Workshop

Carbon Removal Potential: An overview

2 August 2021

Paola Perez-Peña, Principal Research Analyst, paola.perezpena@ihsmarkit.com

Edurne Zoco, Executive Director, edurne.zoco@ihsmarkit.com

Carbon sequestration solutions are classified in two main groups: nature-based solutions and technology-based solutions

Carbon sequestration solutions

Nature-based solutions

- Afforestation and reforestation
- Soil carbon sequestration
- Biochar
- Enhanced weathering and ocean alkalinization
- Ocean fertilization

Technology-based solutions

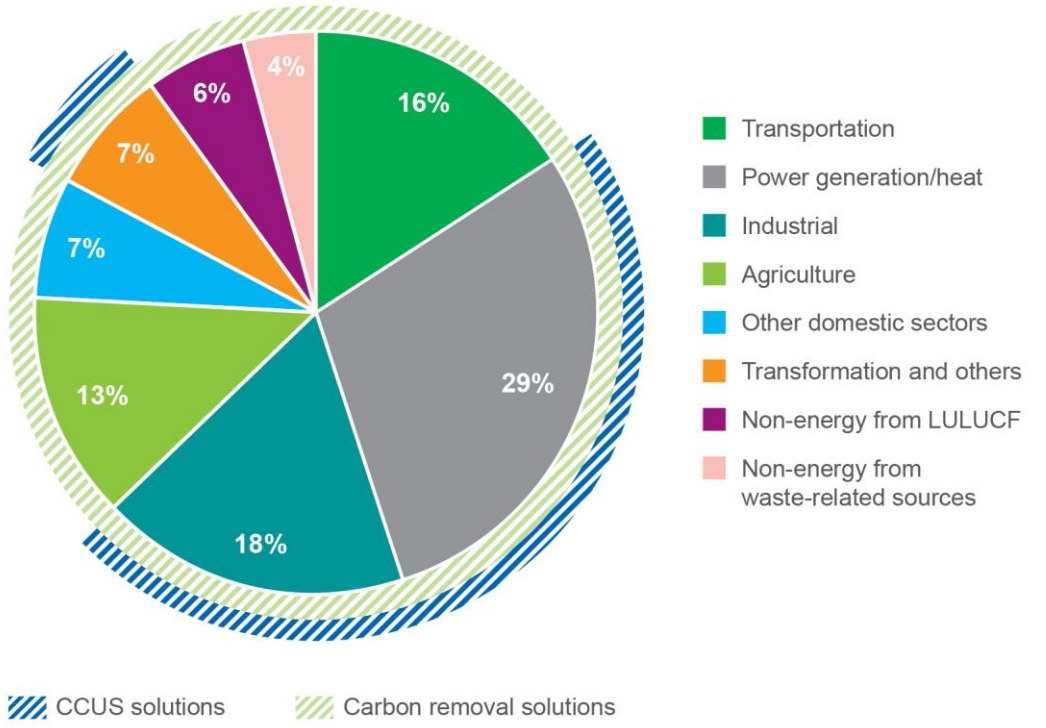
- Direct air capture (DAC)
- Bioenergy with carbon capture and storage (BECCS)
- Carbon capture, utilization and storage (CCUS)
  - Carbon capture and storage (CCS)
  - Carbon capture and utilization (CCU)

Carbon removal: Is a group of nature-base and technology-base solutions that remove and sequester carbon dioxide (CO_2) from the atmosphere.

.
Source: IHS Markit

While CCUS removes CO_2 emissions from fossil fuel–based power and industrial plants, carbon removal solutions balance emissions in atmosphere

Global GHG emissions addressable by carbon sequestration solutions



Note: Most carbon removal solutions are still in very early stages of development. LULUCF = land use, land-use change, and forestry. Transformation and others include refining, coke ovens, and other sectors.

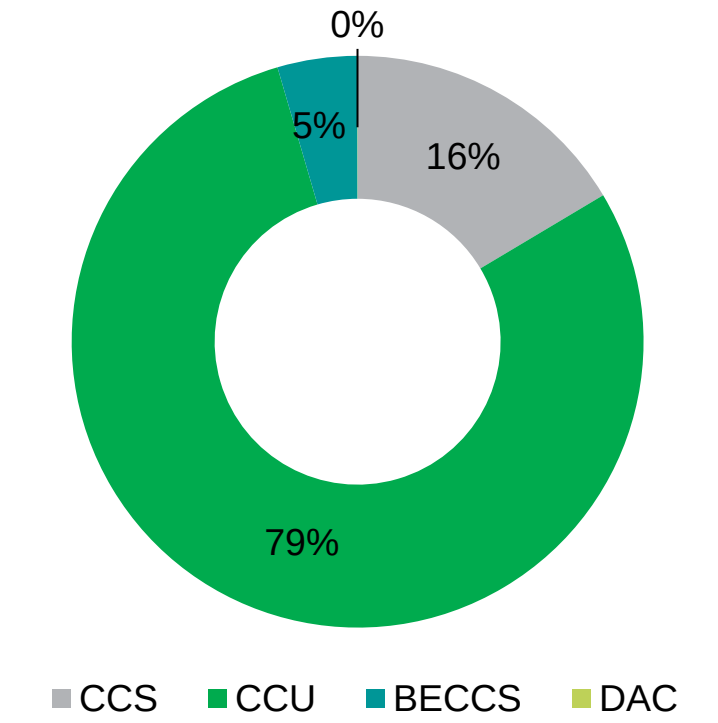
Source: IHS Markit

- CCUS focuses on reducing CO_2 emission from new and existing fossil fuel-based power and industrial plants.
  - CCUS could address up to **54% of global emissions** if deployed in sectors such as power generation/heat, industrial processes, and transformation sectors (refining). However, owing to competition with other technologies, CCUS is expected to address between **4% and 20% of emissions.**

