Rhodium Group

Capturing Leadership

Policies for the US to advance Direct Air Capture technology

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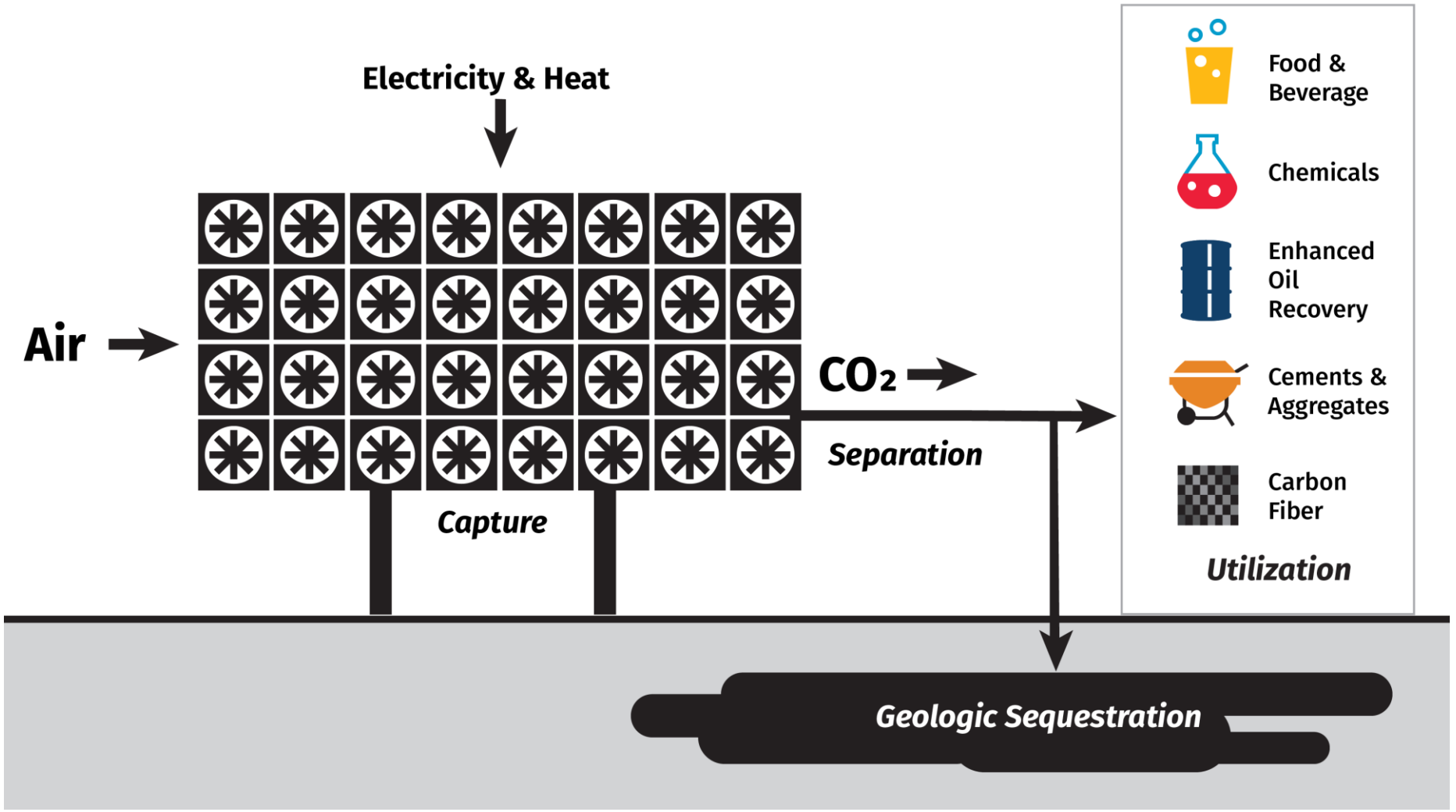
The importance of direct air capture (DAC) for mid-century decarbonization

Direct Air Capture technology is ready to go

Removing CO_2 from the ambient air for utilization or storage



Source: Rhodium Group adapted from World Resources Institute

Bounding DAC's contribution to US mid-century decarbonization

Scenario	Mid-century net GHG Emissions Target(s)	Electrification	Biomass Supply	Natural Sequestration
100by45 – High DAC	100% below 2005 by 2045, 105% below 2005 by 2050	Slow	Constrained	Low
100by45 – Low DAC	100% below 2005 by 2045, 105% below 2005 by 2050	Moderate	Upper bound	High
83by50 – High DAC	83% below 2005 by 2050	Moderate	Constrained	Low
83by50 – Low DAC	83% below 2005 by 2050	Accelerated	Upper bound	High

Economy-wide energy system modeling conducted using the Regional Investment & Operations (RIO) Platform in collaboration with Evolved Energy Research LLC.

All scenarios optimize US energy supply to meet a specified energy demand profile at least cost within a CO_2 emissions constraint.

One of only two US modeling assessments done to-date that incorporates all key negative emissions technologies including DAC.

Energy system and economy changes in 2050

2050 change from 2018

Gross Domestic Product: +2X

Population: +22%

Final energy demand: -21% to 33%

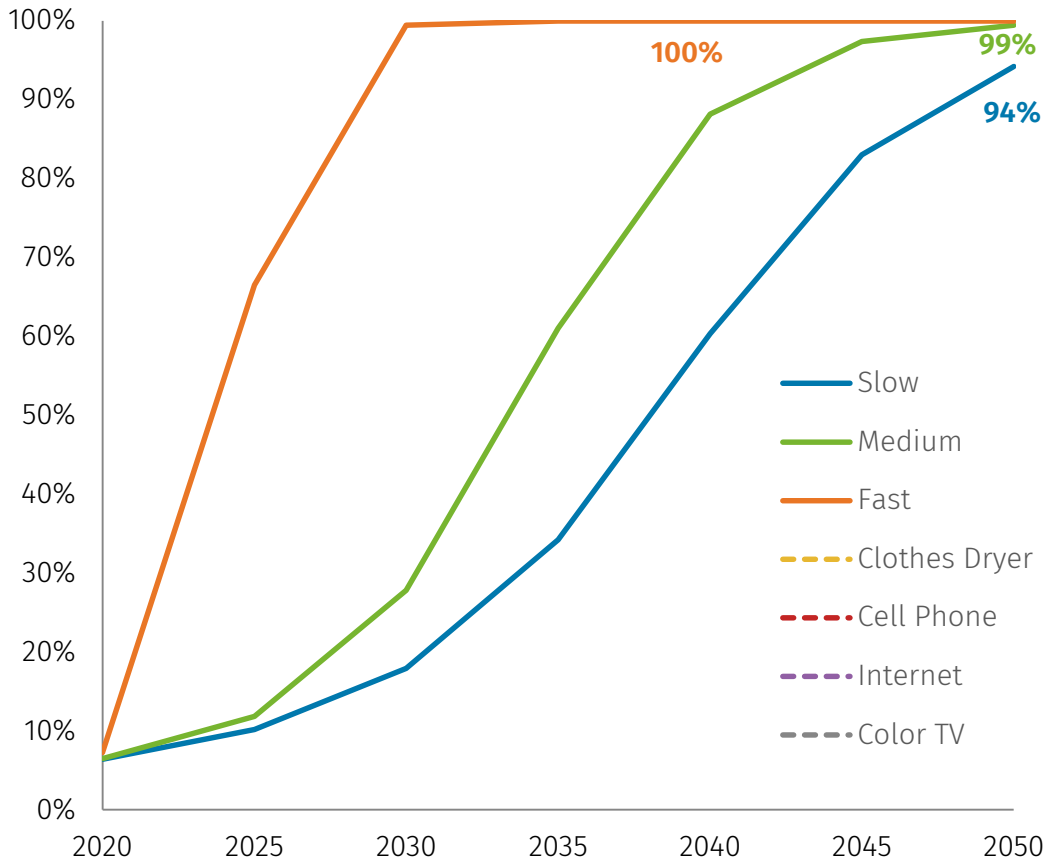
Electricity share of energy demand: +2X to 3X

