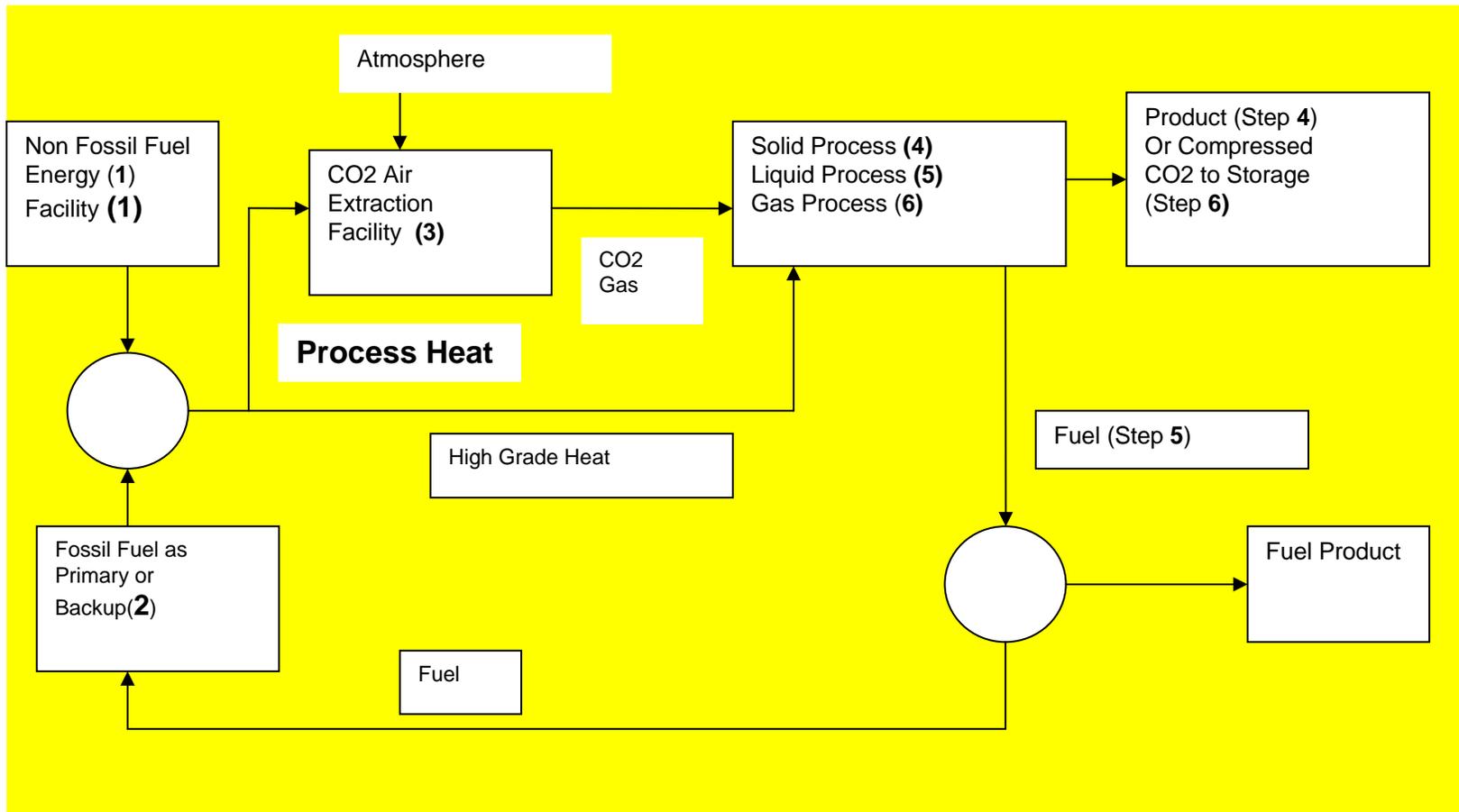


ECONOMIC DEVELOPMENT ENERGY SECURITY AND CLIMATE CHANGE RISK

**Peter Eisenberger
United Nations
November 12, 2009**

**WHY CAPTURE CO₂ FROM THE AIR
and
HOW IT CAN HELP AOSIS COUNTRIES**



Elements of Air Capture Co-generation Technology

1. Solar thermal, geothermal, biomass, nuclear, other processes to provide process heat(PH) for CO2 extraction, **or...**
2. Fossil fuel power generation or other industrial facility like making of liquid fuels, metals, and cement to provide low grade process heat for atmospheric CO2 extraction
3. Carbon dioxide extraction
4. Incorporation of CO2 in solid material manufacture (e.g., construction material), **or...**
5. Catalytic process to covert CO2 to liquid fuels, **or...**
6. Compression for subsequent injection into geologic formations

