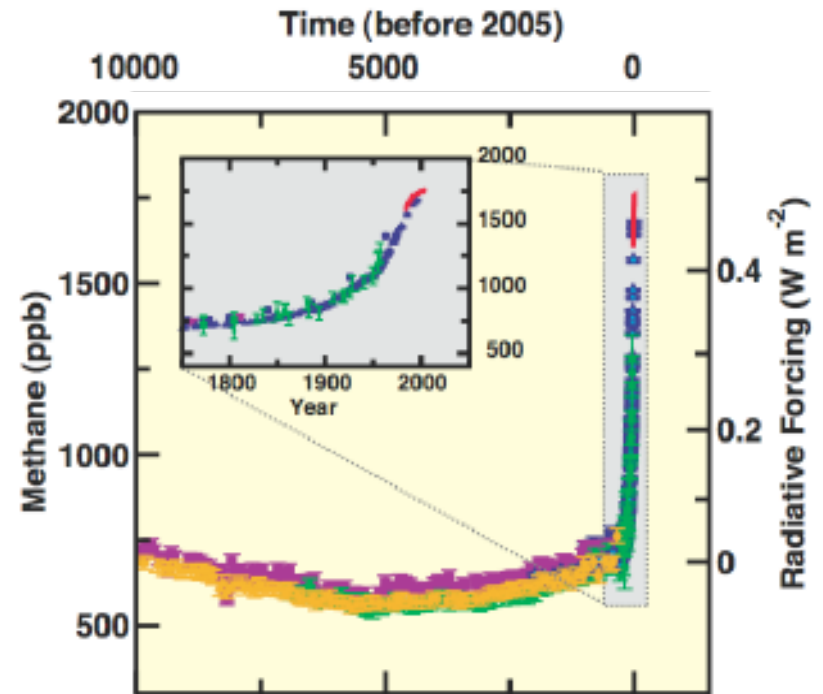
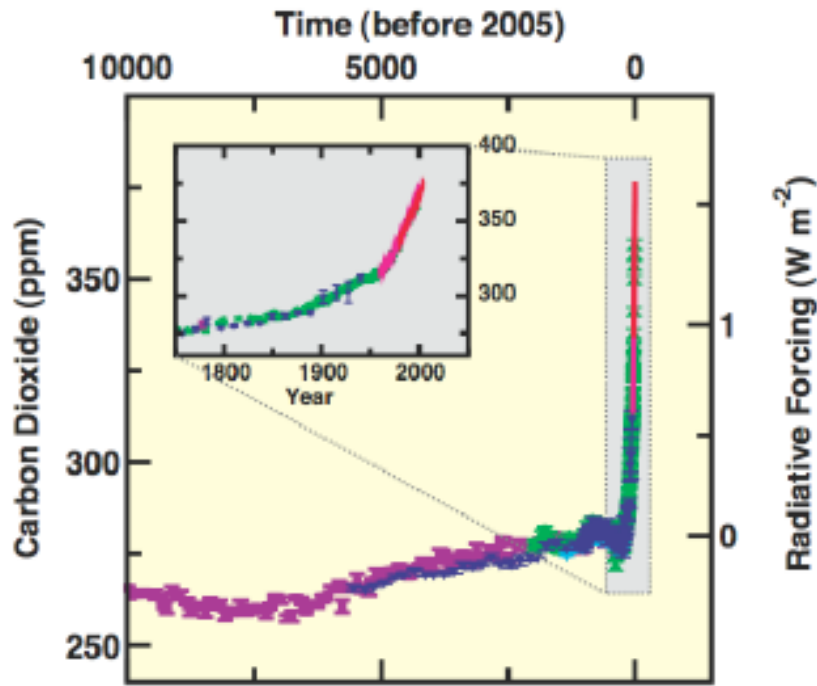
A photograph of an industrial facility, likely a carbon capture plant, featuring large white pipes, yellow metal walkways, and several workers wearing white hard hats and safety gear. The scene is set outdoors under a clear blue sky.

