GTSP

Global Energy Technology Strategy Program

GTSP II: What Have We Learned?

GTSP Steering Group Meeting

May 2005

Jae Edmonds

25 May 2005

Cosmos Club

Washington, DC

Purpose of the Annual Meetings

- To review progress in the GTSP, and
- To solicit advise in directions for the future.

GTSP
Global Energy Technology Strategy Program

Thanks to the Sponsors

- Battelle Memorial Institute
- California Energy Commission
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- Kansai Electric Power
- National Institutes for Environmental Studies (Japan)
- Rio Tinto
- US Department of Energy—Office of Science
- US Department of Energy—Office of Fossil Energy

Yesterday's Technical Sessions

- 9:00 a.m. *Welcome and Introductions*—Ron Sands, Gerry Stokes, Jae Edmonds
- 9:15 a.m. *Scenarios Overview*—Hugh Pitcher, JGCRI
- 9:45 a.m. *Value of Technology*—Leon Clarke, JGCRI

- 10:15 a.m. Break

- 10:30 a.m. *Technology Choice in Industry*—Matthias Ruth, University of Maryland
- 11:15 a.m. *Technology and Climate Change in China*—Ron Sands for Jiang Kejun, ERI, Beijing
- 12:00 noon Working Lunch
- 1:00 p.m. *Technology and Climate Change in India*—P.R. Shukla, IIM, Ahmedabad

- 2:00 p.m. *Technology in Buildings*—Jae Edmonds, JGCRI

- 2:40 p.m. Break

- 3:00 p.m. Nuclear Technologies—Sonny Kim, JGCRI
- 3:45 p.m. Energy Challenges in Northeast Asia—Tae-Yong Jung, IGES, Japan

Today's Agenda

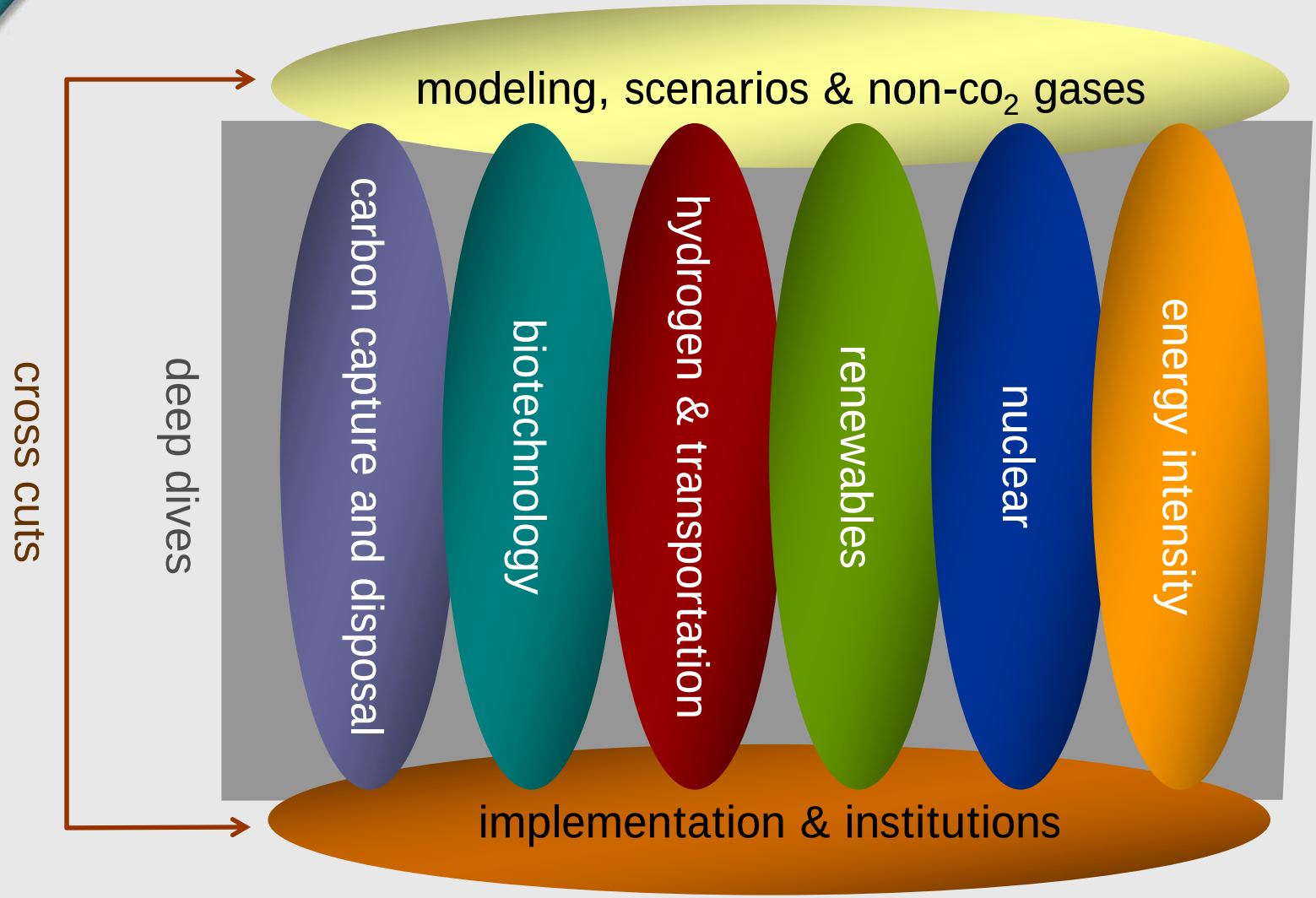
8:00 a.m.	Continental Breakfast	
8:30 a.m.	***Welcome and Introductions***	Richard H. Rosenzweig
8:40 a.m.	***Purpose of Meeting***	Charlette A. Geffen
8:50 a.m.	***What Have We Learned?***	Jae Edmonds
10:00 a.m.	*Break*	
10:15 a.m.	***Global Dimensions of the Energy Technology Strategy***	Gerald Stokes
11:00 a.m.	***Biotechnology: Challenges and Opportunities***	Ari Patrinos
12:00 noon	*Lunch*	
1:00 p.m.	***The Economics of Biotechnology***	Steven Smith
2:00 p.m.	*Break*	
2:15 p.m.	***The Status of the Carbon Capture and Storage Deep Dive***	Marshall Wise & James Dooley
3:15 p.m.	***The Midwest Regional Carbon Sequestration Project: Laying the Groundwork for CCSP Deployment on the Ground***	Dave Ball
4:00 p.m.	Summary of Proceedings and Next Steps	
4:30 p.m.	Adjourn	

The GTSP
Phase II

Objective

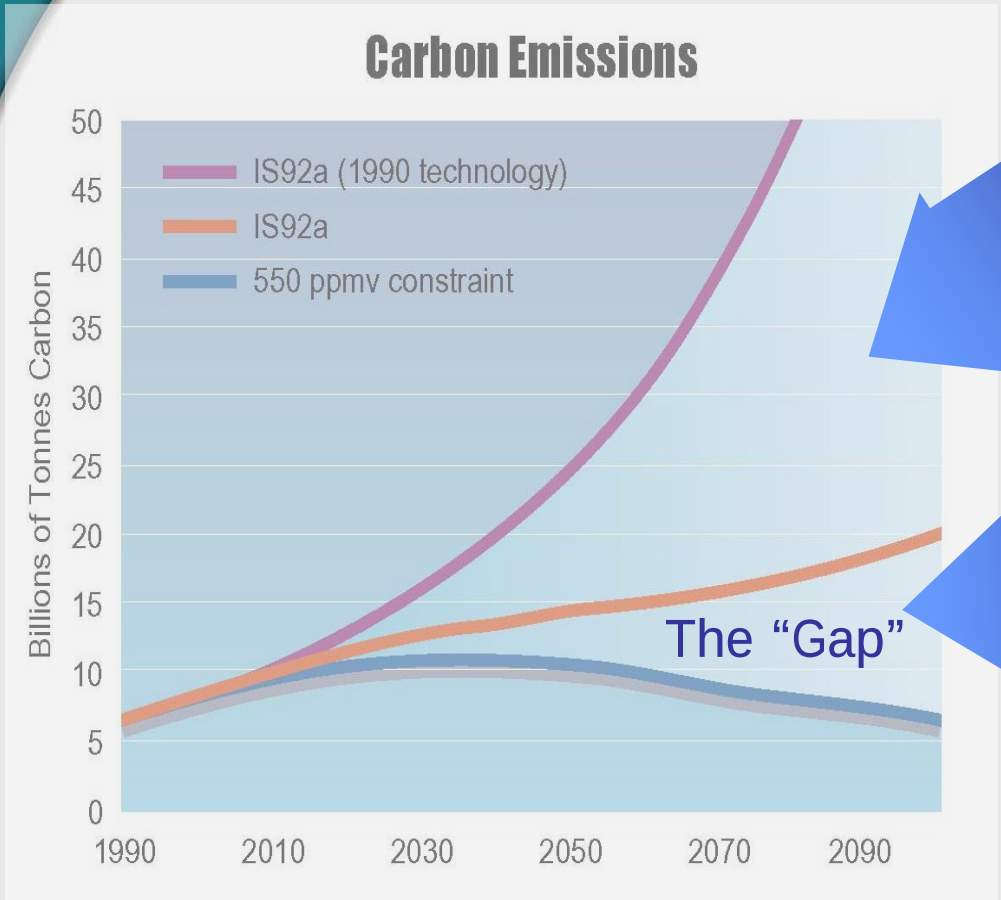
To articulate the cost and environmental performance targets for technologies and technology systems in a climate constrained world and the institutional means of implementation.

GTSP Phase II



Lessons from GTSP Phase I

Achieving the Reference Case Will Not Necessarily Be Easy



Assumed Advances In

- Fossil Fuels
- Energy intensity
- Nuclear
- Renewables

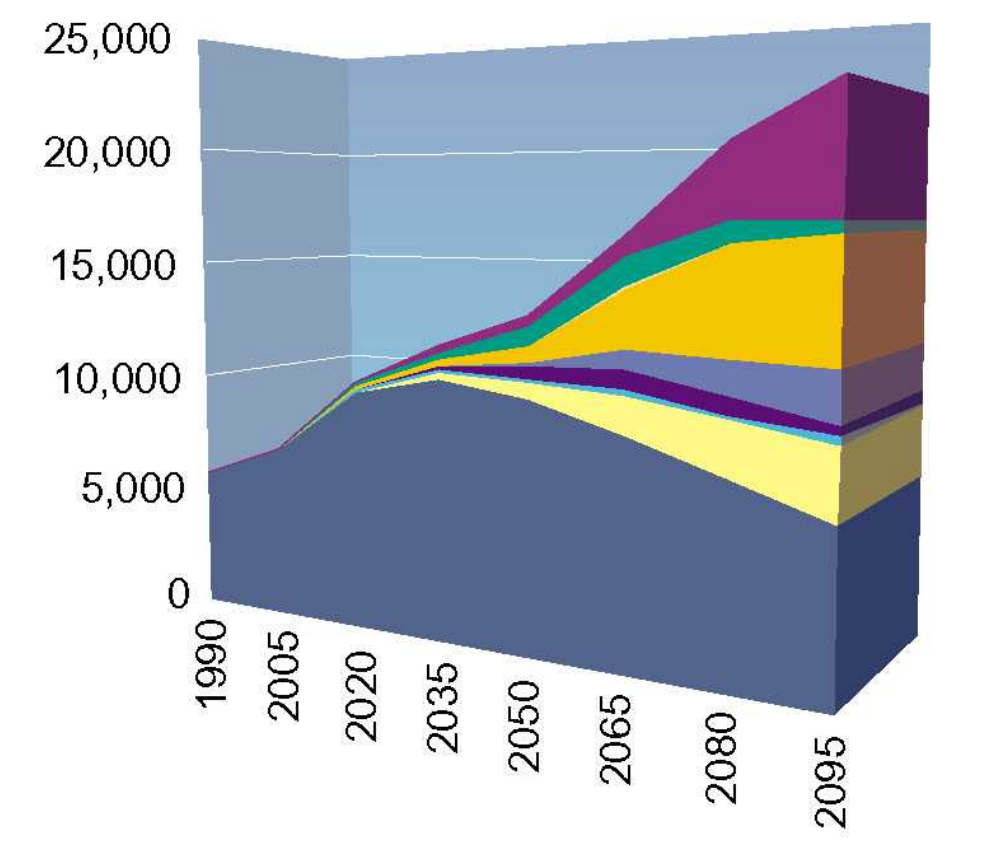
Gap technologies

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

A Technology Strategy Supports A Broad and Competitively Balanced Portfolio (There's No Silver Bullet.)

