Economic and Distributional Impacts of Carbon Fee and Dividend Policies

Jordan Wilkerson

EETD Seminar

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Background

- Boxer—Sanders Climate Protection Act of 2013
  - Fee and Dividend carbon policy
    - Fee of \$20/tCO_2, 5.6% escalation rate
    - Rebate 60% back to households
- What does a policymaker want to know?
  - How effective is the policy?
  - How does it hurt the economy?
  - How does it impact my constituents?
- How does a policymaker get the answers?

National Energy Modeling System (NEMS)

- U.S. Government's forecasting and analytical tool used for all U.S. energy policy analysis

- Massively detailed representation of the U.S. Energy-Economic system
  - NEMS results define the Annual Energy Outlook
  - NEMS results are used as inputs to other models

NEMS: a.k.a. Not Everyone's Modeling Solution

- NEMS is a U.S. energy-economic system model

- No income distributional analysis
- No household distributional analysis
- No state-level analysis

Agenda

- Motivation and Introduction
- Energy–economic impacts of carbon fees
  - Macroeconomic impacts
  - Electricity supply sector impacts
- Household distributional impacts of carbon fees and rebates
  - Describe model and data sources
  - Show household impacts by income, region, and state
- Discussion and model limitations

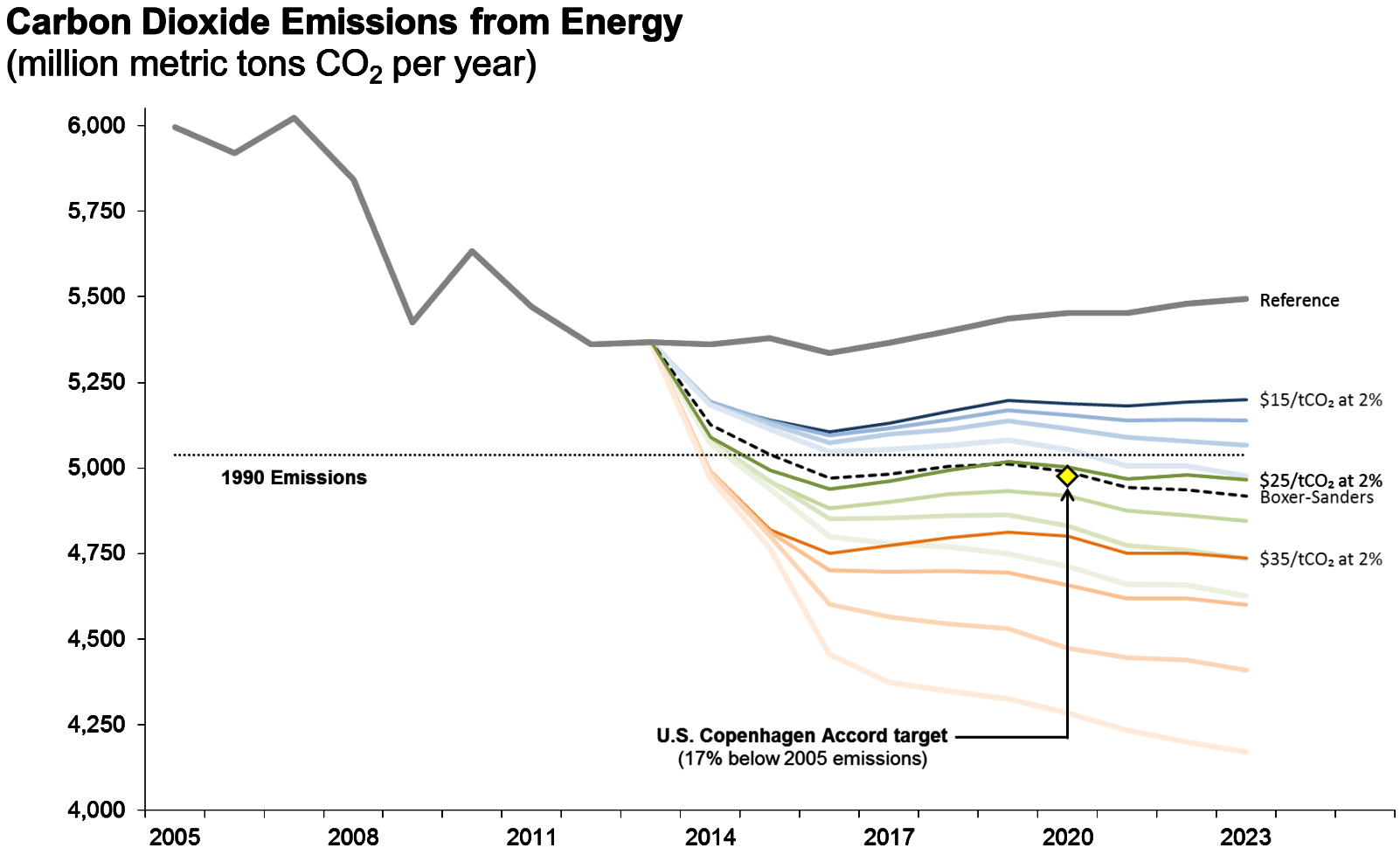
Carbon Fee and Dividends

- Carbon fees*
  - Begin in 2014
    - \$15, \$25, \$35/tCO_2
  - Annual escalation rates
    - 2%, 4%, 6%, 8%

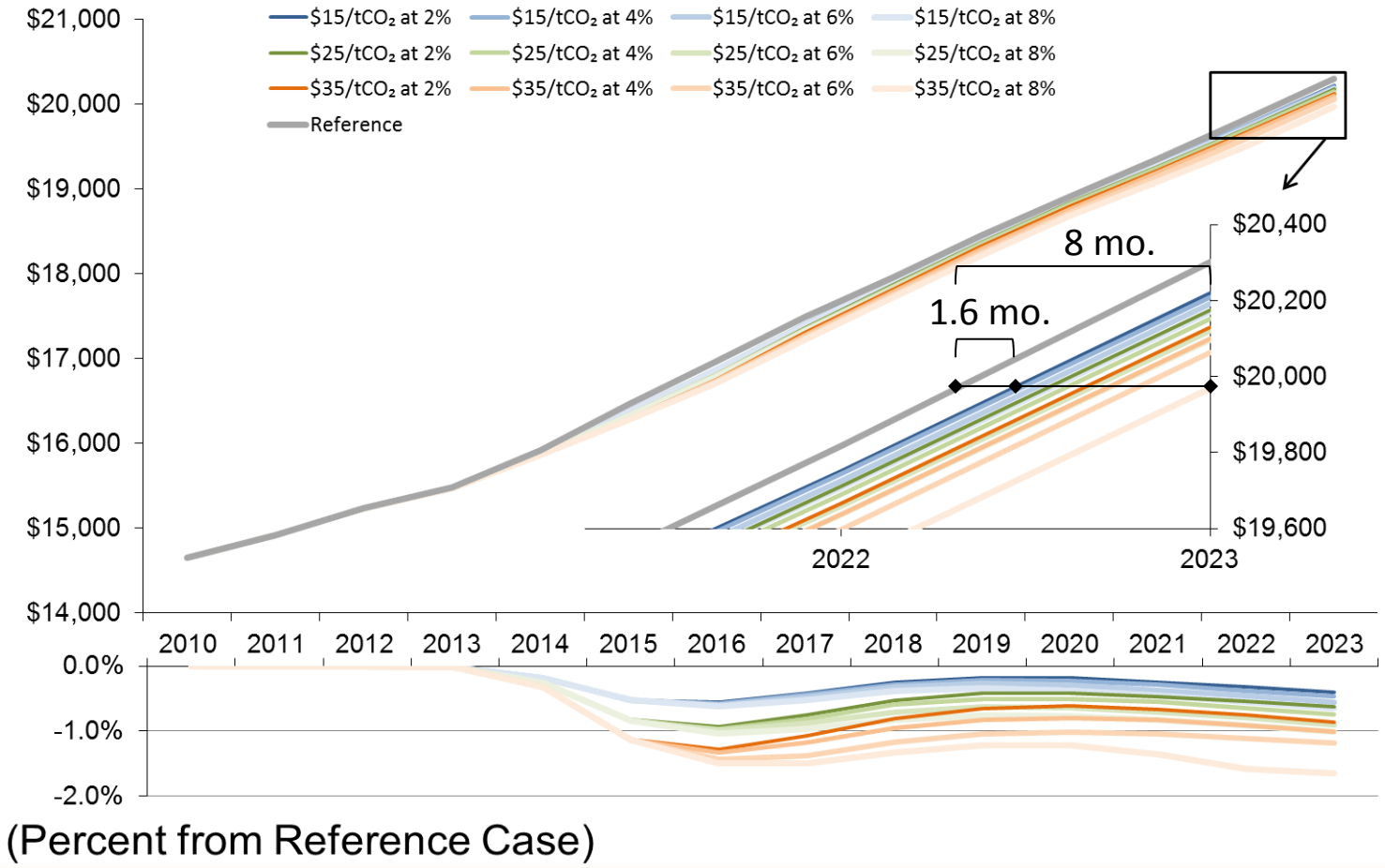
- Per capita rebates
  - Portion of revenues
    - 40%, 50%, 60%

** Waxman et al., 2013, "Carbon Price Discussion Draft ", U.S. House of Representatives, Committee on Energy and Commerce*

How much carbon can we avoid?



