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Technology Options for a Long-Term Mitigation Response to Climate Change

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Ron Sands

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JGCRI Joint Global Change Research Institute

UNIVERSITY OF MARYLAND

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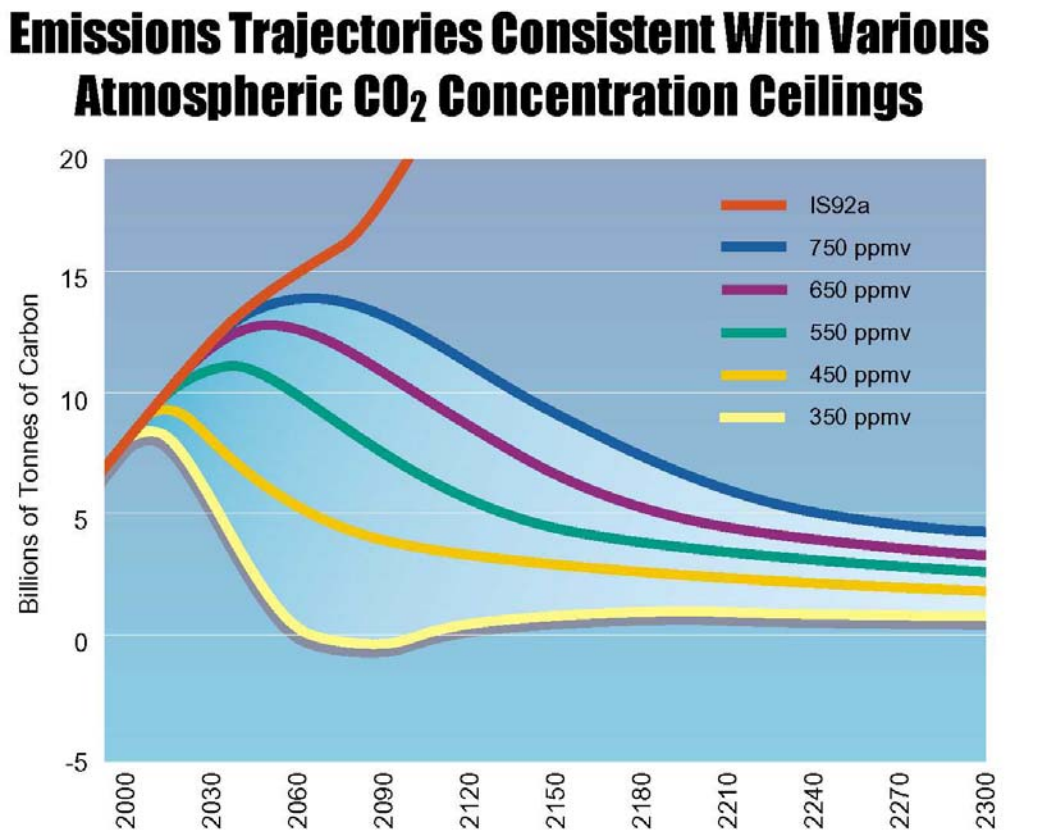
Some Major Points

- Climate change is a long-term issue—century to millennium scale—with implications for today.
- A broad portfolio including energy efficiency, renewable energy, and nuclear power is essential to manage the risk of climate change.
- Several potential additions to the technology portfolio could dramatically reduce the cost of stabilizing CO_2 concentrations—H_2, CCS, biotech.
- The scale of technology deployment, e.g. CO_2 capture & storage, could be HUGE.
- Technology alone will not necessarily stabilize the concentration of CO_2, but will help manage cost.
- Energy R&D is declining.

Stabilizing CO_2 Concentrations

- Stabilization of greenhouse gas **concentrations** is the goal of the Framework Convention on Climate Change

