

mote

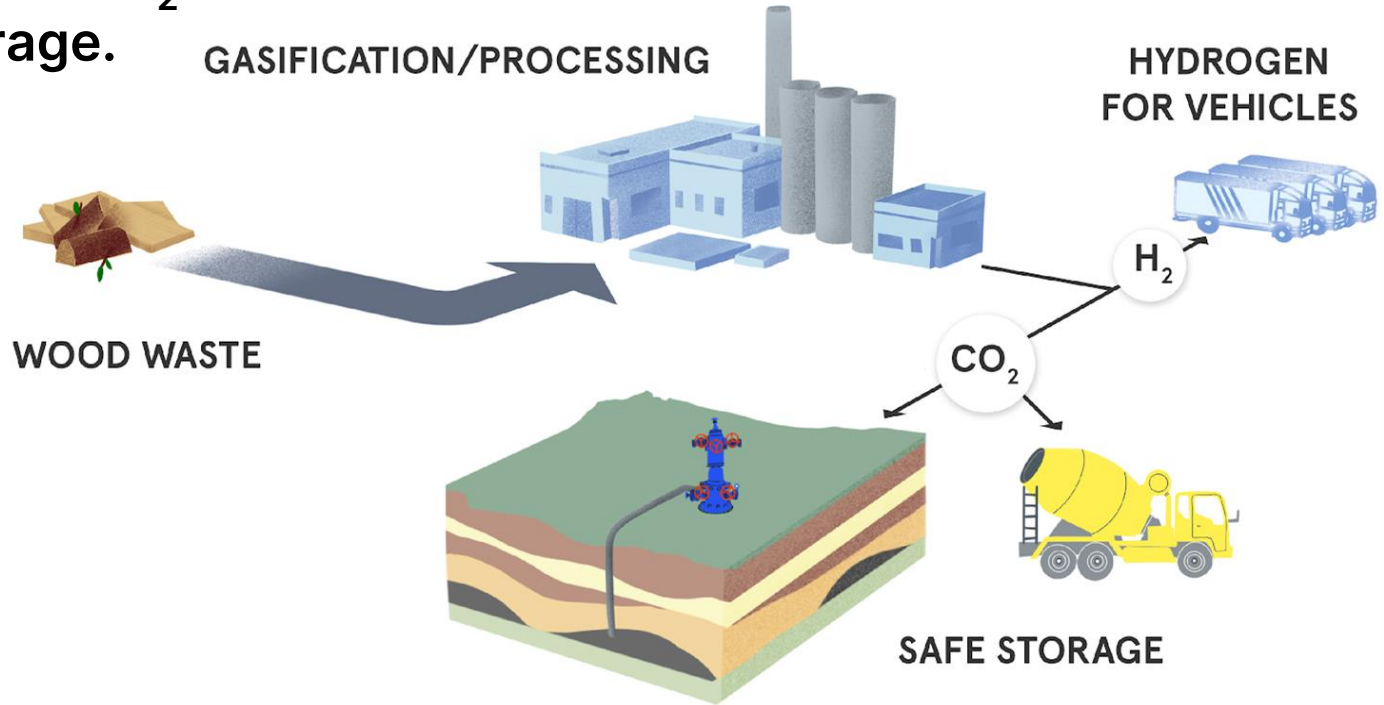
Carbon-negative hydrogen from waste biomass

Joshuah Stolaroff

IEA Task 33 Meeting

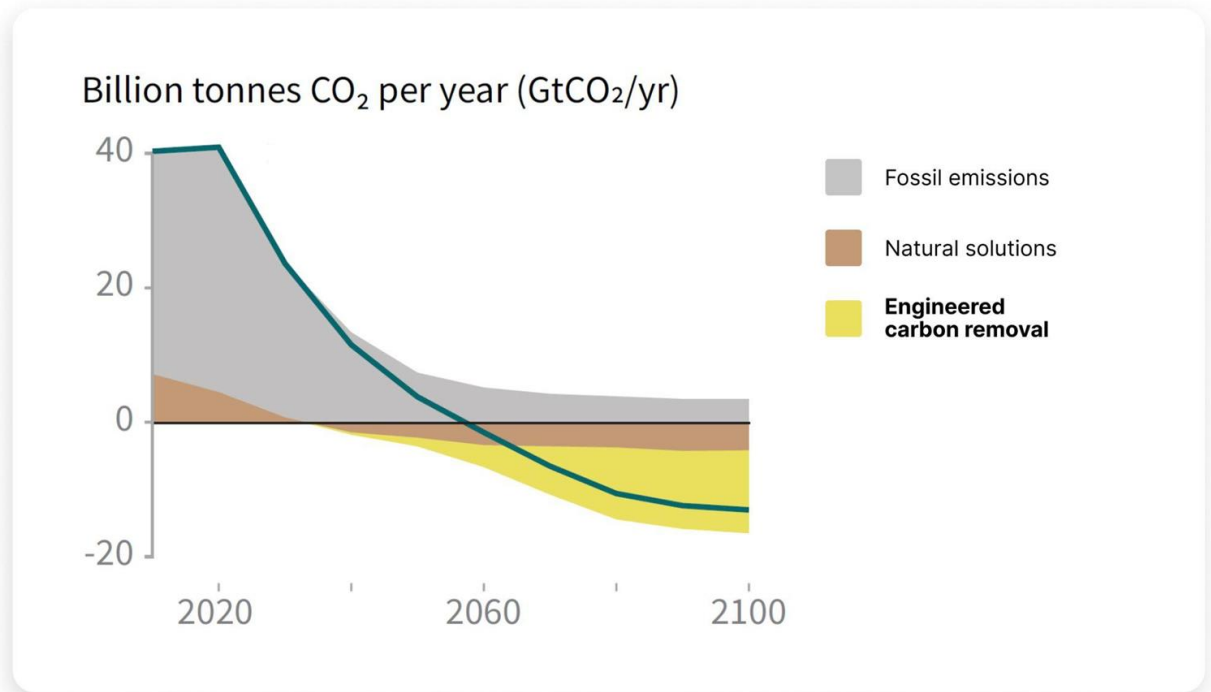
April 19, 2023

We turn woody wastes
into hydrogen for
transportation and CO₂
for geologic storage.



Carbon
removal
makes 1.5°
possible

Gigatons of carbon removal are needed.



Source: IPCC "Middle of the road" scenario (2018)

Net-zero by mid-century is now a widespread goal.

GLOBAL NET ZERO COVERAGE



Country-level coverage only. We do not include sub-national net zero targets in countries without a target.

