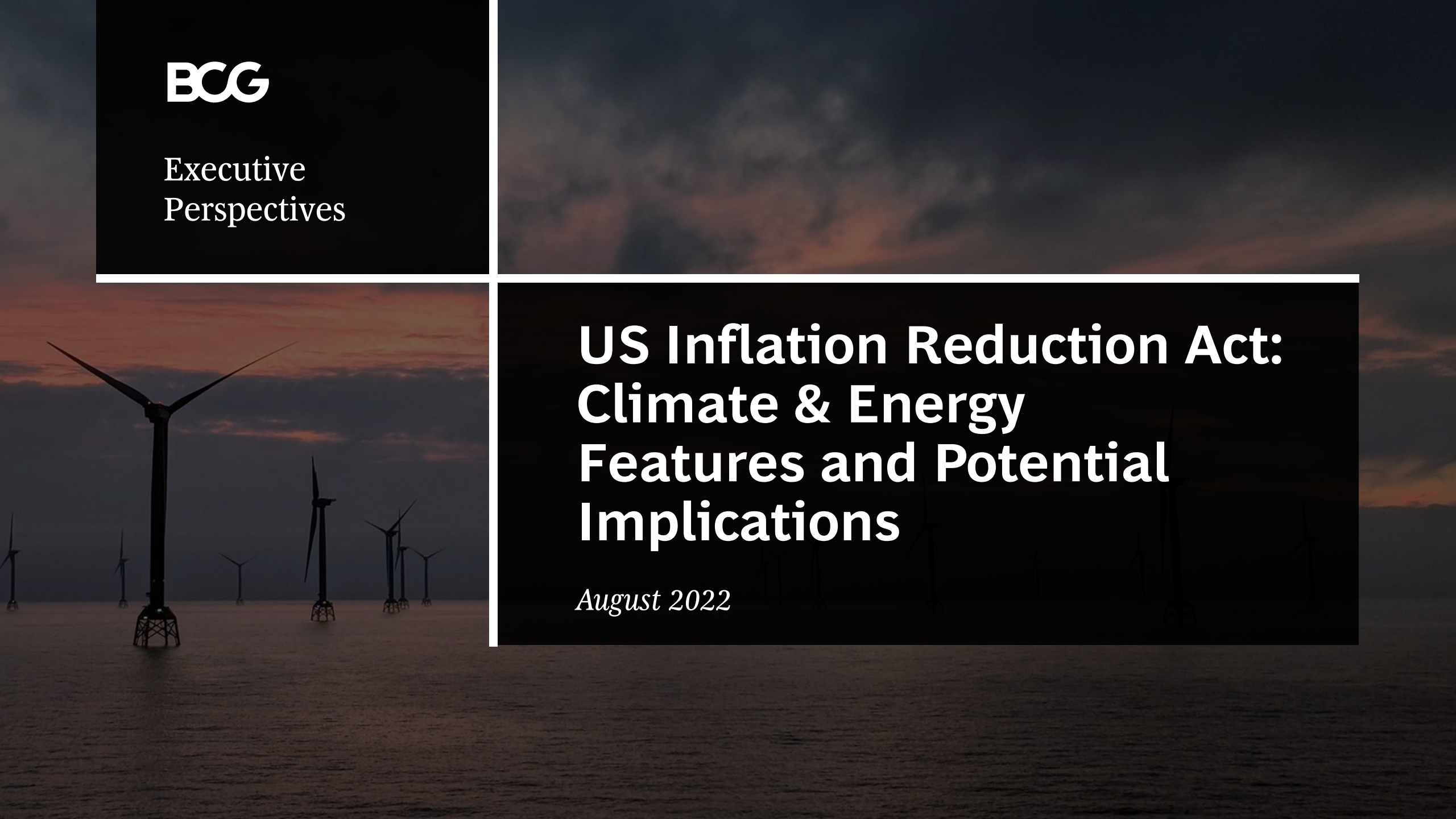


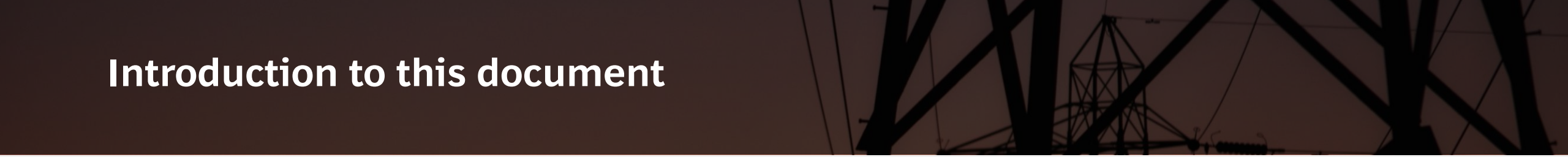
BCG

Executive Perspectives

US Inflation Reduction Act: Climate & Energy Features and Potential Implications

August 2022

Introduction to this document



US Congress recently enacted legislation, the Inflation Reduction Act (IRA), that includes $369B of funding for climate and energy over the next decade. This funding builds on more than $110B of climate and energy funding in the Infrastructure Investment and Jobs Act (IIJA) adopted in late 2021. The primary vehicles for fiscal spending for the IRA will be through tax credits and incentive funding, intended to create investment multiplier effects

Legislation of this magnitude and duration lasting through the 2030s and beyond is likely to have profound and lasting impacts across US and global climate and energy systems, supply chains, industries, and trade

US legislation on climate and energy also has the potential to trigger policy actions from other nations, both large energy producers that compete across these value chains, and large energy consumers

This document provides an overview of the key climate and energy features of the legislation, shares the potential shift in economics of clean energy investments and technologies it can deliver, and describes initial implications and opportunities for firms

The second and third order implications of this legislation will emerge over time. For example, these policies impact the ability of every industry across the economy to decarbonize their supply chains. We will explore these in future BCG Executive Perspectives across select areas of focus

US Congress recently passed legislation to support climate priorities and the energy transition

Infrastructure Investment and Jobs Act (IIJA)

Signed into law Fall 2021

Biden Signs Infrastructure Bill, Promoting Benefits for Americans

How the $1 Trillion Infrastructure Bill Aims to Affect Americans' Lives

Biden Signs Bipartisan Infrastructure Bill, Vowing Change 'For the Better'

Infrastructure Bill Provides Money for Bridges, Broadband, and more

Inflation Reduction Act (IRA)

Passed Summer 2022

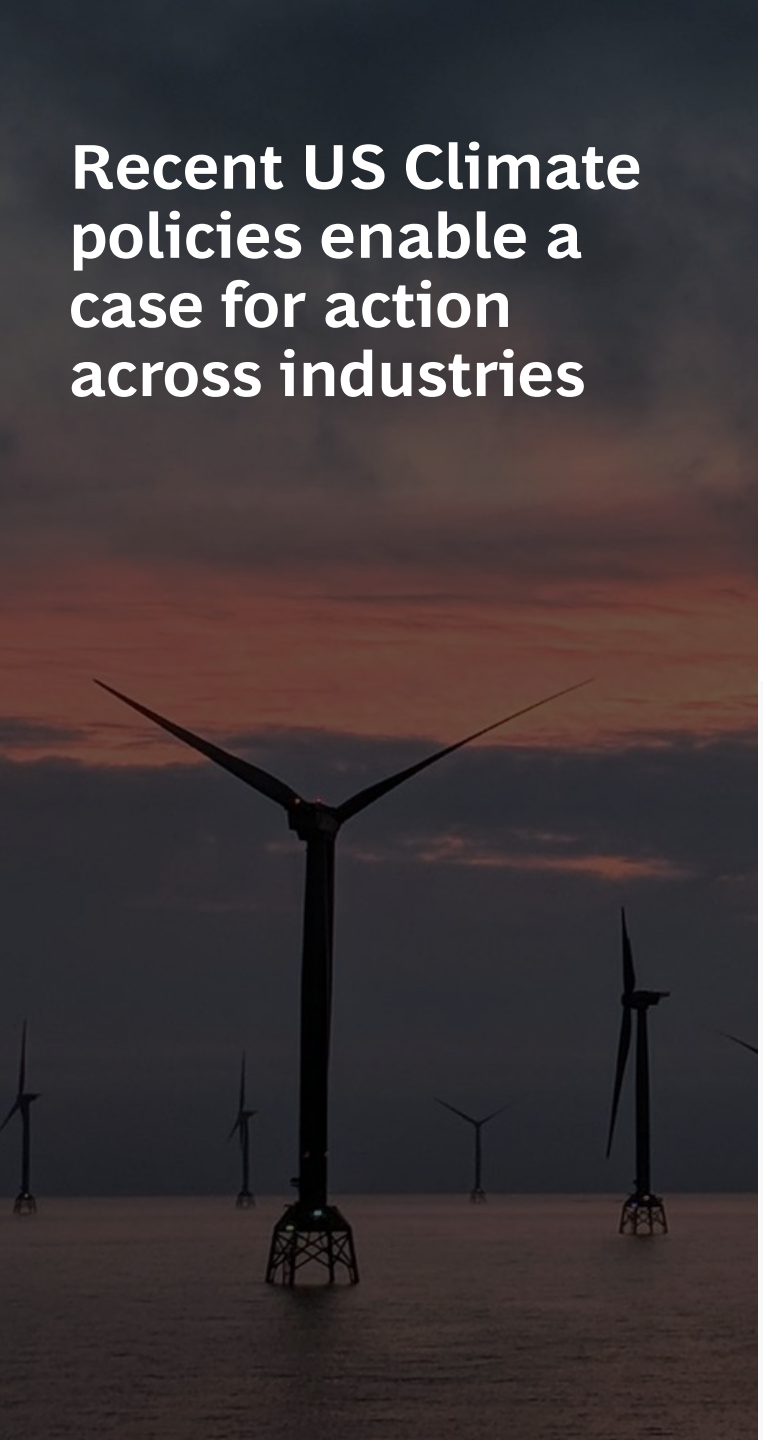
The Inflation Reduction Act Is a Huge Deal for the Climate

Inflation Reduction Act Could Supercharge Grid Energy Storage

Senate passes Democrats' Landmark Tax, Climate, Drugs Bill

What the Inflation Reduction Act incentives mean for your wallet

Recent US Climate policies enable a case for action across industries



1 Key elements of the legislation

Recently passed US climate policies are poised to dramatically shift economic viability of carbon free energy, clean tech, and electric vehicles

- Incentives will materially reduce renewable and other carbon free energy costs, with potential to drive increases in carbon free energy deployment to 65-80% of electricity by 2030
- EV adoption will accelerate by several years, lowering entry price for passenger and heavy-duty vehicles. However, in the near-term this could be constrained by ability to ramp up supply chains
- Significant funding for emerging clean technologies will promote rapid demonstration and deployment, catalyzing decarbonization of hard-to-abate sectors
- Manufacturing tax credits will boost domestic production of key energy and EV components

