Carbon Direct

Carbon Capture for Natural Gas-Fired Power Generation

Low-emissions power to meet rapid growth in electricity use

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Contents

The role of natural gas in meeting United States electricity needs **3**
Power demand growth 3
The role of natural gas in electricity supply 5
Lowering data center emissions with carbon capture **6**
Meeting rapid deployment needs 7
Delivering a steady supply 8
Choosing an appropriate size 8
Lowering carbon emissions 9
Managing costs 9
Developing natural gas-fired power with carbon capture **10**
Choosing a carbon capture technology 10
Navigating transportation logistics 11
Ensuring safe and effective sequestration 11
Assessing full life cycle impacts 12
Connecting to existing infrastructure 13
Conclusion **13**
Acknowledgements **14**
Authors and contributors 14
About Carbon Direct 14
Disclaimer 14

The role of natural gas in meeting United States electricity needs

Power demand growth

Electricity demand in the United States (US) is growing more rapidly than at any point in the past two decades. For nearly 40 years, overall power consumption has remained relatively flat. During this time, power demand growth was driven by population increases and economic expansion but was offset by advances in energy efficiency and decreases in industrial activity. This flat demand for power began to shift upward around 2019, due to increased US manufacturing activity, building electrification, and electric vehicle use.[1] In 2022, artificial intelligence (AI) began its explosive growth with a corresponding proliferation of data center construction. The emerging AI economy and the energy needs of new data centers are fueling a new era of electric power demand in the US.[2] Forecasts for new data center power demand vary, but all show a marked upward trend (**figure 1**).

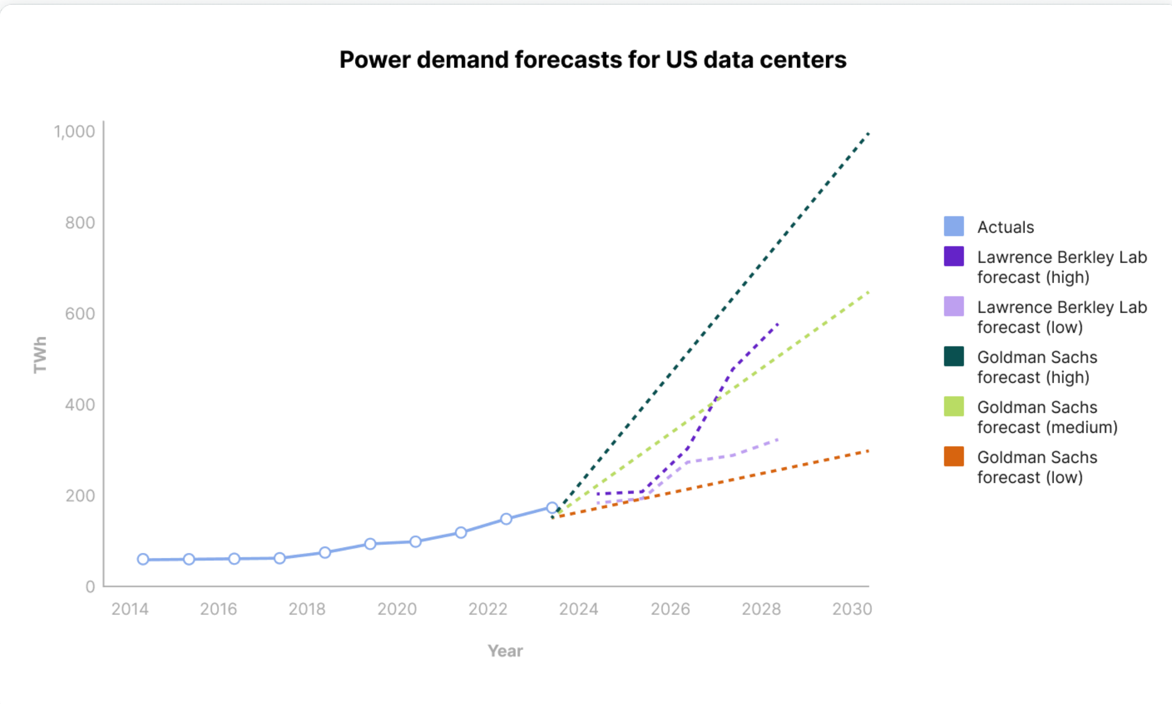

Figure 1: Power demand forecasts for US data centers. Source: Carbon Direct.

