Ocean Iron Fertilization:
Economics, Carbon Policy, and Value of Information

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Outline

- General Framework for Economic Value of Information
- Information about the Ocean Iron Option: Uncertainty and Assumptions
- An Estimate of Potential Value
- Implications for Research

Value of Information: General Framework

- Information has value when it changes decisions/actions/outcomes

- Information changes decisions & outcomes by reducing uncertainty

Value of Information: Ocean Iron Fertilization

- Information on cost and capacity of ocean iron fertilization as a C mitigation option
- Of value to carbon emitters who face (future) carbon taxes (or equivalent)
- Ocean Iron Fertilization is one potential C mitigation technology
- Not an “available” option at present because of uncertainties about cost (including side effects), capacity

Carbon Emitters' Decision: Optimal Mix/Sequence of Mitigation Options

- Context:
  - long time scales (100 yrs)
  - carbon tax or emission cap
- Economic efficiency: start with low cost mitigation options
- Value of information about Ocean Iron Fertilization is closely tied to its value as a C mitigation technology
- Two carbon mitigation paths:
  - Without Iron Fertilization
  - With Iron Fertilization

Major Parameters

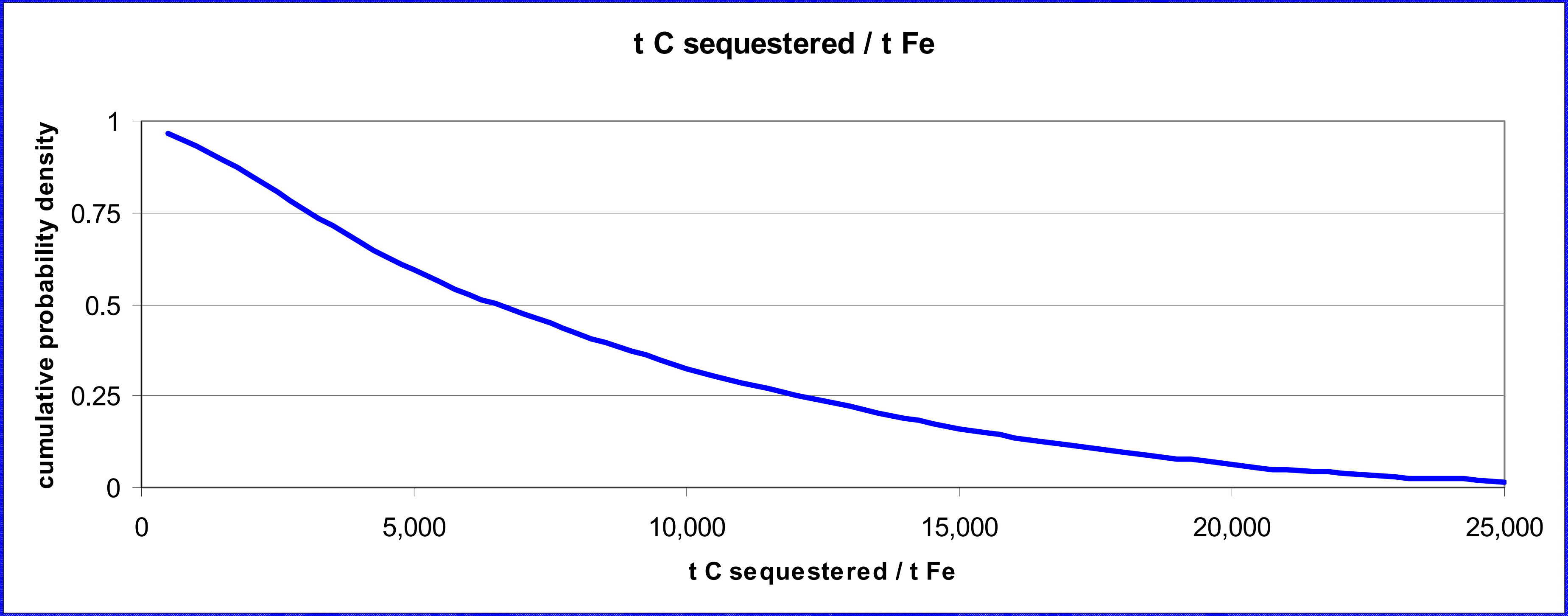
- Cost ($/tC sequestered)
  - Direct cost of Fe delivery (per ton C sequestered)
  - Verification
  - Ecological / Side Effects (Indirect)
- Capacity (tC/y)
  - Southern Ocean
  - Pacific
  - ???
- Climate/carbon policy
  - Carbon price (tax)
  - Will change over time