- Energy Intensity Improvements
  - Industry
  - Buildings
  - Transportation
- Wind and Solar
- Biotechnology
  - Soils
  - Biomass crops
  - Advanced biotechnology
- Nuclear
  - Fission
  - Fusion
- Carbon Capture and Storage
- Advanced Transformation Systems
  - Electricity
  - Hydrogen
  - Bio-derivative fuels

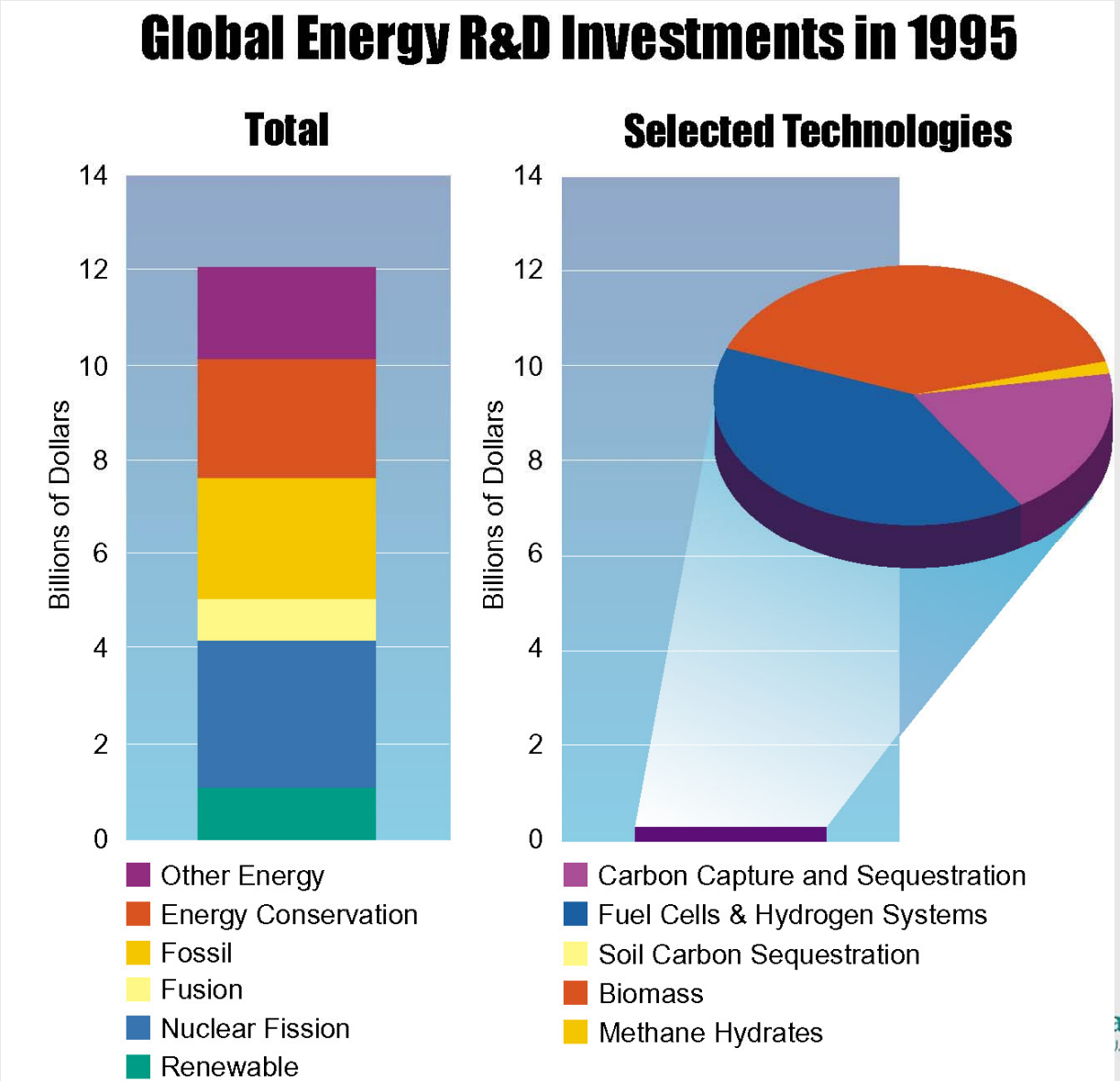
Adding to the Portfolio Will Be Essential



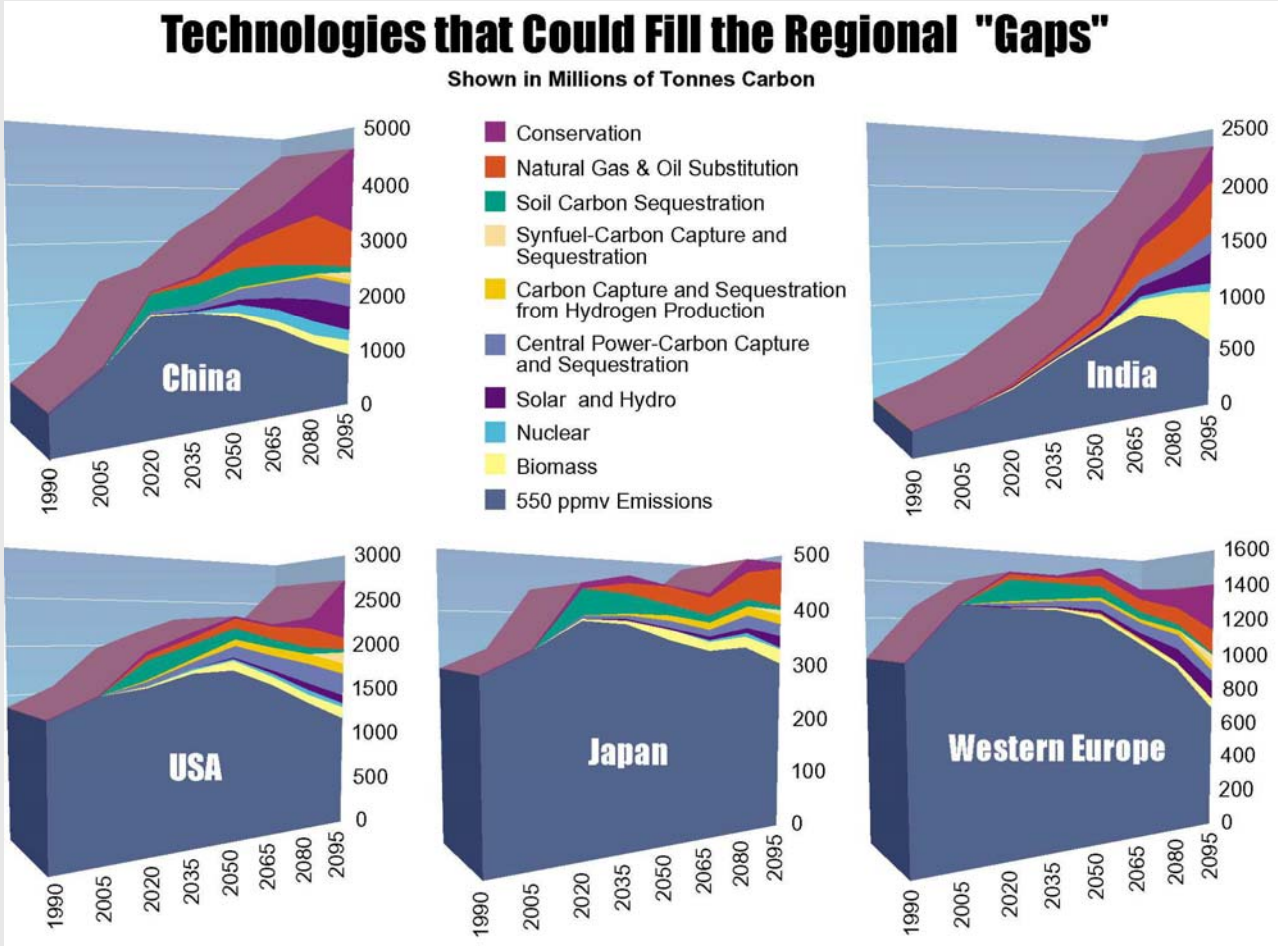
Filling The Technology Gap

- Conservation
- Soil Carbon Sequestration
- Synfuel-Carbon Capture and Sequestration
- Carbon Capture and Sequestration from Hydrogen Production
- Central Power-Carbon Capture and Sequestration
- Solar and Hydro
- Nuclear
- Biomass
- 550 ppmv Emissions

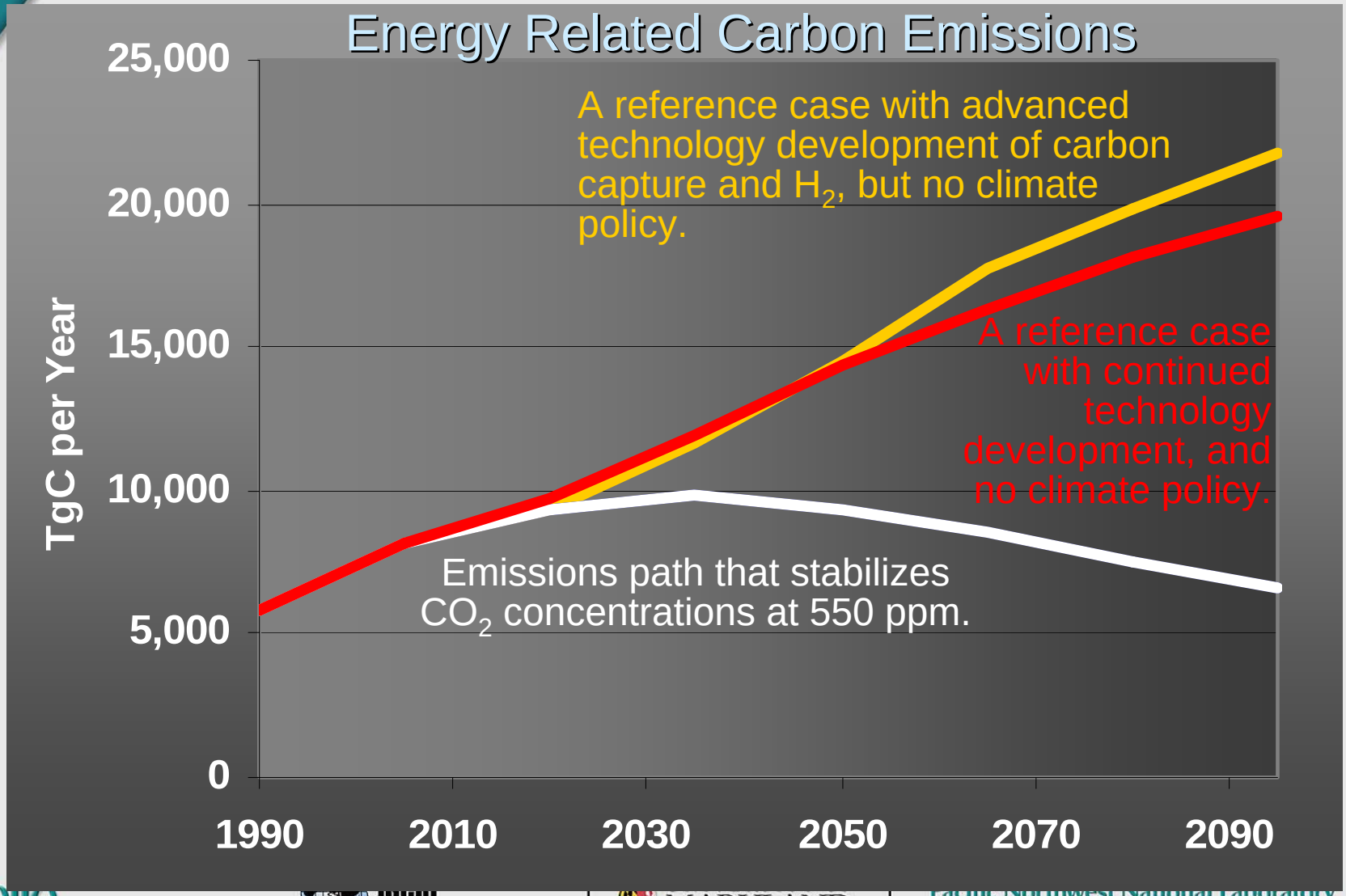
ADDITIONAL Investment Opportunities Exist



Technology Contributions Change With Place and Time

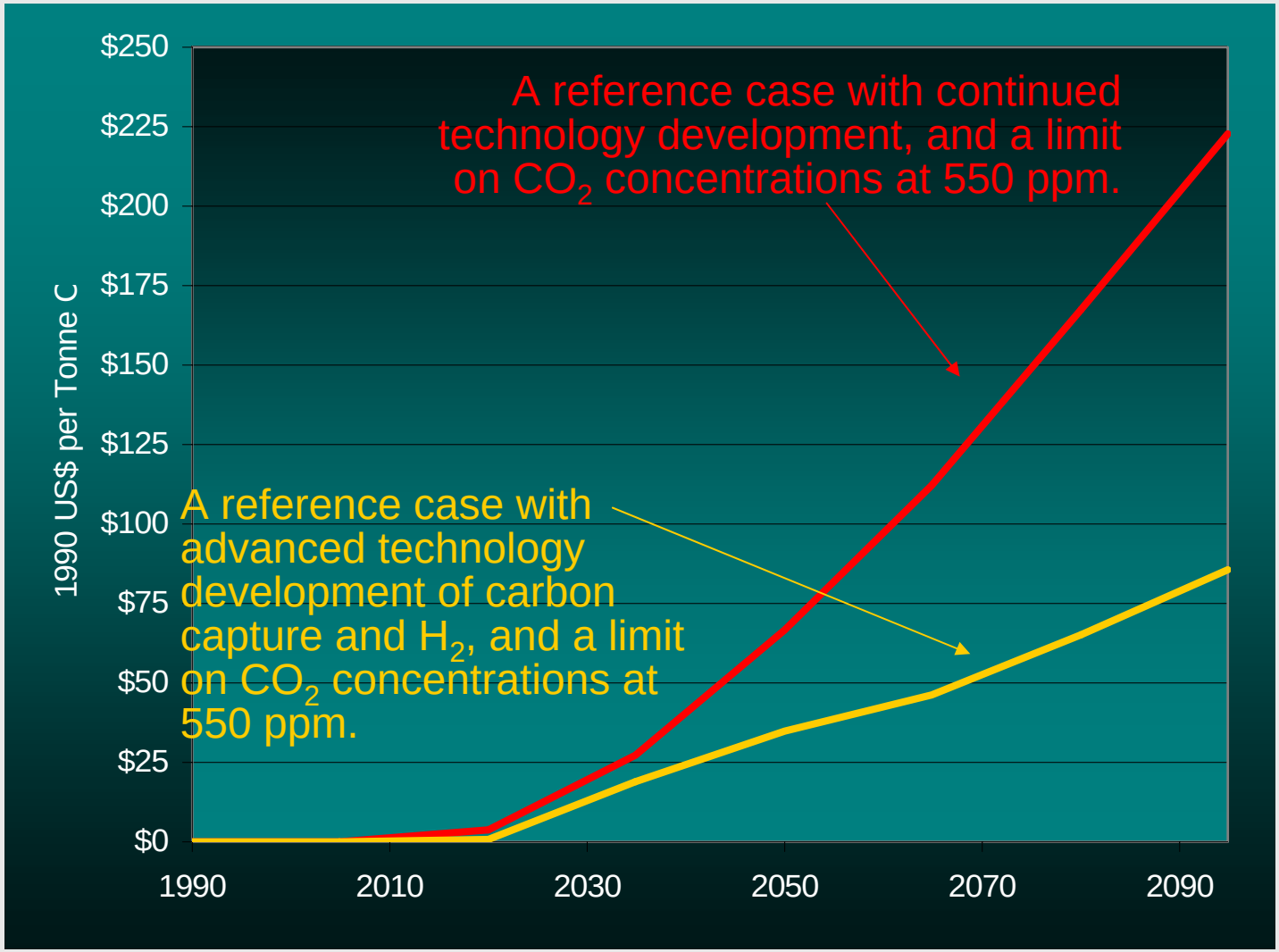


Technology Alone Won't NECESSARILY Stabilize CO_2 Concentrations



Technology Helps Control Cost

- Why control costs?
  - Wasted resources mean other worthy products go un-produced.
  - Or, we settle for lower environmental quality.
- Carbon Tax
- Uniformly & Efficiently Applied Over Time and Space



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GTSP Phase 2

What have we learned?