This new and significant demand for power is already straining the current power grid in some locations. While some load growth in the latter half of this decade was predicted prior to 2022, many power companies have structurally revised their peak winter demand forecasts upward, with some up to 53% higher in just the last three years (**figure 2**). There is a need for rapid development

[1] Wilson JD. 2024. Strategic Industries Surging: Driving US Power Demand. [accessed 2025 Jan 31]. https://gridstrategiesllc.com/wp-content/uploads/National-Load-Growth-Report-2024.pdf.
[2] Goldman Sachs. 2025. AI/data center's global power surge. [accessed 2025 Jan 31]. https://www.goldmansachs.com/pdfs/insights/goldman-sachs-research/five-drivers/FinalReport.pdf.

of additional firm power[3] generation resources, but new development faces significant challenges—some of which are dependent on the type of power being generated:

- **Most new grid-connected projects including natural gas,** are facing multi-year delays in the interconnection queue. At present, there is twice the capacity waiting to be interconnected (2.6 terawatts) as there is currently installed in the US (1.28 terrawatts).[4]
- **New nuclear power** generation requires long development timelines.[5]
- **Geothermal power** is currently limited due to certain regional and drilling constraints.[6]
- **Wind and solar power** are intermittent and do not provide firm capacity without expensive battery storage and/or complementary gas-fired peaking generation.

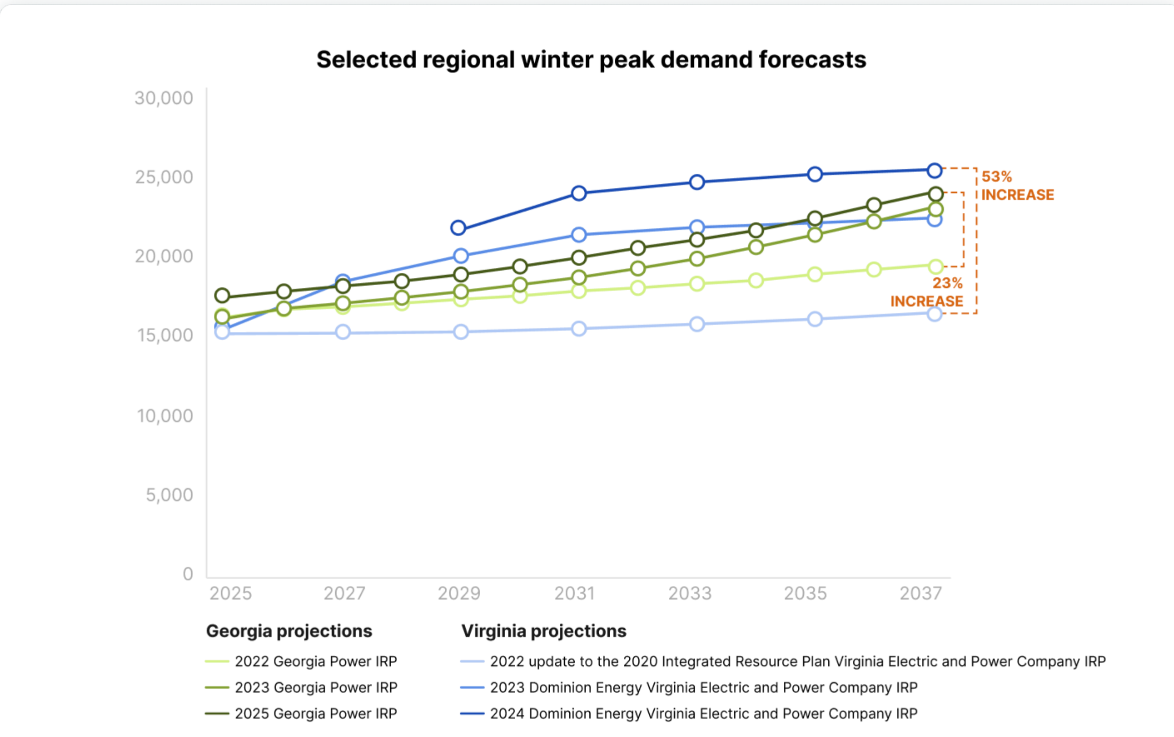

Figure 2. Changes in load growth forecasts in the Integrated Resource Plans (IRP) of Georgia Power[7] and Virginia Electric and Power Company. Source: Carbon Direct.

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[3] United States Energy Information Administration (EIA). Glossary. Definition for "firm power."[accessed 2025 Feb 26]. https://www.eia.gov/tools/glossary/index.php.
[4] Rand J, Manderlink N, Gorman W, Wiser R, Kemp JM, Jeong S, Kahrl F. 2024. Characteristics of Power Plants Seeking Transmission Interconnection As of the End of 2023. [accessed 2025 Feb 27]. https://emp.lbl.gov/sites/default/files/2024-04/Queued%20Up%202024%20Edition_R2.pdf
[5] United States Department of Energy. 2025. Advanced Nuclear. Pathways to Commercial Liftoff. [accessed 2025 Feb 26]. https://liftoff.energy.gov/advanced-nuclear-2/.
[6] United States Department of Energy. 2025. Next-Generation Geothermal Power. Pathways to Commercial Liftoff. [accessed 2025 Feb 26]. https://liftoff.energy.gov/next-generation-geothermal-power/.
[7] Georgia Power data center load interconnection forecasts may be using a higher than standard probability of interconnection compared to other utilities and ISOs.