Context for Evaluating Air Capture

- The world needs much more energy/especially developing countries to power economic growth
- Aggressive efficiency improvements, a shift away from fossil fuels, and use of CCS cannot offset climate change threat
- This creates an imperative for '**carbon-negative**' mitigation measures; that is, measures that can reduce atmospheric carbon faster than emissions will load the atmosphere
- Among such measures, air extraction technology offers advantages of addressing climate change threat without direct intervention in the biosphere or significant collateral environmental impact
 - **Treat CO2 as Pollution (limit and cleanup CO2 emissions)**
- Air capture technology can also create economic incentives for renewable energy development to stimulate economic growth while reducing the climate change threat
- AOSIS and developing countries generally can play important role

Strategic Advantages of Air Capture Because the Source of CO₂ is Air

- Can remove more CO₂ than is emitted
 - **Carbon negative as opposed to carbon neutral**
- Can also be used with non fossil fuels sources
 - **Can facilitate transition to clean energy**
 - **Can use low temperature process heat**
- New paradigm
 - **More energy/reduce climate change threat**
- All countries can participate via the carbon market
 - **AOSIS /developing countries large increase in energy**
- Can help resolve Copenhagen deadlock
 - **AOSIS countries can catalyze resolution/Chichilnisky**

Current Approaches to Climate Change

- **“WEDGES” APPROACH**

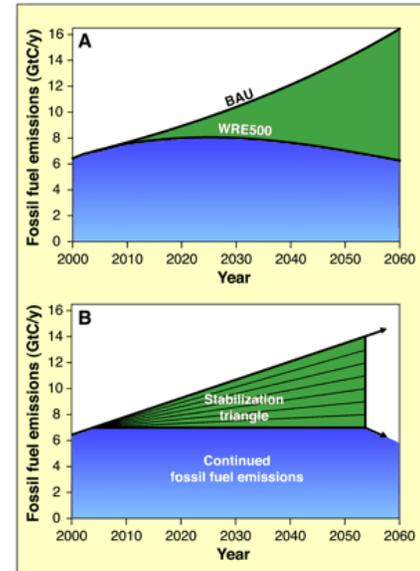
- Sensible, diversified strategy based on existing pathways
- Portfolio of renewable energy and efficiency technologies
- Potential to keep CO₂ below 500ppm (still 2x pre-indust. level)

But may not be sufficient to avoid climate change...

- Depends on continued net natural absorption rate
- Does not address 2005’s already elevated emissions
- Underestimates projected Growth by factor of two
- No solution past 2055

