



ION's Enterprise Pilot Plant
in Pittsburg, CA, USA

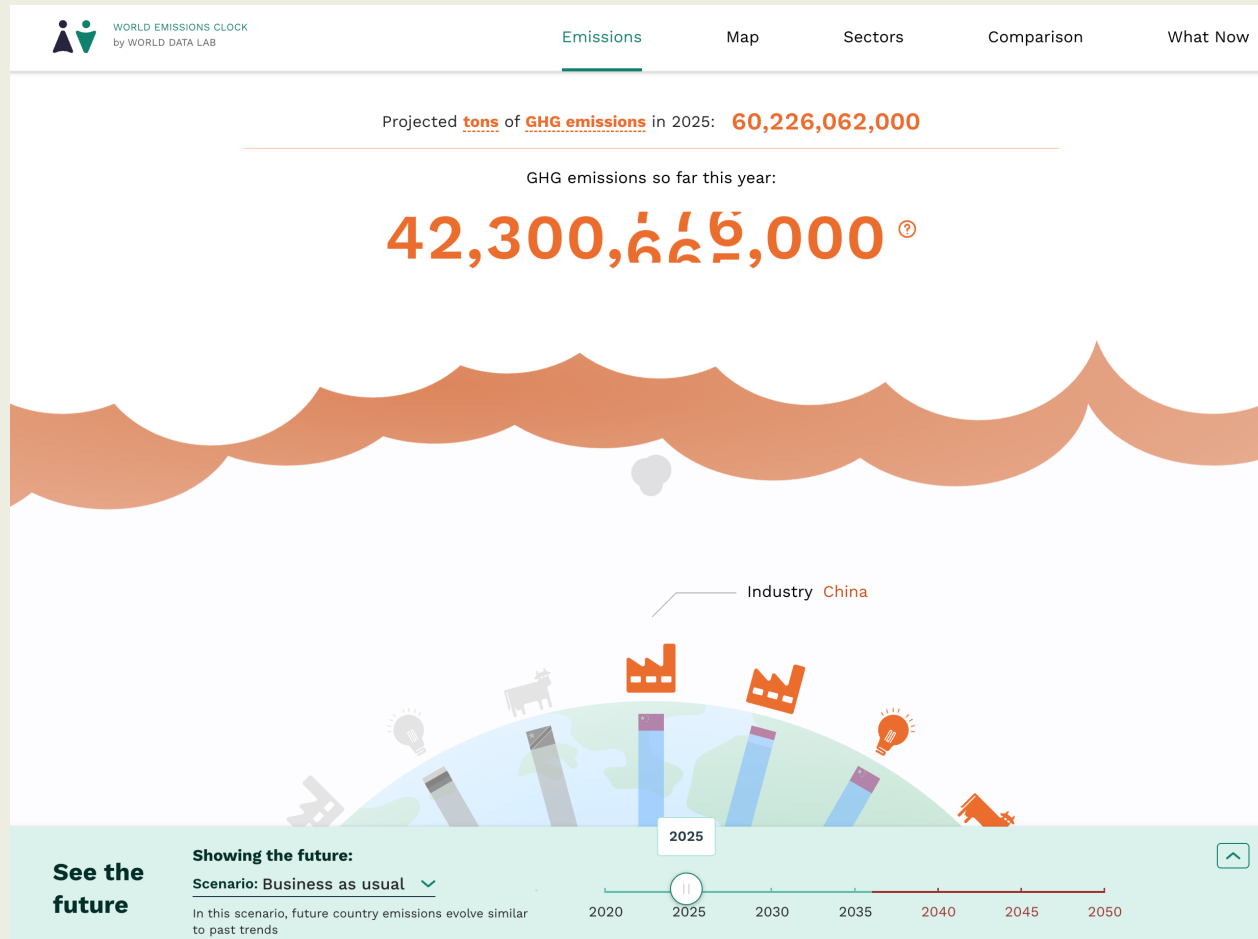
BACK TO THE FUTURE

CAN DEEP DECARBONIZATION TURN BACK THE EMISSIONS CLOCK?

