Integrated Benefits Analysis of the USDOE Advanced Technology Programs

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Disclaimer

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Motivation and Approach

- Objectives of the Integrated Benefits Analysis (IBA):
  - Develop an analytical framework to help inform DOE how modeling tools could be applied to support the energy portfolio review process
  - Understand links between R&D funding, technology performance improvements, and benefits
- Motivation for using MARKAL Model (MARket ALlocation)
  - A well-documented technology optimization model, used widely by DOE program offices
  - Flexible model that can input many different technologies and policy cases
- Approach to the IBA
  - Office of Program Analysis and Evaluation to sponsor the analysis
  - Solicit data from technology programs and other DOE offices (e.g. EIA, PI) for model inputs and assumptions
  - Refine model insights by combining results with other information (e.g. technology barriers) that are challenging to model
  - Maintain transparency of results and utilization of findings

MARKAL-IBA Details

17 Technology Types and 31 Total Technologies Characterized

- Fossil (3)
- Fossil w/ CCS (5)
- Nuclear (4)
- Solar (2)
- Wind (2)
- Geothermal
- Hydrogen
- Stationary Fuel Cells
- Biomass (4)
- ICE, PHEVs/EVs, Fuel Cell Vehicles
- Heavy Duty Vehicles, Other transport
- Efficiency Buildings (3)
- Efficiency – Industry

3 Policy Scenarios Modeled

- Status Quo
  - Existing policies; no carbon cap
- Carbon cap
  - 80% CO_2 reduction of 2005 by 2050
  - 1 GT each domestic/international offsets
- Clean Energy Standard
  - 80% clean power plants by 2050
  - Nuclear & Renewables = 1
  - Coal CCS = 0.85
  - Natural gas = 0.5
  - Natural gas CCS = 0.9

MARKAL-IBA Inputs & Run Matrix

Key Inputs

Assumed R&D Spending	Technology Advancement	Market Cost
Low (Zero Funding)	Low	High
Med (Target)	Med	Med
High (Over Target)	High	Low