Overview of the current market

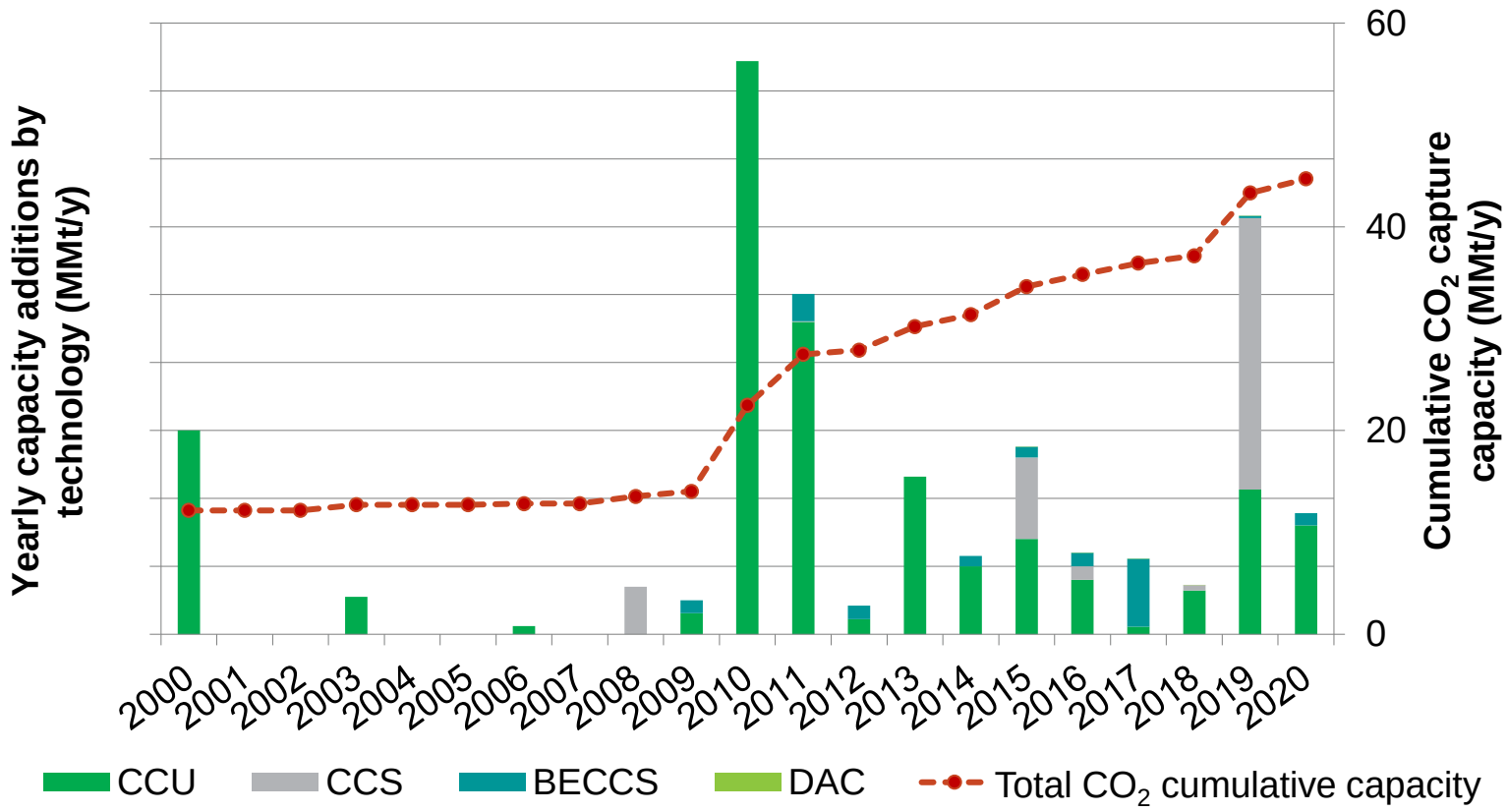
Technology-based solutions have been driven by CCU projects, which account for 79% of current CO_2 capture capacity