One thing in common: uncertainty

Direct Cost (Effectiveness)

- Direct cost = cost of delivering Fe to sequester 1 ton of carbon
- Cost is related to effectiveness: depends on carbon uptake and export to deep water
- Uptake: molar ratios Fe:C from 10^{-4} to 10^{-6}
- Export: 5% to 25% of C uptake sequestered to deep ocean

Direct Cost



Optimistic direct cost estimate: \$4/t CO_2, or \$15/t C

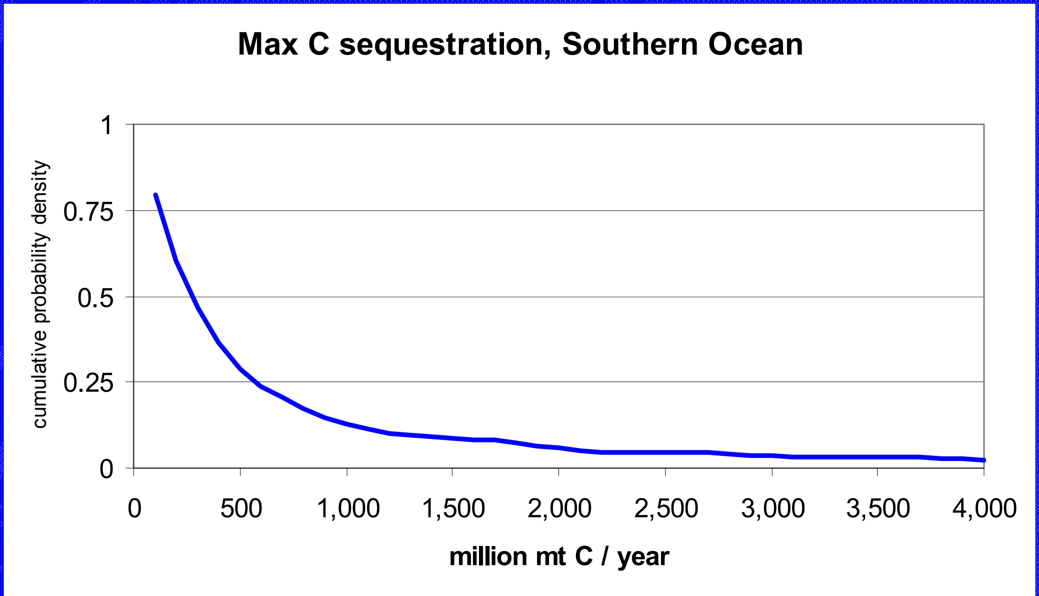
Indirect Cost

- Cost of verification and side effects
- Verification costs are likely to be substantial

- Assumption for calculations: $15/tC
  - Implies limited side effects, affordable verification

Capacity

- Area needed for blooms: 100 - 1,000 km^2/t Fe
- Southern Ocean:
  - 20-35 million km^2
  - One bloom/year
- Pacific:
  - 30-40 million km^2
  - Two blooms/year
- Effectiveness
  (uptake, export)



Climate/Carbon Policy

- C emissions are an environmental externality
- Political decision process; many possibilities
- Good way to characterize climate policies: carbon tax (social cost of carbon) over time
- Economic efficiency: carbon tax based on future damages caused by carbon emissions (trade off investments in C reduction against future losses from climate change)