ERIK MEULEMAN
PCCC-8: WTC – MARSEILLE, FRANCE, SEPTEMBER 2025



WORLD EMISSIONS CLOCK



The cumulative emissions are going up, fast

CDR technologies and projects are being developed and some of them executed

Can deep decarbonization of point sources help, in addition to BECCS?

E.g., can we capture 100% of the added CO₂ formed by combustion, and additional CO₂ from the air that was used in the combustion w/o adding too much fugitive emissions upstream; and off-set the build?

<https://worldemissions.io/>

AI IS DRIVING UNPRECEDENTED ENERGY DEMAND. BLUE POWER VIA CCS IS AN ANSWER THAT EXISTS TODAY.

The New York Times

A New Surge in Power Use Is Threatening U.S. Climate Goals

A boom in data centers and factories is straining electric grids and propping up fossil fuels.

By [Brad Plumer](#) and [Nadja Popovich](#) March 14, 2024

Google's Emissions Shot Up 48% Over Five Years Due to AI

A new report shows that the artificial intelligence boom will test Silicon Valley's climate commitments.

Deloitte
Insights

As generative AI asks for more power, data centers seek more reliable, cleaner energy solutions

Goldman Sachs

ARTIFICIAL INTELLIGENCE

AI is poised to drive 160% increase in data center power demand

May 14, 2024 Share

THE WALL STREET JOURNAL.

BUSINESS | ENERGY & OIL Follow

Chevron, GE Vernova, Engine No. 1 Team Up to Power Data Centers

Joint venture aims to deliver 4 gigawatts of electricity for data centers starting by the end of 2027

By [Mark R. Long](#)

Jan. 28, 2025 9:34 am ET

“The first projects are expected to leverage **seven U.S. made GE Vernova 7HA natural gas turbines.**”

The projects are expected to be designed with the flexibility to integrate lower carbon solutions, such as **carbon capture and storage (CCS) — which is capable of capturing >90% of the CO₂ from the turbines** — and renewable energy resources.”

ION: TECHNOLOGY INNOVATOR WITH A PROVEN TRACK RECORD IN NATURAL GAS CARBON CAPTURE

PURE PLAY CARBON CAPTURE SOLUTIONS PROVIDER

17 years developing an effective and cost-efficient CCS technologies for power generators and industrial emitters.

TRANSFORMATIVE PILOT PERFORMANCE DRIVING COMMERCIAL READINESS

Over 20,000 hours of successful pilot testing at sites including globally recognized “drop in” facilities, the National Carbon Capture Center (NCCC) in Alabama and Technology Centre Mongstad (TCM) in Norway.

ION designed and developed pilot operating since Q3 2023 at Calpine’s Los Medanos Energy Center - a commercial NGCC power plant operating in Northern California.

COMPANY OVERVIEW

Year Founded	2008
Employees	~50
Patents Held	24
Pilot Operating	>20,000 hours



ION Houston Office, USA



ION Pilot Plant in Pittsburg, CA

THE ION CCS SOLUTION: A BETTER MOUSETRAP



PROVEN APPLICATION

- Proven ability to handle (highly oxidative) process and flue gases
- Unparalleled results for decarbonization of gas-fired power plants



DEEP DECARBONIZATION

- Captures 95% by design, and over 99% of CO₂ when preferred resulting in ‘direct air capture-like’ results
- Mitigates the negative impact of equipment downtime on long-term average capture rates



EXTREMELY LOW EMISSIONS

- The total VOC emissions with CCGT type flue gas with ICE-31™ is consistently less than 0.1 ppm. Emissions fall below detectable levels of current Continuous Emissions Monitoring Systems (“CEMS”), allowing customers to operate large scale plants, even in emissions challenged areas



LOWER COSTS

- ION solvent creates a fast and high working capacity reaction with CO₂, therefore lower OPEX and CAPEX as less solvent and smaller equipment is required
- ION system requires little extra energy for operations at elevated capture rates; No energy use runaway, even at capture efficiency rates of >95%, saving operating costs from energy consumption
- ION solvent is extremely stable. The stability extends the life of the solvent without losing capture efficiency, therefore reducing reclamation, solvent replacement, and disposal OPEX