The role of natural gas in electricity supply

Currently, natural gas supplies 40% of the electricity generated in the US and is the largest component of the generation mix, providing 570 gigawatts of capacity. As the incumbent, it is expected to continue to deliver much of the energy for US electricity production into the coming decade.[8] Many analysts project that, despite being intermittent, solar and wind will comprise 60–80% of new electricity generation deployed by 2030, and add 200–400 gigawatts of capacity.[9] Solar power in particular, has benefitted from steep cost declines and fairly steady policy support. However, because of the intermittency and siting constraints associated with renewable energy, analysts expect that most of the remaining power demand will be met with new natural gas generation, adding 100–200 gigawatts of capacity. In fact, energy and electricity equipment companies have already published announcements and reports describing new natural gas-fired generation projects.[10, 11]

While natural gas-fired power generation results in greenhouse gas (GHG) emissions, these emissions can be mitigated through carbon management. Managing emissions from natural gas-fired power generation is particularly important to the hyperscalers operating large-scale data centers and providing massive computing resources, data processing, and storage to users around the globe. These entities have decarbonization targets that are facing increased scrutiny. For instance, Google's 2024 environmental report specifically highlighted the risk of missing its emissions targets as a result of AI's power demands: "In 2023, our total GHG emissions increased 13% year-over-year, primarily driven by increased data center energy consumption and supply chain emissions."[12] Microsoft, in its 2024 environmental sustainability report, also highlighted the need to decarbonize its supply chains.[13]

Against this backdrop, there is a need to rapidly and responsibly deploy firm power to meet increasing electricity demands. **Natural gas-fired generation with carbon capture and sequestration (CCS) is emerging as a competitive decarbonization solution.** Multiple parties have overlapping and sometimes conflicting interests in deploying clean, cost effective, and

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[8] United States Energy Information Administration. 2023. Annual Energy Outlook 2023. [accessed 2025 Feb 26]. https://www.eia.gov/outlooks/aeo/data/browser/#/?id=8-AEO2023&region=0-0&cases=lowupIRA&start=2021&end=2050&f=A&linechart=lowupIRA-d020623a.6-8-AEO2023~lowupIRA-d020623a.7-8-AEO2023~lowupIRA-d020623a.8-8-AEO2023~lowupIRA-d020623a.9-8-AEO2023~lowupIRA-d020623a.10-8-AEO2023~lowupIRA-d020623a.11-8-AEO2023~lowupIRA-d020623a.12-8-AEO2023~lowupIRA-d020623a.13-8-AEO2023&map=&sourcekey=0.

[9] PJM. 2024. Energy Transition in PJM: Flexibility for the Future. [accessed 2025 Feb 27]. https://www.pjm.com/-/media/DotCom/library/reports-notices/special-reports/2024/20240624-energy-transition-in-pjm-flexibility-for-the-future.pdf.

[10] Affairs CP Government and Public. 2025. Chevron, Engine No. 1 and GE Vernova To Power U.S. Data Centers. chevron.com. [accessed 2025 Feb 26]. https://www.chevron.com/newsroom/2025/q1/power-solutions-for-us-data-centers.

[11] Vernova G. 2024. 2024 Invester Update. [accessed 2025 Feb 27]. https://www.gevernova.com/sites/default/files/gev_investor_update_presentation_12102024.pdf.

[12] Google 2024. Environmental Report. [accessed 2025 Feb 27]. https://www.gstatic.com/gumdrop/sustainability/google-2024-environmental-report.pdf.

[13] Microsoft. 2024. How Can We Advance Sustainability? 2024 Environmental Sustainability Report. Global sustainability. [accessed 2025 Feb 27]. https://cdn-dynmedia-1.microsoft.com/is/content/microsoftcorp/microsoft/msc/documents/presentations/CSR/Microsoft-2024-Environmental-Sustainability-Report.pdf.

reliable power. This paper lays out information, key considerations, and realistic expectations related to natural gas-fired power with CCS for these parties. Although new power generation is being planned to meet rising demand across multiple economic sectors, here we focus on key electricity stakeholders in the **data center value chain,** whose current needs are acute and specific:

- **AI companies** providing services that depend on the operation of the data centers
- **Data center developers** which may include hyperscalers, real estate developers, co-location providers, and other computing technology companies
- **Power producers** mainly in the business of building and operating generation facilities
- **Electric utilities** responsible for power delivery to data centers while maintaining reliable and cost-effective electricity for existing customers

In the following sections, we use the term "stakeholders" for this set of actors within the data center value chain. We also acknowledge that each opportunity to evaluate natural gas-fired power generation with CCS, in comparison to all other generation options, will be unique and will depend on the local community support, regulatory environment, interconnection constraints, and commercial structure of the project.