- Stabilizing the concentration of CO_2 is a very long term problem

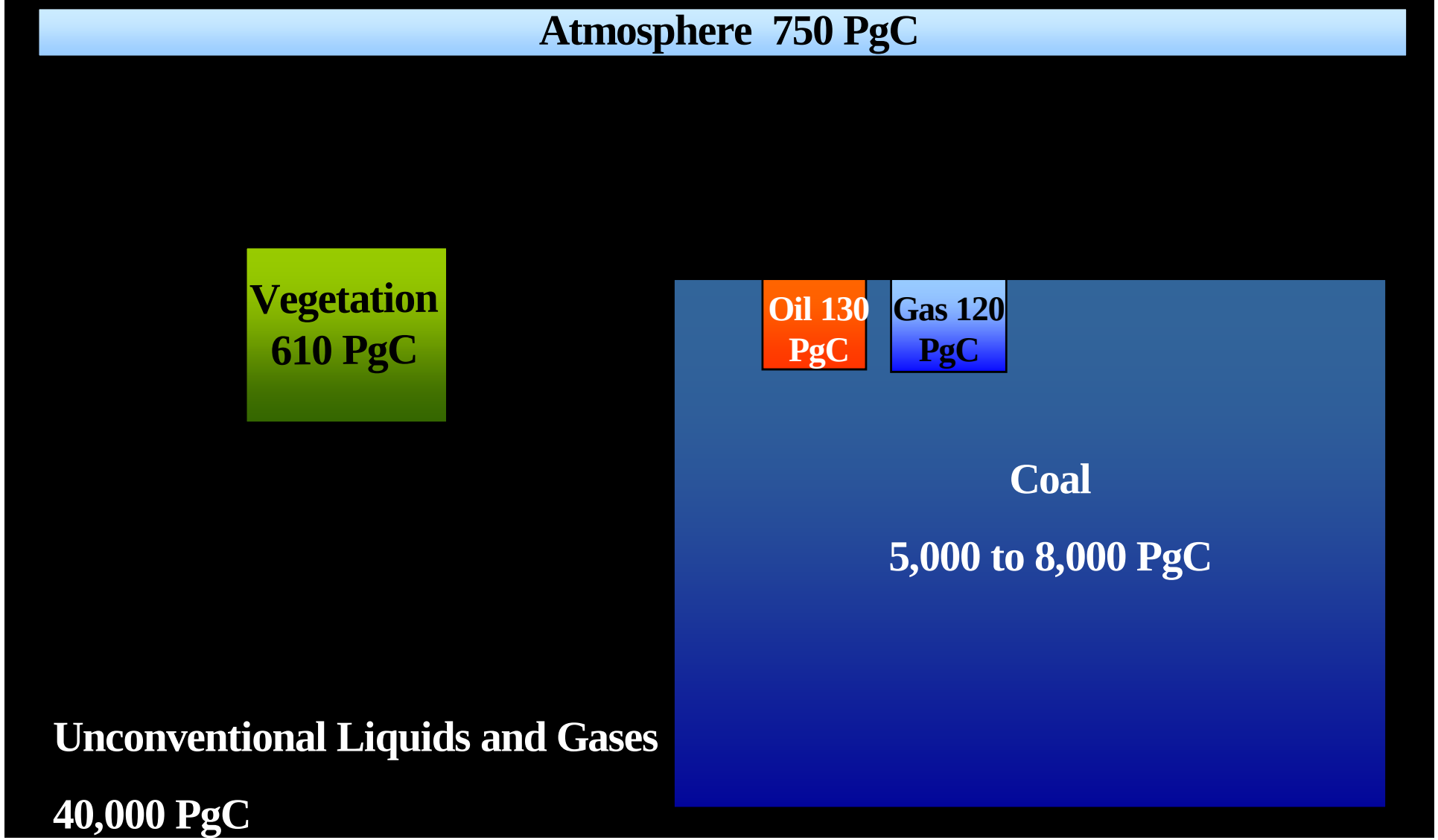


- Stabilization means that GLOBAL emissions must peak in the decades ahead and then decline indefinitely thereafter.

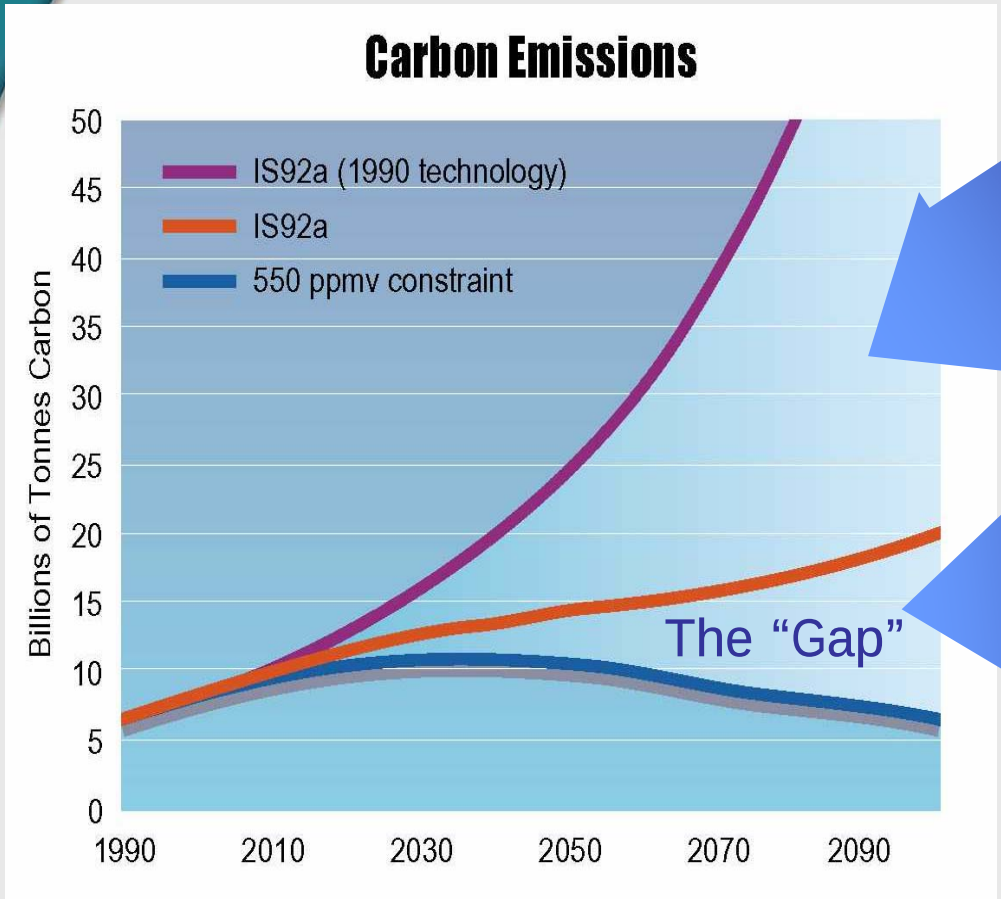
Will the Problem Go Away on Its Own?