Current CO_2 capture capacity by solution



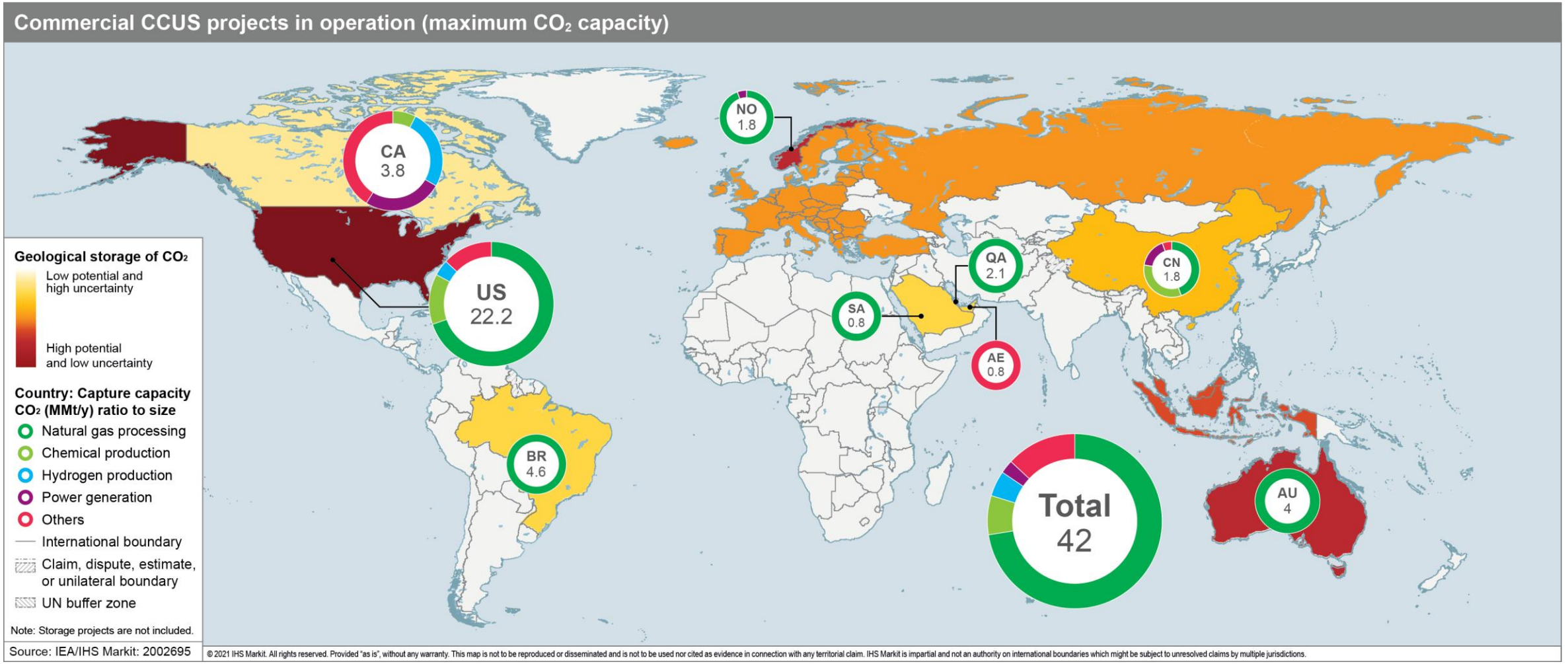
Note: This chart does not include "storage only" projects.
Source: IHS Markit

Evolution of CO_2 capture capacity—All technology-based solutions



Note: This chart does not include "storage only" projects.
Source: IHS Markit

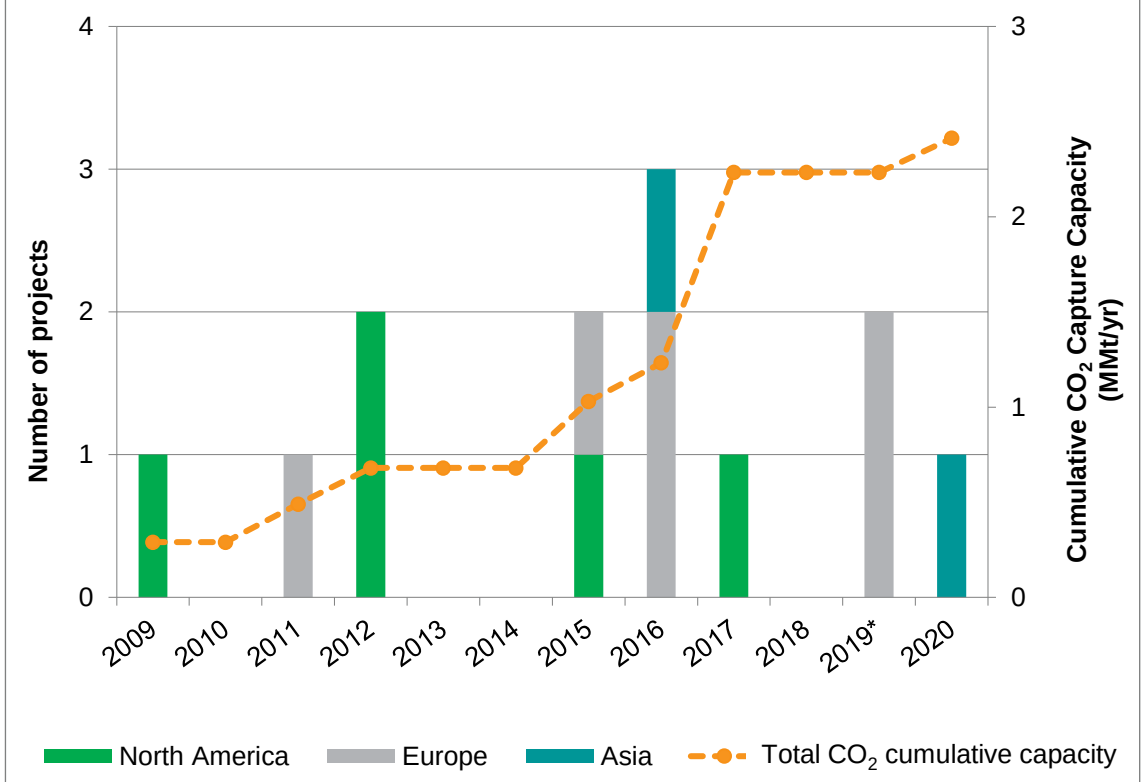
Most of the current CCUS* capacity is in the Americas, with the US accounting for more than 50% of the capacity, mainly from natural gas processing