Lowering data center emissions with carbon capture

Stakeholders in the data center value chain, like all major new electricity users, must balance multiple priorities as they plan to power large new facilities. Hyperscalers have emphasized in their public remarks that sourcing firm, quickly available power is a top priority.[14] Other priorities include capacity, flexibility, price, and climate impact. In addition to new natural gas-fired plants, stakeholders are looking at all available options including new wind, solar, battery storage, nuclear, and geothermal generating plants, as well as expanding or extending the use of existing natural gas-fired and coal-fired units. This paper does not attempt to recreate analyses that compare all options on the basis of cost[15, 16, 17, 18] or carbon intensity (CI).[19, 20] Rather, it describes opportunities and challenges related to natural gas-fired power generation with CCS for those stakeholders who require an additional option.

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[14] Moss S. 2024 Apr 19. Meta's Mark Zuckerberg says energy constraints are holding back AI data center buildout. [accessed 2025 Feb 27]. https://www.datacenterdynamics.com/en/news/metas-mark-zuckerberg-says-energy-constraints-are-holding-back-ai-data-center-buildout/.
[15] National Renewable Energy Laboratory. 2024. 2024 Electricity Annual Technology Baseline: Technologies and Data Overview. [accessed 2025 Feb 27]. https://atb.nrel.gov/electricity/2024/index.
[16] Lazard. 2024. Levelized Cost of Energy+. [accessed 2025 Feb 27]. https://www.lazard.com/research-insights/levelized-cost-of-energyplus/.
[17] BloombergNEF. 2024. New Energy Outlook 2024. [accessed 2025 Feb 27]. https://about.bnef.com/new-energy-outlook/.
[18] United States Energy Information Administration. 2022. Levelized Costs of New Generation Resources in the Annual Energy Outlook 2022. [accessed 2025 Feb 27]. https://www.eia.gov/outlooks/aeo/pdf/electricity_generation.pdf.
[19] Khutal H, Kirchner-Ortiz KM, Blackhurst M, Willems N, Matthews HS, Rai S, Yanai G, Chivukula K, Jamieson MB, Skone TJ. 2020. Life Cycle Analysis of Natural Gas Extraction and Power Generation: U.S. 2020 Emissions Profile. [accessed 2025 Feb 27]. https://www.netl.doe.gov/projects/files/LifeCycleAnalysisofNaturalGasExtractionandPowerGenerationUS2020EmissionsProfile_012425.pdf.
[20] National Renewable Energy Laboratory. 2021. Life Cycle Greenhouse Gas Emissions from Electricity Generation: Update. [accessed 2025 Feb 27]. https://www.nrel.gov/docs/fy21osti/80580.pdf.

Carbon capture technologies have been developed to mitigate GHG emissions from major stationary sources such as cement kilns, steel mills, fertilizer factories, refineries, and power plants. These technologies use chemical reactions to filter carbon dioxide (CO_2) molecules out of facility exhaust that would otherwise be released into the atmosphere. To keep this captured CO_2 out of the atmosphere, it must then be pressurized and injected into a deep disposal well—a process known as geologic sequestration. If a geological storage well cannot be constructed at the site of capture, the CO_2 must be transported to the sequestration site by pipeline, rail, barge, or truck. **CCS is shorthand for this entire scope of activities comprising CO_2 capture, transportation, and geologic disposal.**

The basic operating principles of CCS make it suitable for application on large natural gas-fired electricity generators that run steadily. It is not suitable for small-scale installations or intermittent operations, which may make more sense to power with wind or solar energy. Therefore, **carbon capture is not expected to displace renewable generation.** Rather, it is complementary in situations that require large-scale, continuous delivery of electric power.

CCS can eliminate 95% of CO_2 emissions[21, 22] and the majority of other pollutants in exhaust from natural gas-fired electricity generation, resulting in firm power with very low CO_2 emissions. However, CCS does not address methane leakage and other pollution impacts upstream of electricity generation in the natural gas value chain. If poorly planned and implemented, CCS could worsen those impacts.