Won't the limited conventional oil and gas resource force a transition in the near term to a world based on energy efficiency and renewable and nuclear energy forms?

FOSSIL FUEL RESOURCES



Stabilizing CO_2
Base Case and "Gap" Technologies



<u>Assumed</u> Advances In

- Fossil Fuels
- Energy intensity
- Nuclear
- Renewables

Gap technologies

- CO_2 capture & storage
  - Adv. fossil
- H2 and Adv. Transportation
- Biotechnologies
  - Soils, Bioenergy, adv. Biological energy

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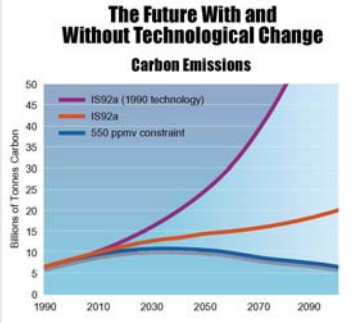
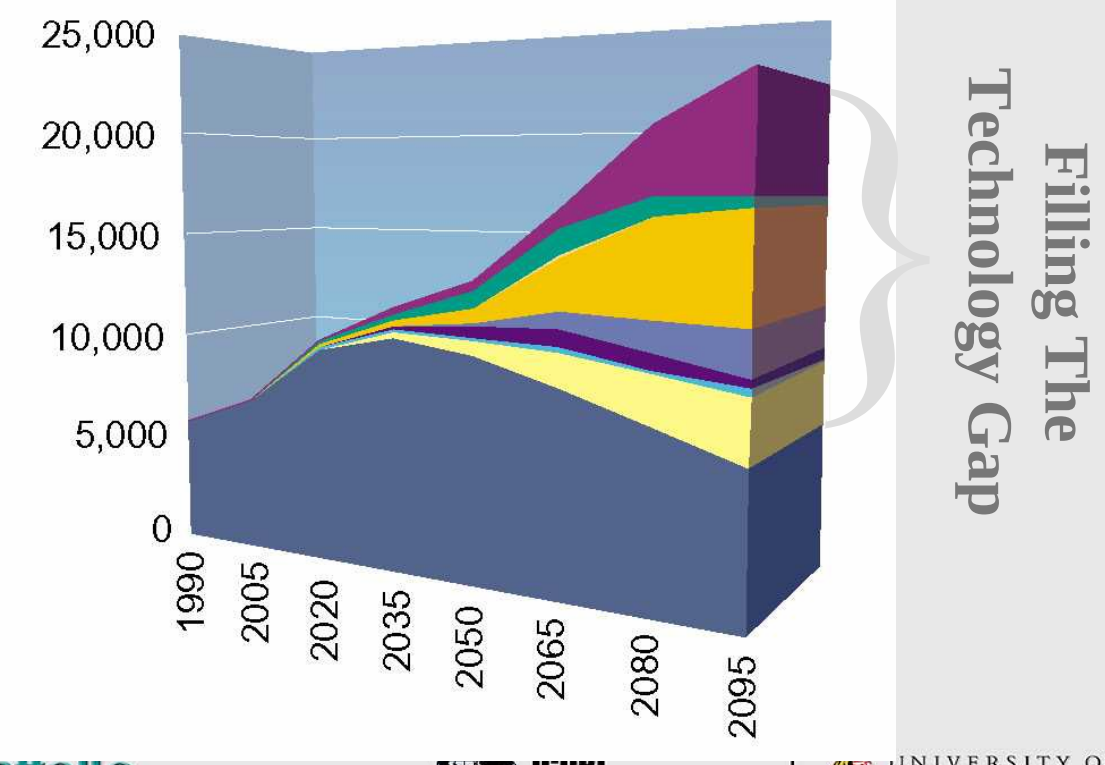
Technology Breakthroughs Are Essential to Stabilizing Concentrations and Controlling Costs. For Example …