CCS

The story is more nuanced than we (the research community) told previously

- Regionally distributed resource associated with a specific place.
- Participation in the IPCC special report on CCS.
- The presence of CCS as an option in the context of a value to carbon affects important electric utility decisions.
- Seemingly minor technological parameters can have a large impact on the global energy system, e.g. capture rate on CO2 from power plants.

Technology & Stabilization Regimes

Stabilization of climate change can lead to large-scale deployment of technologies that are presently only minor components of the global energy system.

- Carbon dioxide capture and storage,
- Hydrogen, and/or
- Biotechnology—commercial biomass, terrestrial sequestration and technologies flowing from the intersection of genomics and nanotechnologies.

How Big?

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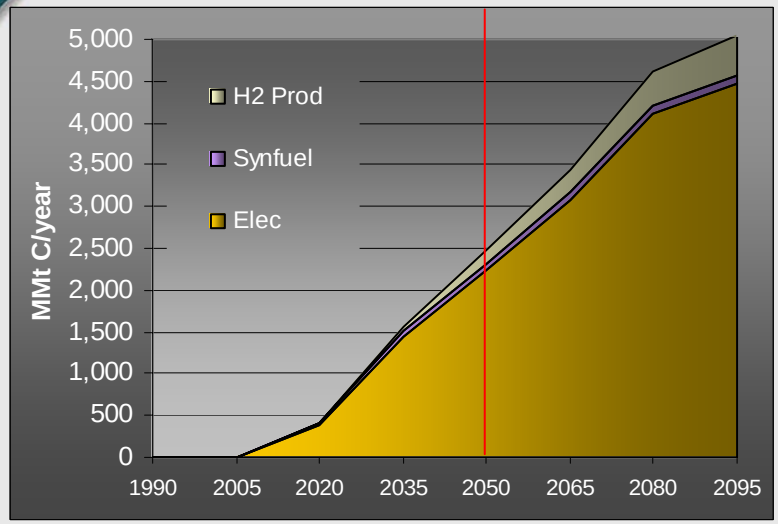
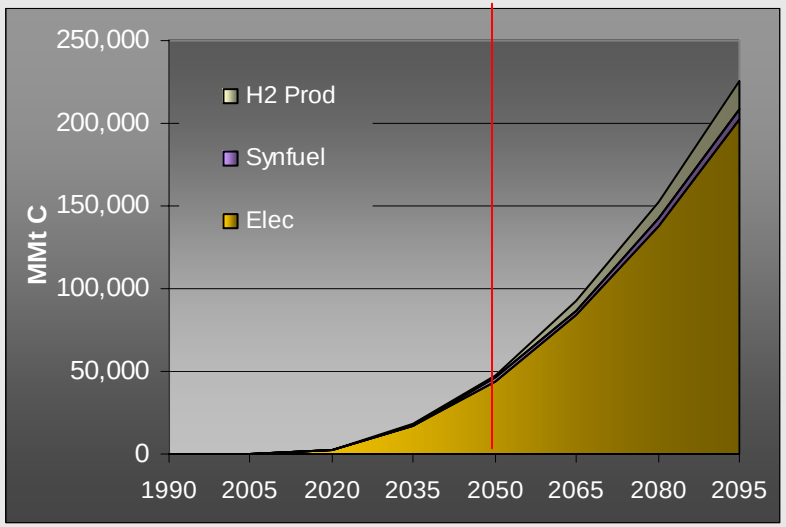
Annual Carbon Storage

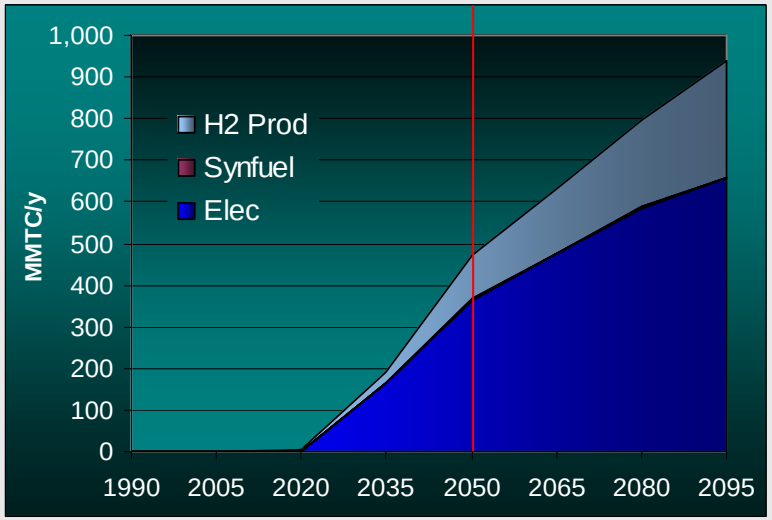
Cumulative Carbon Storage

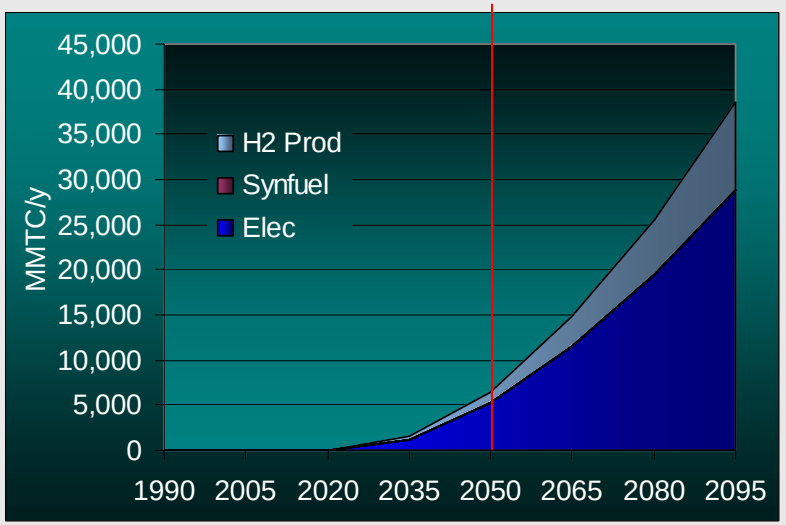
Global





USA





PNNL MiniCAM Output, EMF-19, B2 scenario with CCS and H2

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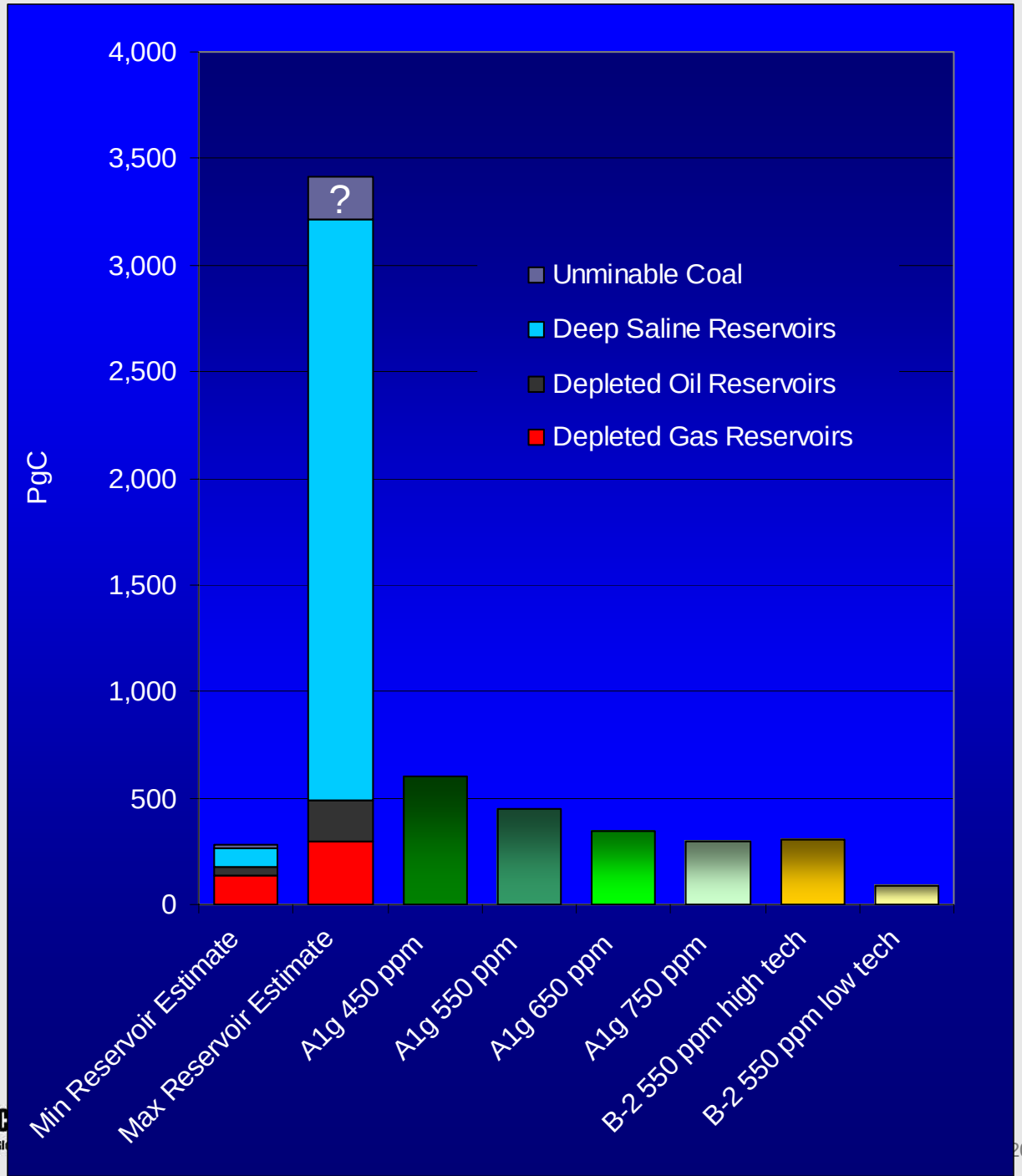
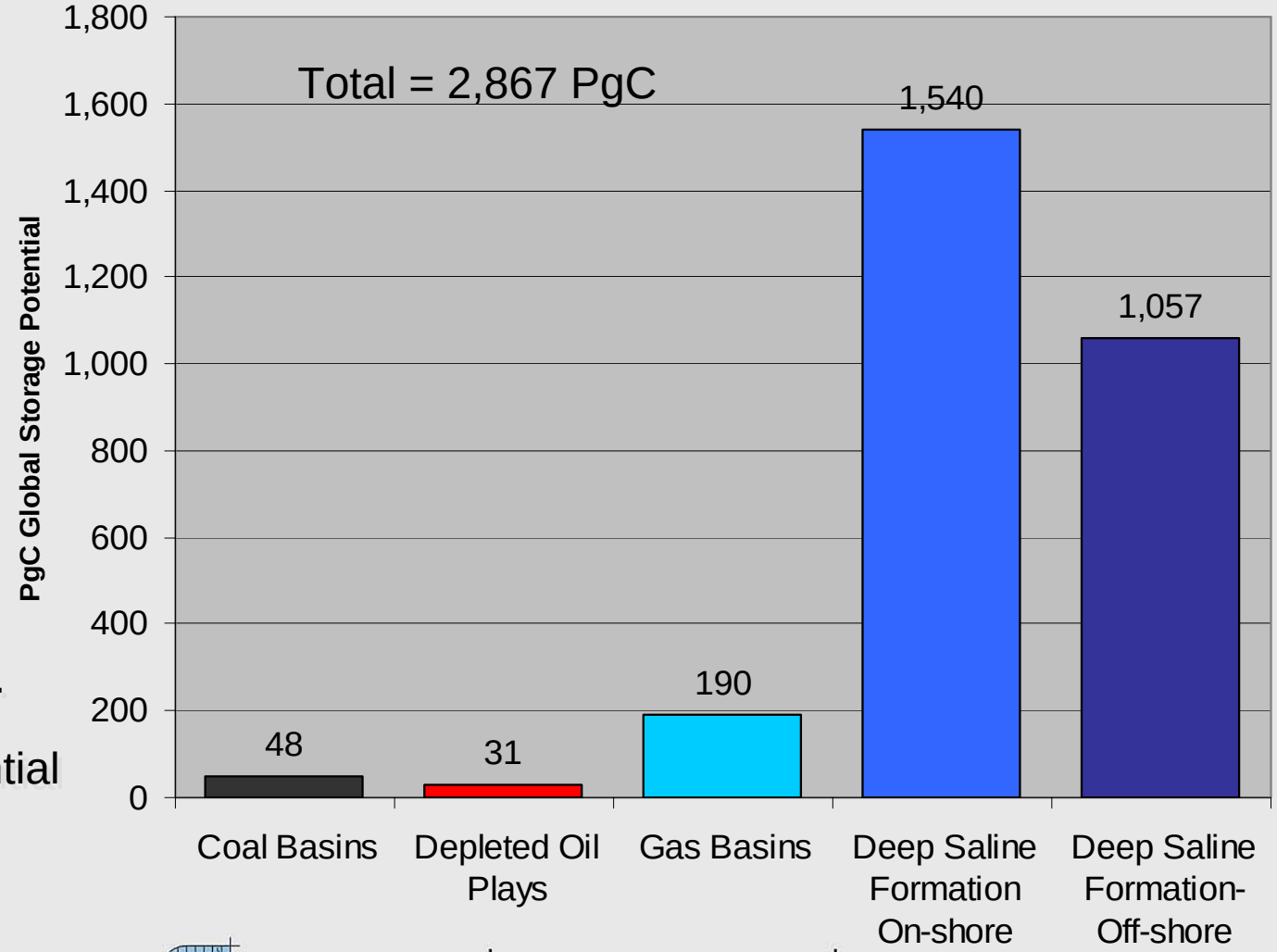
Storage Estimates Compared to Carbon Dioxide Capture Estimates—Regionally Unconstrained Storage



