CCS and the U.S. Energy Ecosystem and Policy

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Regional Carbon Management Partnerships Applicant Education Workshops: April 7, 2022

Carbon Capture and Storage (CCS) and Carbon Dioxide Removal (CDR) Are Essential for Net Zero by 2050

1970's

- CO_2-EOR
- CO_2 sourced from natural and industrial sources

1990's

- Norwegian Sleipner Offshore CO_2 Capture and Storage Project

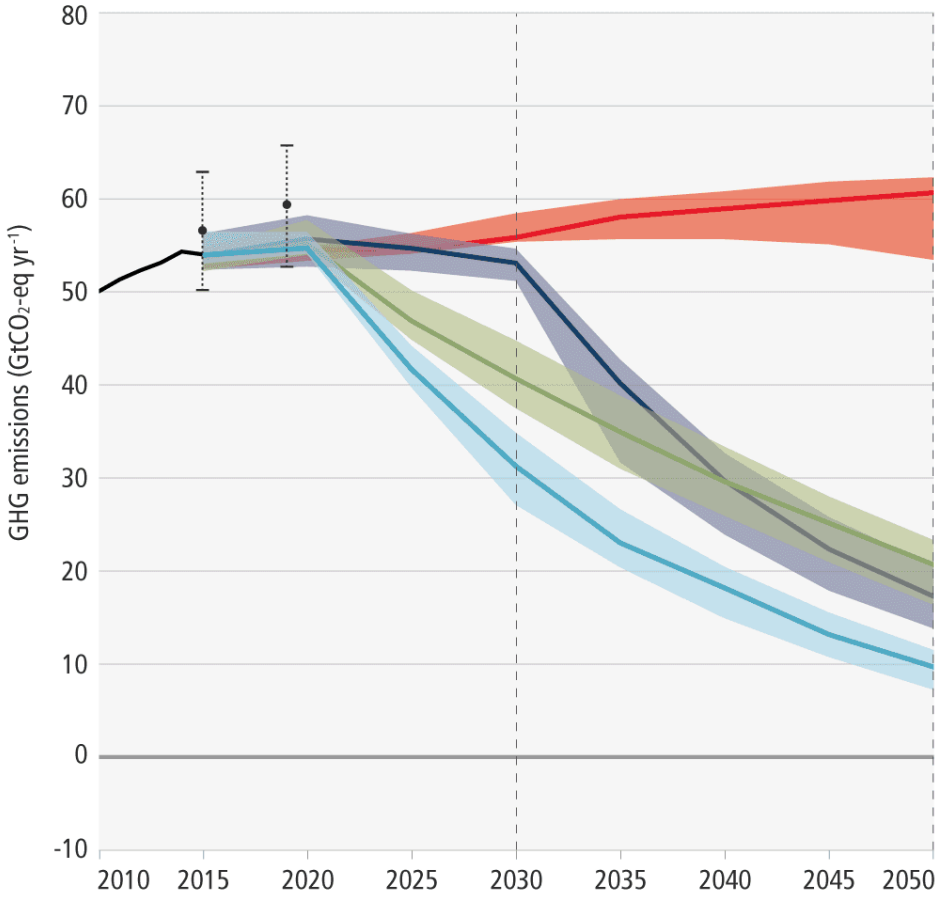
2000's

- IPCC Special Report on Carbon Capture and Storage
- Government research support for Carbon Capture and Storage

2010's

- Recognize "hard-to-abate" sectors of the economy need CCS
- Net zero is required to stabilize warming
- Carbon dioxide removal is needed
- Accelerating deployment of Carbon Capture, Storage, and Utilization

Rapid and Large Emission Reductions are Needed to Limit Warming to Less Than 1.5 to 2 °C