Meeting rapid deployment needs

Natural gas-fired power generation has a small physical footprint, is technically simple, and offers predictable power-generation characteristics that are well suited to meeting data center power demand. Over the past 25 years, public utilities and independent power producers have demonstrated that a **natural gas-fired power plant without CCS can be designed and built within a span of 18 months.** When fitting these facilities with CCS systems, there will be longer lead times required for sourcing capture equipment, preparing infrastructure to transport CO_2, as well as for permitting and constructing CO_2 storage wells. **Developers should expect that planning, constructing, and integrating the full CCS value chain will add 18–36 months to a project's timeline.**[23]

Stakeholders who need electricity brought online quickly may have the option to build a natural gas combined-cycle plant that is capture ready. A capture-ready facility is one that includes dedicated valves and piping to connect carbon capture equipment, reserves enough space to build the carbon capture plant, and facilitates access for CO_2 transport to an appropriate sequestration site. Bringing a capture-ready plant online before CCS is operational may be an effective way to acquire sufficient electricity quickly. However, building a capture-ready plant

[21] SLB Capturi. 2025. Just Catch™. [accessed 2025 Feb 27]. https://www.capturi.slb.com/products/just-catch%E2%84%A2.
[22] ION Clean Energy. 2023. How it works. [accessed 2025 Feb 27]. https://www.ioncleanenergy.com/how-it-works.
[23] Incorrys. 2024 Aug 8. Capital Cost of Power Generation by Source. Incorrys Articles: Energy Forecasts. Data, Intelligence, and Forecasts for New Energy, Environment, and New Technology. [accessed 2025 Feb 28]. https://incorrys.com/incorrys-articles-energy-forecasts/.

without an explicit commitment to deploy CCS in the shortest possible timeframe is inconsistent with serious climate action.

Delivering a steady supply

A natural gas-fired plant with CCS can supply hundreds of megawatts (MW) of low-carbon electricity while steadily running at full power or slowly varying its output over the course of the day without stopping or idling. **These characteristics make natural gas with CCS a good match for baseload or intermediate load applications**[24] such as data centers that are planning to continuously run at a high level of power consumption, industrial applications that plan to run around the clock, and electricity suppliers that are expanding their capacity in response to increasing regional demand.

Natural gas-fired power generation can be built in locations that do not have enough land area available for renewable forms of power generation like wind and solar. They can often be sited conveniently close to electricity transmission infrastructure and end users. Natural gas-fired power generation with CCS is competitive with both geothermal and nuclear electricity in terms of providing enough baseload power. Further, it offers cost advantages and is speedier to bring to market.[25]

However, natural gas-fired plants that regularly start and stop or that spend significant time at idle (e.g., simple-cycle[26] plants and peak-load plants[27]) will not perform as well in terms of carbon capture. Specifically, they will have efficiency lags ramping up and down and may have much lower CO_2 capture rates. Because carbon capture equipment is capital intensive, installing it on lower-capacity plants means that those capital costs are spread across a smaller quantity of produced electricity; the result is higher power costs. For both of these reasons, power purchasers should be skeptical of simple-cycle or peak-load plants being advertised as capture-ready.

Choosing an appropriate size

Stakeholders involved in the development of data centers that use more than 100 MW of electricity should consider natural gas-fired power generation with CCS alongside other generation options. At the 100-MW scale, the CO_2 emissions from natural gas-fired power generation without CCS amount to nearly 500,000 tonnes per year, representing a significant opportunity for carbon mitigation.[28] Although it is technically possible to apply CCS to small-scale

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[24] United States Energy Information Administration. 2024. Electricity generation, capacity, and sales in the United States. [accessed 2025 Feb 27]. https://www.eia.gov/energyexplained/electricity/electricity-in-the-us-generation-capacity-and-sales.php.
[25] Incorrys. 2024 Aug 8. Capital Cost of Power Generation by Source. Incorrys Articles: Energy Forecasts. Data, Intelligence, and Forecasts for New Energy, Environment, and New Technology. [accessed 2025 Feb 28]. https://incorrys.com/incorrys-articles-energy-forecasts/.
[26] A simple-cycle plant generates electricity from a spinning turbine shaft and exhausts hot gases to its flue stack. It is less expensive and less efficient than a combined-cycle plant which harvests energy from its exhaust to produce additional electricity. Combined-cycle plants are better candidates for CCS because they can use some of the energy harvested from the exhaust to run the capture equipment.
[27] United States Energy Information Administration. 2024. Electricity generation, capacity, and sales in the United States. [accessed 2025 Feb 27]. https://www.eia.gov/energyexplained/electricity/electricity-in-the-us-generation-capacity-and-sales.php.
[28] 500,000 tonnes of CO_2 is roughly equal to the annual climate impact of 100,000 gasoline-fueled passenger vehicles.

generators (and modular solutions are available), the characteristics of carbon capture and the logistics of managing CO_2, drive strong economies of scale. Therefore, large electricity users, or consortia of small users who can pool their electricity loads, are more appropriate customers for natural gas-fired power generation with CCS.

Lowering carbon emissions

Natural gas-fired power generation with CCS is an enabling technology that allows faster deployment of reliable, low-carbon, baseload power. Compared to natural gas-fired power generation without CCS, it offers a five-fold reduction in climate impacts and a reduction in direct CO_2 emissions of 90–95%. Electricity consumers can expect to receive power with a CI of 80–120 kg CO_2e/MWh[29] from natural gas with CCS,[30] or an even lower CI in certain circumstances. For comparison, power from wind and nuclear energy is estimated to have a CI of 10–15 kg CO_2e/MWh and the average CI of all power sources from grids in the US is 450 kg CO_2e/MWh.

