The Role of FUSION in a Long-Term, Global Energy Technology Strategy

To Address Climate Change

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THE GLOBAL ENERGY TECHNOLOGY STRATEGY PROJECT

CURRENT SPONSORS

- Battelle
- British Petroleum
- EPRI
- European Union
- Mobil Oil
- Japan's NIES
- Toyota Motor Corporation
- U.S. Department of Energy

A TECHNOLOGY STRATEGY COLLABORATION

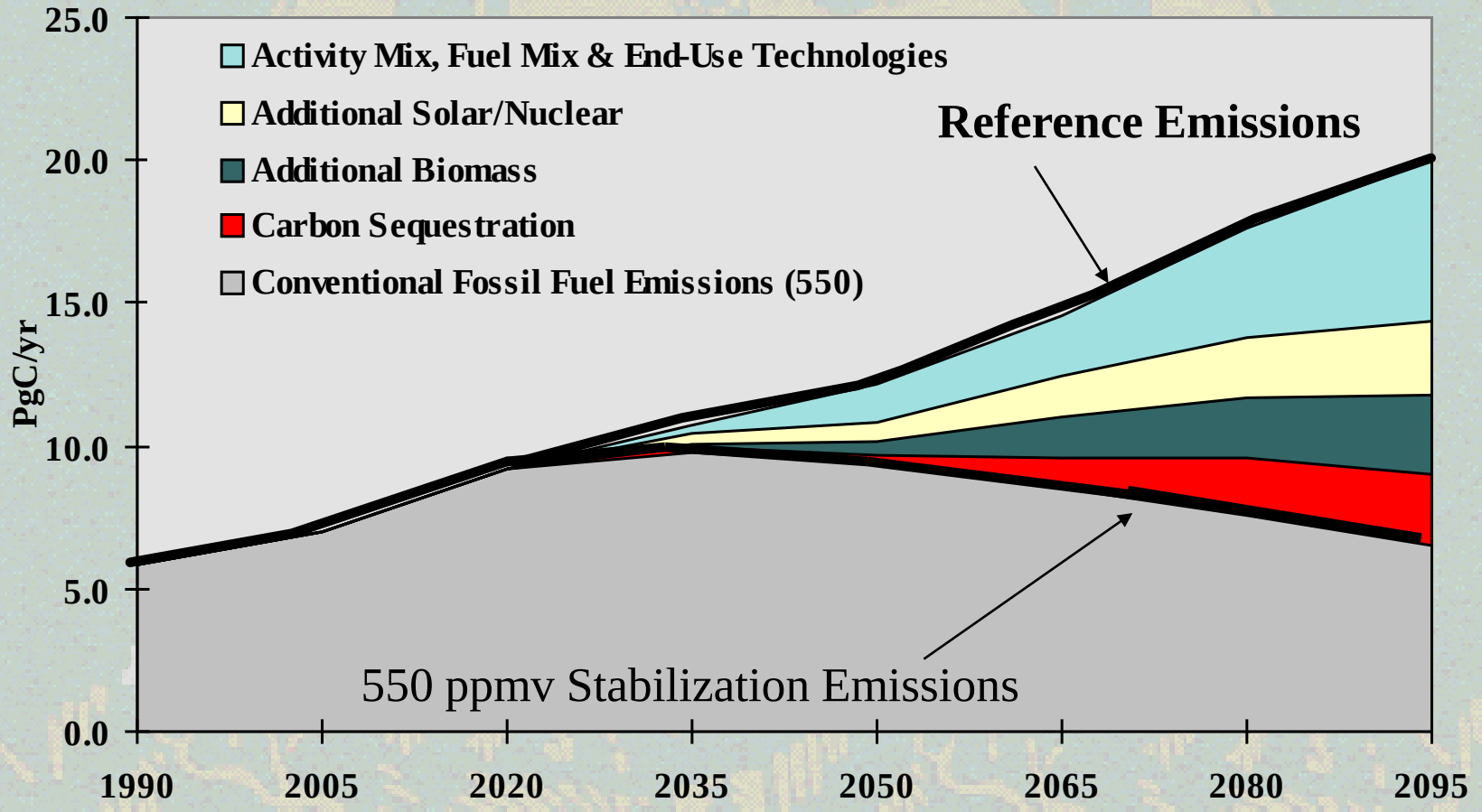
INTERNATIONAL

- Beijing Energy Research Institute
- Centre International de Recherche sur l'Environnment et le Developpement
- Council on Agricultural Science and Technology
- Council on Foreign Relations
- Indian Institute for Management
- Intern'l Inst. for Applied Systems Analysis
- Japan Science & Technology Corporation
- Korean Energy Economics Institute
- National Autonomous University of Mexico
- National Inst. for Env. Studies, Japan
- Potsdam Institute for Climate Studies
- Stanford Energy Modeling Forum
- TATA Energy Research Institute