Battelle

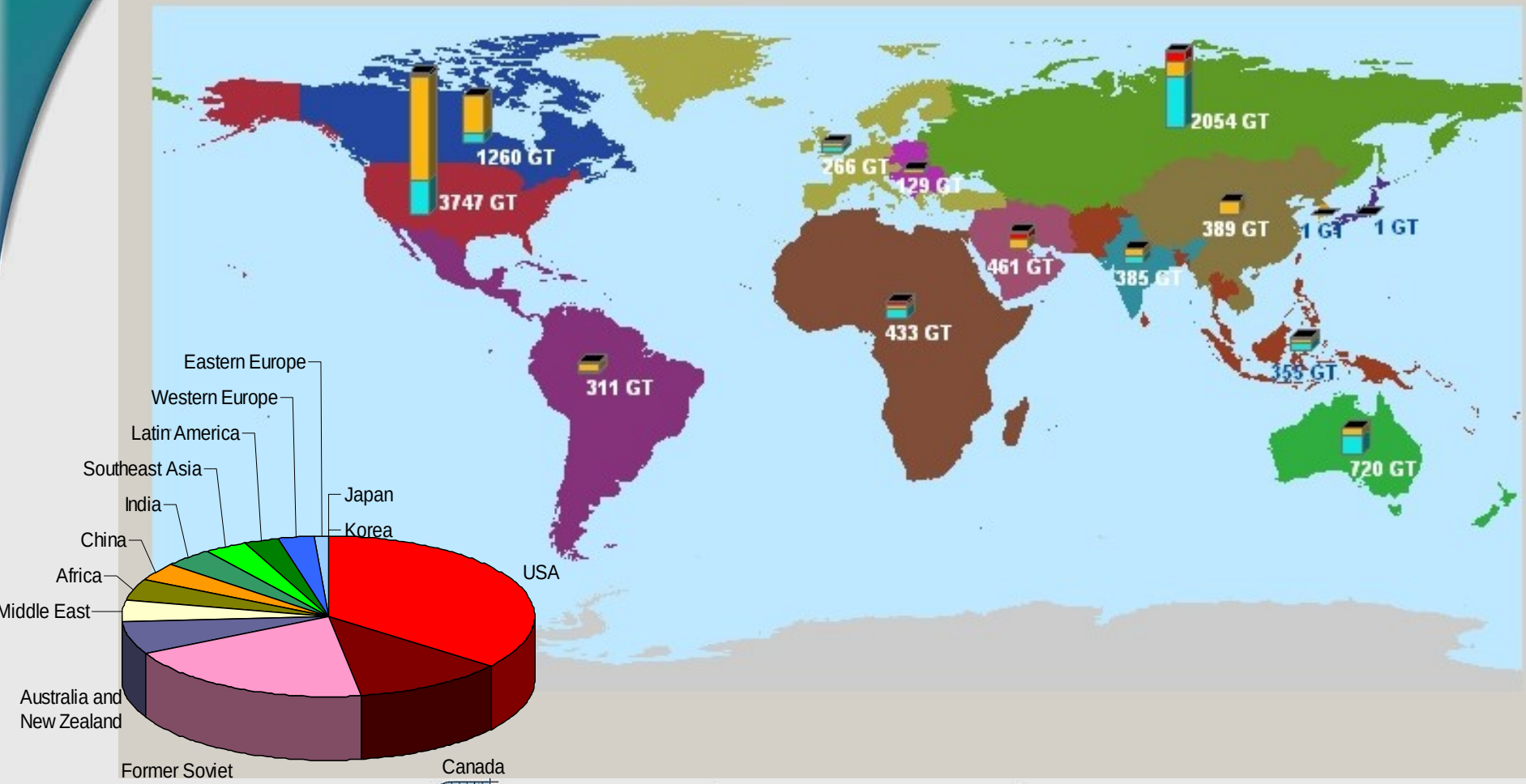
JGC Joint Gl

Estimates of Global Capacity Imply That Large Scale CCS Deployment Implies Usage of Deep Saline Formations



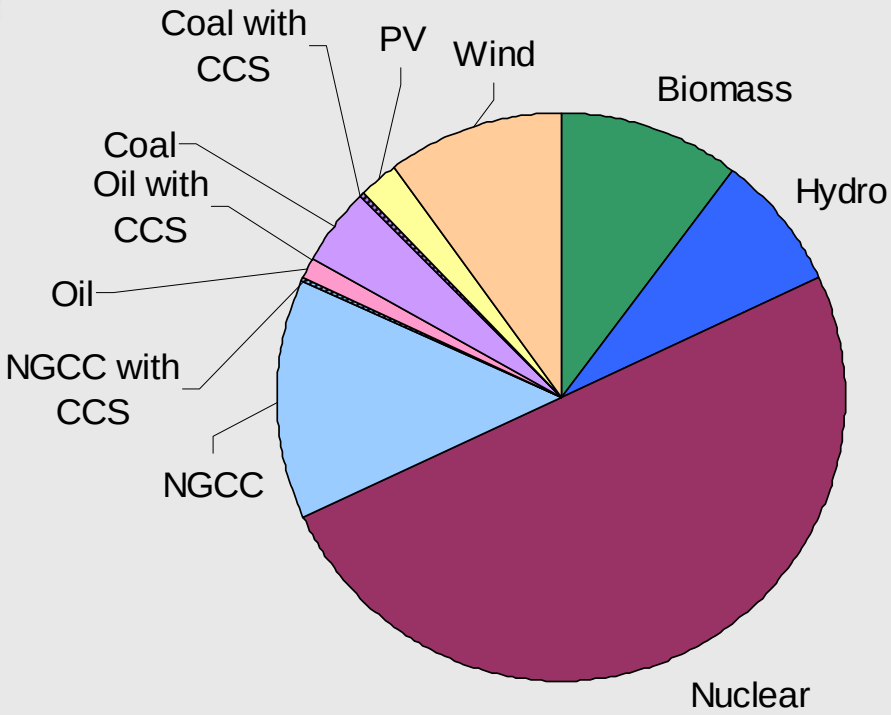
Dooley, et al. Estimate of Global Potential Reservoir Capacity

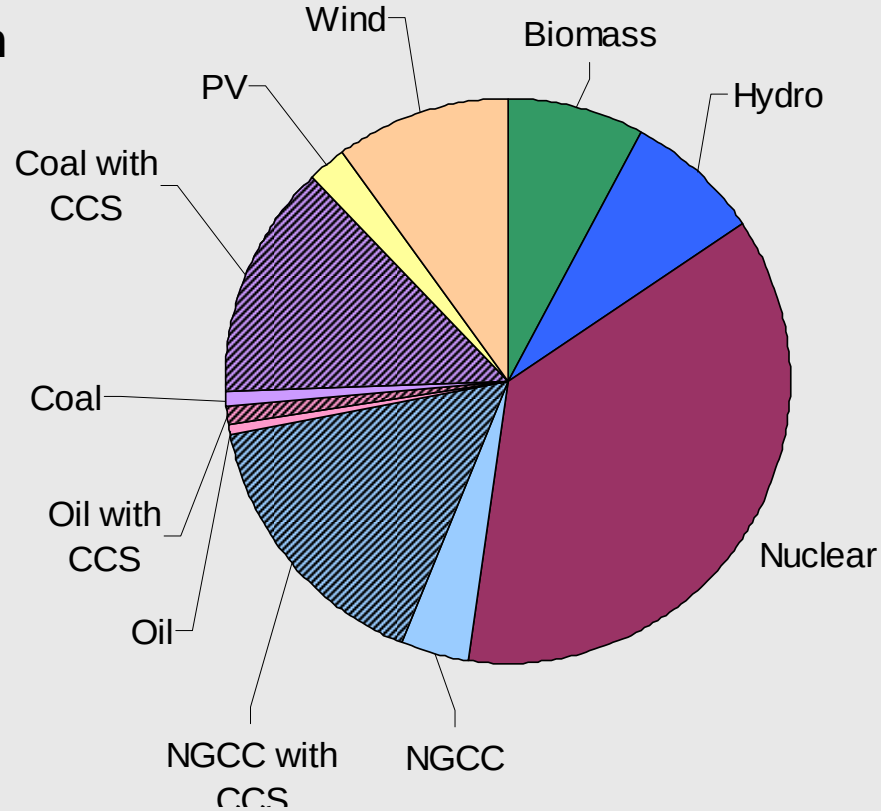
Global CO_2 Storage Capacity: Now



Composition of Power Generation in Japan, 2095

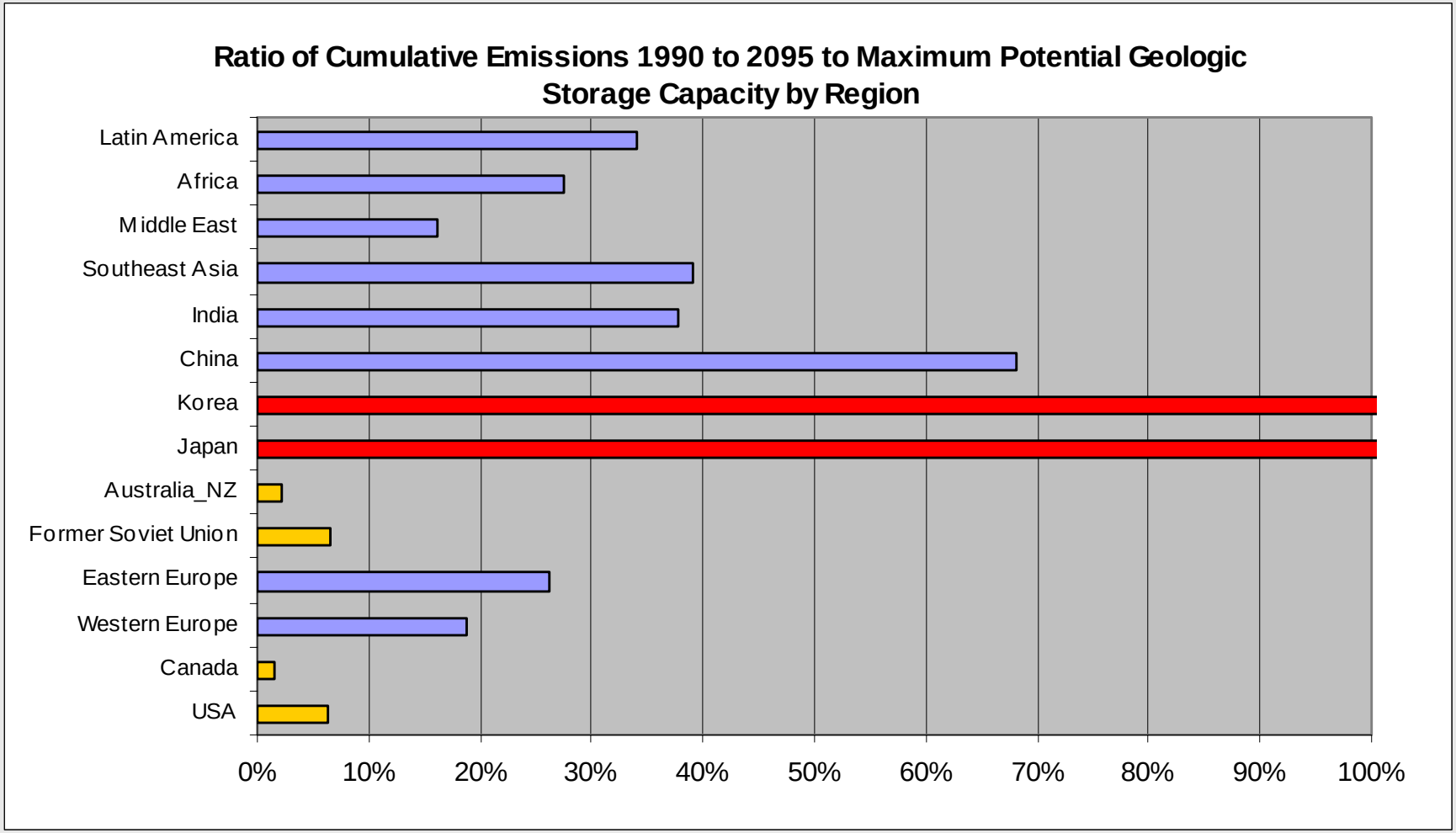
Regionally limited CCS Available, 550 ppm





Unlimited CCS Assumed Available, 550 ppm

Better Estimates of Storage Would Make a Big Difference in Key Regions



CCS

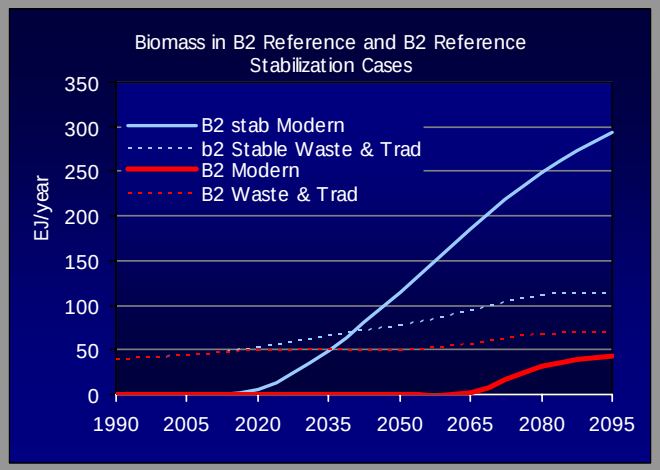
- The overriding conclusion from our work on CCS is that this technology is potentially an important component of a technology strategy to address climate change.

