

# The Cost of Reducing Emissions

EES 3310/5310

Global Climate Change

Jonathan Gilligan

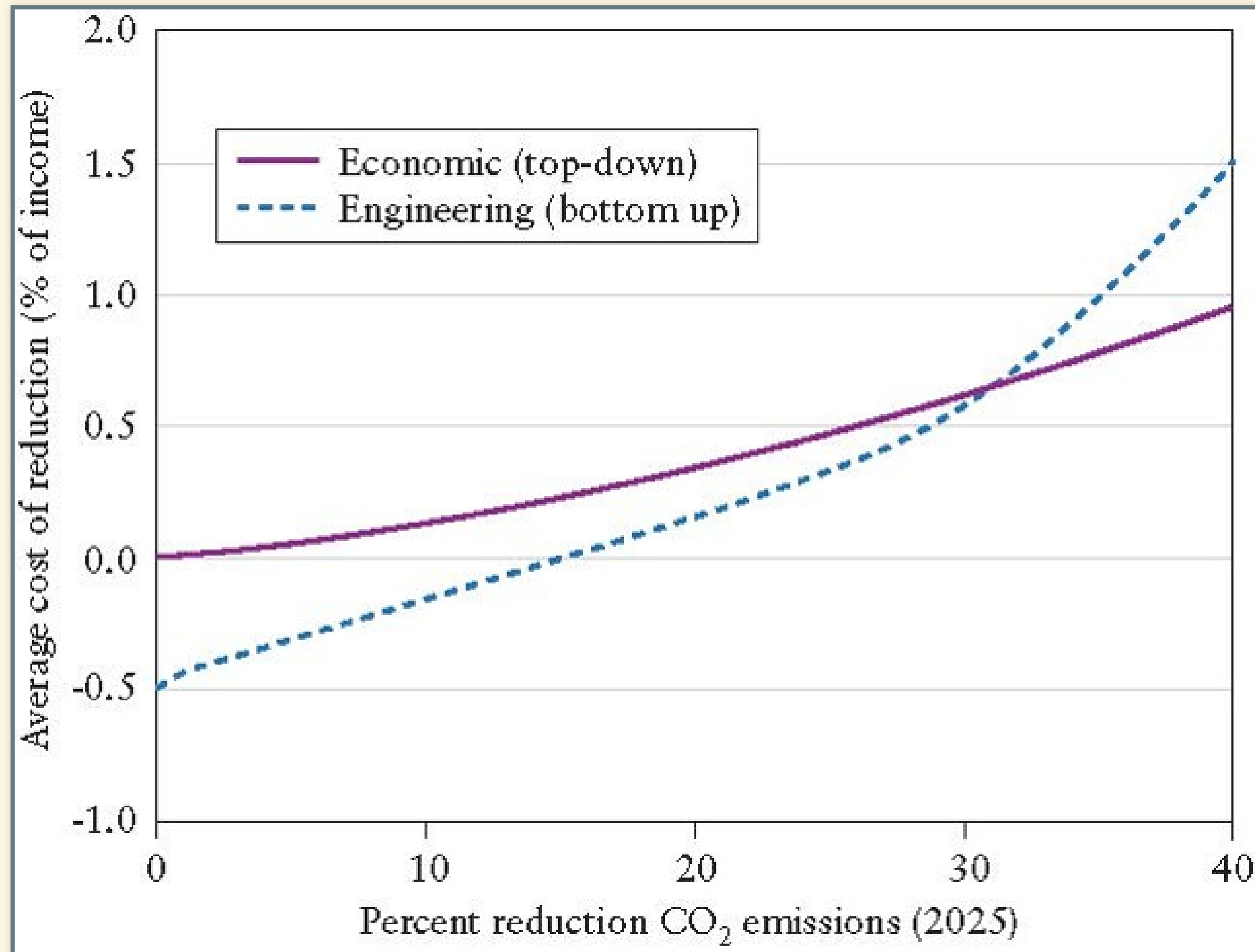
Class #27: Wednesday, March 30 2022

# Big Concepts

# Big Concepts

- Cost per ton of reducing emissions
  - Marginal vs. average cost
  - Diminishing marginal returns on investment (increasing marginal cost of mitigation)
- A different look at top-down vs. bottom-up
- Implications for policy:
  - The importance of participation
  - The need for new technology
  - Market-driven vs. command-and-control
- Comparison:
  - Pielke vs. Nordhaus