Near complete decarbonization of electricity.

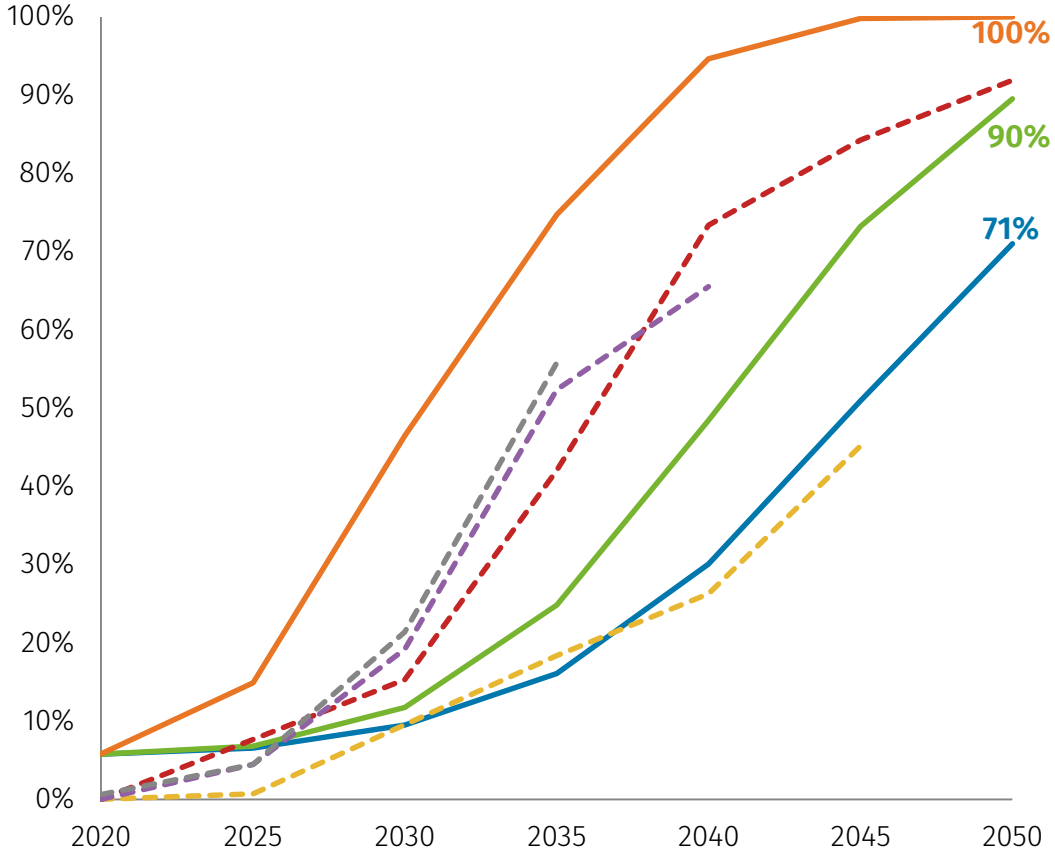
Electrification is rapid in all scenarios

Example: Light-duty vehicles (LDVs), % of total

LDV Sales



LDV Stock



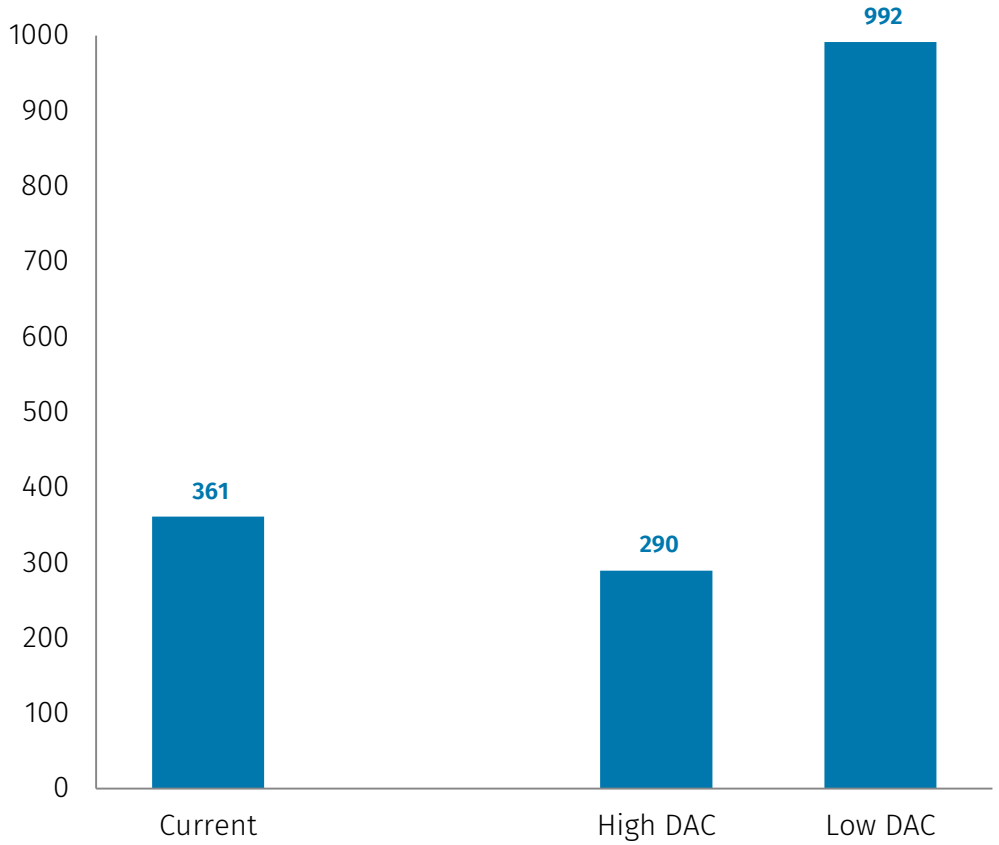
Source: Rhodium Group and Evolved Energy Research analysis.

