Impact of IRA, IIJA, CHIPS, and Energy Act of 2020 on Clean Technologies

Deep Dive | Direct Air Capture

APRIL 2023
1. Legislation assessed here includes Inflation Reduction Act (IRA), Infrastructure Investment and Jobs Act, CHIPS and Science Act, and the Energy Act of 2020
Source: BCG analysis
Direct Air Capture (DAC) | Executive Summary

Direct funding from the IIJA and expanded tax credits from the IRA will drive ~5-15 Mtpa in DAC deployments by 2030 and make the US the most attractive location for future DAC projects, with the $180/tCO₂e value from the IRA higher than any other scheme for monetizing carbon removals¹

These deployments will be kickstarted by $3.5B in funding from the IIJA for an initial 4+ Mtpa of US DAC deployments across 4 DAC hubs (up from <0.1 Mtpa today) with a further ~$5B to support buildout of CO₂ transport / storage infrastructure.

Subsidized prices for high quality carbon removals will also stimulate demand, allowing the US to invest in domestic manufacturing capabilities and rapidly commercialize novel tech (e.g., metal organic frameworks), driving down costs from ~$600/tCO₂e today to ~$300/tCO₂e in 2030.

These policies and the U.S.’s leadership in DAC will drive ~$0.2B in additional exports through 2030 ($0.3B in 2030 vs $0.1B without policy support) as costs decline and create up ~1,000 new jobs through 2030, primarily from domestic DAC deployments leveraging novel tech selling into global CO₂ removal credit markets.

To support U.S. competitiveness, future policies should focus on further driving DAC down the cost curve via continued RD&D and commercialization funding, targeting <$100 / tCO₂e at which point significant global demand is expected to be unlocked.

Additionally, alignment with international standards for carbon removals will open access to export markets and streamlined permitting & direct government procurement of DAC removals will allow project developers to de-risk projects and build robust pipelines.

1. EU ETS near peak value of ~$100/tCO₂e but not applicable for carbon removals as of 2022  2. Total number of positions created through 2050; incremental new jobs calculated as the sum of all non-negative one-year differences in # job-years (e.g., 2021 job-years minus 2020 job-years gives 2021 new jobs); incremental new jobs added to sum from prior period for cumulative calculation.  

Note: All numbers on lefthand side are based on projections from the IEA’s 2021 Announced Pledges (APS) scenario and are cumulative from 2020-50 for all value chain segments.

Source: DOE; IEA; BCG Analysis
Recent policies have resulted in significant increases in size of US market, exports, and jobs within DAC although market remains small through 2030

Impact of recent US policies (incl. IRA, IIJA) on cumulative market & job creation from 2020-2030

**US domestic market**
- US cumulative domestic market through 2030 increased from $1.1B to $2.8B after IRA/IIJA due to increased domestic deployments

**US exports**
- US cumulative exports through 2030 increased from $0.1B to $0.3B after IRA/IIJA due to expanded domestic manufacturing

**US job creation**
- New job creation in US DAC industry ('20-'30) increased to ~1,000 after IRA/IIJA due primarily to increased domestic deployments

Note: All numbers based on IEA WEO STEPS scenario pre- and post-IRA based on change over timeframe from 2020-2030
Source: BCG analysis
Legislation impact | IRA & IIJA support of DAC expected to drive a ~4x increase in DAC deployments by 2030 and drive down net costs by ~50%

**DAC deployed capacity expected to increase ~400% by 2030**

DAC Deployed Capacity (Mt CO2/yr)

- **2020 Capacity**: <0.1
- **2030 Capacity/Volume pre-incentives**: 1
- **2030 Capacity/Volume post-incentives; Base Scenario**: 5
- **2030 Capacity/Volume post-incentives; Optimistic Scenario**: 16

Large range of potential outcomes given favorable conditions within the US

**Unit costs expected to reduce an additional 10-25% by 2030 from IRA...**

Incremental % change of unit cost in 2030 relative to 2022

- **Business as usual**: -45%
- **Capacity & learning rate effect**: -10-25%
- **Total cost decline**: -55 - 70%