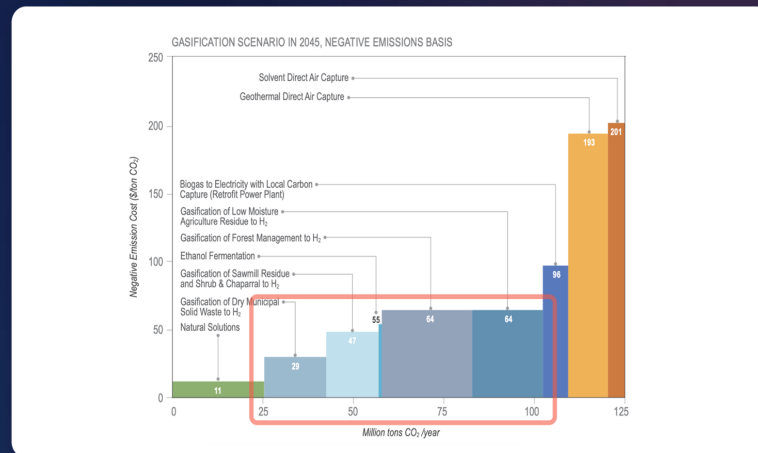
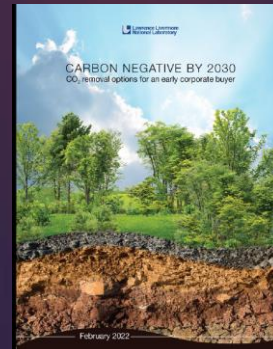
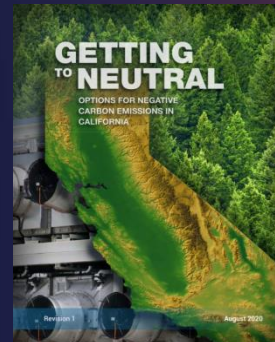
NET ZERO NUMBERS



Out of 198 countries, 713 regions, 1,177 cities and 2,000 companies.

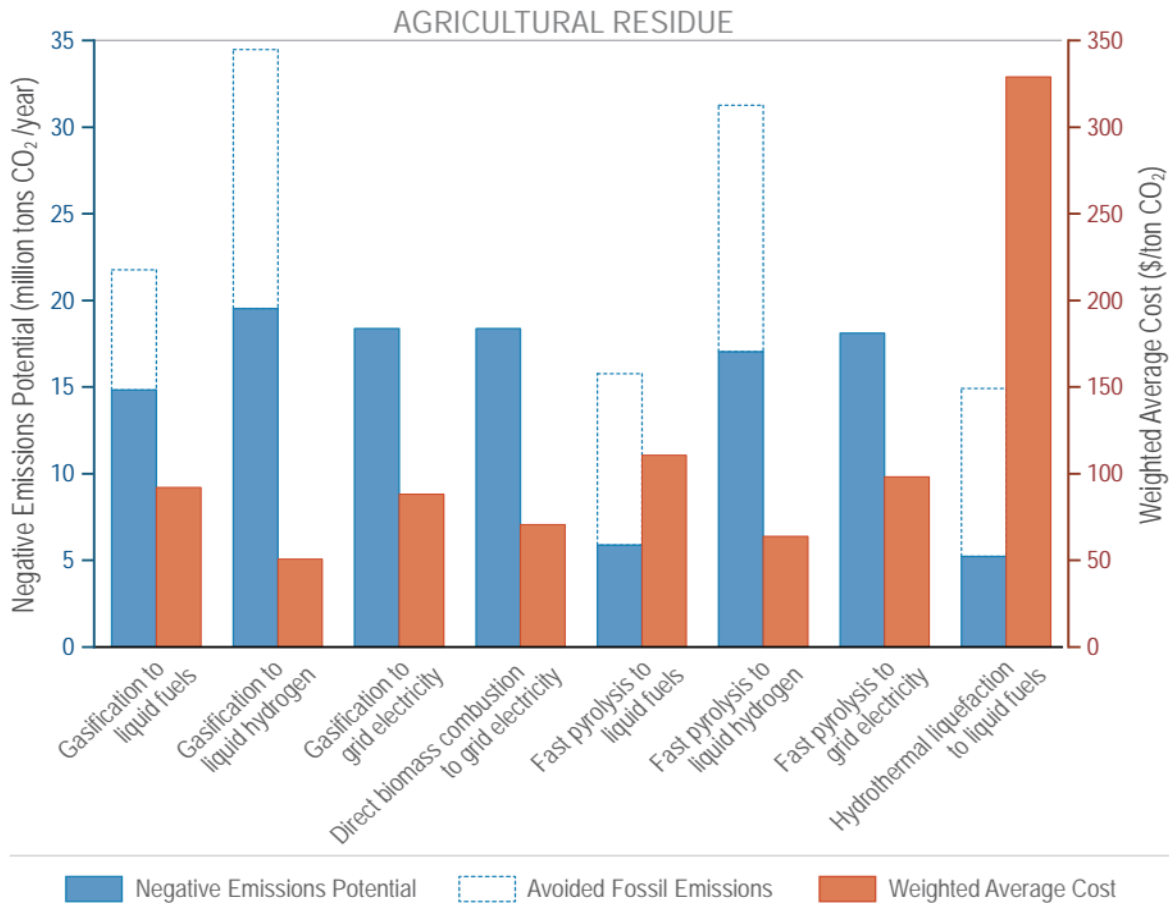
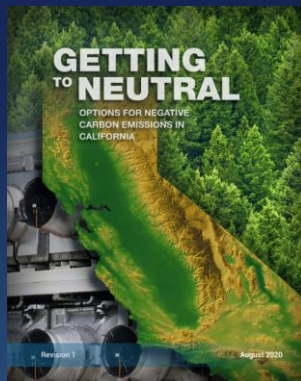
Source: *zerotracker.net*