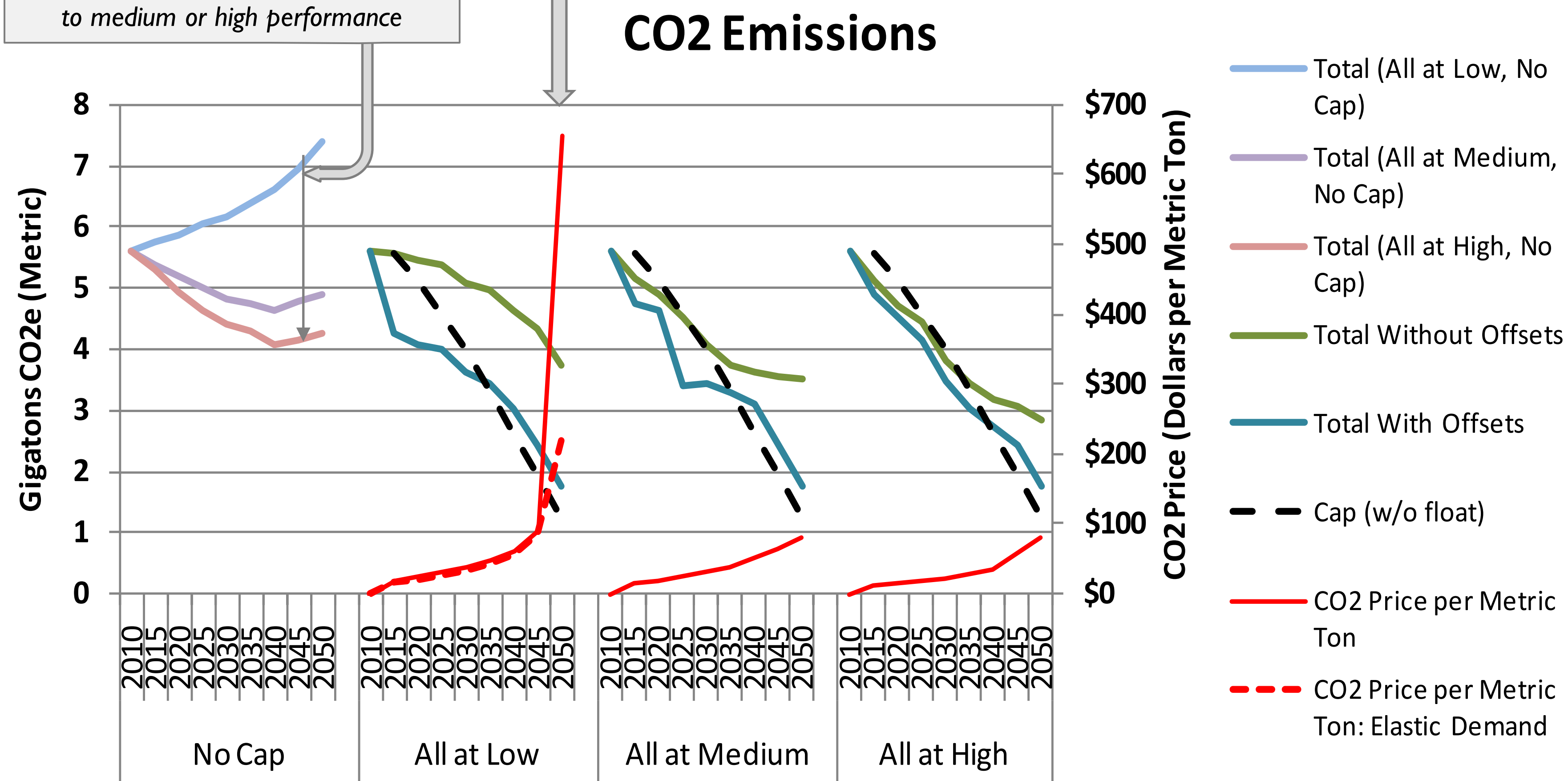
Run Matrix

Reference (AEO Baseline)	1
No carbon cap runs	22
Additive: 1 tech at High, all others at Low	20
Additive: 1 tech at High, all others at Medium	12
Subtractive: 1 tech at Low, all others at Medium	18
Subtractive: 1 tech at Low, all others at High	19
Combination/Other	14
Sensitivity	21
Total	127

