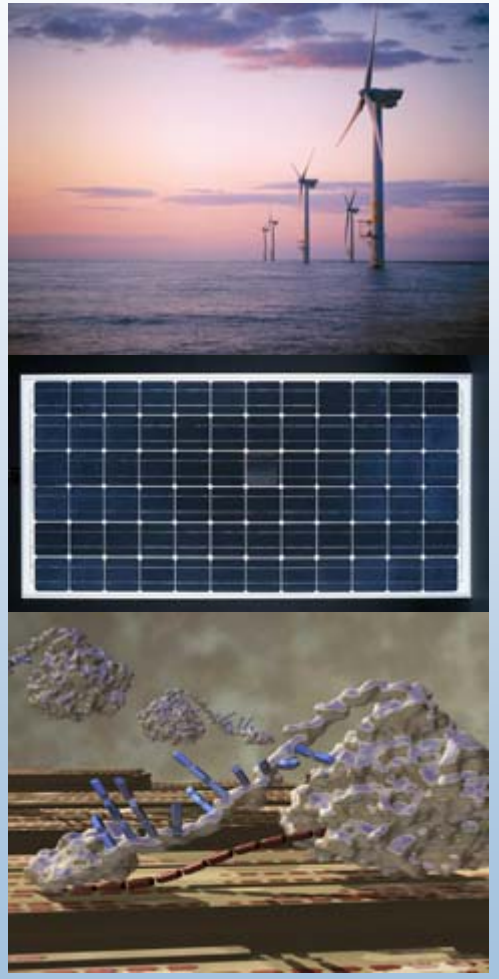




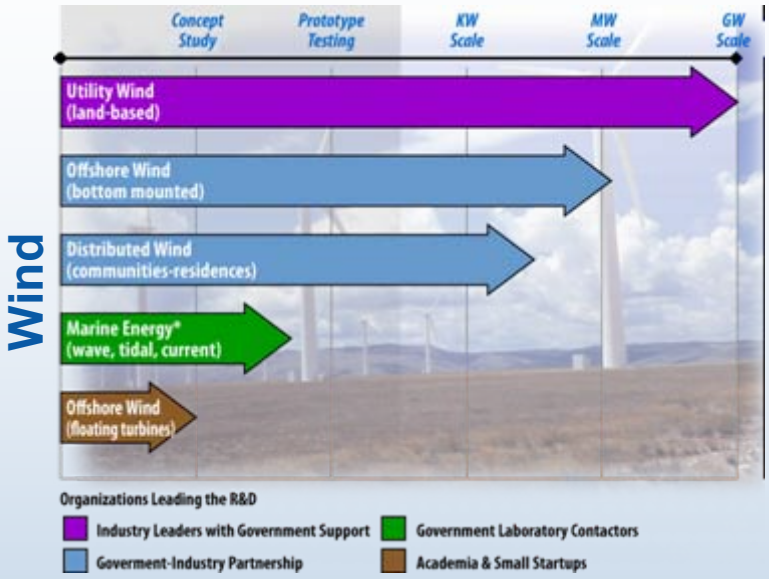
Technology Innovation Challenges

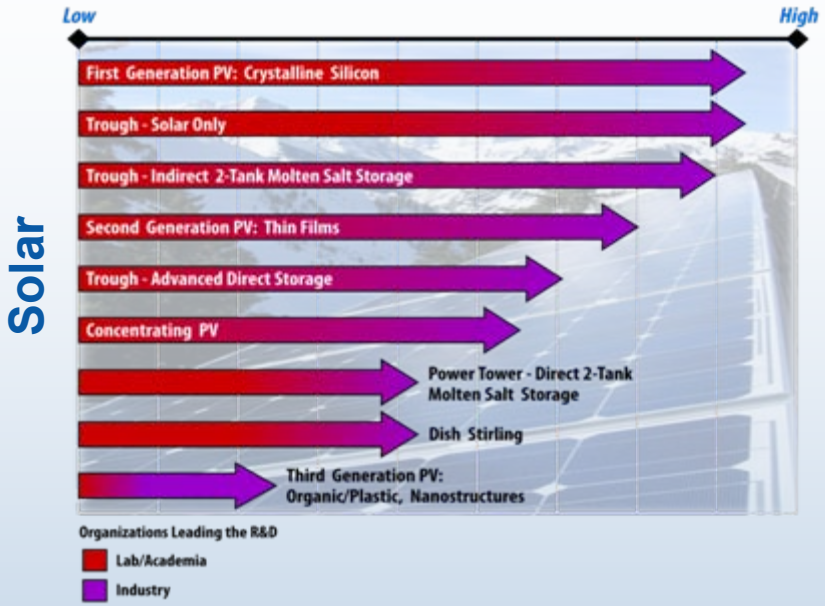
The Next Generation

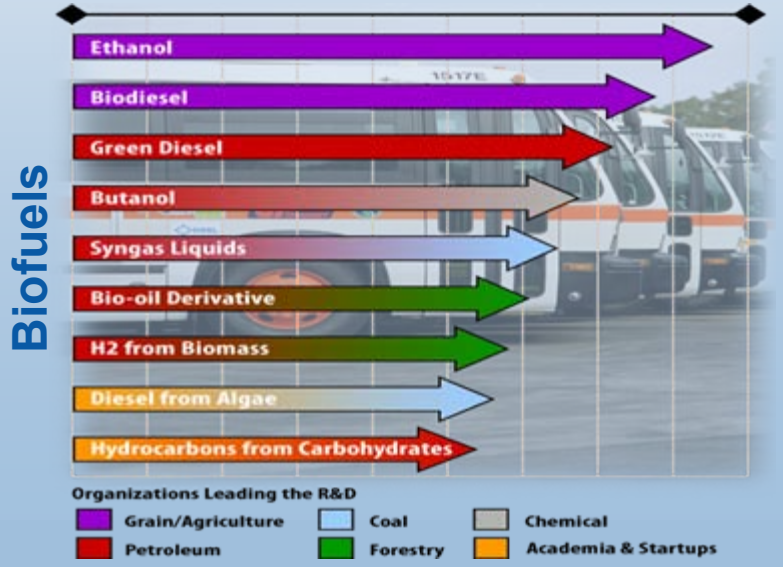
- Wind Turbines
  - Improve energy capture by 30%
  - Decrease costs by 25%
- Solar Systems
  - Improved performance through, new materials, lower cost manufacturing processes, concentration
  - Nanostructures
- Biofuels
  - New feedstocks
  - Integrated biorefineries

