Data Centers, and Carbon Capture for Natural Gas-Fired Generation

Dr. Julio Friedmann
Chief Scientist, Carbon Direct

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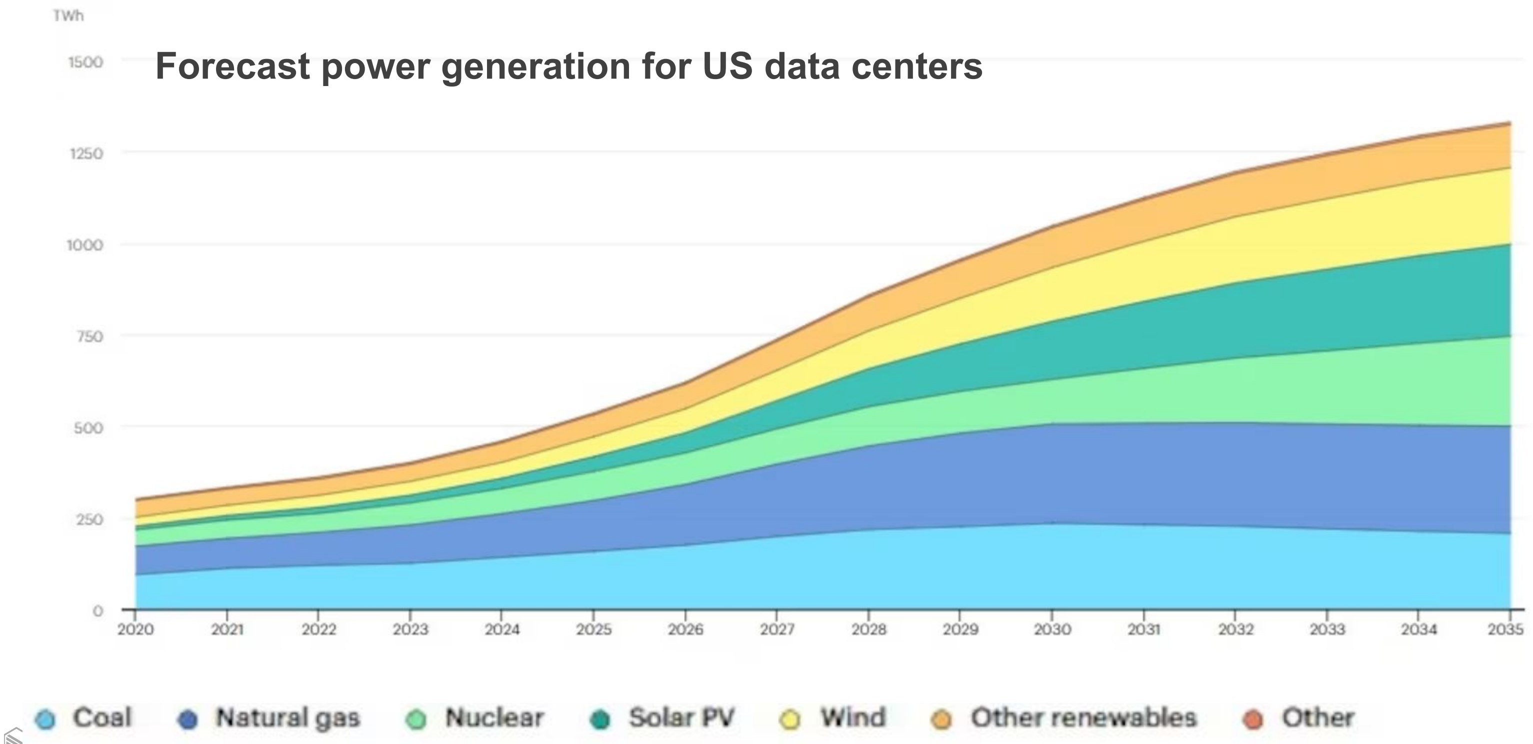
US POWER DEMAND