A climate technology company spun out of work at LLNL



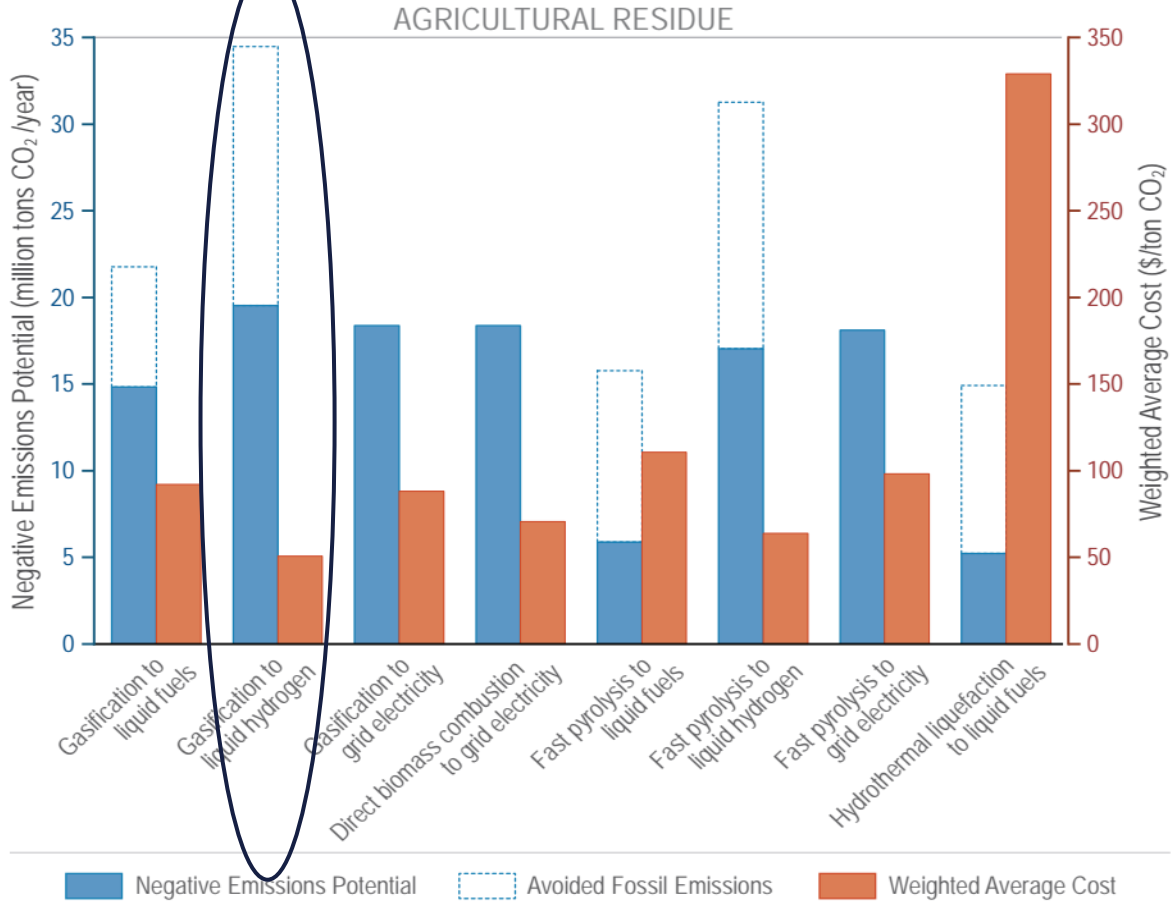
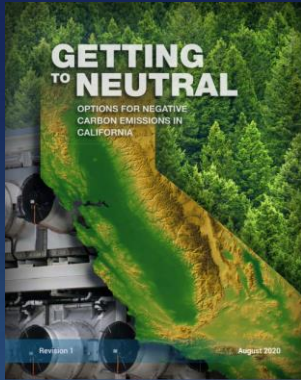
At LLNL, we compared dozens of carbon removal pathways.

Mote's was the best.

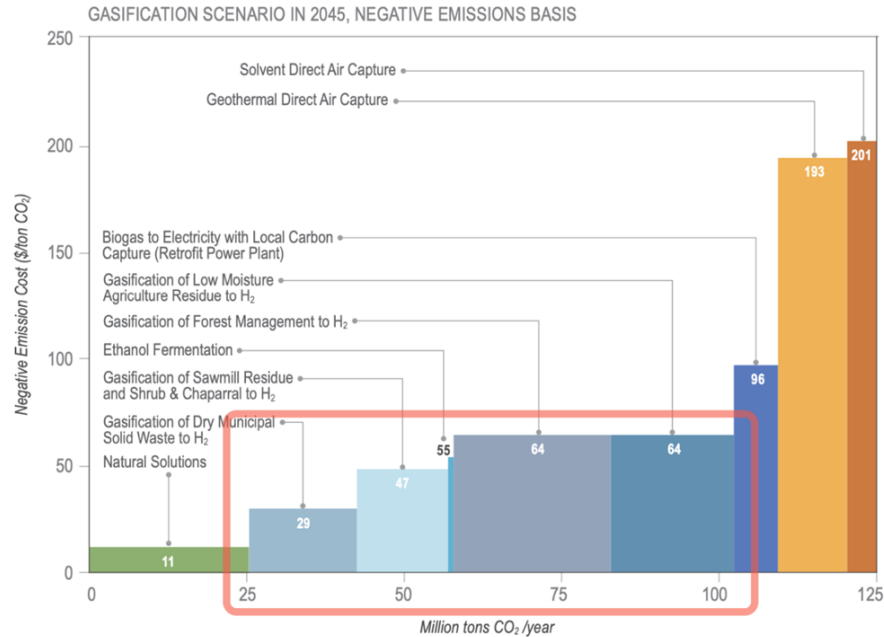


At LLNL, we compared dozens of carbon removal pathways.

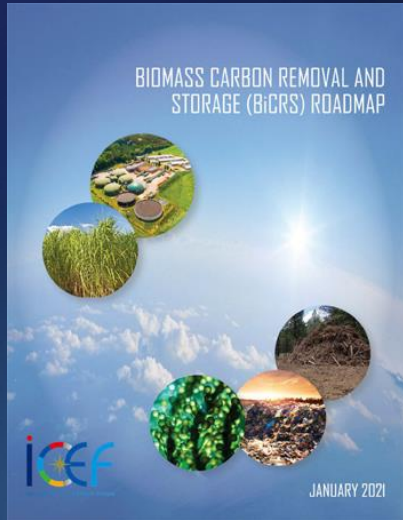
Mote's was the best.



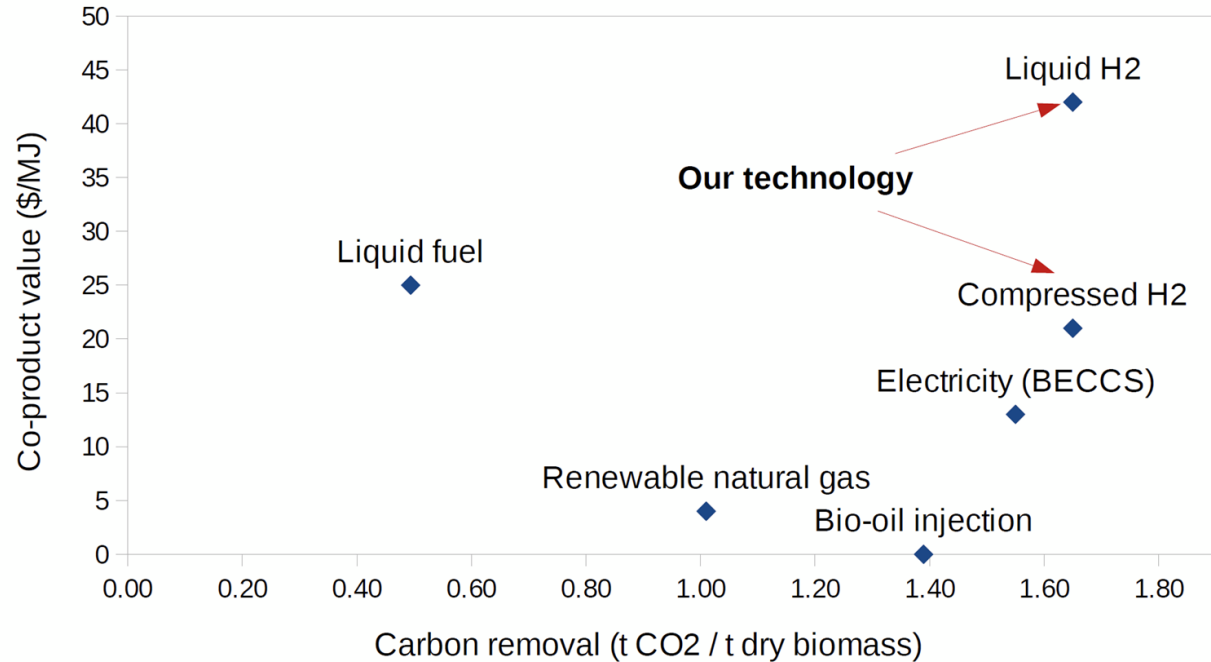
Biomass
gasification to
H2 can meet
the bulk of
California's
carbon removal
needs.



