

Modeling Economy-wide Deep Decarbonization

What happens to the rest of the energy system matters for the electric system

NATIONAL ACADEMIES COMMITTEE ON THE FUTURE OF ELECTRIC POWER IN THE US, IRVINE, CA | FEBRUARY 2, 2020

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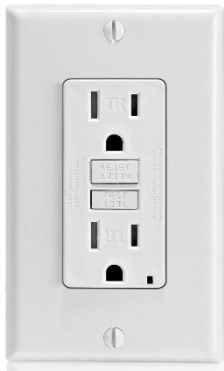
Pathways to decarbonizing the rest of the energy system intersect with electricity

Policy, technology, economics and consumer adoption will set the pace of change



Energy Efficiency

- Reduce electric load and change load shape
- Reduce demand for fossil fuel, electro-fuels and carbon removal



Electrification (direct and electro-fuels)

- Increase electric load
- Potential for load flexibility

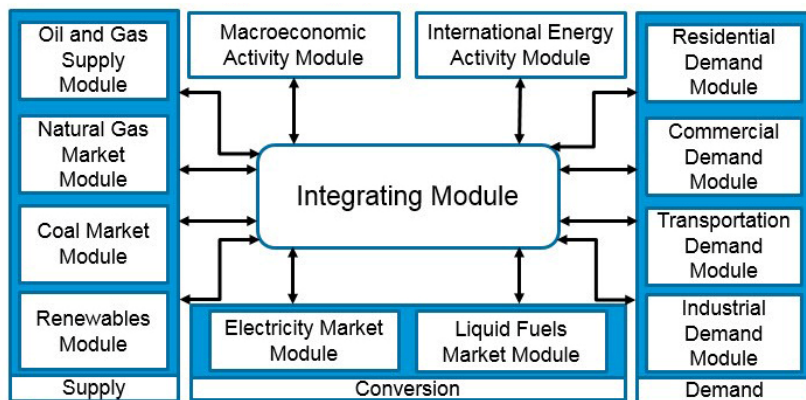


Technological Carbon Dioxide Removal (CDR)

- Increase electric load
- Potential for load flexibility

US energy system models used by Rhodium Group

RHG-NEMS



Created by the Energy Information Administration, operated and maintained by Rhodium Group

