

Technology and policy characterization in energy system modeling

Focus areas for improving deep decarbonization analysis

ENERGY INFORMATION ADMINISTRATION WORKSHOP | APRIL 27, 2021

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Key energy system modeling components relevant to decarbonization

Technology cost and performance

- How much does it cost to build or purchase new equipment and devices?
- How much does it cost to run them?
- How well do they do their jobs?

Resource estimates

- How much of a resource exists?
- Where does it exist?
- What are the qualities of the resource?
- How granular is the geographic representation?

Technology / infrastructure representation

- Is a technology or infrastructure component represented in the model?
- Is it represented in all applicable sectors?

Macroeconomic representation

- How are macroeconomic dynamics represented?
- How do macroeconomics interact with the energy system and vis-a-versa?

Algorithms representing actors and markets

- How do consumers make purchase and consumption decisions in the model?
- How do firms do the same?
- How does that compare with the real world?

Policy representation

- Are federal policies currently on the books represented?
- Are potential new policy frameworks represented?
- Are subnational policies represented?

Select technology representation in the National Energy Modeling System

Many technologies are not incorporated to the degree necessary for modeling a net-zero energy system

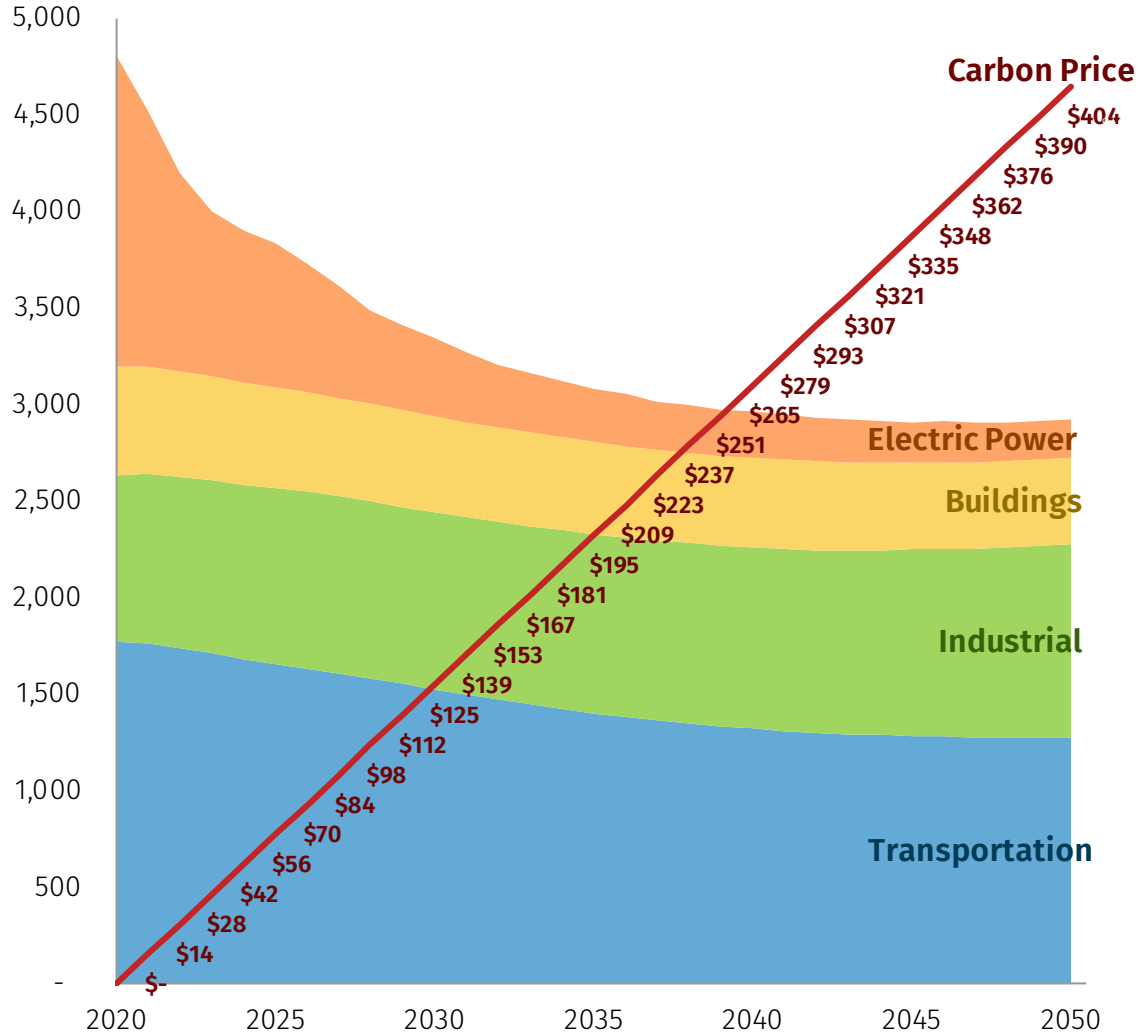
	Electric power	Transportation	Industrial	Buildings	Fuel production	Carbon removal
Carbon capture	YES	N/A	NO	N/A	NO	NO
Synthetic drop-in fuels	NO	NO	NO	NO	NO	N/A
Heat pumps	N/A	NO	NO	YES	N/A	N/A
Direct Air Capture	N/A	N/A	N/A	N/A	N/A	NO
Hydrogen turbines	NO	N/A	NO	NO	N/A	N/A
Electrolyzers	NO	NO	NO	NO	NO	N/A
Bioenergy w/ carbon capture	NO	N/A	NO	N/A	YES	YES
Batteries	YES	YES	NO	NO	N/A	N/A
Demand response	N/A	NO	NO	NO	N/A	N/A