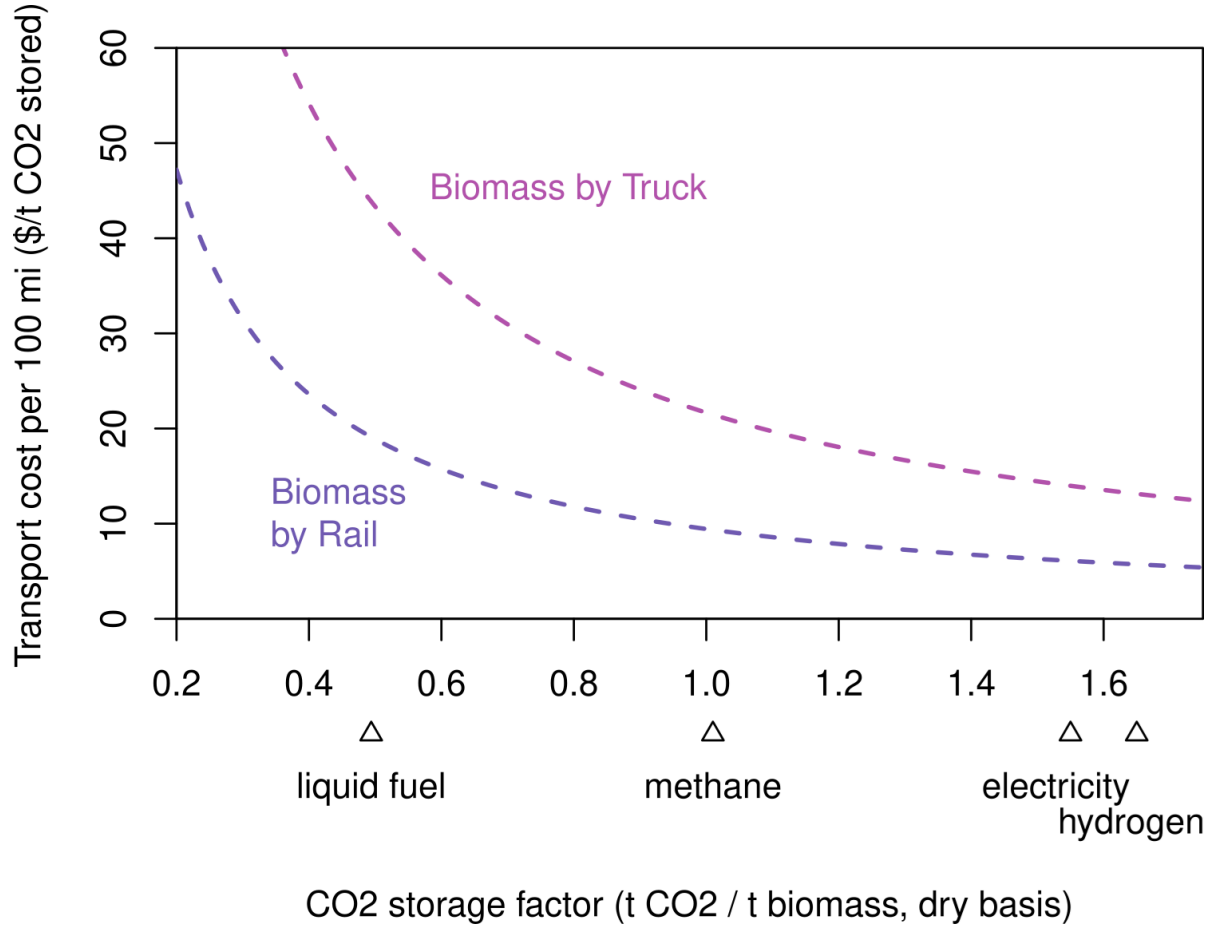
Biomass gasification to hydrogen has fundamental advantages.