2 Direct implications

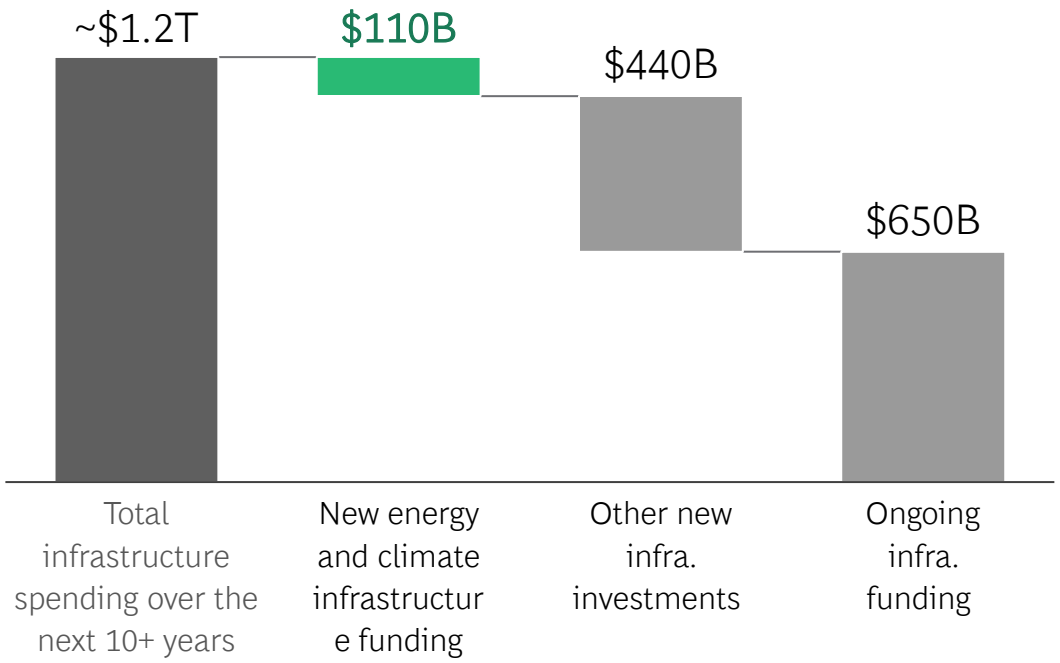
These policies will make decarbonization cheaper across industries, but executives must start now to capture their full value

- **Reduce costs:** Take advantage of sizable credits that reduce energy and transportation costs, regardless of industry
- **Re-evaluate decarbonization plans:** Leverage massive shifts in carbon abatement curves and clean technology improvements to reduce greenhouse gas emissions
- **Capture early mover advantage:** Act now to mitigate bottlenecks expected to emerge in low carbon infrastructure development and related supply chains
- **Pursue new value pools**: Plan ahead for how you can shape and capture value from new markets in energy, transportation, or manufacturing

1 Overview: Infrastructure Investment and Jobs Act (IIJA) and Inflation Reduction Act (IRA) include $479B in new climate and energy spending

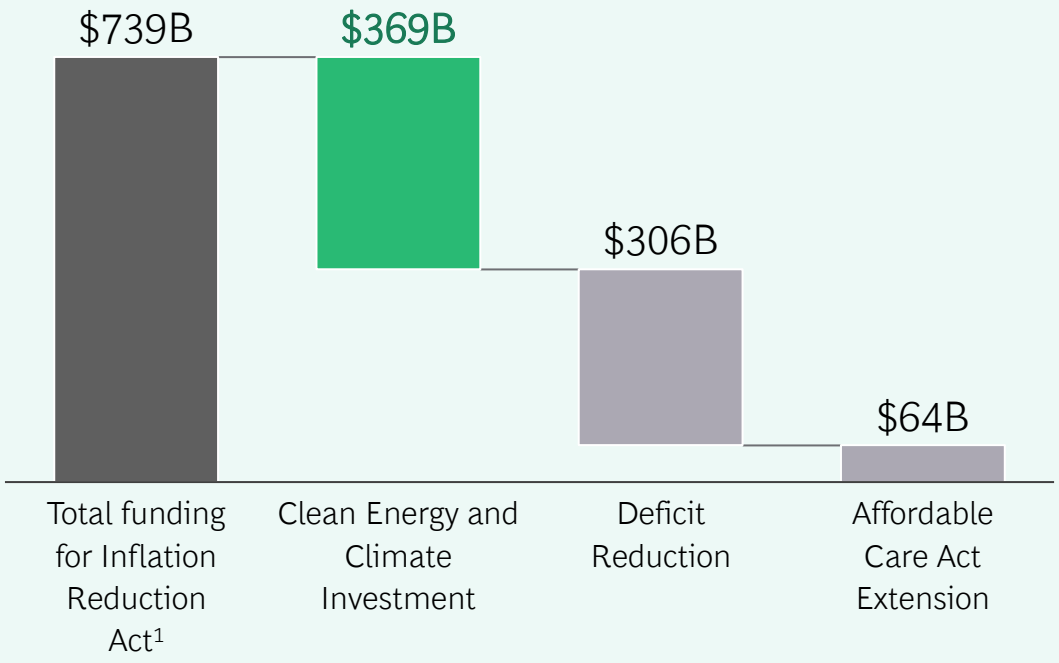
Infrastructure Investment and Jobs Act (IIJA)

Signed into law Fall 2021



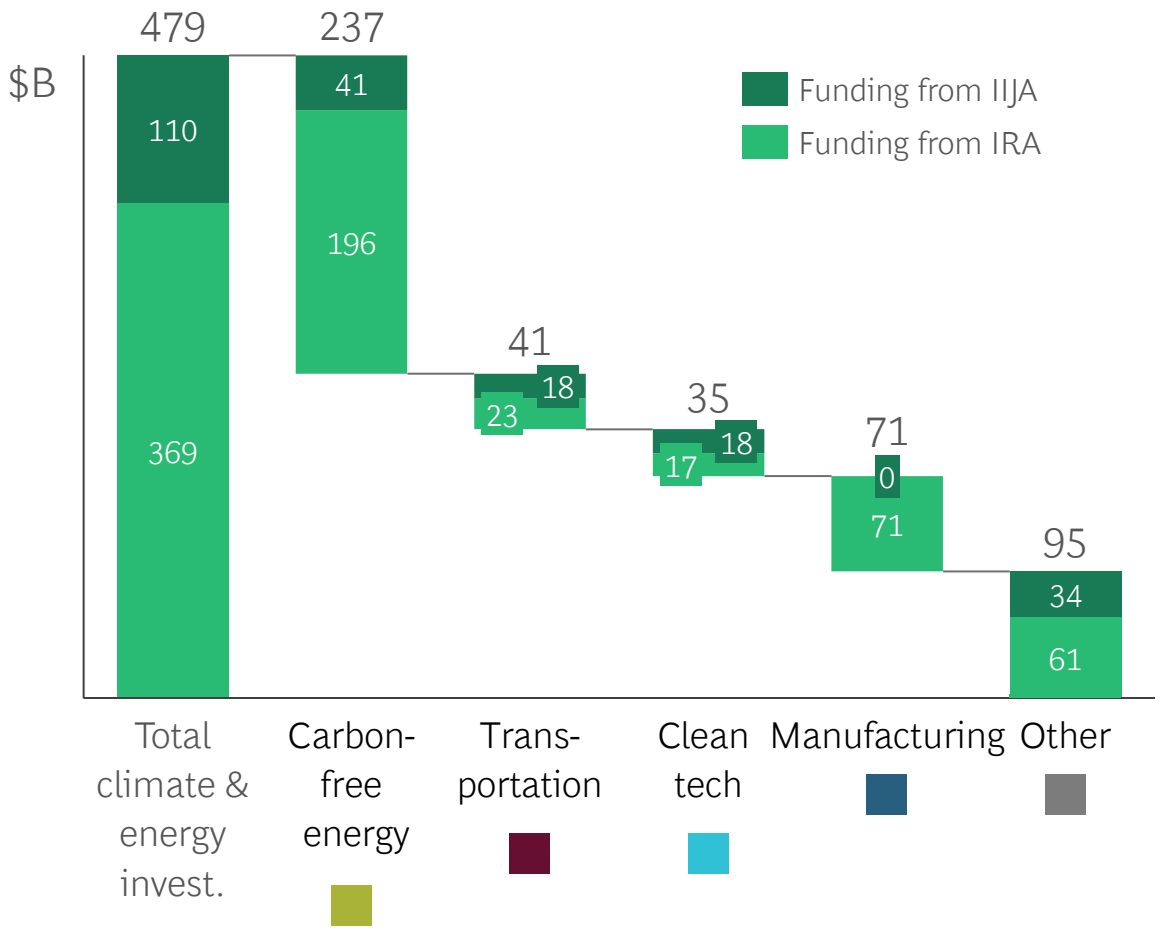
Inflation Reduction Act (IRA)

Passed Summer 2022



1. Includes corporate tax, prescription drug pricing reform, and IRS tax enforcement
Source: 'FACT SHEET: Historic Bipartisan Infrastructure Deal', The White House

1 Detail: Infrastructure Investment and Jobs Act (IIJA) and Inflation Reduction Act (IRA) include $479B in new climate and energy spending



Key incentives:

Carbon-free energy	• Tax credits for investments in solar and storage • Tax credits for producing wind and nuclear energy • Tax credits for transmission interconnects related to these clean energy projects • Funding for energy efficiency
Transportation	• Tax incentive for purchase of electric vehicles • Funding for EV charging infrastructure
Clean tech	• Carbon capture tax credit for point source capture • Carbon capture tax credit for direct air capture (DAC) • Tax credit for production of clean hydrogen • Funding for hydrogen and DAC hubs • Funding for sustainable aviation fuels (SAF)
Manufacturing	• Funding for advanced manufacturing production • Investment for advanced industrial facilities
Other	• Agriculture initiatives • Methane emissions charge (*revenue generating*) • Resilience investments (e.g., rural area dev.) • Greenhouse gas reduction fund

Note: additional details on the IIJA and IRA in appendix; Source: EPA, CBO, BCG analysis

1 This funding will drive material changes to the energy, transportation, and manufacturing sectors and will spur innovation in clean tech

$237B

Carbon-free energy

Ramp up adoption of renewable and nuclear electricity in the US, and increase energy efficiency