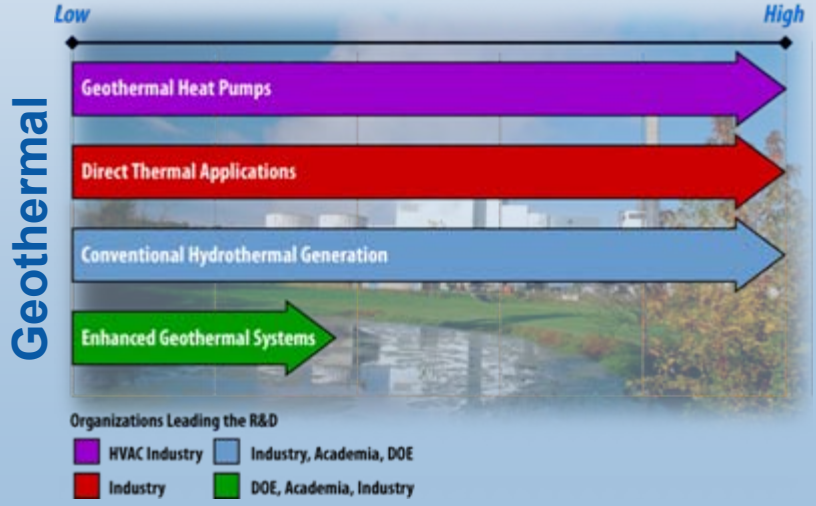


Technology Maturity Pathways





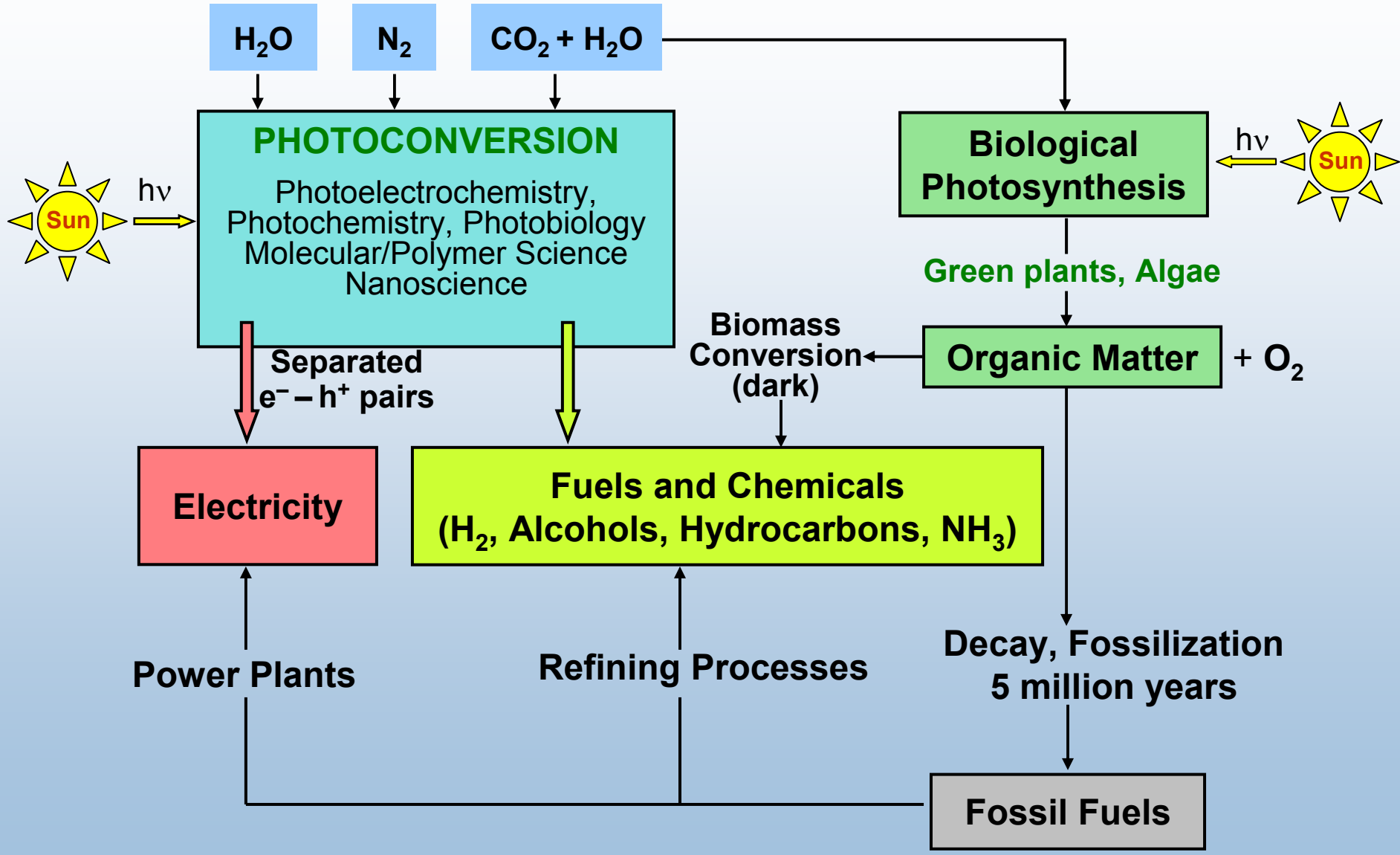




Achieving the Right Balance:
Technology Investment Pathways

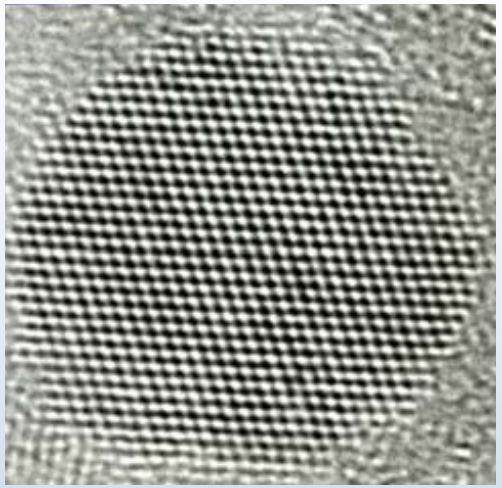
Source: NREL 2007