# Guidelines for Carbon Dioxide Capture, Transport, and Storage



WORLD RESOURCES INSTITUTE

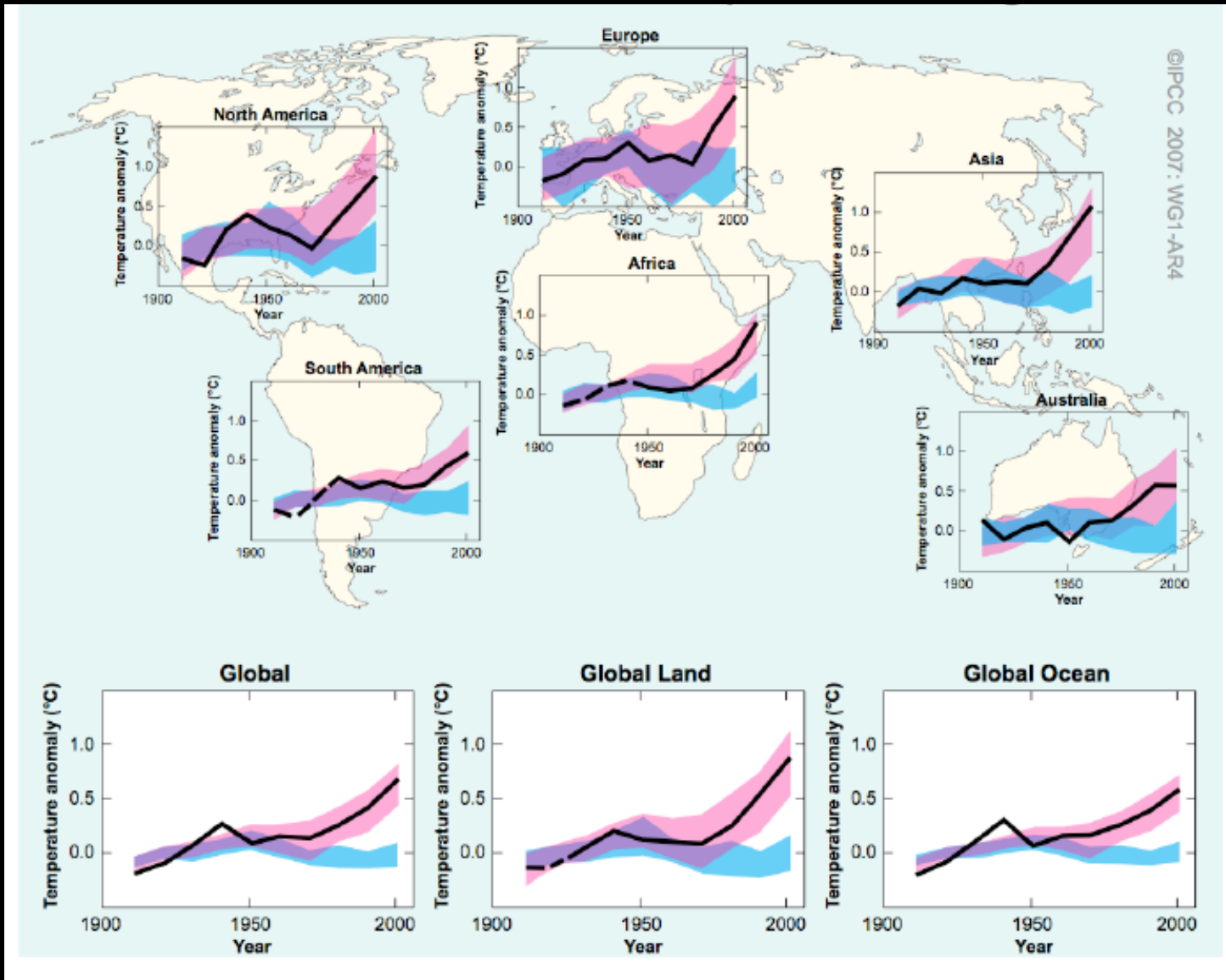