Capturing uncertainty around biomass supply and natural sequestration

Current and 2050

US biomass supply

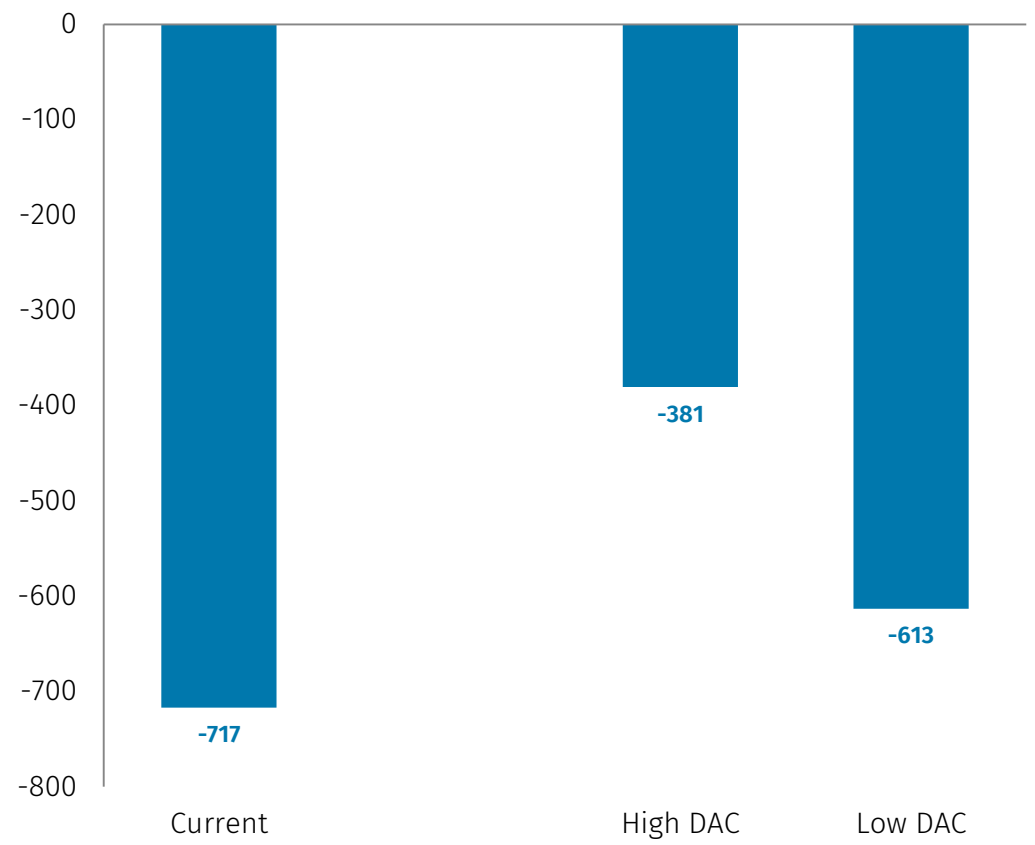
Million dry tons per year



DOE, US Department of State and Rhodium Group analysis.

CDR from natural carbon sequestration

Million metric tons CO2e



EPA, US Department of State and Rhodium Group analysis..

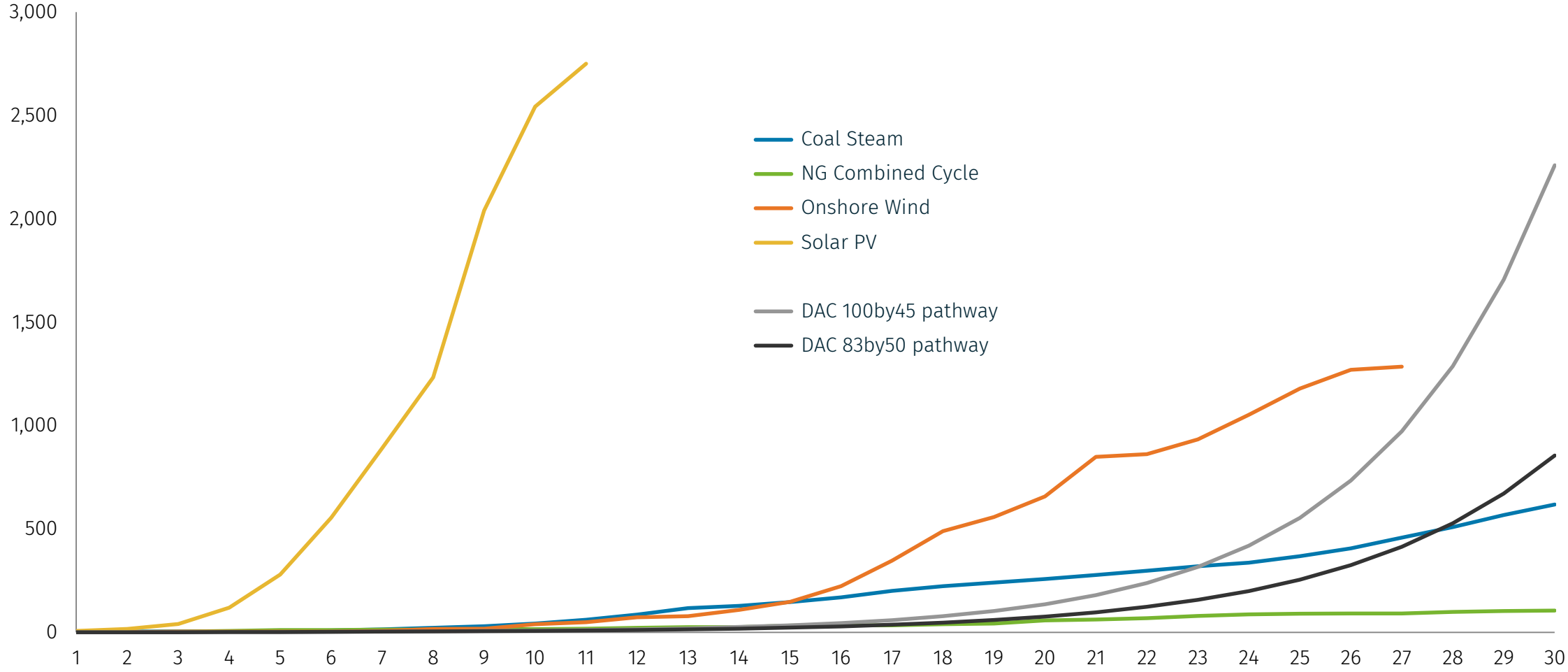
Direct air capture is key to meeting long-term climate targets

Million metric tons CO2e, current and 2050

Source: Rhodium Group and Evolved Energy Research analysis.