Managing costs

The cost of new baseload electricity from natural gas combined-cycle generators without CCS is estimated to be $40–70/MWh in 2025. Adding CCS is estimated to increase the levelized cost of electricity by 50–100%.[31]

The cost premium for CCS is due to the capital cost of the capture equipment, the increased fuel needed to run the capture process, other operating costs, and the cost of transporting and storing captured CO_2. Although the total and relative impacts of each factor will vary with local conditions, the cost of capture equipment is projected to be the largest driver in most projects. Other factors that impact total project cost include physical location features like elevation and access to water, as well as commercial issues such as market structure and contract terms for power attributes like reliability and flexibility.

In the US, tax credits such as the federal 45Q credit for carbon sequestration are available that can substantially reduce the cost of CCS. **Combining all of these effects and uncertainties, we estimate that new natural gas-fired electricity generation with CCS will cost $65–100/MWh when deployed at scale.**[32] While this exceeds the average projected cost of wind or solar power without battery storage in some markets, it is cost competitive against renewable generation with battery storage, and may be the most cost-effective climate mitigation option in some locations (e.g., where renewable electricity is infeasible due to transmission constraints or physical unavailability).

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[29] kg CO_2e/MWh = kilograms of carbon dioxide equivalent emissions per megawatt hour.
[30] Khutal H, Kirchner-Ortiz KM, Blackhurst M, Willems N, Matthews HS, Rai S, Yanai G, Chivukula K, Jamieson MB, Skone TJ. 2020. Life Cycle Analysis of Natural Gas Extraction and Power Generation: U.S. 2020 Emissions Profile. [accessed 2025 Feb 27]. https://www.netl.doe.gov/projects/files/LifeCycleAnalysisofNaturalGasExtractionandPowerGenerationUS2020EmissionsProfile_012425.pdf.
[31] Burnard K. 2023 Feb 16. NETL's Updated Performance and Cost Estimates for Carbon Capture Equipped Power Generation (2023-04). IEAGHG. [accessed 2025 Feb 27]. https://ieaghg.org/insights/netls-updated-performance-and-cost-estimates-for-carbon-capture-equipped-power-generation/.
[32] Lazard. 2023. Levelized Cost of Energy Analysis. [accessed 2025 Feb 27]. https://www.lazard.com/media/nltb551p/lazards-lcoeplus-april-2023.pdf.

Developing natural gas-fired power with carbon capture

Even when other low-carbon electricity options are not available, choosing natural gas-fired power with CCS as a decarbonization solution is a complex decision. **Developers must consider capture, transportation, storage, life cycle impacts, and infrastructure connectivity independently, as a system, and as compared to alternatives.**

Although CCS systems have been operating for decades, very few have been deployed on natural gas-fired power generation.[33] Expertise in CCS technology as a means to decarbonize electricity use is not widespread. However, just as wind and solar grew from small communities of passionate innovators to large industries, CCS technology can also develop and grow with sufficient investment and supportive policy. Stakeholders in the data center value chain can partner with the community of CCS experts to quantify the full climate impact of CCS, align power generation with their local utility, determine project feasibility, and initiate concept selection and design.

Choosing a carbon capture technology

Carbon capture technologies are key to decarbonizing natural gas-fired power generation, and come in several forms. Solvents, sorbents, and membranes are all technologies that can be used for capturing CO_2 from existing gas turbines, boilers, and engines.[34] Those same technologies, as well as oxyfiring, may be considered for inclusion in newly-built power plants. **Project developers should anticipate a rigorous concept selection process that evaluates the physical space available, capital costs, energy use, operating costs, and technical maturity of capture options.**

Capturing CO_2 is an energy-intensive process. Therefore, developers should anticipate either lower power generation efficiency in the form of 20–30% less electricity output[35] or similarly increased fuel consumption, depending on system configuration. Additionally, capture technologies are chemical processes that operate best at a steady output level, making them well-suited to power plants that run continuously, and poorly suited to peak-load plants.

Carbon capture technologies are based on existing technologies that have been used for decades in the energy and chemical industries. However, prior to 2025, they have not been deployed widely on natural gas-fired power plants.[36] Therefore, the supply chain for key components such as absorber towers, solvent solutions, sorbent materials, and compressors may be strained. Stakeholders are encouraged to monitor lead times for major pieces of CCS equipment just as closely as they watch the supply chain for transformers and other items critical for electrical

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[33] Global CCS Institute. 2024. Global Status of CCS 2024: Collaborating for a Net-Zero Future. [accessed 2025 Feb 27]. https://www.globalccsinstitute.com/wp-content/uploads/2024/11/Global-Status-Report-6-November.pdf.