PATHWAYS+RIO



Owned and operated by Evolved Energy Research

Energy Efficiency and End-use Electrification

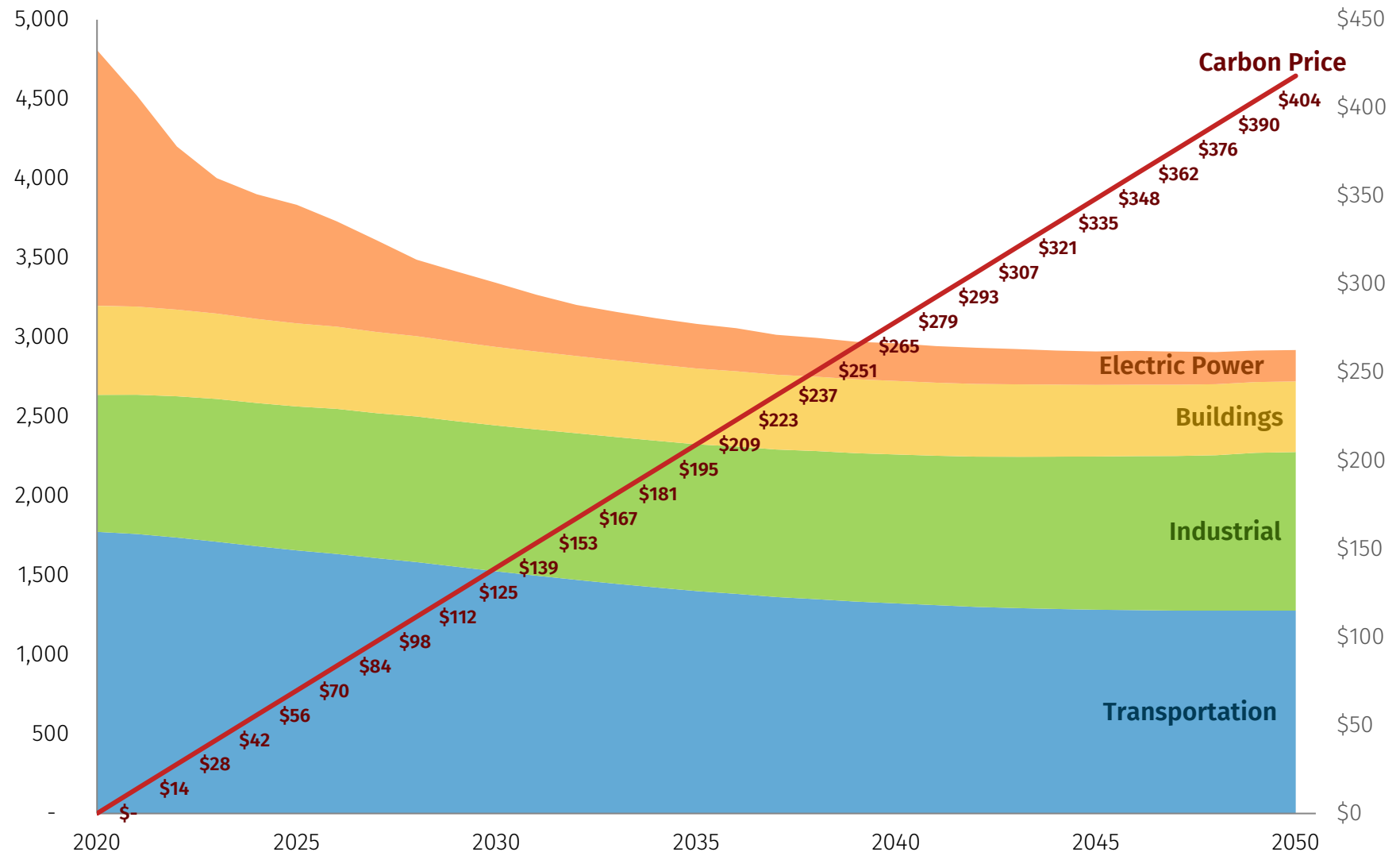
- Detailed representation of equipment, costs, performance and consumer choice
- Detailed policy representation
- Detailed representation of equipment, costs, performance
- User defined deployment, no consumer choice or policy representation

Electrofuels and CDR?

- No electrofuel representation
- No CDR representation
- Detailed representation of production costs and performance of electrofuels and CDR
- Economic deployment of both technologies