Biotechnology

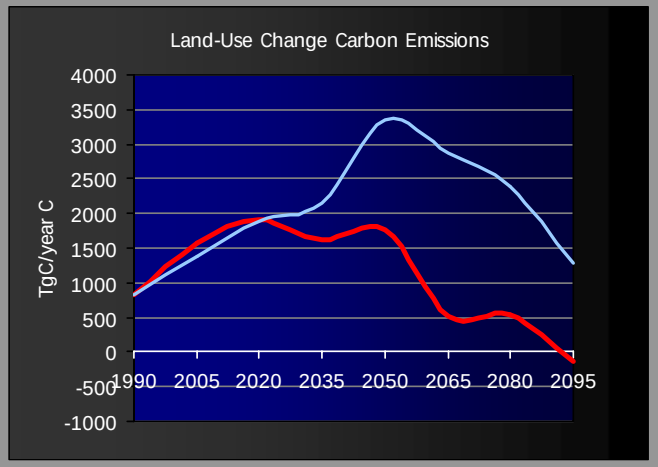
- A portfolio unto itself
- Soil carbon
- Interface with agriculture & agricultural productivity.
- Potential of modern biological science to create revolutionary breakthroughs.
- Combining biotechnology with CCS.

Biomass and Land-Use Change Emission

Energy



Land-use Emissions



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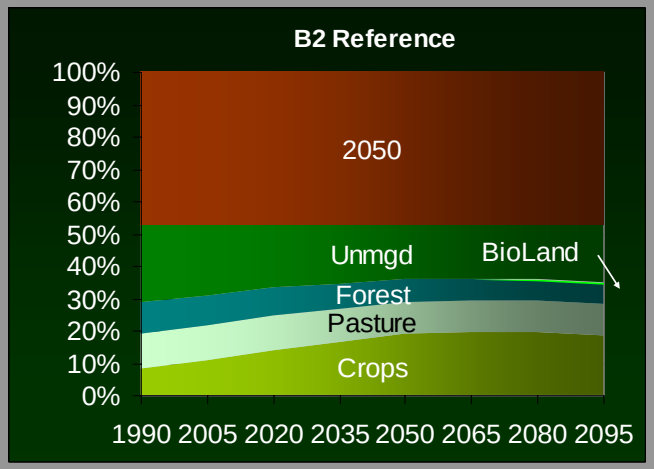
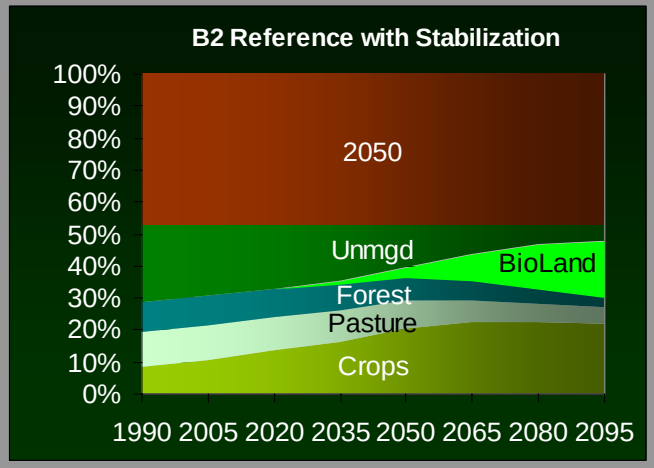
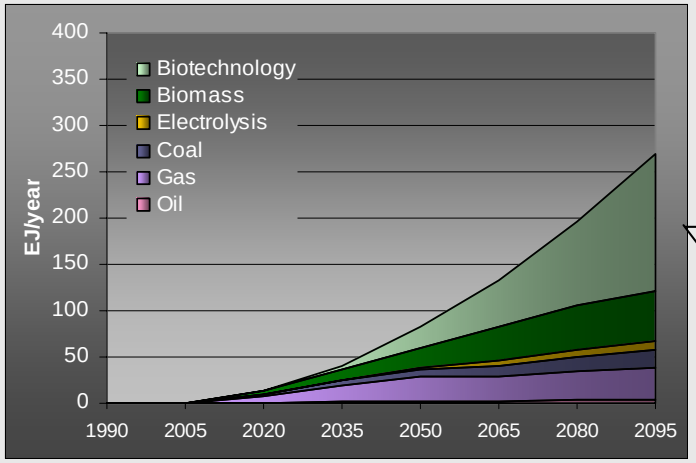


B2 Reference with Climate Stabilization

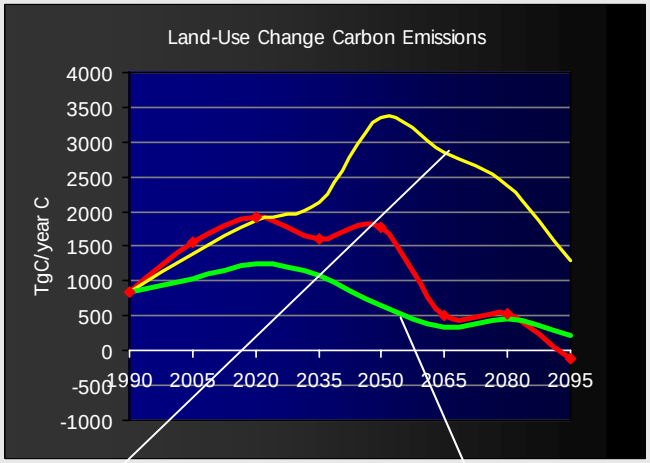


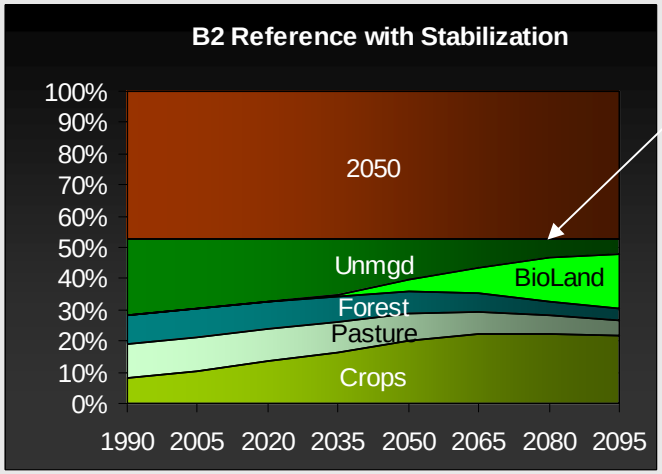
H2 and Biotech
B2 AT with Stabilization

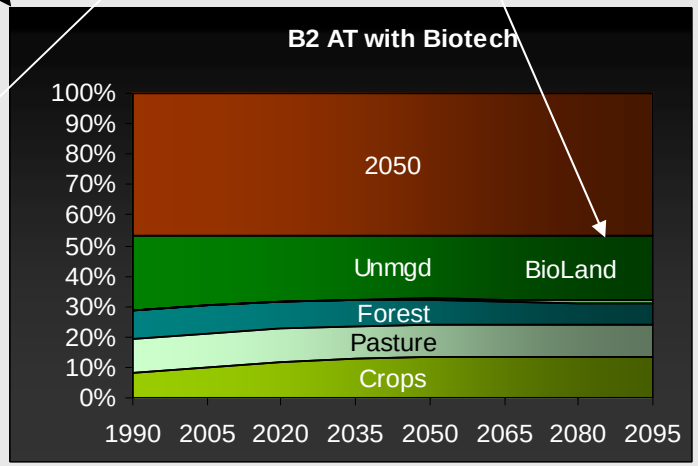
What if agricultural and biomass crop productivities could be maintained and a biological source of H2 that is cost-competitive with CH4?



Biotechnology& Land Use







Combining Biotechnology with CCS

- We have begun to explore the implication of combining commercial biomass production with CCS in electricity production.
- Preliminary work
- The principal conclusion is that this combination of technologies could be an important component in a world that is limiting net CO_2 emissions to the atmosphere.
  - Implications for land-use
  - Implications for CCS deployment—complementary technologies.

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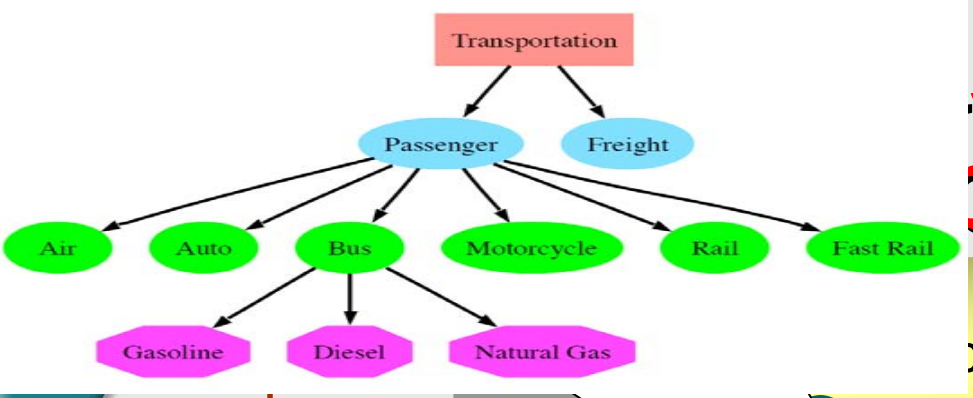
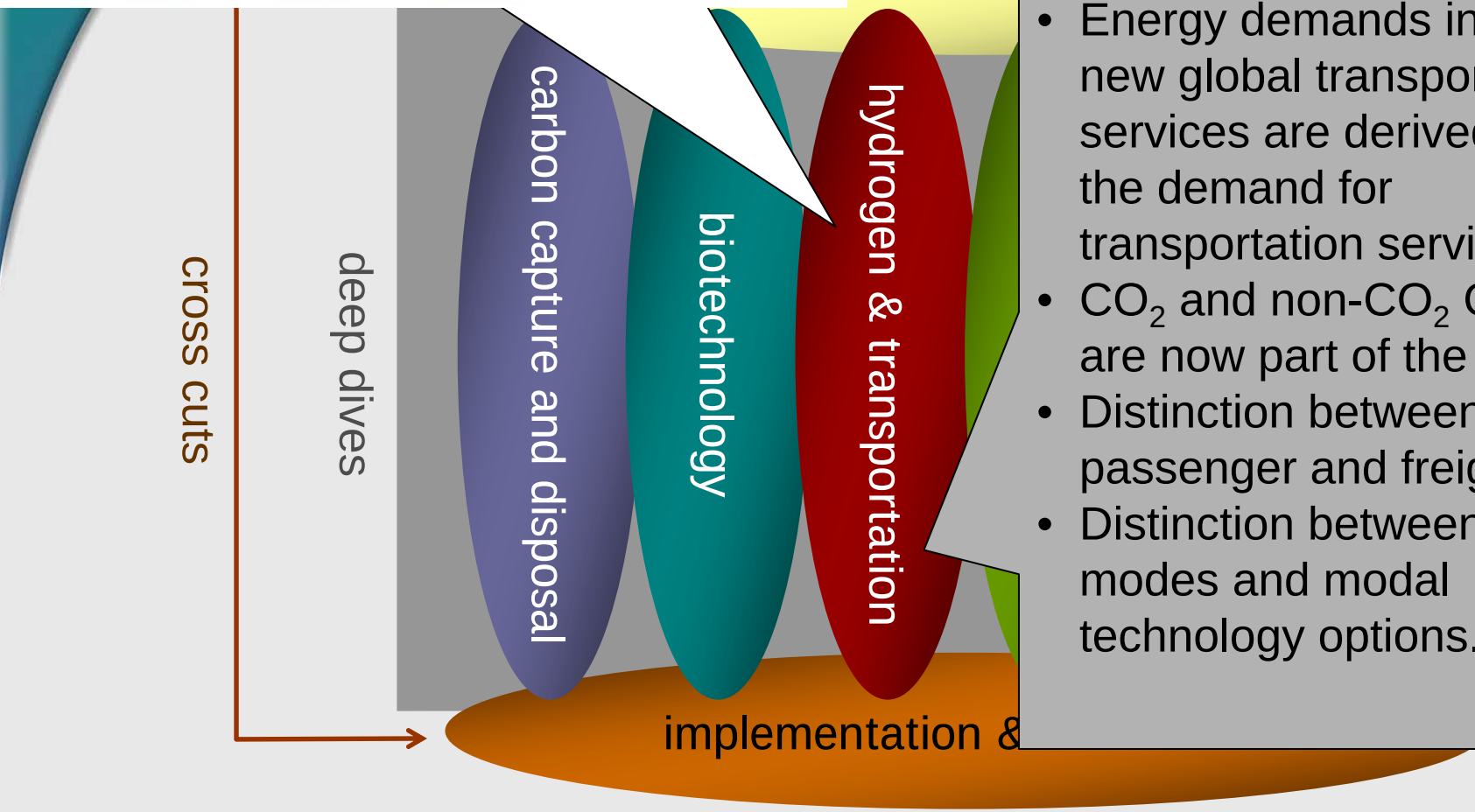
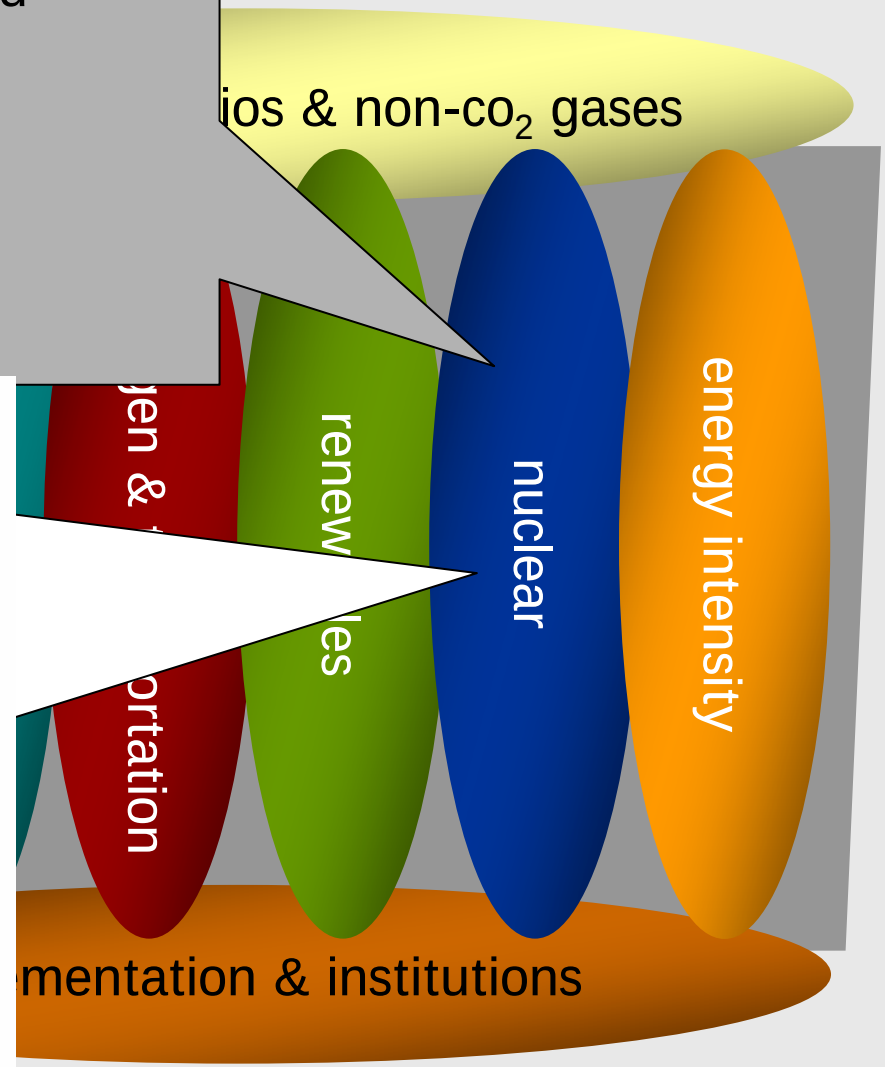