* CCUS includes CCS and CCU projects.
Note: AE = United Arab Emirates; AU = Australia; BR = Brazil; CA = Canada; CN = mainland China; NO = Norway; US = United States.

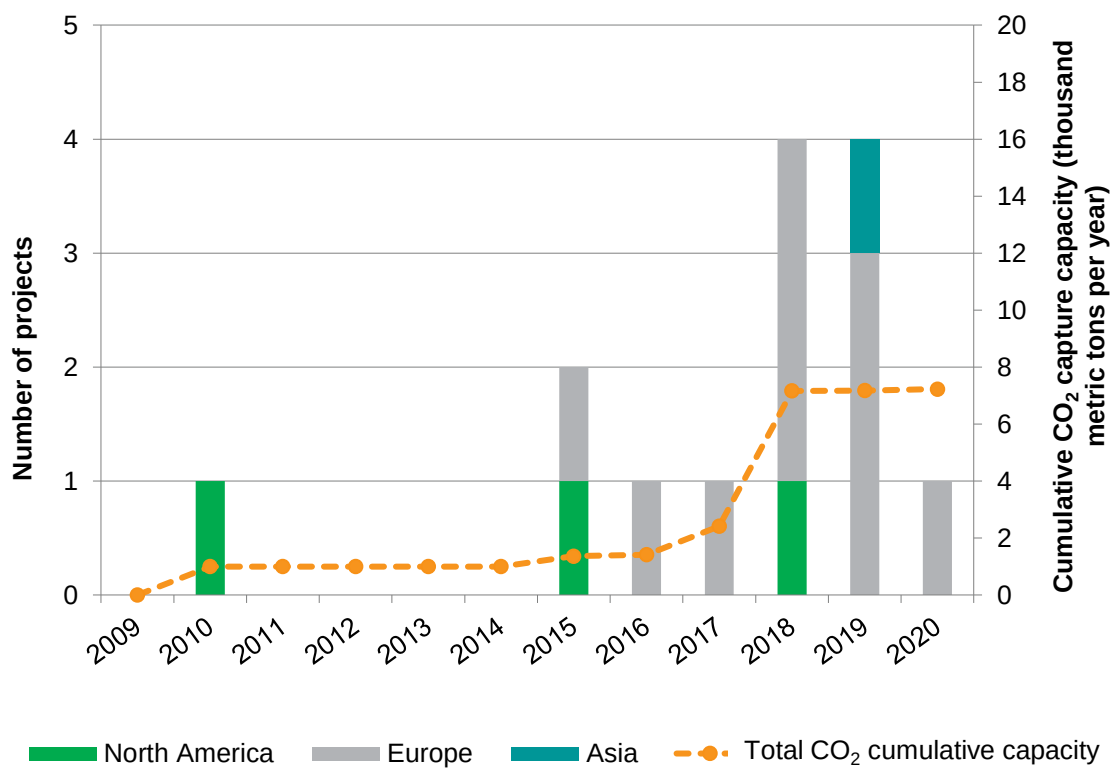
BECCS and DAC solutions are still in the demonstration phase, current operating capacity accounts for only 5% of total CO_2 capture capacity

Bioenergy with CCU/CCS operating projects by year



Note: *All project during 2019 were pilots.
Source: IHS Markit, IEA, NETL CCUS Database, MIT Carbon Capture and Storage Project Database