US emissions under a carbon price in RHG-NEMS

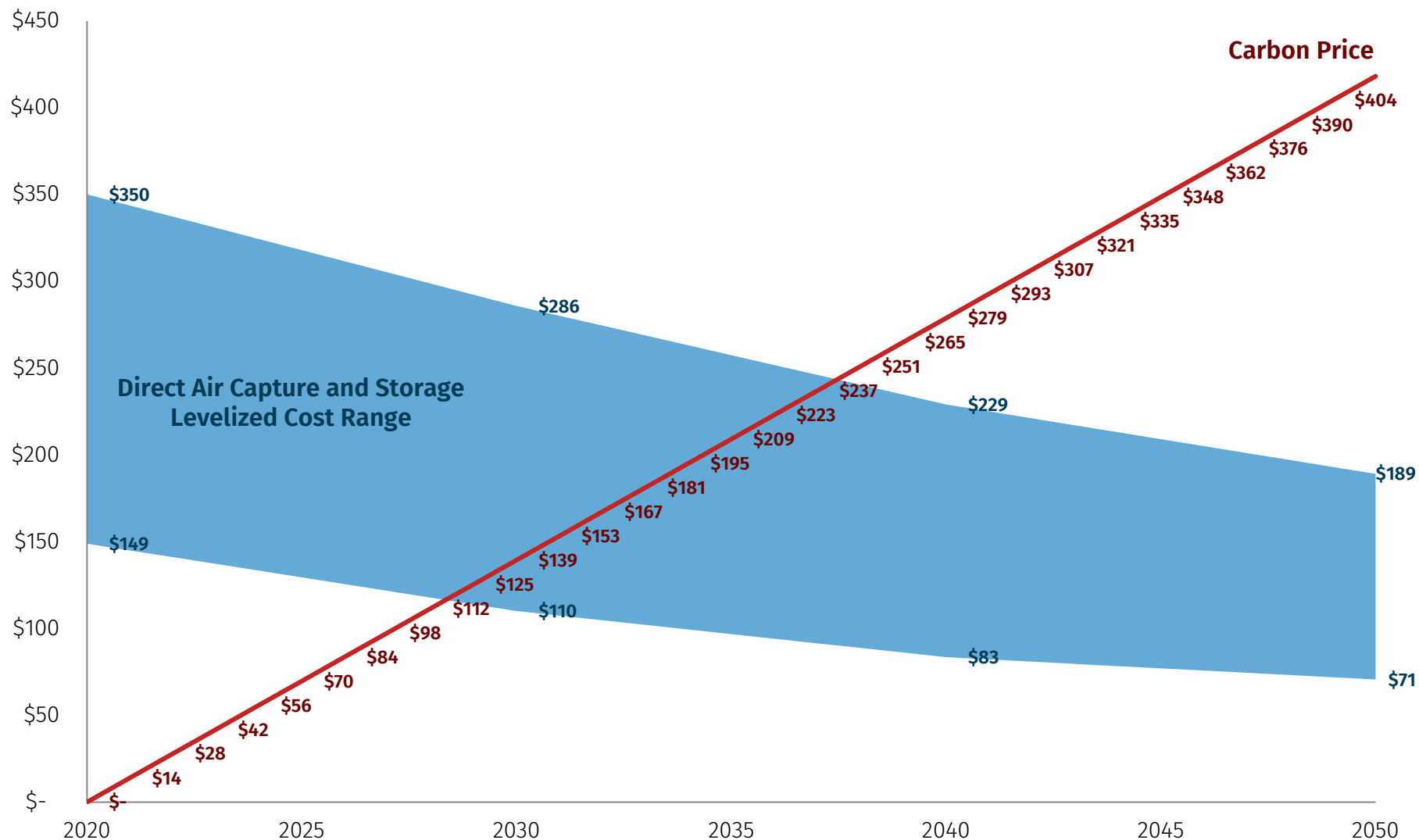
Million metric tons fossil Combustion CO₂