# Change in GHG Concentrations



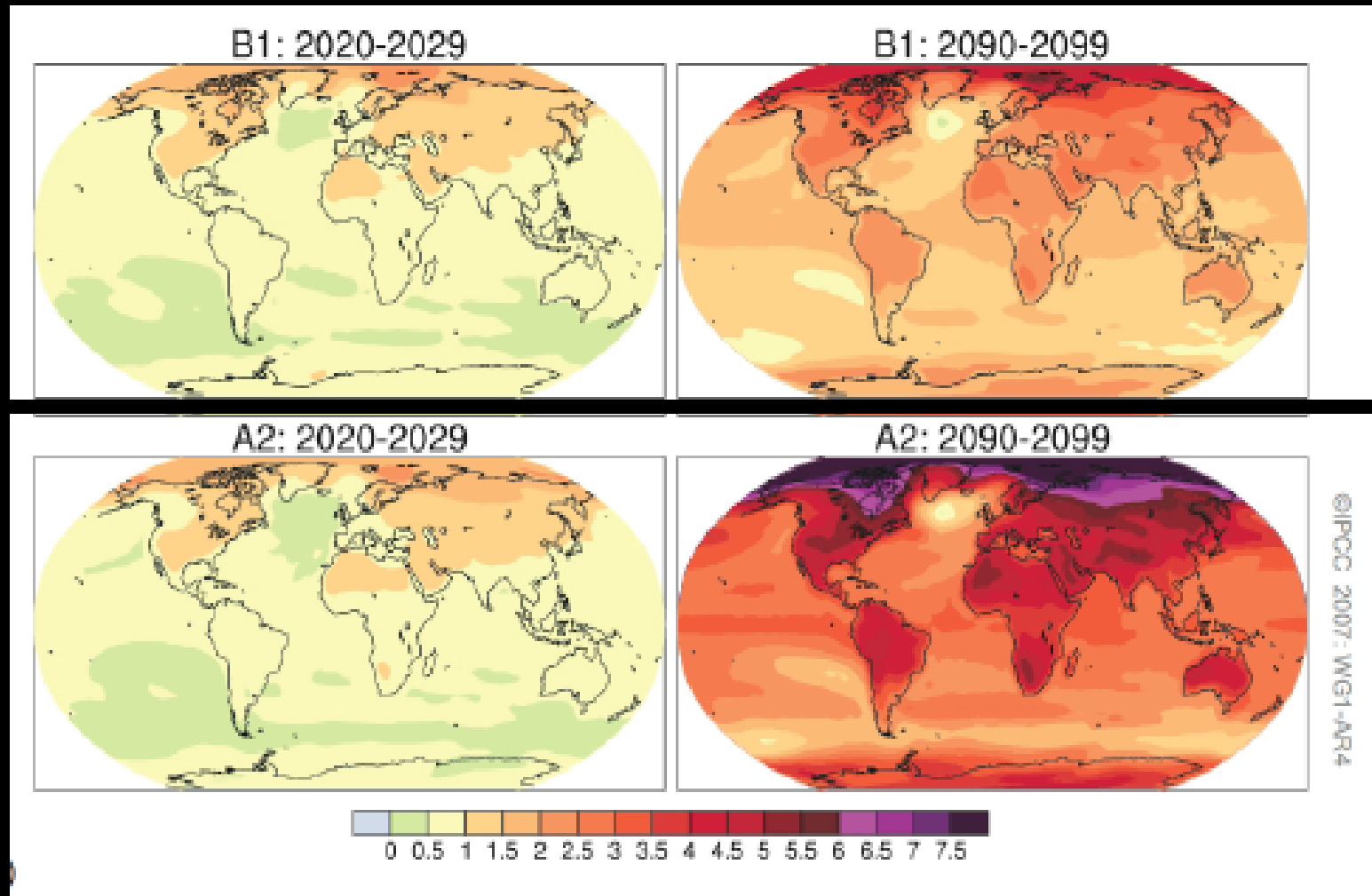
Source: IPCC, 2007



# Global Temperature Changes