Driven by tax credits that reduce costs

$41B

Transportation

Accelerate EV adoption

Driven by incentivizing EV purchases and funding EV charging infrastructure

$35B

Clean tech

Catalyze innovation to address hard to abate emissions

Driven by facility funding and technology-specific incentives

$71B

Manufacturing

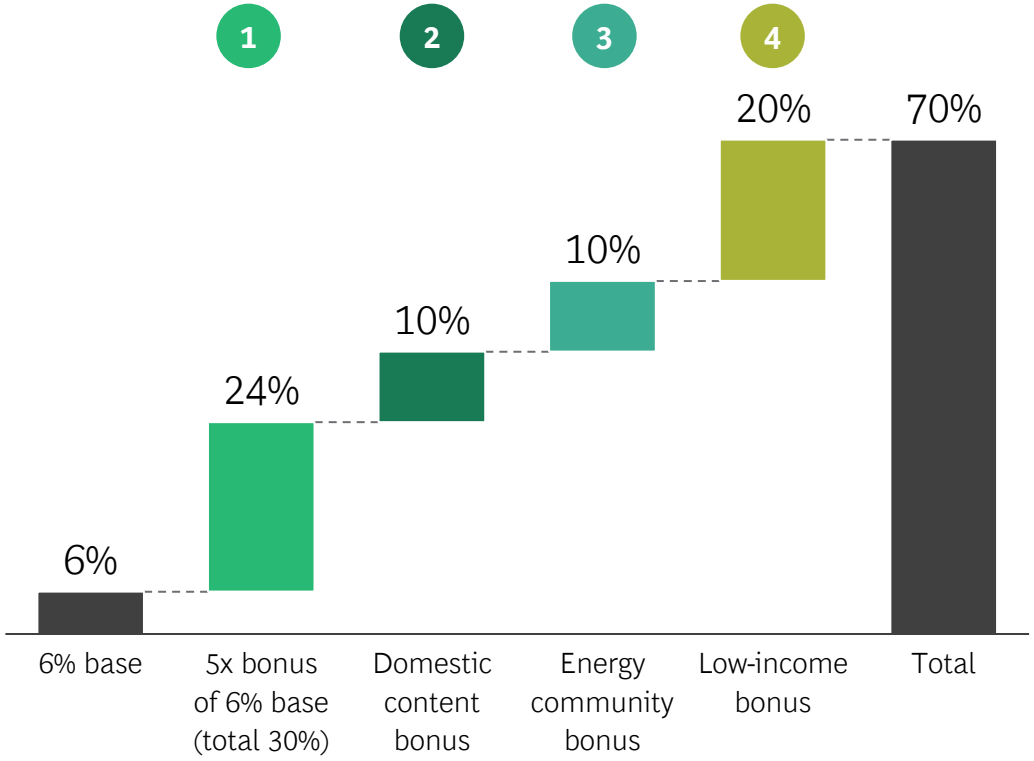
Spark domestic manufacturing of low carbon infrastructure components

Driven by facility funding

Note: additional details on the IIJA and IRA in appendix; Source: EPA, CBO, BCG analysis

1 Carbon-free energy | Base, multipliers and bonus tax credit structure intended to shape and target clean energy investments

Renewable investment tax credit eligible for bonuses up to 70% of upfront investment cost



With a potential to increase base incentive by 10x while also supporting a just transition

1 **Prevailing wages and apprenticeship** qualify projects for a **5x bonus multiplier** over base for most non-manufacturing credits

> Significant apprenticeship opportunities to **help upskill the US workforce** in low-carbon technologies

2 **Domestic content bonus** provides up to a **10 ppt bonus** on renewable energy production or investment tax credit

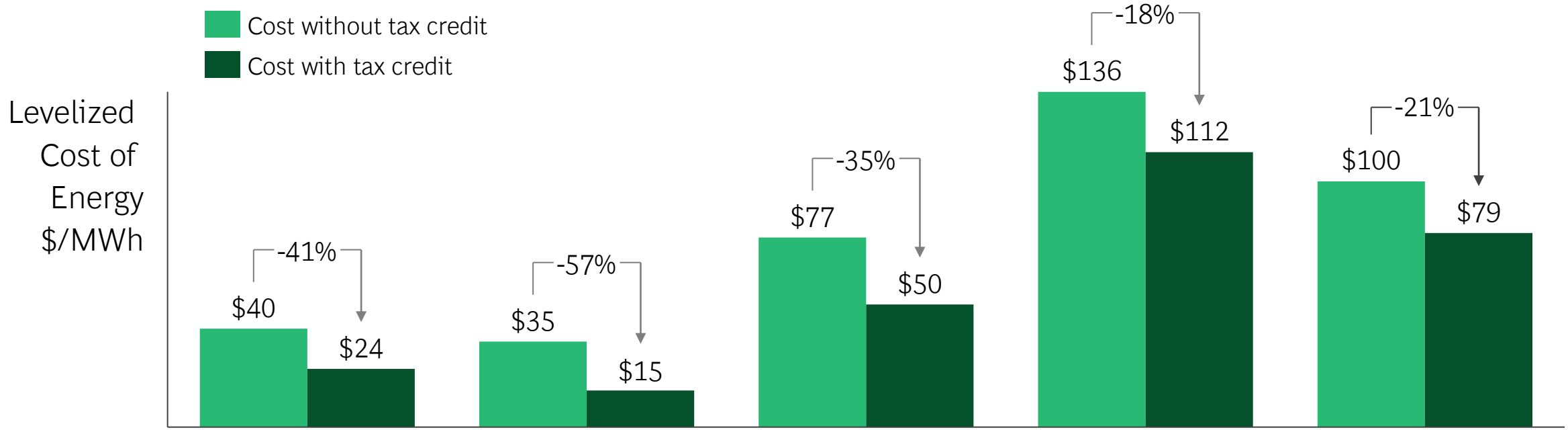
> Domestic content bonus to **incentivize shift to US manufacturing**, requiring ≥55% of all parts to be produced in the US by 2027 and 100% of steel and iron for turbines and solar panels

3 4 Investment in the **energy community** and **low-income community** qualifies renewable energy projects for up to a **10 and 20 ppt bonus** credit increase, respectively

> Support for the energy and low-income communities to **enable economic development and jobs**

Note: Not all clean energy technologies are eligible for all bonuses; ppt (percentage point); production tax credit eligible for similar bonuses, but domestic content and energy community bonuses are 10% increases (not 10 ppt); low-income community bonus has project cap of 5 MW
Source: 'FACT SHEET: Historic Bipartisan Infrastructure Deal', The White House

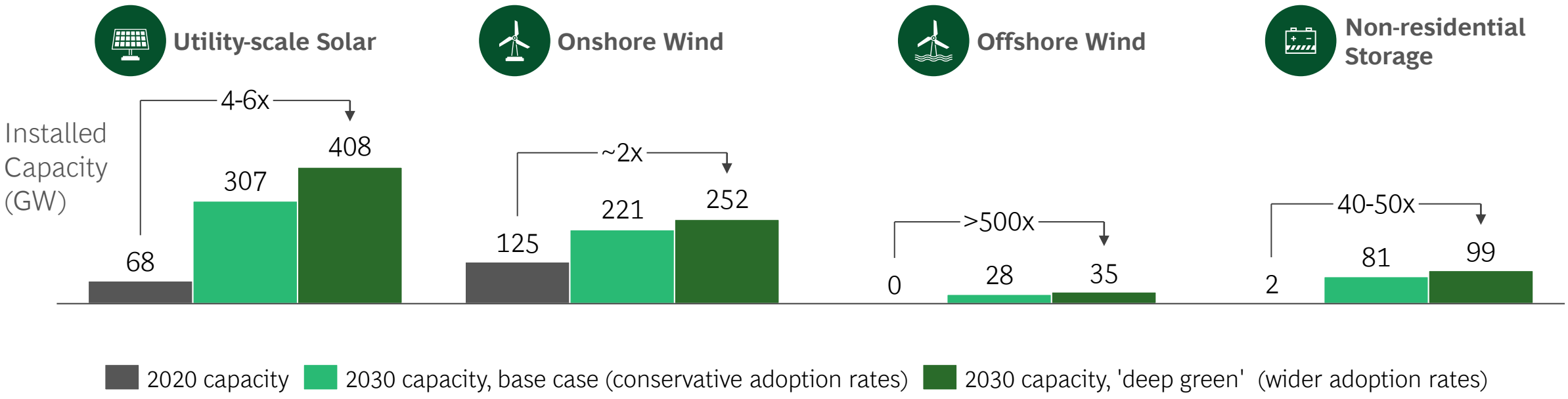
1 Carbon-free energy | Full tax credits can significantly reduce costs of generating renewable energy



	Solar	Onshore wind	Offshore wind	Storage	Nuclear[1]
Post-IRA incentive applied	**50%** Investment Tax Credit	**$31/MWh**[2] Production Tax Credit	**50%** Investment Tax Credit	**50%** Investment Tax Credit	**$31/MWh**[2] Production Tax Credit

1. New small-modular reactor; 2.Assumes $15/MWh incentive, inflation adjusted and with bonuses; Note: all technologies assume base + prevailing wage bonus + domestic production bonus + energy community bonus. Source: Lazard, BCG analysis

1 Carbon-free energy | Potential for step change increase in renewable energy buildout by 2030 and beyond



Improved economics of renewables and storage will accelerate transition from fossil fuel generation

- Expect upwards of 65-80% generation from renewable capacity in 2030 vs. ~40% in 2020
- Projects that start construction in or before 2032 eligible for tax credits; expect continued growth past 2030
- Need for firm (low-carbon) generation to ensure grid reliability and resiliency remains