CONCLUSIONS

- **Fusion--and in particular electricity--has a major role to play in a technology strategy to address climate change, but**
- **Fusion will be part of a technology portfolio, including**
  - *Supporting technologies e.g. batteries & fuel cells, and*
  - *Complementary technologies e.g. biomass, solar, conservation, nuclear, natural gas, hydrogen, generation, carbon capture & sequestration.*

Energy Technologies
Filling the Global CO_2 Emissions Gap (An Illustrative Example)



FILLING THE GAP

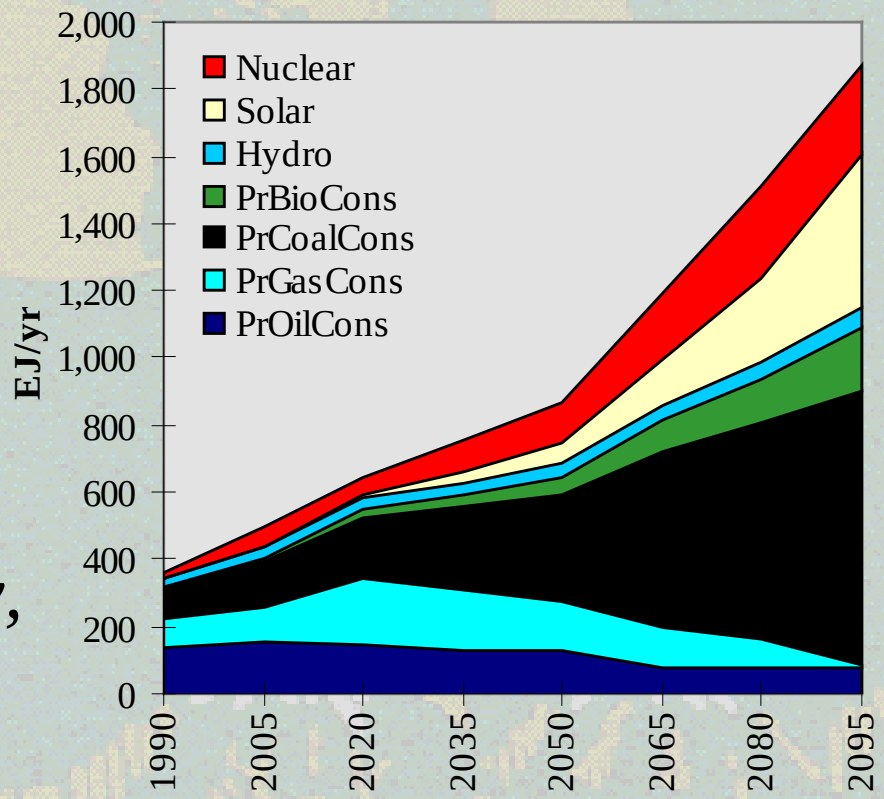
- No one technology will solve the climate problem alone.
- A mix of technologies will be needed including--fusion, solar, fission, biomass, conservation, and fossil fuels.
- The contribution of technologies to the solution will depend on their relative economic performance.

CONCLUSIONS

- Fusion will benefit from emissions mitigation, but
- Unless it is economically competitive, its role will be limited.
- The value of successful research on fusion energy is great.

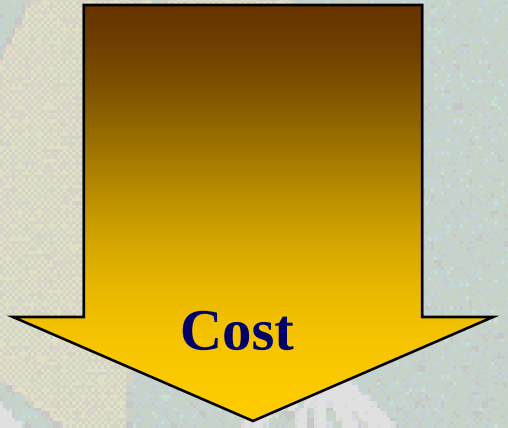
REFERENCE CASE

- *Unconventional Oil & Gas production is limited by coal availability and low-cost of synthetic fuels.*
- *Coal is the dominant form of primary energy, but is used primarily in a transformed state.*