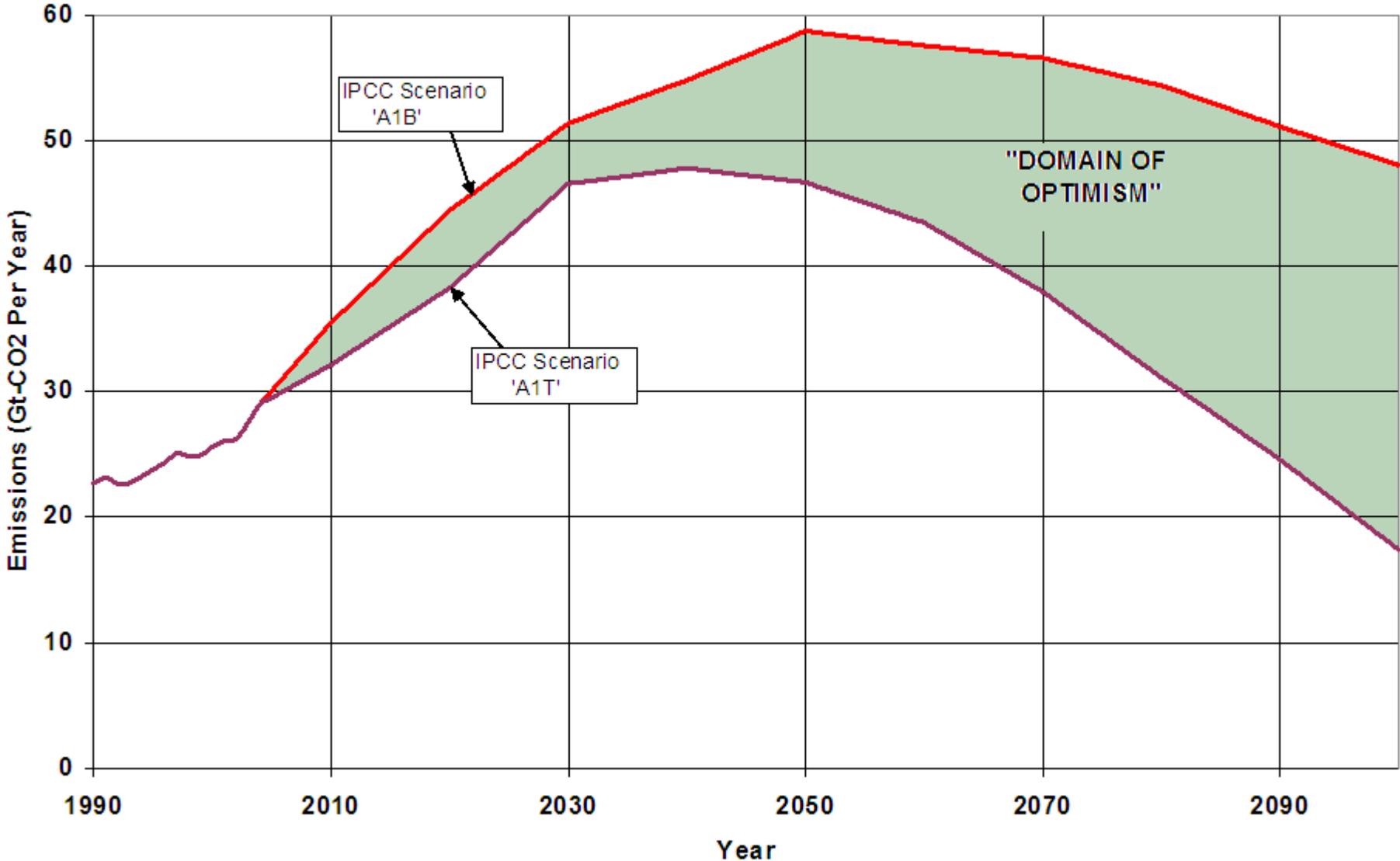
- **GEO-ENGINEERING APPROACHES**

- Growing list of proposed strategies for altering the global climate system, including:
 - Fertilizing the Ocean with Iron
 - Inject Particles in Atmosphere
- Can have potentially massive unintended impacts
- Emergency steps at best