Effects of Policy & R&D Funding on Carbon Emissions

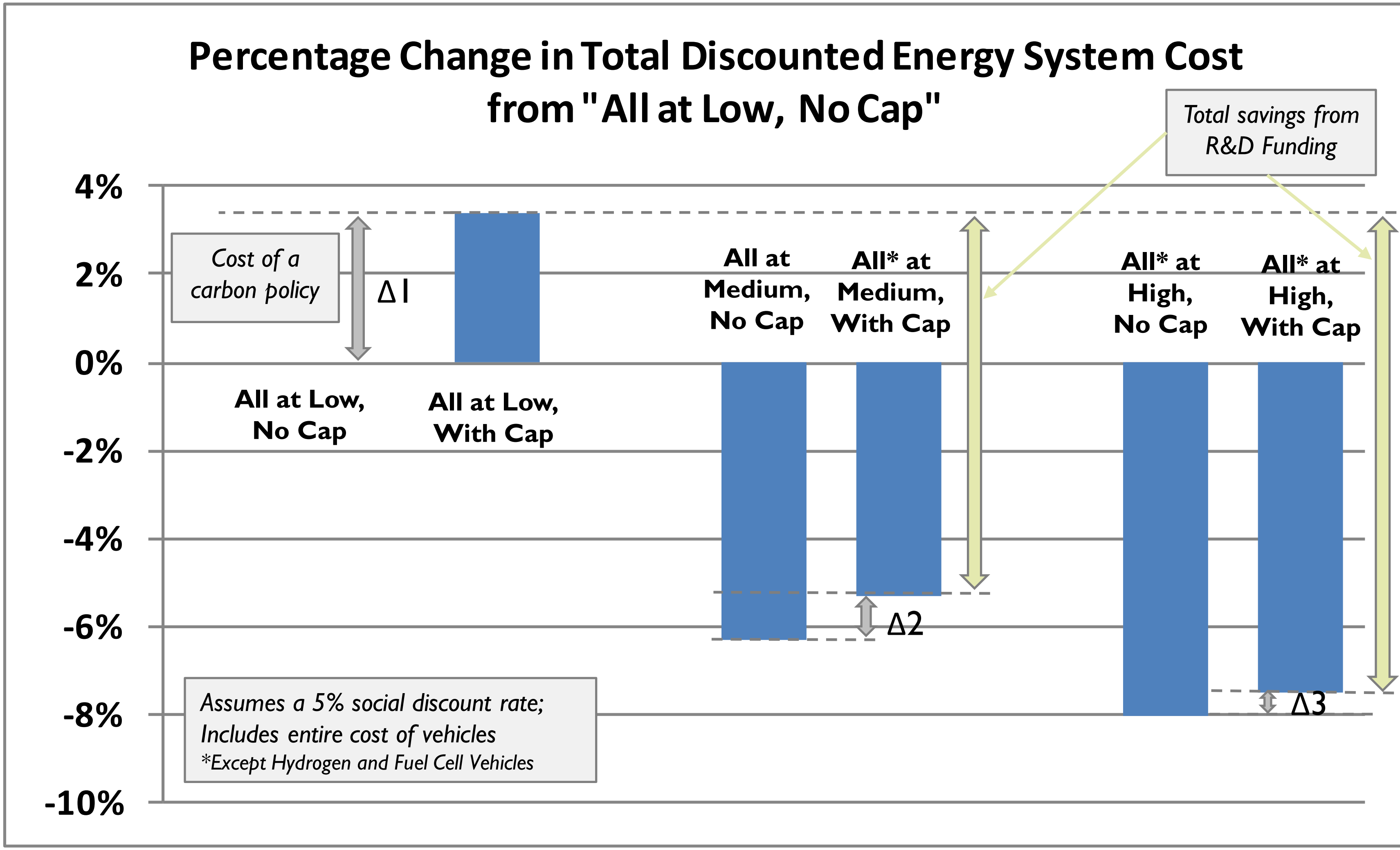
In the absence of a comprehensive carbon policy, CO2 emissions can be reduced by advancing all technologies to medium or high performance

Presence of a carbon cap achieves emission reduction goals, but in the absence of technology advancement at a high cost to society