STAR TEAM

- ION has a team of experienced carbon capture experts who spent most of their careers improving the post-combustion amine-based carbon capture process
- Partnership is at the core of how ION does business.
- Investors and/or key collaborators (public): Carbon Direct, Chevron, Denbury, Williams; Kiewit, Koch Engineered Solutions, Sargent & Lundy, Calpine, TECO

THE PROOF IS IN THE PILOTS

**National Carbon Capture Center
Wilsonville, AL, USA**



10 TPD CO₂
Project Apollo

**Natural Gas Boiler at
industrial pilot scale**

**Technology Centre Mongstad
Mongstad, Norway**



200 TPD CO₂
Project Slingshot

**NG & Refinery gases at
demonstration scale**

**Koch Engineered Solutions HQ
Wichita, KS, USA**



2.8 TPD CO₂
Bedrock Pilot

**Performance validation
between ION Solvent and
Koch Glitsch's
Innovative Structured Packing**

**Los Medanos Energy Center
Pittsburg, CA, USA**



10 TPD CO₂
Enterprise Pilot (ENTP)

**Long term operational
validation of ICE-31™ design
with real NGCC flue gas**

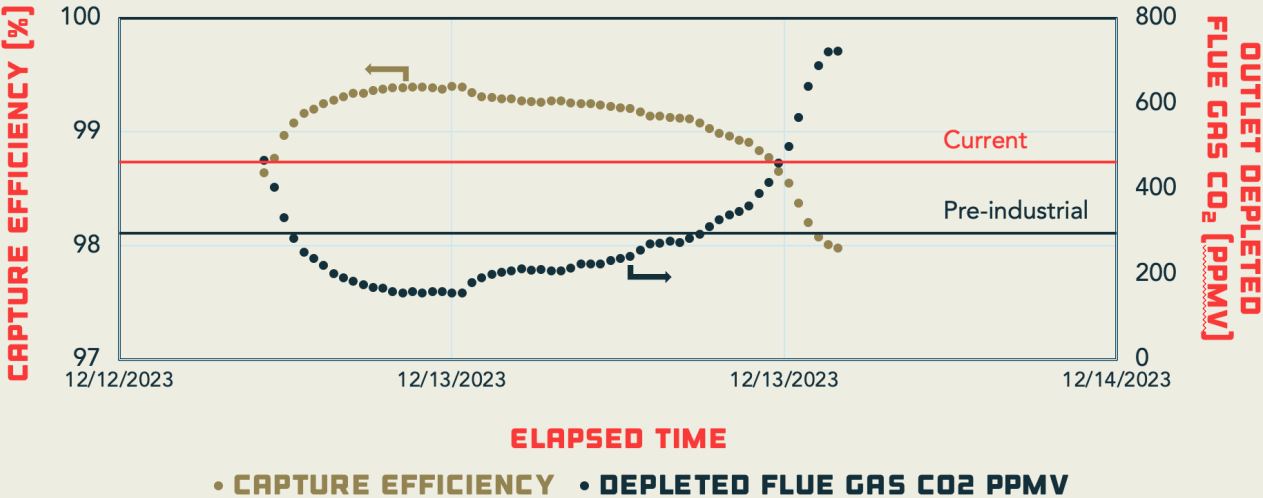
VARIETY OF FLUE GASES

Safely operated over 20,000 total hours of testing to date with NG flue gases, refinery gases, and coal flue gas