DAC projects additions by year



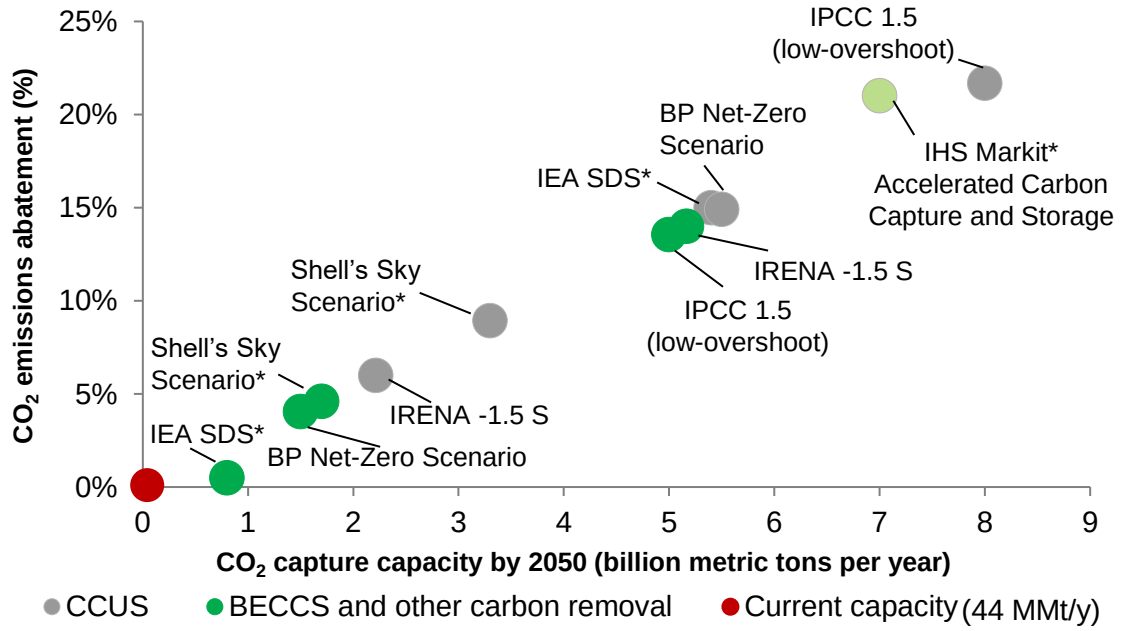
Note: Two projects on 2010 and 2018 from Global Thermostat are not operating. The innovation center from Carbon Engineering is not considered in this chart.
Source: IHS Markit, IEA, company website

Carbon sequestration potential

Consensus on the need for carbon sequestration is increasing

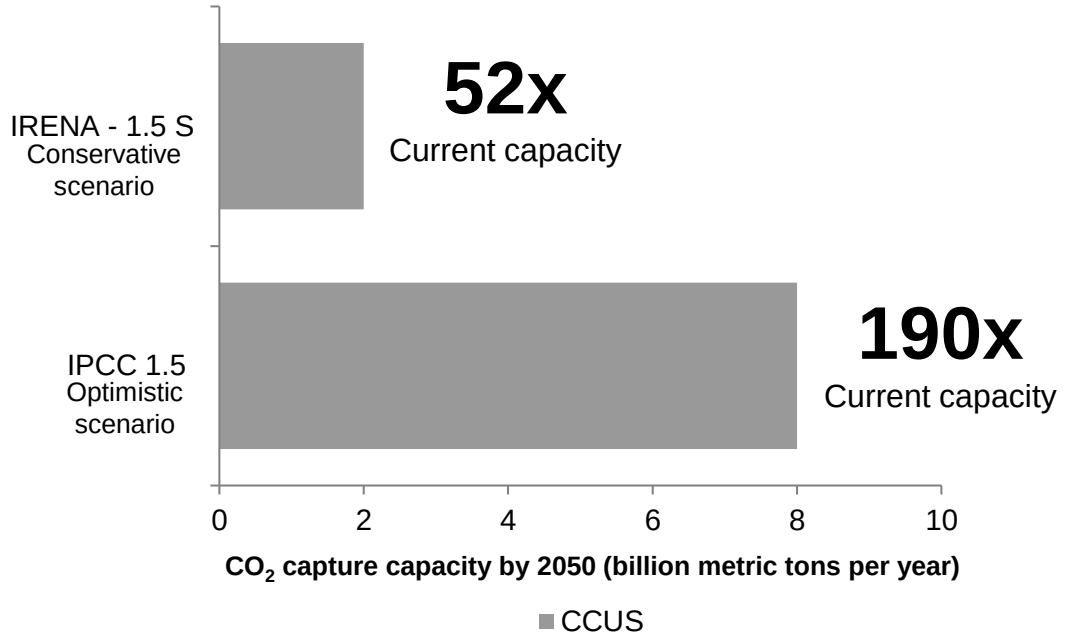
Between 4% and 20% of CO_2 abatement could come from carbon sequestration solutions by 2050

Carbon sequestration share to meet net-zero targets—Scenarios



Note: IHS Markit Accelerated Carbon Capture and Storage numbers includes both CCUS and BECCS.
*These scenarios estimate net zero will be reached beyond 2050.
Source: IHS Markit, IRENA, IEA, IPCC, BP, Shell