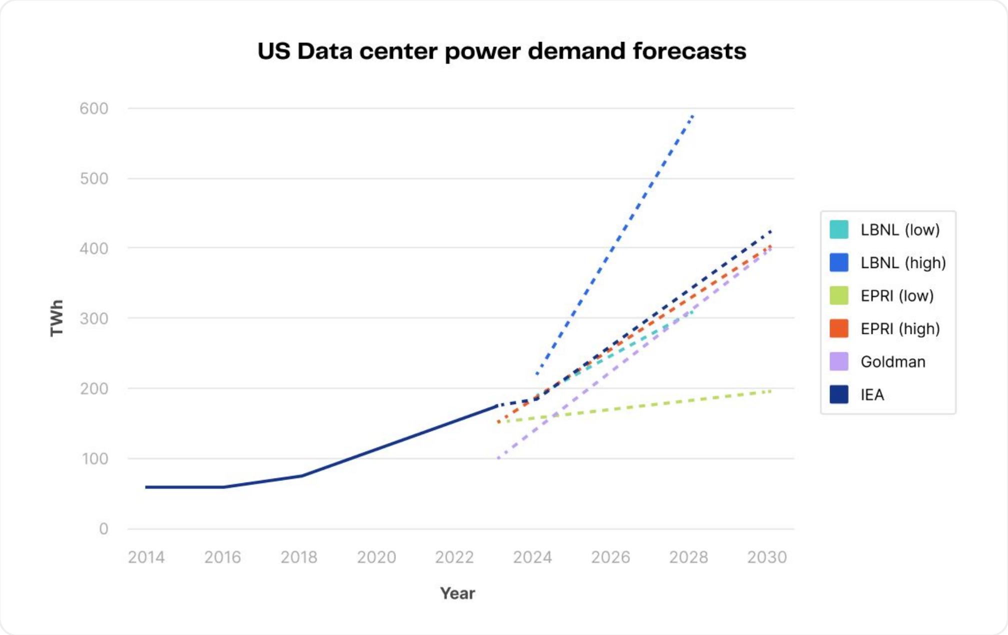
Data centers driving significant power demand increase in near-term (10-year forecast)



Source: Reuters, 2025, based on IEA, 2025

US POWER DEMAND

Data centers driving significant power demand increase in near-term (5-year forecast)



- Significant focus has been on new market segment load growth: AI driven data center load growth
- AI data center are expected to drive a lot of near-term growth
- Forecast surveys: data center market grows 200 TWh today to 400 TWh (2030)
- Nat gas: 81 Gw new NG power by 2030; 19 bcf gas (5x growth) by 2035

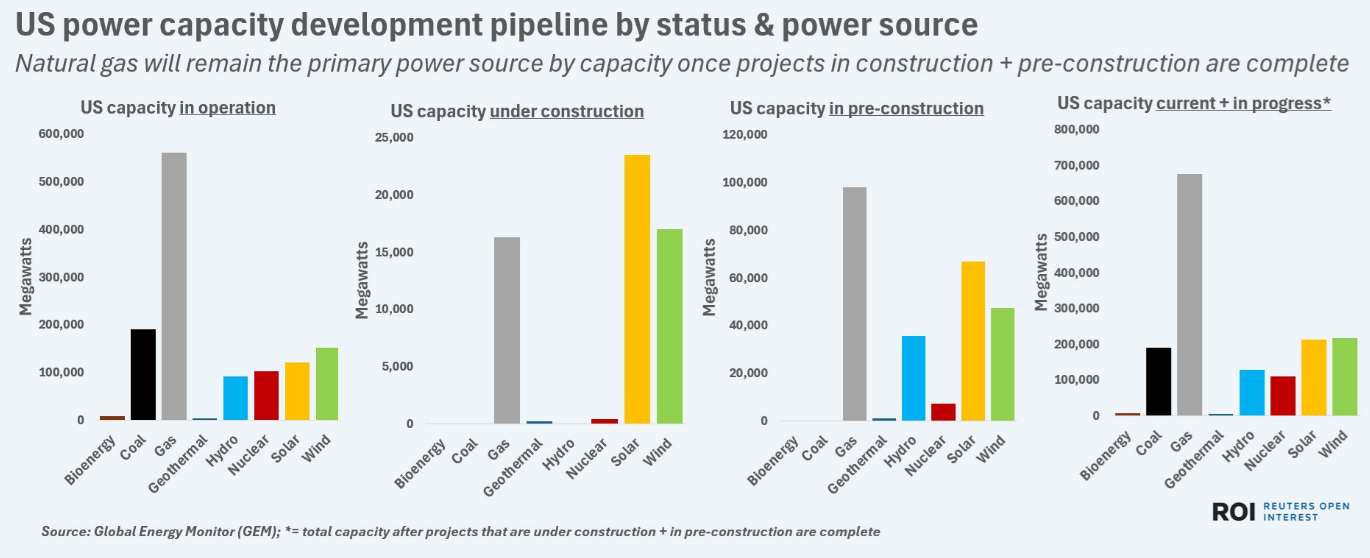
U.S. data center power demand could reach 106 GW by 2035: BloombergNEF