# The cost of reducing emissions



# Top-down vs. Bottom-up

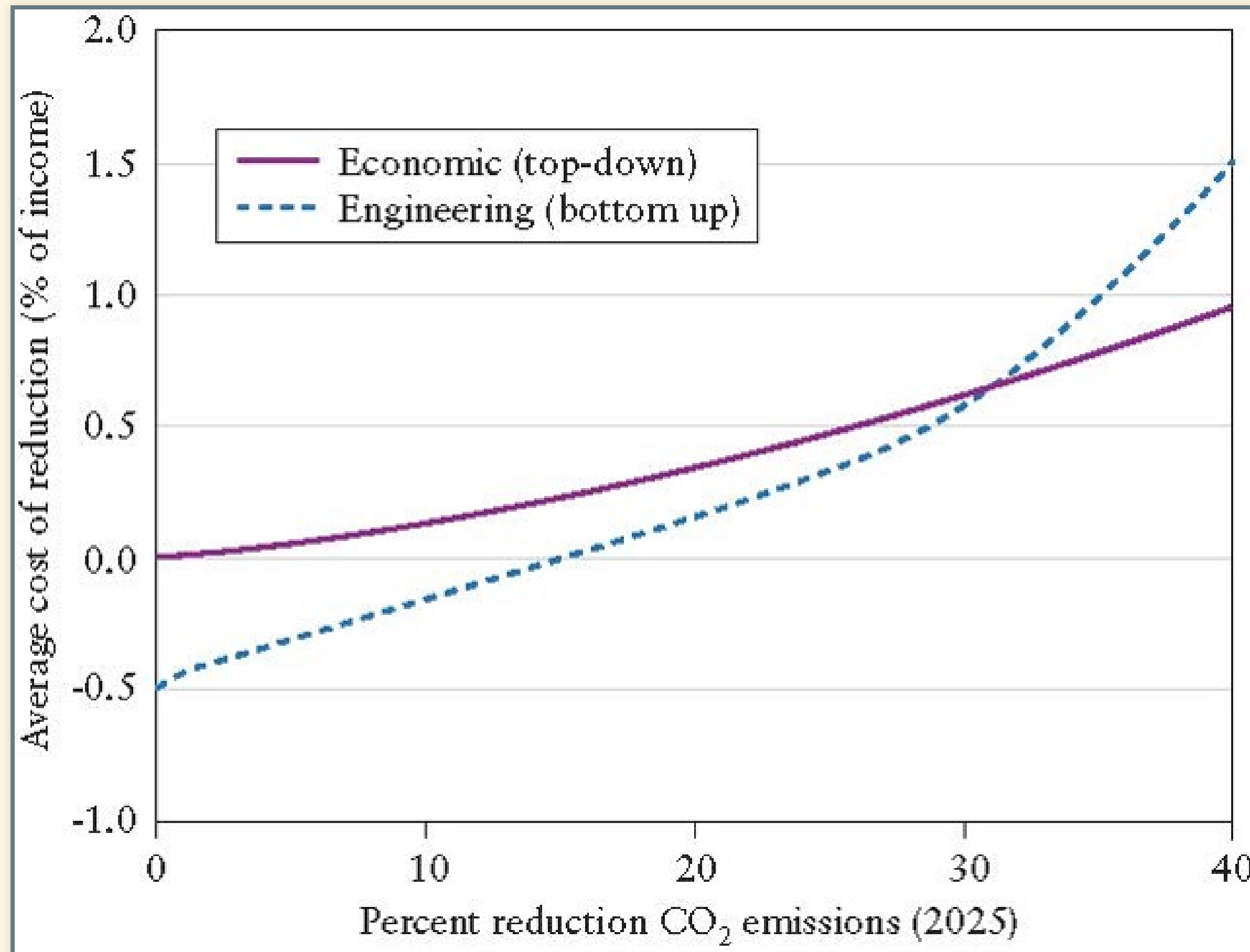
## Climate Fix (Pielke)