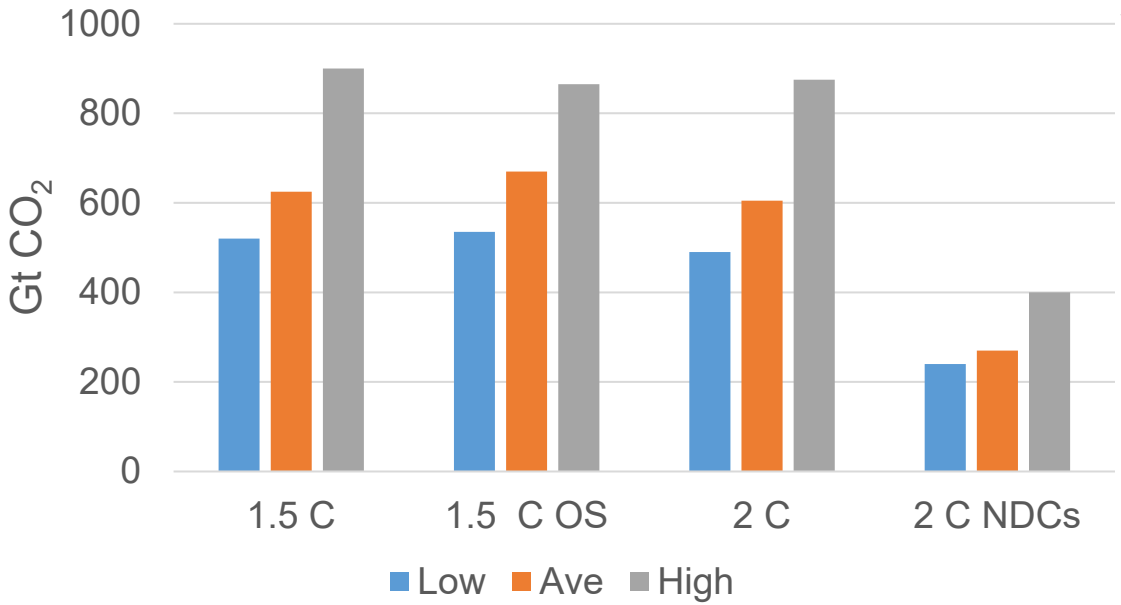


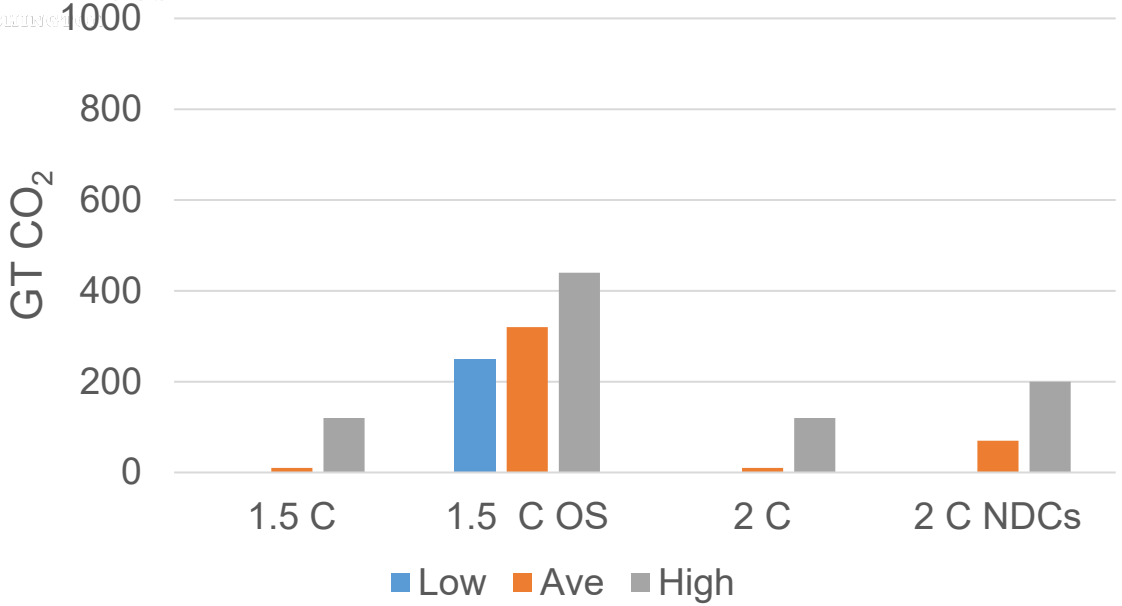
Modelled pathways:

- Trend from implemented policies
- Limit warming to 2°C (>67%) or return warming to 1.5°C (>50%) after a high overshoot, NDCs until 2030
- Limit warming to 2°C (>67%)
- Limit warming to 1.5°C (>50%) with no or limited overshoot
- Past GHG emissions and uncertainty for 2015 and 2019 (dot indicates the median)

IPCC, Working Group III, April 2022

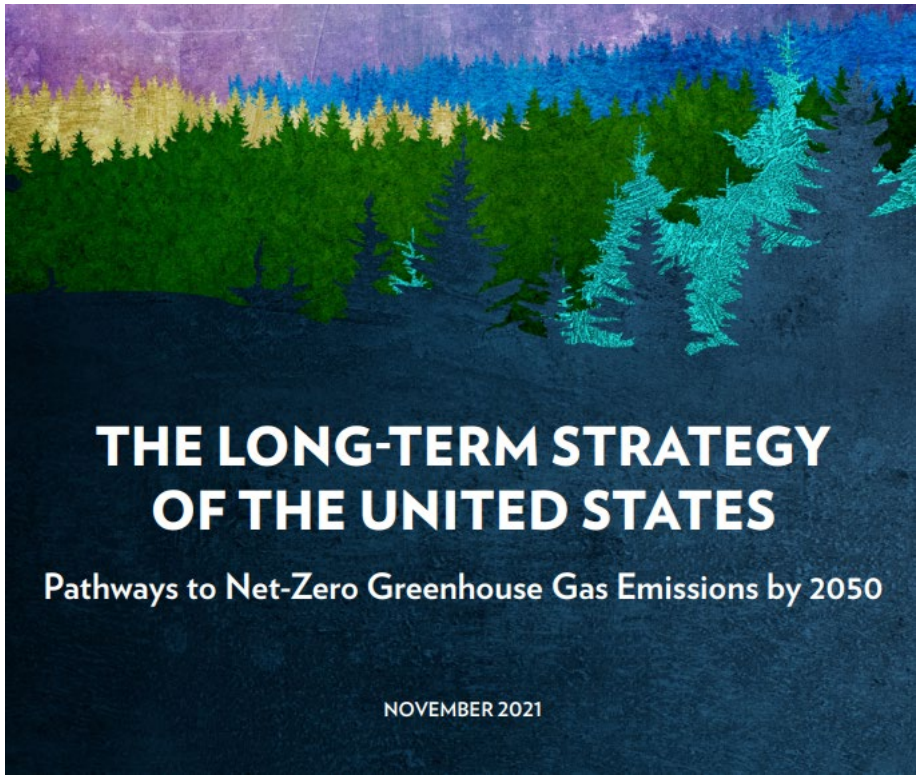
Carbon Capture, Utilization, and Storage (CCS) & Carbon Dioxide Removal (CDR) are Necessary to Meet Emission Reduction Goals