Photoconversion for Solar Fuels and Electricity



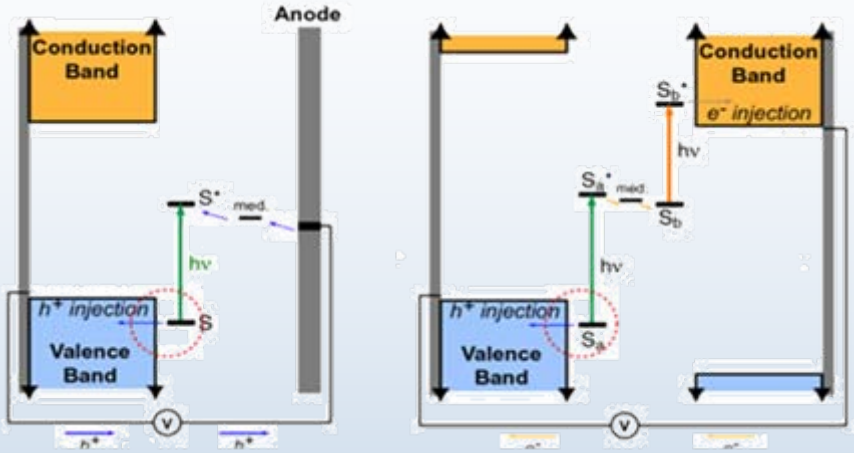
Revolutionary Photoconversion Approaches to Solar Electricity and Fuels

PEC Hydrogen Production

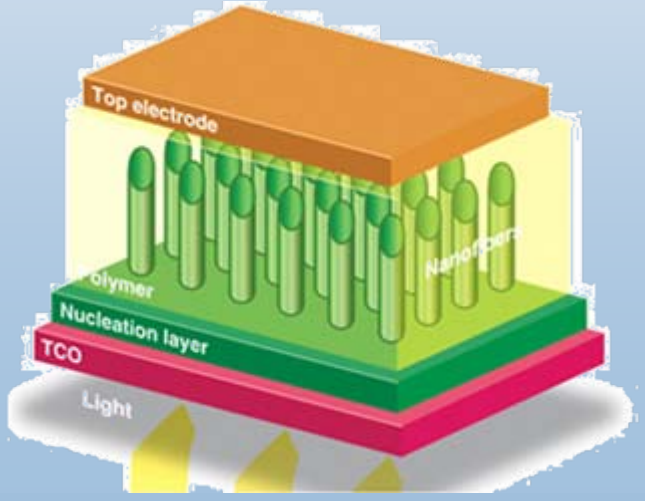


Silicon nanocrystal (dia = 7 nm)