# Projected Surface Temperature

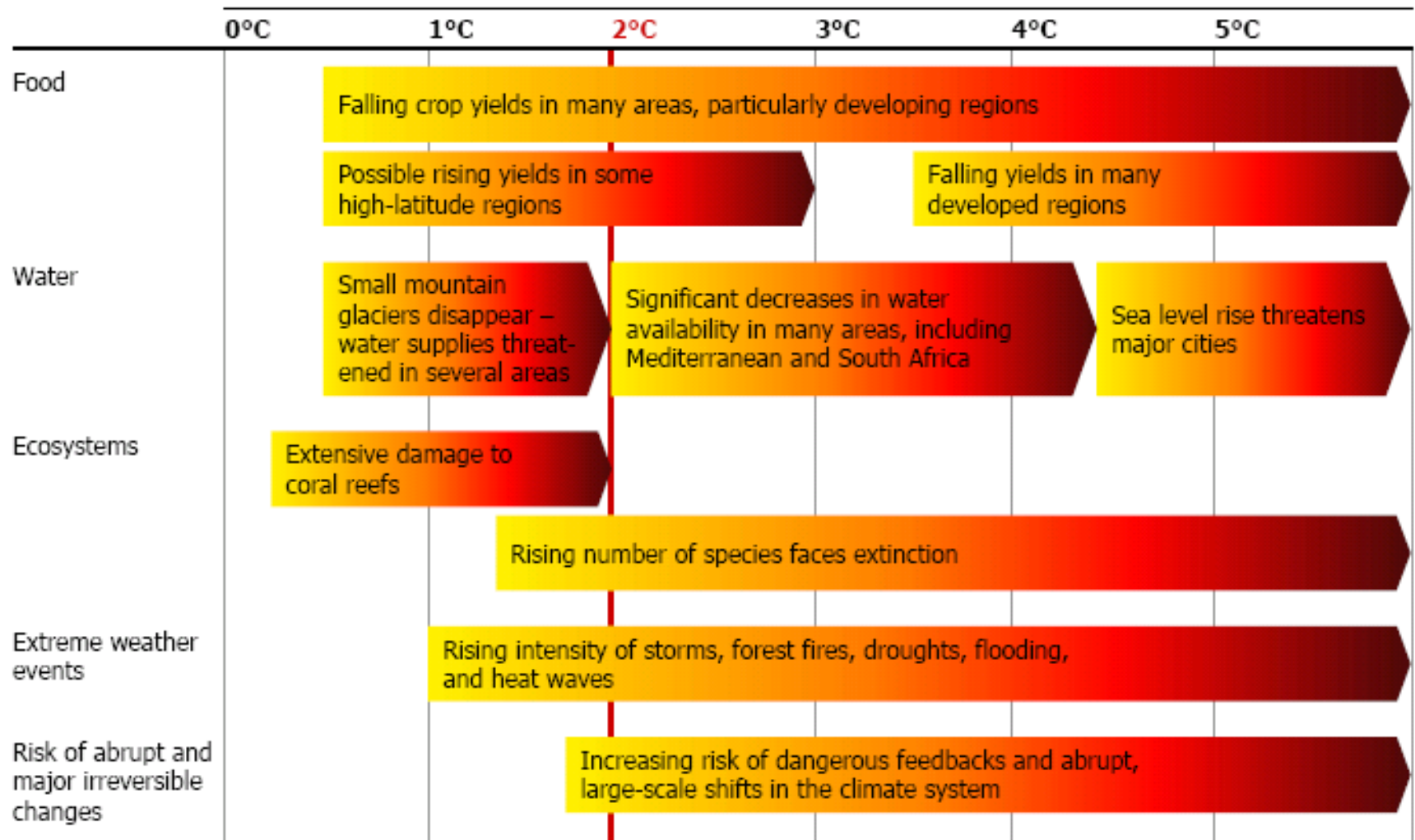


Source: IPCC, 2007



# Summarizing the Impacts