…at what cost to the economy?



Economic Drivers

- Disaggregation: Expanded Kaya Identity

$$CO_2 = P * \frac{GDP}{P} * \left[\frac{FE}{GDP} * \frac{PE}{FE}\right] * \left[\frac{TCO_2}{PE} * \frac{CO_2}{TCO_2}\right] \rightarrow 1$$

Pop.	Affluence	Energy Intensity	Energy Supply Losses	Carbon Intensity	Released Carbon

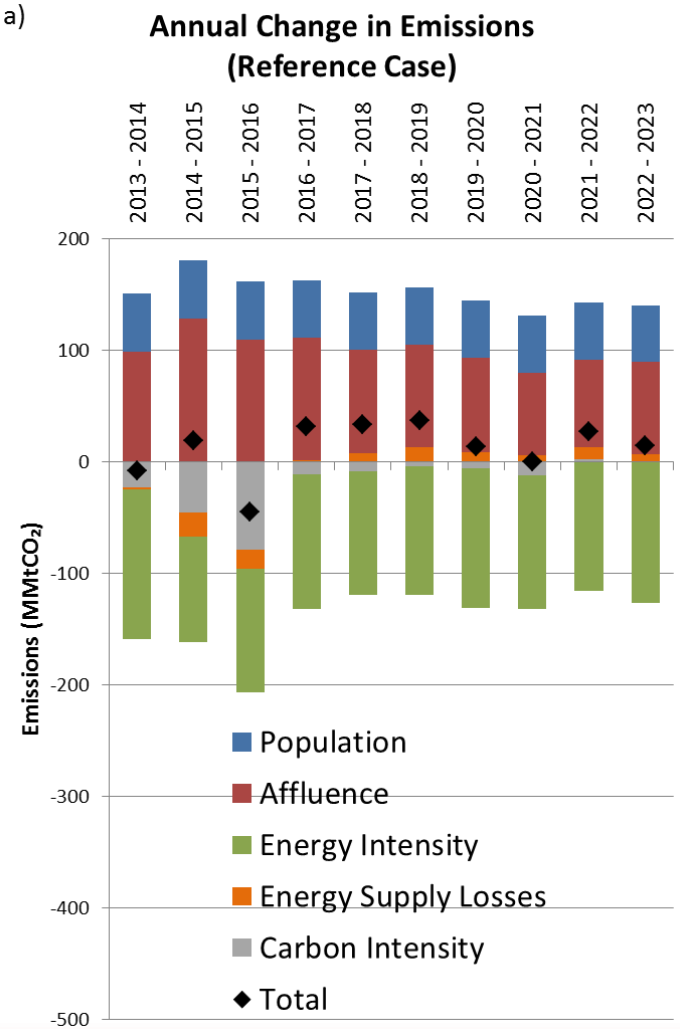
- Decomposition: Log Mean Divisia Index (LMDI I)

$$\Delta C_{tot} = C^t - C^0 = \Delta C_{pop} + \Delta C_{aff} + \Delta C_{ei} + \Delta C_{esl} + \Delta C_{emf}$$

$$\Delta C_{ei} = \sum_i \frac{C_i^t - C_i^0}{\ln(C_i^t) - \ln(C_i^0)} \ln\left(\frac{ei^t}{ei^0}\right)$$

Kaya—LMDI Results

a)



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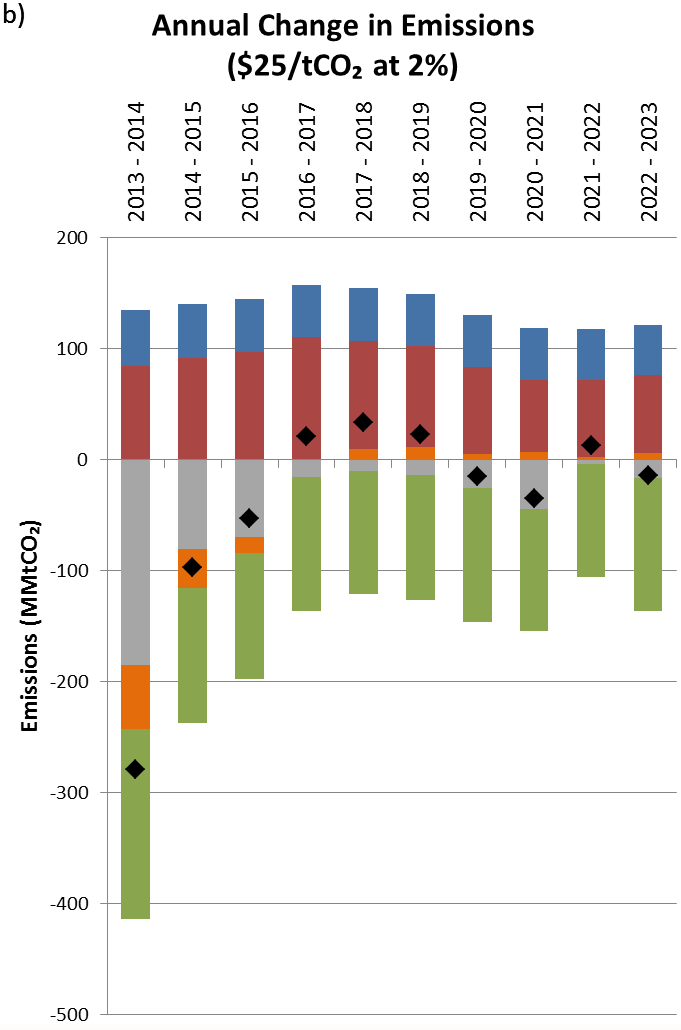
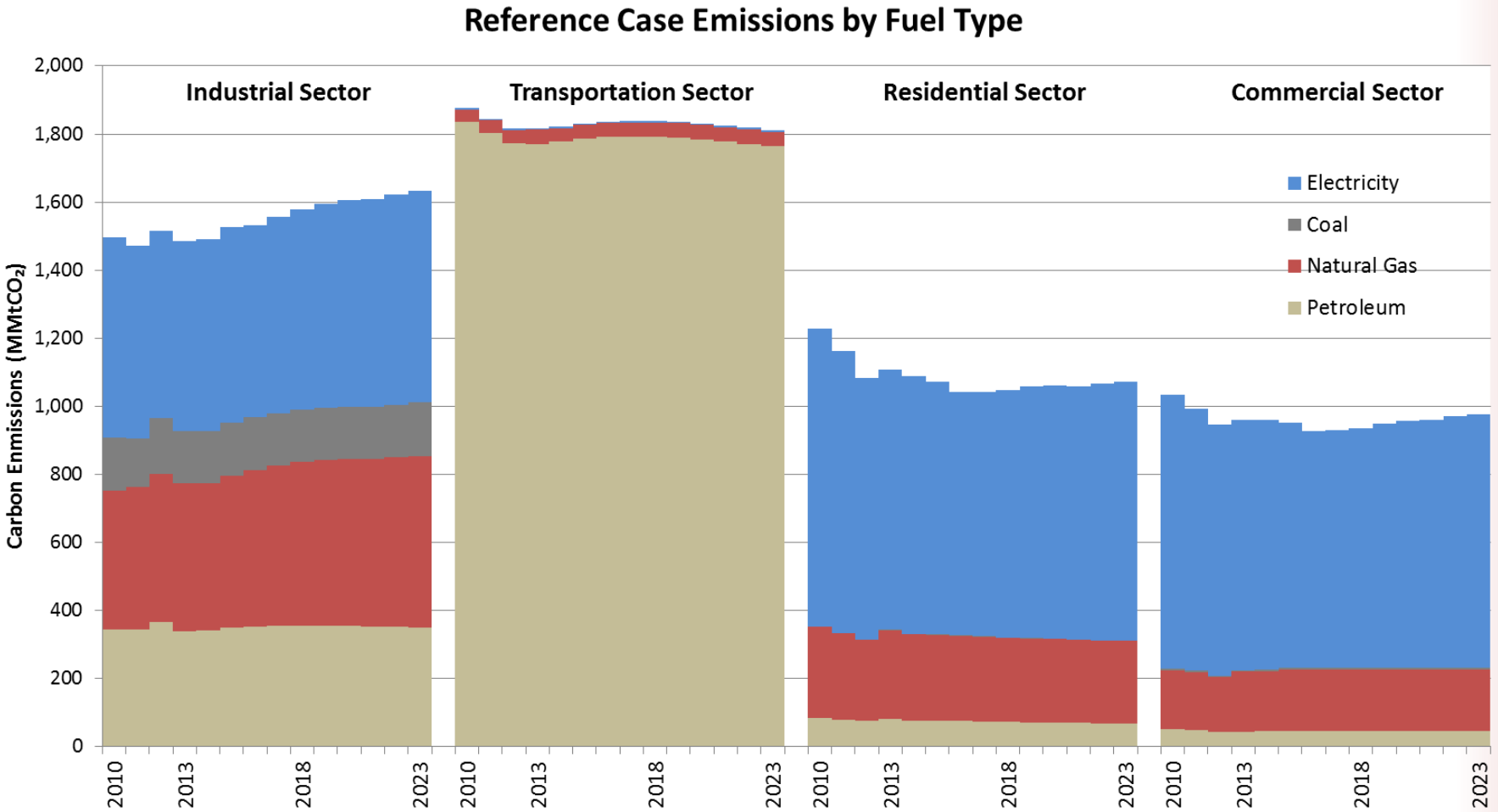
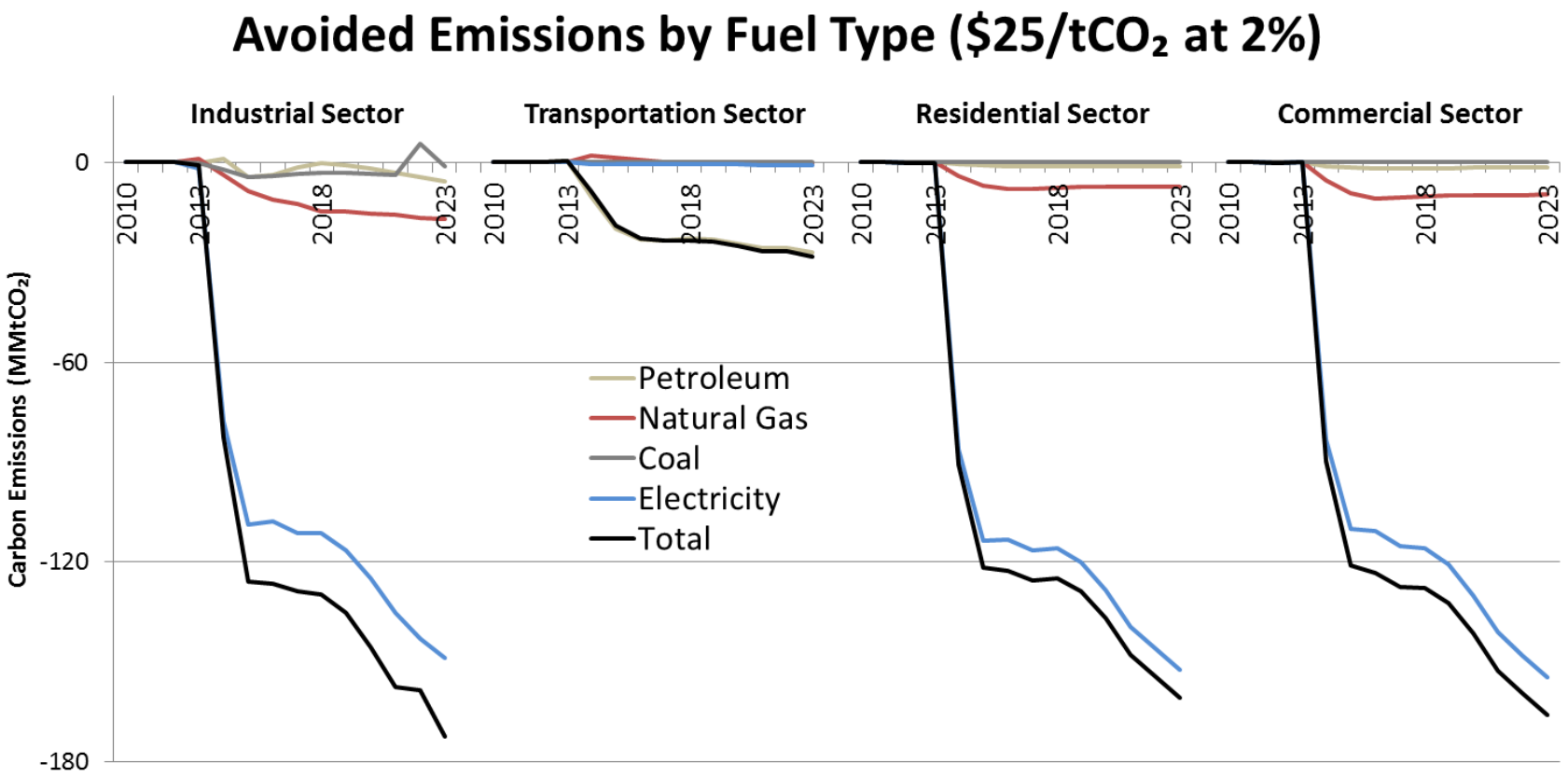