**Projected cost of DAC ($/tCO2) inclusive of new tax credits, 2022 vs. 2030**

<table>
<thead>
<tr>
<th>Year</th>
<th>Total cost pre-incentive</th>
<th>LCFS Credit Price</th>
<th>45Q Tax Credit</th>
<th>Net cost of DAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>2022</td>
<td>$600&lt;sup&gt;1&lt;/sup&gt;</td>
<td>$180</td>
<td>$420</td>
<td>$235</td>
</tr>
<tr>
<td>2030</td>
<td>$300&lt;sup&gt;3&lt;/sup&gt;</td>
<td>$180</td>
<td>$120</td>
<td>$10</td>
</tr>
</tbody>
</table>

1. Projected cost of DAC today, 2. Net $/tCO2 will increase once the tax credit window expires, complicating project financing, 3. Projected cost of Liquid solvent DAC 4. 2022 LCFS price based upon the Q3 2021 LCFS average price of $185/t. 2030 LCFS price decline is due to expected surplus of available LCFS credits from renewable diesel expansion 5. Business as usual: 2030 capacity projection pre-IRA based on IEA stated policy (STEPS) scenario 6. Capacity effect: incremental cost reduction due to added US capacity and additional global deployment (assumed 3x US increase) 7. Learning rate effect: incremental cost reduction due to de-risked commercialization (US moving early) and innovation (improved learning rates)

Note: 2030 pre incentives and 2030 post incentives (Base Scenario) based on IEA STEPS projections

Source: IEA, CARB, Stillwater Associates; BCG analysis
Key incentives | Expanded 45Q tax credits from the IRA and ~$12B in funding from the IIJA are the key drivers of this market expansion

Major IRA 45Q expansion significantly decrease projected costs of DAC

Prior 45Q credit of $35-50/tCO2e increased to $130-180/tCO2e, bringing costs down to ~$100/tCO2e level where significant demand is unlocked

Secured Geologic Storage Permitting: Grants for states to establish well permitting programs

Carbon Utilization & Procurement: Grants for state/local govt to procure products made from captured CO2

Carbon Dioxide Transportation Infrastructure: Low-interest loans for large CO2 pipeline projects

Carbon Storage, Validation, and Testing: Funding for commercial large-scale carbon sequestration projects

Carbon Removal: Funding for 4 DAC hubs and pre-commercial demos. Includes $3.5B for DAC hubs and $115M in prizes for demos

Carbon Capture Technology Program (CCUS): Funding for R&D, pilots, and large-scale commercial CCUS projects (not DAC but strong synergies). Includes $3.5B for pilots and demos & $100M for FEED program on CO2 infra

Funding for DAC from IIJA ($B)

- $12B
- $12B
- $2.1B
- $2.5B
- $3.6B
- $3.6B
- $0.3B
- $0.1B

Net $/tCO2 will increase once the tax credit window expires, complicating project financing

Stacking with ~$100/tCO2e LCFS credits in CA can drive costs down to ~$0/tCO2e

1. IIJA appropriated funds for an existing program created by Energy Act of 2020
Source: IIJA; IEA; BCG Analysis
Pre-legislation challenges | DAC deployment dependent on financial support to de-risk projects and enable infrastructure buildout

**Illustrative project timeline**

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Years 2-3</th>
<th>Years 4-5</th>
<th>Years 6+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-development</td>
<td>Design &amp; development</td>
<td>Construction</td>
<td>Operations</td>
</tr>
<tr>
<td>OEM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project development</td>
<td>Tech/site evaluation</td>
<td>Installation (w/ EPC)</td>
<td>Solvent management</td>
</tr>
<tr>
<td></td>
<td>GTM strategy</td>
<td>Financing evaluation &amp; finalization</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Customer, partner &amp; site selection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPC</td>
<td>FEED study</td>
<td>Project management</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Construction prep</td>
<td>Construction</td>
<td></td>
</tr>
<tr>
<td>O&amp;M</td>
<td></td>
<td>Capture ops, maintenance, etc.</td>
<td></td>
</tr>
<tr>
<td>Transport &amp; storage</td>
<td>Land &amp; pore access</td>
<td>Environmental impact &amp; permits</td>
<td></td>
</tr>
<tr>
<td>Offtake</td>
<td>FEED study</td>
<td>CO2 injection permitting</td>
<td>Pipeline &amp; storage monitoring</td>
</tr>
<tr>
<td></td>
<td>Credit certification</td>
<td></td>
<td>Ongoing offtakes</td>
</tr>
</tbody>
</table>