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A Portfolio of Technologies Is Necessary

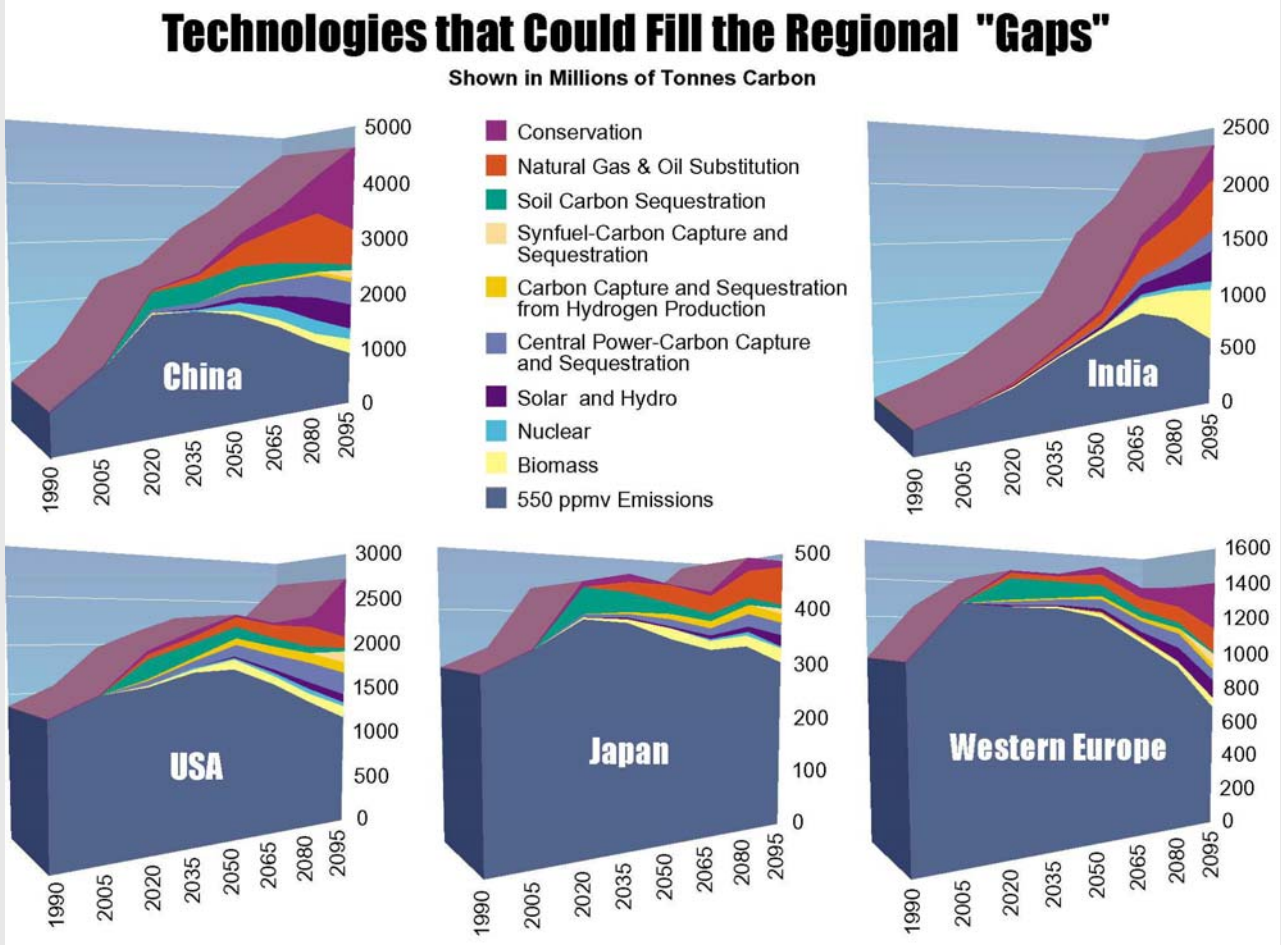
to Manage the Risks of Climate Change and to Respond to Evolving Conditions in …