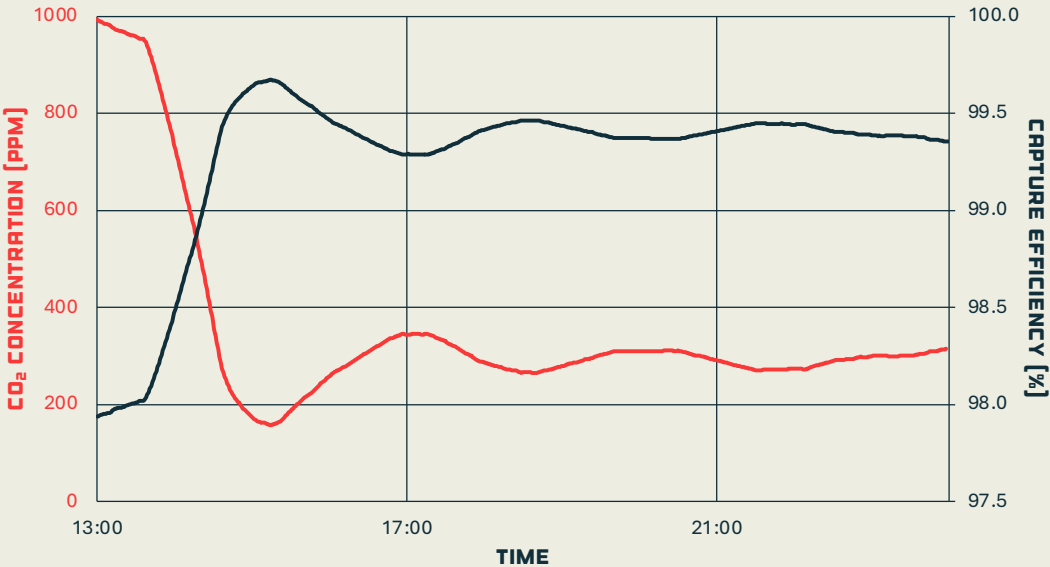


ICE-31™ EMITTING PRE-INDUSTRIAL CO₂ CONCENTRATIONS

Technology Centre Mongstad
Mongstad, Norway
Project “Slingshot”



Los Medanos Energy Center
Pittsburg, CA, USA
Project “Enterprise”



ENTERPRISE: DEEP DECARBONIZATION

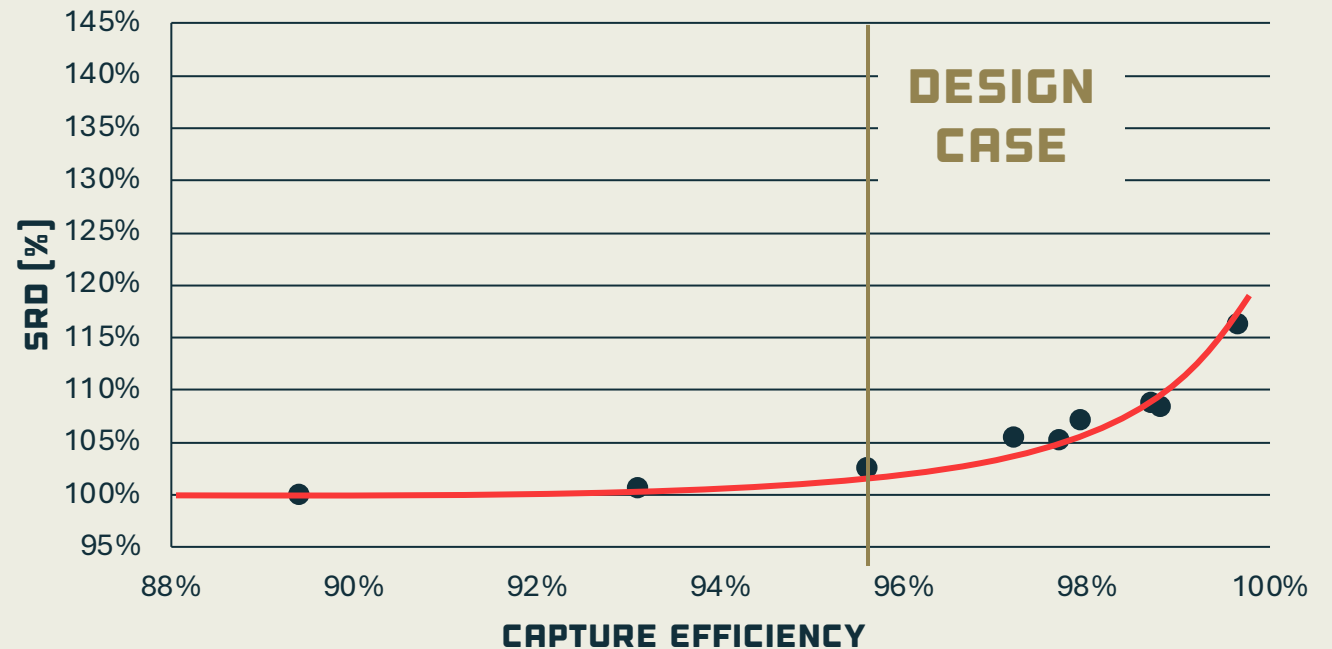
Approximately 4.8 Vol% CO₂ in inlet flue gas