CCUS capacity expected by 2050 per scenario

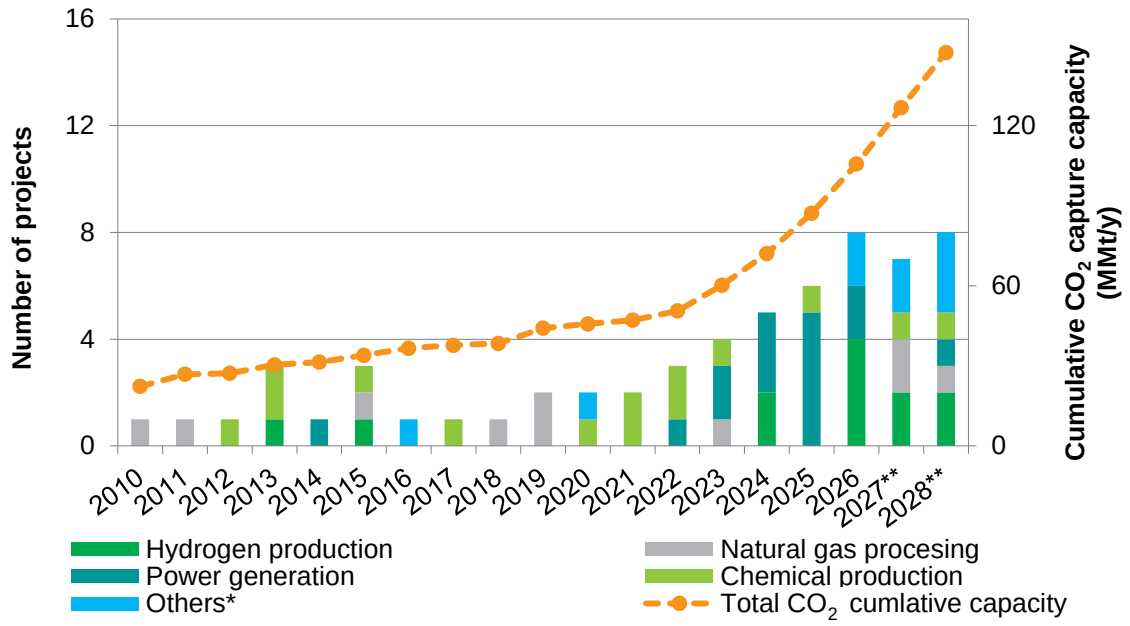


Source: IHS Markit, IRENA, IPCC

Various energy scenarios define different paths to meet net-zero targets; however, all of them concur with the need for carbon sequestration solutions to reduce emissions, and therefore the significant increase of CCUS projects required in the next 30 years.

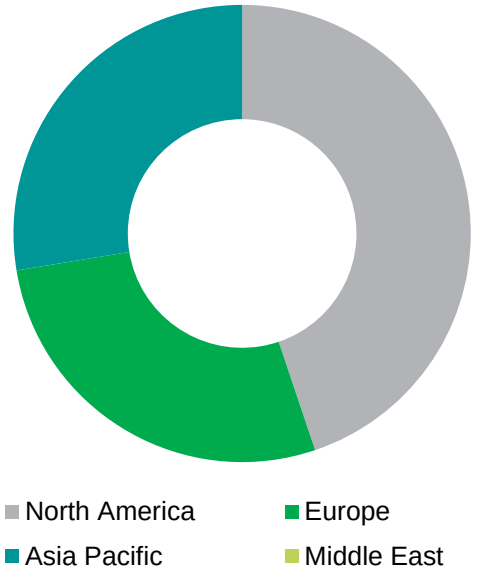
The number of CCUS operating projects is expected to more than double in the next 10 years, mainly driven by decarbonization ambitions

CCUS projects additions by year



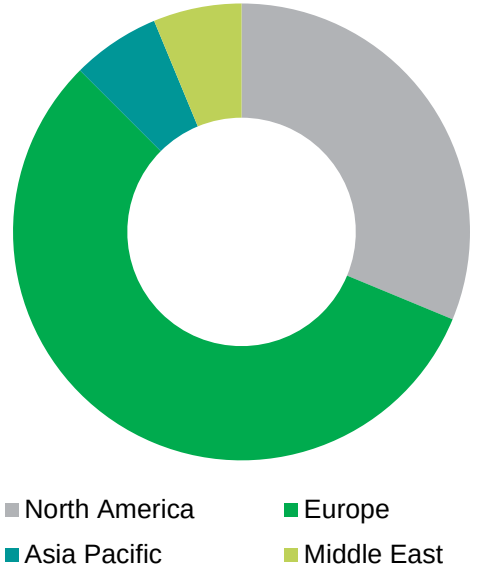
* "Others" includes cement and iron production, and water to energy.
** 2027 and 2028 compile the projects that have been announced but do not have a defined project timeline.
Note: Only includes CCUS large-scale projects. Capacity additions between 2021 and 2026 based on company announcements.
Source: IHS Markit