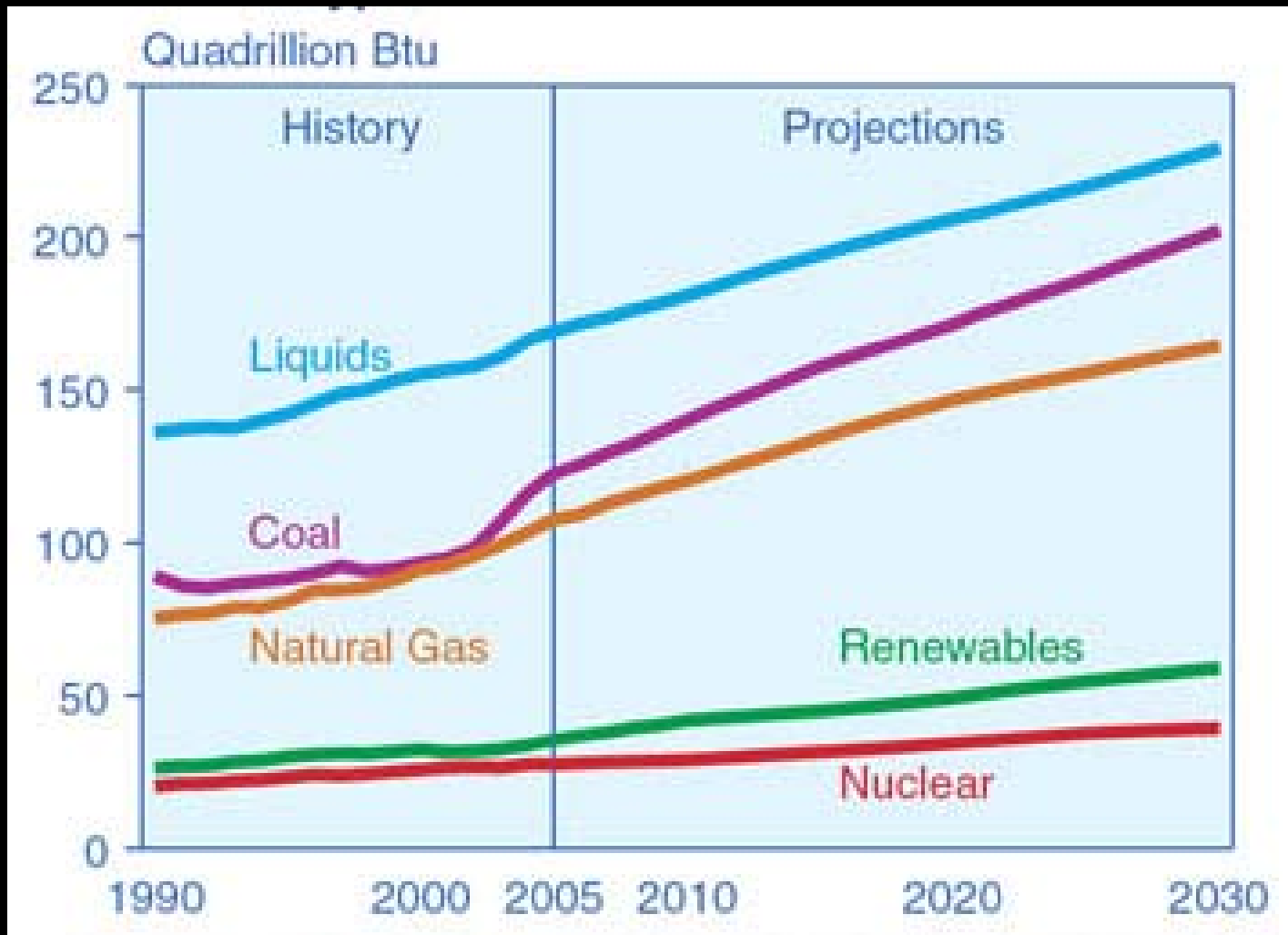
Global temperature change (relative to pre-industrial)



Source: Stern Review, 2006 (exsum v)