Sustained net-negative CO₂ emissions

- ~425 ppm CO₂ in ambient air
- Comfortably less than 300 ppm CO₂ in the outlet

ENTP was designed for 95.7%. Utilizing existing equipment, increasing CE from 95% to 99% requires 7% extra SRD, whereas from 99% to 99.5% is another 7%

With extra packing the extra SRD is only 2-3% for extra capture at 99.5% compared to 95%



CO₂ CAPTURE FOR CCGT POWER PLANTS

ION + STRONG PARTNERS WITH SUBJECT MATTER EXPERTISE

- EPC and OEM Partners seamlessly integrate with ION's team to meet all our customers' project needs
- Bankable full wrap and performance guarantees available from world class EPC providers

ION's ICE-31™ solvent is unique for CCGT flue gas; we've designed CO₂ capture facilities and executed FEED studies for multiple large CCGT power plants while tackling numerous design modifications to meet the needs of each project. Public projects:

SUTTER DECARBONIZATION PROJECT

550 MW, 1.75 MTPA CO₂
\$270M DOE OCED award



Air cooling due to no access to cooling water

POLK POWER STATION

1,190 MW, 3.7 MTPA CO₂
\$110M DOE CarbonSAFE award



Efficiency optimized due to access to low-cost water

DELTA ENERGY CENTER

835 MW, 2.4 MTPA CO₂
DOE NETL FEED award



Thermal storage option due to variable dispatch of host facility

SEPTEMBER 2025

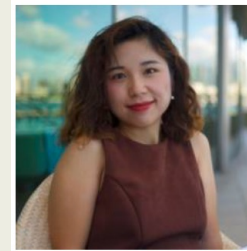
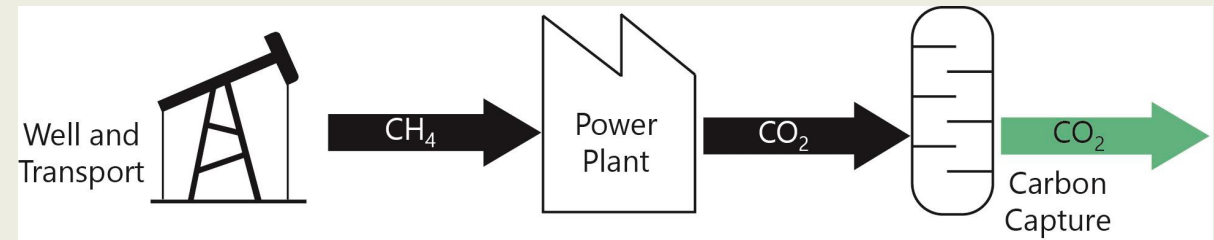
DECARBONIZING THE WHOLE CHAIN

LAWRENCE LIVERMORE NATIONAL LAB

Assessed emissions from the whole chain from NG-well, via power production with CO₂ removal from the flue gas including compression to 150 bar

Costed deep decarbonization including incremental costs from 99 to 99.5% capture efficiency

Modelled: MEA and ICE-31™



Wenqin Li (PI)