US DAC goals and electric power technology deployment pathways

Cumulative number of installed typical size units in each year after first commercial deployment, 30-year timeframe

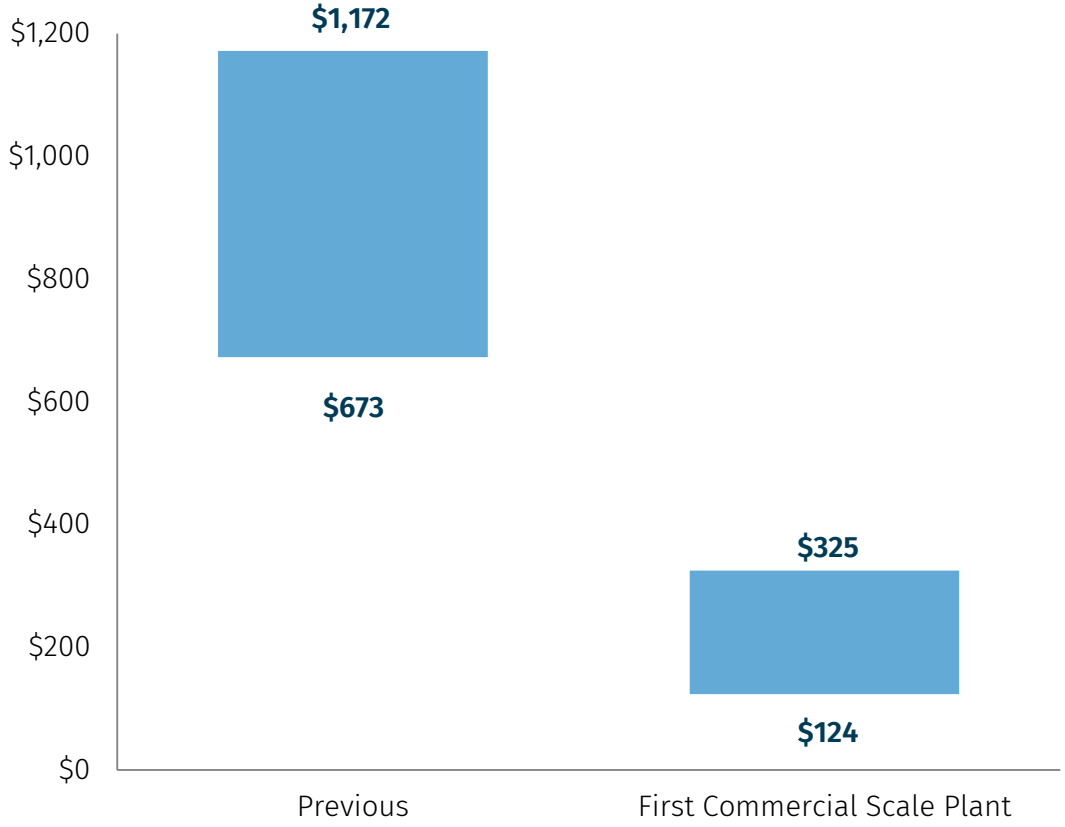


Source: Rhodium Group analysis.

Direct air capture is ready to break through

DAC cost estimates

Levelized dollar per ton CO2 removed from the atmosphere



Source: House, et al. APS, NASEM and Rhodium Group analysis. Note: Values do not include the cost of transportation, injection, and storage of CO2. All values are adjusted for inflation. Expected costs reflected estimates