# Energy is a Key Climate Driver



Source: EIA, 2008

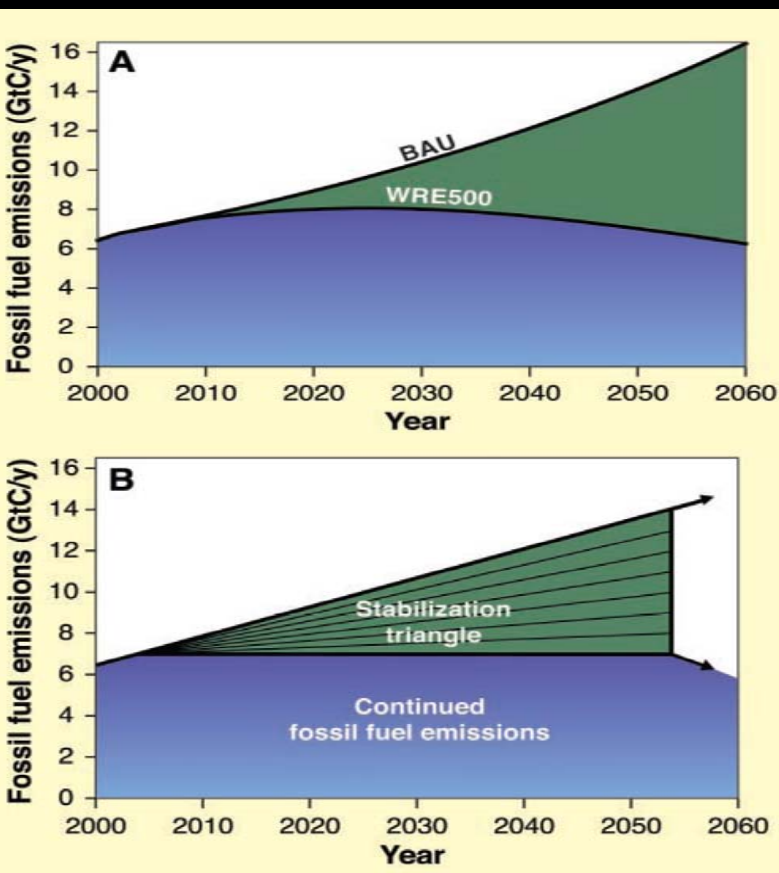
# Targets: The IPCC

<b>CO<sub>2</sub> Concentration at Stabilisation (2005=379 ppm)</b>	<b>CO<sub>2</sub>-equivalent Concentration at Stabilization (includes aerosols; 2005=375 ppm)</b>	<b>Year in which global emissions peak</b>	<b>Global average temperature above pre-equilibrium</b>	<b>Change in global CO<sub>2</sub> emissions in 2050 (% of 2000 emissions)</b>
350 – 400	445 – 490	2000 – 2015	2 - 2.4 °C	-85 to -50
440 – 485	535 – 590	2010 – 2030	2.8 - 3.2 °C	-30 to +5
570 – 660	710 – 855	2050 – 2080	4 - 4.9 °C	+25 to +85

Source: IPCC AR4



# CCS: Part of the Solution



Today's Technology	Actions that Provide 1 Gigaton/year of Mitigation	Major Issues
Coal Plants	Replace 1,000 conventional 500-MW plants with "zero-emission" power plants	Technical, Social, & Economic Viability
Geologic Sequestration	Install 3,500 Sleipners, at 1 Mt of CO <sub>2</sub> per year	Technical, Social, & Economic Viability
Nuclear	Build 500 1 GW plants	Economics, Safety, Non-proliferation,
Efficiency	Deploy 1 billion cars at 40 mpg instead of 20 mpg	Distributed opportunity that is hard to capture
Wind	Install 750 x current	Geographic

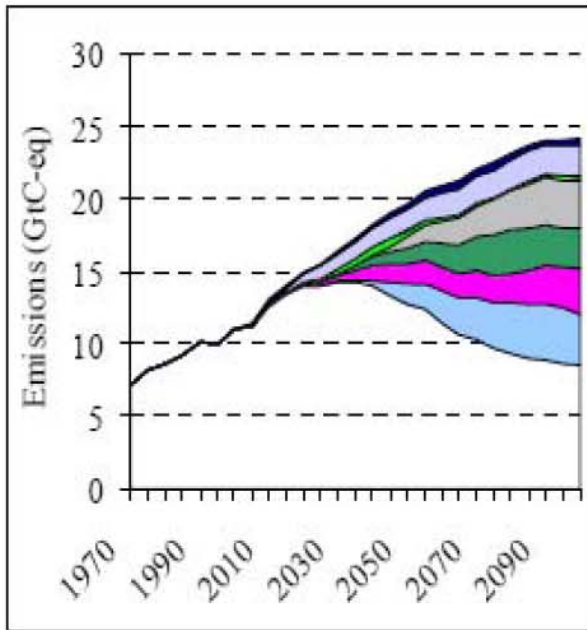
Source: Pacala and Socolow, Science, 2004