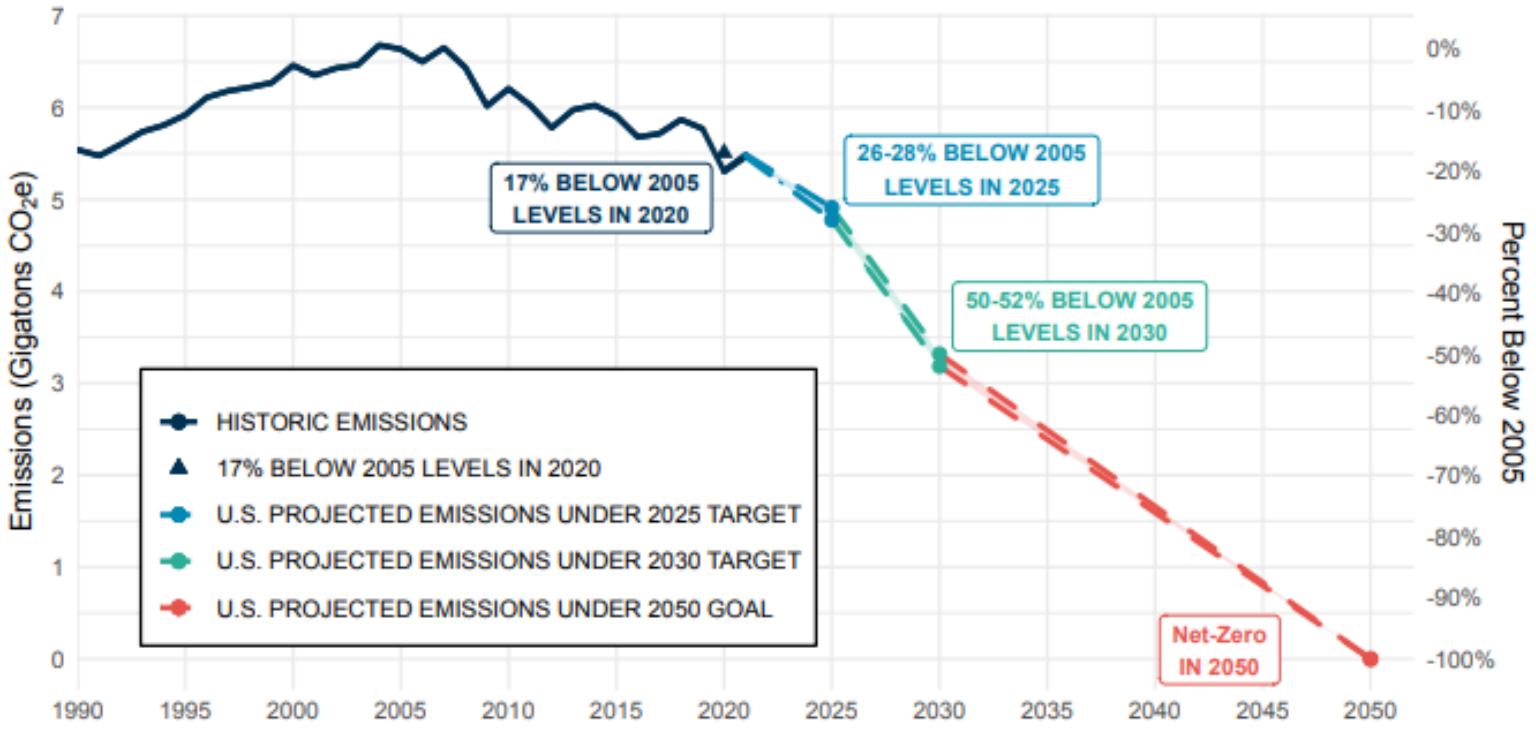




IPCC, Working Group III, April 2022

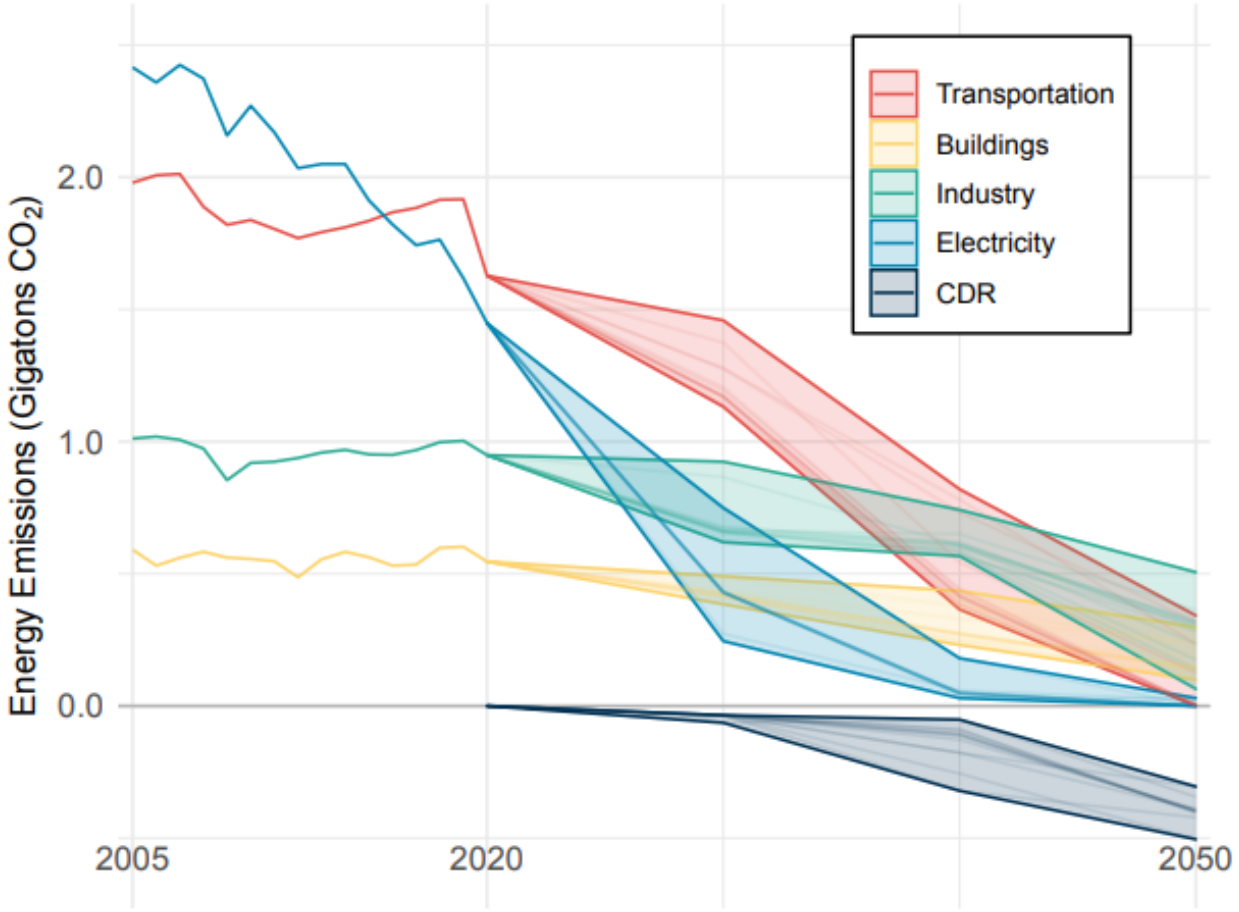
The U.S. National Long Term Climate Strategy Maps Out Pathways to Net Zero By 2050