Mengyao Yuan

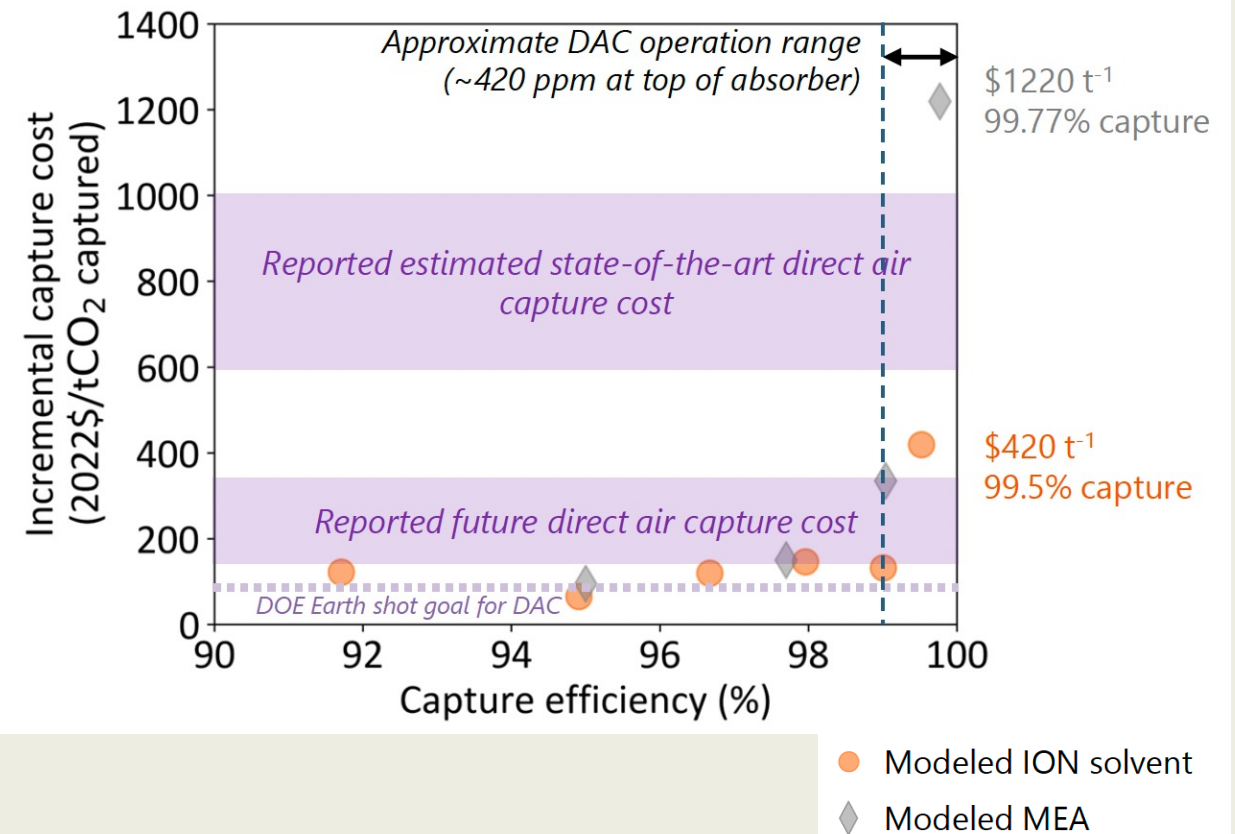
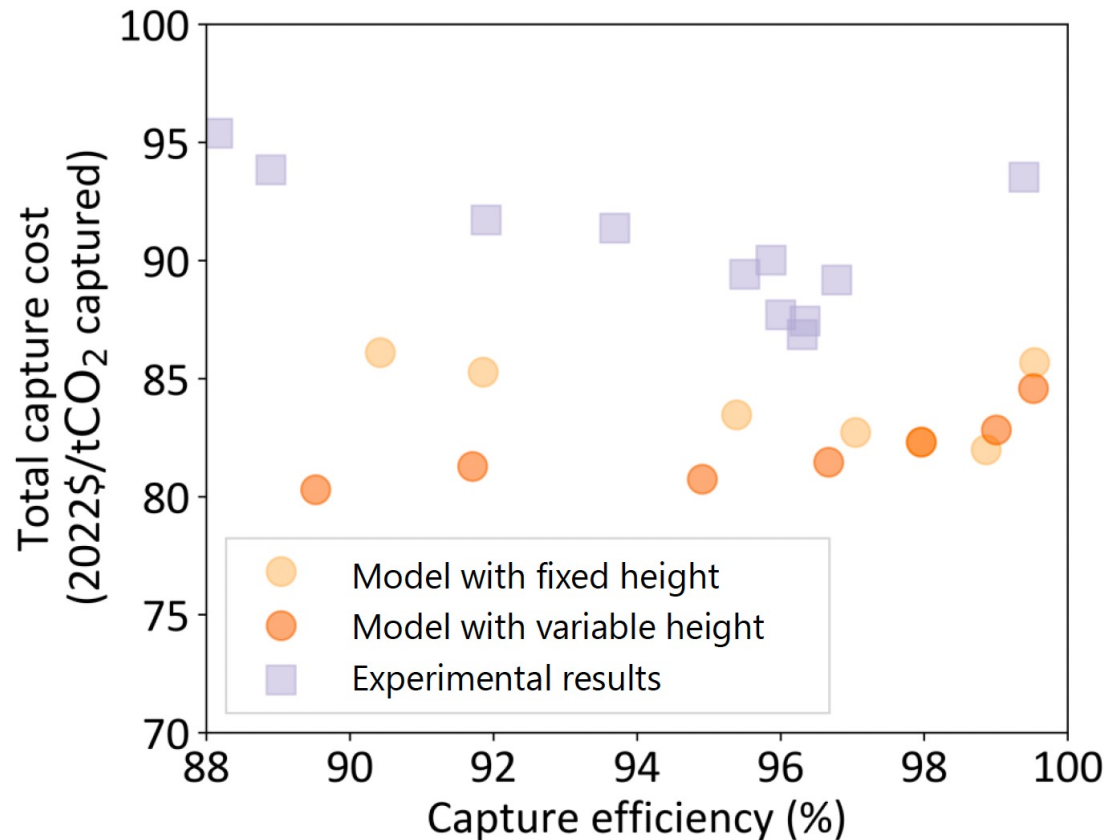