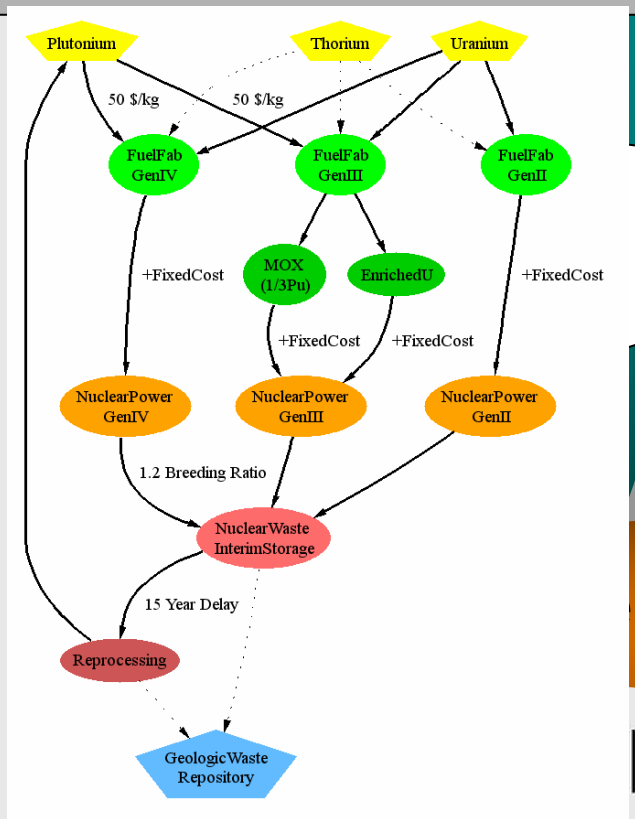
- Last year the new transport sector was implemented for the USA only. This year the model is global.
- Energy demands in the new global transportation services are derived from the demand for transportation services
- CO_2 and non-CO_2 GHG's are now part of the story.
- Distinction between passenger and freight.
- Distinction between modes and modal technology options.

e II New
nents

- Top-down models generally have not considered nuclear technology explicitly.
- The fuel cycle is addressed explicitly
- Technological change is modeled explicitly:
  - •Gen II
  - •Gen III, and
  - •Gen IV reactors.
- Fuels are tracked

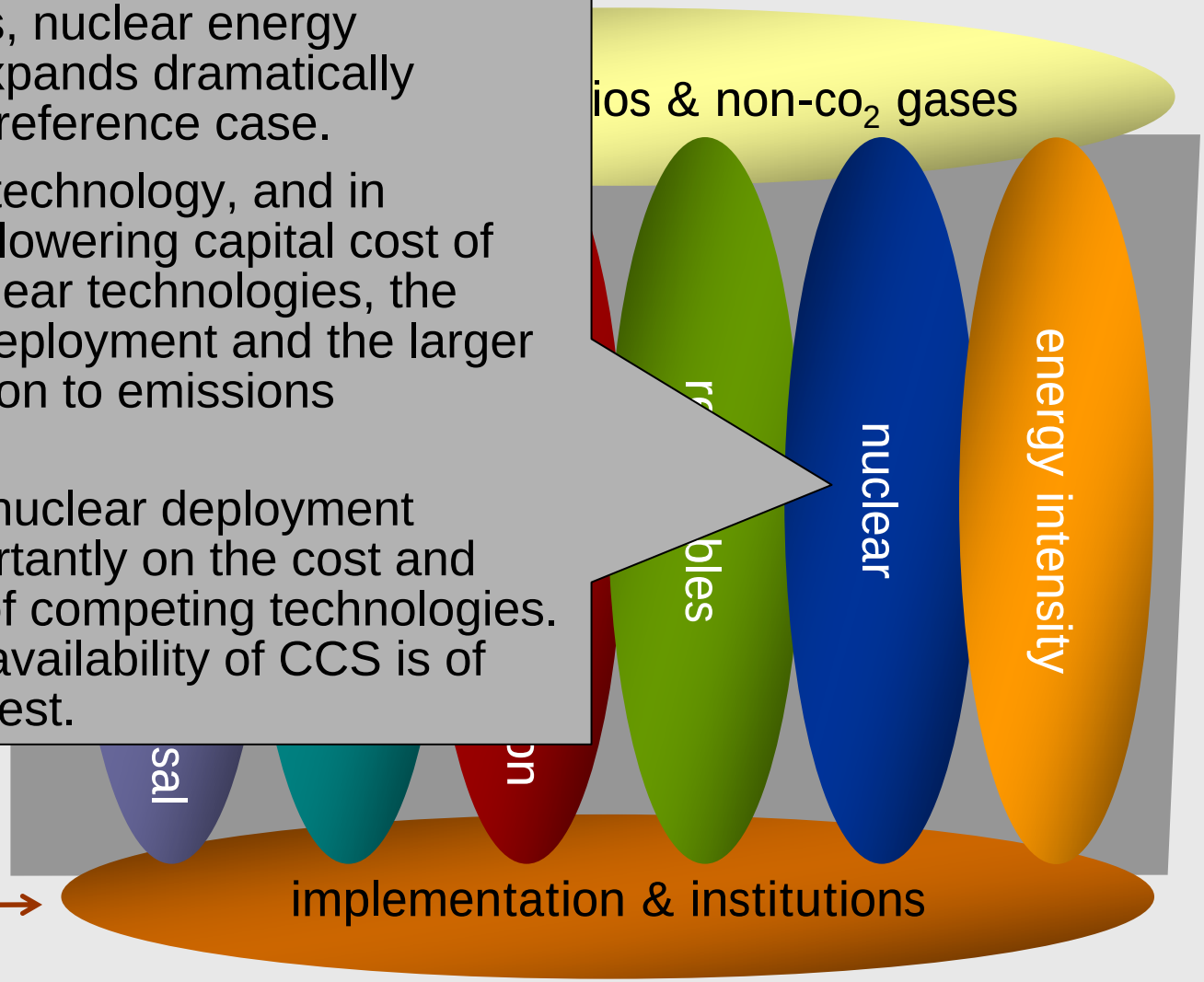


cross cuts

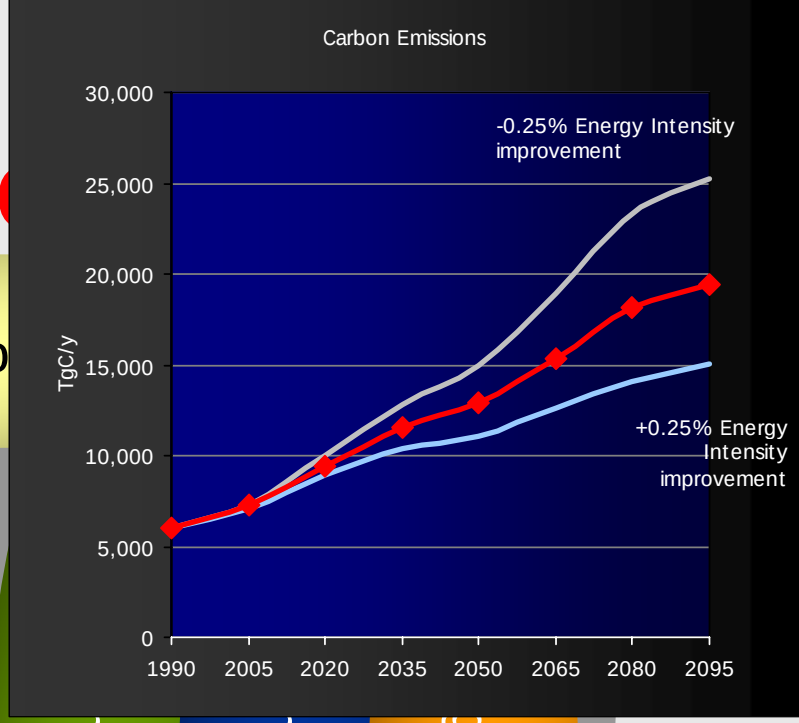


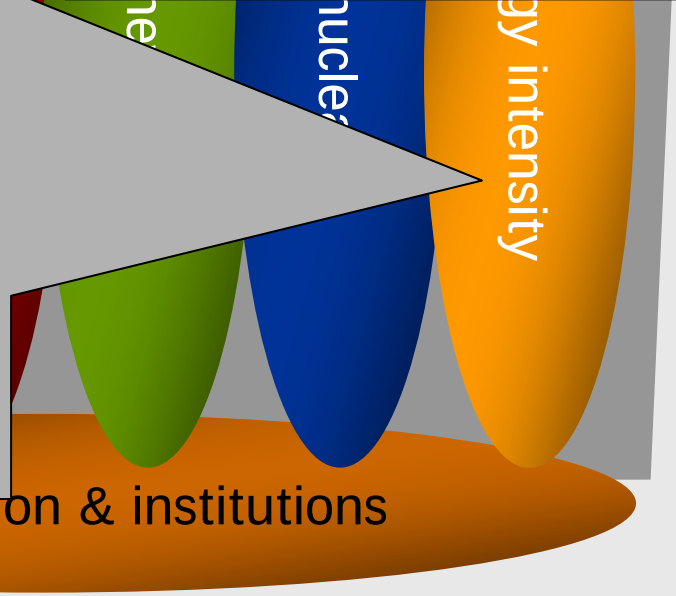
e II New
nents

- Market penetration for Gen III and IV reactors is potentially thousands of reactors by the end of the century.
- In the presence of a limit on CO2 concentrations, nuclear energy deployment expands dramatically relative to the reference case.
- the better the technology, and in particular, the lowering capital cost of advanced nuclear technologies, the greater their deployment and the larger their contribution to emissions reductions.
- The extent of nuclear deployment depends importantly on the cost and performance of competing technologies. The cost and availability of CCS is of particular interest.



- Potentially large component of both the reference case and response to climate change.
- In most top-down models energy intensity is controlled by one parameter, AEEI.
- AEEI provides significant emissions reductions in the reference case, but does not distinguish contributions by technology source.
- Since the last Steering Group Meeting significant progress has been made in building the capacity to consider end-use energy technology explicitly in a top-down model.
- This work was made possible by support from a GTSP related program sponsored by the US DOE Office of Energy Efficiency and Renewable Energy as well as GTSP sponsors.