REFERENCE CASE
FUSION TECHNOLOGY

Cost	Year
>$0.50/kWh	2035
$0.15/kWh	2050
$0.05/kWh	2095

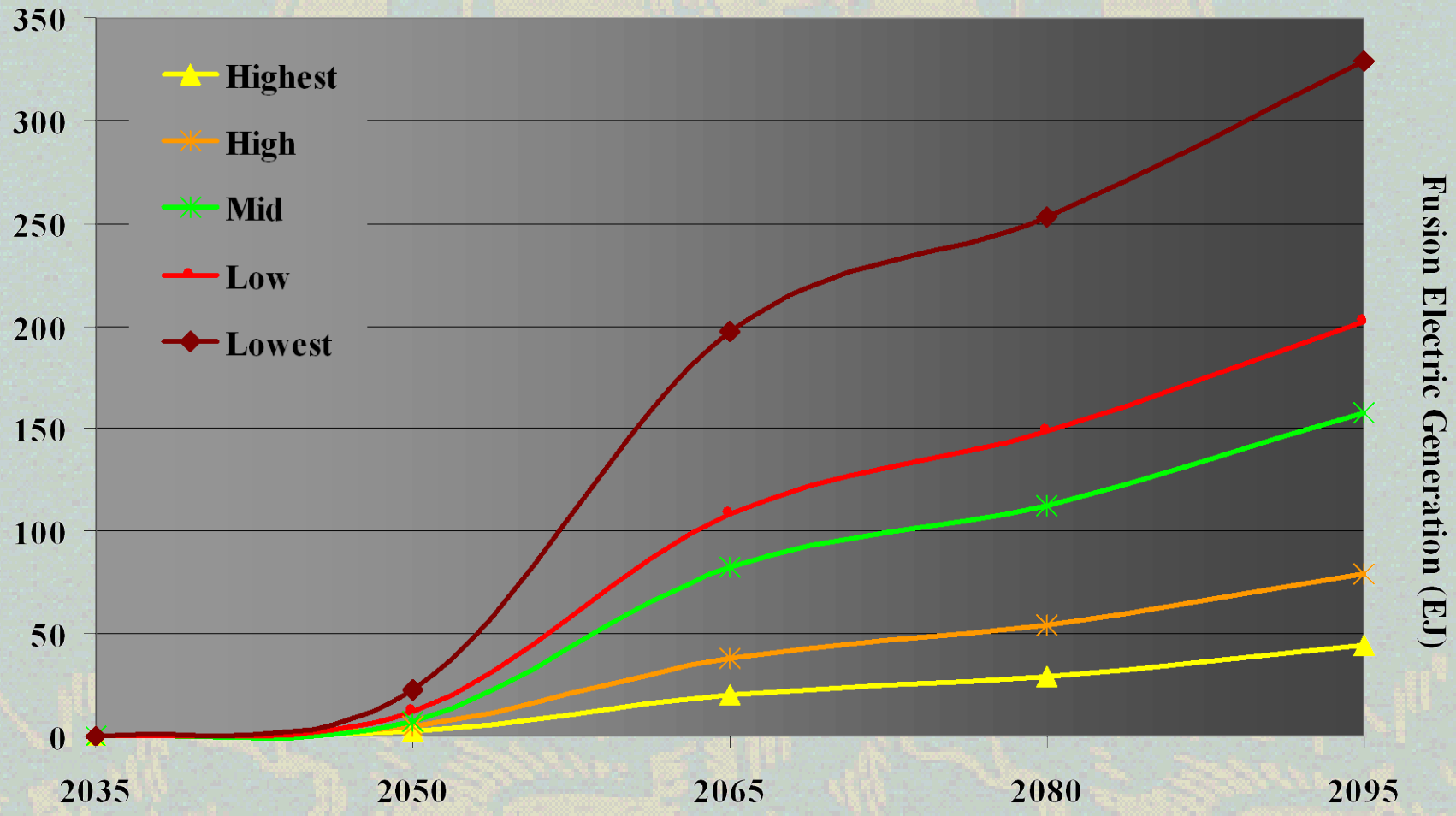


FUSION COST SENSITIVITY
(2095 Cost, 1996 $)

- Lowest = $0.03/kWh
- Low = $0.04/kWh
- Mid = $0.05/kWh
- High = $0.08/kWh
- Highest = $0.10/kWh