A Simple Model: Climate Policy

GHG concentrations → climate

climate → damages (GDP loss with respect to baseline)

damages → carbon tax (or emissions caps)

carbon tax (or emissions caps) → emission levels (reduction from baseline)

emission levels (reduction from baseline) → GHG concentrations

Policy

Atmospheric CO_2 for Alternate Climate Policies

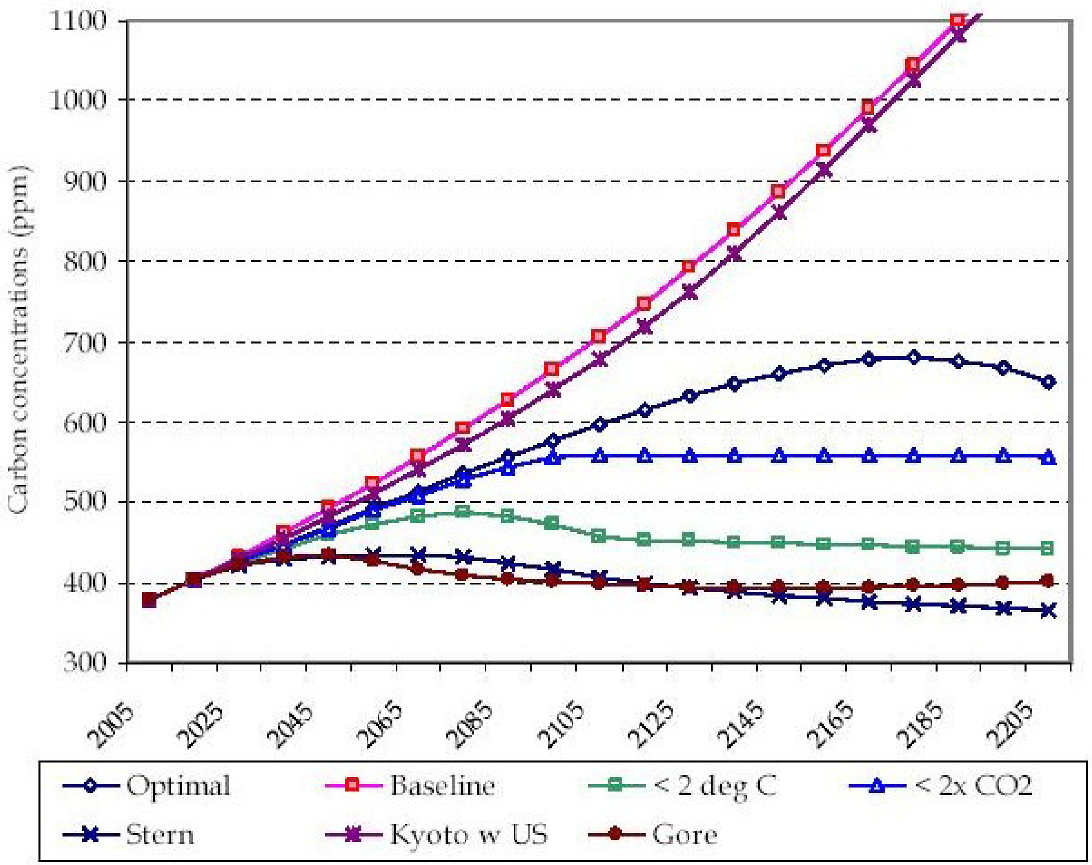


Figure V-7. Atmospheric CO_2 concentrations by policies

Source: Nordhaus 2007

Global Emissions under Alternate Climate Policies

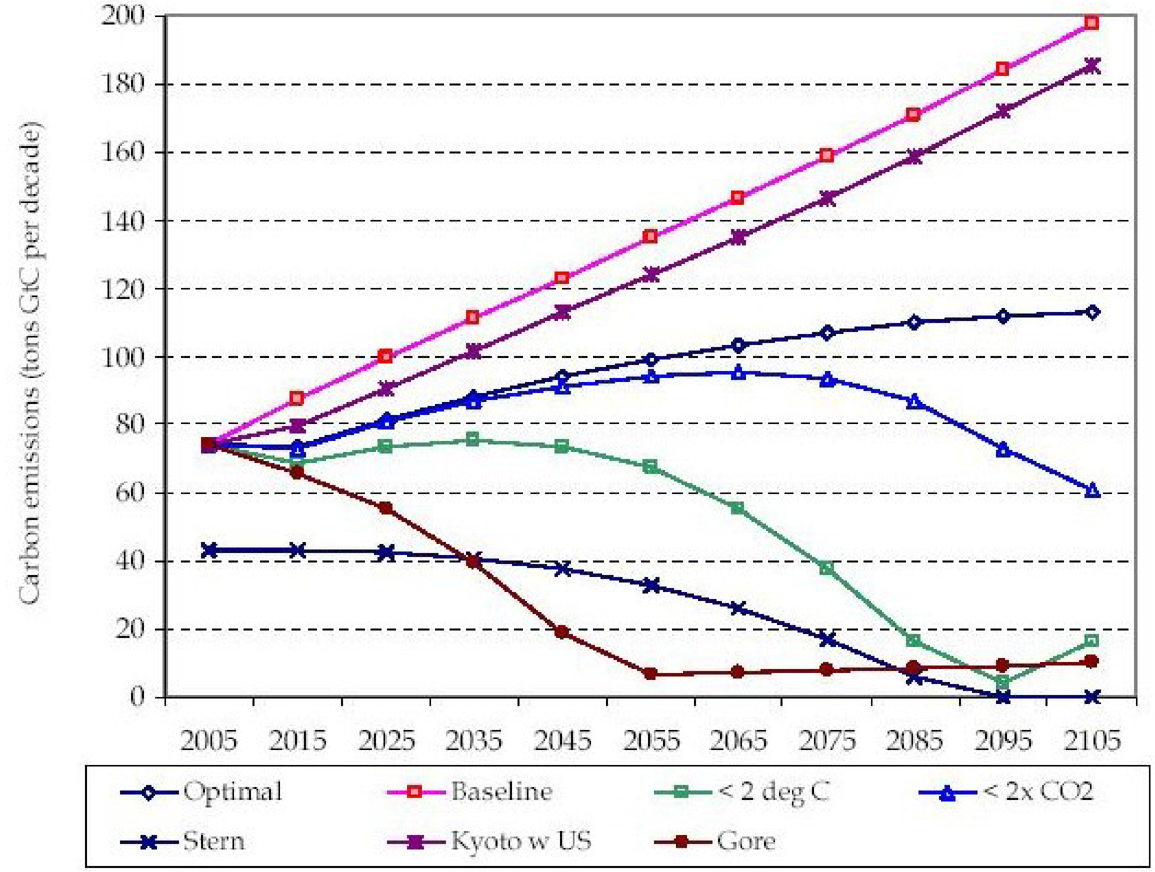