U.S. Long Term Climate Strategy: Domestic Climate Policy Office and the State Department, 2021

Sectoral Pathways to Net Zero 2050 Include CCS and CDR



Transportation

- H_2 from natural gas & CCS
- Biofuels with CCS

Buildings

- H_2 from natural gas & CCS

Industry

- CCS for steel, cement, ammonia, and chemicals
- H_2 from natural gas & CCS

Electricity

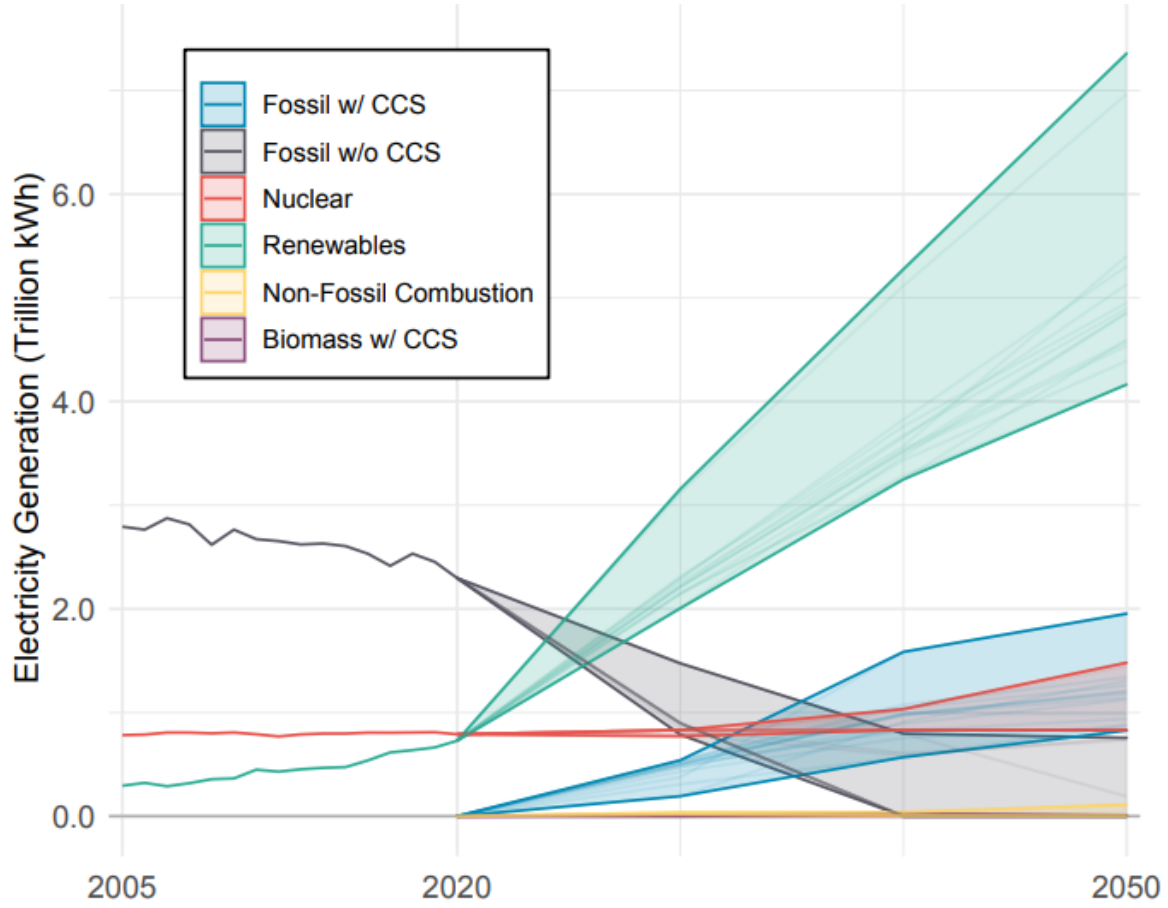
- Natural gas or coal & CCS
- Biomass plus CCS
- H_2 from natural gas & CCS
- H_2 from biomass & CCS

U.S. Long Term Climate Strategy: Domestic Climate Policy Office and the State Department, 2021

