

Modernizing the U.S. Coal Fleet: Extending Plant Life Through Retrofits, Digitalization, and Efficiency Upgrades

United States Energy Association

BOTTOM LINE UP FRONT

Recent federal policy shifts have eased some regulatory pressure on existing coal plants and strengthened the case for preserving strategically valuable firm capacity. In this environment where dependable replacement capacity, transmission upgrades, or fuel-supply alternatives do not exist, coal plant retrofits including, controls modernization, and digital upgrades may extend the useful life of existing plants at reasonable cost and with measurable reliability benefits.

WHY COAL FLEET MODERNIZATION IS BACK IN THE POLICY DISCUSSION

In January 2026, the U.S. Energy Information Administration (EIA) reported that the United States is entering its strongest four-year period of electricity demand growth since 2000, with large computing facilities and data centers emerging as a major driver. For policymakers, that combination matters. A system facing stronger demand growth has less room for avoidable losses of firm capacity, particularly in regions where transmission, interconnection, alternate fuels, or replacement resources are lagging.

Recent retirement data points in the same direction. On April 13, 2026, EIA reported that only 2.6 GW of coal-fired capacity retired in 2025, the least annual total in 15 years. That was far below the 8.5 GW that operators had planned to retire at the start of 2025. 4.8 GW of retirements were delayed and another 1.1 GW of planned retirements were cancelled. This means that plant owners, regulators, and grid operators are making practical decisions to keep some existing units available longer than once expected.

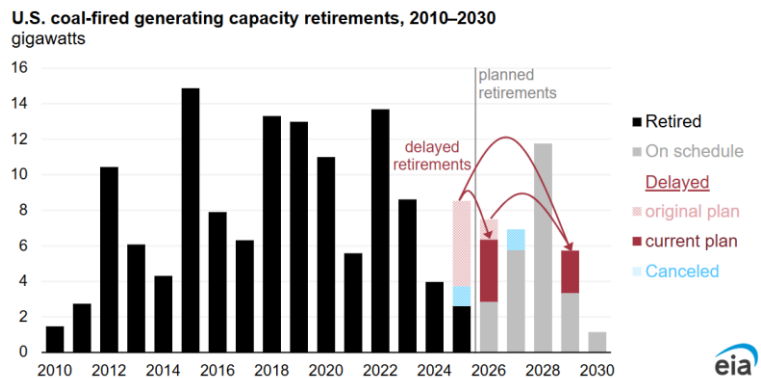


Image 1. U.S. coal-fired generating capacity retired in 2025 was the least in 15 years. Source: U.S. Energy Information Administration (EIA), Today in Energy, April 13, 2026.

The North American Electric Reliability Corporation (NERC) January 2026 *Long-Term Reliability Assessment* underscores that resource adequacy risks are rising as electricity demand accelerates, particularly in areas where firm replacement capacity and transmission infrastructure are not being added quickly enough. Plants that are already built, interconnected, staffed, and supported by on-site fuel supplies can continue to provide dependable power while the broader system adds new generation and delivery infrastructure.

NERC’s 2025 *Long-Term Reliability Assessment* makes clear that these pressures are not uniform across the country. Reliability needs are increasingly regional, shaped by differing patterns of load growth, retirement

schedules, available transmission, and the pace at which replacement resources move from development to operation. This has important implications for coal modernization policy. The value of extending the life of an existing plant is likely to be greatest in regions where electricity demand is rising rapidly, transmission expansion is lagging, or new generation remains delayed in permitting, interconnection, or construction pipelines. In that context, coal modernization is best understood not as a one-size-fits-all approach, but as a targeted, region-specific tool for preserving dependable capacity and supporting grid reliability where it is needed most.

HOW COAL PLANT MODERNIZATION WORKS

Modernizing a coal plant is a plant-by-plant process of evaluating how an existing facility can operate more efficiently and reliably under current grid conditions. The starting point is usually an assessment of the unit’s age, heat rate, outage history, maintenance needs, environmental compliance requirements, fuel-handling systems, and role in the surrounding power system. From there, owners and operators determine whether targeted investments can improve performance enough to justify extending the unit’s useful life. Modernization decisions remain highly plant-specific, depending not only on grid need and policy support, but also on a unit’s remaining useful life, capital requirements, operating profile, and local market conditions.