1 Transportation | Electric vehicle purchase price parity accelerates >5 years

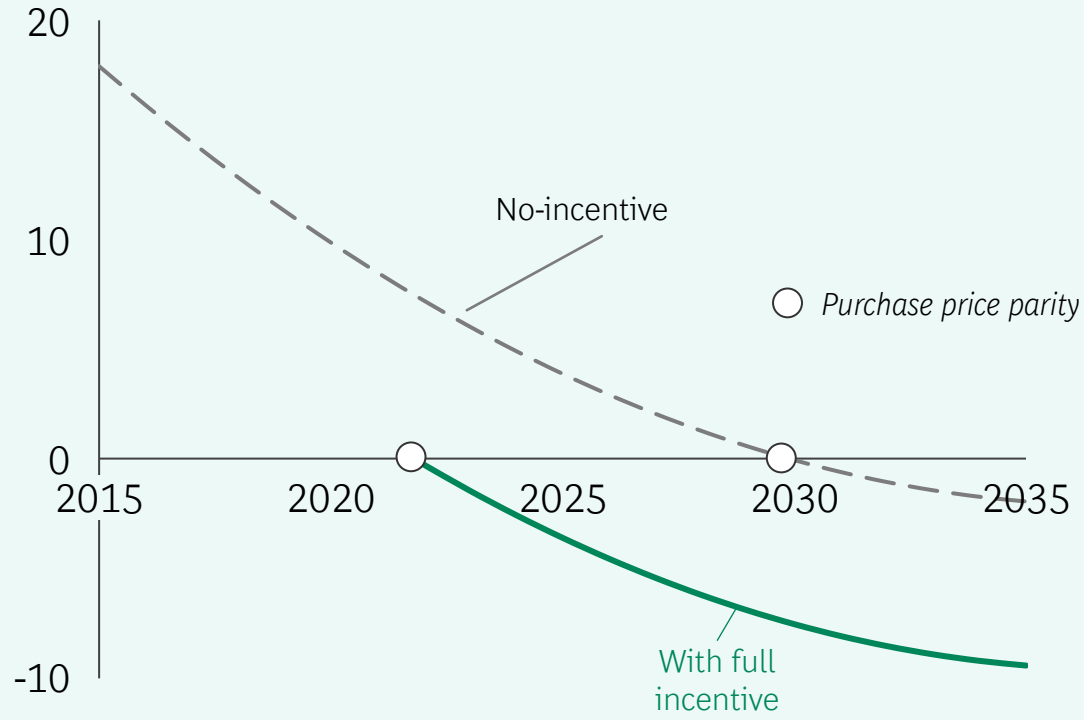
Passenger vehicles:

- Incentive: Up to $7500 for new purchases, up to $4000 for used
- Purchase price parity jumps forward 5 years[1] for qualifying passenger vehicles compared to internal combustion engine vehicles (ICE)
- 5-year total cost of ownership favors battery electric vehicles immediately[1]

Commercial vehicles:

- Incentive: $40,000 for new purchases
- Includes off-highway vehicles

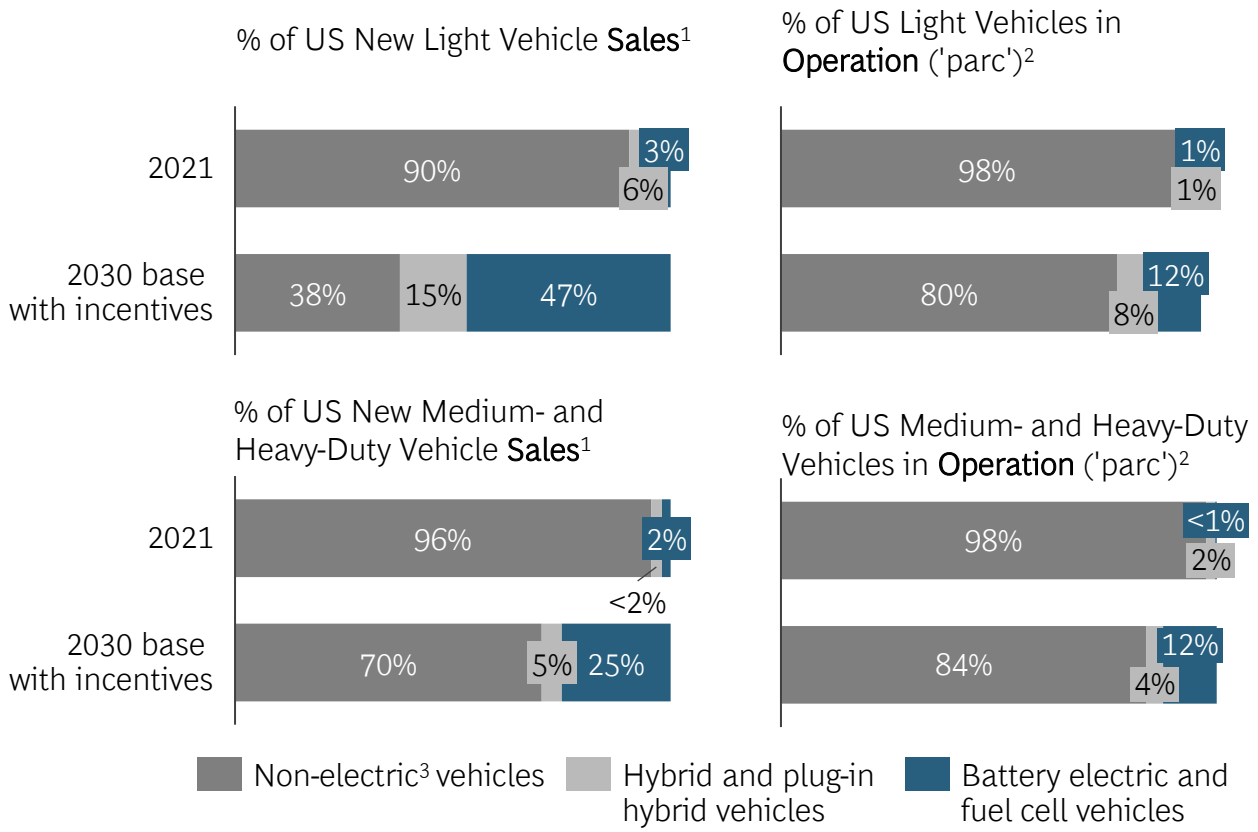
Purchase price difference between internal combustion engine and battery electric vehicles
Segment: Compact SUV (SUV – M)
US Dollars ('000)



1. Purchase price parity and total cost of ownership parity differ by vehicle segment (e.g., SUV vs sedan) and state where vehicle is purchased (some states have additional purchase incentives)
Source: BCG powertrain model

1 Transportation | Close to half of vehicle sales likely to be electric by 2030

>10% of light-, medium, and heavy- vehicles in operation expected to be electric by 2030



Stack-able incentives in the form of:

- Point of sale rebate
- 30% rebate on EV charging / alternative fuel hardware + installation
- Higher residual values due to used vehicle credit
- …and continued state-level incentives such as LCFS (California)

Several non-financial factors in the Inflation Reduction Act are also likely to drive adoption:

- Eliminates volume cap for individual vehicle manufacturers
- Provides 10-year incentive certainty
- Simplifies incentive payout

1. Forecast includes all light vehicles, except heavy vans; 2. Assumes decrease in scrappage rate over time (EVs + AVs); Including such changes in consumer mobility behavior as car and ride sharing; 3. Includes internal combustion (diesel + gasoline) and mild hybrid electric vehicles
Source: BCG Powertrain Model 'base case incl. incentives'; BCG vehicles in operation (VIO) model

1 Transportation | US domestic and trade allied battery supply chains will need to ramp up quickly to qualify for the incentives

Sourcing requirements:

Inflation Reduction Act mandates two sourcing requirements to receive the clean vehicle credit, starting in 2023:

- 40% of battery minerals sourced from US or country with free trade agreement
- 50% of battery components manufactured in US, Mexico, or Canada

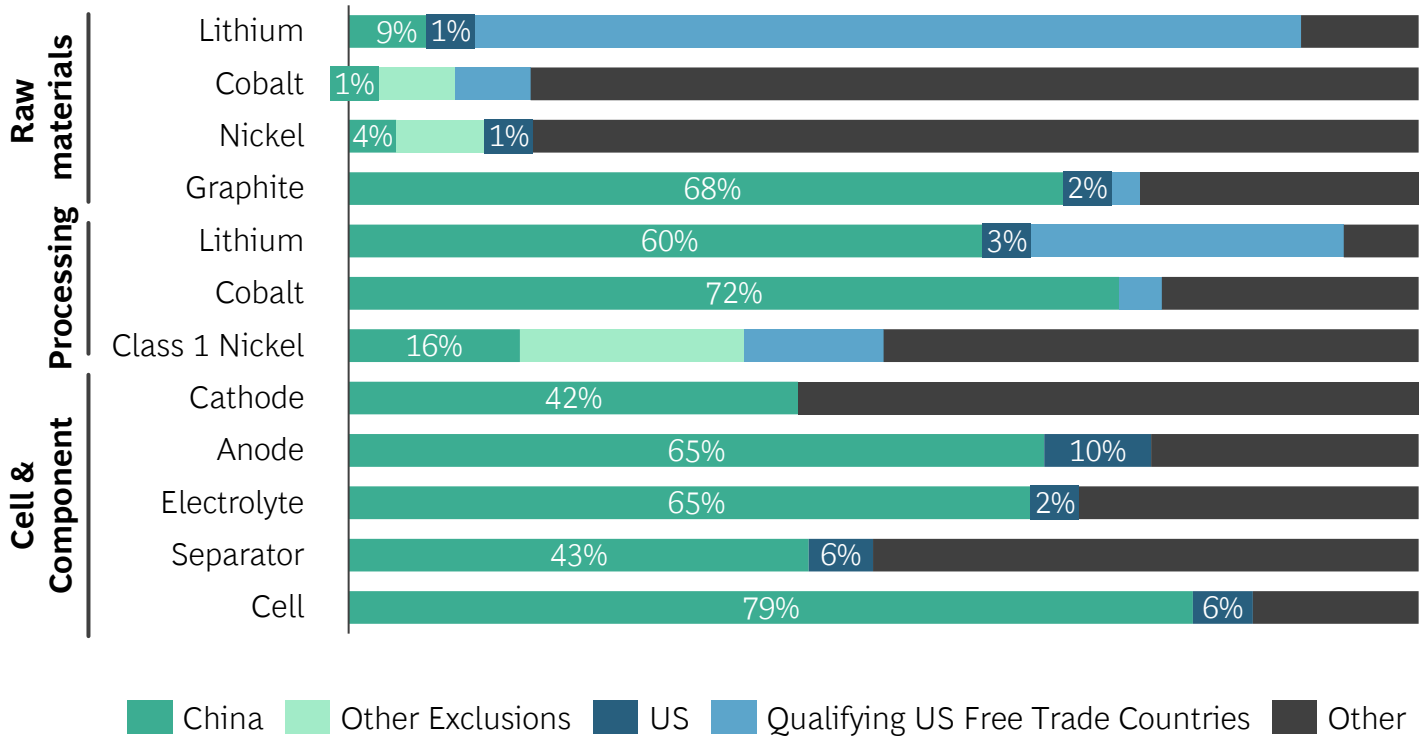
These percentages increase 10 ppts/y [1]

'Excluded entities':

Disqualifies vehicles that are imported or built with battery materials sourced from 'foreign countries of concern' (namely, China + Russia)

Today's EV batteries rely heavily on raw materials from China

Share of global production, 2021 (%)