Source: Rhodium Group analysis.

Incomplete technology representation leads to an incomplete picture

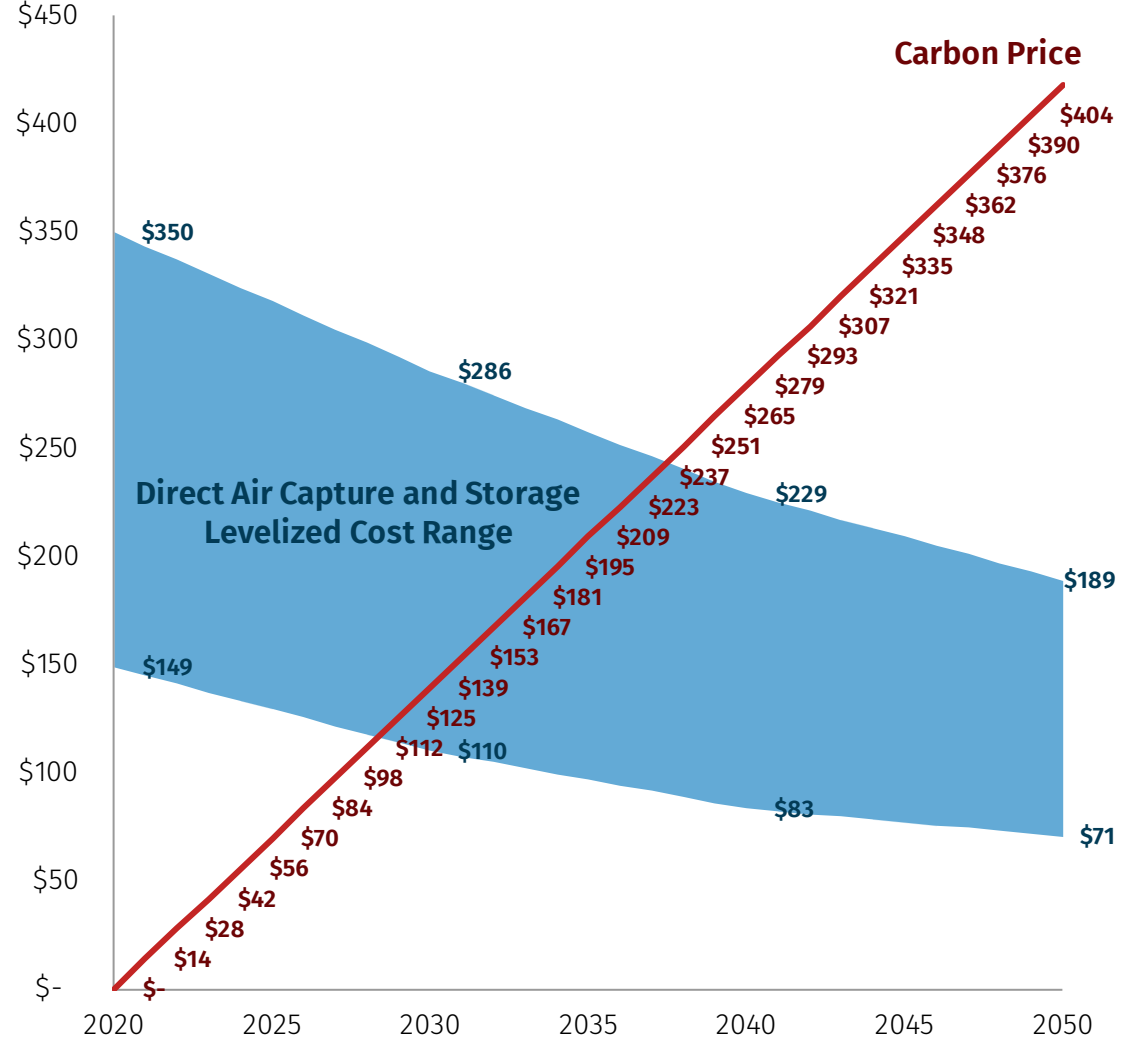
US GHG emissions under a carbon tax

Million metric tons fossil combustion CO₂



Direct air capture and storage costs compared to a carbon tax

\$/2019/metric ton



Source: Rhodium Group analysis. Note: Carbon price pathway is derived from the Climate Action Rebate Act of 2019.