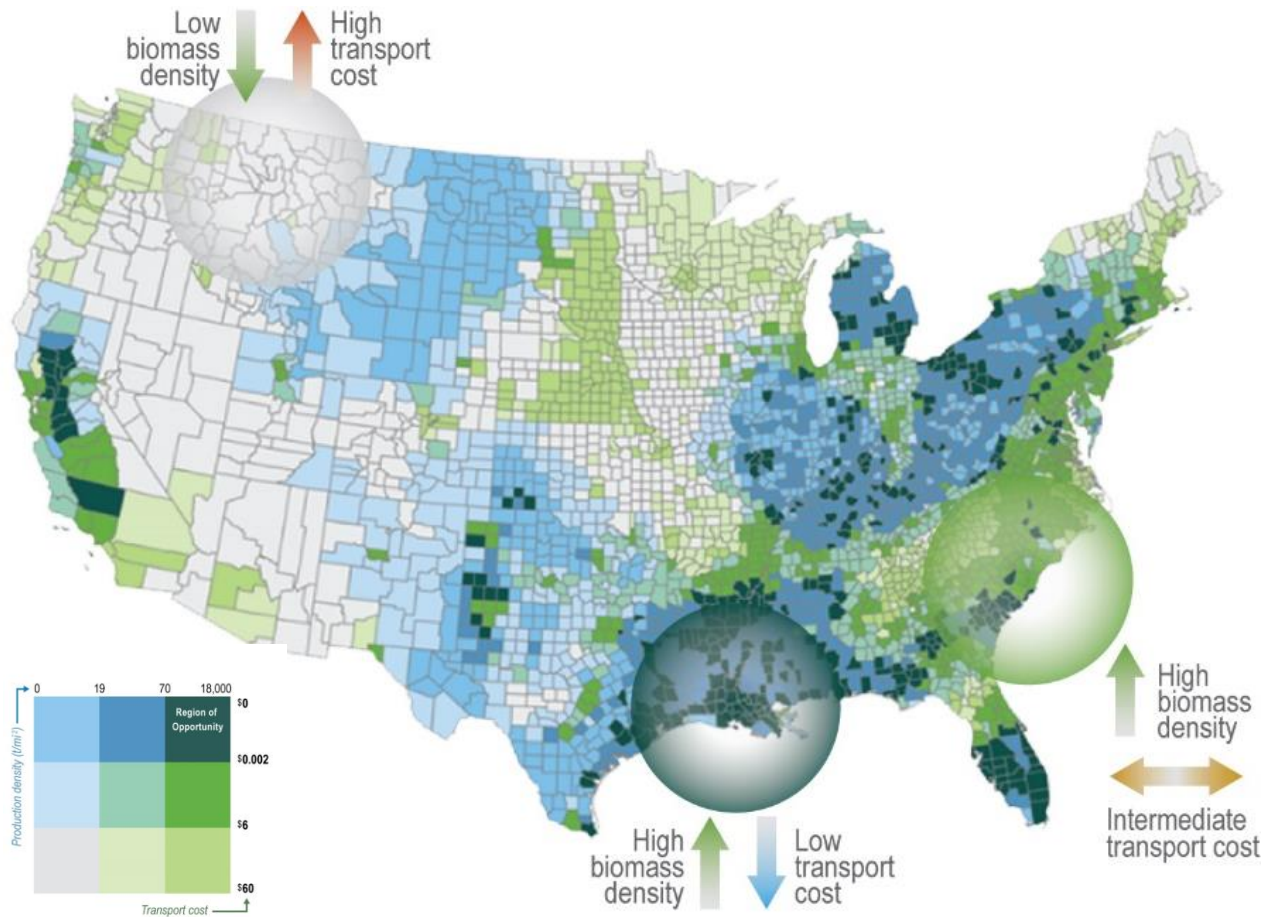
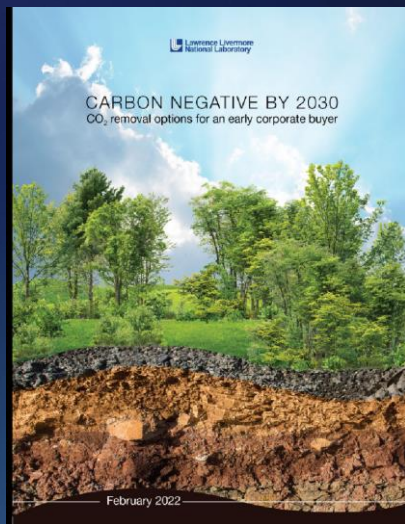
Biomass carbon removal pathways



H₂-BiCRS has better feedstock reach



Enough waste biomass for ~1000 plants in the US.