FUSION MARKET PENETRATION

Reference Case, Alternative Fusion Costs



EMISSIONS MITIGATION CASES

FUSION POWER & EMISSIONS MITIGATION

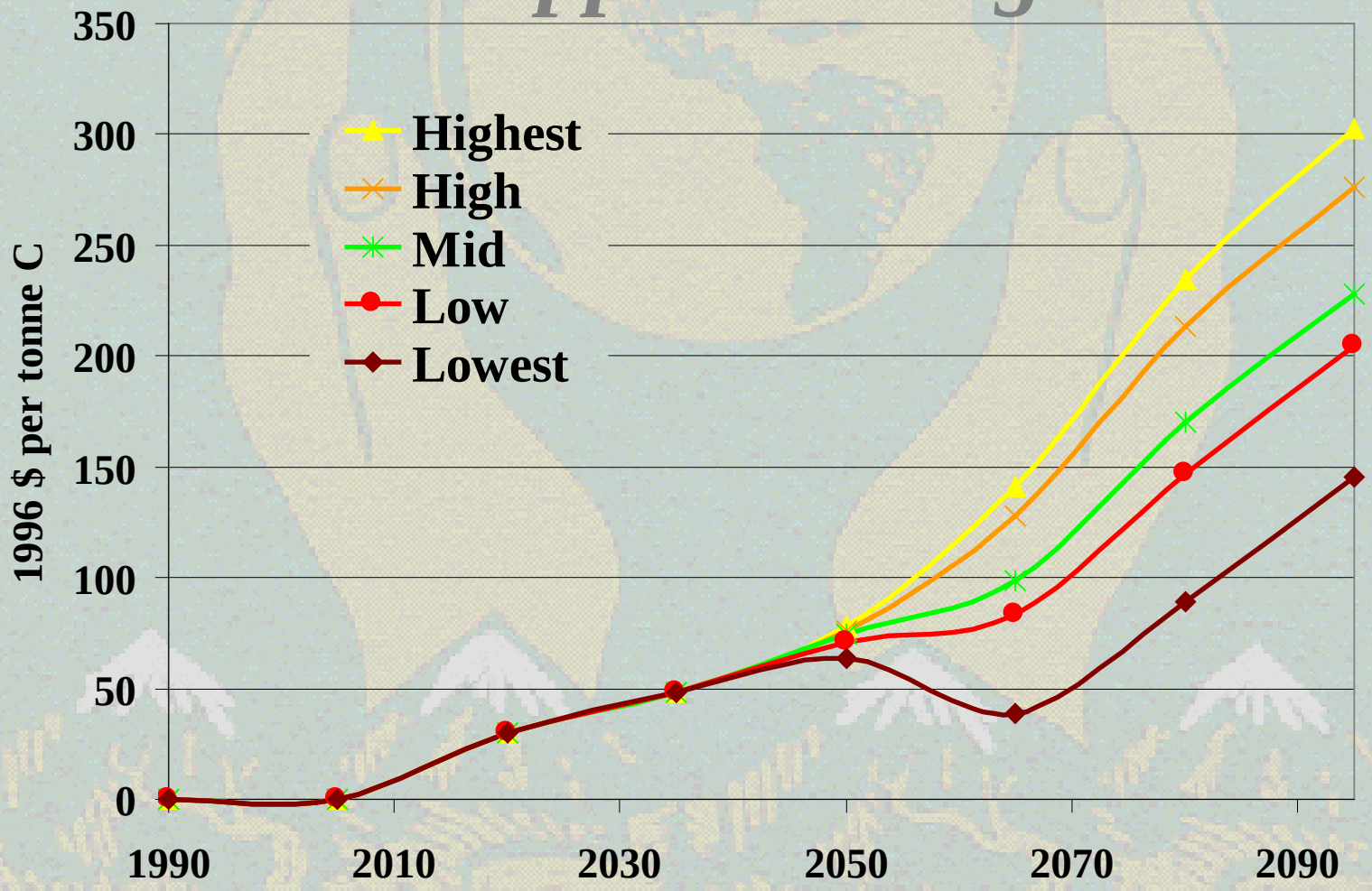
- **Fusion benefits from carbon taxes.**
- **Each $100/tonneC is worth**

$0.011 to $0.018/kWh

(depending on fossil fuel alternative)