EFFICIENCY IMPROVEMENT

One common pathway is **efficiency improvement**. EIA’s *Annual Energy Outlook 2026* assumptions explicitly model heat-rate improvement retrofits for existing coal units. In practical terms, that means upgrading or refurbishing equipment so the plant can generate the same

Infrastructure Pace: Development is uncertain as few projects are approved. Growth is threatened by supply chain, interconnection process and approval delays.

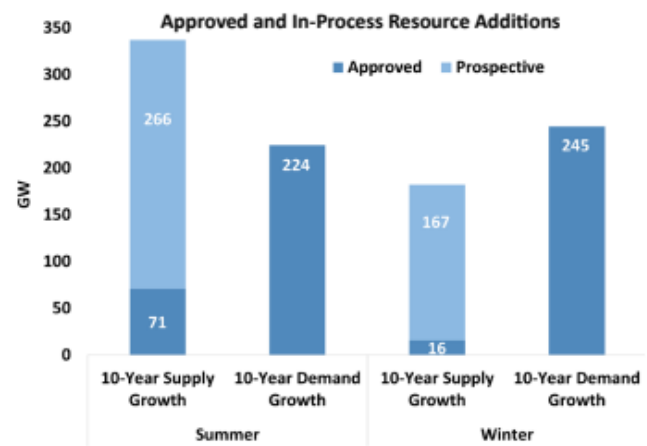


Image 2. NERC’s 2025 *Long-Term Reliability Assessment* highlights rising adequacy risks, faster demand growth, and uncertainty in replacement resource delivery. Source: North American Electric Reliability Corporation (NERC), 2025 *Long-Term Reliability Assessment* infographic, January 2026.

amount of electricity while burning less fuel. These upgrades may include improvements to boilers, turbines, condensers, feedwater heaters, air-preheater systems, and control systems. A lower heat rate can reduce fuel costs and lower emissions of sulfur dioxide, nitrogen oxides, mercury, and carbon dioxide per unit of electricity generated.

RELIABILITY AND OPERATIONAL FLEXIBILITY

A second modernization pathway involves improving **reliability** under cycling and expanding **operational flexibility** where practical. Most coal plants were originally designed for steady baseload operation, but some units are now being asked to operate more frequently in load-following, partial-load, and start-stop modes as grid conditions change over the course of the day. This creates real technical constraints. Coal units are steam-cycle plants, and raising or lowering output requires changes in boiler pressure and temperature. Repeated ramping can cause thermal expansion, contraction, fatigue, and stress in boilers, piping, tubes, turbines, and related balance-of-plant equipment.

Modernization does not make coal plants equivalent to fast-ramping gas units. Instead, flexibility-oriented upgrades are aimed at managing these constraints more effectively. Practical measures can include improving combustion stability, reducing minimum-load limitations, strengthening monitoring of boiler and turbine conditions, upgrading materials where cycling stress is severe, improving condenser performance, and using advanced controls to reduce heat-rate penalties and forced-outage risks during partial-load and ramping operation. In this sense, modernization can help selected coal units operate more efficiently and reliably under changing grid conditions, while preserving their core value as firm, fuel-secure capacity.

DIGITALIZATION

A third pathway is **digitalization**. DOE's Hydrocarbons and Geothermal Energy Office (HGEO's) Office of Coal now explicitly frames part of its mission around artificial intelligence tools, robotics, automation, and digital twins (data-driven virtual replicas of physical plant systems that allow operators to monitor performance, anticipate maintenance needs, and test operational improvements without affecting the actual units). In practice, this means applying advanced sensors, monitoring tools, software, and data analytics to improve how plants are operated and maintained. Digital upgrades can help identify equipment problems before they lead to forced outages, improve combustion performance in real time, optimize maintenance schedules, and give operators better visibility into how the plant is performing under different operating conditions. In some cases, these digital tools can deliver meaningful performance improvements quicker and at lower cost than major physical rebuilds.

COAL MODERNIZATION IS NOW REFLECTED IN FEDERAL POLICY

On February 11, 2026, the U.S. Department of Energy (DOE) announced **\$175 million in investment for six projects** intended to modernize, retrofit, and extend the useful life of coal-fired power plants serving rural and remote communities, as part of an effort to expand and reinvigorate

portions of the U.S. coal fleet through upgrades that increase efficiency, extend plant life, and add dependable capacity using existing infrastructure.