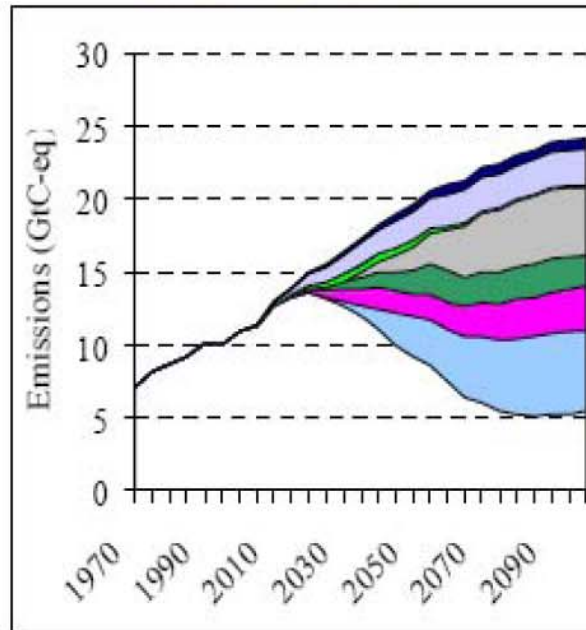


# Filling the wedges

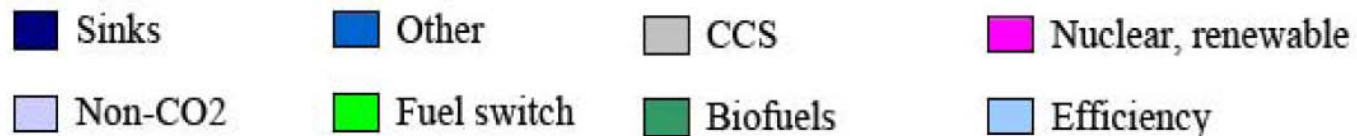
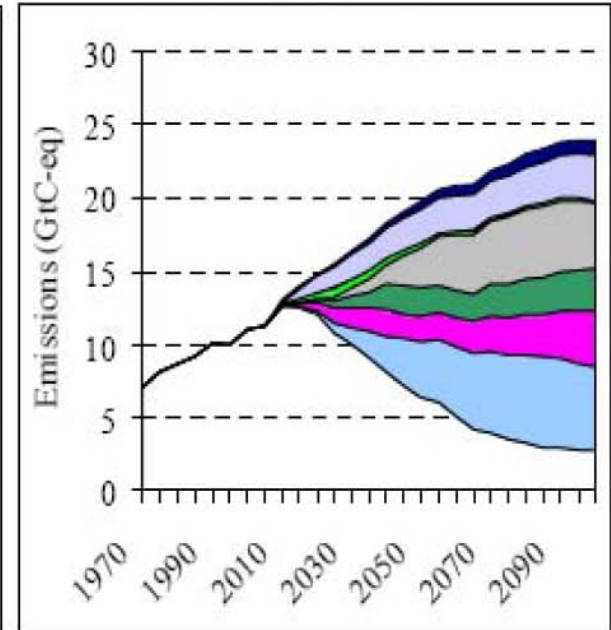
650 ppm



550 ppm



450 ppm



Source: van Vuuren, den Elzen, Lucas, et al. 2006



# U.S. Remains Key Player in Coal

- Currently world's 2nd largest producer and consumer
- 50% of U.S. electricity generation
- Total consumption projected to increase ~30% by 2030



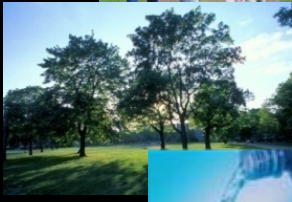
# WRI's Approach

Develop a set of guidelines for  
responsible carbon capture,  
transport and storage



# WRI CCS Guiding Principles

1. Protect human health and safety
2. Protect ecosystems
3. Protect underground sources of drinking water and other natural resources
4. Ensure market confidence in emissions reductions through proper GHG accounting
5. Facilitate cost-effective, timely deployment



# Major Finding



We know enough  
to begin carbon  
capture and  
storage  
demonstrations in  
the US **now**