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

Direct air capture costs vs. a carbon price

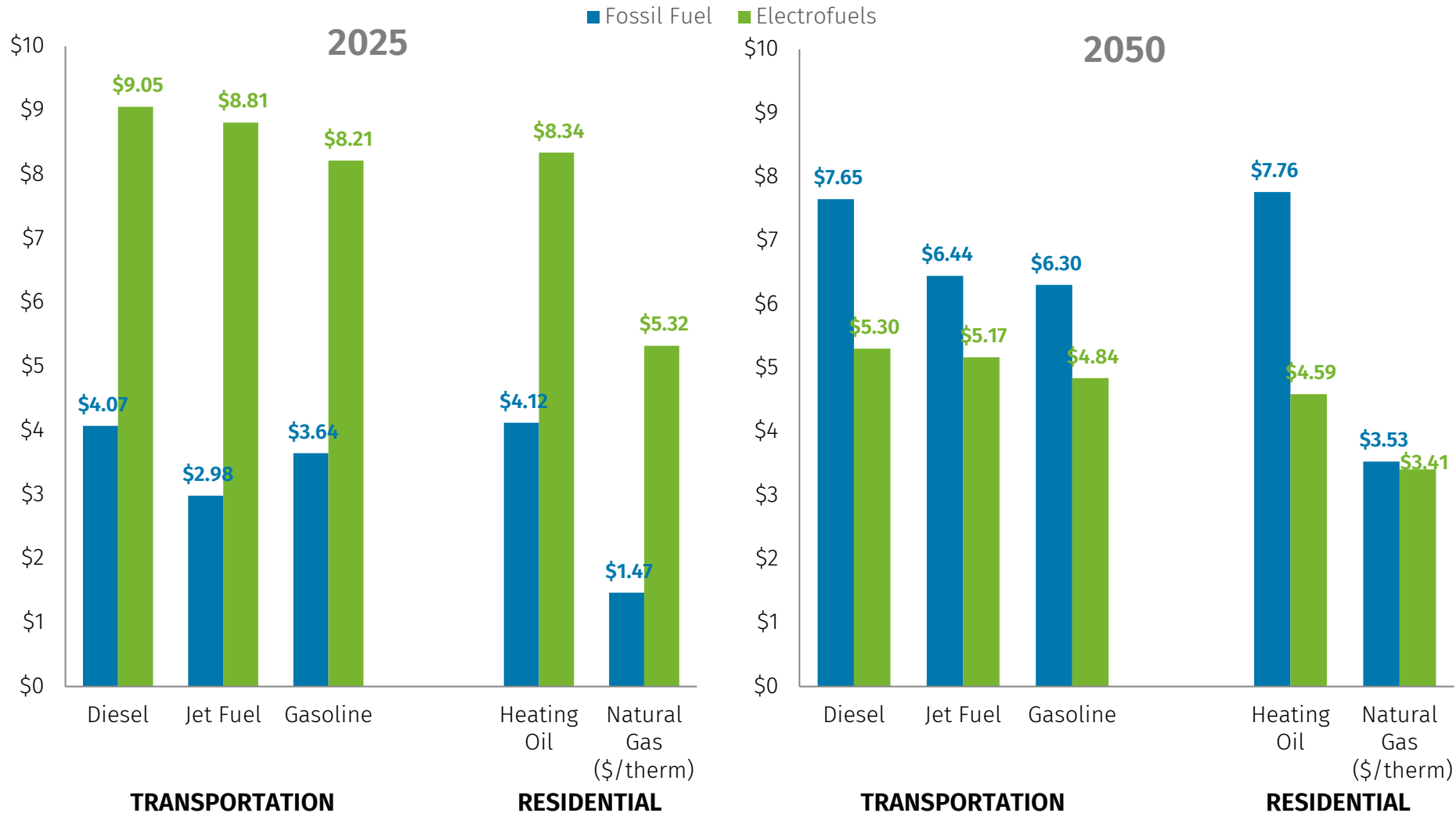
\$2019/Million metric ton



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

Electrofuels vs. fossil fuels with carbon price

Retail \$2019/gallon unless otherwise stated



Source: Rhodium Group analysis. Note: Electrofuels estimates derived from Agora Verkehrswende, Agora Energiewende and Frontier Economics (2018)