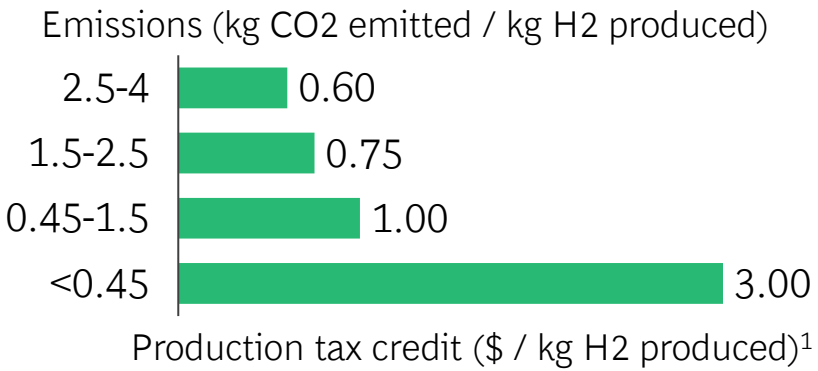


Note: All dates refer to when construction must start by or safe harbor achieved by
1. For minerals: Up to 80% by 2027; for components: up to 100% by 2029, but no 10 ppts/y increase in 2025 (vs 2024)
Source: H.R.5376 - Inflation Reduction Act from congress.gov

1

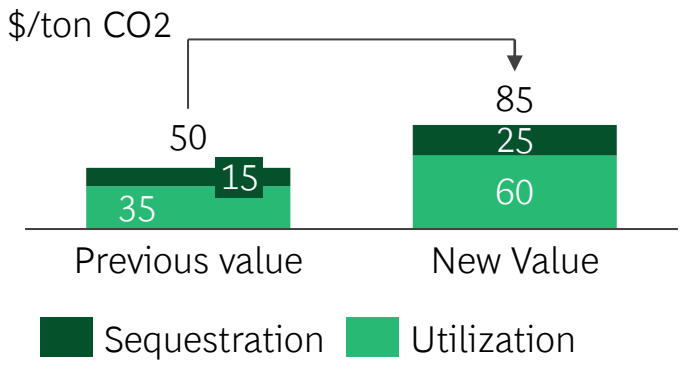
Clean tech | Significant incentives to help scale clean hydrogen, CCUS, and DAC

Hydrogen (H2)



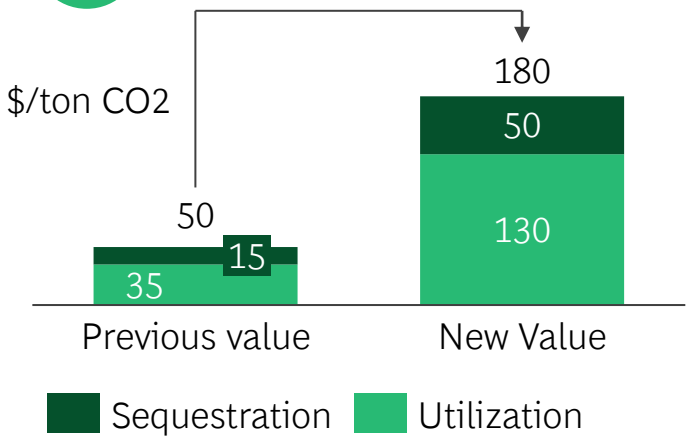
Hydrogen can receive significant incentives, with exact value depending on the associated emissions; additional $8B to build regional H2 hubs

Carbon capture, utilization, and storage (CCUS)



Expansion of existing 45Q credit to $85/ton for permanent geological sequestration of CO2, or $60/ton for utilization of CO2 (incl. enhanced oil recovery)

Direct Air Capture (DAC)



Expansion of existing 45Q credit to include additional incentive for carbon captured directly from the atmosphere, with $180/ton for sequestration of CO2 ($130/ton for utilization); $3.5B for DAC hubs

1. Assumes facility receives 5x bonus from meeting prevailing wage and apprenticeship requirements; Note: $/tCO2 ($/ton of carbon dioxide)

1

Clean tech | Incentives improve cost competitiveness of clean hydrogen against traditionally produced hydrogen

Two forms of clean hydrogen (H2):

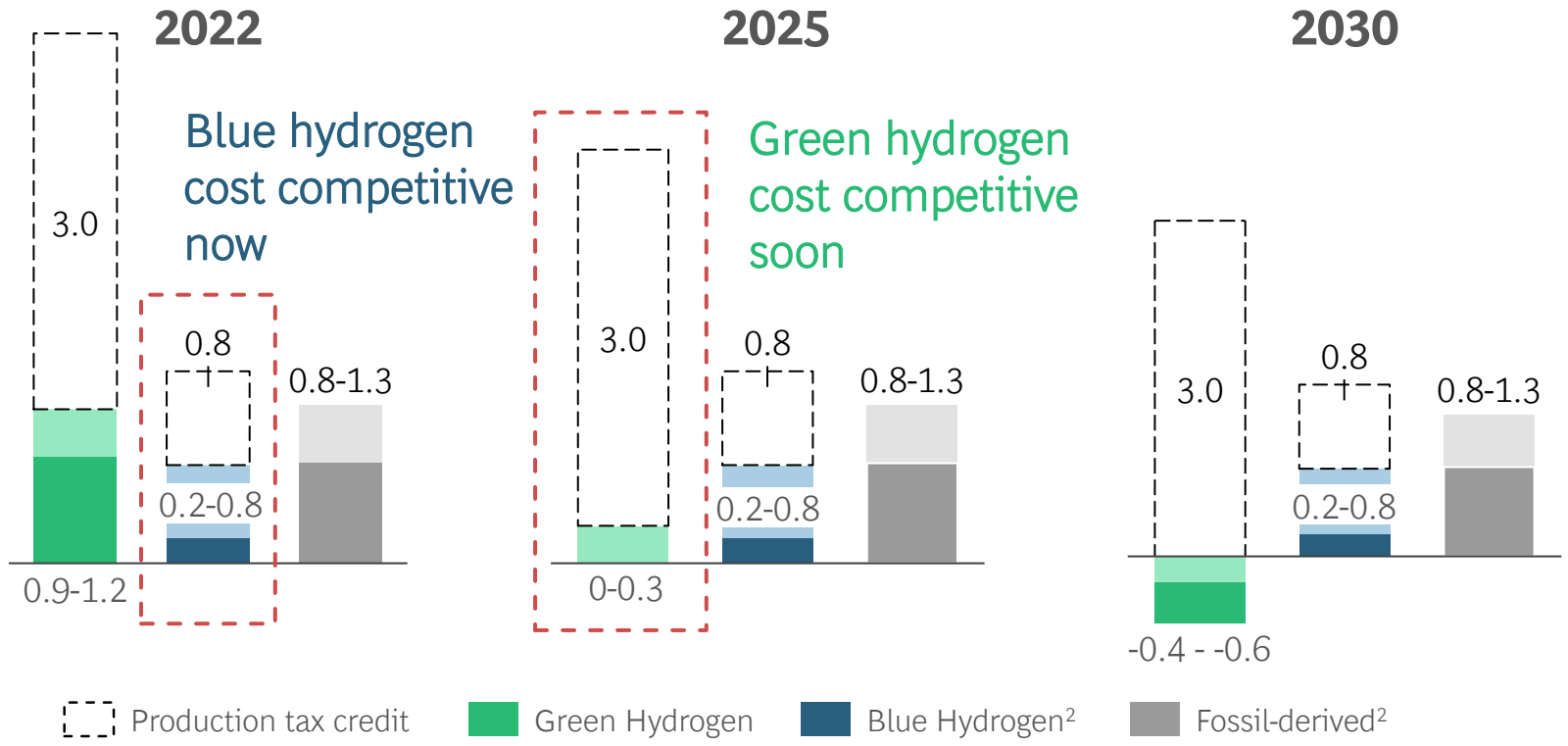
Green: Renewable energy + water electrolysis

Blue: Fossil-derived hydrogen + carbon capture

United States Levelized Cost of Hydrogen

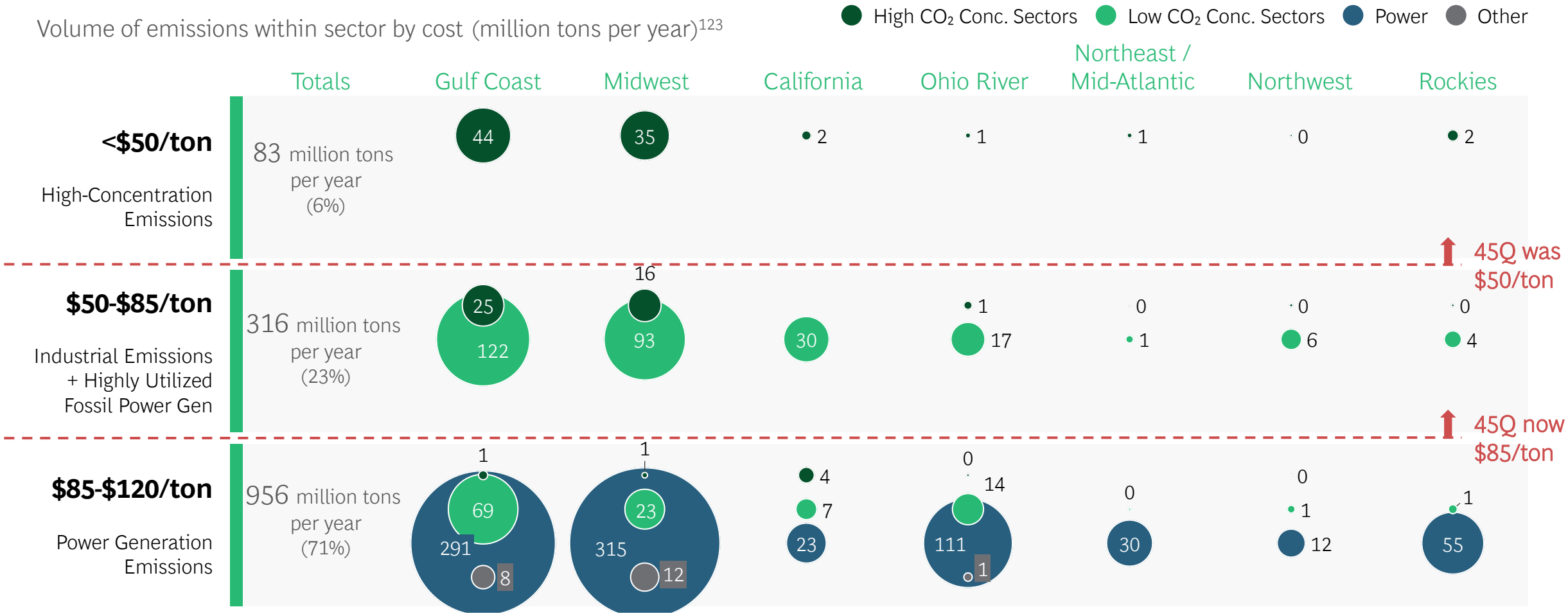
($/kg hydrogen, production cost)[1,2]