FUSION CAN HAVE A LARGE EFFECT ON THE VALUE OF CARBON 2005 TO 2095

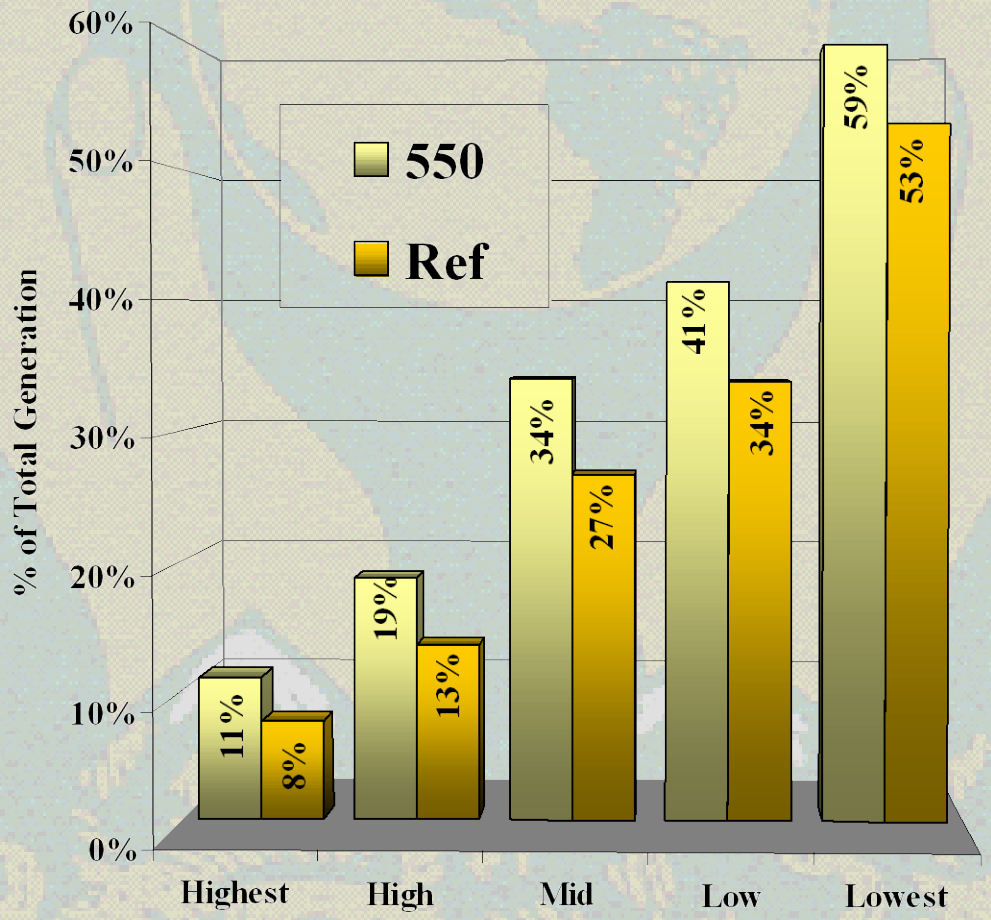
550 ppmv ceiling



FUSION INTERACTION WITH OTHER TECHNOLOGIES

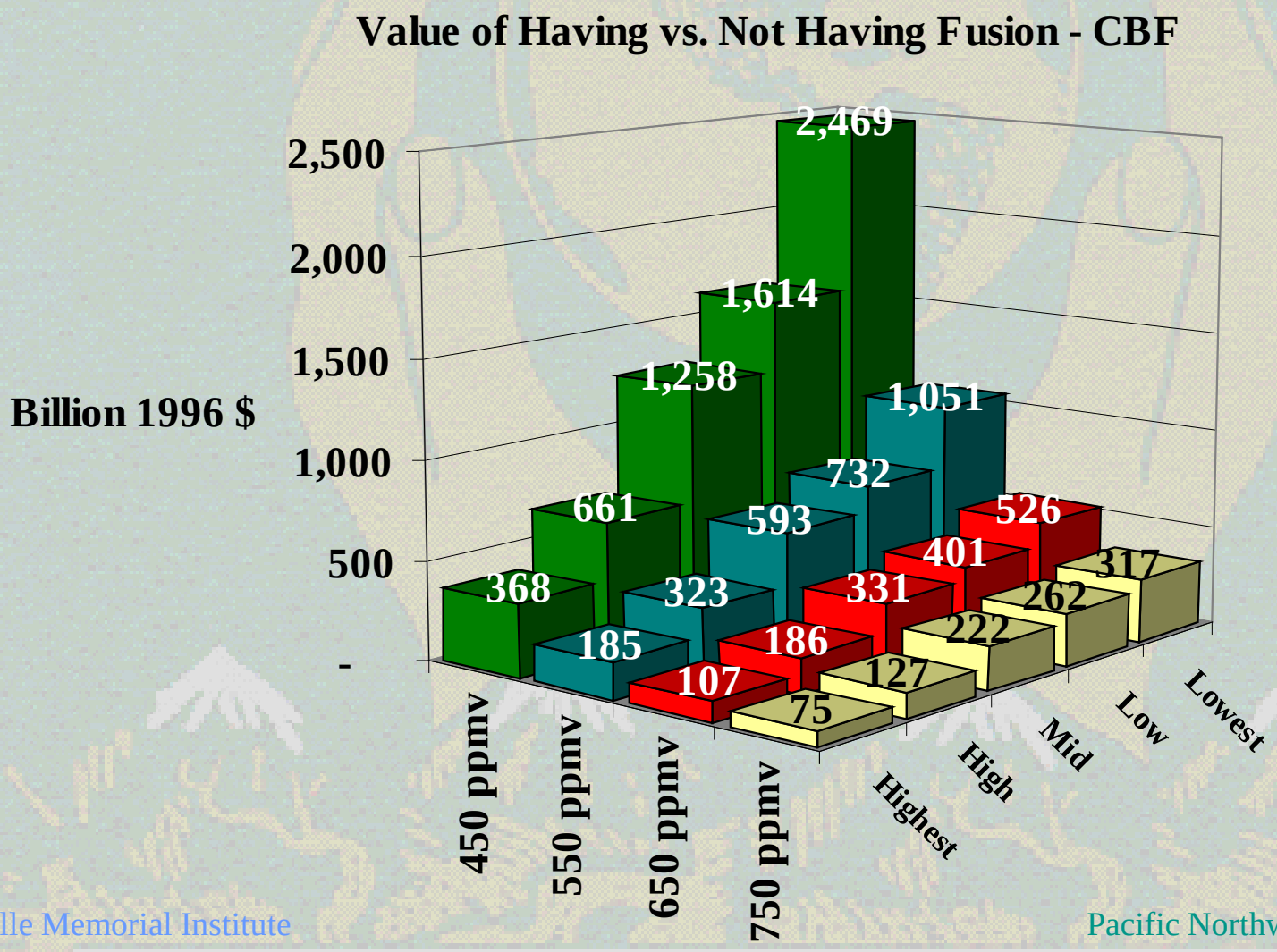
- **High cost fusion benefits only marginally because it is more expensive than alternative mitigation options.**
- **Low cost fusion significantly reduces carbon emission mitigation requirements.**