[34] Intergovernmental Panel on Climate Change. 2005. Carbon Dioxide Capture and Storage. [accessed 2025 Feb 27]. https://www.ipcc.ch/site/assets/uploads/2018/03/srccs_wholereport-1.pdf.

[35] Burnard K. 2023 Feb 16. NETL's Updated Performance and Cost Estimates for Carbon Capture Equipped Power Generation (2023-04). IEAGHG. [accessed 2025 Feb 27]. https://ieaghg.org/insights/netls-updated-performance-and-cost-estimates-for-carbon-capture-equipped-power-generation/.

[36] Global CCS Institute. 2024. Global Status of CCS 2024: Collaborating for a Net-Zero Future. [accessed 2025 Feb 27]. https://www.globalccsinstitute.com/wp-content/uploads/2024/11/Global-Status-Report-6-November.pdf.

interconnection. Manufacturing, installation, and commissioning of carbon capture systems all contribute to the multi-year timeline required to fully deploy CCS on natural gas-fired electricity.

Navigating transportation logistics

Transporting captured CO_2 from a power plant to a sequestration site is just as important as the capture itself. **A pipeline is the most efficient way to move large volumes of CO_2 over long distances, but CO_2 can also be transported in pressurized tanks by truck, rail, or barge.** Stakeholders should account for the cost, life cycle emissions, and timeline of developing transportation infrastructure when planning a natural gas with CCS project. Stakeholders should also plan for transportation and order dedicated loading and shipping equipment. This work should coincide with design and construction of the capture facility because lead times are likely to be comparable across both systems.

For pipelines, developers must secure rights-of-way and permitting, which is particularly challenging for routes that cross state lines. Developers must also plan to build transloading terminals (equipment used to fill and empty CO_2 transport vessels) with intermediate storage tanks for truck, rail, and barge shipments. For capture projects that are sited near proposed CO_2 pipeline routes,[37] rail, truck, or barge options may be feasible as an interim solution while waiting for a pipeline to be built.[38]

Ensuring safe and effective sequestration

Geologic sequestration is a critical piece of carbon management. If there is no sequestration, there is no project. Sequestering CO_2 safely and permanently is accomplished by injecting it deep underground, commonly in a dedicated saline formation. Many areas of the US offer suitable sites for CO_2 storage,[39] particularly in regions such as the Midwest, the Gulf Coast, the Mountain West, and California. In the US, this requires a Class VI well, a designation granted by the US Environmental Protection Agency (EPA) or by a state that has been granted primacy,[40] such as Louisiana. It takes significant time and resources to characterize the local geology of a potential storage site, which is not only necessary for safe and secure operation, but required to obtain a permit and tax credits under the Inflation Reduction Act's 45Q provisions for carbon sequestration. Today, although relatively few Class VI wells are currently operational, the EPA has dramatically increased the rate of permit processing. Several states now have primacy to grant permits (i.e., North Dakota, Wyoming, Louisiana, and West Virginia).

Stakeholders seeking to source power from natural gas-fired facilities with CCS should understand the landscape of existing and pending Class VI permits,[41] and plan to partner with reputable Class

[37] American Carbon Alliance. n.d. Map of Carbon Pipelines. [accessed 2025 Feb 27]. https://americancarbonalliance.org/map-of-us-pipelines/.
[38] For reference, a natural gas-fired power plant designed to deliver 200 MW after being fitted with CCS, can produce enough CO_2 to fill 30 rail cars per day.
[39] National Energy Technology Laboratory. 2015. Carbon Storage Atlas: Fifth Edition. [accessed 2025 Feb 27]. https://www.netl.doe.gov/sites/default/files/2018-10/ATLAS-V-2015.pdf.
[40] United States Environmental Protection Agency. 2022 Jun 9. Primary Enforcement Authority for the Underground Injection Control Program. [accessed 2025 Feb 27]. https://www.epa.gov/uic/primary-enforcement-authority-underground-injection-control-program-0.
[41] United States Environmental Protection Agency. 2023 Apr 27. Current Class VI Projects under Review at EPA. [accessed 2025 Feb 27]. https://www.epa.gov/uic/current-class-vi-projects-under-review-epa.

VI well owners or applicants. Parties seeking to develop a Class VI well as part of their natural gas with CCS project should incorporate substantial geologic sequestration expertise into their team. It is critical that developers ensure the injection well is operational by the time carbon capture is brought online. The multi-year development timeline for carbon capture and transportation systems is compatible with the process of identifying a Class VI well developer who will be ready on time—planning for all three stages (carbon capture, transportation, and sequestration) should happen simultaneously.

Assessing full life cycle impacts

While CCS is an effective way to reduce emissions from power generation, it does not eliminate climate impacts entirely. **Developers should analyze CCS projects on a full life cycle basis,** and should compare them to alternative ways to meet the same energy demands.