Lighter shades reflects range of cost uncertainty[2]



1. Excludes infrastructure costs associated with storage and delivery to end consumer 2. Lighter shade reflects pricing uncertainty regarding natural gas (lower limit $2/MMBTU, upper limit $5/MMBTU) and electricity 3. Starts at $0.4/kg H2 for 60-75% greenhouse gas reduction vs fossil-derived hydrogen, goes up to $0.75/kg H2 for 75-85% greenhouse gas reduction.
Source: BCG North America H2 Supply Model

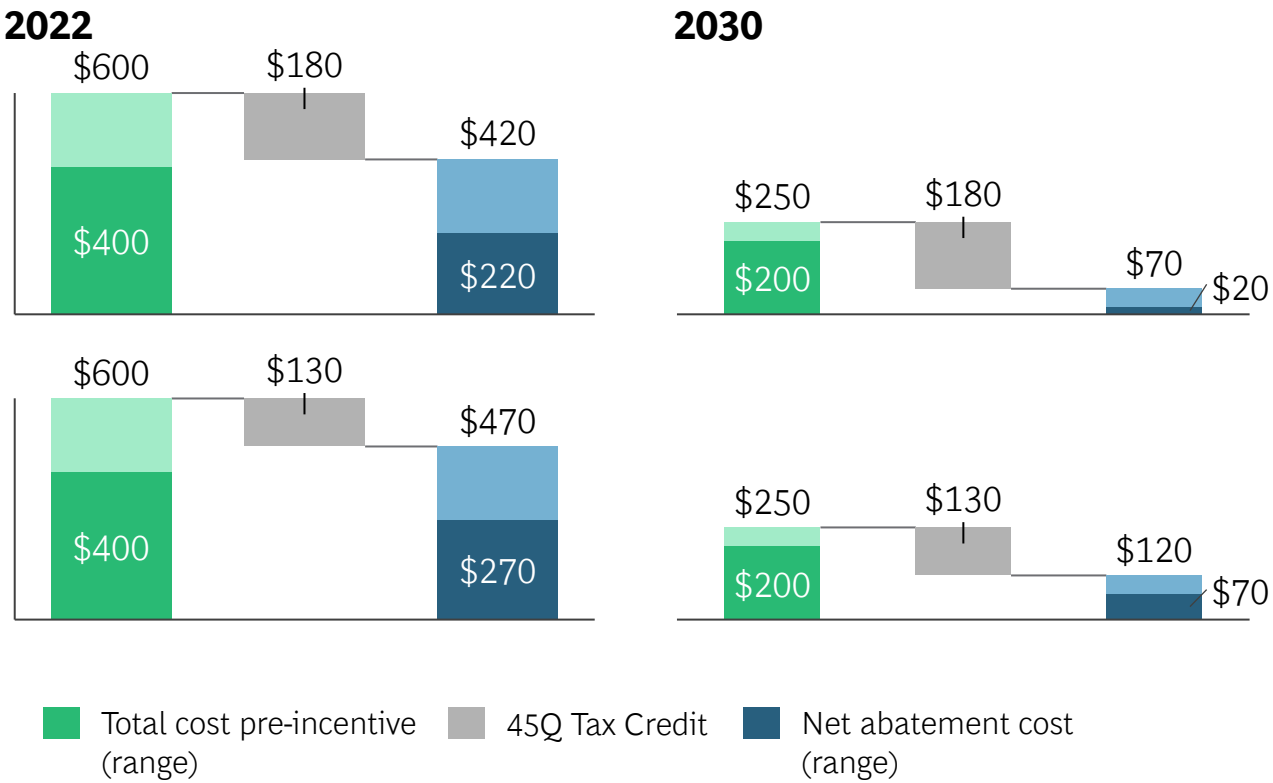
1 Clean tech | Higher 45Q tax credit will triple the scale of emissions addressable with CCUS



1. High CO_2 sectors include: Ammonia, Chemicals (ferm.), Conv. Oil (incl. NGP), H2, Petrochem.; Low CO_2 sectors include: Aluminum, Cement & Lime, Iron & Steel, and Petroleum Refining; Power sectors include: Fossil power Generation; Others include: Waste management, Wood, Pulp and Paper and Other Manufacturing | 2. Abatement costs based on emitters assigned to hubs within BCG CCUS tool, covering selected regions, using hub T&S costs, per emitter data directional |3. Excludes ~690 Mtpa from isolated emitters which are not connected to hubs and ~120 Mpta over $120/ton; Source: EPA flight database 2019; BCG CCUS tool

1 Clean tech | Direct air capture (DAC) incentive makes DAC facilities significantly more attractive

Projected cost of DAC ($/ton) inclusive of new tax credits, 2022 vs. 2030



DAC is investable now with these significant incentives

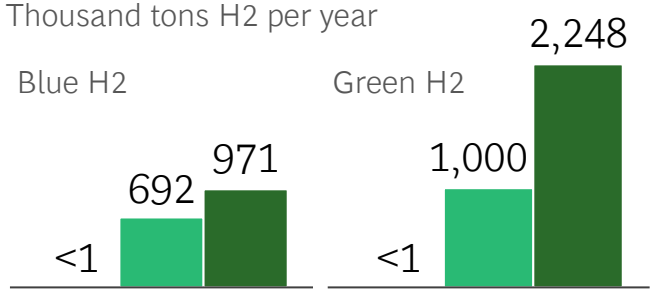
Lower technology costs plus 45Q tax credits will reduce DAC costs and provide a ceiling for Net Zero costs

Source: CARB; Stillwater Associates; BCG Research

1

Clean tech | Higher incentives likely to accelerate deployment of clean technologies

Hydrogen (H2)



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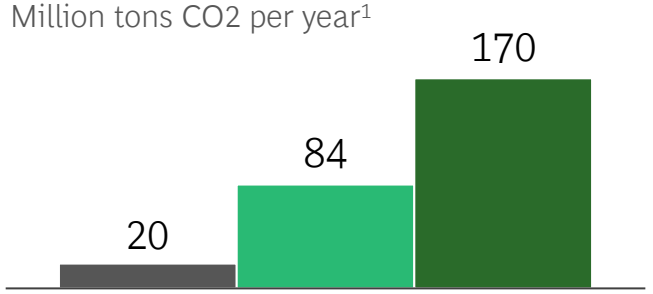

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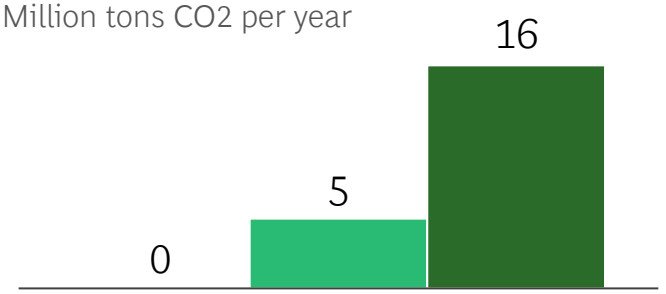


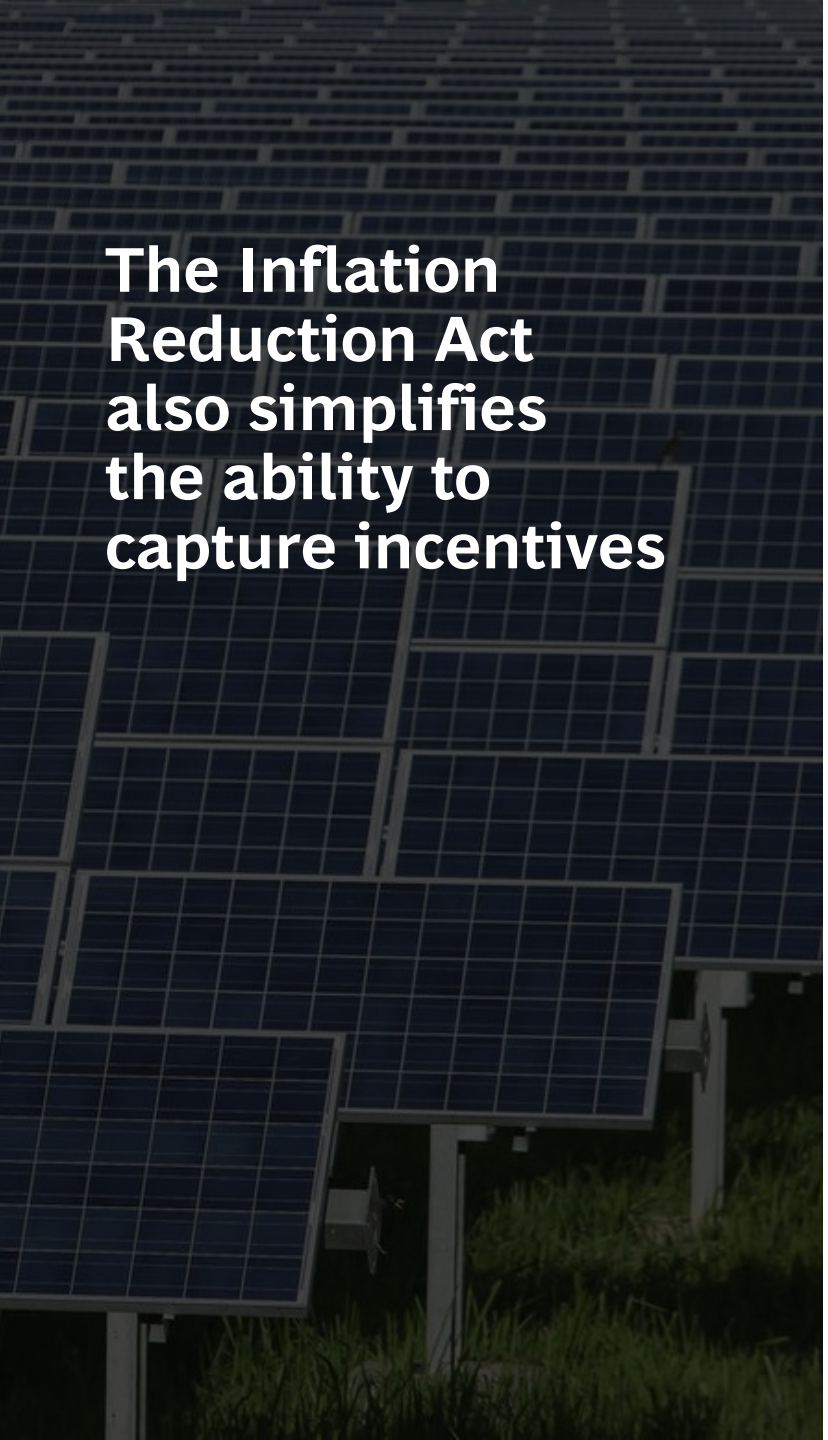
2020 volume | 2030 volume, base case (conservative adoption rates) | 2030 volume, 'deep green'(wider adoption rates)