Effect of 550 ppmv Stabilization on Fusion's Electricity Share of 2095 Power Generation Market



VALUE OF SUCCESSFUL FUSION R&D WITH EMISSIONS MITIGATION

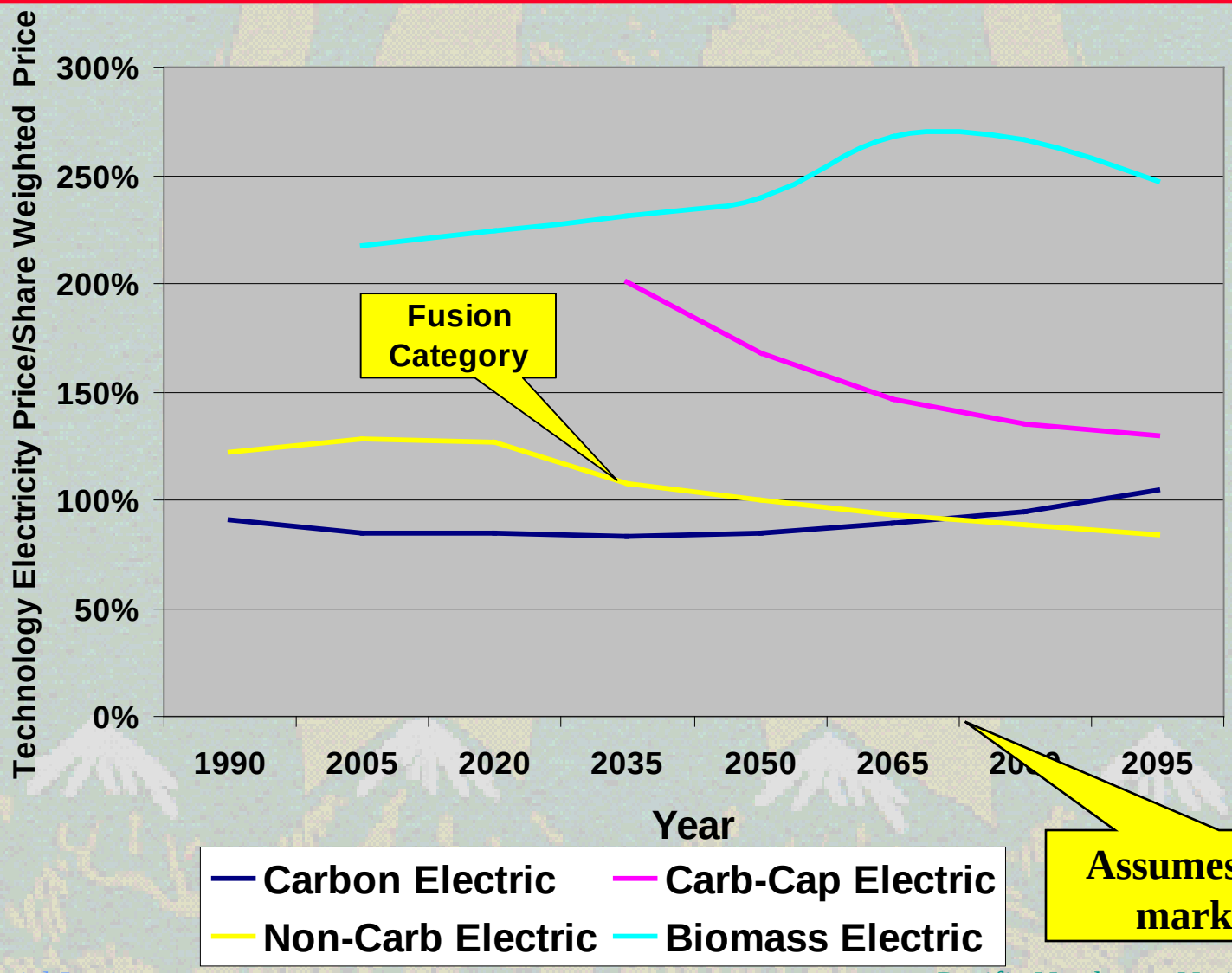