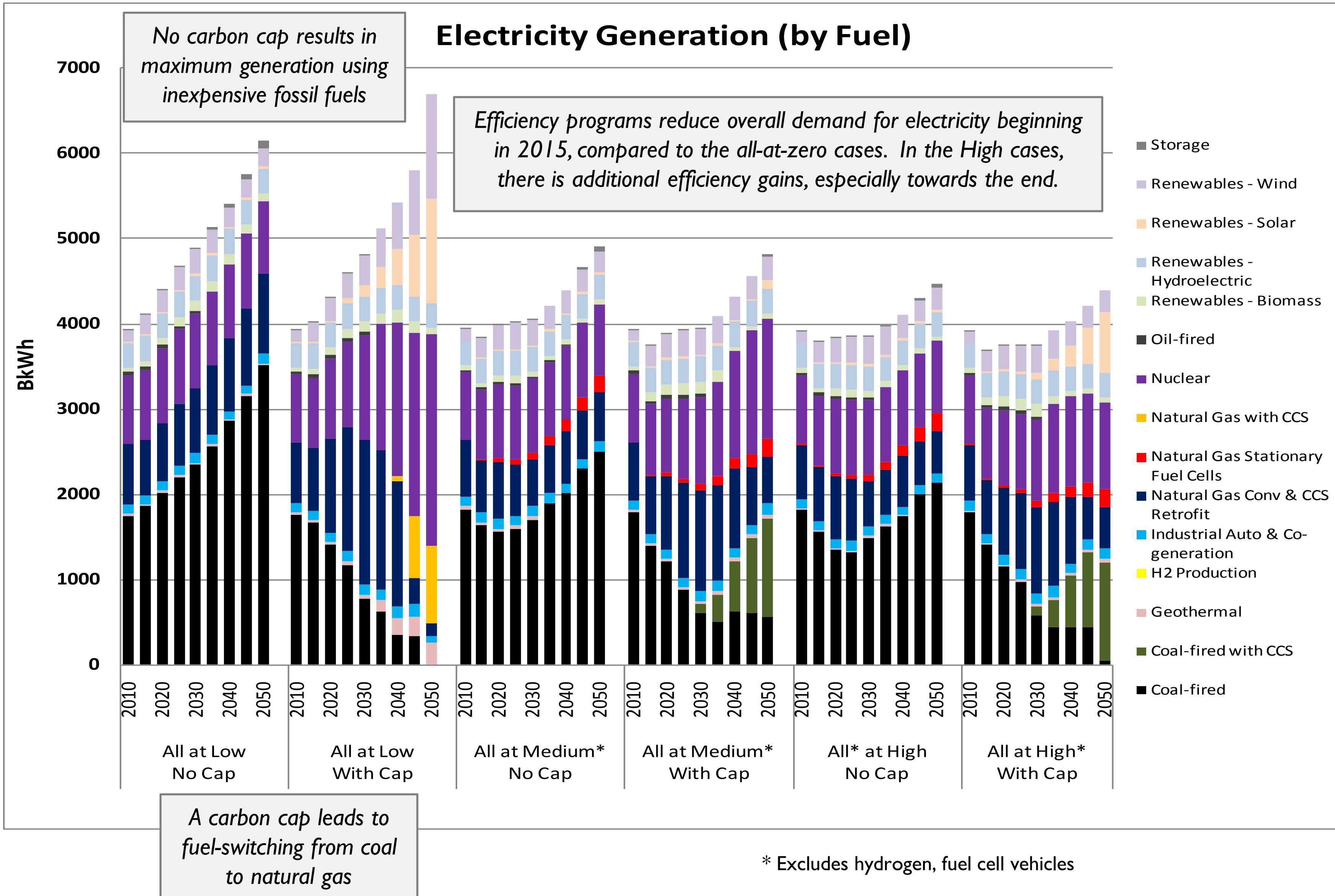
The combination of a carbon cap AND advancing all technologies reduces emissions well below what one lever can accomplish individually, while also using fewer offsets and keeping CO2 price reasonable.