1. Science,
2. Economy,
3. Policy,
4. Energy Resources, and
5. Regional Technology Needs.

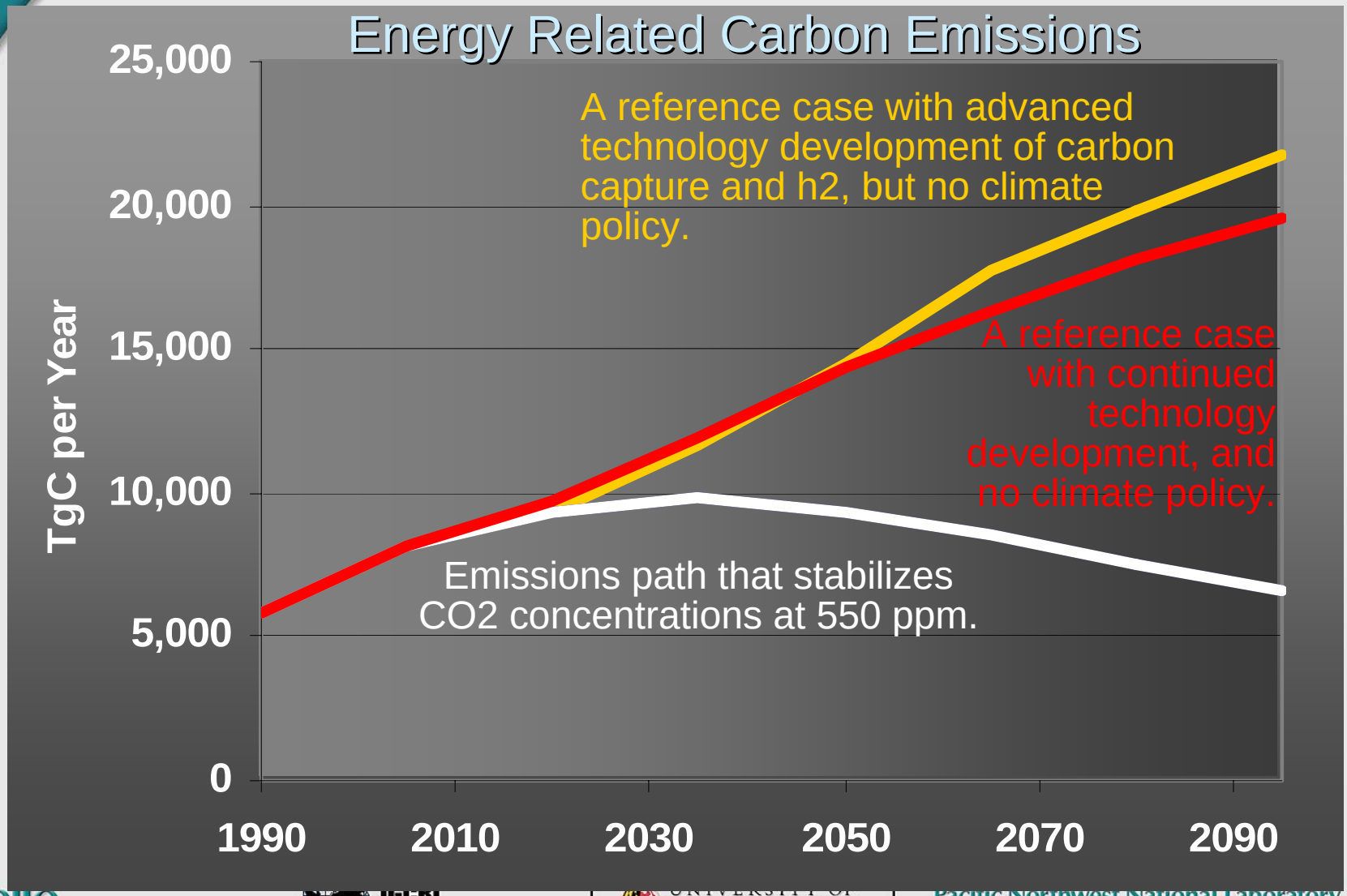
A Technology Strategy Requires A Portfolio of Technologies

- Energy Intensity Improvements
  - Industry
  - Buildings
  - Transportation
- Wind and Solar
- Biotechnology
  - Soils
  - Biomass crops
  - Advanced biotechnology
- Nuclear
- CO_2 Capture and Storage
- Hydrogen systems