Figure V-6. Global emissions of industrial CO_2 per decade by policy

Source: Nordhaus 2007

Emission Control under Alternate Climate Policies

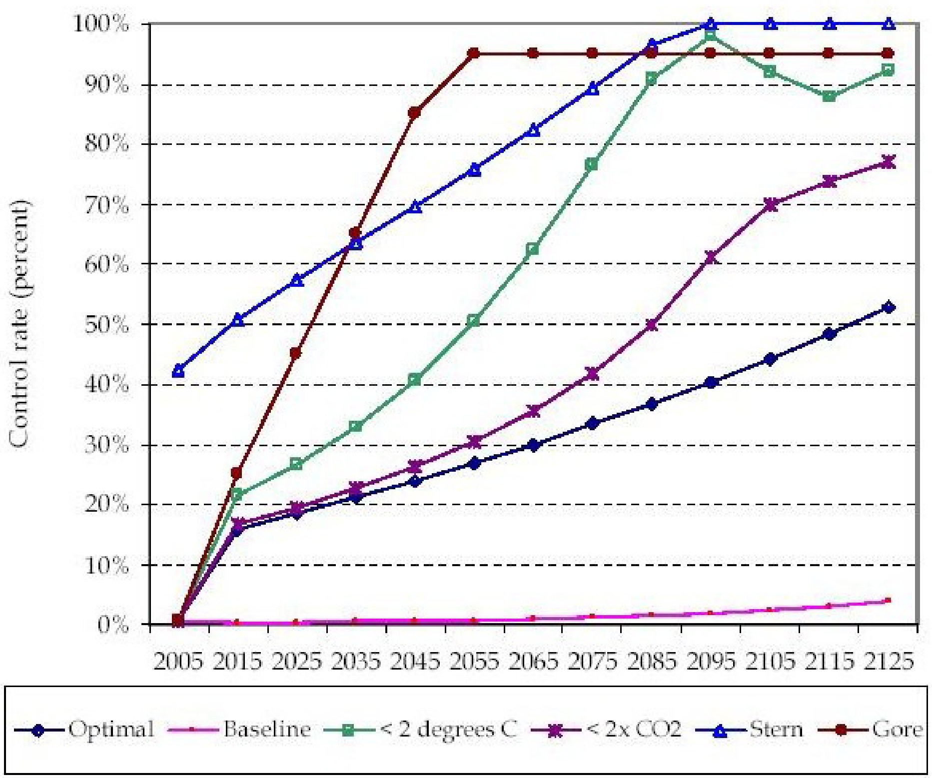


Figure V-5. Emissions control rates for different strategies
This figure shows the global emissions control rate for CO_2 under different strategies for the next century. Note the upward tilted "ramp" of the strategies. Emissions controls begin in 2008 unless otherwise assumed. Policies begin in the second period (2015 representing 2011-2020).