- **Top-down** = macroeconomic calculation
- **Bottom-up** = individual components of Kaya identity:
  - Technology:
    - $e$  = energy intensity
    - $f$  = carbon intensity

## Climate Casino (Nordhaus)

- **Top-down** = macroeconomic calculation
- **Bottom-up** = Engineering:
  - Individual energy technologies
    - Nuclear
    - Coal
    - Gas
    - ...

# The cost of reducing emissions



# Assumptions

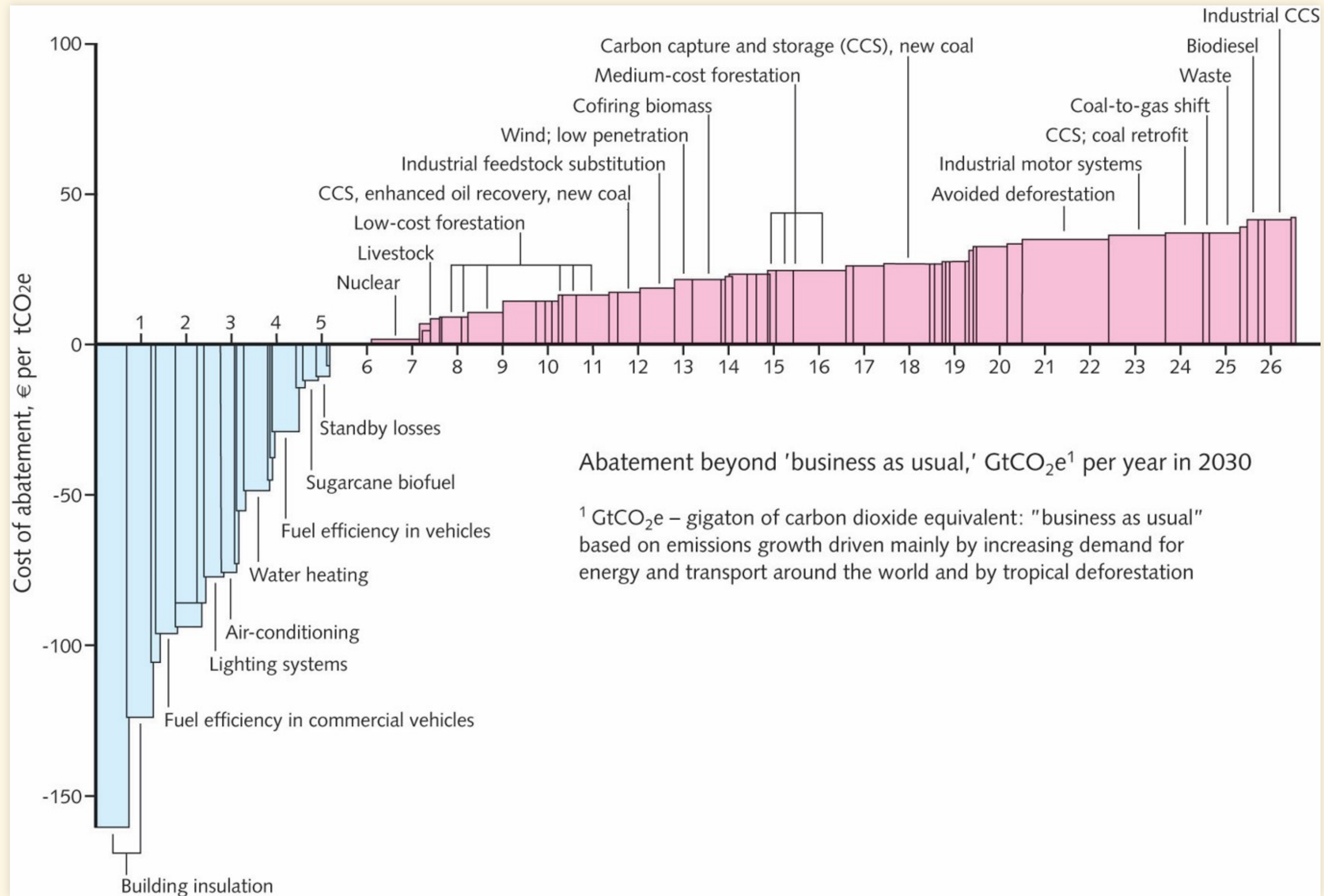
## Top Down

- No negative-cost options
  - \$100 bill on sidewalk
  - Examples:
    - ...

## Bottom Up

- All technology is new
  - What about existing infrastructure?

# Do Negative-Cost Options Exist?





# Potential for Emissions Reduction

# Nortel

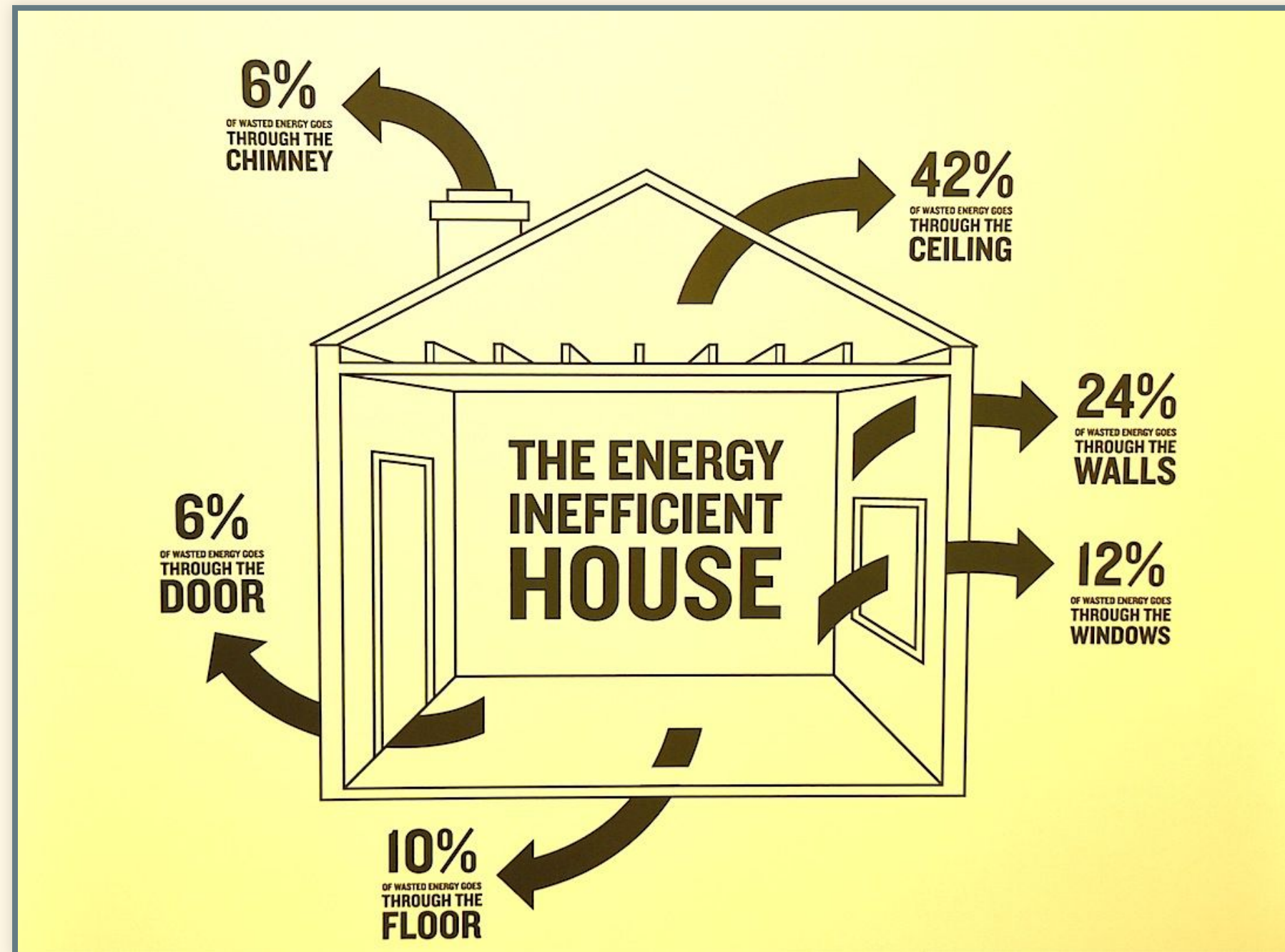
- Electronics manufacturing
  - CFC-113 for cleaning circuit boards
    - Cheap, safe
- Concern about ozone layer:
  - 1988: Voluntary pledge to eliminate CFCs
  - Citrus-based cleaner:
    - Even cheaper
    - No chemical disposal costs
    - \$1 million initial costs
    - \$4 million savings in first 3 years