Technology Contributions Change With Place and Time

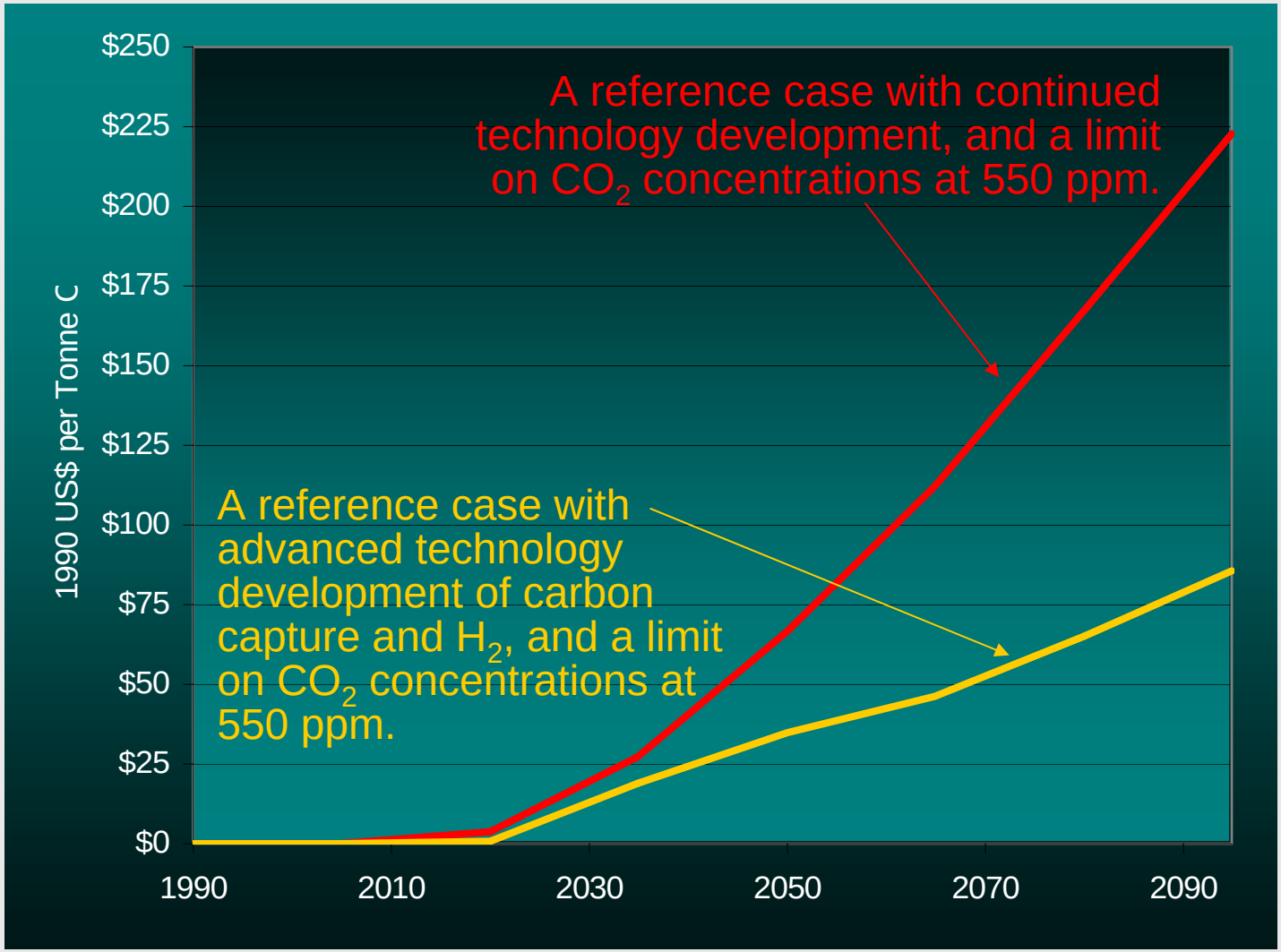


Technology Alone Won't NECESSARILY Stabilize CO_2 Concentrations



Technology Helps Control Cost

- Carbon Tax
- Uniformly & Efficiently Applied Over Time and Space



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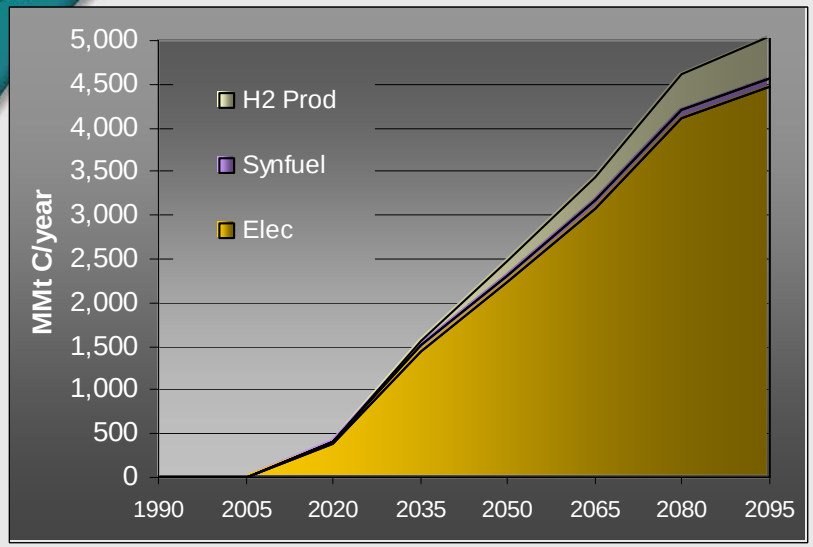
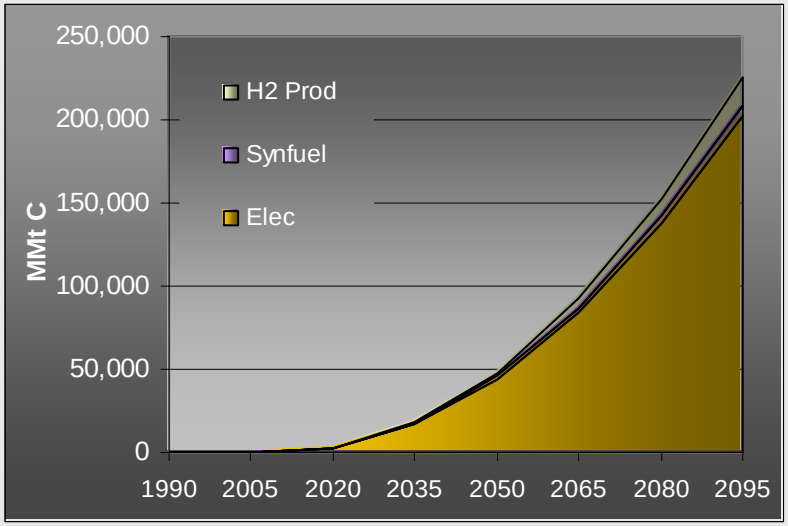
CO_2 Capture and Storage B2 AT with Stabilization





Carbon Storage Reservoir	Range (PgC)