DAC State of play

- Three DAC companies with commercial ready technology

CLIMEWORKS

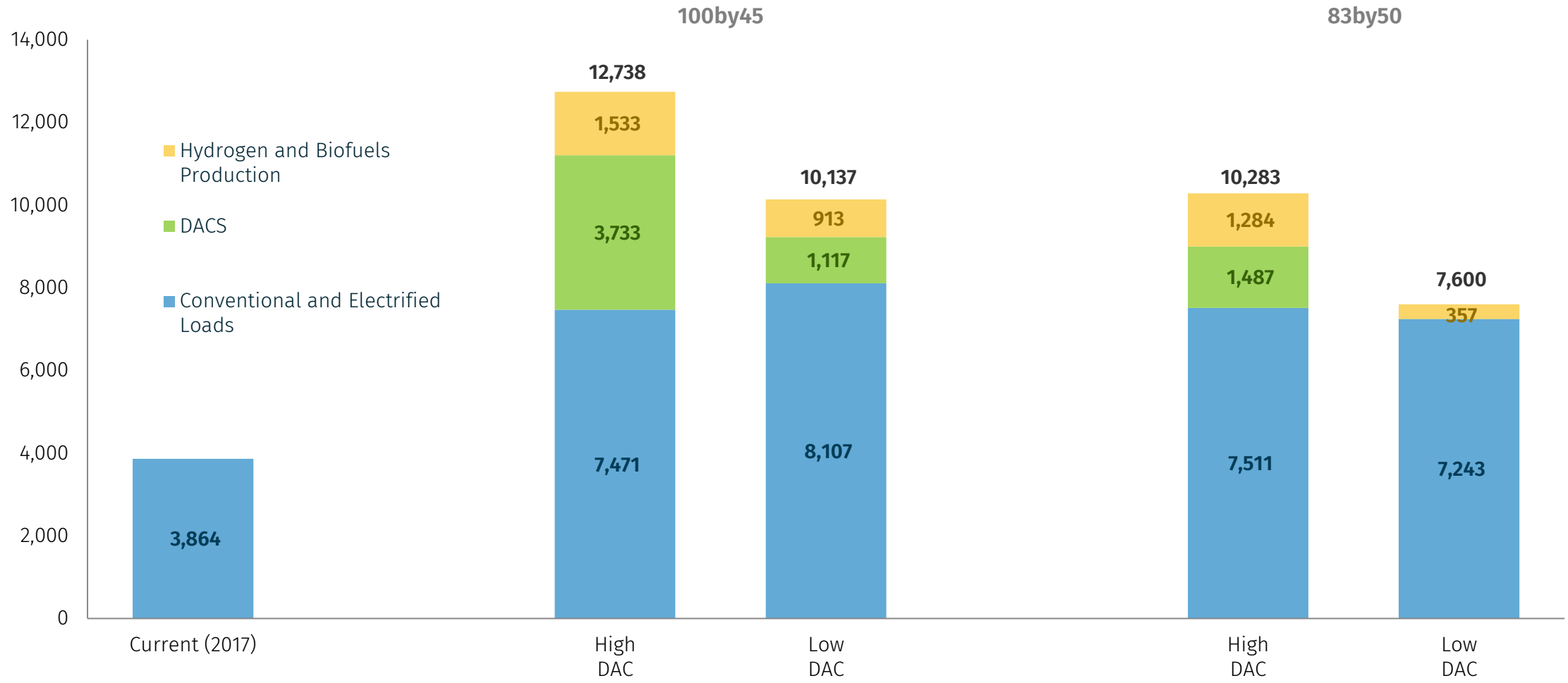
Global Thermostat

Carbon Engineering

- 11 plants deployed, max capacity: 4,000 tons/year
- Initial policy support: Federal 45Q Tax Credit and California Low Carbon Fuel Standard
- Over $5 trillion dollar global carbon tech market potential
- Nearly 400 million ton global demand for CO2

US Electric demand could triple

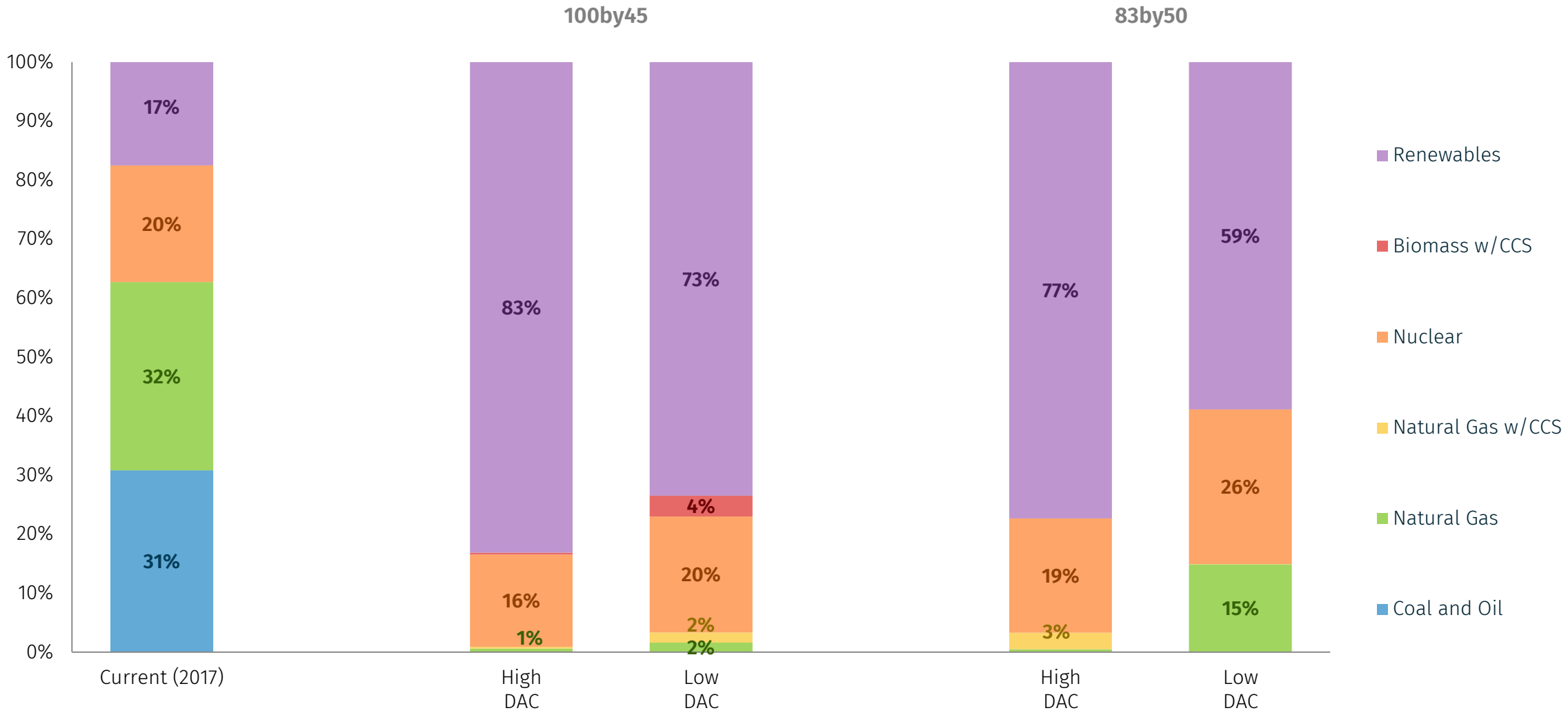
Terawatt hours, current and 2050



Source: Rhodium Group and Evolved Energy Research analysis.