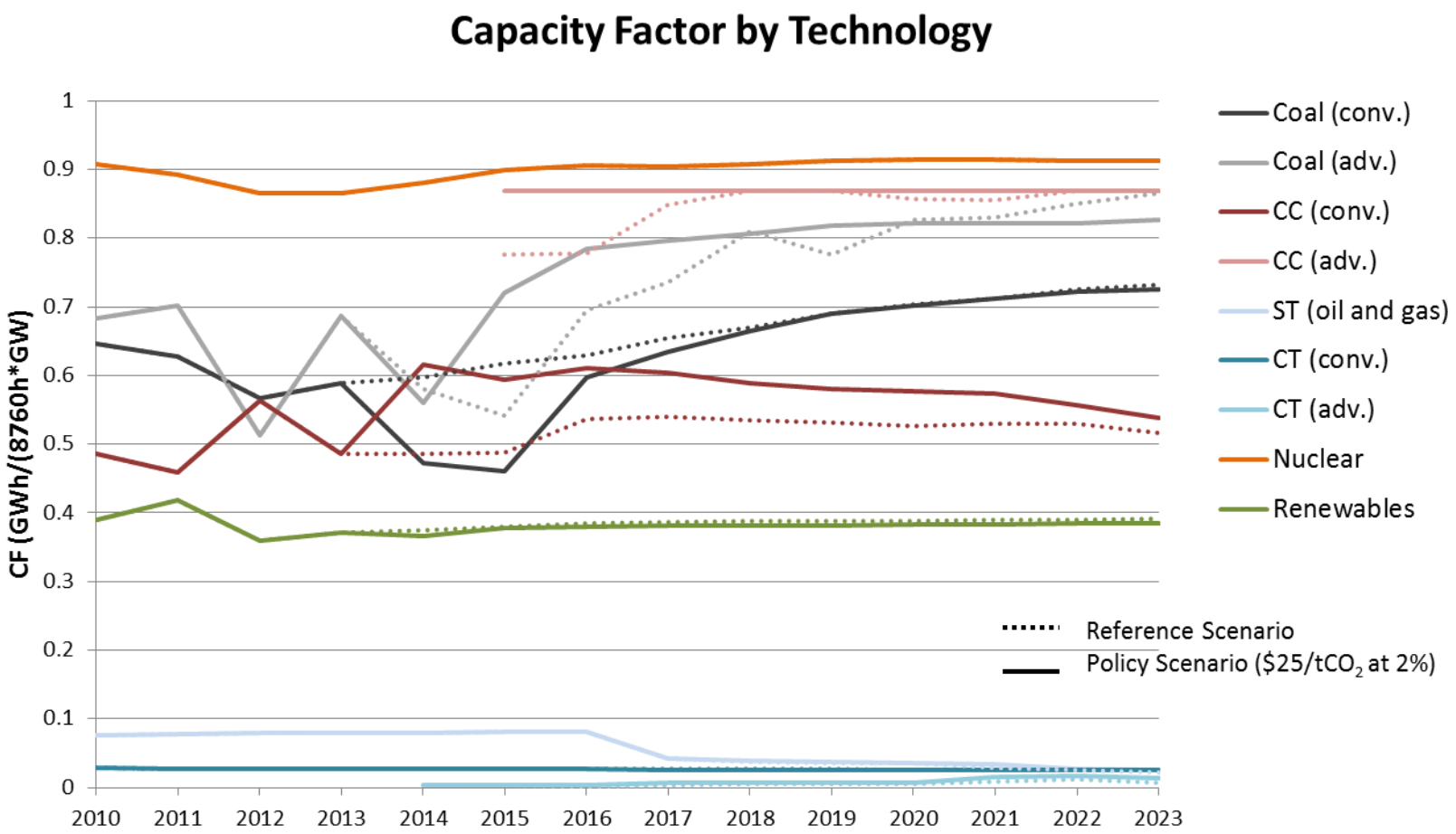
Carbon Emissions by Sector



Avoided Carbon by Sector and Fuel



Electricity Supply Sector



Summary of Economic Impacts

- Significant carbon emissions can be avoided without significantly affecting the economy
- Impacts to GDP are likely overstated
  - no account for reductions in healthcare costs
  - no policies aimed at reducing carbon emissions
  - no account for possibility of induced innovation
- Decarbonizing the electricity sector will account for 85% of the avoided carbon
  - This occurs in the first year by re-dispatching available combined cycle plants in place of coal-fired plants

Economic Impacts (cont.)