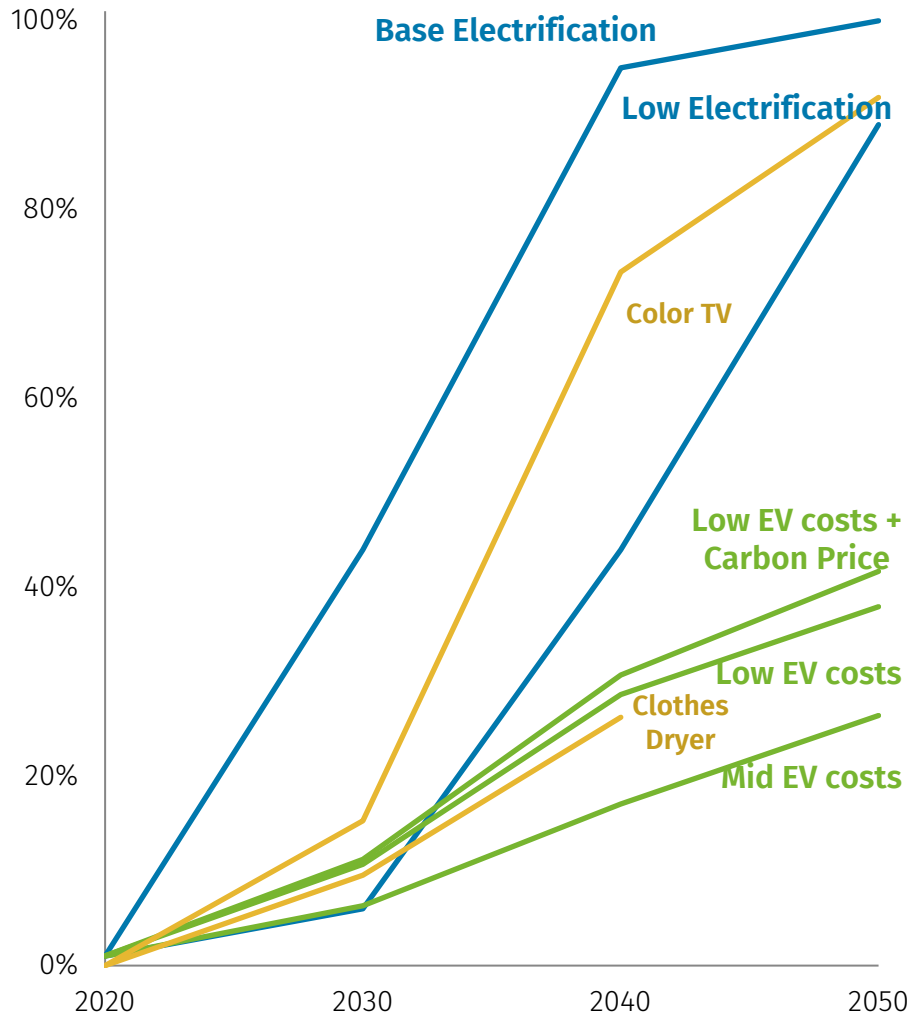
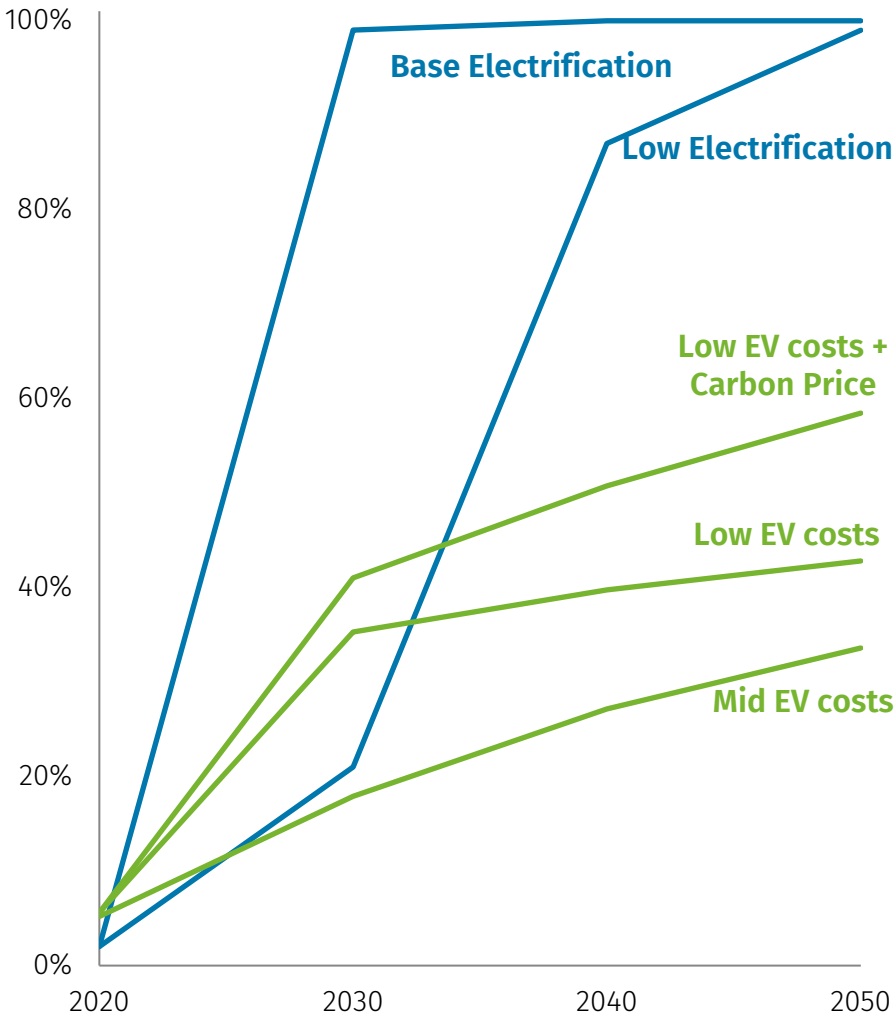
Light-duty electric vehicle deployment