US electric generation mix is dominated by renewables

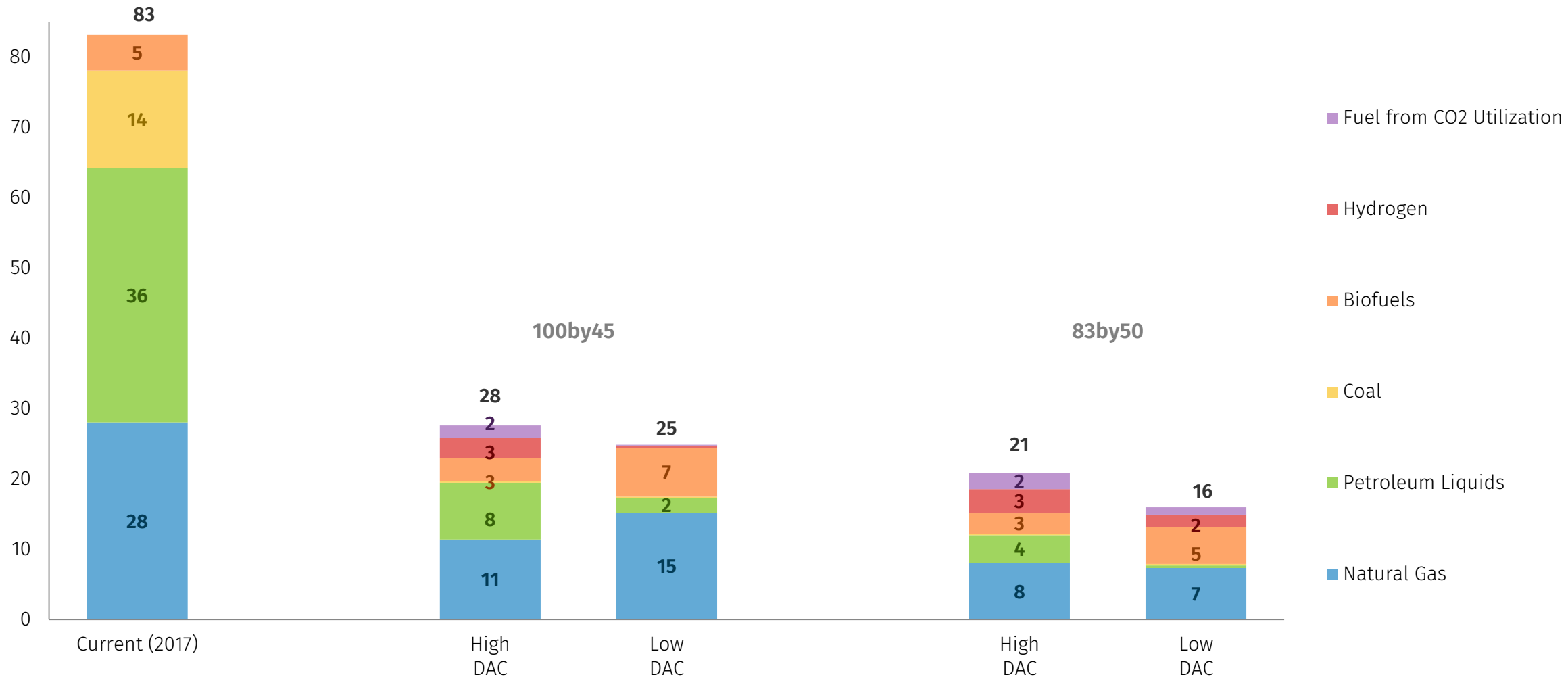
% of total generation, current and 2050



Source: Rhodium Group and Evolved Energy Research analysis.

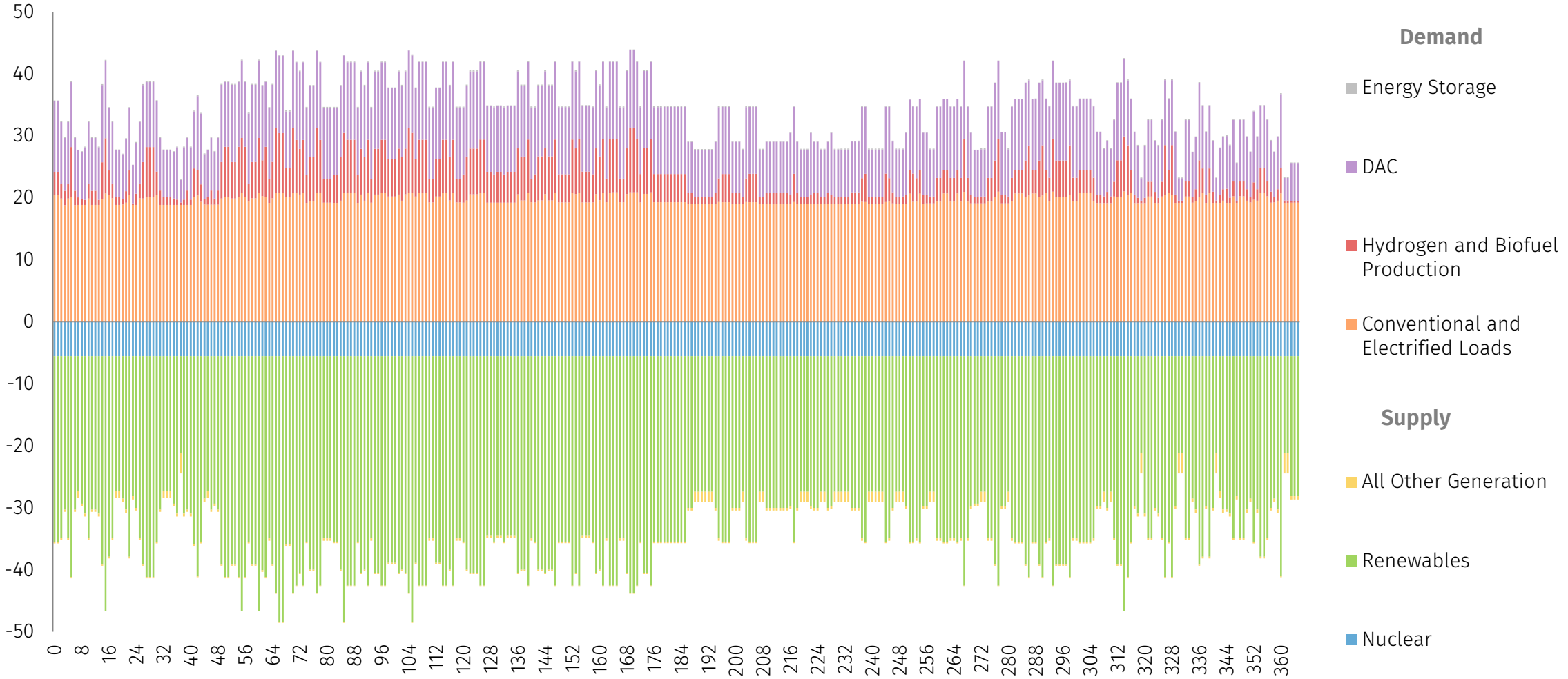
Non-electric energy demand is less than half of current levels

Quads, current and 2050



Source: Rhodium Group and Evolved Energy Research analysis.