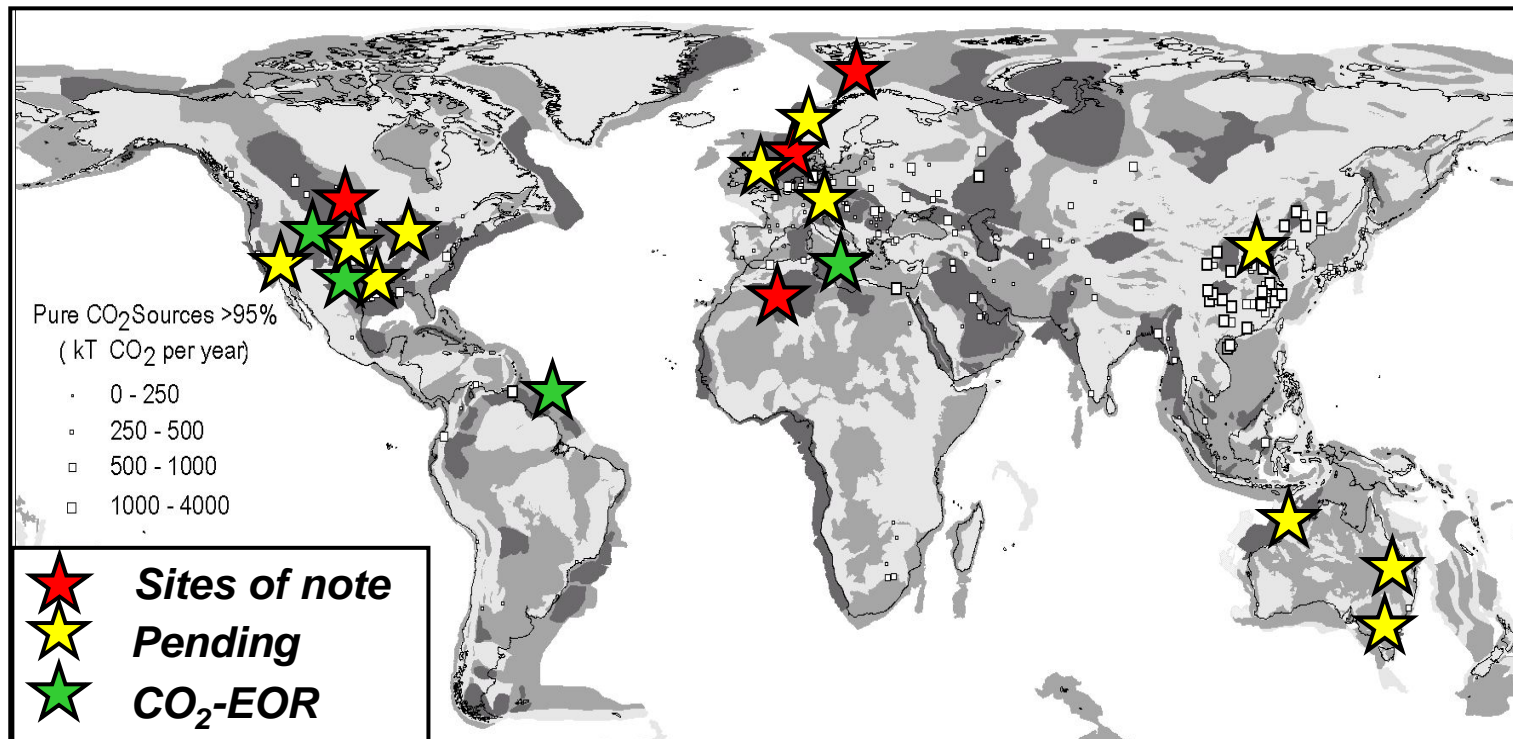
Julio Friedmann

## Four propositions re CCS (plus one implication)

- CCS is necessary (not sufficient) for climate
- Much is already known – but not everything
- Questions & concerns (technical & legal) should be dealt with
- The existence of questions & concerns does not diminish the climate necessity of CCS

# We need large projects to give the technical basis regulation and legal frameworks

***The projects demonstrate the high chance of success for CCS***



***These studies are still not sufficient to provide answers to all key technical questions or to create a regulatory structure***

# Information is needed urgently for key stakeholders

- **Potential operators:**
  - *What's needed to be safe and effective?*
- **Potential regulators:**
  - *How to keep the public interest without undue burden?*
- **Potential investors/insurers:**
  - *How can I tell a good site or a good actor from a risky one?*
- **Potential policy makers:**
  - *How can CCS be safely, swiftly, economically deployed?*
- **The public:**
  - *What's known, what's not, and what's most important?*

***Much is known and there are decent answers;  
better answers are wanted and required***

Sarah Forbes



The Guidelines Do NOT  
make an argument whether  
or not to do CCS.

Instead, they say *how* to  
do it



# WRI CCS Stakeholder Group



# Recommendations for Policymakers



# Policymakers

- Demonstrate all capture approaches
  - Capture 1a
- Facilitate pipeline network
  - Transport 3a, 3b, 4a
- Provide clarity on pore space ownership
  - Storage 4b
- Assure clarity for post-closure
  - Storage 3c, 8a, 8b



# Recommendations for Regulators





# Regulators

- Comply with existing laws
  - Capture 2a, Transport 1b, Storage 6k
- Evaluate potential impacts
  - Capture 2e; Transport 2c; Storage 2a
- Focus on what, not how
  - Storage 1d and 7d
- Establish publicly accessible registry



# Recommendations for Project Developers and Operators



# Project

## Developers/Operators

- Integrate planning and operations
  - Capture 1b, Storage 1d, 2f, 5a5, 6m
- Fit-for-purpose design
  - Capture 1c, Transport 1a, Storage 6e
- Base site selection specific data



Storage Box 5





02/25/2008 04:02 PM



Real-world  
geology means  
every site is  
different

Injection Well in Michigan. Source: Battelle



Well head at Frio Source Texas BEG

Guidelines  
provide  
benchmarks  
for  
evaluating  
potential  
projects