**Key pre-IRA gaps to be addressed**

1. Most DAC technology remains too expensive to economically remove significant amounts of CO₂
2. Limited regulations around CO₂ emissions and lack of monetization mechanisms today limit widespread deployment of DAC
3. Insufficient renewables infrastructure available to fully power DAC facilities
4. Long permitting timelines and limited clarity on long-term storage and monitoring liability slows down project development
5. Insufficient infrastructure currently built out with few permitted wells for CO₂ storage
6. Few & inconsistent standards around carbon removals limits demand for high quality DAC credits

Source: ADB; International CCS Knowledge Center; BCG analysis
Remaining challenges | Additional policy intervention is needed to provide long-term clarity and certainty for continued DAC investment

Pre-legislation priority challenges

1. High cost of DAC tech

2. Limited regulations around CO2 emissions & lack of monetization mechanisms

3. Insufficient renewables infrastructure to power DAC facilities with challenges around permitting and transmission

4. Long permitting timelines and limited clarity on CO2 storage liability

5. Insufficient CO2 transport & Storage infrastructure

6. Lack of standards around carbon removals

Changes from recent legislation (IRA, IIJA, CHIPS, and EA 2020)

- RD&D funding for novel & modular techs to drive down cost
- $4B in direct funding for DAC Hubs from IIJA

- Expanded $130-180/tCO2e tax credit from 45Q in IRA

- Various ITCs and PTC for renewable energy and funding for transmission and storage buildout

- $100M for states to establish well permitting programs in IIJA

- $2.1B for financing CO2 pipelines in IIJA
- $2.5B for large-scale carbon sequestration projects

Remaining areas to target with future policies

- Continued support needed for commercialization of US-developed technological breakthroughs to support R&D to project pipeline

- Limited demand for developing new DAC projects without permanent mechanism for pricing CO2 (by-sector or economy-wide)

- Continued need for baseload renewables (e.g., geothermal, storage) / transmission near DAC facilities & CO2 storage sites

- Limited clarity on long-term storage & monitoring processes & liabilities at the federal level

- Need for further analysis of sub-surface capacity in US and other countries where US companies could develop projects

- Need to work with international community to define standards for high quality removals

Source: C2ES; DOE; IIJA; IEA; BCG Analysis
Summary | Actions to further boost U.S. competitiveness

Key levers that will enable the US to win the DAC market

- **RD&I and commercialization support**
  Support for early commercial DAC deployments and follow-on funding for initial manufacturing hubs to drive costs down to <$100/tCO2e

- **Regulations & long-term monetization opportunities**
  Permanent monetization opportunities (e.g., LCFS in CA, direct government procurement) for DAC projects to replace 45Q after it expires and/or regulations mandating CO2 reductions

- **Alignment with international standards**
  Establish quality and verification standards for DAC credits (e.g., permanence) and align on standards with key export partners to ensure offtake and de-risk market for buyers

- **Processes & infra. for long-term storage**
  Streamline federal rules for storage and monitoring (e.g., length of liability), define clear permitting processes, and invest in necessary infrastructure to allow OEMs to deploy their tech at scale

Source: BCG analysis
## Backup | New legislation provides incentives for Direct Air Capture (I/II)