VALUE of FUSION TECHNOLOGY



Value Of Particular Fusion R&D Targets

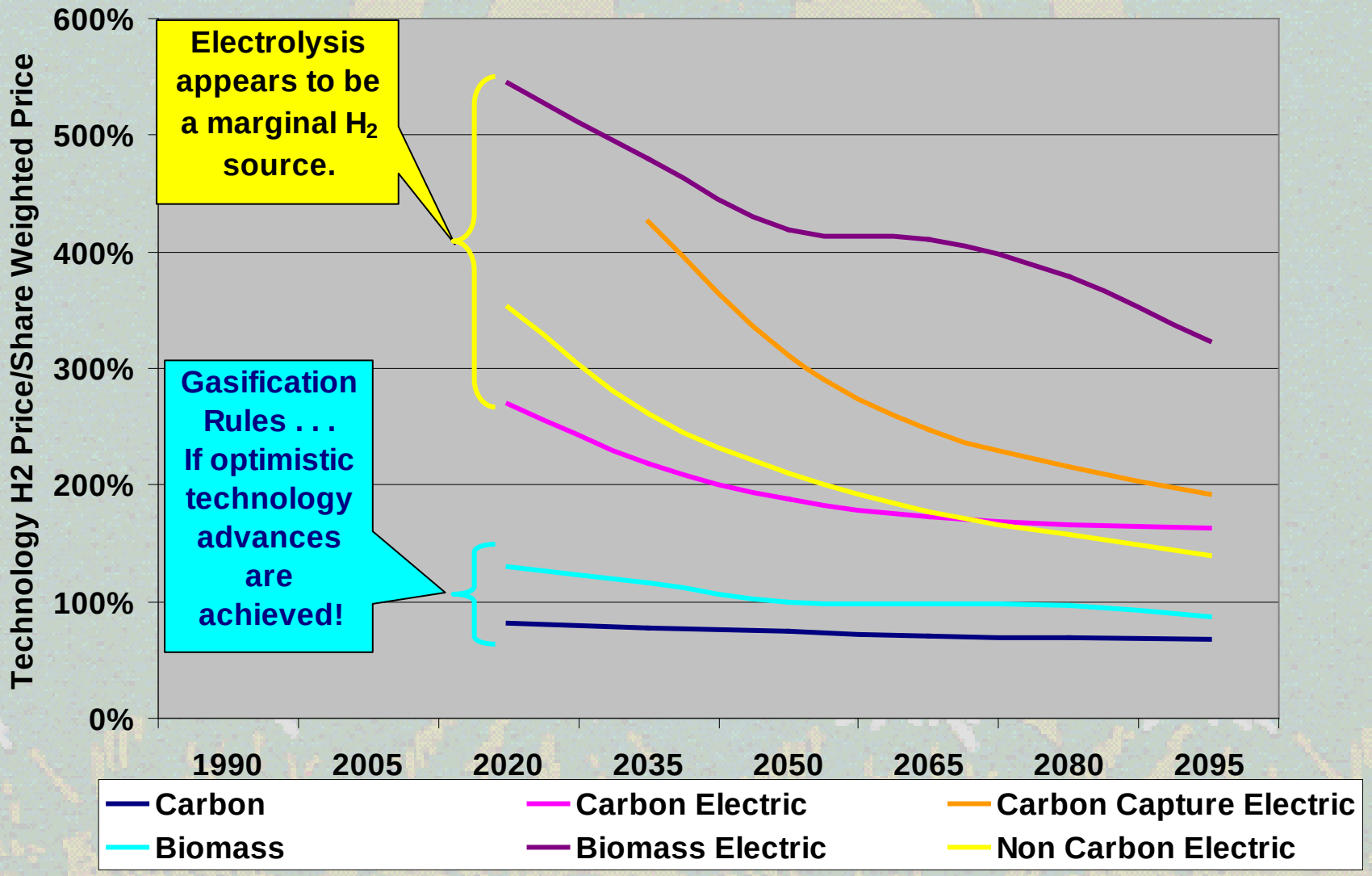
Electricity Market: Price Ratios

(USA Stabilization at 550 ppm less USA BAU)