Entering Front-End Engineering Design for our first facility

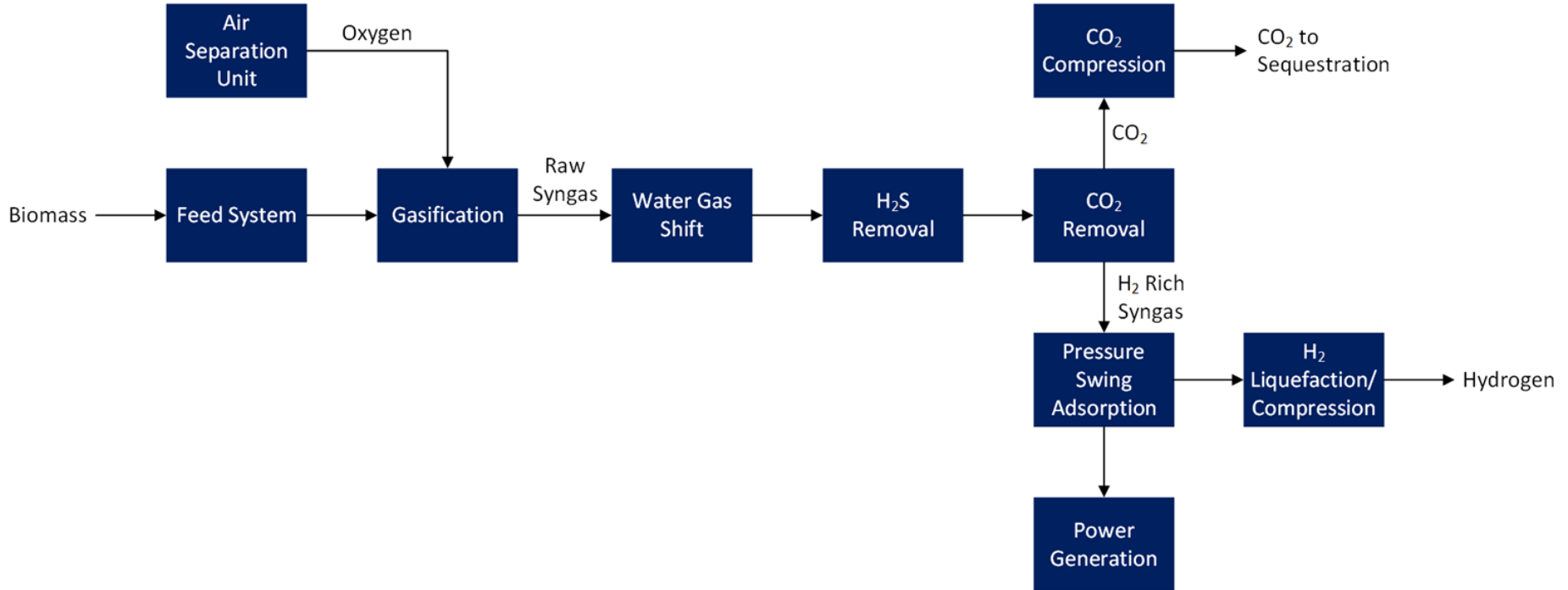


400,000 ton/yr CO₂ removal

60 ton/day hydrogen

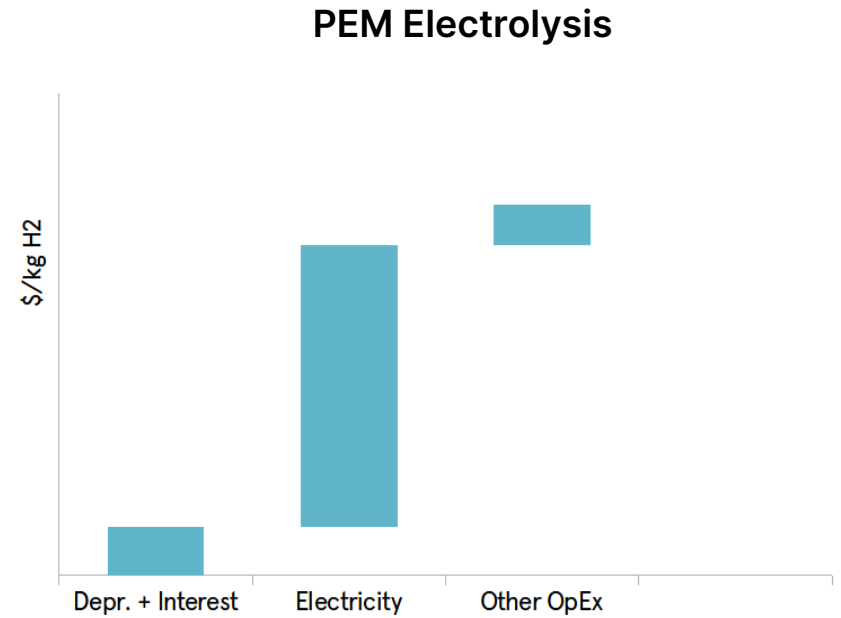
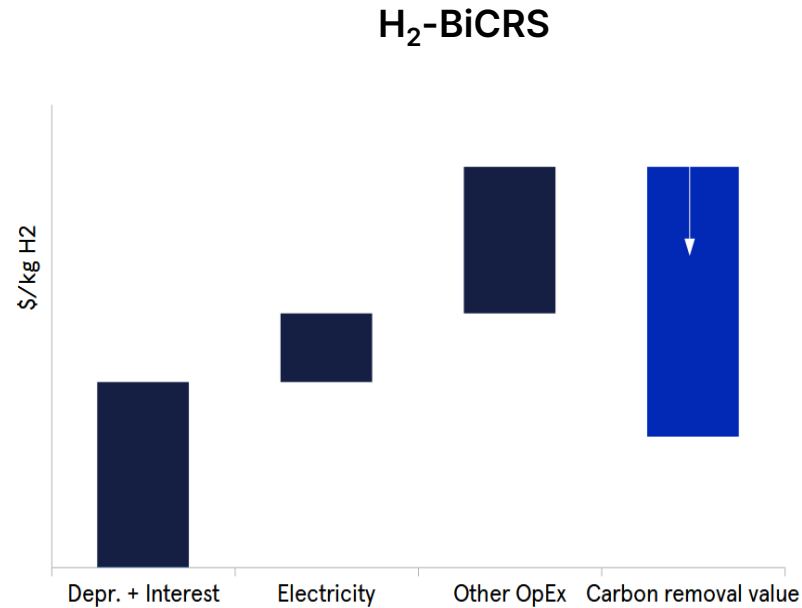
Operation in 2025

Process Overview

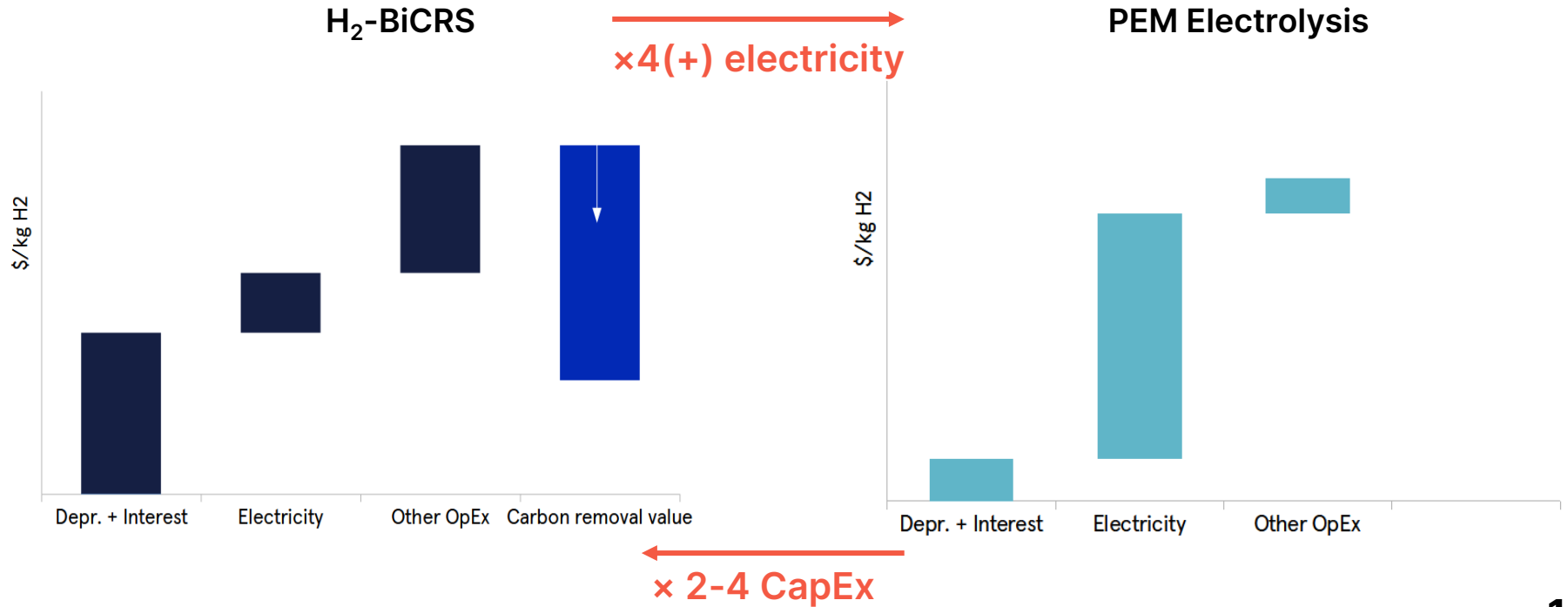


Why biomass instead of electrolysis?