- Remaining 15% of avoided emissions will come from reduction in demand (efficiency and behavior)
- Transportation sector will see very little change from these policies
- Almost all avoided emissions from the building sectors will come from cleaner electricity supply
- There are several energy intense industries that may need assistance

- Obtain equivalent CO_2 reductions as anticipated from EPA CAA 111(d), with much lower oversight costs and confusion

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NEMS doesn't track households

- NEMS provides forecast of prices and quantities by fuel type and region
  - no per capita or per household information
  - no income categories or distributions

- Correlate NEMS aggregate forecast expenditure to measured household expenditure

Household Policy Costs

- NEMS forecasts prices and quantities by fuel
  - Direct cost for each fuel type:

$$\underbrace{(Price\ x\ Quantity)}_{Policy}^{yr} - (Price\ x\ Quantity)^{yr} = Policy\ Cost^{yr}$$

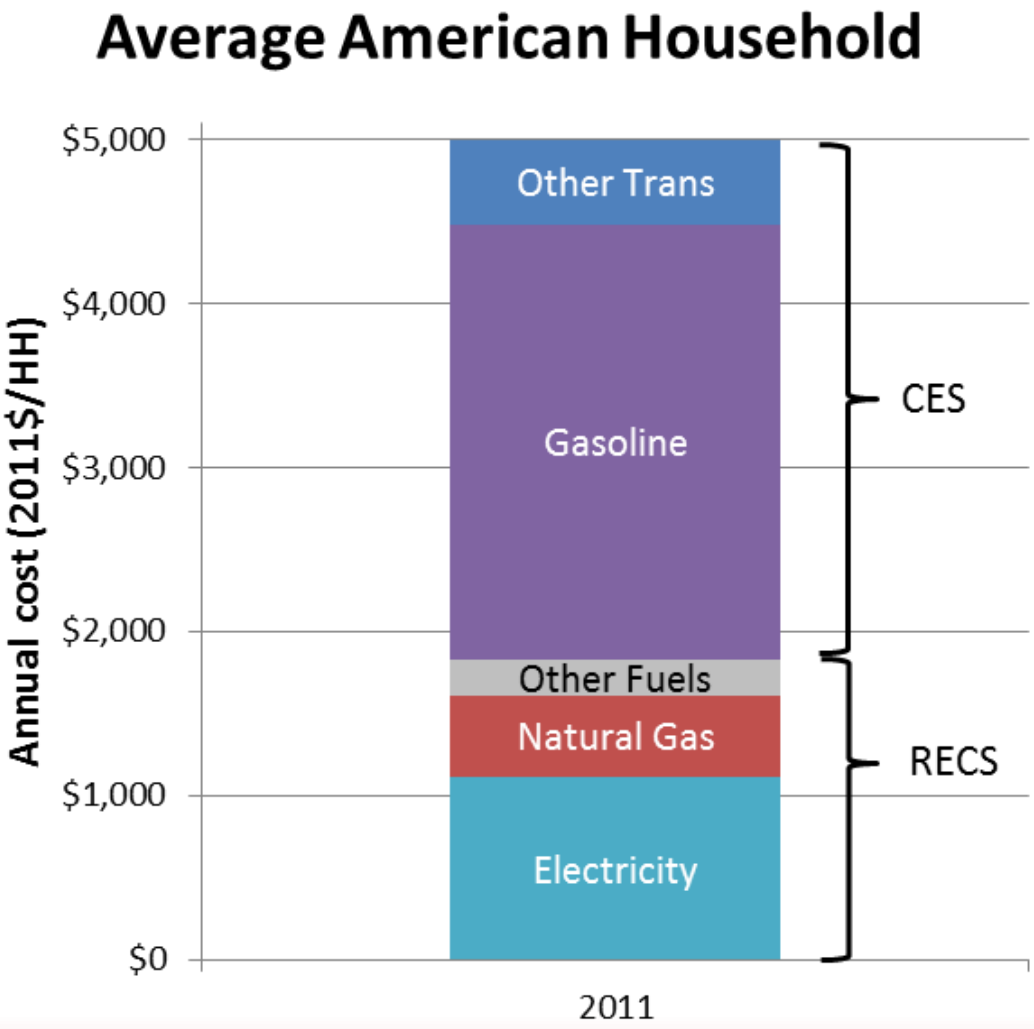
- Combine with expenditure by household (HH)
  - Scale aggregate policy cost to get HH policy cost

$$\left(\frac{HH\ Expend.}{Price\ x\ Quantity}\right)^{base\ yr} x\ Policy\ Cost^{yr} = HH\ Policy\ Cost^{yr}$$

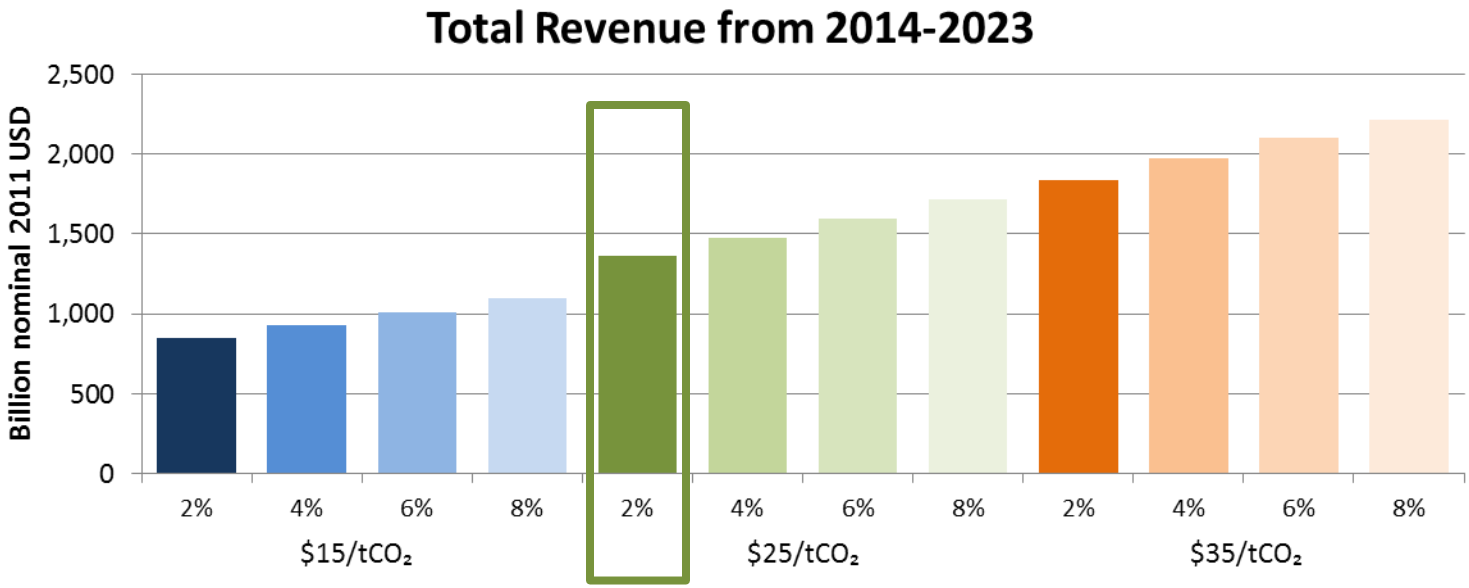
Household expenditure data

- Residential Energy Consumption Survey (RECS)
  - Extremely detailed data on household energy consumption and expenditure by fuel, region, income, technology, etc.
  - No transportation related activity
- Consumer Expenditure Survey (CES)
  - Very coarse energy expenditure data
  - Includes gasoline and other transportation expenditures