Representation of select policies in the National Energy Modeling System

Some decarbonization policy options have limited or no representation

Explicit representation

Carbon tax

- Applied upstream
- Economy-wide or sectoral
- Tax flows through to delivered prices

LDV fuel economy standard

- Detailed compliance option representation
- Compliance flexibility
- Detailed vehicle class representation

Partial representation

45Q capture tax credit

- Almost no industrial representation
- Electric power production tax credit repurposed to represent \$/ton capture incentive

Clean electricity standard

- Detailed crediting by fuel and technology
- Binding constraint on capacity instead of energy

Limited / no representation

Low carbon fuel standard

- No apparent representation

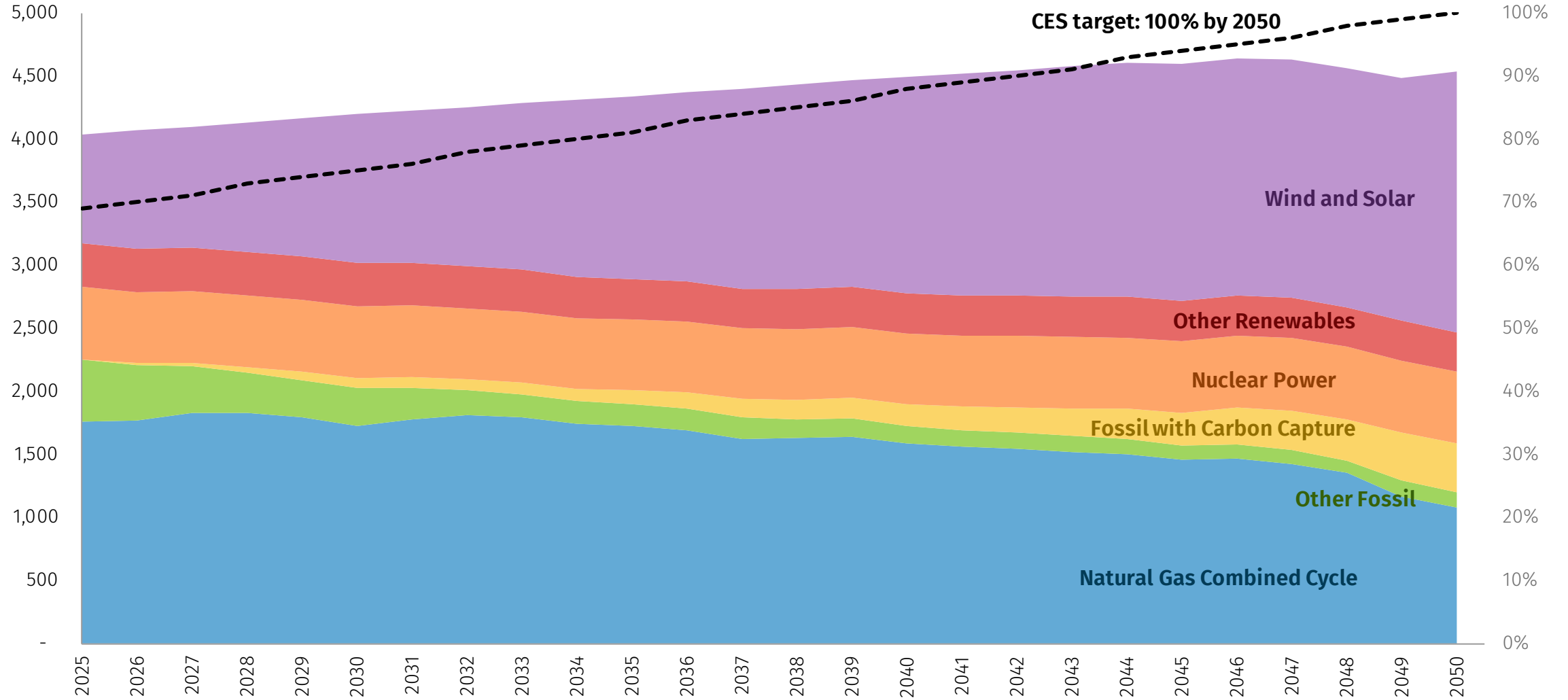
Energy efficiency resource standard

- No quantitative savings constraints
- Energy measures defined as spending not energy

Incomplete policy representation also leads to an incomplete picture

US utility-scale electric power generation under a 100% CES

Terawatt hours (left axis), Clean % of retail sales (right axis)



Source: Rhodium Group analysis. Note: Uncontrolled fossil received partial credit based on carbon intensity relative to coal. Crediting banking and alternative compliance payments are not available in the CES scenario shown above. Other fossil includes coal, oil and natural gas steam as well as combustion turbined. Other renewables includes hydro, geothermal and biomass..

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