Nicholas Cross



Source: N. Cross, M Yuan, W. Li, Techno-economic Analysis of Liquid Absorbent-Based Carbon Capture for Achieving Net-Zero Natural Gas Power Generation, AIChE 2024 National Conference, 2024

COST OF CAPTURE & INCREMENTAL COST



Source: N. Cross, M Yuan, W. Li, Techno-economic Analysis of Liquid Absorbent-Based Carbon Capture for Achieving Net-Zero Natural Gas Power Generation, AIChE 2024 National Conference, 2024



CCGT+CCS COMPETITIVE WITH RENEWABLES

CARBON DIRECT REPORT

Timing: Natural gas-fired generation's ability to leverage existing grid infrastructure makes it a viable option today

Reliability: Natural gas-fired can meet the reliability demands of data centers due to its inherent dispatchability and lack of intermittency.

Emissions: ELCC-adjusted life cycle assessment indicates that natural gas-fired generation with carbon capture and storage could have lower effective CO₂ equivalent emissions than solar power backed with 4-hour battery storage.

Cost: Market analysis identified several NG+CCUS opportunities that align with data center demand. Cost structure that is consistent with anticipated green premiums and demonstrate competitiveness with other low-carbon power options.

Source: Stuckert, N., et al., *Carbon Capture for Natural Gas-Fired Power Generation*, Carbon Direct: **Meeting Data Center Electricity Demand**, 2025

RYAN COWNDEN – SHEFFIELD UNIVERSITY

Article in ES&T, 2024,

Implementing (existing) best practices for reducing emissions from NG production

Life cycle GHG emissions from:

- Natural gas fueled power generation with CCS
- Comparable to wind power, and
- Significantly below solar PV