Deep Saline Reservoirs	*87 to 2,727*
Depleted Gas Reservoirs	*136 to 300*
Depleted Oil Reservoirs	*41 to 191*
Unminable Coal	*>20*
Basalt Formations	*>1,000*
Deep Ocean	*1,400 to 27,000*

Source: Herzog et al. (1997), Freund and Ormerod (1997), PNNL (2001).

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Value of Technology Improvements

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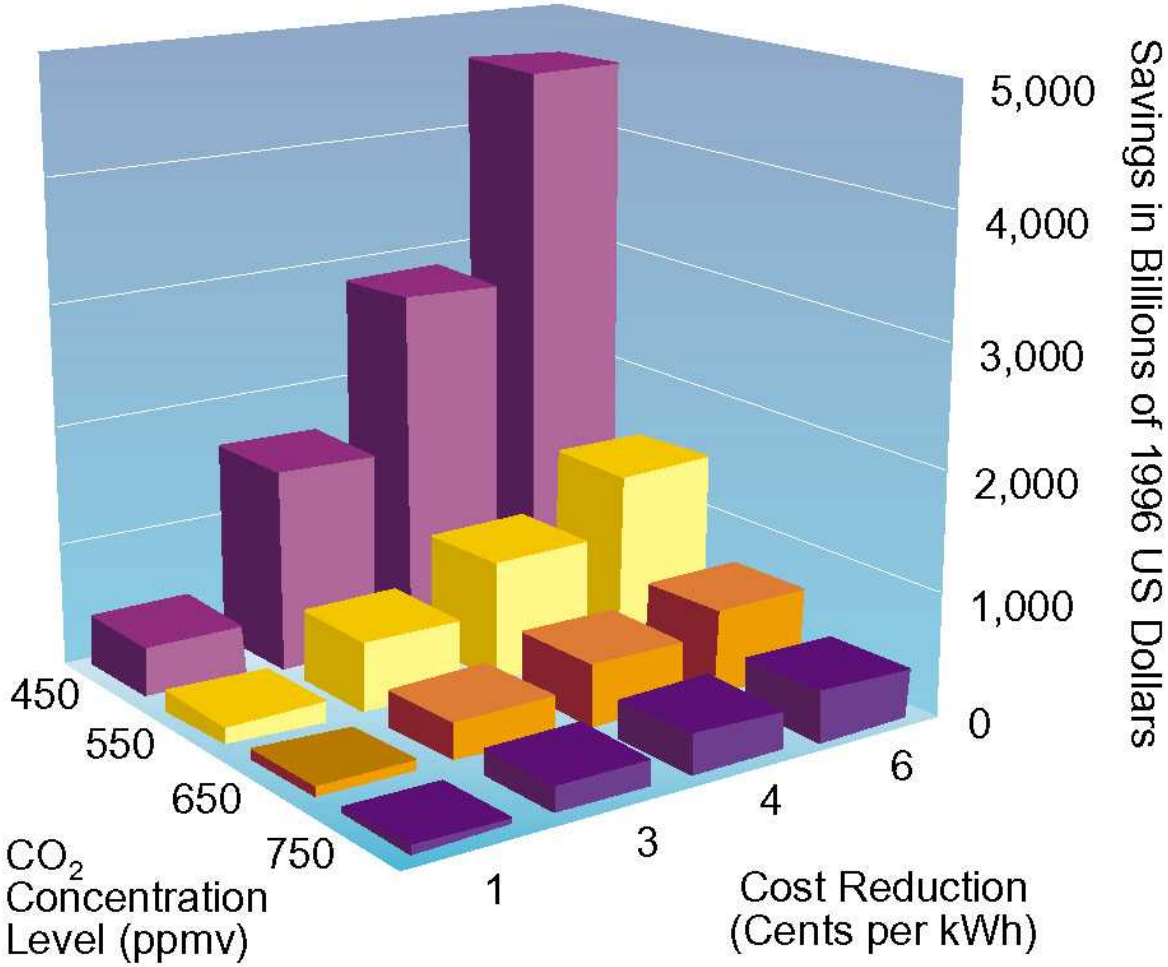
Value of Solar Photovoltaic Technology Improvement