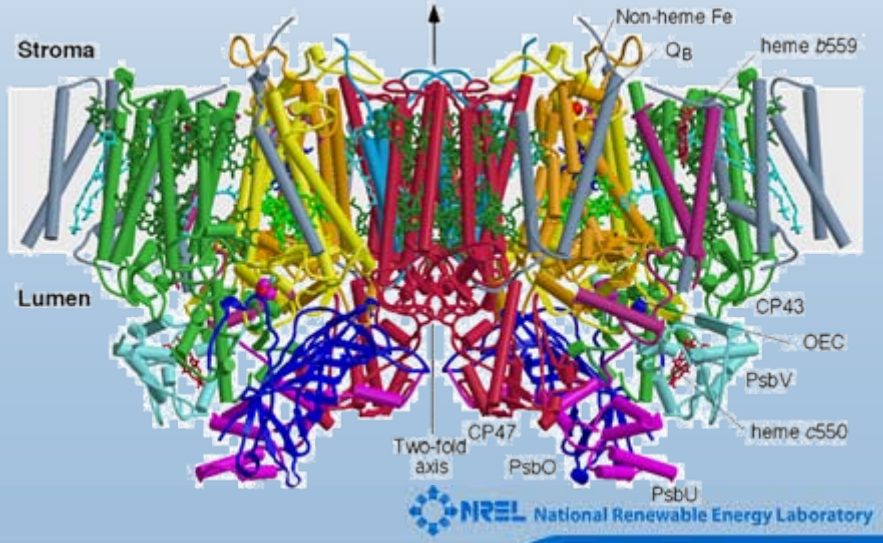
PEC Fuels and Electricity



Excitonic Photovoltaics

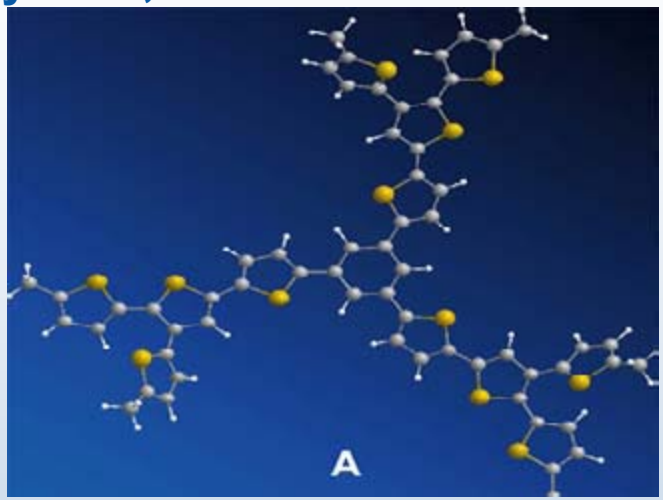


Photobiological Hydrogen Production

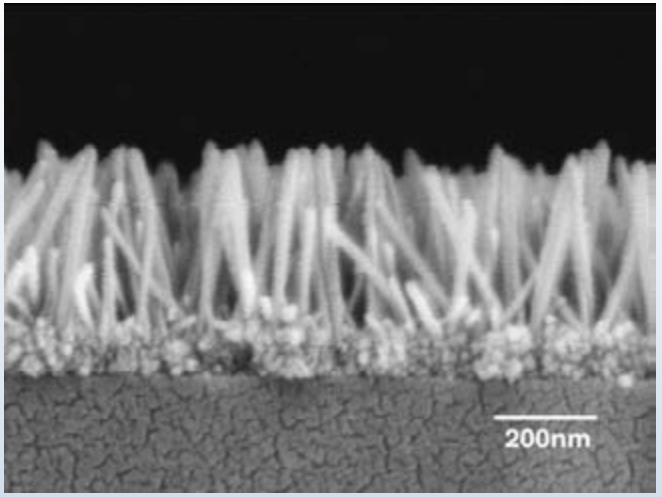


Revolutionary Organic, Molecular, and Hybrid Inorganic-Organic Approaches to Solar Electricity

Polymers, Dendrimers and Fullerenes

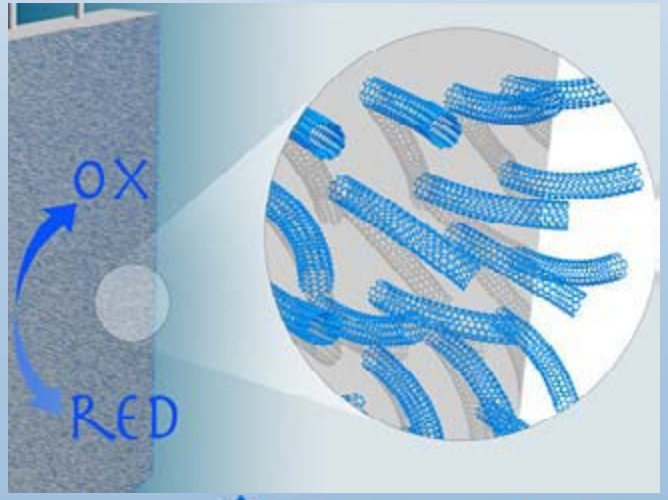


Novel Structured Assemblies



Advanced Photon Management

Nanotube Photoelectrochemistry



Promise of renewable energy is profound and can be realized if we…

- Aggressively seek a global sustainable energy economy
- Accelerate investment in technology innovation
- Acknowledge and mitigate the carbon challenge with the necessary policies

It is a matter of national will and leadership

NREL

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