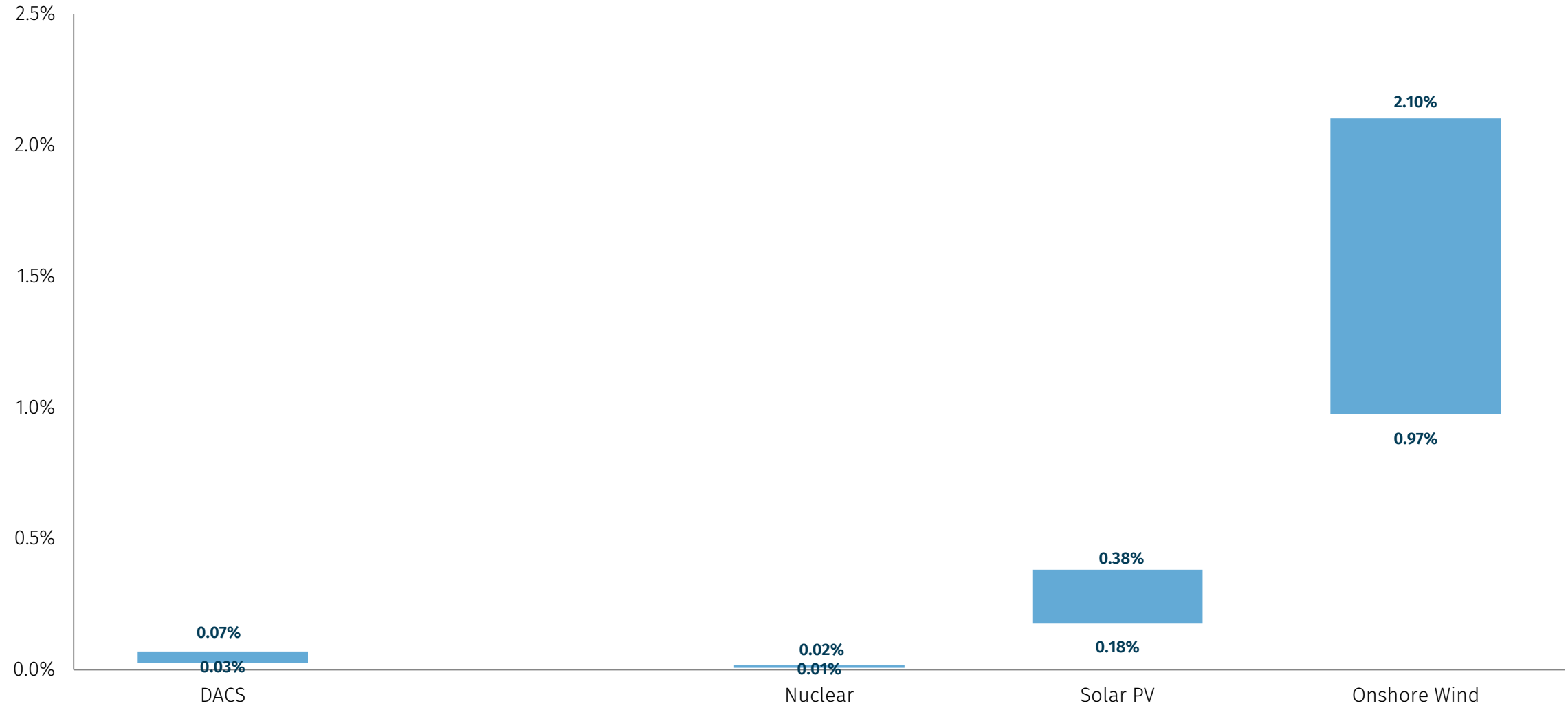
DAC plays a large role in daily electric system balance



Source: Rhodium Group and Evolved Energy Research analysis

DAC with sequestration has a relatively small land area footprint

% of continental US land, 2050



Source: Rhodium Group and Evolved Energy Research analysis.

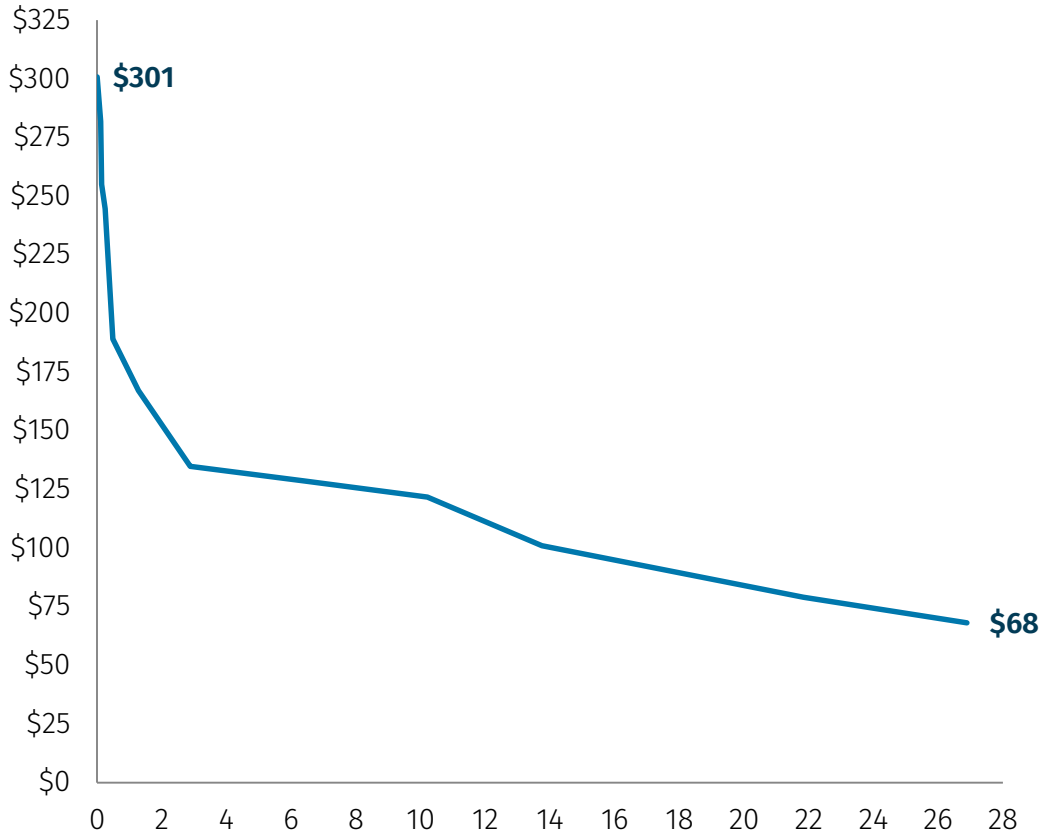
The role of federal policy for DAC spans from development to deployment.