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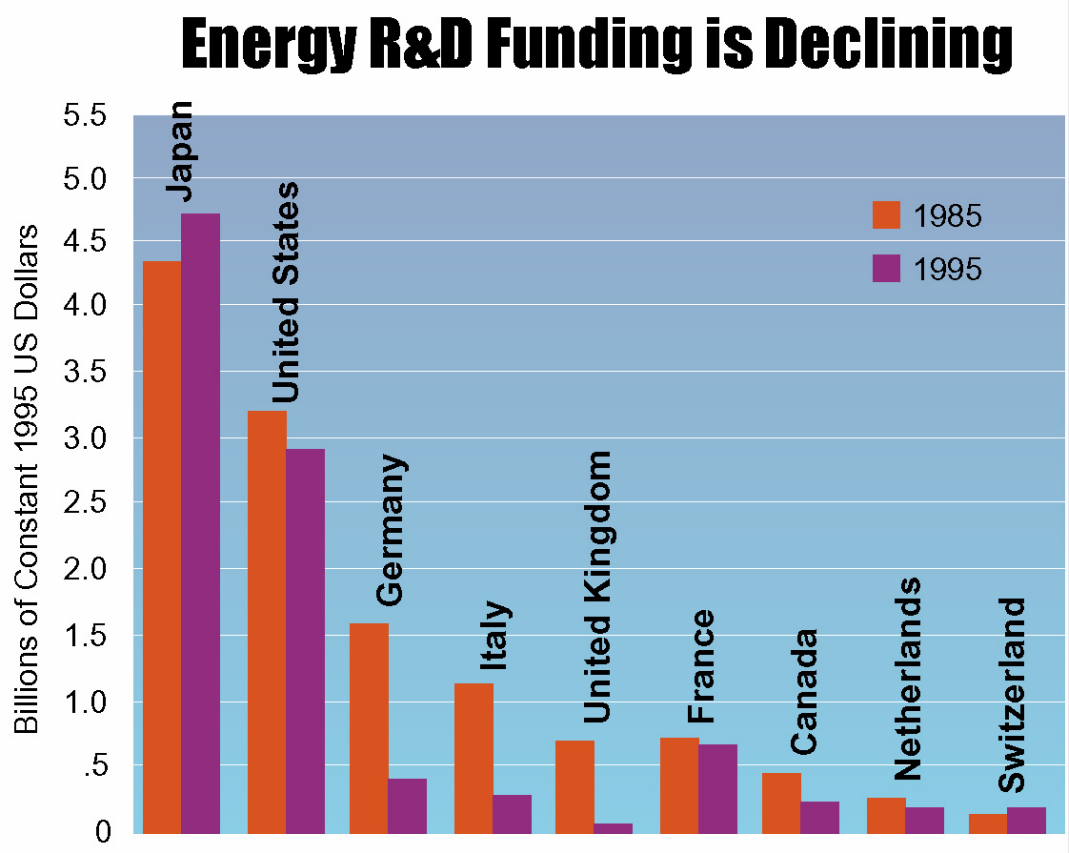
Energy R&D Investments Are Declining …



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The GTSP Web Site

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