GTSP Pha
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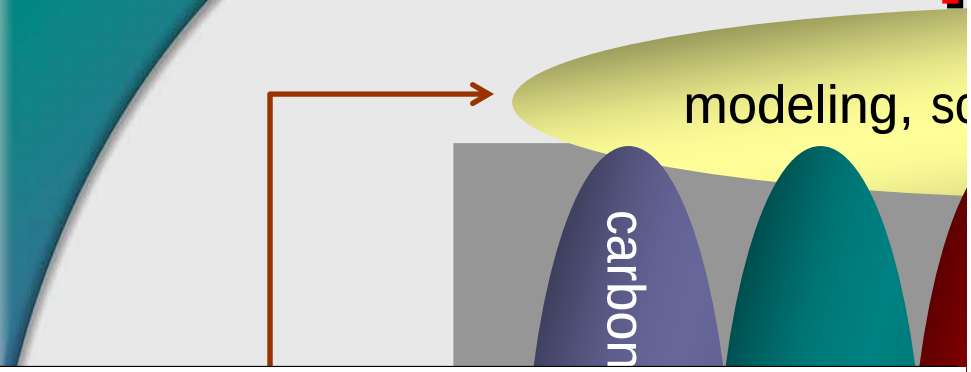
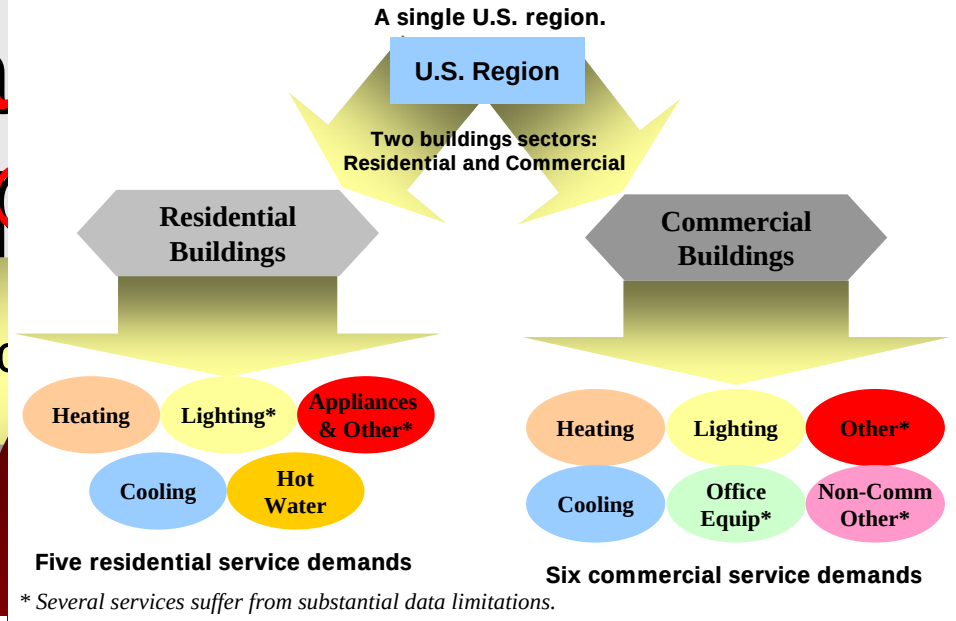
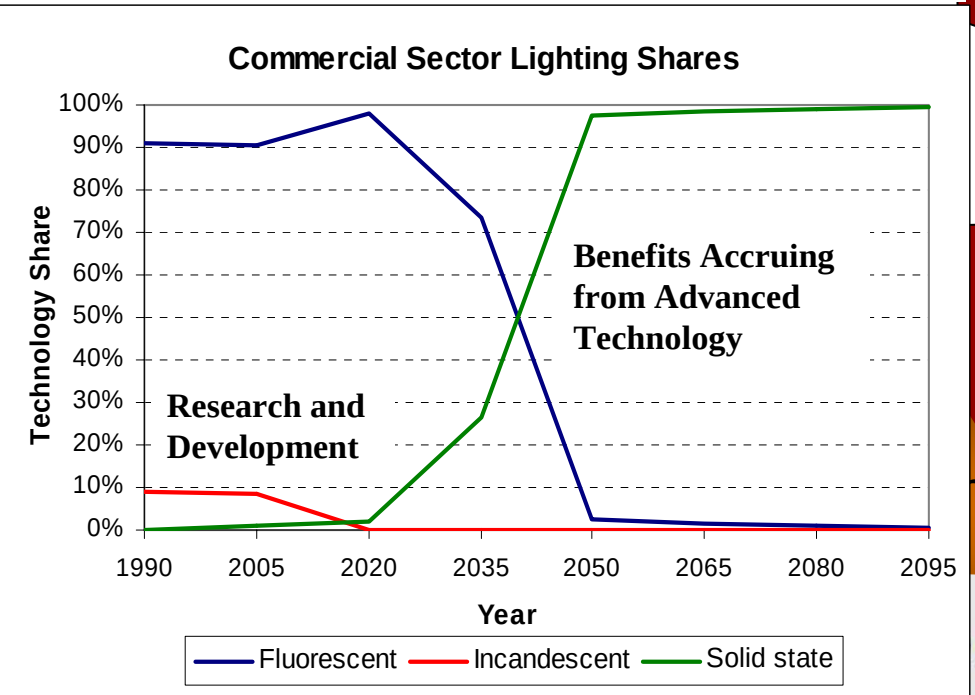
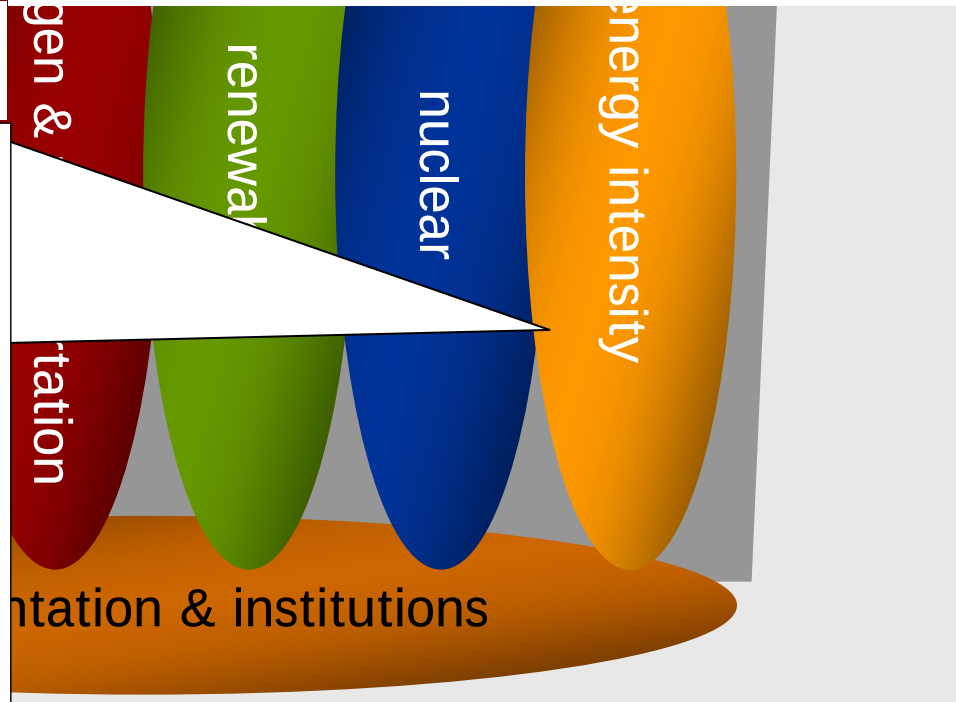
GTSP
Global Energy Technology Strategy Program





Illustrative Results of Scenario of Commercial Lighting Sector Development





UNIVERSITY OF MARYLAND | Pacific Northwest National Laboratory
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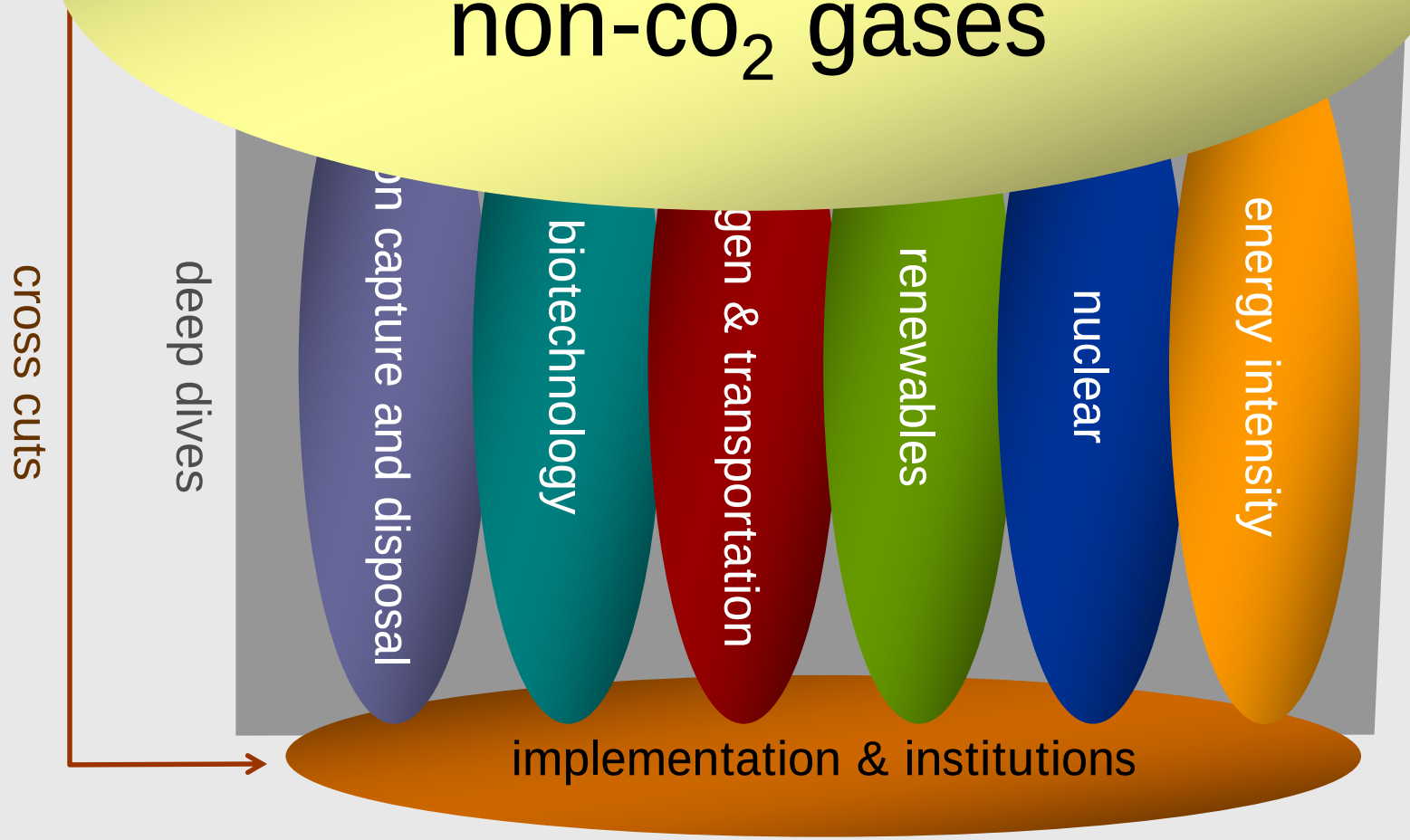
GTSP Phase II: New

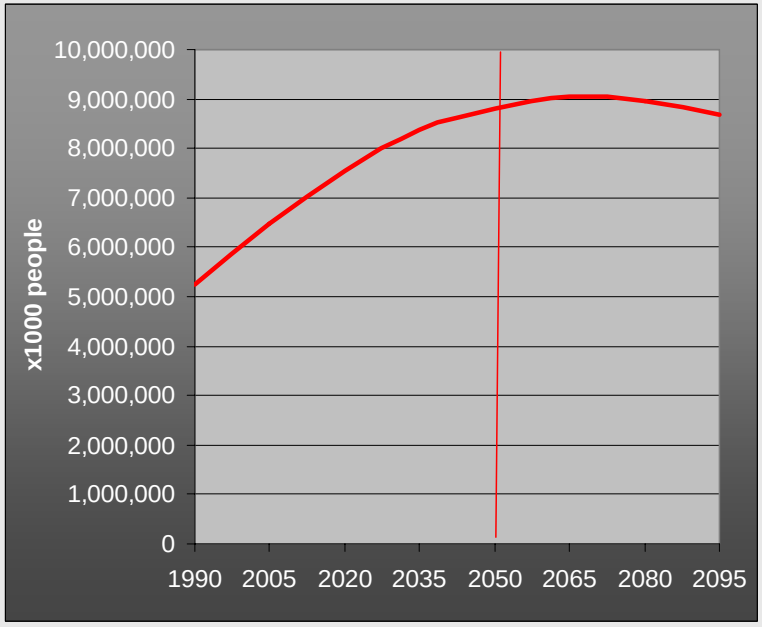
modeling, scenarios & non-co_2 gases



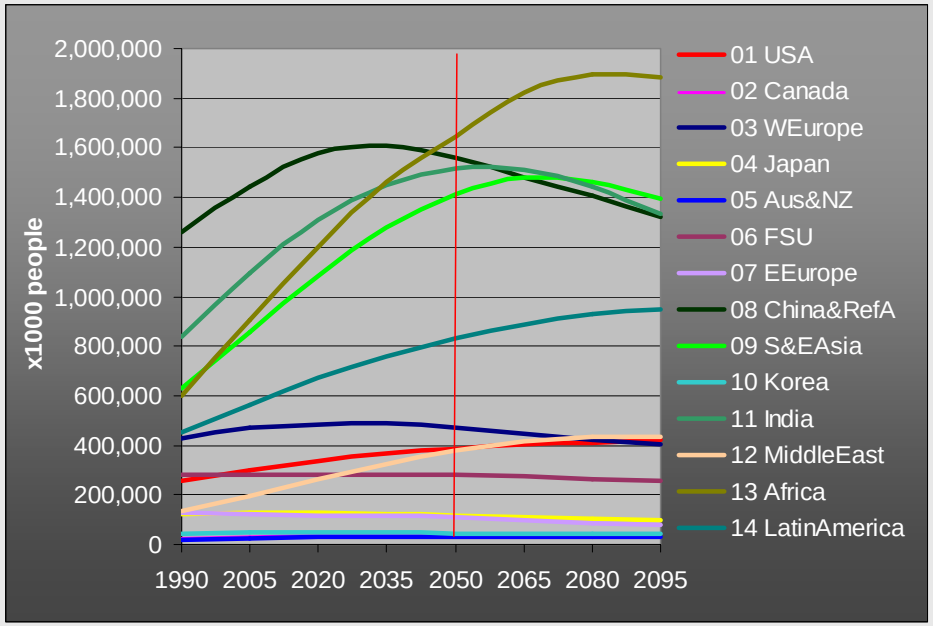
Scenarios

- Developing new scenarios from the ground up for the CCSP process.
- Developing new GDPs cognizant of PPP versus MER issues.
- New energy technology assumptions.