Effects of Policy & R&D Funding on Energy System Cost



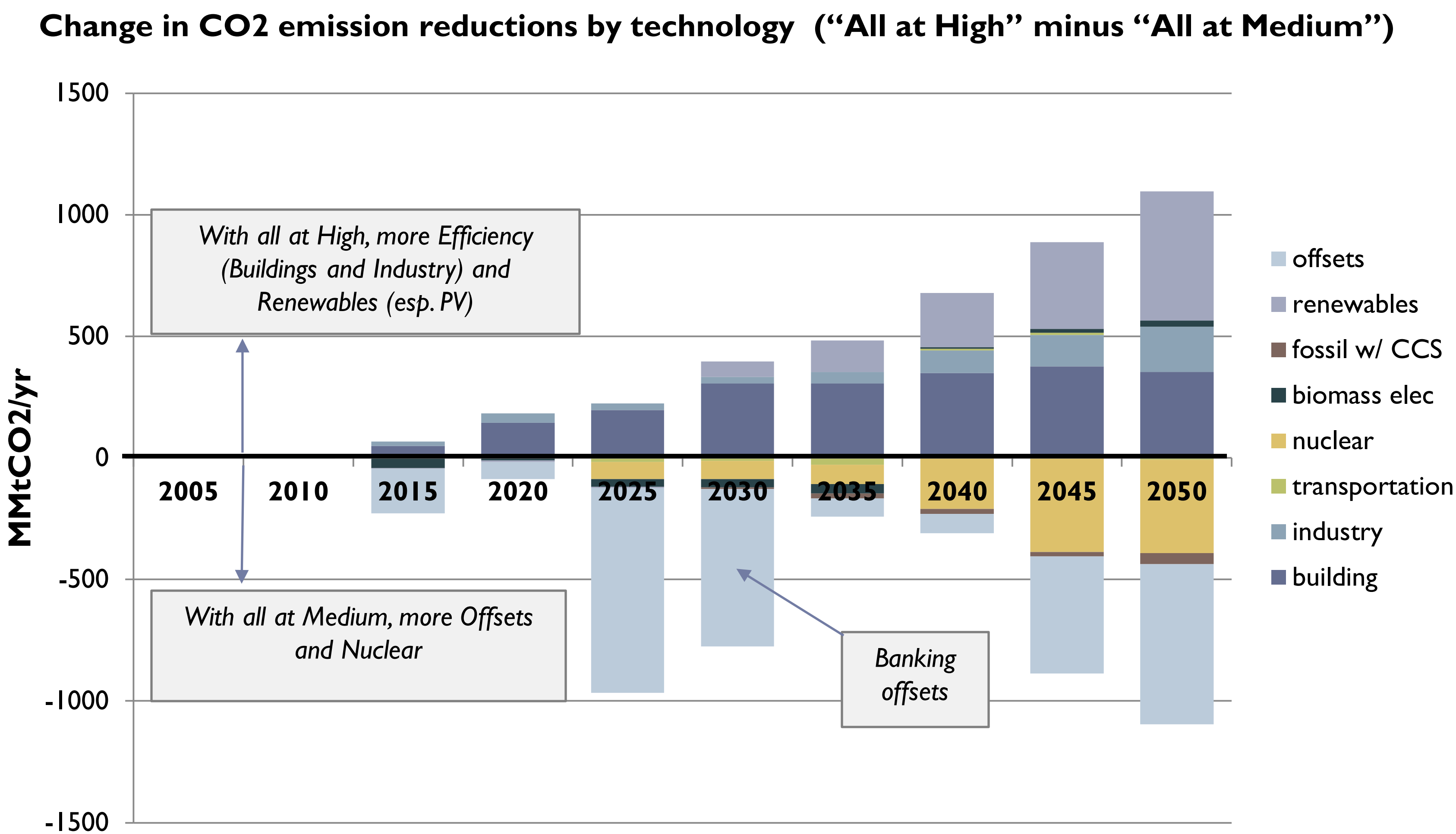
Advancement of all energy technologies significantly lowers the cost of meeting a carbon cap.