Source: Nordhaus 2007

Carbon Prices for Alternate Climate Policies

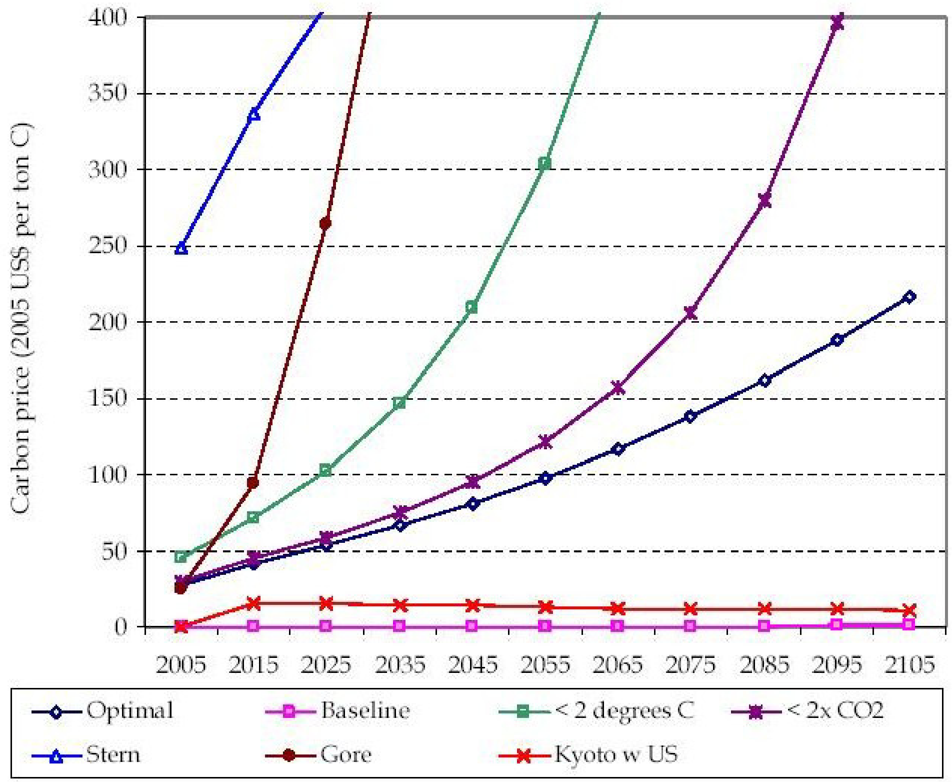
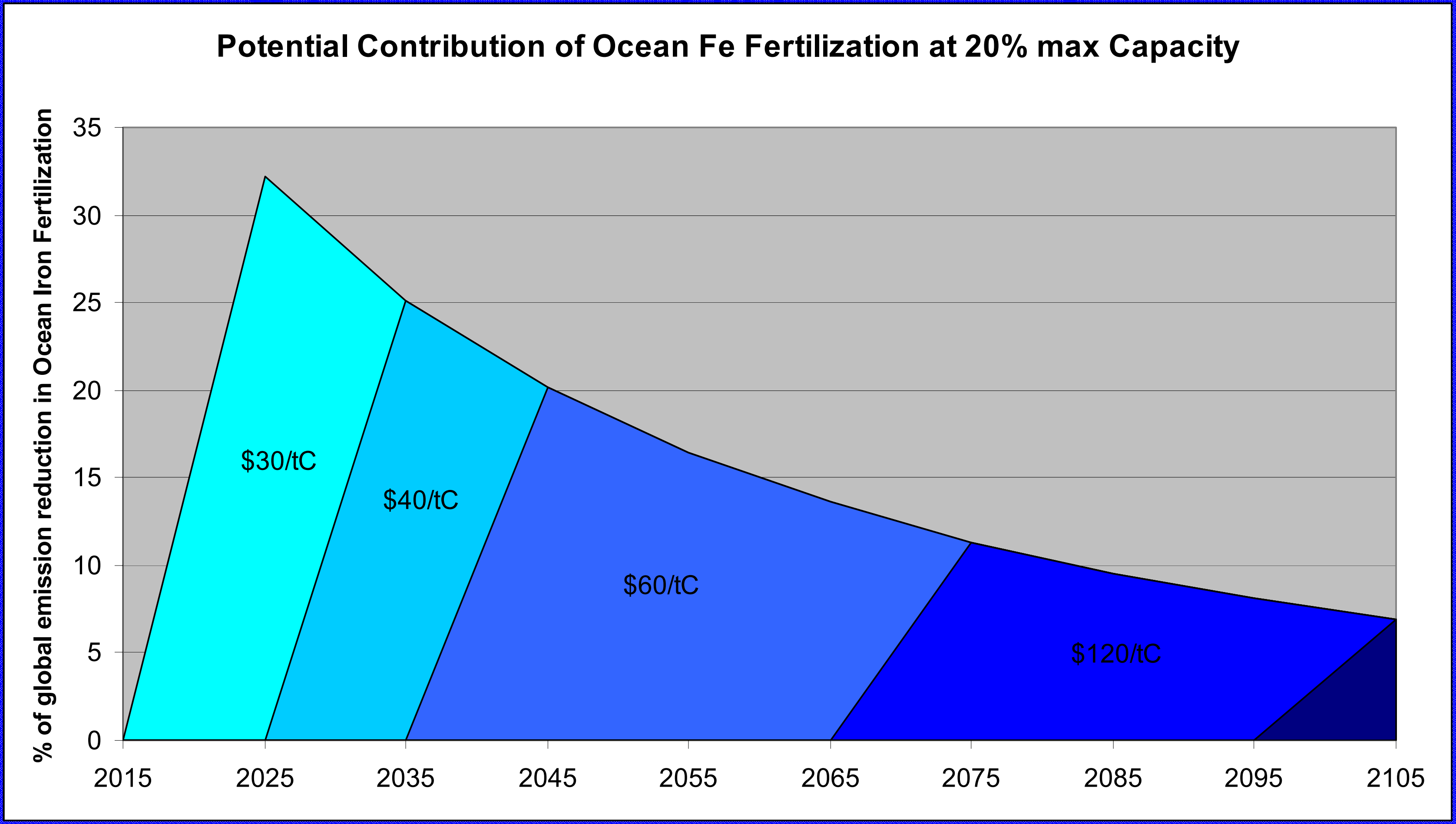