GE Vernova expects to end 2025 with an 80-GW gas turbine backlog that stretches into 2029

CCS Opportunities – System Level

Pending Emissions Lock-In

- Long-lived NGCC assets – and their emissions – being deployed at rapid rate
- CCS retrofits reduce emissions from existing sources
- New-build NGCC with CCS can avoid significant new emissions



CCS Opportunities

Clean Firm and Dispatchable Power

Similar characteristics as natural gas-fired generation but with significantly reduced emissions

- Can help integrate variable renewables
- Other clean options may not be commercially available today

Scalable Capacity

NG+CCS projects can vary in size from hundreds of MW to multiple GWs

Broad Geographic Availability

Feasible in multiple U.S. regions including those experience load growth: Gulf Coast, Texas, Midwest, Great Plains, Mountain West, and California

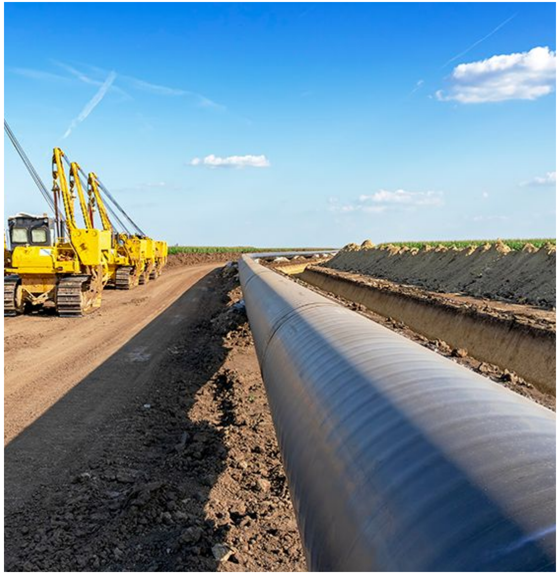
Retrofit Capability

CCS can be retrofitted onto existing natural gas-fired generators, enabling them to continue to run with substantially reduced emissions

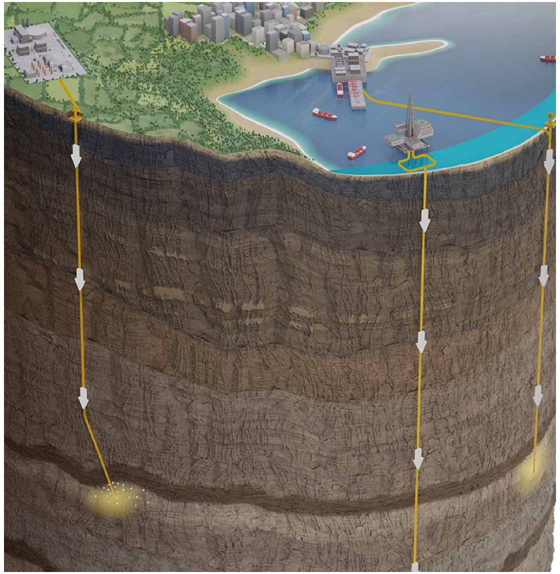
FEATURES OF CCS

NG-CCS project considerations

Ravenna CCS Mitsubishi Heavy Industries KM CDR Process



Great Plains Institute



Geoscience Australia

Capture

Amine-based solvents are the leading technology for CO_2 capture at NGCC.

Transportation

Pipeline is the lowest cost compared to ship, rail, barge, and truck options.

Geologic sequestration

Storage is permanent in regulated deep saline aquifer disposal wells.

CARBON CAPTURE AND STORAGE (CCS)

Natural gas generation with carbon capture has additional advantages in some markets and geographies compared to other clean firm power approaches.