History can repeat itself with Federal support for DAC

Policies that accelerate deployment can drive down costs

Historical cost of solar energy

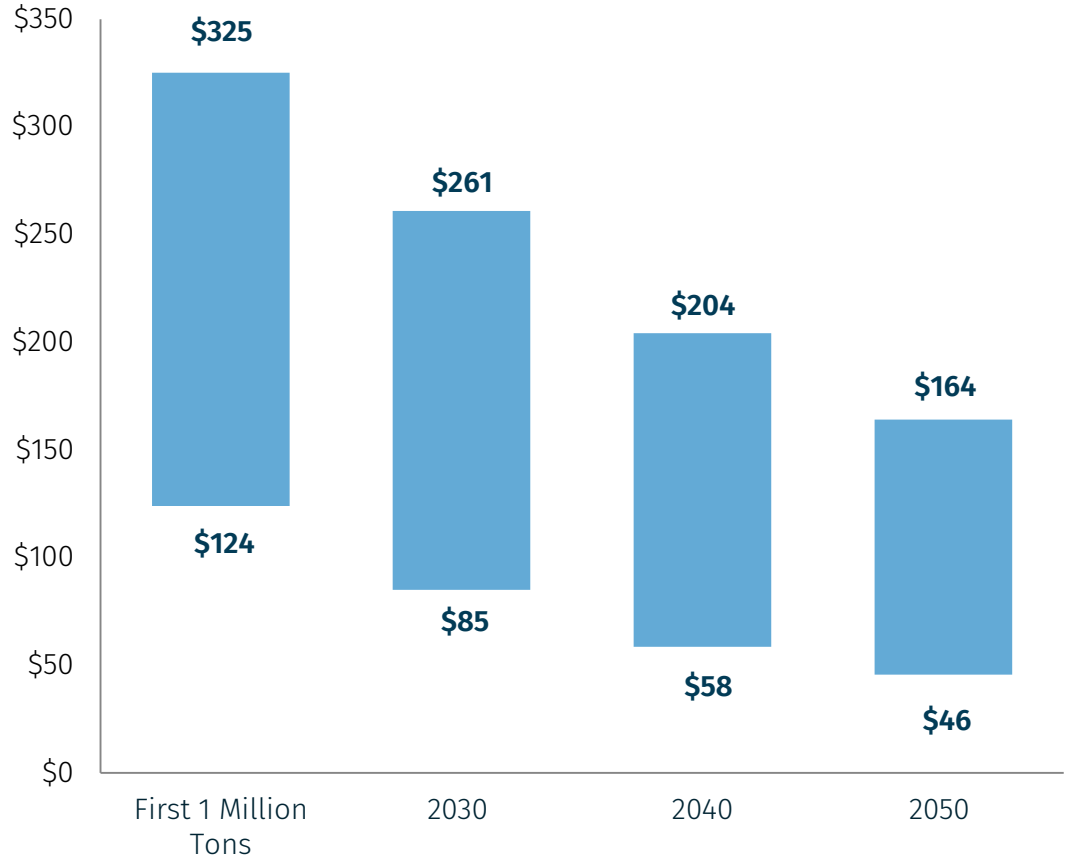
Cumulative deployment, GW (x-axis); Levelized cost of energy, $/MWh (y-axis)



Source: Lawrence Berkeley National Lab, EIA, Rhodium Group analysis.

Current and projected cost of DAC with policy action

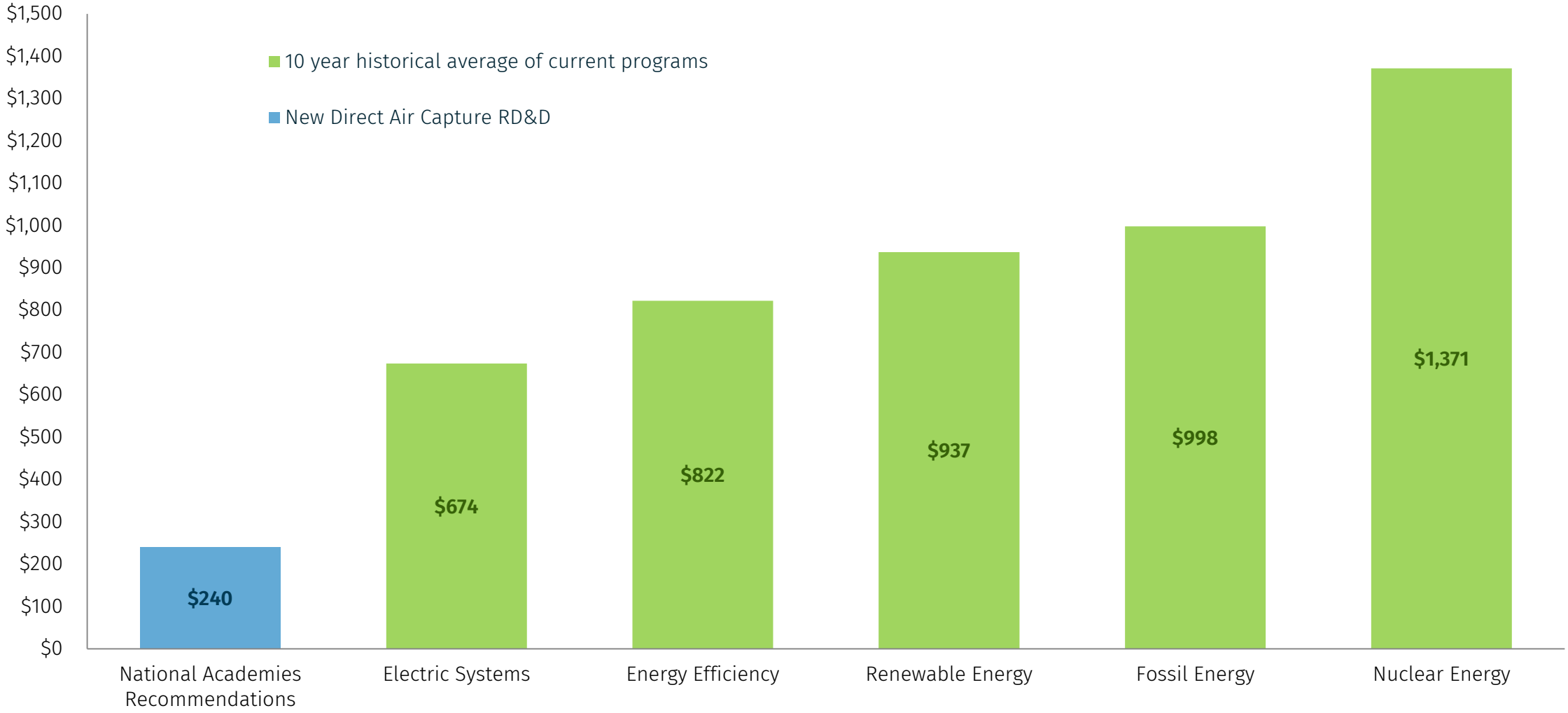
30-year levelized $2018/metric ton



Source: Rhodium Group analysis.

DAC RD&D recommendations cost less than current programs

10-year average annual funding, $millions



Source: NASEM, Congressional Research Service and Rhodium Group analysis.

Federal policy opportunities to support direct air capture

Deployment policies

1. Leverage government procurement
2. Improve the 45Q tax credit
3. Clean fuels policy

Finance policies

1. Investment Tax Credit (ITC)
2. Loan Guarantees
3. Master Limited Partnerships (MLPs)
4. Private Activity Bonds (PABs)

Other policy incorporation

1. Clean Energy Standards
2. Infrastructure
3. Carbon pricing
4. Comprehensive climate policy packages

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WASHINGTON, D.C. | MAY 16, 2019

Full report available here:
https://rhg.com/research/capturing-leadership-policies-for-the-us-to-advance-direct-air-capture-technology

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