CCS technology is expected to scrub 95% of the CO_2 from a power plant's emissions.[42, 43] Therefore, the CI of power derived exclusively from a natural gas-fired generator fitted with CCS cannot be zero. At a minimum, the CI will be 20 kg CO_2/MWh, or 5% of the combustion CO_2 emissions from a comparable natural gas-fired plant without CCS.

Upstream emissions from producing, processing, and transporting natural gas are also important to consider. Upstream emissions are proportional to the amount of natural gas used by a facility, and natural gas-fired electric generators with CCS use 20–30% more natural gas than generators without CCS. Upstream emissions typically contribute a baseline of 40 kg CO_2e for each MWh of electricity generated, plus another 40 kg CO_2e/MWh for every 1% of methane leakage in the natural gas supply chain. Although average methane leakage is estimated to be 1% in the US, leak rates vary widely by location. They have been observed to be as high as 9% in some places, and less than 0.25% in others. Upstream emissions add 50–350 kg CO_2e/MWh to any natural gas-fired electricity generation project. The upper end of that range is nearly equivalent to the amount of climate mitigation that is achievable with CCS. Therefore, stakeholders should seek to purchase natural gas supplies with very low upstream methane leakage that is third-party verified, or work with their natural gas supplier to quantify and reduce upstream methane leakage on all natural gas-fired electricity generation projects.

Other life cycle emissions from construction, CO_2 transportation, and additional water use[44] will factor into the project's climate impact, and should be considered during procurement and commissioning.

When comparing the total impact of natural gas-fired power with CCS to alternative scenarios, developers should use consistent system boundaries that include the construction and operation of the full value chain and the timeline to deploy different technologies. For example, deploying capture-ready, natural gas-fired power and then quickly fitting it with CCS might result in lower life

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[42] SLB Capturi. 2025. Just Catch™. [accessed 2025 Feb 27]. https://www.capturi.slb.com/products/just-catch%E2%84%A2.
[43] ION Clean Energy. 2023. How it works. [accessed 2025 Feb 27]. https://www.ioncleanenergy.com/how-it-works.
[44] Dycian Y. 2022. The Carbon Footprint of Water. WINT. [accessed 2025 Feb 27]. https://wint.ai/blog/the-carbon-footprint-of-water/.

cycle emissions than an approach where solar photovoltaics are slowly added in areas where the regional grid has a high CI. Conversely, if natural gas-fired power plants cannot be quickly fitted with CCS, this could result in a project that has higher life cycle emissions than a project that pursues power from solar energy in areas where solar photovoltaics are easy to build and integrate.

Connecting to existing infrastructure

In addition to CO_2 transportation and sequestration, stakeholders need to carefully assess connections to other infrastructure. **A key consideration is interconnection between the power generation facility and an electrical grid.** Data center operators must also consider interconnection of their load to the local grid. This is true regardless of if power is generated by natural gas, wind, solar, or another energy source. The local utility must review each new connection to ensure that it won't destabilize other users, and most utilities are already backlogged with other projects. Interconnection equipment such as large transformers and high voltage power lines take time to build and install. For natural gas-fired power with CCS, developers also need to ensure that sufficient capacity is available within the local delivery network for natural gas. Natural gas supply may be constrained by the size of existing piping, and availability may vary by season because some gas systems run close to their maximum capacity during the winter heating season.

These challenges exist whether a data center is connecting to a grid with sufficient resources, accepting electricity from utility-operated new power generation, or procuring dedicated power. This is because, in most cases, the local grid will be used to back up and smooth out power fluctuations and disruptions. Stakeholders building electricity generation that is not connected to the electrical grid may bypass the interconnection queue but will still need to connect to a local grid to procure electrical switchgear,[45] deploy systems to regulate generation, and ensure adequate fuel supply when using natural gas.

Conclusion

Demand for electricity is rapidly increasing, driven by the immediate buildout of AI-focused data centers and supported by the long-term trend of industrial expansion and electrification. In locations where power needs are large and sustained, integrating natural gas-fired power generation with CCS is an important decarbonization strategy. It complements renewable and other low-carbon electricity supplies in fulfilling substantial energy demands while enabling stakeholders in the data center value chain to meet their climate commitments. This approach offers a scalable, reliable, and low-carbon energy solution, ensuring high availability to meet escalating energy demands. However, stakeholders must carefully consider the deployment timelines, infrastructure requirements, and life cycle emissions associated with this approach. Navigating this complex landscape requires collaboration with experienced partners who can provide the expertise and guidance needed to implement effective CCS strategies for natural gas-fired power generation. Such collaboration will ensure competitive, efficient, and responsible operation for a broadly electrified future.

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[45] Schnieder Electric. 2025. Understanding Switchgear. [accessed 2025 Feb 27]. https://www.se.com/us/en/work/featured-articles/what-is-switchgear/.

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