Unit Economics favor H₂-BiCRS over H₂ electrolysis

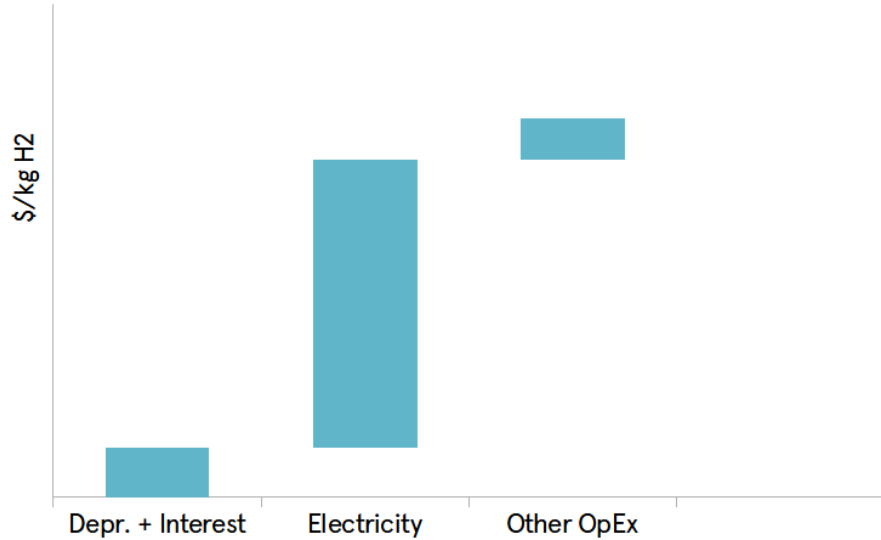


Electrolysis is OpEx heavy, capital light



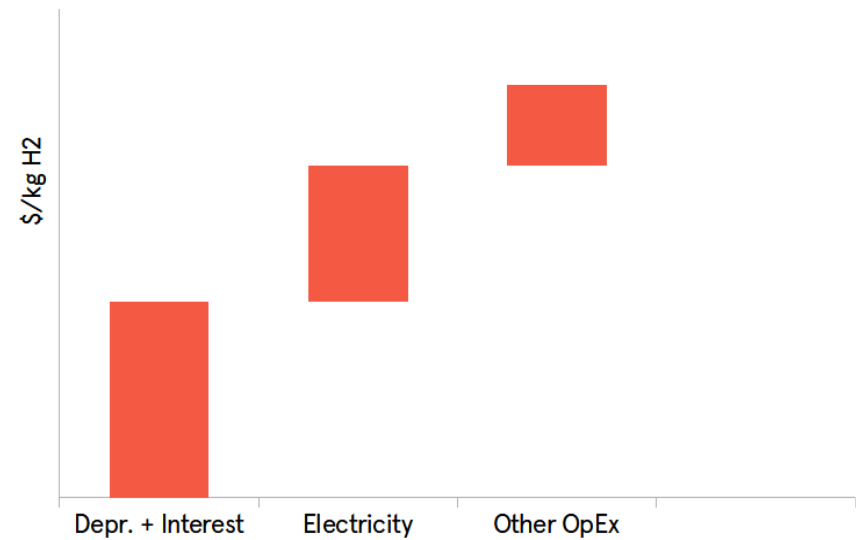
Electrolysis with opportunistic renewables doesn't help on unit costs

PEM Electrolysis



→
×4 CapEx

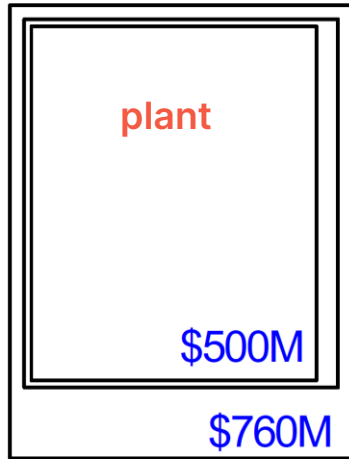
Opportunistic Electrolysis



**Big new projects need new
electricity supply.**

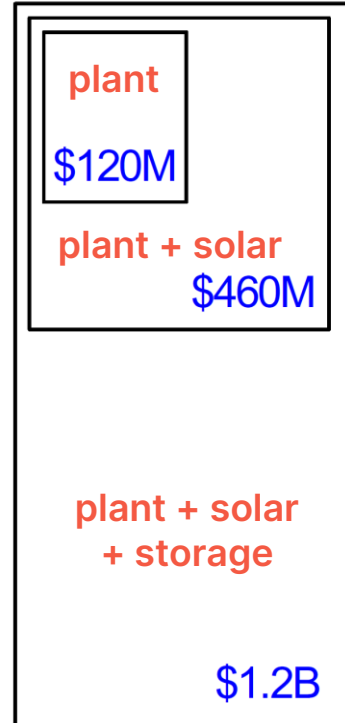
Electrolysis CapEx is high when considering electricity

H₂-BiCRS



plant + solar
+ storage

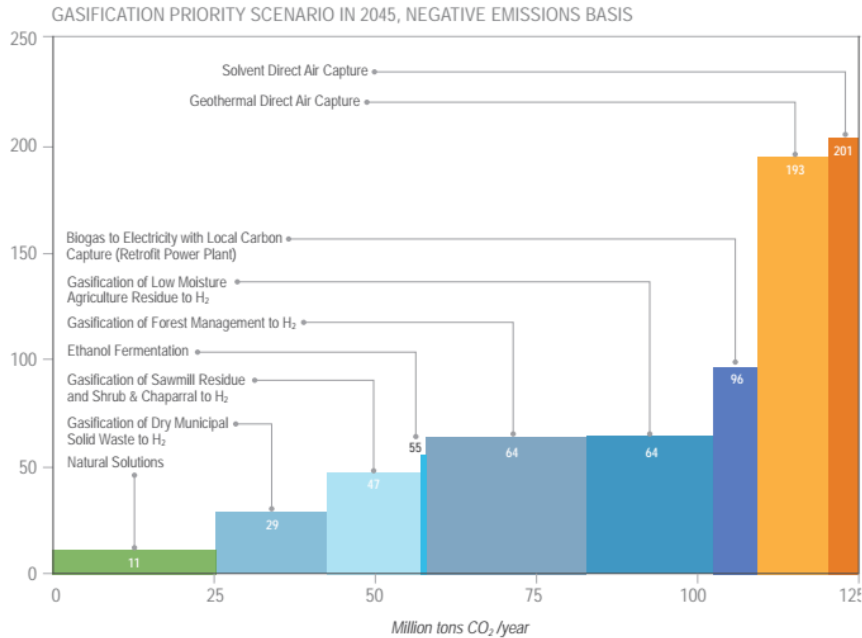
PEM Electrolysis



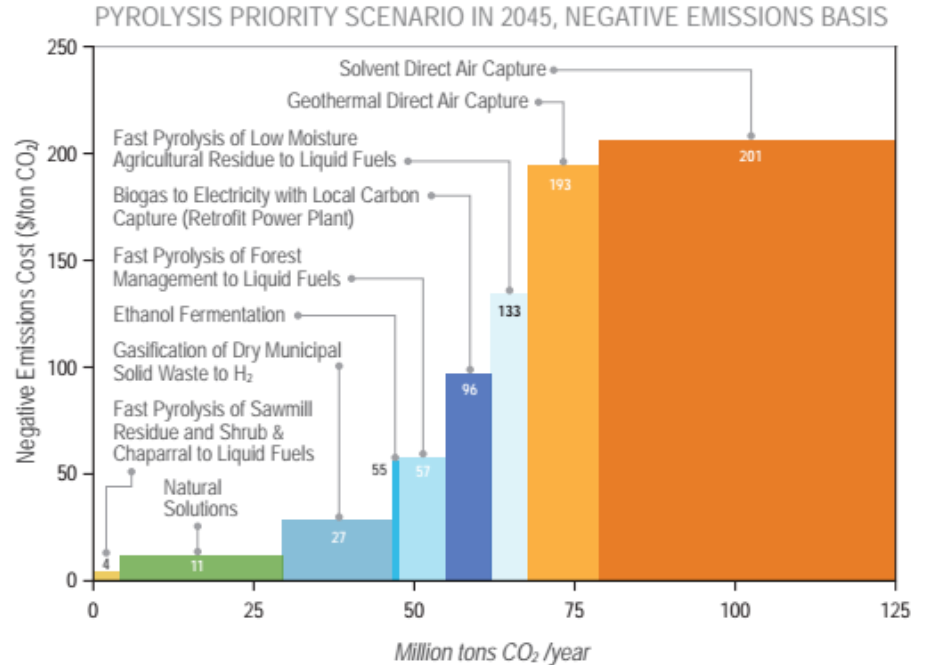
Solar source: NREL. U.S.
Solar Photovoltaic System
and Energy Storage Cost
Benchmarks: Q1 2021

Demand for carbon removal is rigid.