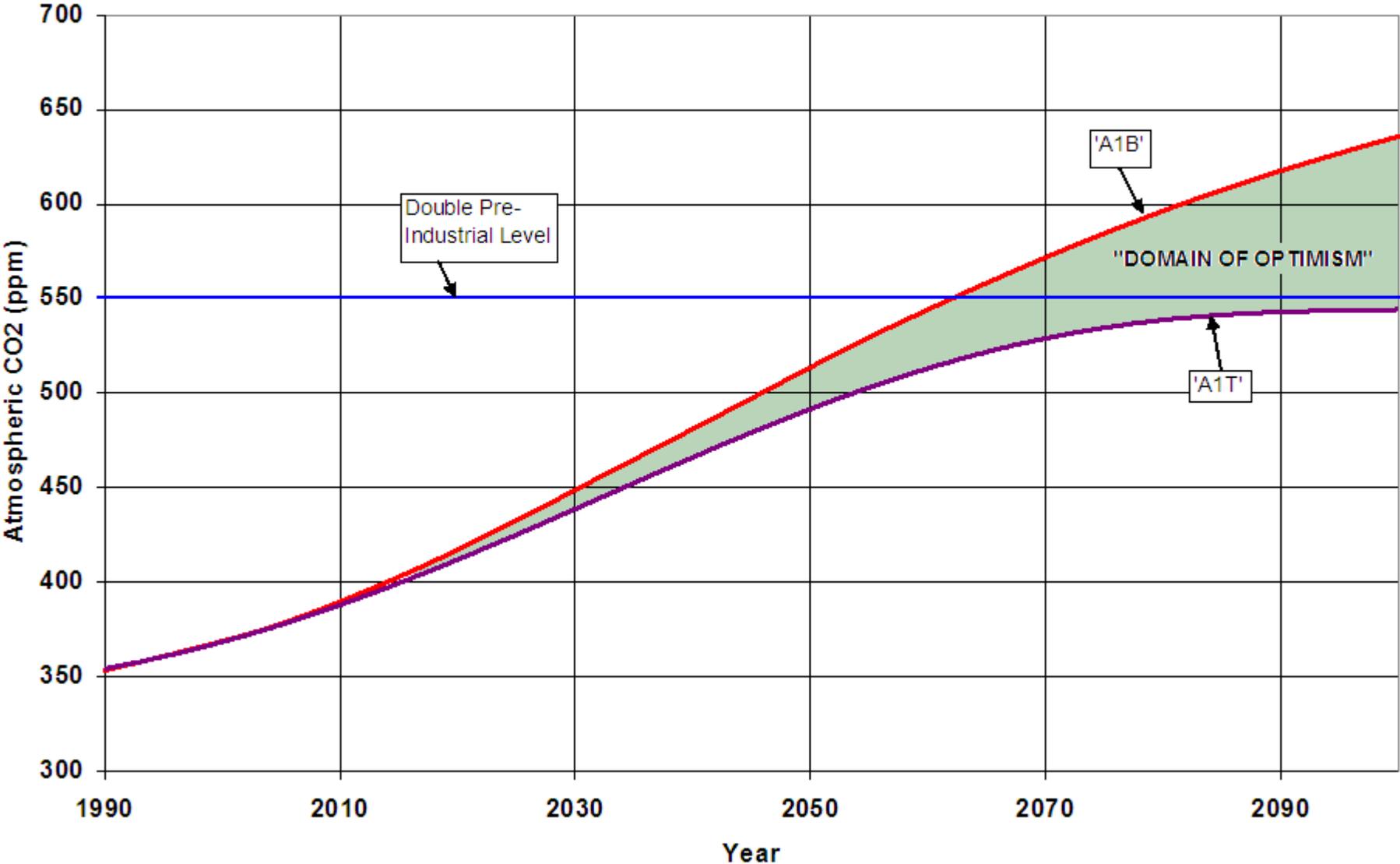


A safe, effective, and affordable solution to climate change is still urgently needed