Effects of Policy & R&D Funding on Electricity Generation



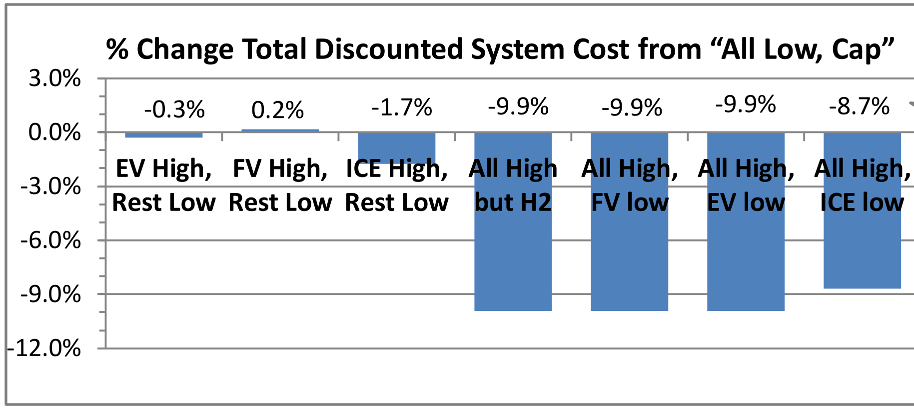
* Excludes hydrogen, fuel cell vehicles

Changes in Carbon Reductions by Technologies



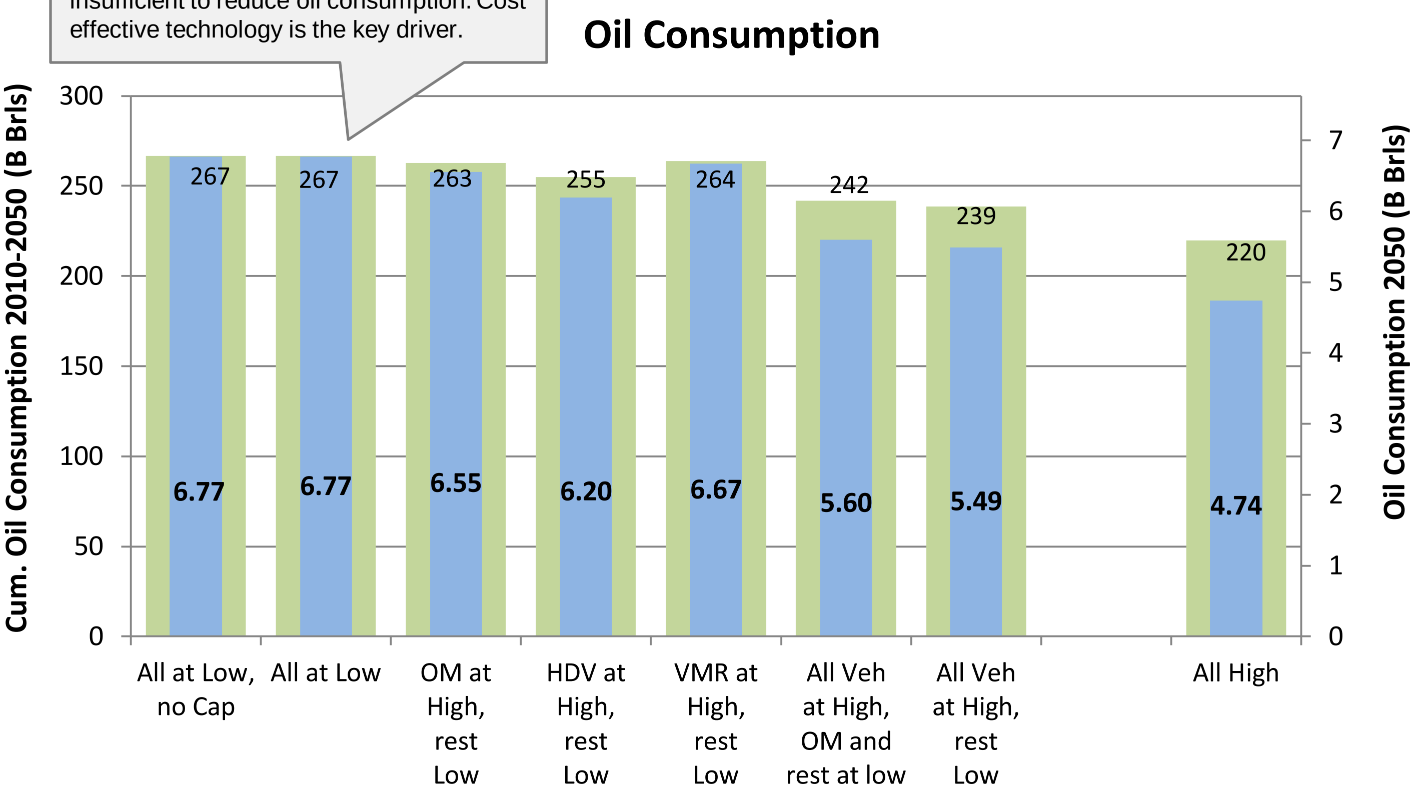
Transportation Sector Impacts

More efficient Vehicles and Other Modes of Transportation can reduce oil consumption and system cost



All transport techs at high reduces system cost by almost 10%.