Technology penetration

PATHWAYS RHG-NEMS Historical Examples

SALES

STOCK



Source: Rhodium Group analysis and Evolved Energy Research 350 PPM Pathways for the US.

US energy demand today and midcentury

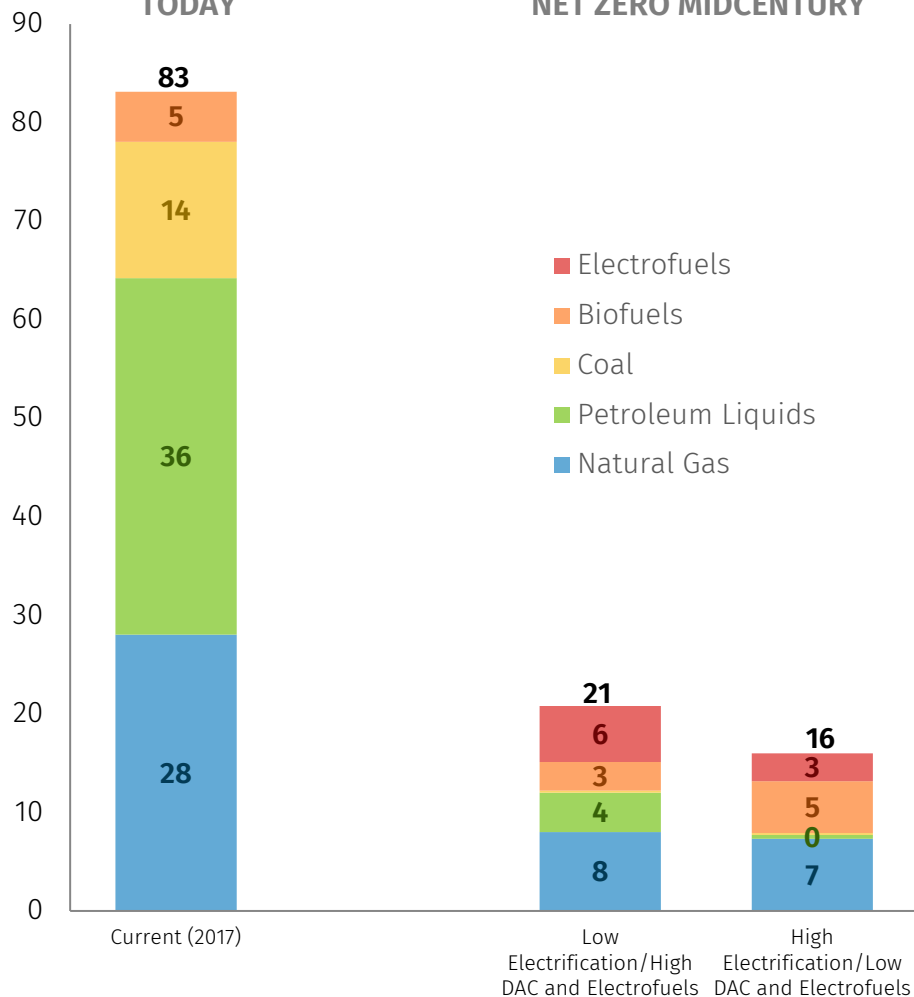
US annual non-electric demand

Quads

TODAY

NET ZERO MIDCENTURY

- Electrofuels
- Biofuels
- Coal
- Petroleum Liquids
- Natural Gas



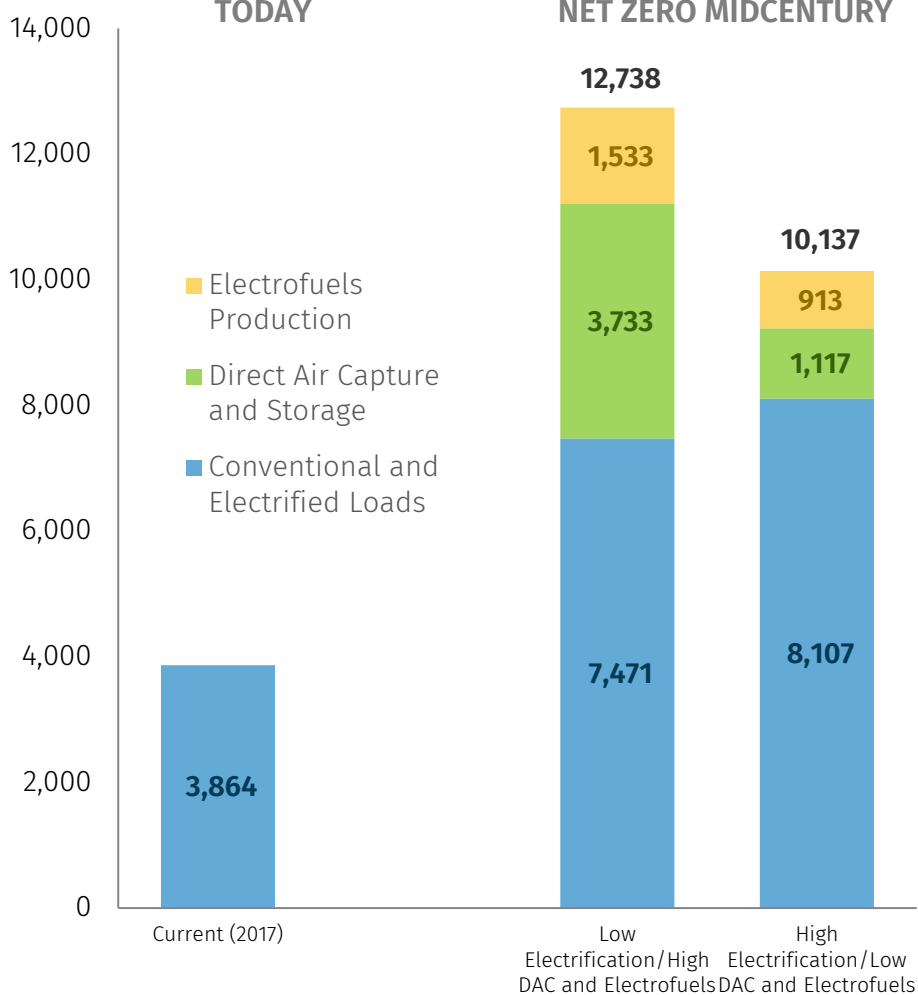