# Walker's Crisps



- British snack-food company
  - Makes potato chips
  - Buys potatoes by the pound
- Farmers sell by the pound
  - Make sure potatoes are as wet as possible
  - Humidified warehouses
  - Cost of shipping
- Dry potatoes make better chips
  - Walker's must dry potatoes
    - Cost of heating, dehumidifying
    - Changed the way they bought potatoes
  - Saved money, reduced CO<sub>2</sub> emissions
    - 4,800 tons CO<sub>2</sub> per year
    - \$290,000 annual savings
  - Subsequent measures
    - Reduced CO<sub>2</sub> emissions 50%
    - Saved \$500,000 per year

# Home energy efficiency



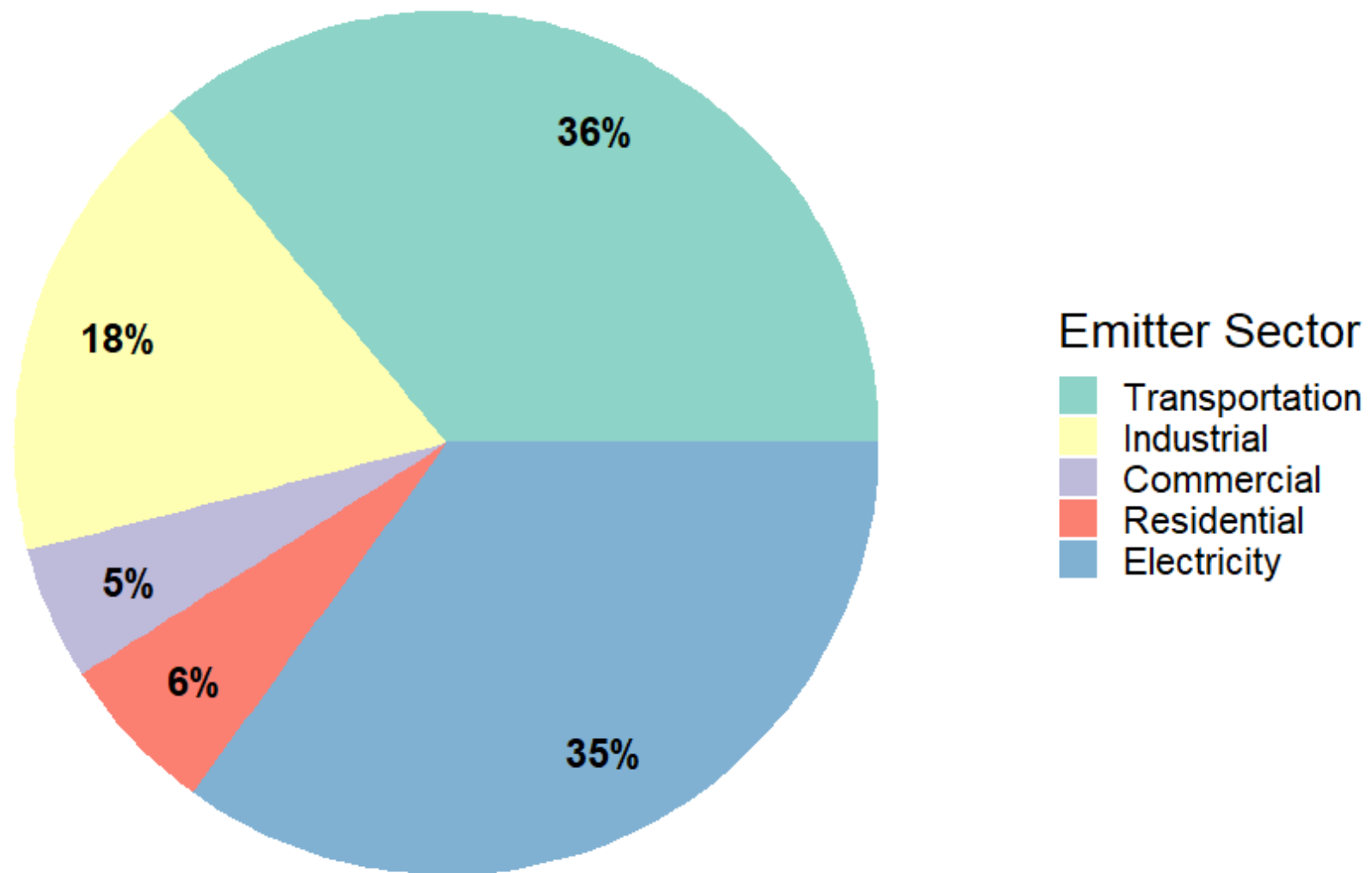
- Insulation, weatherization
  - \ \$1000 on sealing leaks saves \ \$500 per year
    - Improving insulation
      - Costs \ \$0.25–\ \$2.75 per square foot
      - Savings \ \$0.50–\ \$2.90 per square foot per year
      - Payback time <1 year to 6 years
- So why don't people do things that save money and help environment?
  - Don't know what to do
  - Too much bother/inconvenience
  - Can't afford up-front costs
  - ...