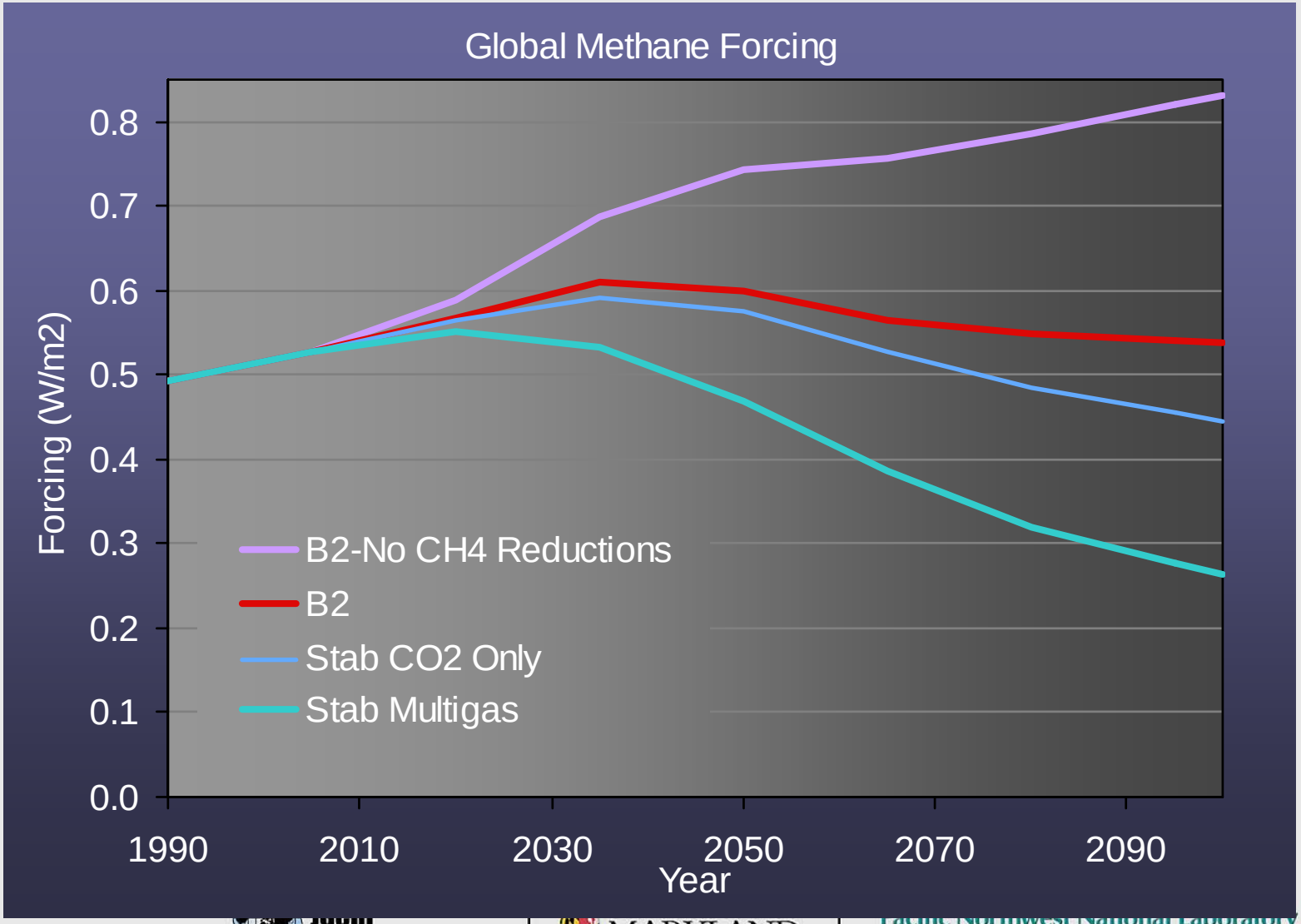
Global Population



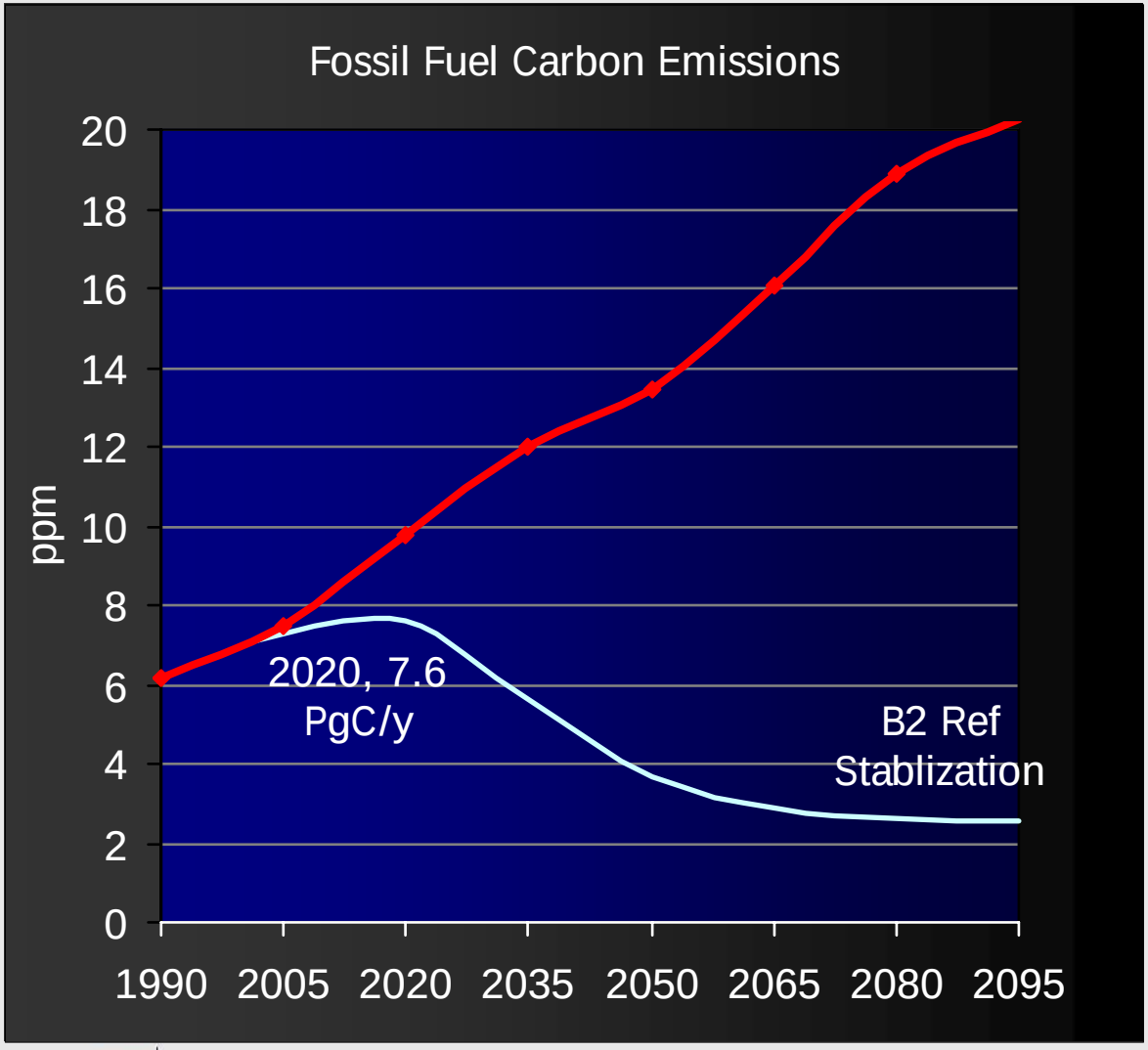
Regional Components of the Global Population



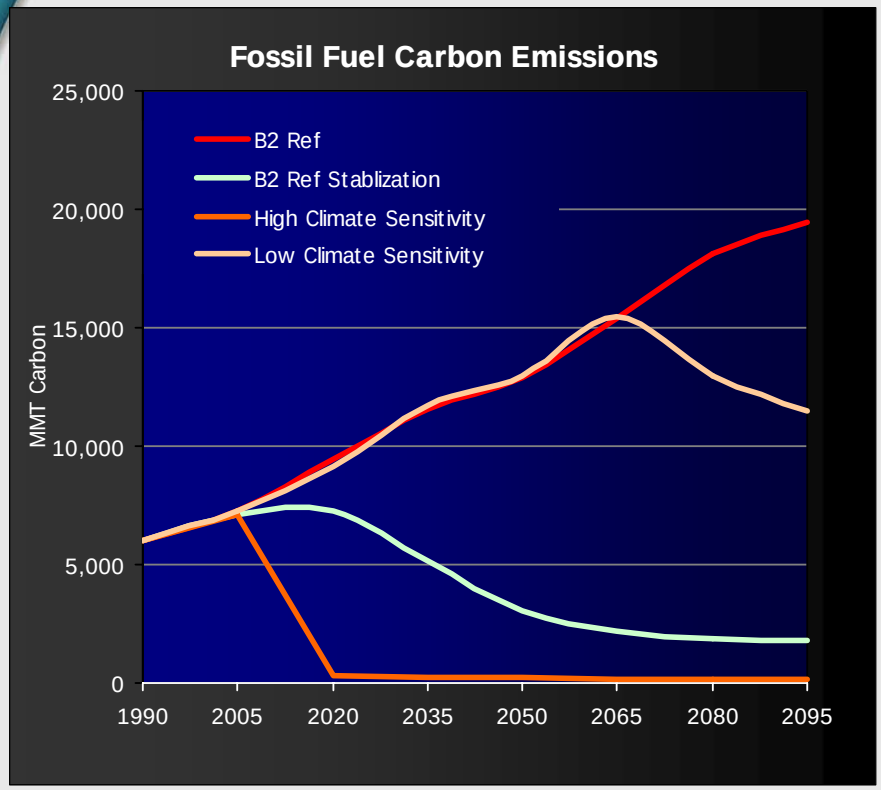
BAU Matters in Non-CO_2 GHGs

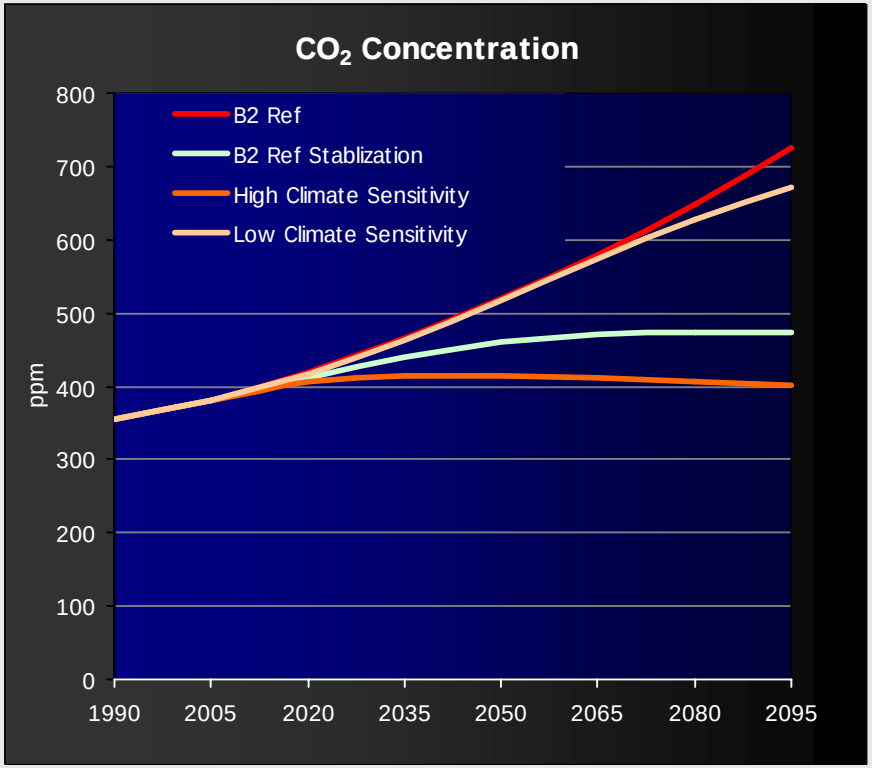


Limiting GMST to 2ºC CO_2 Emissions



Uncertainty in Climate Sensitivity GMST Change Stabilization at ΔT<2°C For Climate Sensitivities of 1.5, 2.5, and 3.5°C





Whither GTSP?

- GTSP Phase 2 is in its 3rd year.
- We are beginning the process of documenting the lessons learned.
  - Carbon dioxide capture and storage
  - Biotechnology
  - Hydrogen and advanced transportation systems
  - Nuclear power
  - Energy efficiency
  - Other renewables
  - Cross-cutting themes

GTSP Phase III

- We are also beginning to think about the shape of future research and the frame for a potential GTSP Phase III.
  - Technology development and deployment will be time and place dependent.
  - The muddle in the middle
    - Regional
    - Temporal
    - Technology specific
- Your comments are welcome.

GTSP

Global Energy Technology Strategy Program

END

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