Updates to Direct Air Capture Sorbent Case Studies

Kshitij Patel[1,2], Hari Mantripragada[1,2], Alex Zoelle[1,2], Sam Henry[1,2], Troy Teel[1,2], Mark Woods[1,2], Timothy Fout[3], Sally Homsy[1]

[1]U.S. Department of Energy (DOE), National Energy Technology Laboratory (NETL), Pittsburgh PA/Morgantown WV; [2]NETL support contractor, Pittsburgh PA; [3]DOE

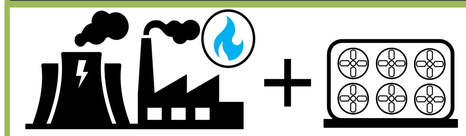
Research & Innovation Center

NATIONAL ENERGY TECHNOLOGY LABORATORY

Background

This poster reports **preliminary results** from an update to NETL's 2022 **"Direct Air Capture [DAC] Case Studies: Sorbent System" (Rev1)**. This series aims to present an independent assessment of the performance and cost of generic sorbent-based DAC case studies and can serve as a guideline for DAC techno-economic analysis development. The cost estimate methodology used is the same one employed by NETL for mature technology and does not fully account for the unique cost premiums associated with the initial, complex integrations of established and emerging technologies in a commercial application.

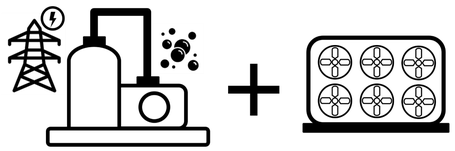
System Configuration (100,000 tonnes $CO_{2\ net}$/yr)



DAC Paired with Combined Heat and Power (CHP)

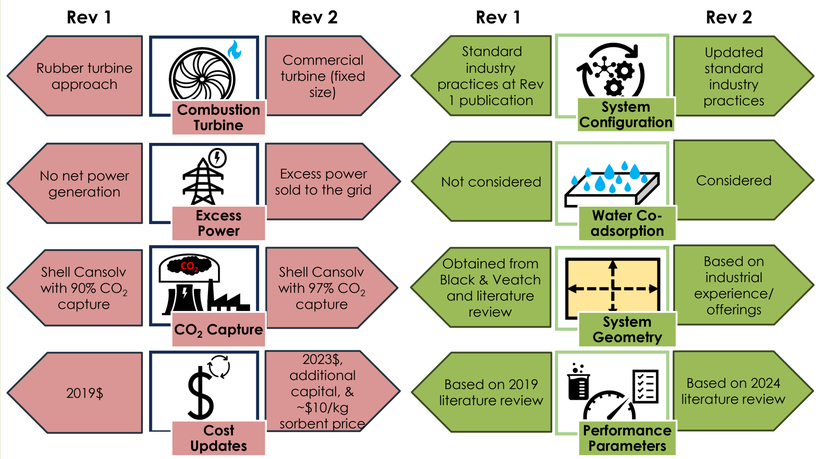
DAC Paired with Electric Boiler (EB)*

*Base case assumes carbon-free grid electricity



Updates for Rev 2

- Process configuration, system performance, and sorbent cost are updated to reflect learnings from recent literature and align with current industry practices
- Two new regeneration schemes are included in the analysis
- The sensitivity analysis is updated and expanded
- Financial parameters are updated in alignment with recent NETL publications



Case Nomenclature

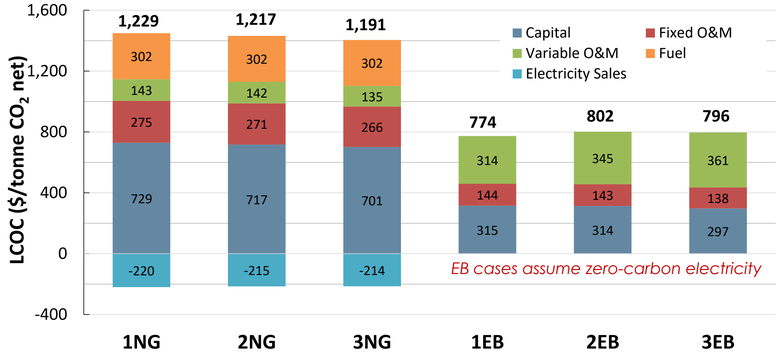
1NG – DAC w/ Direct Temperature Vacuum Swing Adsorption (D-TVSA) + CHP
2NG – DAC w/ Direct Temperature Swing Adsorption (D-TSA) + CHP
3NG – DAC w/ Indirect Temperature Swing Adsorption (ID-TSA) + CHP
1EB – DAC w/D-TVSA + EB
2EB – DAC w/D-TSA + EB
3EB – DAC w/ID-TSA + EB