Clean hydrogen's cost reductions will drive use as a low-carbon fuel for energy or transport, and as a feedstock to decarbonize production of steel and other materials

Increased cost competitiveness of carbon capture bring carbon abatement for several sectors in-the-money, e.g., refining, cement, and steel

With expectations of cost declines, support for DAC provides "backstop" carbon removal technology

1. Does not include direct air capture (DAC)



The Inflation Reduction Act also simplifies the ability to capture incentives

Investment clarity

Qualification timing: Bills provides funding for projects that start construction by the end of 2032

Funding duration: Several incentives provide tax credits for 10+ years (e.g., 10-year clean energy production tax credit, 12-year carbon sequestration tax credit)

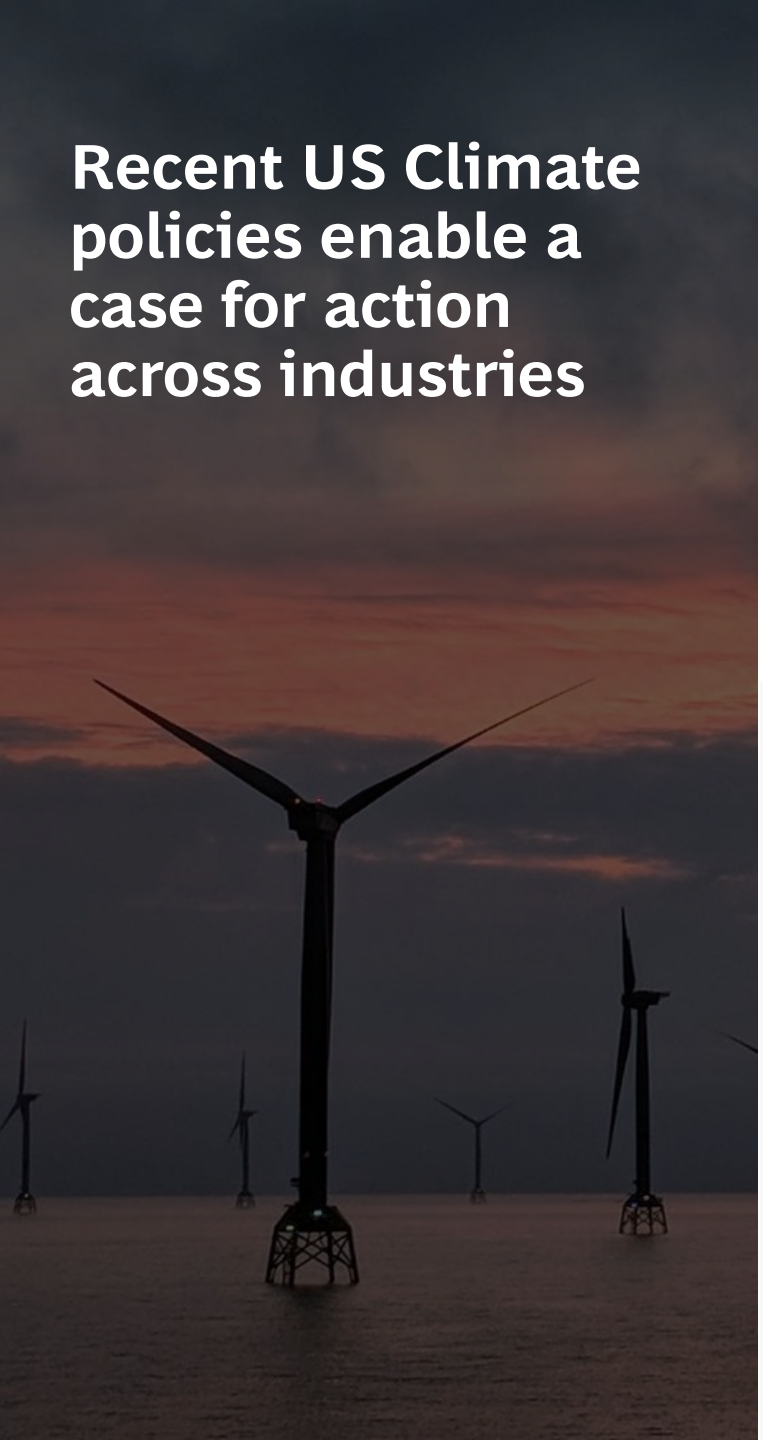
Transferability

Transferability removes need for equity investment to receive tax credits, simplifying financing

Direct pay

Direct pay allows immediate payment rather than tax credit for EVs, but is allowed in only limited settings for other incentives (e.g., only tax-exempt and governmental entities for renewables, only allowed for 5 years for carbon capture)

Recent US Climate policies enable a case for action across industries



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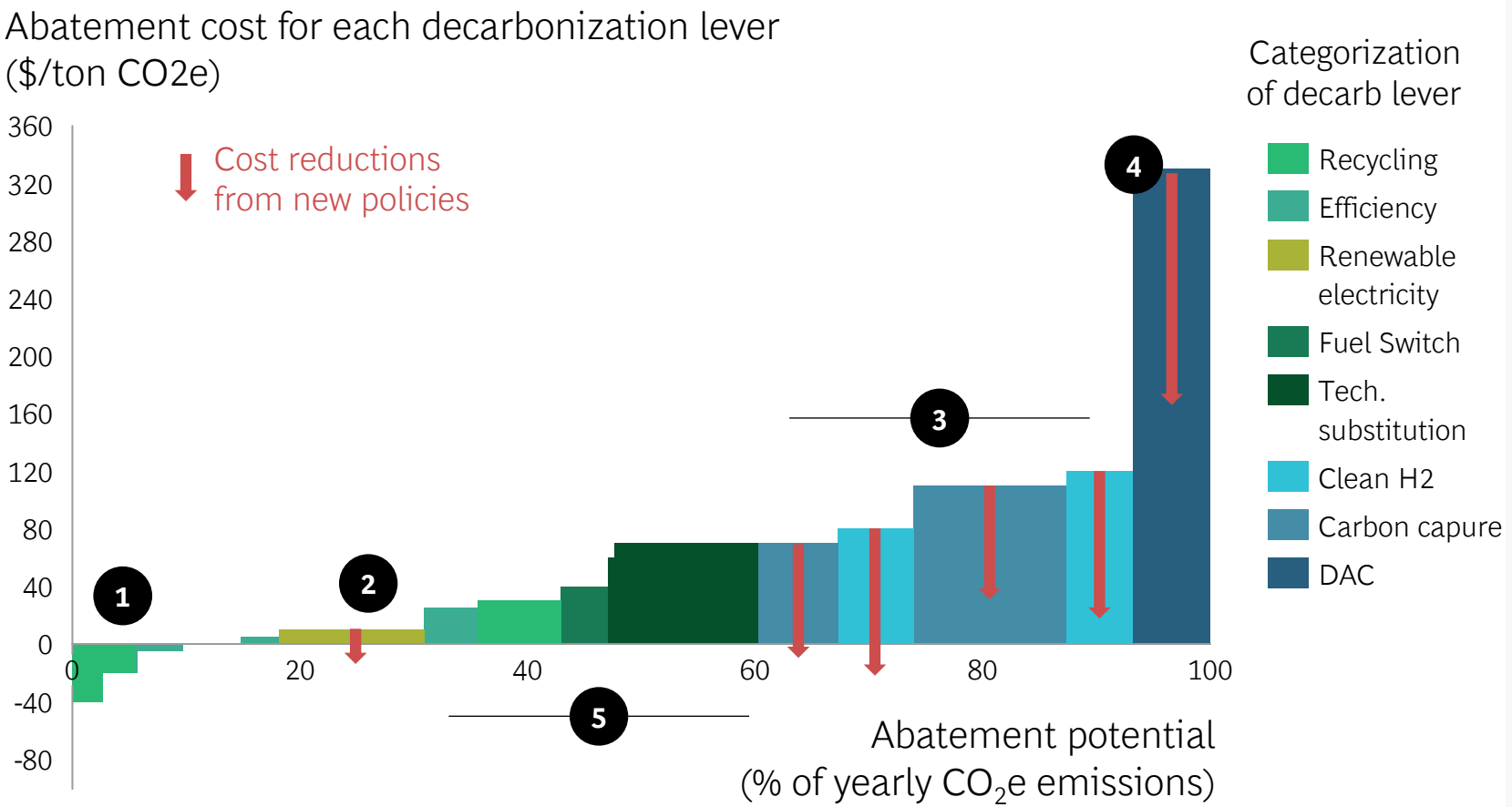
2 Reevaluate decarbonization plans | Massive changes to decarbonization actions: Steel example

Illustrative example – steel industry

Abatement cost curve for direct operations of illustrative steel plant

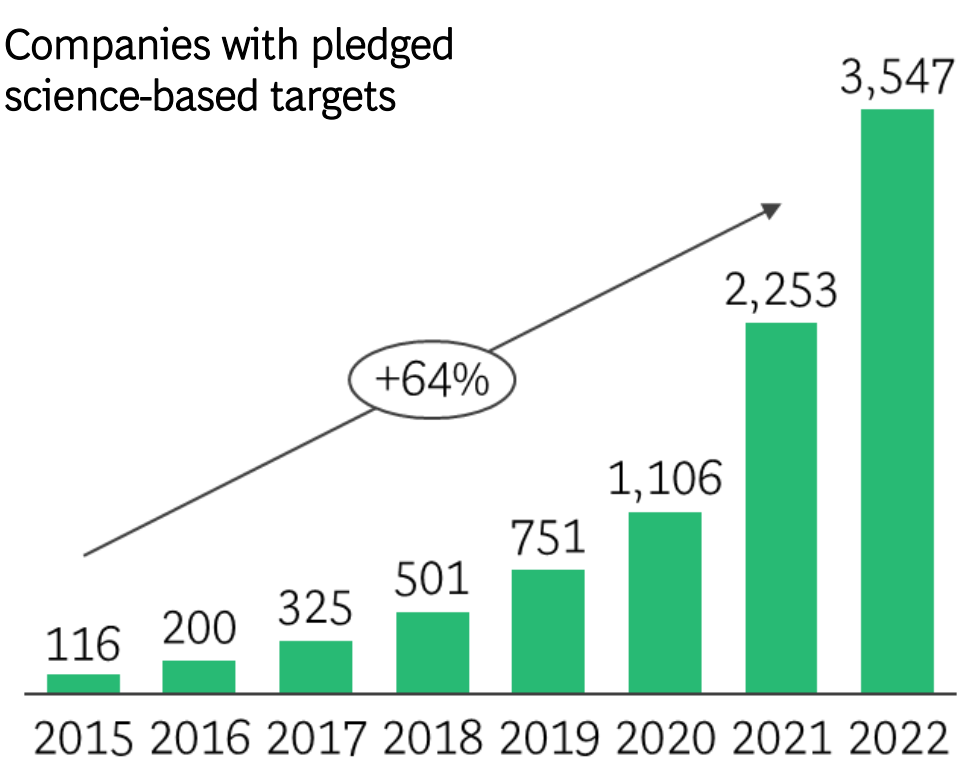


1. Lowest cost decarbonization levers are often already cost-saving
2. Switching to renewable energy reduces absolute costs based on new incentives, in addition to abating greenhouse gas emissions
3. Certain clean hydrogen (H2) and carbon capture levers are now in-the-money; others are not yet but are now higher priority
4. Direct air capture (DAC) provides an abatement cost ceiling
5. Other technologies are now relatively more expensive as decarbonization levers, changing prioritization and tradeoff considerations