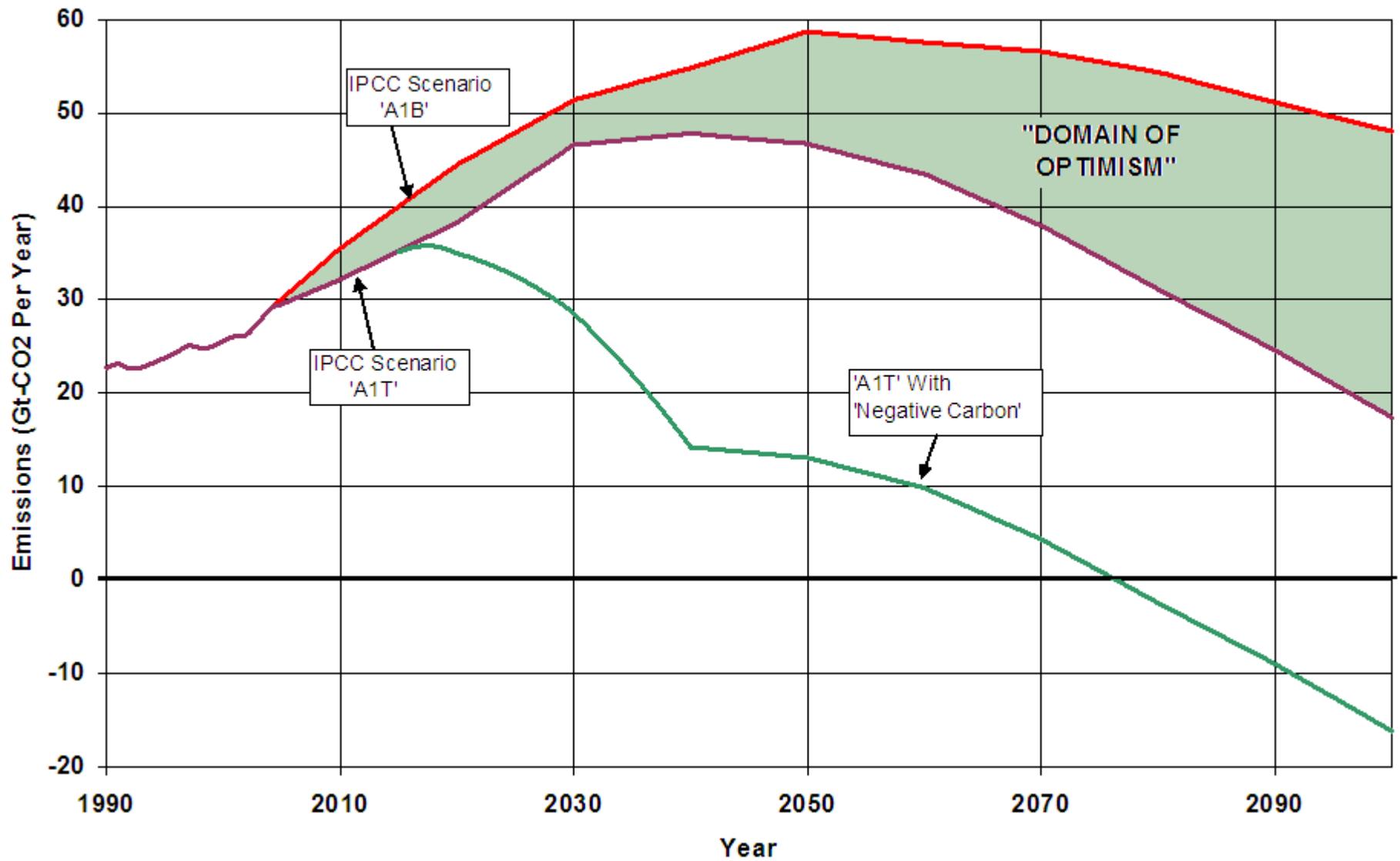
Carbon Dioxide Emissions Pathways



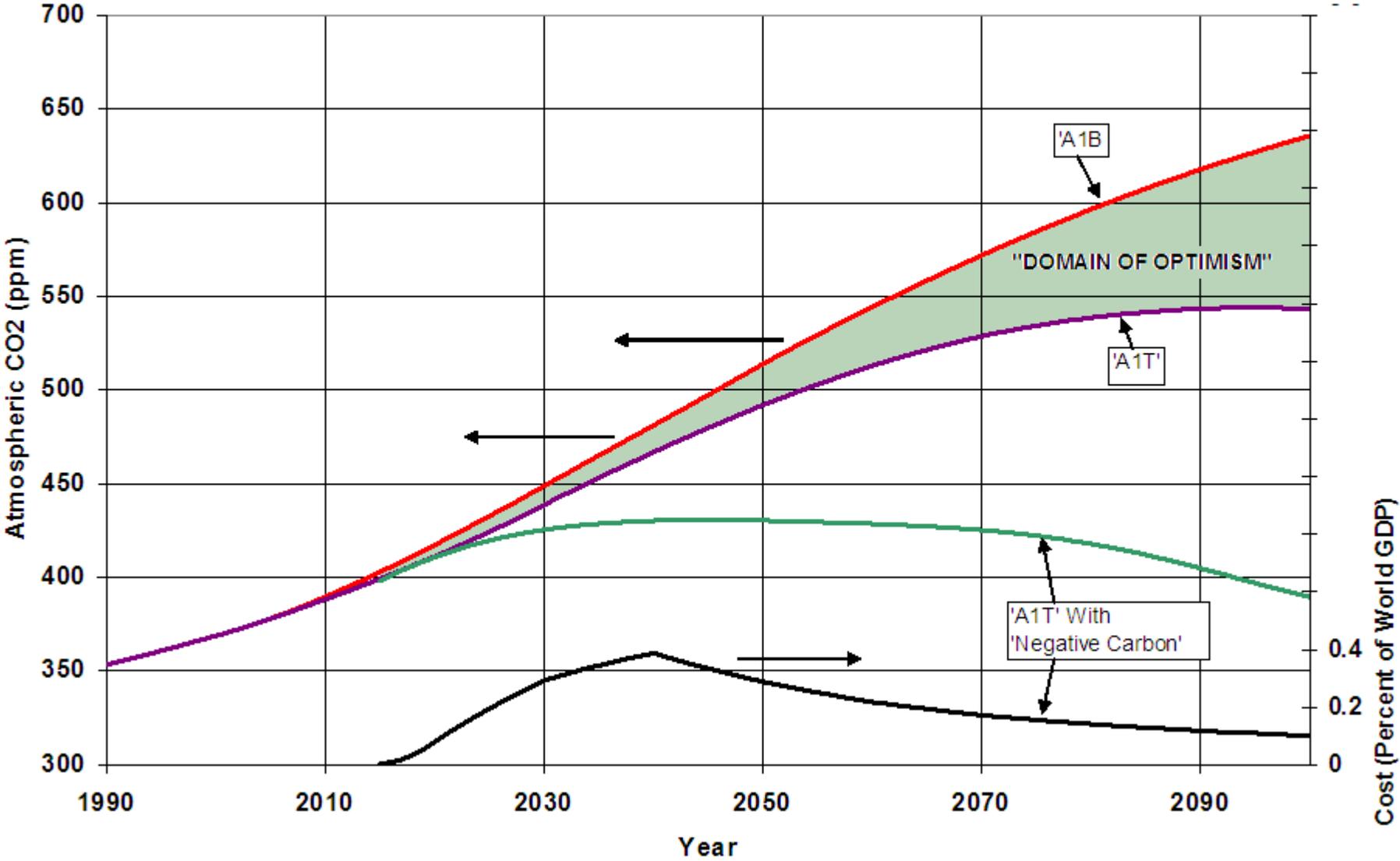
Atmospheric Carbon Dioxide Pathways