Household Energy Expenditures



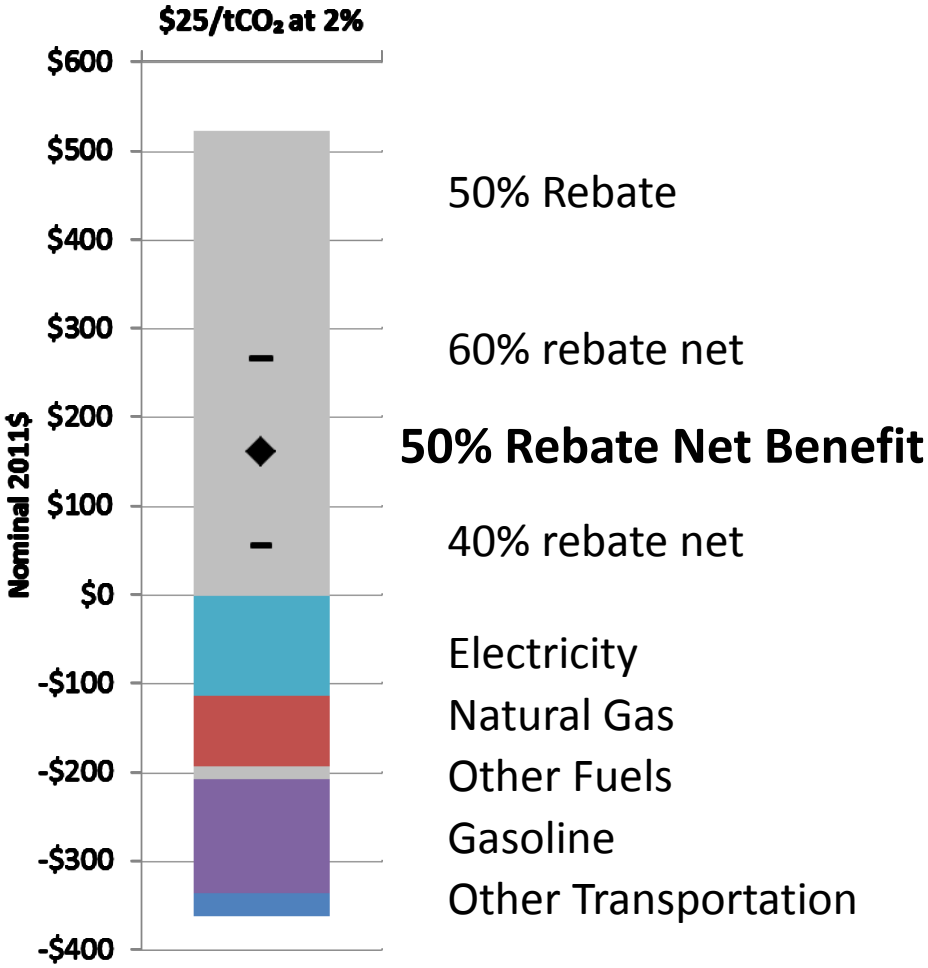
50% Rebate of NEMS Revenues



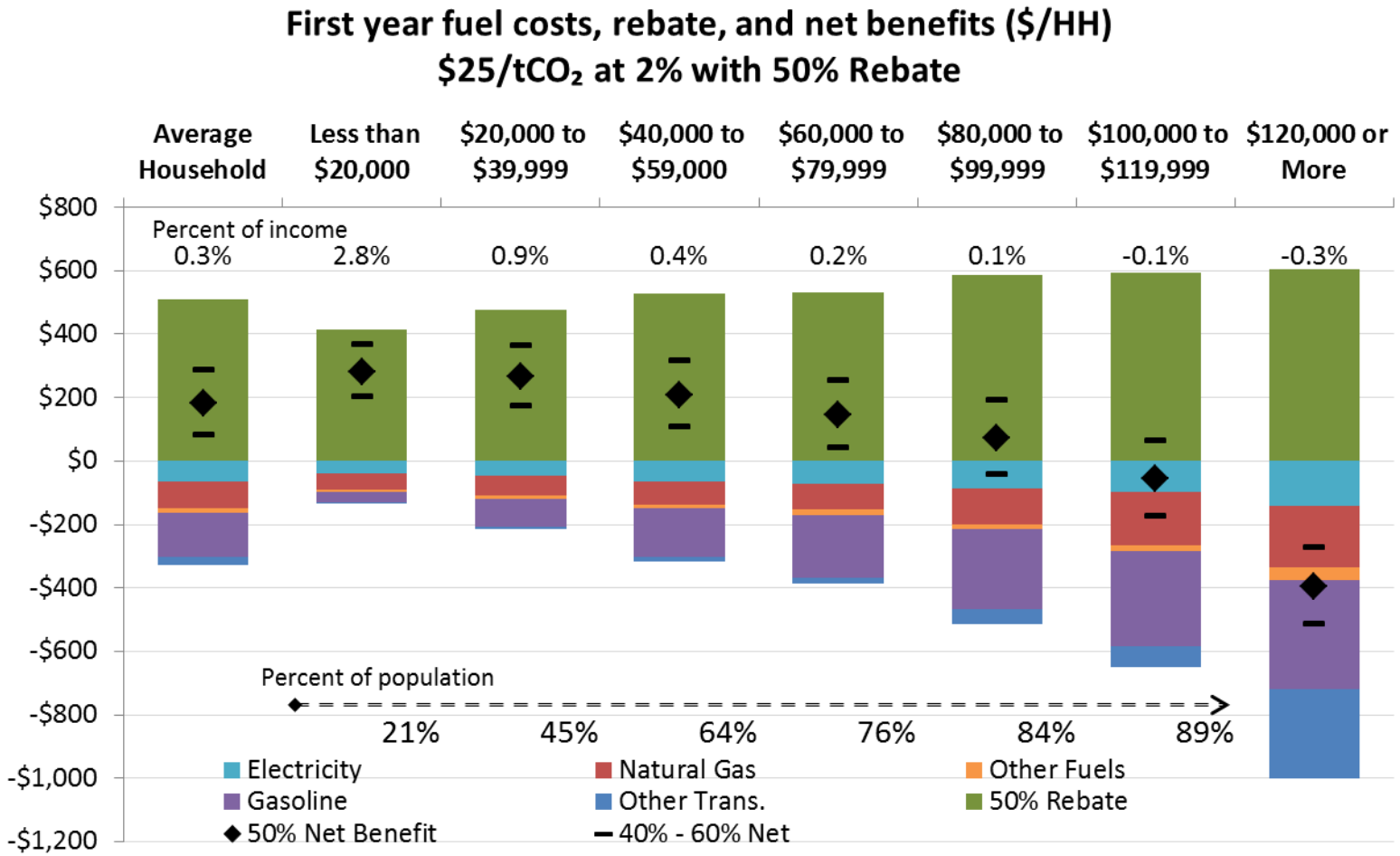
50% Household Rebate: $\left(\frac{50\% * revenue}{population}\right)^{yr} * people\ per\ household$

Average American household first year rebate ($25/tCO2 at 2%): $\$520\ per\ household$

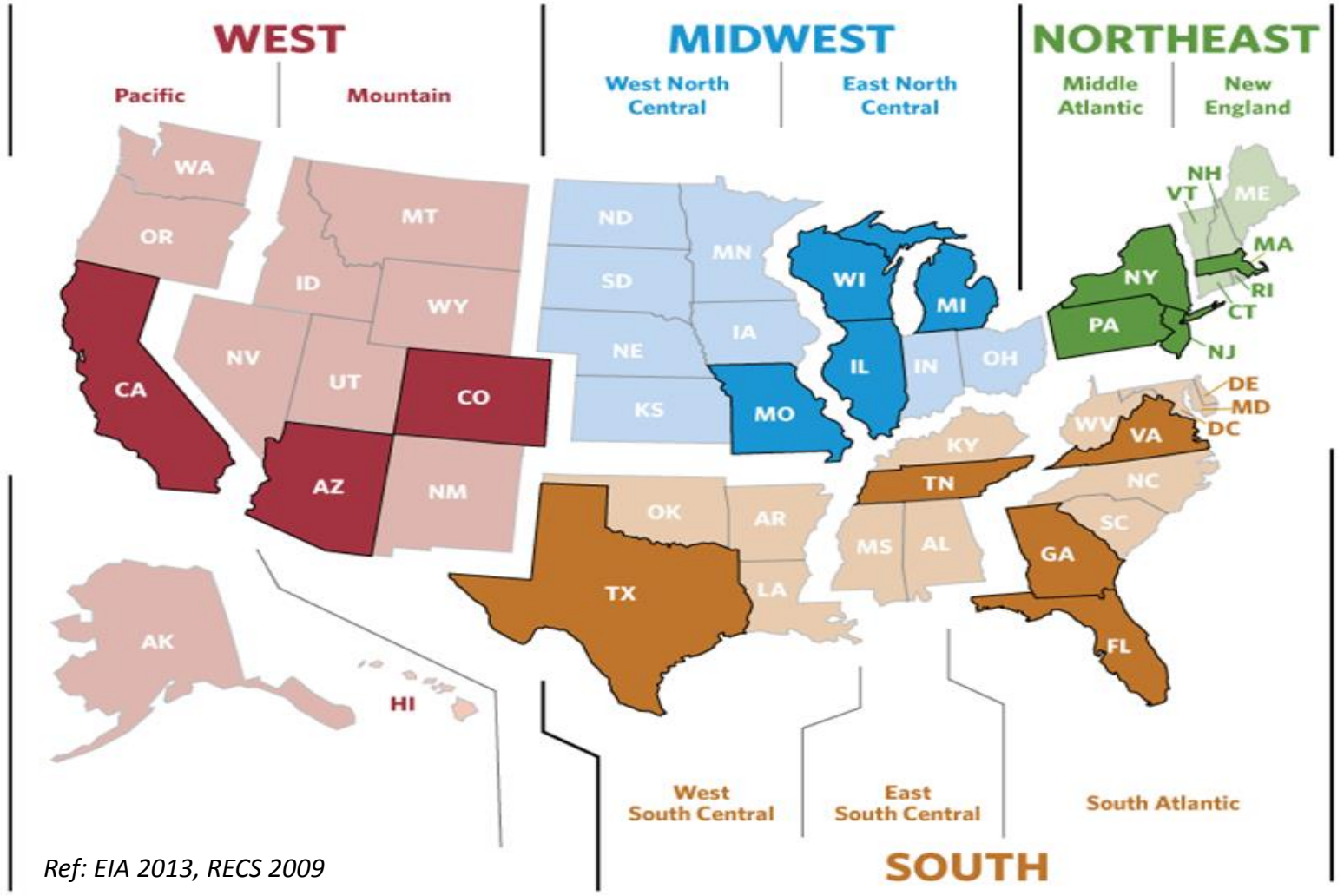
Policy Cost and Benefit to Average American Household