Multiple Synergistic Actions Result in Cost Effective Net Zero Solutions

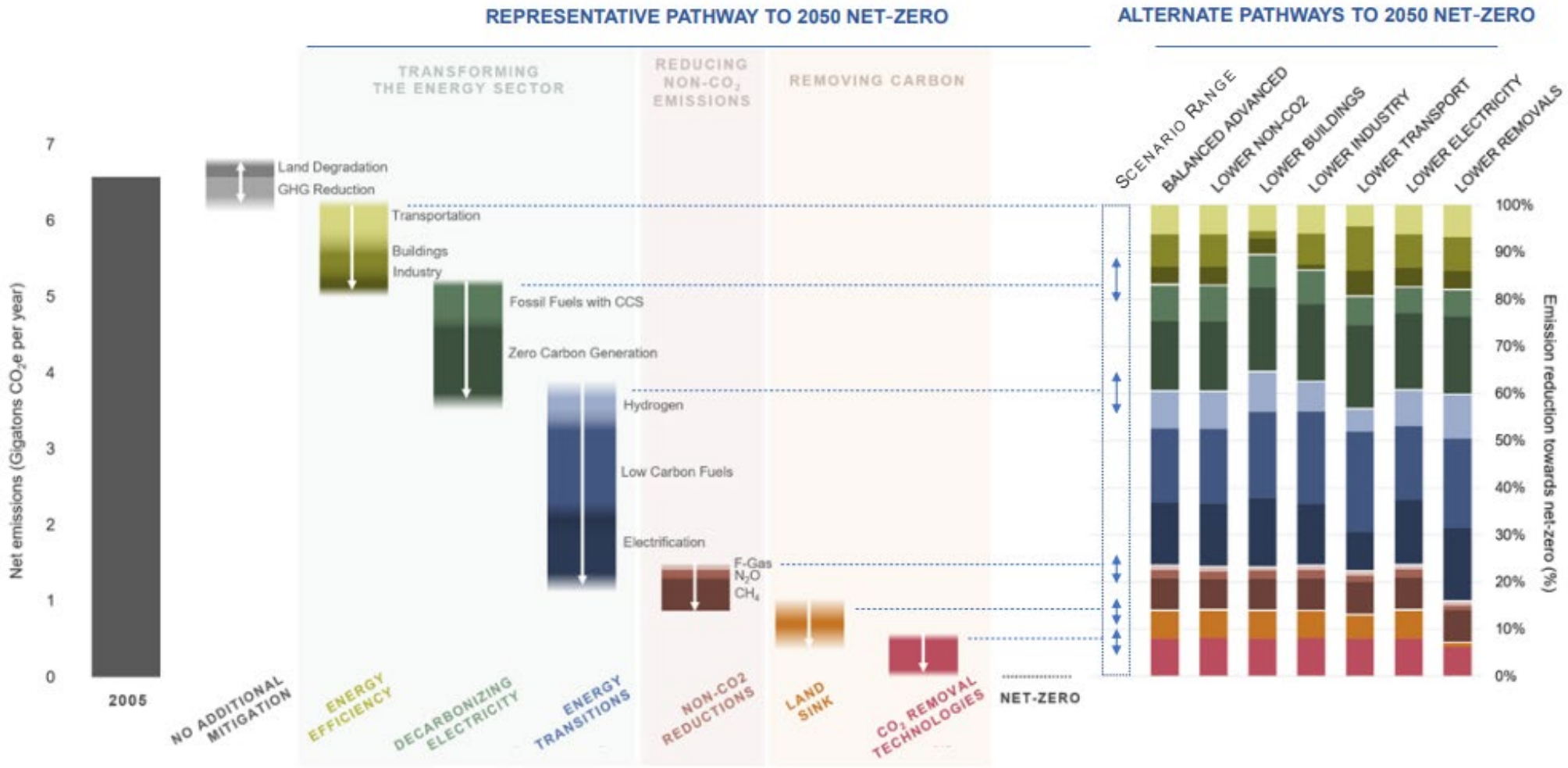
Electricity Sector

- Renewables & energy storage
- Nuclear
- Natural gas or coal with CCS provides “Clean Firm Power”
- Bio energy with CCS (BECCS) provides electricity and CDR
- Renewable gas



U.S. Long Term Climate Strategy: Domestic Climate Policy Office and the State Department, 2021