US annual electric demand

Terawatt hours

TODAY

NET ZERO MIDCENTURY

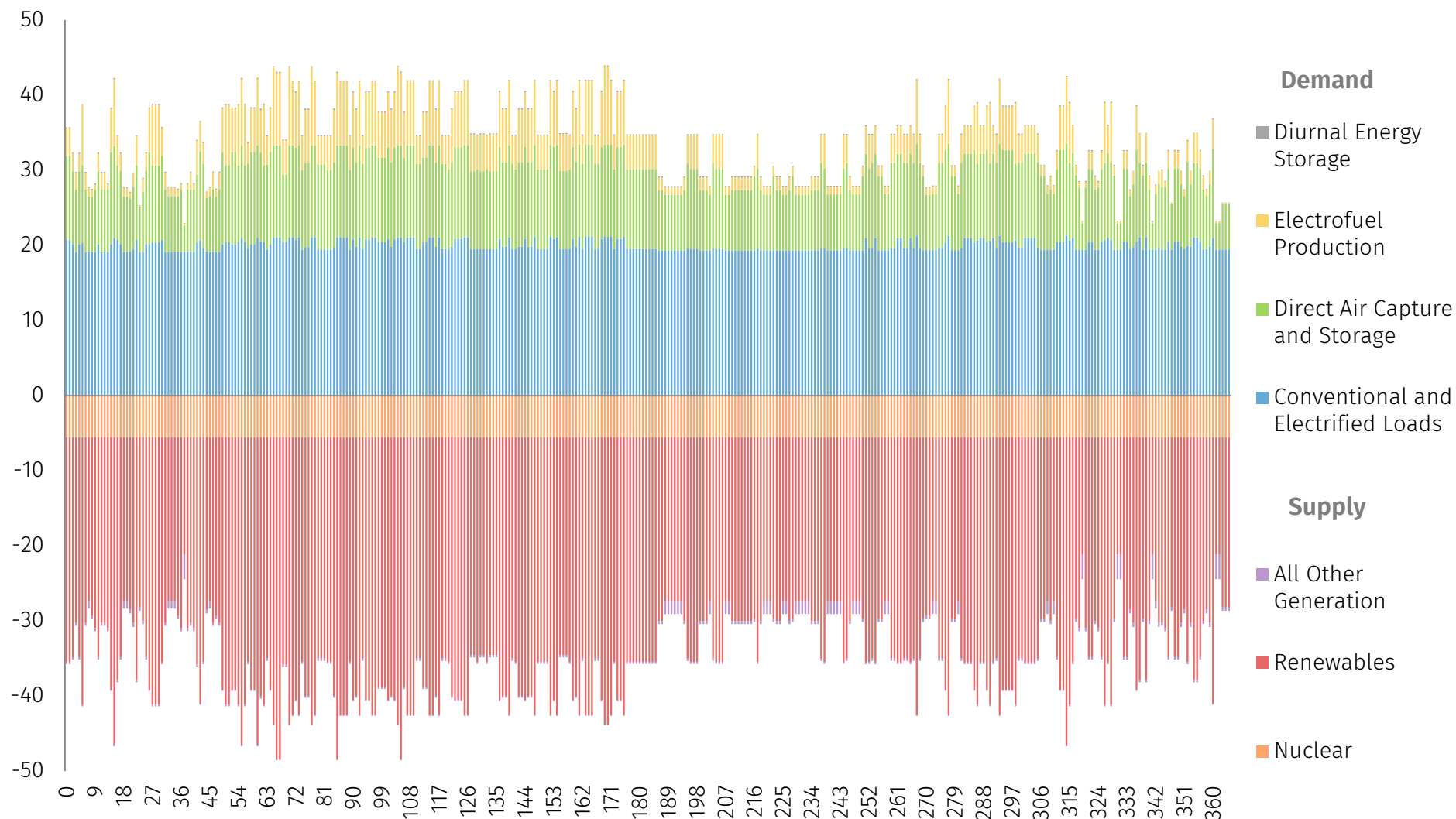
- Electrofuels Production
- Direct Air Capture and Storage
- Conventional and Electrified Loads



Source: EIA, Rhodium Group and Evolved Energy Research analysis using PATHWAYS and RIO

Daily electric balance net zero high DAC and electrofuels, 2050

Terawatt hours



Source: Rhodium Group and Evolved Energy Research analysis.

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Additional resources:

<https://rhg.com/research/taking-stock-2019/>

<https://rhg.com/research/capturing-leadership-policies-for-the-us-to-advance-direct-air-capture-technology>

<https://www.evolved.energy/post/2019/05/08/350-ppm-pathways-for-the-united-states>

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