Source: <https://pubs.acs.org/doi/10.1021/acs.est.4c02933>

CCGT WITH CCS HAS SIMILAR CARBON FOOTPRINT AS RENEWABLE ENERGY

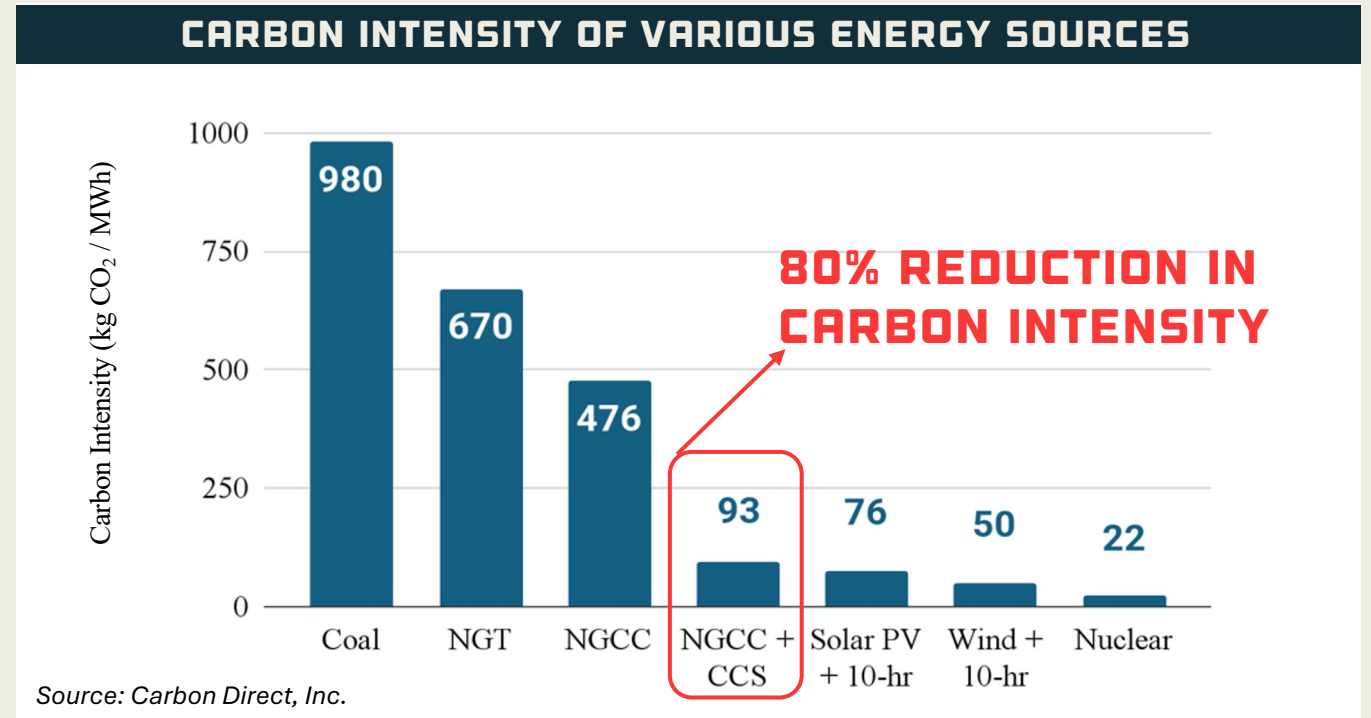
Adding carbon capture to existing power plants and other emissions sources can achieve similar carbon intensity to renewable energy sources

CCGT + CCS yields an 80% reduction in carbon intensity compared to CCGT without capture

- Most remaining C.I. comes from production and transportation of natural gas

Read the full Carbon Direct report here:

<https://www.carbon-direct.com/research-and-reports/meeting-data-center-electricity-demand>



EACI = ELCC-adjusted carbon intensity ; **ELCC** = Effective load carrying capacity

NGT = Natural Gas Turbine; **NGCC** = Combined Cycle Gas Turbine;

PV = Photo Voltage; **BESS** = Battery Energy Storage System; **CCS** = Carbon Capture and Storage



CONCLUSION

ION

- ION technology is ready for commercial deployment: We have deep understanding of our CO₂ capture system based on extensive performance testing, and a strong network of renowned collaborators with subject matter expertise
- Deep decarbonization of point sources is possible; and even negative emissions has been demonstrated (within site boundary)
- ION enables commercial projects to produce clean, firm, reliable power, and fast

THIRD PARTIES

- The impact of deep decarbonization results was evaluated with regards to the incremental increases of:
 - upstream fugitive emissions of natural gas (production and transport), and
 - the incremental additional cost of CO₂ capture above 99%
- The carbon intensity of CCGT + advanced CCS is on par with renewables, however not net negative
- CCGT + advanced CCS slows the world emissions clock tremendously
- However, to turn back the world emissions clock, one needs to incorporate BECCS and/or other CDR



LET'S GO CAPTURE SOME CARBON.