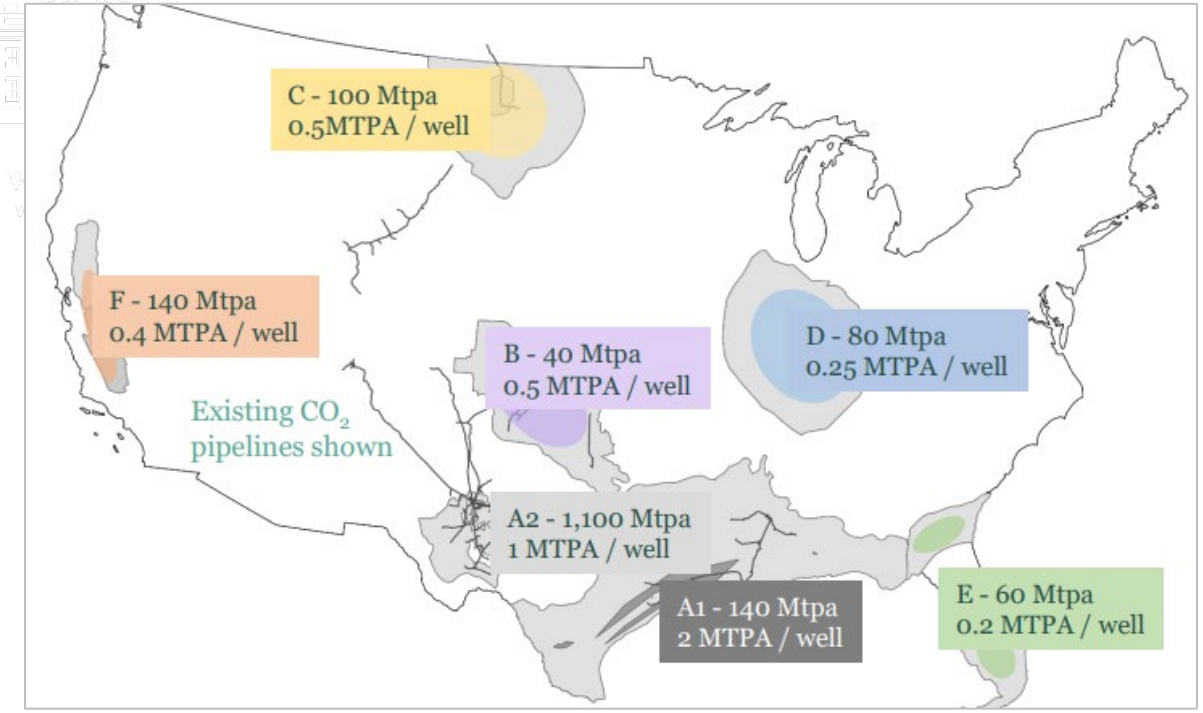
CCS/CDR provide 10-20% of Reductions Net Zero 2050 Scenarios



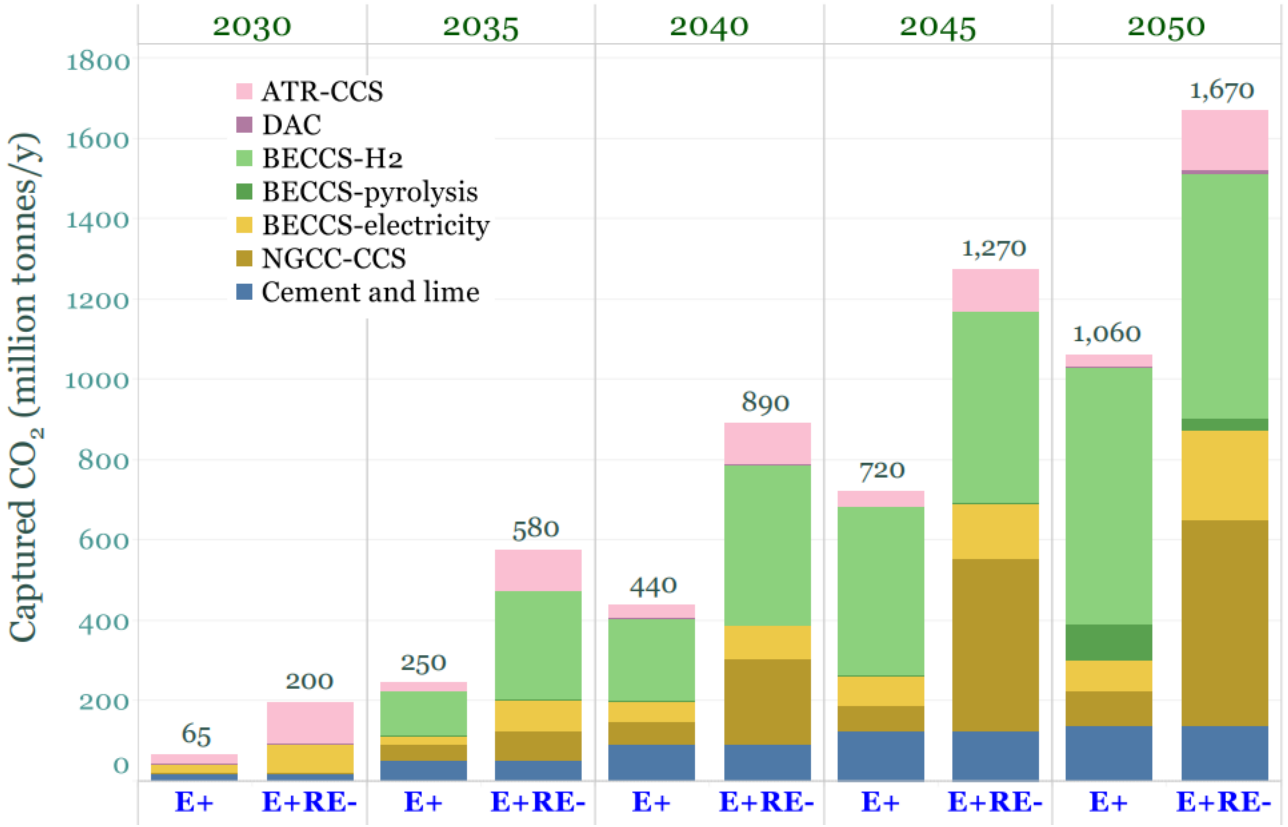
U.S. Long Term Climate Strategy: Domestic Climate Policy Office and the State Department, 2021