Note: Assuming 2500 Mt of crude steel production by 2040; CO2e (carbon dioxide equivalent)
Source: BCG Decarbonization tool; BCG analysis

2 Capture early mover advantage | 'Sustainability scarcity' is likely, given expected rapid scale-up

Corporate decarbonization commitments have continued to grow…



… but supply is expected to fall short of demand for several key technologies

4x

Forecasted supply of US solar will need to grow by ~**4x** to meet demand by 2030

100x up to **200x**

Supply of green hydrogen will need to grow **100 – 200x** to meet projected global demand by 2050

1/3

Supply of key metals for battery production is **less than 1/3** of what is required to meet 2030 demand[1]

Source: Net Zero Tracker; Science-Based-Targets initiative (SBTi); Cairn Energy Research Advisors; Renewable Energy Buyers Alliance (REBA) Corporate Renewable Energy Deal Tracker, 2019, Wood Mackenzie Global Solar PV Market outlook Q4 2021, Net additions, Solar PV - IEA Renewables 2021, Cairn Energy Research Advisors, The Global Commitment 2020 Progress Report

2 Pursue new value pools | New value pools will emerge in energy, transportation, and manufacturing

Carbon-free energy

1 A **technology/software company** expands its asset management and analytics product to manage the operations of the growing base of utility-scale renewables

5 A **smart home and home security** player expands offering to support residential customers with rooftop solar and distributed battery installation

Transportation

2 A **medium-duty OEM of ICE vehicles** starts manufacturing electric delivery trucks and also expands into services associated with EV charging infrastructure

6 A **heavy-duty vehicle service company** with sites across the US expands it's offering to cover electric and fuel cell vehicles for fleet operators and long-haul trucking players

Clean tech

3 An **energy player** builds large scale green hydrogen parks in advantaged US hubs to produce green Ammonia for export

Deep dive provided on next page

7 A **chemicals company** scales up production of CO_2 adsorbent to take advantage of a growing carbon capture market

Manufacturing

4 A **pulp and paper manufacturer** builds a cost advantaged zero carbon facility in the US to sell net zero packaging solutions to the global market

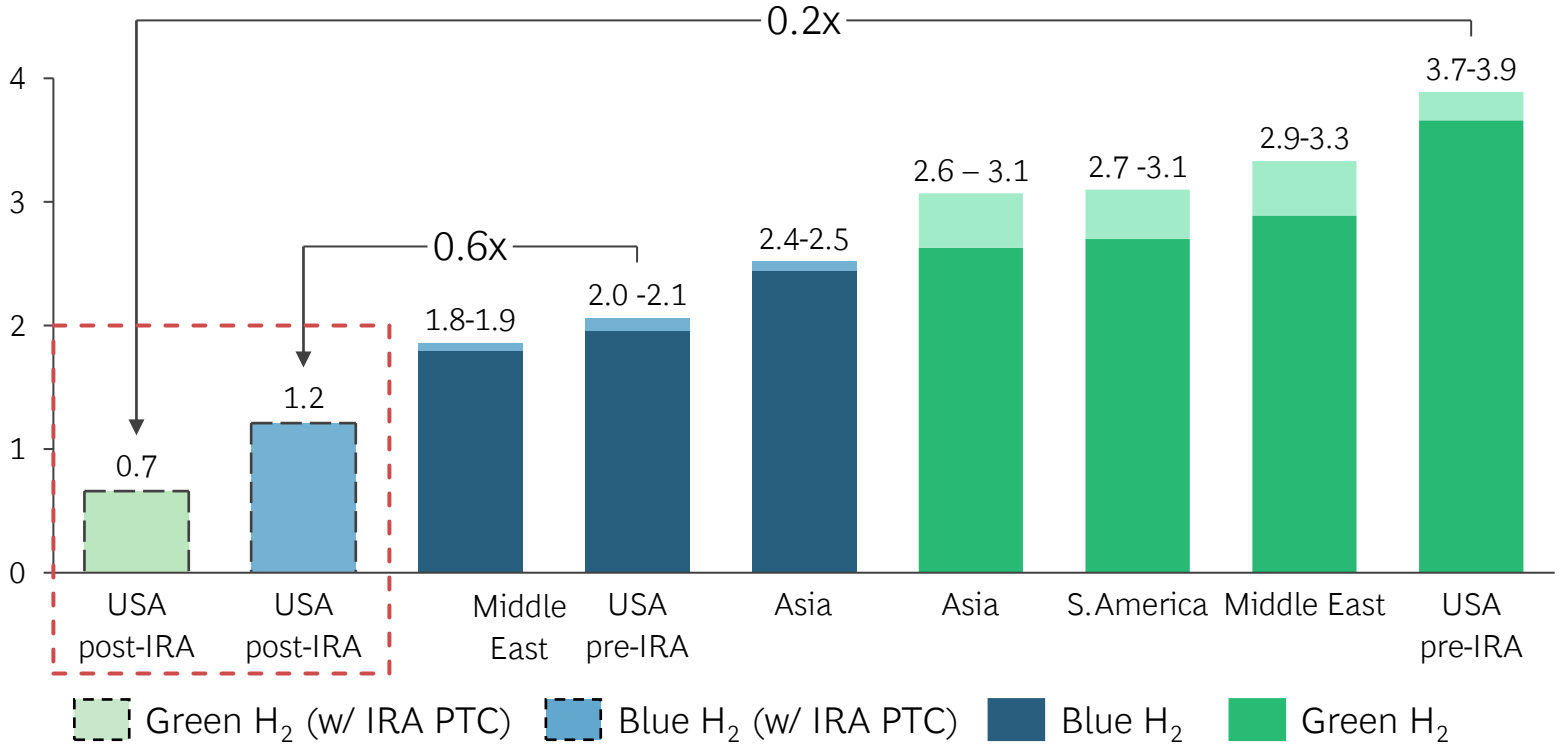
8 A **metals processing company** builds new capacity to supply processed ore to EV battery cell and pack manufacturers

2 Pursue new value pools | US export competitiveness will improve in a step change: N. Asia Hydrogen Example

Illustrative example – Low-Carbon Hydrogen in N. Asia

Delivered Levelized Cost of Low-Carbon Ammonia (LCOH) in N. Asia

2030 Delivered LCOH ($/kg H2 eq.) in N.Asia[1]



Green: Renewable energy + water electrolysis

Blue: Carbon capture on fossil-derived hydrogen

Pre-IRA: US-produced blue H_2 competitive with but not cheapest source of clean hydrogen for N. Asia consumption

Post-IRA: **US H_2 becomes the most competitive option** for N. Asia

The incentives shift competitiveness of green vs. blue H_2, and have **long-reaching global impacts that re-order supply competitiveness of the US vs. others**

1. Median delivered cost shown where applicable; Note: Includes high-potential supply sources into N. Asia, not exhaustive; Middle East, S. America and Asia are representative of individual countries in region; IRA includes $3/kg Production Tax Credit (PTC) for Green Hydrogen and $0.75/kg PTC for Blue Hydrogen;
Source: BCG Hydrogen Supply Model

Closing thoughts: Far-reaching climate & energy legislation, implementation is a huge effort

This legislation reduces the cost of low-carbon technologies, at scale, making many of them more competitive than fossil-fuel based technologies by 2030 in many applications and sectors, with far-reaching impacts across the economy, including those shared here

The incentives become more straightforward to access in many cases, but there are additional challenges to be overcome for implementation:

- Detailed rulemaking and regulatory clarity on specifics to access full bonus amounts
- Regulatory support, e.g., simplified permitting, pending potential companion legislative action
- Supply chain bottlenecks, to ensure adequate supply regardless of origin of components
- Development considerations and constraints, e.g., water availability and land use concerns

There will be meaningful knock-on effects, both globally and at the state & local level, including similar laws in other countries, complementing state legislation (e.g., the recent climate bill in Massachusetts), etc.

Beyond its broad, industrial policy-like approach, the bill may also shape consumer perceptions, shifting the 'new normal' for renewable energy, electric vehicles, H2, and other key components of a low-carbon economy

Further reading

Electric vehicles

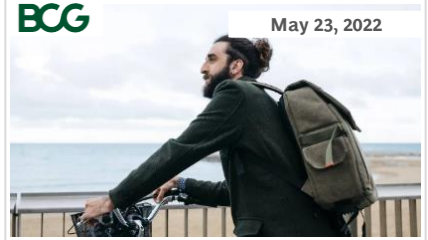
Electric Cars Are Finding Their Next Gear

US Inflation Reduction Act Implications for Auto Industry

Decarbonizing supply chains

Value Creation in a Decarbonizing Economy

Climate Disruption and the Path to Profits for Machinery Makers



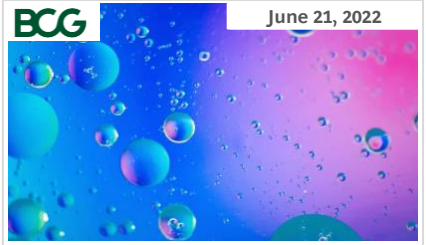
The Climate Actions Companies Should Take Today

Energy transition

An Inflection Point for the Energy Transition

Hydrogen

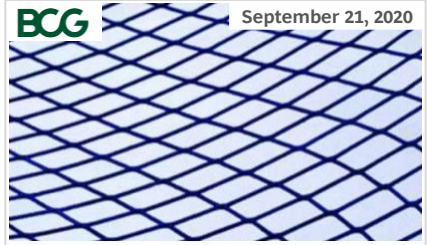
The Green Tech Opportunity in Hydrogen



How to Meet the Coming Demand for Hydrogen

Carbon capture

The Business Case for Carbon Capture



Think Small to Unlock Carbon Capture's Big Potential

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