Carbon Dioxide Emissions Pathways



Atmospheric Carbon Dioxide Pathways



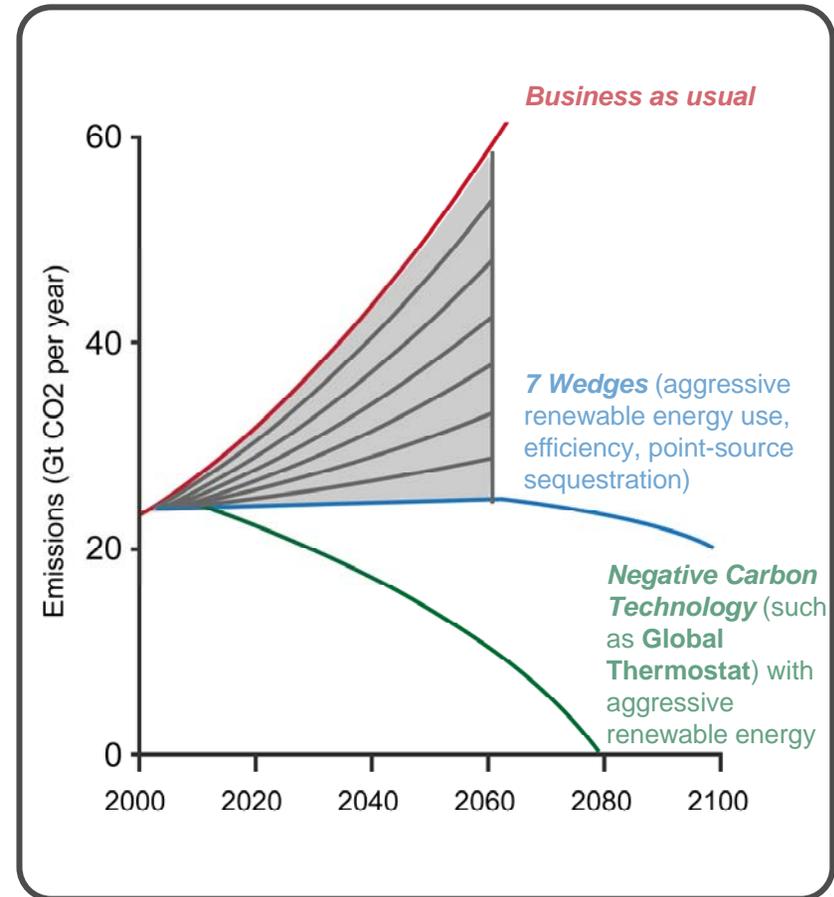
The Need for Going Carbon Negative...