Bottoms-Up Modeling Confirms the Important Role of CCS/CDR

https://netzeroamerica.princeton.edu/the-report

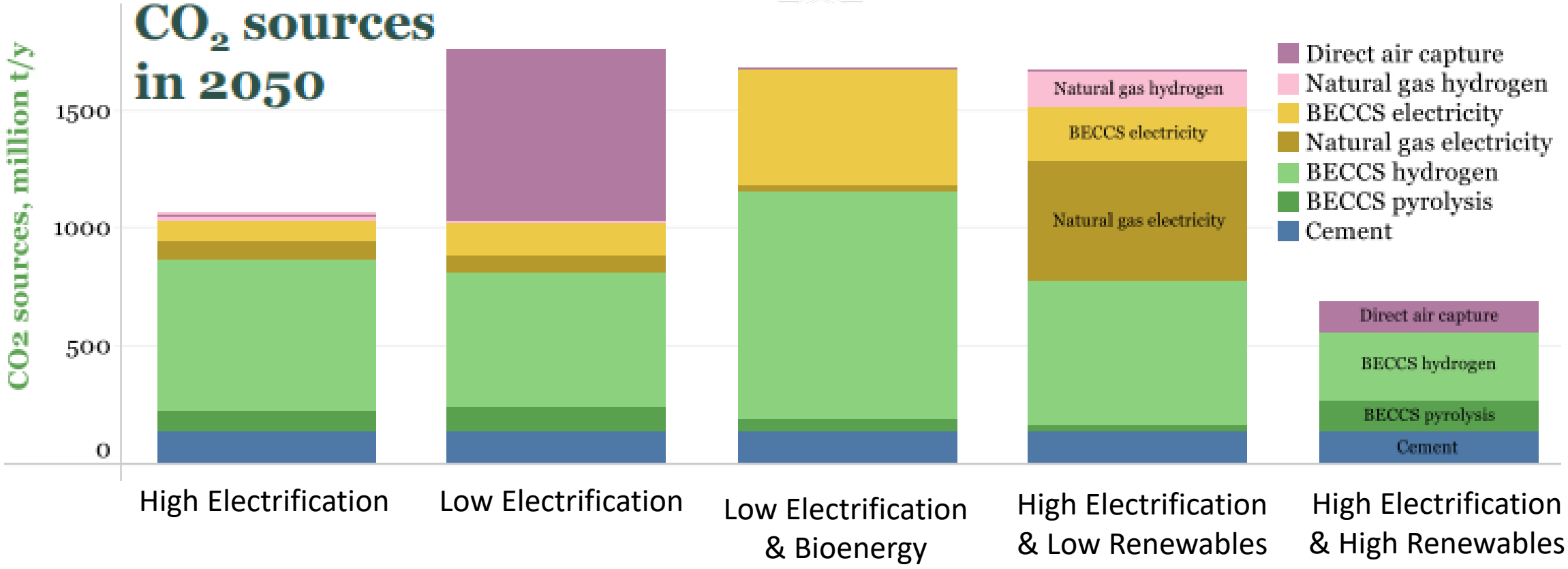


U.S. Energy System Requires Growing Deployment of CCS for a Wide Variety of Energy Applications



https://netzeroamerica.princeton.edu/img/Princeton%20NZA%20FINAL%20REPORT%20SUMMARY%20(29Oct2021).pdf