Figure V-4. Carbon prices for different strategies

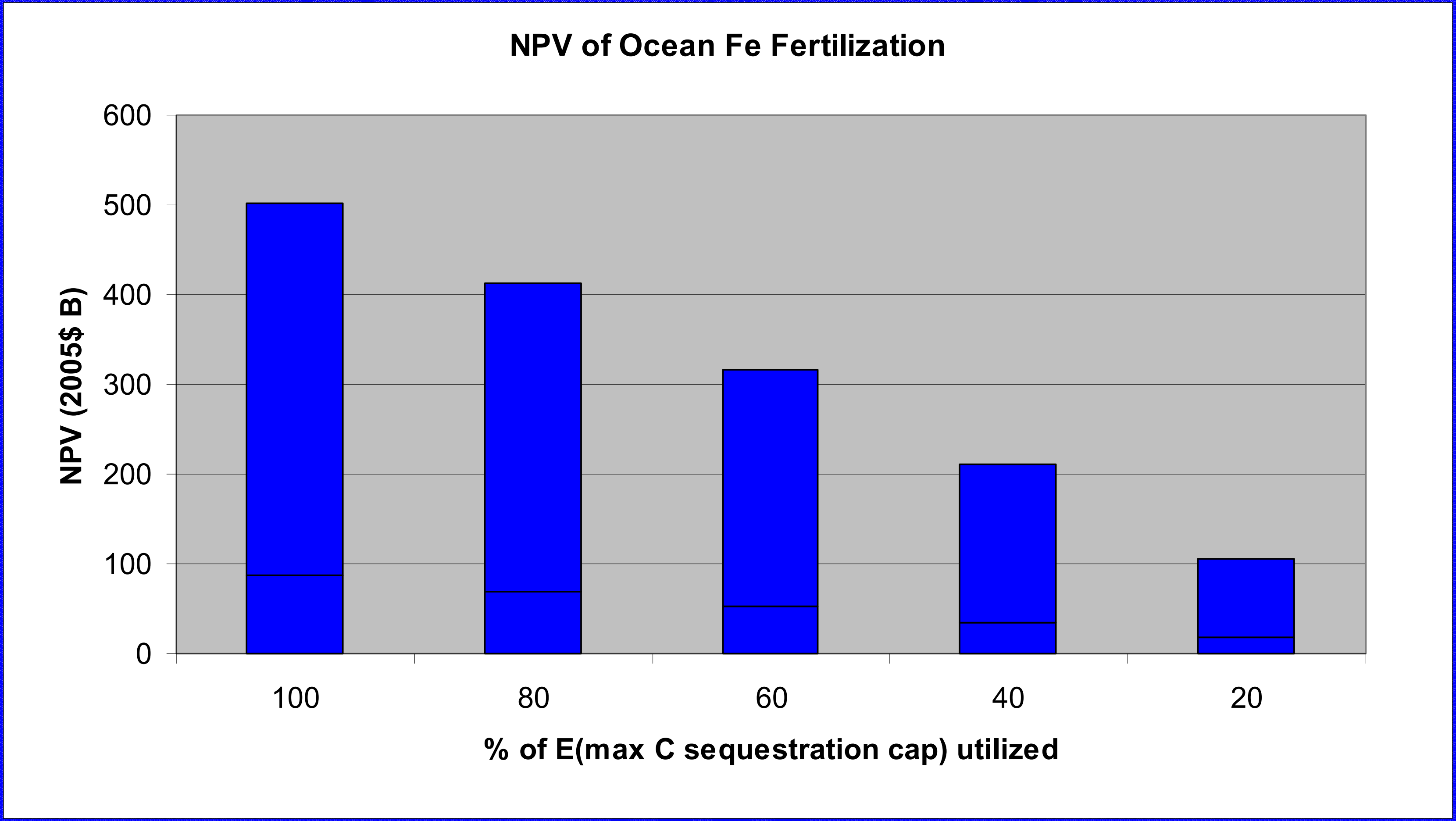
This figure shows the globally averaged carbon price of CO_2 under different strategies for the next century. Note the upward tilt of the strategies. Note these are per ton carbon; for prices per ton of CO_2, divide by 3.67. Policies begin in the second period (2015 representing 2011-2020).

Source: Nordhaus 2007

Ocean Iron Fertilization in C Reduction in Optimal Climate Policy



Value of the Ocean Iron Option



Value of Information

- Potential value may be [$100b] in 2005 present value terms under an economically optimal climate policy
- 10-20% of global emission reductions to 2100
- Timing of ocean fertilization in optimal carbon mitigation -> we have some time (decades) to get the science right
- Justifies investment in research to reduce uncertainties about effectiveness, side effects, and verification

Summary

- Remaining uncertainties about effectiveness and potential side effects are large

- Potential value is significant: PV [$100b]
  - If it works
  - If side effects are minimal
  - If verification is affordable

- Investment in research is warranted

- There is no hurry (under economically optimal policy)