# The Household Sector

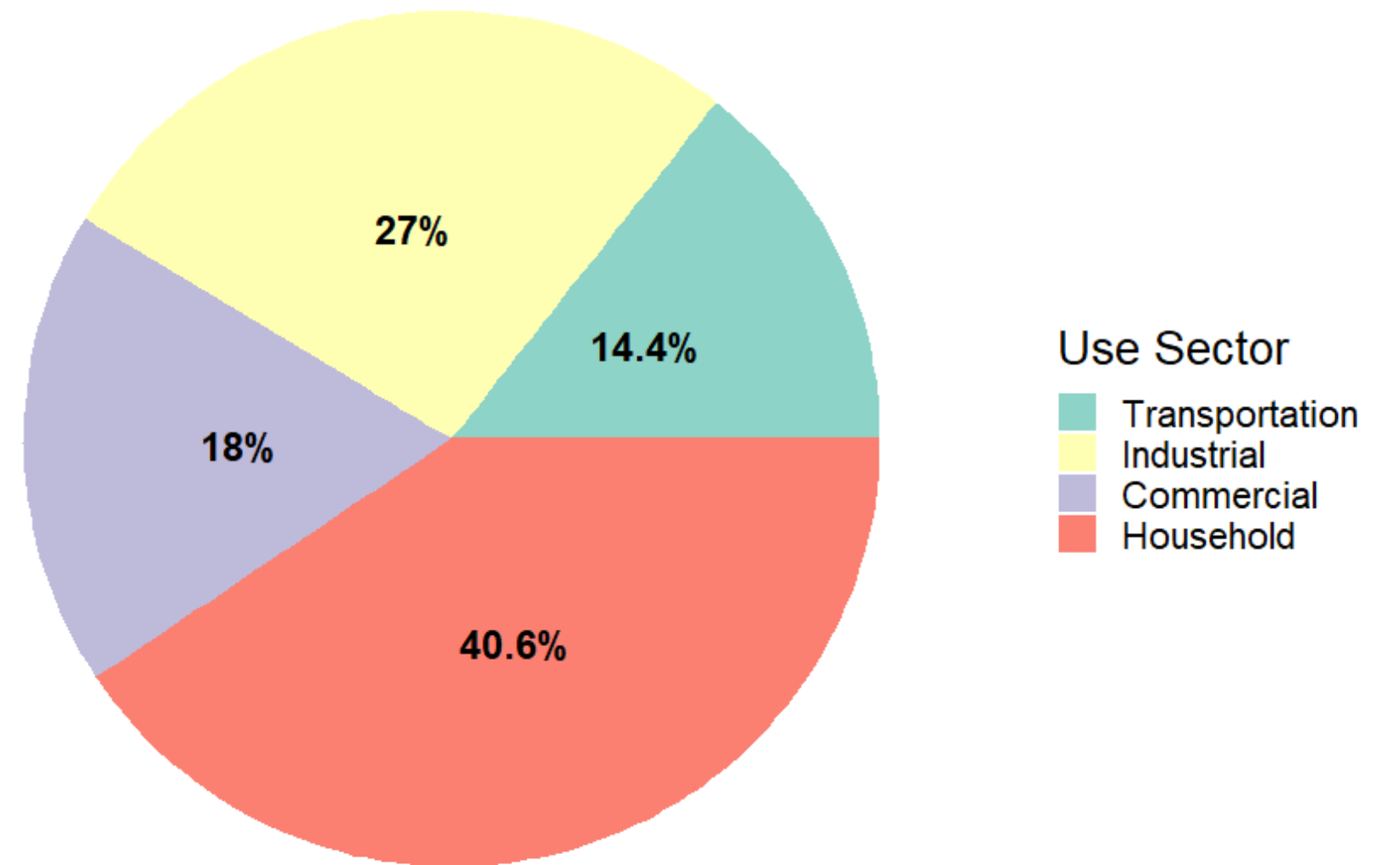


# Who Emits CO<sub>2</sub>?

CO<sub>2</sub> emissions by sector of emitter



CO<sub>2</sub> emissions by sector of user



# “The Behavioral Wedge”

- Dietz, Gardner, Gilligan, Stern, & Vandenberg (2009)
- Households can cut emissions ~38%
- With the right incentives, households could be persuaded to voluntarily cut emissions 20%
  - 450 million metric tons of CO<sub>2</sub> per year
  - 7.35% of total US emissions
  - More than the whole nation of France