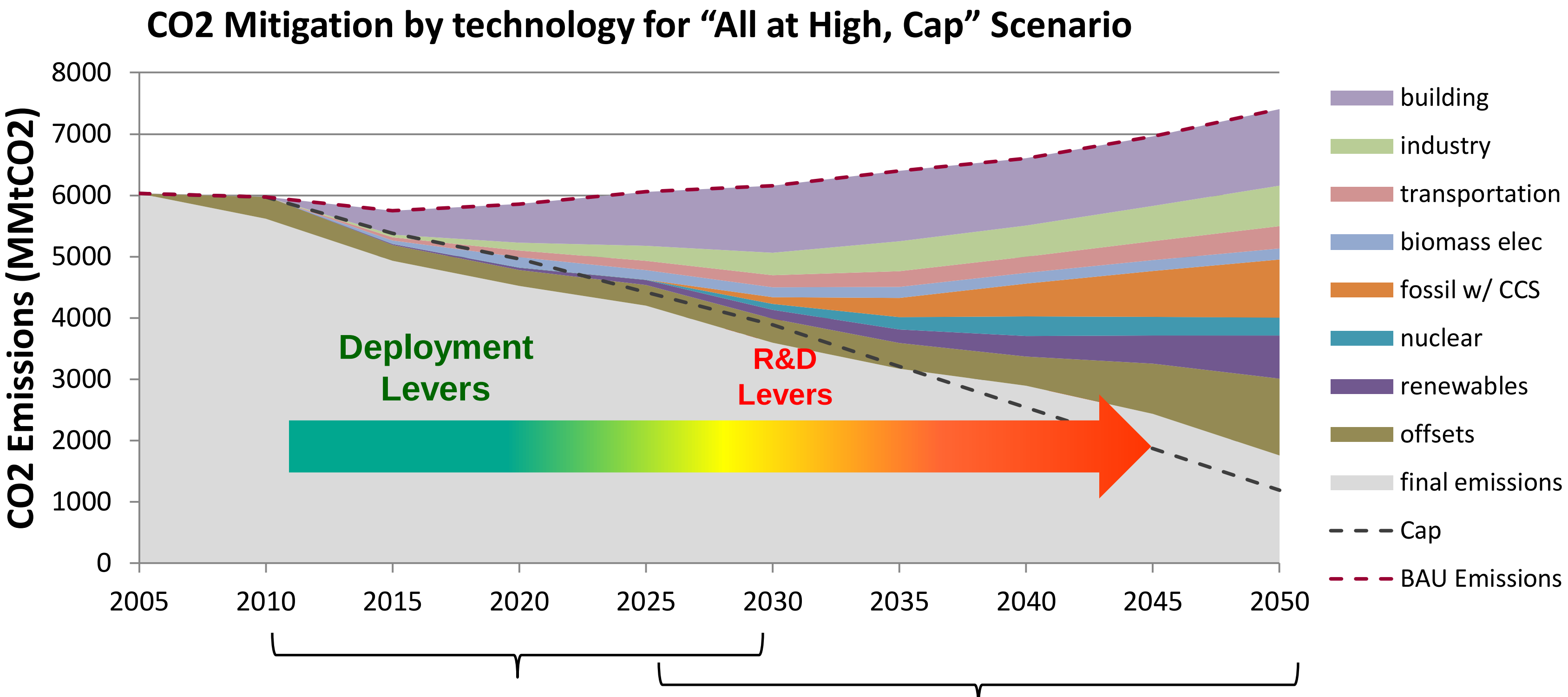
A carbon cap, even with low technology and a high CO2 marginal price, is insufficient to reduce oil consumption. Cost effective technology is the key driver.



With LDV and HDV technology improvements, oil consumption can decrease 20% per year by 2050.

Though insensitive to a CO2 price, transportation sector emission reductions can reduce the need for expensive reductions elsewhere.

Optimally achieving CO2 mitigation goals requires both near-term deployment incentives and long-term R&D investments



Efficiency Codes and Standards, Loan Guarantee, Tax Subsidies/Credits most effective near term strategies

R&D payoff for advanced technologies longer term gain

Possible Future Work

- Deeper exploration of the impact of technology cost uncertainty
- Analysis of policy uncertainty
- Focused technology scenarios and sensitivities
- Modeling of regional Implications
- Continue assessing barriers and other non-modeled information

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