Assessing the Sectoral Value of Carbon Capture and Storage, given the New Economics of Solar PV

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Carbon Capture and Storage

- Applications across the energy system:
  - Power
  - Industry
  - Hydrogen Generation
  - Liquids Production

- CCS in IAM literature generally has:
  - High Deployment
  - High Value

Source: Huppman et al. (2018) – IAMC 1.5°C Scenario Explorer
The new economics of solar PV

Methodology

2DS

Vary Sectoral Availability of CCS

Information on the value of CCS in different sectors

2DS

Vary Cost of Solar PV

Information on how the sectoral value of CCS is eroded by cost reductions in PV

2DS-FullTech
2DS-NoIndustrialCCS
2DS-NoH2CCS
2DS-NoBECCS
2DS-NoFossilCCS

2DS_NoH2CCS_HighPV
2DS_NoH2CCS_MediumPV
2DS_NoH2CCS_LowPV
Sectoral Value of CCS

2DS Scenarios

- TIAM gives high value to negative emissions
- Value of CCS varies significantly across sector
Sectoral Value of CCS

Sectoral Value of CCS in 2°C-NoLim scenarios

PV cost reductions reduce the value of CCS by:

- 30% (BECCS)
- 40% (Industry and Fossil)
- 70% (Hydrogen)
Case Study: Industrial CCS
Emissions by Sector

Change in Sectoral Emissions due to lack of Industrial CCS
(2°C-NoLim Scenarios)
Case Study: Industrial CCS
Fuel Switching in Buildings Sector

- Shift away from gas and solids (combustion), to heat and electricity
### Case Study: Industrial CCS

**Fuel Switching in Transport Sector**

- Shift away from oil towards biomass and electricity

![Graph showing energy mix changes in 2050](image)

**Final Energy | Transport: Change in Energy Mix in 2050**

No Industrial CCS (2°C-NoLim Scenarios)

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>Change in Energy Mix (EJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>High PV Costs</td>
</tr>
<tr>
<td>Electricity</td>
<td>Medium PV Costs</td>
</tr>
<tr>
<td>Electricity</td>
<td>Low PV Costs</td>
</tr>
<tr>
<td>Gas</td>
<td></td>
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<tr>
<td>Hydrogen</td>
<td></td>
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<tr>
<td>Liquid Biomass</td>
<td></td>
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<tr>
<td>Liquid Oil</td>
<td></td>
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</tbody>
</table>

*Note: The graph illustrates the change in energy mix for different energy sources under the specified scenarios.*
Case Study: Industrial CCS
Fuel Switching in Industrial Sector

- Electricity provides over 50% of final energy by 2100 in the industrial sector.
- Also a significant role for gas as a source of medium and high-grade heat.
Case Study: Industrial CCS

Fuel Switching in Industrial Sector

- Electricity provides over 70% of final energy by 2100 in the industrial sector.
- Fossil fuel utilisation in industry falls by 88% from 2050-2100.
Case Study: Industrial CCS
Electricity Generation

- Electricity generation more than quadruples by 2100
- VRE penetration of 60%
- Renewables represent >90% generation
Case Study: Industrial CCS
Electricity Generation

- More rapid phase out of coal (generation falls 94% 2020-2030)
- Electricity demand up 4% by 2050
- Electricity demand post-2050 up by 10-20%
Sectoral Value of Industrial CCS
And the role of low-cost solar PV in eroding it (2°C Scenarios)

No CCS in the Industrial Sector

Less decarbonisation in the industrial sector: Higher residual industrial emissions.

Reliance on alternative means of industrial decarbonisation: Greater long-term electrification of industry.

Quicker phaseout of coal-fired power: Coal generation in 2030 down 75% compared to scenarios with Industrial CCS

Greater near-term electrification of end-use sectors: Electricity demand up 4% by 2050

Greater electricity demand: Electricity demand up 10-20% between 2050-2100

Solar PV meets the generation shortfall from the coal phase-out: PV meets 70-90% of generation shortfall

Solar PV provides much of this additional electricity: PV Generation up 8-10% by 2050

Solar PV provides much of this additional electricity: PV Generation up by 10-40% between 2050-2100
The importance of CCS availability

- Very different forms of CCS are prioritised depending on the overall availability of T&S
Sectoral Value of CCS
Transport and Storage limited to 5GtCO₂/year
• In a world with limited T&S availability, BECCS Liquids has the greatest value.

• Sensitivity of system value to PV cost reductions is altered.
Conclusions and Further Work

Key Points:
- CCS still has significant value in deep mitigation pathways
- The feasibility of large-scale CCS deployment is uncertain
- Future mitigation pathways must be resilient to the potential for technology failure:
  - Understanding the sectoral value of CCS
  - Understanding how the new economics of solar PV can increase resilience to the possibility of CCS failure

Further Work:
- Value of CCS in more stringent mitigation pathways (1.75DS)
- Sensitivity analyses into techno-economics of CCS
Thanks and questions

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