Impacts by Household Income

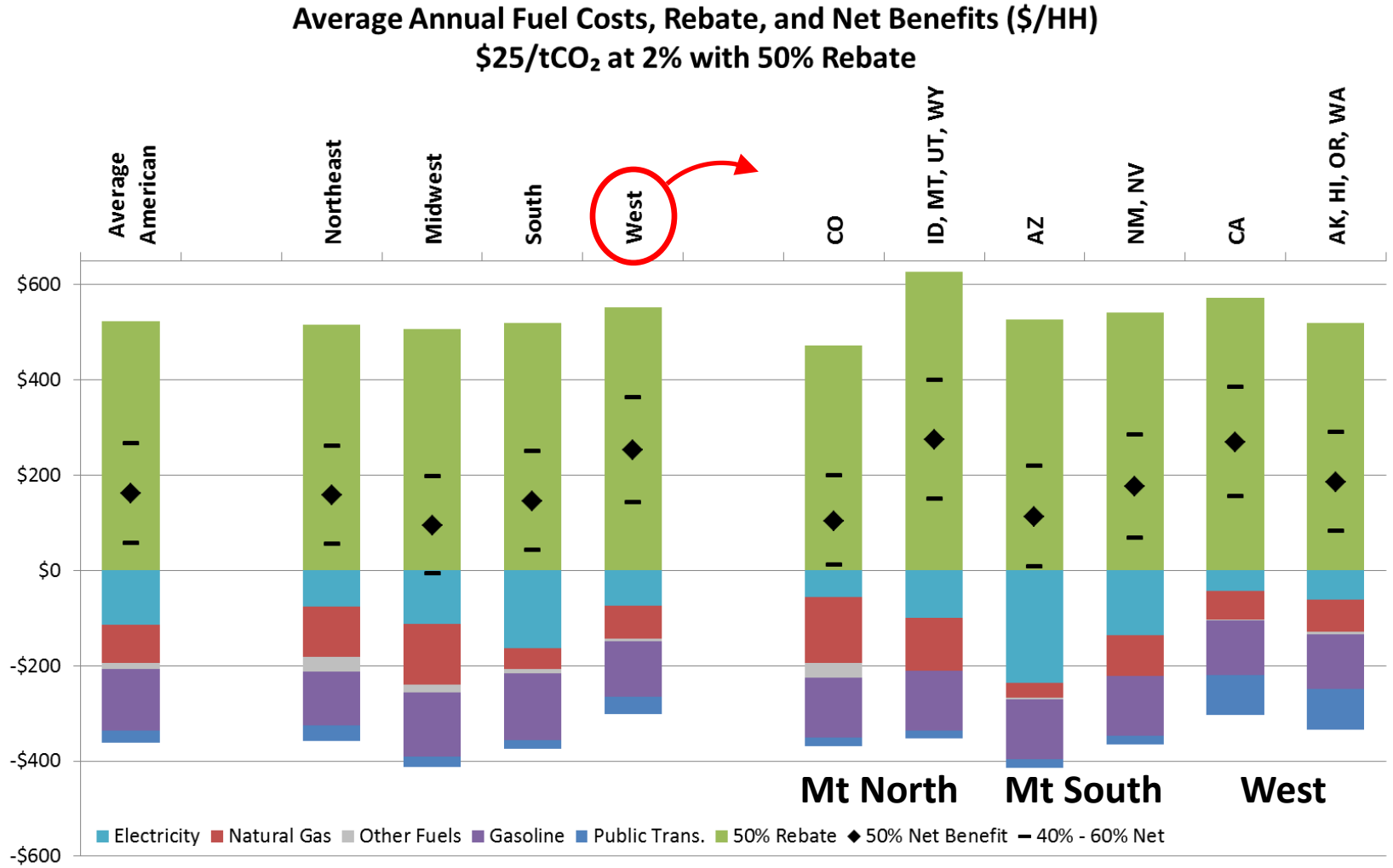


Geographic Resolution



Ref: EIA 2013, RECS 2009

State Level Impacts



Summary of Distributional Impacts

- We can forecast integrated impacts to households in 16 states from carbon fee and rebate policies
- A 50% rebate of the revenues to households will
  - offset the direct costs for 84% of all households,
    - including all households earning less than $100k
  - benefit lower income households more,
    - demonstrating progressive carbon policies
- Certain regions are exposed to higher carbon electricity fuels and harsher climate
  - yet all regions (and states) are positive with 50% rebate

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Can we improve the solution?

- There are two parts to this question:
  - Can we integrate the household rebate inside of NEMS?
  - Can we protect Energy Intense and Trade Exposed industries within the NEMS framework?

Rebates in NEMS

- Model revenue recycling methods are limited
  - 100% to businesses (revenue or deficit neutral)

    -or-
  - 100% to consumers (revenue or deficit neutral)

    -or-
  - 100% to deficit reduction

EIA carbon side cases

- But what does giving money to consumers mean in the model?

Taxpayer rebates are not the same as per-capita rebates

- Returning money to consumers reduces aggregate personal income tax
  - who pays most of the income taxes?
    - Top quintile contributes 70% of all U.S. personal taxes*
    - Top two quintiles contribute 85%*
    - Lowest quintile contributes 0.5%*
- Rewards the wealthiest
- Underestimates re-spending effect

** CBO 2013, "The Distribution of Household Income and Federal Taxes, 2010"*

Protecting exposed Industries

- Returning revenue to all businesses reduces aggregate corporate taxes
  - Which corporations pay the most corporate taxes?
    - Wealthiest 0.1% contribute 85% of all corporate taxes*
    - Wealthiest 5% pay over 95% of all corporate taxes *
- What about individual industries?

** Tax Policy Center, 2011, "Balance Sheet and Tax Items, by Size of Business Receipts, 2008"*

EIA's analysis

- Over write endogenous energy prices with manually adjusted exogenous prices for particular industries
- New price based on carbon content of fuels
- Rerun the model with hard-coded prices

- This alleviates the burden for certain industries but has significant problems
  - Improper price signal feedback to the rest of the economy
  - Unable to account for lump sum transfers
  - Money still won't likely go to energy efficiency improvements

Summary of Model Limitations

- NEMS is essentially a collection of appliance-stock models and process models
  - Rich bottom-up technology representation
  - Almost no financial levers or hooks into the model
- NEMS is a simulation of existing policies
  - Not intended to be a scenario analysis tool

- Everyone who uses results from this model needs to know these limitations

Related papers (all in progress)

- ***Economic impacts from carbon fee and dividend policies:***
  - ***Part I: Macroeconomic and electricity sector impacts*.**
  - ***Part II: Household distributional impacts.***

  Wilkerson, J. T., Cullenward, D. J., Wara, M., & Weyant, J. P.
- ***U.S. Demand sector decomposition and analysis***

  Cullenward, D. J., & Wilkerson, J. T.
- **A Distributional Analysis of the Climate Protection Act of 2013: Impacts on Emissions, the Economy, and Household Energy Expenditures.**

  Cullenward, D. J., Wilkerson, J. T., Wara, M., & Weyant, J. P.

- **Demonstration of potential leakage of CAA 111(d)**

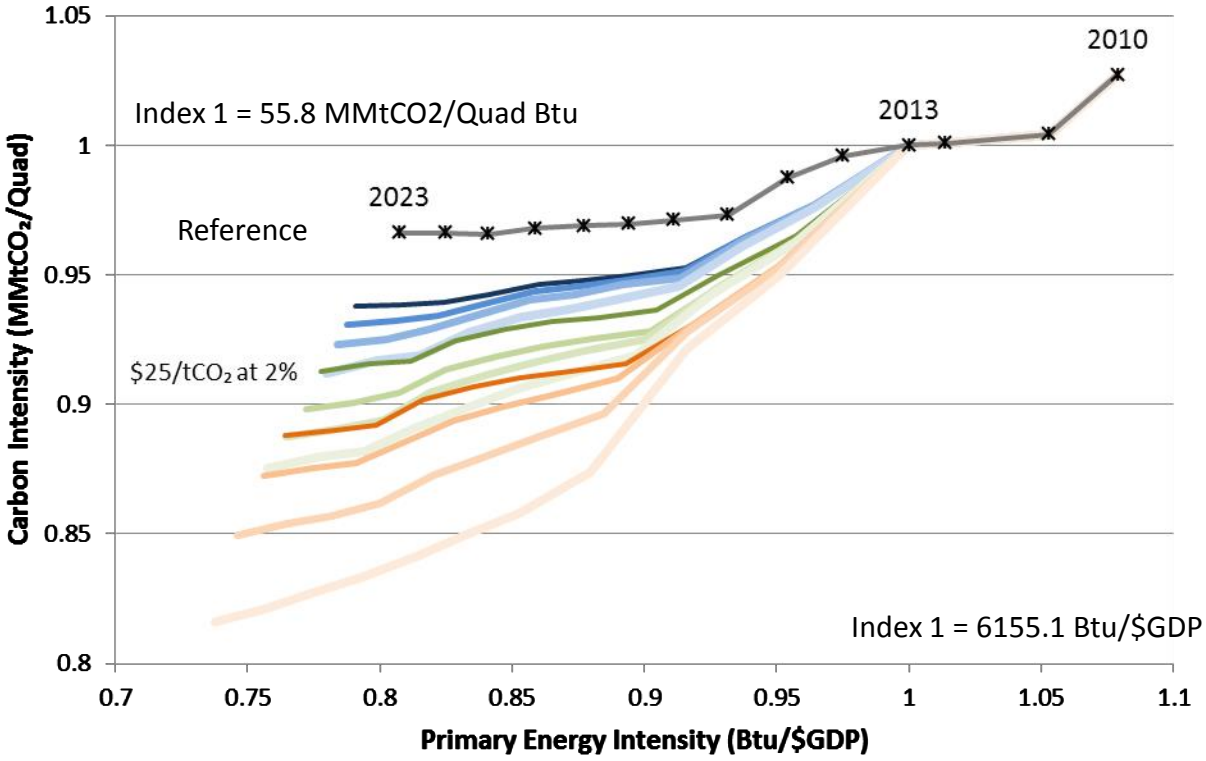
  Wilkerson, J. T., Wara, M., Cullenward, D. J.