Expected operational CCUS projects between 2021 and 2026



Note: Only includes CCUS large-scale projects.
Source: IHS Markit

Announced CCUS projects

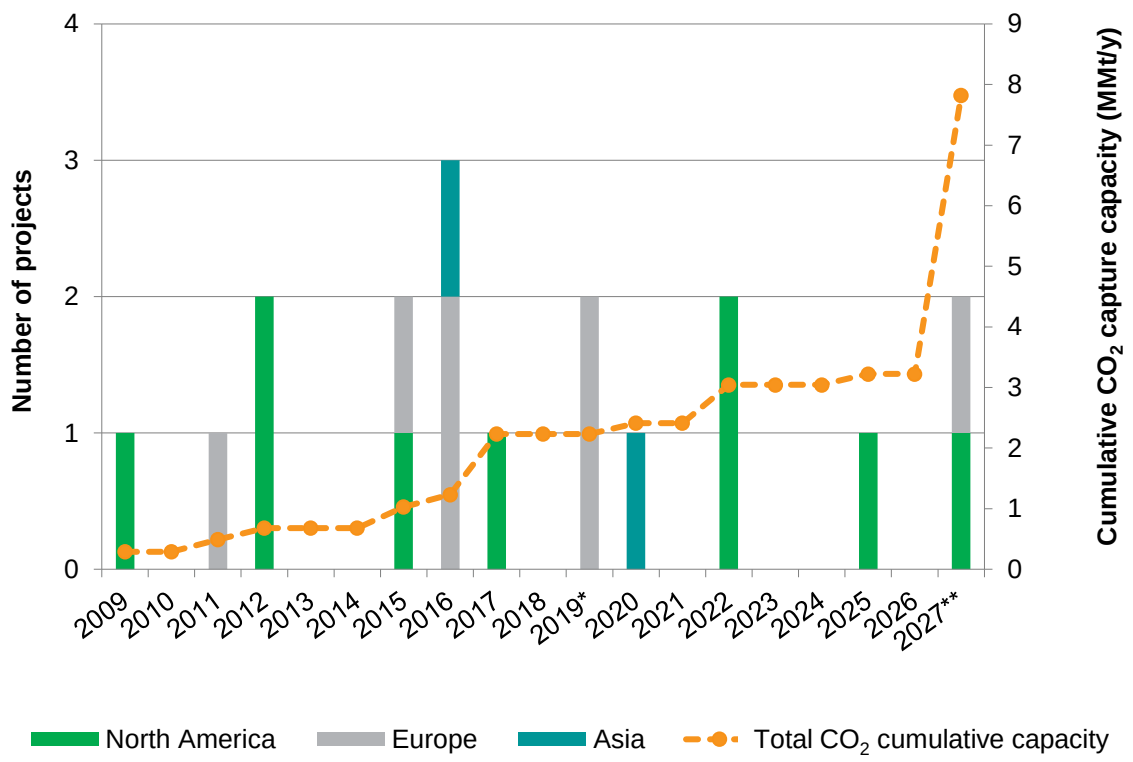


Note: Only includes CCUS large-scale projects.
Source: IHS Markit

The CCUS industry will have to grow faster than expected in order to meet expectations from multiple net-zero scenarios. However, this growth will be highly dependent on policy support.

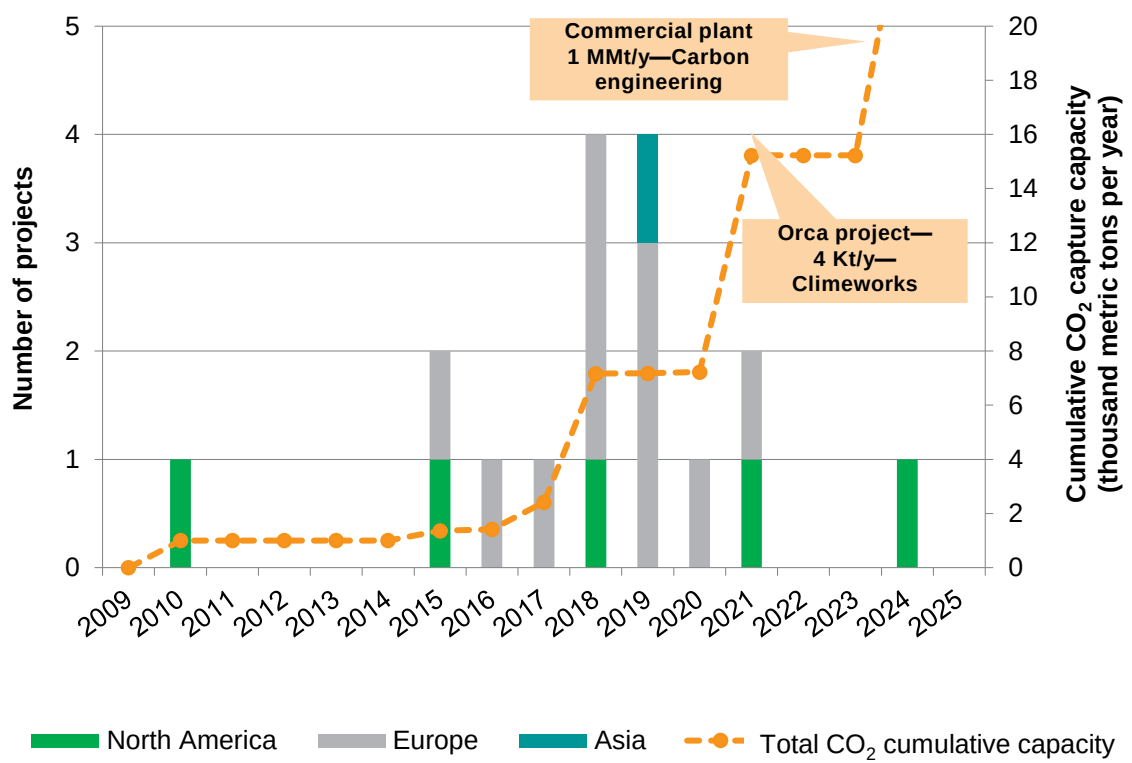
BECCS and DAC solutions have a small project pipeline, therefore capacity increase will be limited in the next five years