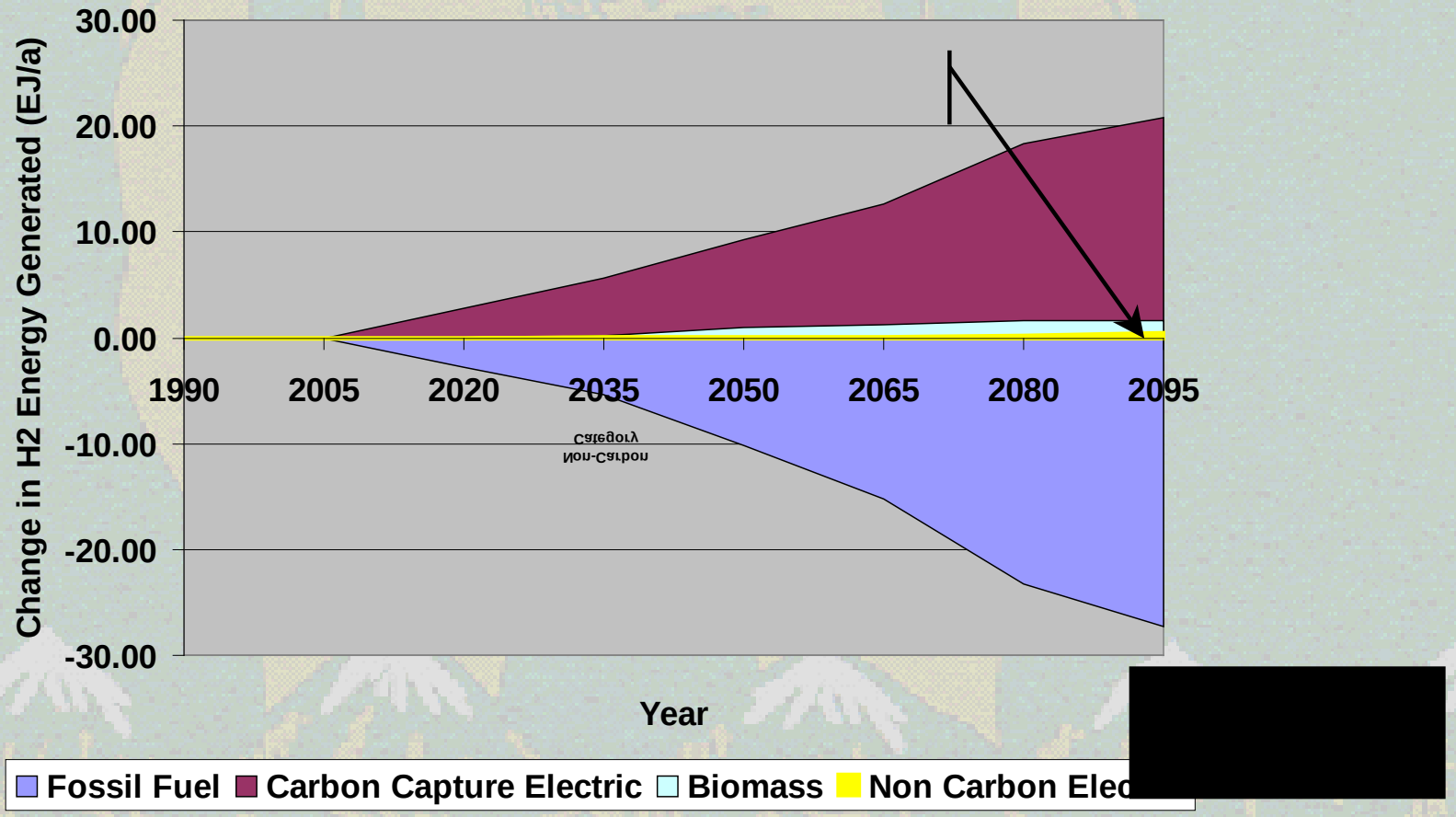
Hydrogen Market: Price Ratios

(USA Stabilization at 550 ppm less USA BAU)



How Does Hydrogen Production Technology Change With Stabilization Policy?

(USA Stabilization at 550 ppm less USA BAU)



CONCLUSIONS

Fusion's role in a technology strategy to address climate change

- **Fusion has a major role to play in Electricity production . . .but**
- **Fusion power will not be a major contributor to Hydrogen production unless**
  - *Significant advances occur in electrolysis technology and*
  - *Fusion can demonstrate a competitive advantage (E.g. using heat)*

CONCLUSIONS

- Fusion will benefit from emissions mitigation, but
- Unless it is economically competitive, its role will be limited. E.g. hydrogen generation

CONCLUSIONS

- **Fusion R&D needs to identify and target those unique features that can give fusion a competitive advantage.**
  - **Capitalize on fusion's unique technical characteristics.**
  - **"Only a foolish elephant tries to be a mouse[1]"**
- **In this regard, a critical, comparative study of competitive technology characteristics and performance projections is essential.**

1) Attributed to Lau Tzu by JFC