- **Carbon Neutral is not enough**

- Neutralizing new and existing emissions does not prevent atmospheric concentration of CO₂ from further increasing
- It doesn't solve the climate risk problem (keeping atmospheric concentrations below 450 ppm)

- **Carbon-Negative is Required**

- To reduce atmospheric concentrations faster than the natural absorption rate
- To achieve a safe level of CO₂ concentration



Air Capture Can Make Going Carbon Negative Possible

Pacala and Socolow, *Science*, Vol 305, 8/13/2004, Pg 969.
Note: 7 Wedges refers to the seven stabilization wedges, created by Wigley, Richels & Edmonds, necessary to achieve an atmospheric concentration of CO₂ of 500 ppm by 2125.

Air Capture

VS.

Other Carbon Capture Methods

Technology / method	Upfront cost	Ongoing costs	Scalability	Negative externalities	Other
Air Capture of CO ₂	LOW	Medium	Highly scalable; flexible application	Minimal	Could provide additional revenue to accelerate the transition to renewable energy
Ocean iron fertilization	Low	Low	Highly scalable	Extreme: Alteration of key biological systems	Does not address the root cause of climate change
Atmospheric seeding	Low	Low	Highly scalable	Extreme: Potential alteration of global water cycle	Significant unknowns; does not address the root cause of climate change; can be exploited by individual nations to pursue their own agendas
Clean coal*	High	Medium	Limited to new power plants	Environmental impact of coal mining	Does nothing to offset CO ₂ from non-coal sources
Other point source capture*	Medium	High	Limited to point sources	Minimal	Does not offset CO ₂ from mobile sources; impurities in flue gas degrade sorbent

* Not carbon negative

AIR CAPTURE BY AOSIS

- Current energy production globally- 5×10^{20} joules/ 1.33×10^{14} kwhr
 - Projected Global growth by 2050 2-3, larger in developing countries
- Can use air capture to remove 2kg of CO₂/kwhr of energy produced
 - Will assume 50% use thus 1kg of CO₂/kwhr of new energy produced
- AOSIS
 - 5% of the world's population/less than .1% of energy use
 - Will assume 1% of the world energy use($.1 \times 10^{20}$ joules) by 2050
 - Could remove as much as 2 gigatonnes of CO₂/yr by 2050
 - If carbon market price \$25/tonne than \$50 billion in carbon credits/yr
 - Sequestration in saline aquifers possible
- Captured CO₂ can contribute to energy security and economic development
 - Feed to algae to make green liquid fuels/chemical feedstocks
 - Combine with hydrogen from water to make green fuels
 - Use for enhanced oil recovery
 - Make fertilizers
 - Construction material/concrete
 - Greenhouses/Carbonated soda/cleaning

CONCLUSION

- **EXISTING EFFORTS WILL NOT PREVENT THE THREAT OF CLIMATE CHANGE IF THERE IS STRONG ECONOMIC GROWTH**
- **NEED NEGATIVE CARBON SOLUTIONS**
- **AIR CAPTURE CAN PREVENT THE RISK OF CLIMATE CHANGE**
 - **LOWEST RISK TECHNOLOGICAL APPROACH/POLLUTION PARADIGM**
 - **NEEDS PUBLIC INVESTMENT TO ACCELERATE DEVELOPMENT**
- **ALL COUNTRIES CAN PARTICIPATE IN THE CARBON MARKET**
 - **AOSIS/DEVELOPING COUNTRIES CAN PLAY IMPORTANT ROLE**

NEGATIVE CARBON POWERED BY RENEWABLE ENERGY SOURCES CAN STIMULATE ECONOMIC GROWTH, PROVIDE ENERGY SECURITY WHILE MITIGATING CLIMATE CHANGE RISK