Bioenergy with CCUS/CCS projects additions by year



*All project during 2019 were pilots. **2027 compiles the projects that have been announced but do not have a defined project timeline
Note: (1) Projects after 2020 are announced projects, timeline of these projects could change. (2) Projects in 2011 capture CO_2 from two different sources, one of them being bioenergy so only part of the carbon captured is associated to BECCS.
Source: IHS Markit, IEA, NETL CCUS Database, MIT Carbon Capture and Storage Project Database

DAC projects additions by year

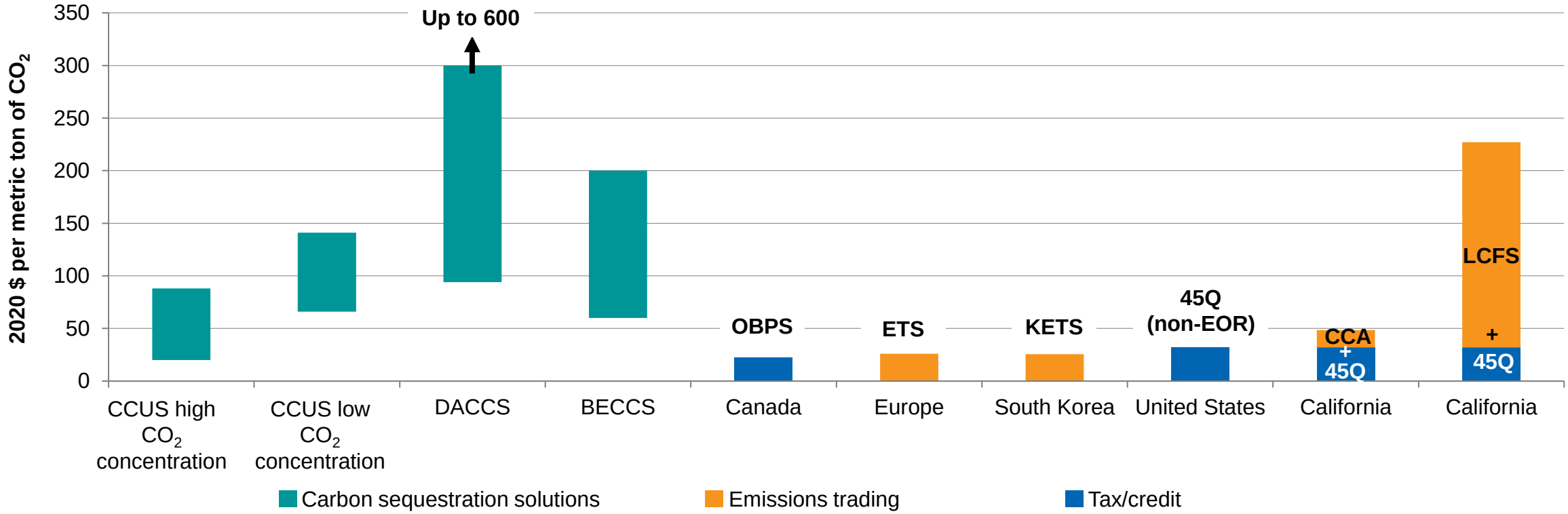


Note: (1)Two projects on 2010 and 2018 from Global Thermostat are not operating. The innovation center from Carbon Engineering is not considered in this chart. (2) 2024 project is contingent on several factors and timeline of this project could change.
Source: IHS Markit, IEA, company website

Carbon capture costs are highly project specific

Most of the Current policies in place are not enough to incentivize large-scale development of CCS, however LCFS could be the exception

Carbon sequestration solution cost comparison versus selected current emissions scheme pricing (2020 $ per metric ton of CO_2)



Note: (*) BECCS costs based on biomass-power generation and BECCS applied to industrial processes. BECCSS capture from bioethanol or biomass gasification is not considered in the cost estimation.
OBPS: Output-Based Pricing System; ETS: Emissions Trading Systems; KETS: Korea Emissions Trading Scheme; CCS: California Allowance; LCFS: Low-Carbon Fuel Standard
Source: IHS Markit, IPCC, NETL, National Petroleum Council, Carbon Engineering, Climeworks

IHS Markit Customer Care

CustomerCare@ihsmarkit.com
Asia and the Pacific Rim
Japan: +81 3 6262 1887
Asia Pacific: +604 291 3600
Europe, Middle East, and Africa: +44 1344 328 300
Americas: +1 800 447 2273