QUESTIONS

ADDITIONAL SLIDES

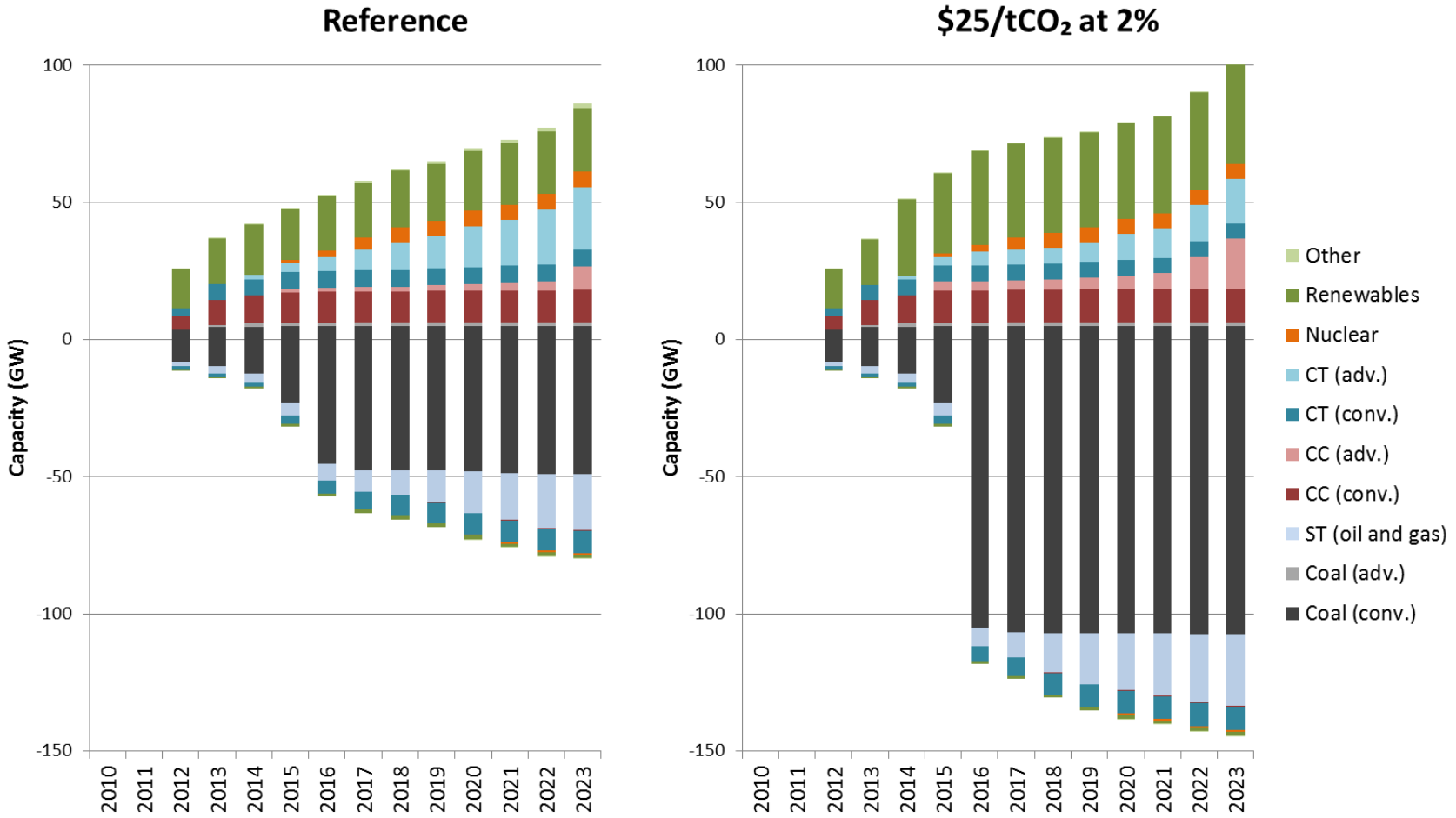
Carbon vs. Energy Intensity

$$\frac{TCO_2}{PE}$$

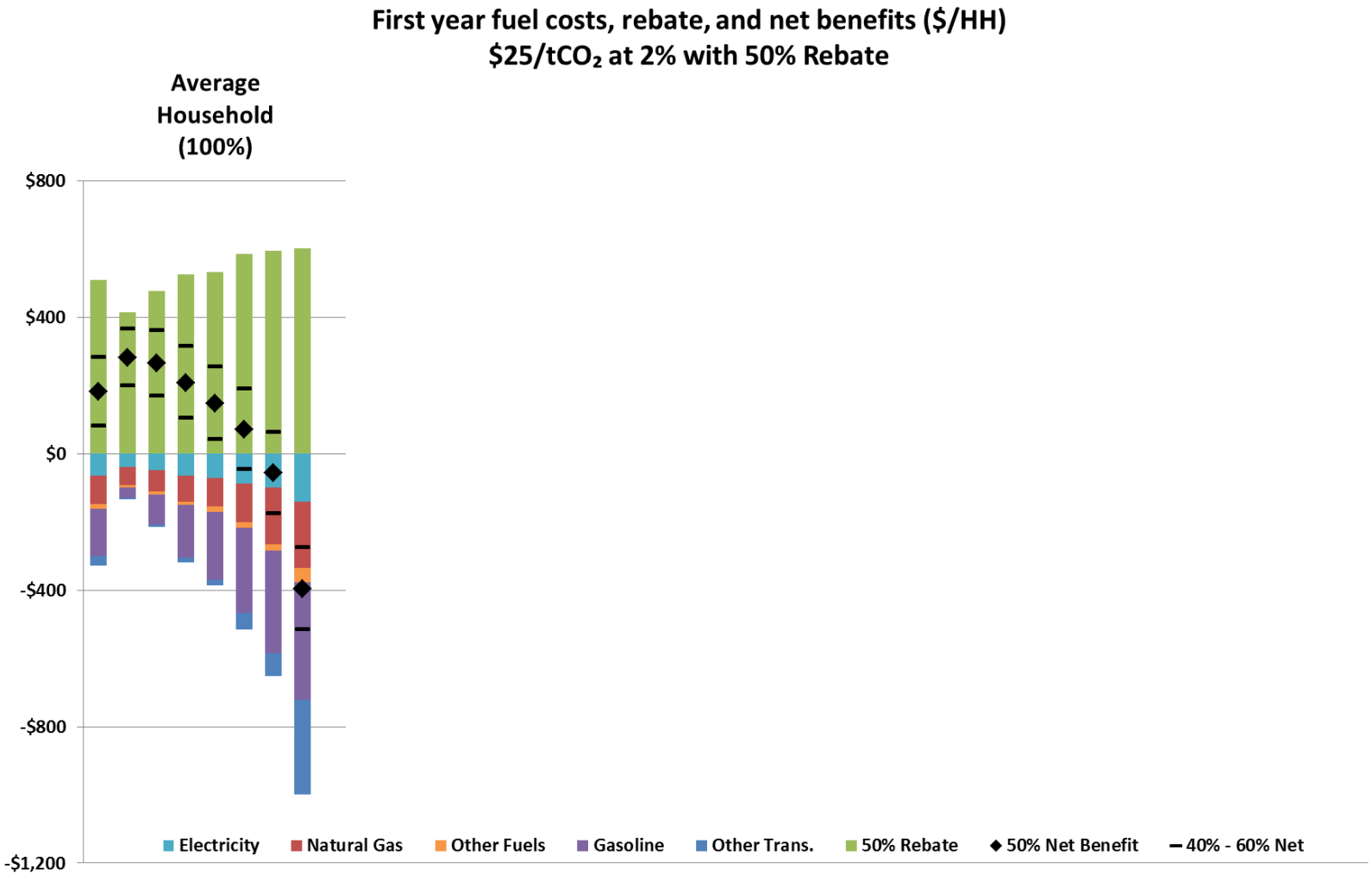


$$\left[\frac{FE}{GDP} * \frac{PE}{FE}\right]$$

Electricity Sector Cumulative Retirements and Additions



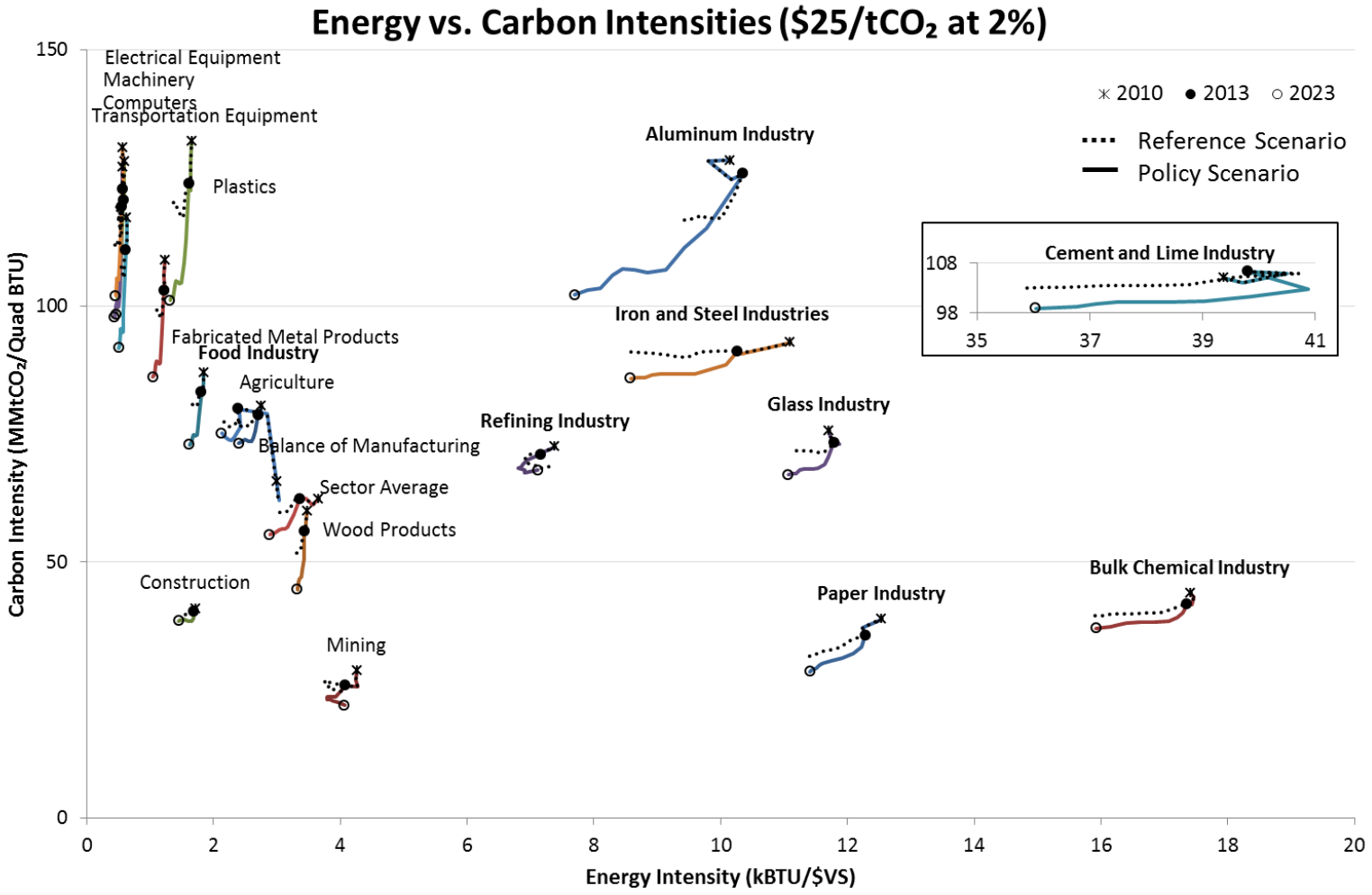
…by Household Income and Region



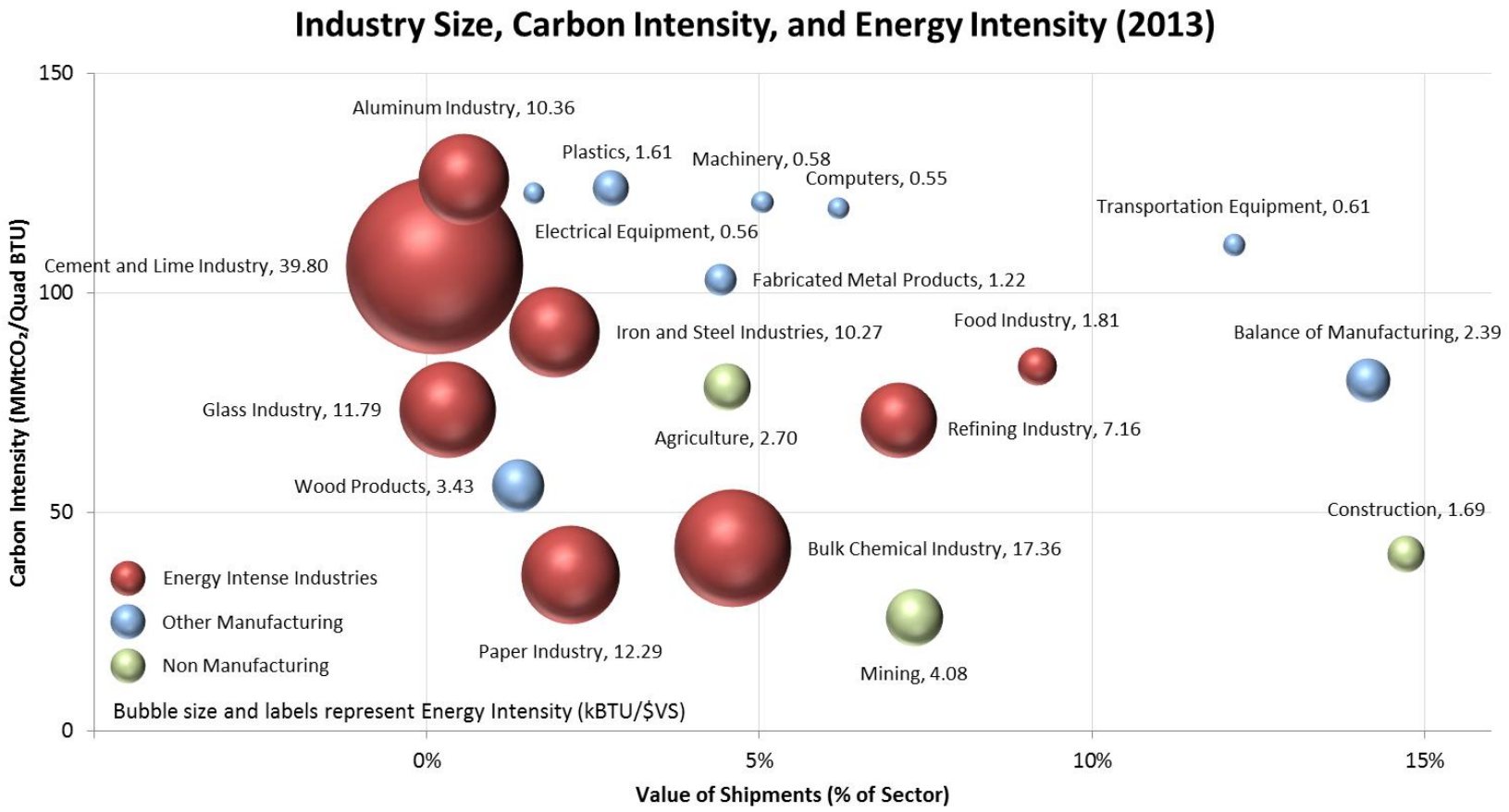
Can we protect exposed industries?

- For trade exposed industries:
  - EIA's Method with their model…
  - Over write endogenous energy prices with manually adjusted exogenous prices for particular industries
  - New price based on fraction of export exposure and carbon content of energy resources
    - If carbon fee affects price by $x/MMBtu and 5% of products are exported, then new price is 95% *$x/Mmbtu
  - Rerun the model with hard coded prices
  - This alleviates the burden for certain industries but has two significant problems
    - Improper price signal feedback to the rest of the economy
    - Unable to properly account for revenue recycling

Energy vs. Carbon Intensities



Size of Industries



Carbon policy discussions

- Cap and Trade
  - Complex, opaque, and indirect system
  - Price volatility and gaming by market participants
  - Vulnerable to extreme market events (e.g., shale gas)
- Carbon Fee
  - Transparent prices
  - Requires much less oversight or manipulation
  - Consistent rebating and revenue recycling