Large Amounts of Carbon Capture and Storage are Anticipated for All Scenarios



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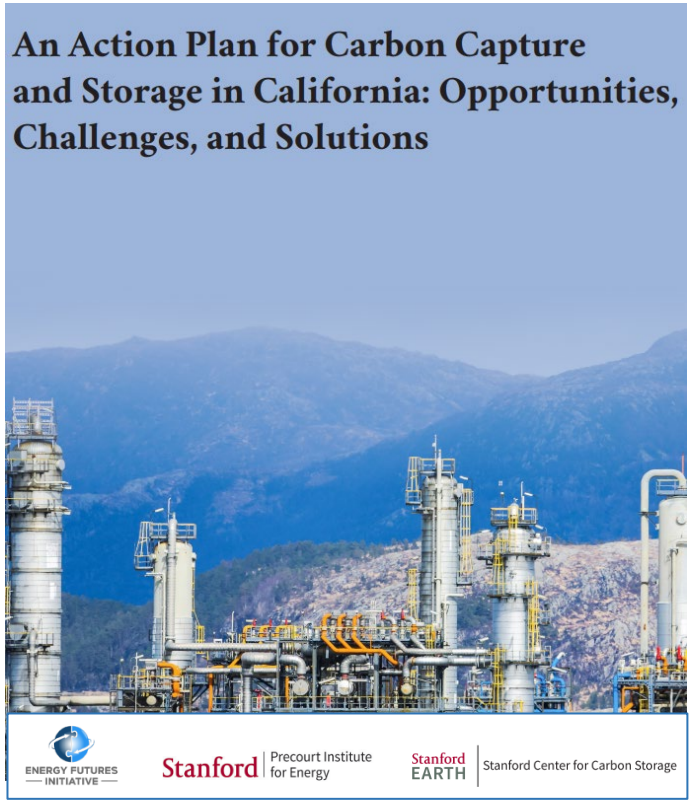
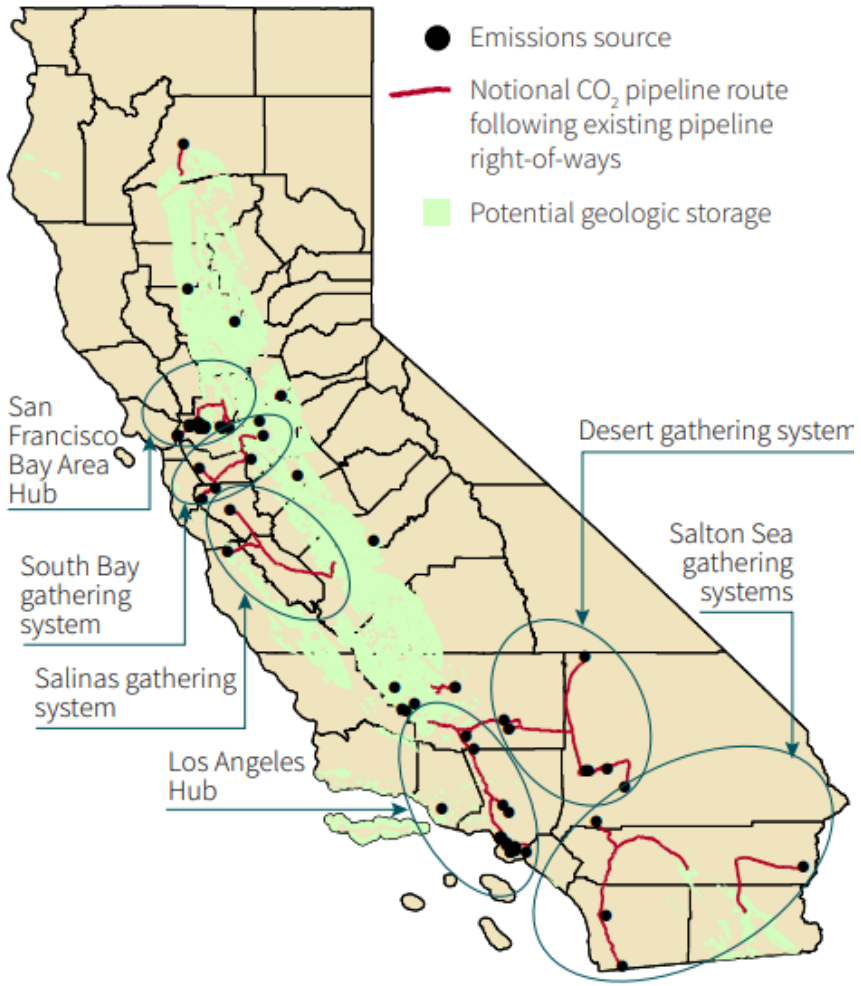
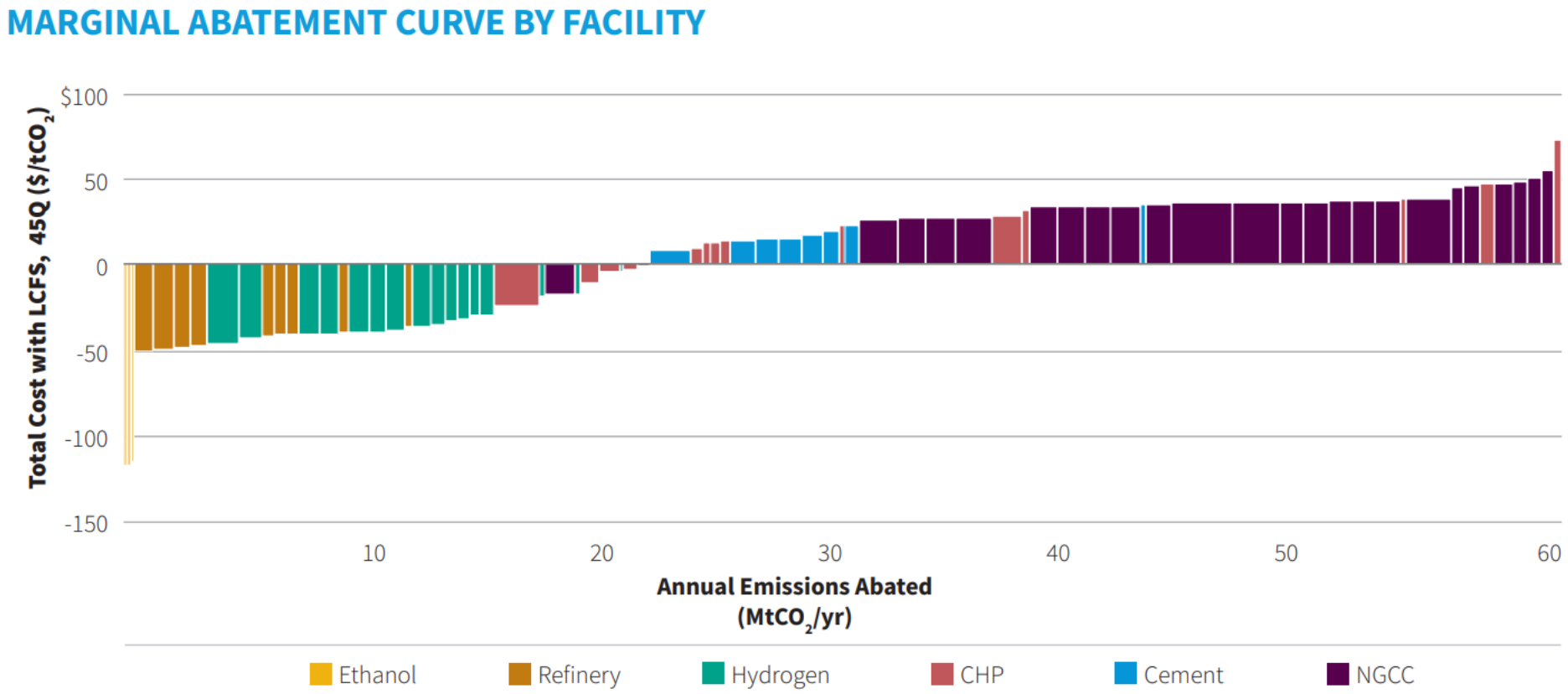
State-Level Technoeconomic Assessment of the Role CCS





https://sccs.stanford.edu/ccs-in-ca/full-report-form

With Current Policy Frameworks, Some Applications of CCUS Are Cost Competitive Today



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In short… it's time to get going

- Carbon capture and storage & carbon dioxide removal are needed for Net Zero 2050
- Expected to contribute between 10-20% of needed emission reductions
- Contributes to emission reductions in every energy sector
- Cost reductions are needed to realize the full potential
- Now's the time to beginning scaling up