Performance & Cost Results

Performance Summary

Case → Auxiliary Load (in MWe) ↓	1NG	2NG	3NG	1EB	2EB	3EB
DAC CO_2 Compressor	1.7	1.8	1.7	1.5	1.6	1.6
DAC Fan	19.4	19.4	19.4	17.6	18.1	18.1
CO_2 Capture + Compression (Only NG cases)	6.6	6.6	6.6	-	-	-
Vacuum Compressor	0.4	-	-	0.4	-	-
Electric Boiler (Only EB cases)	-	-	-	27.8	33.5	38.3
Balance of Plant	2.0	2.0	1.6	0.6	0.6	0.2
Total	**30.1**	**29.8**	**29.3**	**47.9**	**53.8**	**58.2**
NG Input Energy (Only NG cases) (in MWth)	260	260	260			

- **NG cases have higher steam demand (2.2-2.6x) than corresponding EB cases.** The steam requirement of the 97% capture system accounts for 50% to 60% of the steam requirement with the remainder due to uncaptured CHP emissions that must be made up for via larger gross DAC CO_2 removal



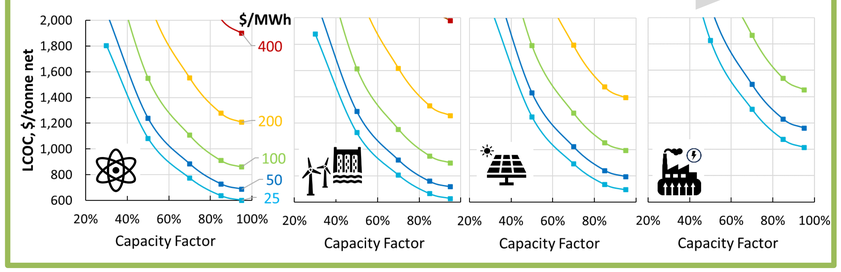
NG cases

- **Capital cost is the largest contributor** to net levelized cost of capture (LCOC)
- Comparison across cases shows that **TVSA will result in a higher COC** due to higher capital expenditures

EB cases

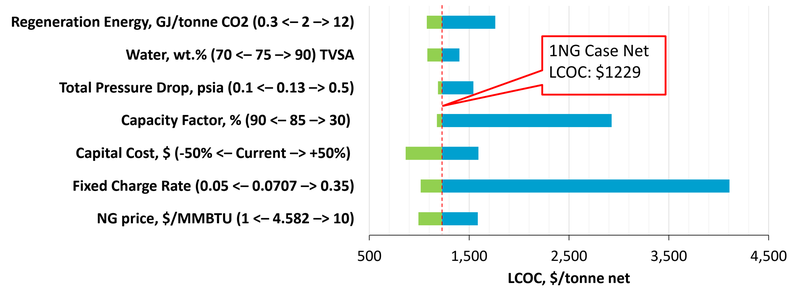
- **Variable operation and maintenance (O&M) accounts for 40–45% of net LCOC**
- Comparison across cases shows that **TVSA will result in lower LCOC** due to reduced variable O&M

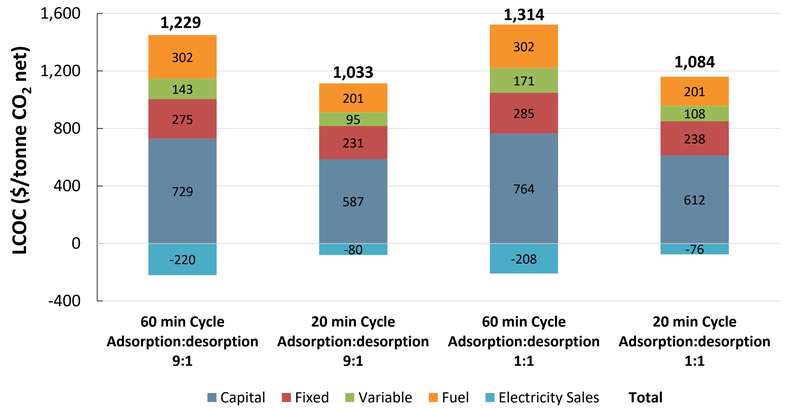
For electric boiler cases, as the carbon intensity of electricity increases, net capture decreases and the LCOC increases (Case 1EB)



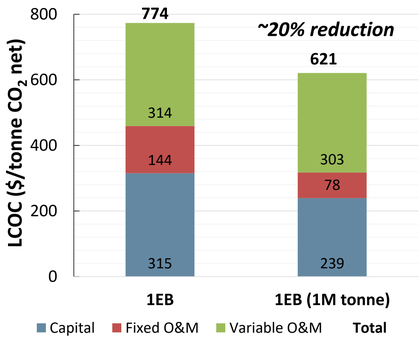
Preliminary Results, Do Not Cite

Sensitivity Analysis





Reducing cycle time from 1 hour to 20 minutes **has the potential to reduce LCOC** by ~20 to 30%



Increasing system **scale to** accommodate a **1 million tonne per year net CO_2 capture rate reduces LCOC by ~20% for** the **1EB case**

QR code link to the Rev 1 Report

Disclaimer

This work was funded by the United States Department of Energy, National Energy Technology Laboratory, in part, through a site support contract. Neither the United States Government nor any agency thereof, nor any of their employees, nor the support contractor, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.