<table>
<thead>
<tr>
<th>Provision</th>
<th>Summary</th>
<th>Type</th>
<th>Total investment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IRA Section 13104</strong></td>
<td>Increases tax credit 45Q for sequestration and utilization to a maximum of $180/t for sequestration and $130/t for use with additional prevailing wage and apprenticeship requirements</td>
<td>Production Tax Credit (PTC)</td>
<td>$3.22B to 2033</td>
</tr>
<tr>
<td><strong>IIJA DAC Hubs</strong></td>
<td>Authorizes program for projects that contribute to development of 4 regional DAC hubs. Facilities must capture min of 1M MtCO2e and be located in regions with fossil fuel industry</td>
<td>Grant Funding</td>
<td>$3.5 billion to 2026</td>
</tr>
<tr>
<td><strong>IIJA/Energy Act² DAC Technologies Prize Competitions</strong></td>
<td>Prize competition to qualified¹ DAC facilities of metric tons of qualified CO2 &amp; verified disposal/utilization. Facilities must capture &gt;50k tCO2/yr</td>
<td>Grant Funding</td>
<td>$115 million to 2025</td>
</tr>
<tr>
<td><strong>IIJA Sec. 40302/Energy Act³ Carbon Utilization Program</strong></td>
<td>State/local government grants to procure products derived from captured carbon. Expands DOE’s Carbon Utilization program to include standards &amp; certifications for commercialization of CO₂ products</td>
<td>Grant Funding</td>
<td>$310 million to 2026</td>
</tr>
<tr>
<td><strong>IIJA Sec. 40303 / Energy Act³ Carbon Capture Technology Program</strong></td>
<td>Expands DOE’s Carbon Capture Technology program to include front-end engineering &amp; design for CO₂ transport infrastructure</td>
<td>Grant Funding</td>
<td>$100 million</td>
</tr>
</tbody>
</table>
| **IIJA Sec. 40304 CO₂ Transportation Infrastructure Finance & Innovation** | Establishes CO₂ Infrastructure Finance and Innovation Act, providing flexible, low-interest loans for CO₂ transport infrastructure projects & grants. | Loan Authority / Market Enabler | $2.1 billion  
• $600M for 2022-2023  
• $300M for 2024-2026 |

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1. Must capture carbon directly from ambient air, must capture more than 50,000 metric tons of qualified CO2 annually  
2. DAC Tech Prize Competitions was originally approved in the Energy Act of 2020 and funded in the IIJA  
3. Originally approved in Energy Act of 2020; Source: DOE, IRA, IIJA, BCG Analysis
## Backup | New legislation provides incentives for Direct Air Capture (II/II)

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<tr>
<td>IIJA Sec. 40305 / Energy Act(^1) Carbon Storage Validation &amp; Testing</td>
<td>Expands DOE’s Carbon Storage Validation &amp; Testing program to include large-scale commercialization of new/expanded sequestration projects &amp; transport infrastructure</td>
<td>Grant Funding</td>
<td>$2.5 billion to 2026</td>
</tr>
<tr>
<td>IIJA Sec. 40306 Secure Geologic Storage Permitting</td>
<td>Funding for permitting of wells for geologic sequestration of CO2 &amp; creates grant program for states to establish Class VI permitting programs</td>
<td>Grant Funding</td>
<td>$75 million</td>
</tr>
<tr>
<td>IIJA Sec. 40307 Geologic Carbon Sequestration</td>
<td>Allows DOI to permit carbon sequestration on outer Continental Shelf</td>
<td>Market Enabler</td>
<td>N/A</td>
</tr>
<tr>
<td>IRA Section 13501: 48C Advanced Energy Manufacturing Project Tax Credit</td>
<td>Extension of the advanced energy manufacturing project credit. Base rate of 6% and 30% tax credit if wage and apprentice requirements are satisfied</td>
<td>Manufacturing Tax Credit</td>
<td>$10B</td>
</tr>
<tr>
<td>CHIPS Sec. 10102</td>
<td>Establishes a “Carbon Sequestration Research and Geologic Computational Science Initiative” and at least two carbon storage research and geologic computational science centers</td>
<td>Market Enabler</td>
<td>$250M through 2027</td>
</tr>
</tbody>
</table>

1. Originally approved in Energy Act of 2020  
Source: DOE, IRA, IIJA, BCG Analysis
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