Gaps left by less-expensive carbon removals will be met with Direct Air Capture

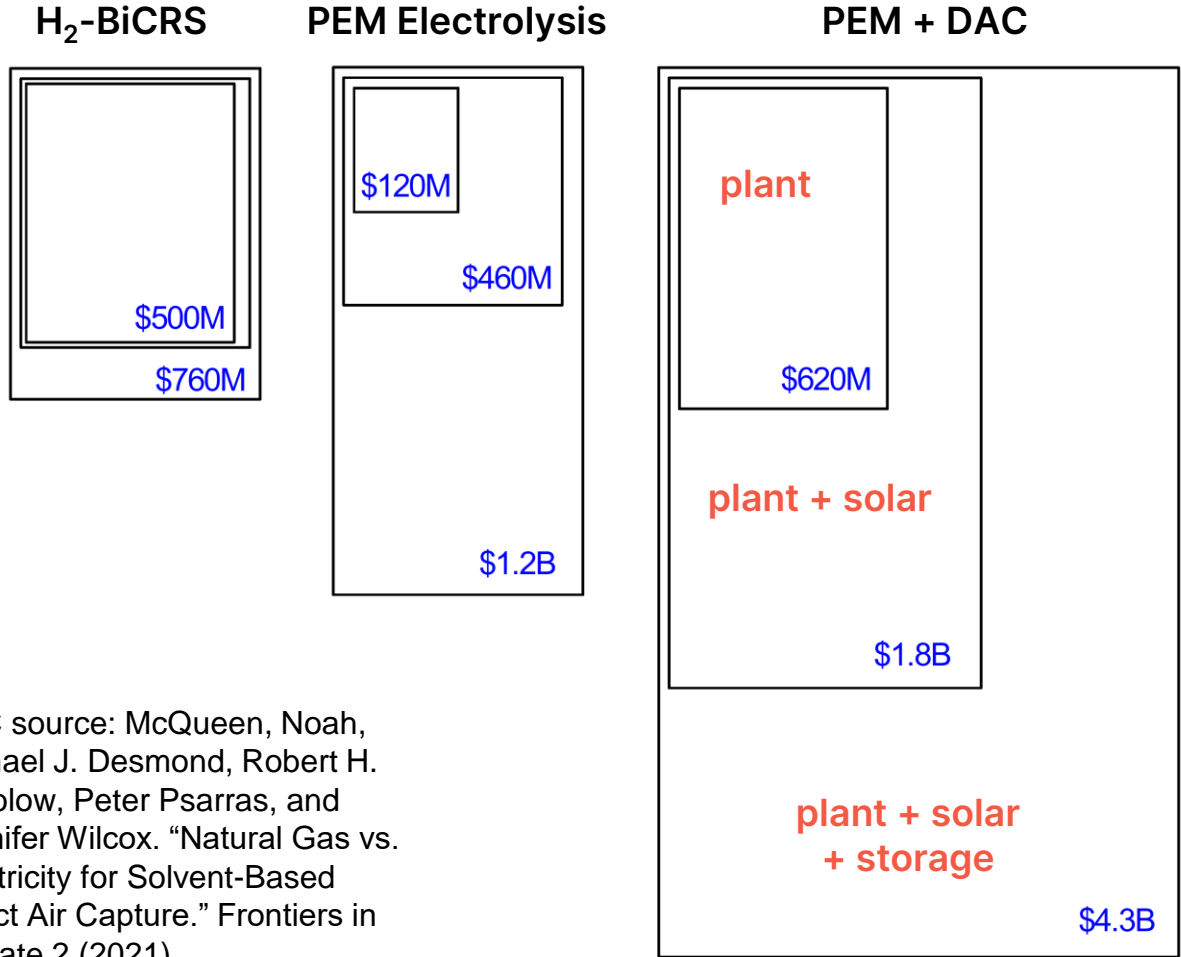


\$8B/yr



\$14B/yr

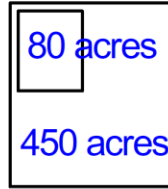
H₂-BiCRS far less capital intensive than Electrolysis + DAC



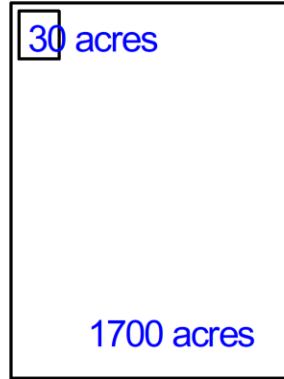
DAC source: McQueen, Noah, Michael J. Desmond, Robert H. Socolow, Peter Psarras, and Jennifer Wilcox. "Natural Gas vs. Electricity for Solvent-Based Direct Air Capture." *Frontiers in Climate 2* (2021).

H₂-BiCRS also saves huge swaths of land.

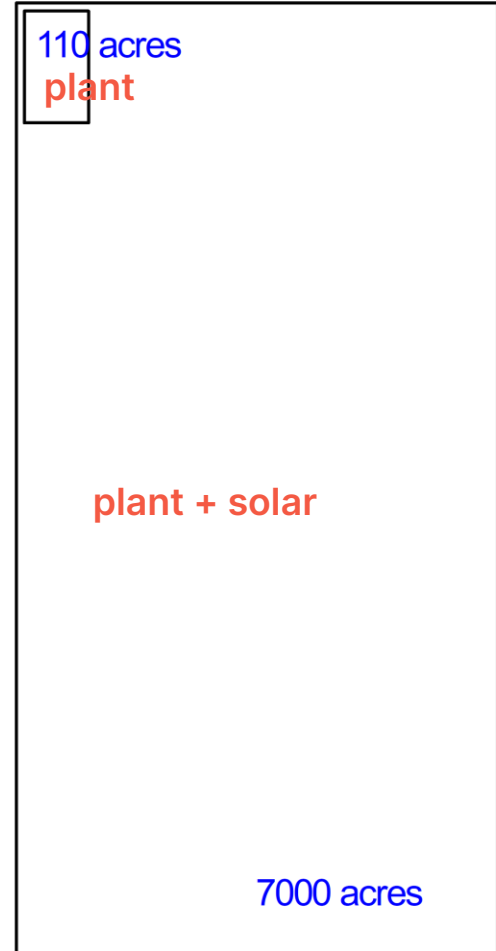
H₂-BiCRS



PEM Electrolysis



PEM + DAC



Conclusions

Biomass gasification to hydrogen with CCS is an amazing opportunity to efficiently solve multiple problems.

- Carbon removal
- Clean energy
- Waste management

Mote is forging partnerships to scale quickly.



Thank you

Contact: josh@motehydrogen.com