What is the value of CCS?

Piera Patrizio, Yoga Pratama, Niall Mac Dowell

Imperial College London
Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies

S. Pacala* and R. Socolow**
Science, 2004

“We need CCUS, [but] it remains a pre-commercial technology. [In the UK], we want to have the option to deploy CCUS at scale during the 2030s, subject to costs coming down.”
Some key questions

1. Does CCS *have* any value?

2. How helpful are cost targets?

3. Should we believe in unicorns?

4. Other kinds of value?
Some key questions

1. Does CCS have any value?

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4. Other kinds of value?
CCGT-CCS technologies provide the greatest value
Value of CCS is context specific

CF Heuberger, et al, Computers and Chemical Engineering, 2017
Value \neq \text{cost}

**LCOE**

<table>
<thead>
<tr>
<th>25%-75%</th>
<th>UK data</th>
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<tbody>
<tr>
<td>Range within 1.5IQR</td>
<td></td>
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<tr>
<td>Median Line</td>
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<tr>
<td>Mean</td>
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**System Value**

- **Storage**
- **CCS**
- **Onshore Wind**

*CF Heuberger, et al, Computers and Chemical Engineering, 2017*
Some key questions

1. Does CCS have any value?

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How helpful are cost targets?

• We know that CCS
  • Is integral to least cost decarbonisation targets
  • Provides value to the electricity system
  • Is vital to decarbonising industry

• Yet we persistently
  • Hear that the “cost must come down”
  • Wait on new technologies
  • Set isolated cost targets
Some key questions

1. Does CCS have any value?

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4. Other kinds of value?
Should we believe in unicorns?

• We typically assume perfect foresight
• This is not the world we live in...
• Can we trust in technological optimism?
• What is the least regrets strategy?
Perfect foresight capacity expansion

![Graph showing capacity installed (GW) vs. carbon intensity (t_CO2/MWh) for various technologies over time.](image-url)

- **Enforced decarbonisation**
- Lead-acid battery
- Pumped Hydro
- Interconn. (IE)
- Interconn. (FR, NL)
- Solar PV
- Wind-Offshore
- Wind-Onshore
- BECCS
- CCGT-PostCCS
- Coal-PostCCS
- OCGT
- CCGT
- IGCC
- Coal
- Nuclear

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CF Heuberger, et al., Nature Energy, 2018
Imperfect foresight capacity expansion

If the “super tech” fails to materialise, we have an **overbuilt and underutilised** power system.

CF Heuberger, *et al.*, Nature Energy, 2018
Myopia in planning affects operation and cost

CF Heuberger, et al., Nature Energy, 2018
What does matter?

The power system is changing...

“+” → “+++/+++” = low → high value

*modelled as minimum stable generation point, up-/down time

<table>
<thead>
<tr>
<th>Technology Feature</th>
<th>Value in future power systems</th>
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<tbody>
<tr>
<td>High Efficiency</td>
<td>+</td>
</tr>
<tr>
<td>High Flexibility*</td>
<td>++</td>
</tr>
<tr>
<td>Low CAPEX</td>
<td>+++</td>
</tr>
<tr>
<td>Dispatchability</td>
<td>+++</td>
</tr>
<tr>
<td>Firm capacity/ancillary service provision</td>
<td>+++</td>
</tr>
<tr>
<td>Low OPEX</td>
<td>+</td>
</tr>
<tr>
<td>High Rate of Deployment</td>
<td>++</td>
</tr>
</tbody>
</table>

M Schnellmann, CF Heuberger, SA Scott, JS Dennis, N Mac Dowell, 2018, Int J GHG Con, Accepted
Some key questions

1. Does CCS *have* any value?

2. How helpful are cost targets?

3. Should we believe in unicorns?

4. Other kinds of value?
Can we measure social value?

• We need more than just a discussion around technologies...
• Wider social impacts are becoming popular (COP24, UN SDGs)
• How do we account for social equity in evolving energy systems?
• It’s an intertwined word...
Some key questions

1. Does CCS have any value?  YES!

2. How helpful are cost targets?  Unhelpful, and simplistic...

3. Should we believe in unicorns?  No!

4. Other kinds of value?  Jobs; across all levels of the economy...