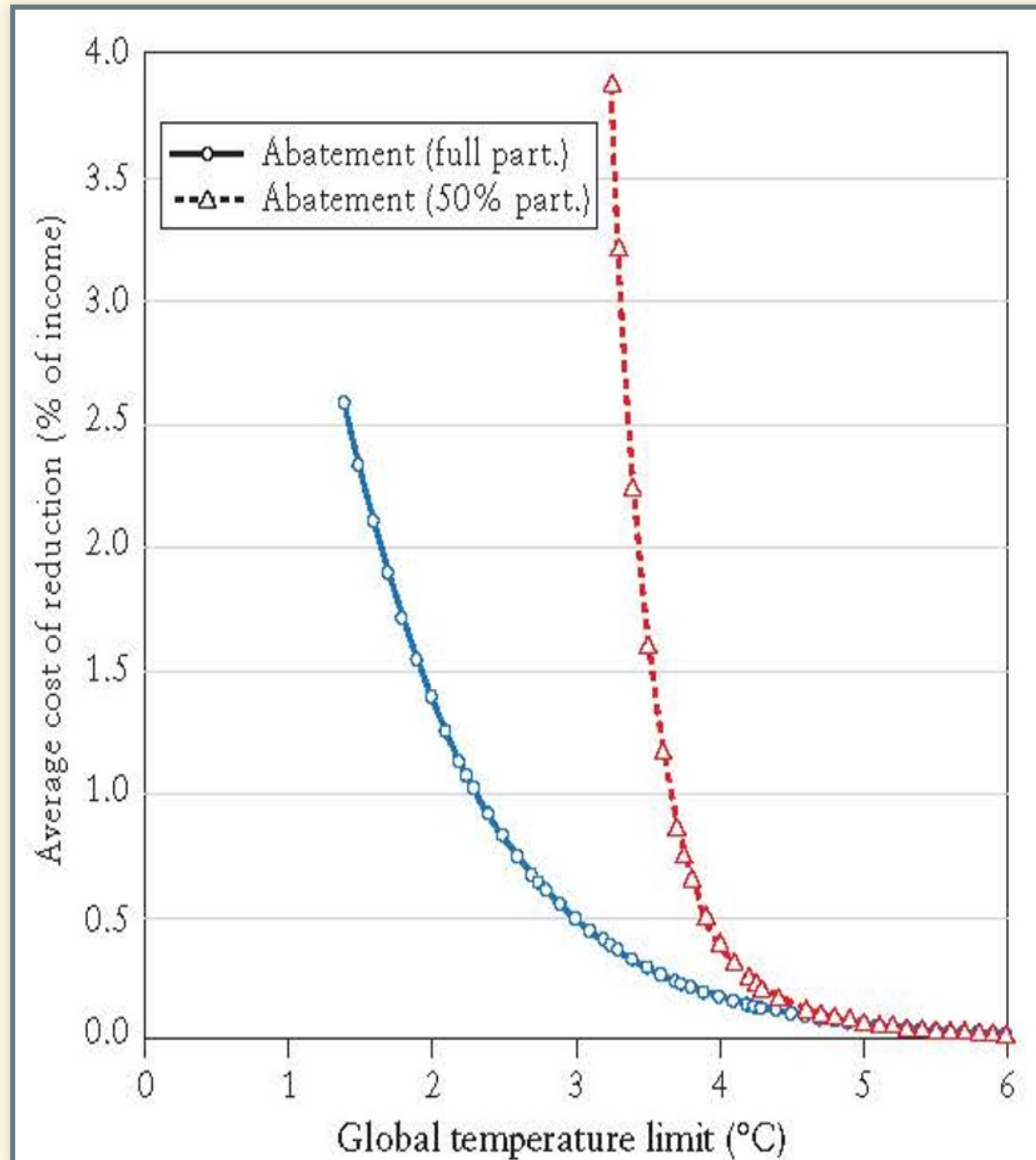
# Policy Implications



# Climate Casino on Policy

- Different actions have different costs/ton
  - Same action may have different costs at different firms
- Government doesn't know enough to micromanage actions efficiently
  - Put a cost on carbon and let market allocate actions
    - Those who can cut emissions cheaply do a lot
    - Those for whom cutting emissions is expensive do less
    - What matters to the environment is total cuts, not whether everyone cuts the same amount.

# Participation



Full participation vs. only countries representing 50% of emissions

# Nordhaus on Policy

*The favorite policies of most countries today are energy efficiency regulations....*

*However, such regulations will not touch the area where reductions are most economical—electricity generation from coal. ...*

*[C]areful analyses show that coal is king when it comes to reducing CO<sub>2</sub> emissions.*

# Nordhaus on Policy

*Economists and policymakers do not have the information to micromanage the energy system for 315 million Americans or 7 billion earthlings.*

*The economy is too complicated and evolves too rapidly.*

*Rather, ... economists emphasize that policy should be designed to provide strong incentives to reduce CO<sub>2</sub> emissions and to develop new low-carbon technologies.*

# Bill Gates on Policy

- We need an energy revolution
- Put a price on carbon to motivate the market
- But ...
  - Markets are not good at revolutionizing energy
    - Failure rates of venture-capital investments
  - Government does very well at investing in basic research
    - Calls for massive government support for energy R&D