Costs
Where infrastructure is available, costs ~30% increase in costs ($4/MMBTU gas +45Q tax credits):

New build/greenfield: $70-100/MWh
Retrofit/brownfield: $40-80/MWh

Time to market
Where access to infrastructure exists (e.g., pipelines, class VI wells) time to market can be quick: **2028-2031** in many cases. This is significantly faster than many other pathways to clean firm power

NG+CCS: projects announced

Peterhead project (UK) - 2028

- Part of Teesside Hub
- 910 MW new, 2 Mt CO2/y
- 3000 temp/1000 ongoing new jobs

Calpine retrofit projects - 2029-2030

- Yuba City: CA - 500 MW retrofit, ~1.4 Mt/y
- Baytown, 800 MW retrofit, 2 Mt CO2/y

Broadwing: Decatur, IL - 2029-2030

- Google + ADM +Low C Infrastructure
- 400 MW new build; ~1 Mt CO2/y
- First big data center NG+CCS project

Anticipated projects

- Meta megaproject, LA: ~2.2 GW new,
- NextEra + ExxonMobil: ~1.2 GW new
- Crusuo-Tallgrass, WY: ~1.8 GW new

FEATURES OF CCS

Characteristics of NG-CCS

Characteristic	Details
Cost	● CCS doubles the capital cost of natural gas power (for example \$1500 → \$3000/kW per NETL baseline study) ● CCS increases the levelized cost of natural gas power by 30-50% (for example \$60 → \$90/MWh) ● Levelized cost of emissions reduction is \$60 to \$120/tonne-CO_2e, before applying incentives or subsidies.
Energy	● CCS retrofit of an existing NGCC plant will increase the heat rate by 20%-30% (for example 6800 → 8200 BTU/kWh) ● Equivalently: CCS reduces power plant efficiency by 6-10 percentage points (for example 50% → 42% HHV Basis)
Emissions	● 90% - 95% lower CO_2 emissions at the power plant exhaust stack (for example 370 → 35 kg-CO_2/MWh) ● 75% - 80% lower life cycle GHG emissions from power production (for example 430 → 98 kg-CO_2e/MWh)
Timeline	● 18 months to build a natural gas combined cycle power plant *without* CCS, not accounting for supply-chain bottlenecks ● 18 - 36 months *additional* to build a power plant with CCS
Scale	● 100 MWe minimum plant size for cost-efficient CCS. Smaller sizes are possible when T&S infrastructure is shared. ● 500,000 tonnes-CO_2 per year minimum
Flexibility	● Capture systems can be designed for efficient operation at 50% - 100% of nameplate capacity. ● Ramp rate of 1% - 10% of rated power per minute ● Cold startup to full operation in 60 - 120 minutes

CCS Challenges and Risks

Technology/Operational

First-of-a-kind (FOAK) integration risks for natural gas power plus capture, transport, and storage at scale, including:

- Cost or schedule overruns in construction or commissioning
- Under-performance or unscheduled downtime

Economic

Offtake agreements are complex transactions that carry risk around:

- Large capital projects relying on achieving scale to reach economic efficiency
- Impact of fuel price on EAC costs
- Other (e.g., interest rates, capital costs, supply chains)

Reputational

Relatively new option unfamiliar to many buyers – and their end customers

- Uncertainty around compatibility with climate ambitions
- Skepticism/opposition among some stakeholders

Scope 2 Accounting for CCS: Like RECs, but not RECs

GHG Protocol

Lack of concrete guidance but no prohibition.

- Current GHGP's S2 Guidance provides a pathway.
- S2 hierarchy allows emissions factors of PPAs, utility/supplier contracts to lower S2 in absence of attribute instrument
- New Scope 3

Developing EACs for CCS

Just as RECs have enabled renewables to scale, a tradeable market instrument could help CCS to scale

- NG+CCS is not zero emissions, but would likely convey low-GHG emission rate
- More work needed to define scope of attributes CCS EAC would convey

Evolving Rules

GHGP and SBTi are developing reforms. This presents risk and opportunity for CCS

- Time and location based attributional accounting and additionality
- GHGP could more explicitly address CCS; could be helpful or not
- SBTI draft of CNZS excludes CCS from definition of "zero carbon electricity". Different for power sector

Resources from Carbon Direct

WHITE PAPER
Carbon Capture for Natural Gas-Fired Power Generation

BLOG
Carbon Capture for Natural Gas-Fired Power Generation

BLOG
From Capture-Ready to Capture-Committed

REPORT
Meeting Data Center Electricity Demand

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Contact Julio Friedmann

jfriedmann@carbon-direct.com

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Thank you.