CURRENT DOE-SELECTED COAL PLANT MODERNIZATION PROJECTS

Six DOE-selected modernization projects are tied to specific plants and utilities. They include upgrades at the **Mountaineer Power Plant** and **John E. Amos Power Plant** in West Virginia for Appalachian Power; **Cardinal Plant Units 1 and 2** in Ohio for Buckeye Power; **Belews Creek Steam Station** in North Carolina for Duke Energy Carolinas; **Ghent Generating Station Unit 2** in Kentucky for Kentucky Utilities; **Fort Martin Power Station** in West Virginia for Monongahela Power; and **Kyger Creek Station** in Ohio for Ohio Valley Electric Corporation.

Plant	State	Utility	Modernization Scope	Primary Modernization Objective
Mountaineer Power Plant and John E. Amos Power Plant	West Virginia	Appalachian Power Company	Electrostatic precipitator modernization, reheater restoration, cooling-tower and condenser upgrades, and roof replacements	Efficiency, environmental performance, and life extension
Cardinal Plant Units 1 and 2	Ohio	Buckeye Power, Inc.	Turbine rotor replacements, generator refurbishment, boiler upgrades, Selective Catalytic Reduction (SCR) catalyst replacement, and Flue Gas Desulfurization (FGD) refurbishment	Reliability, affordability, compliance, and long-term operational viability
Belews Creek Steam Station Units 1 and 2	North Carolina	Duke Energy Carolinas, LLC	Reliability upgrades across boiler, turbine-generator, and balance-of-plant systems	Reliability, forced-outage reduction, and continued dependable service
Ghent Generating Station Unit 2	Kentucky	Kentucky Utilities Company	SCR installation to preserve capacity and support compliance	Capacity preservation and environmental compliance
Fort Martin Power Station	West Virginia	Monongahela Power Company	Coal-handling upgrades, including crusher replacement and redundancy improvements	Fuel-handling reliability, combustion stability, and operational resilience
Kyger Creek Station	Ohio	Ohio Valley Electric Corporation	Transformer replacements, emissions-control upgrades, digital controls modernization, and mechanical repairs	Grid reliability, operational resilience, cybersecurity, and equipment-life extension

Source: U.S. Department of Energy, *Project Selections: Restoring Reliability Through Coal Recommissioning and Modernization*.

DOE described the funding as part of a broader effort to expand and reinvigorate portions of the coal fleet through targeted upgrades that increase efficiency, extend plant life, and add dependable capacity using infrastructure that is already built and connected to the grid.

BUDGET SIGNALS ARE REINFORCING THE MODERNIZATION AGENDA

Similarly, DOE’s FY 2027 Budget in Brief states that the Office of Coal is focused in part on modernizing and extending the life of the existing coal-based power fleet and optimizing efficiencies across the extraction, processing, and power-generation value chain. More broadly, the FY 2027 budget requests \$3.5 billion for activities intended to rapidly add and deliver additional baseload power, including upgrades for coal, natural gas, and nuclear equipment. Together, these budget signals indicate that coal fleet modernization is positioned as one component of a broader DOE strategy to strengthen reliability, preserve firm generation, and make better use of existing energy infrastructure.

REGULATORY AND POLICY SHIFTS ARE CHANGING THE MODERNIZATION OUTLOOK

Regulatory and federal policy developments have also affected the economics and timing of coal-plant modernization. EPA’s December 2025 Steam Electric Effluent Limitations Guidelines (ELG) Deadline Extensions Rule extended wastewater compliance deadlines for coal-fired power plants, giving facilities more time to evaluate compliance pathways. In February 2026, EPA also finalized the repeal of certain 2024 Mercury and Air Toxics Standards (MATS) amendments for coal and oil-fired power plants. In parallel, EPA proposed repealing the Biden-era 2024 Carbon Pollution Standards for fossil fuel-fired power plants, a separate rule from the Obama-era Clean Power Plan that had already been repealed and later limited by the Supreme Court’s 2022 decision in *West Virginia v. EPA*. DOE has also used its emergency authority under section 202(c) of the Federal Power Act to keep specific generating units, including coal-fired units, available for operation where reliability concerns warranted delay of planned retirements. Taken together, these actions have changed the near-term planning environment. Plants facing tighter compliance or retirement timelines now have more room to weigh retrofit, modernization, continued operation, and retirement options.

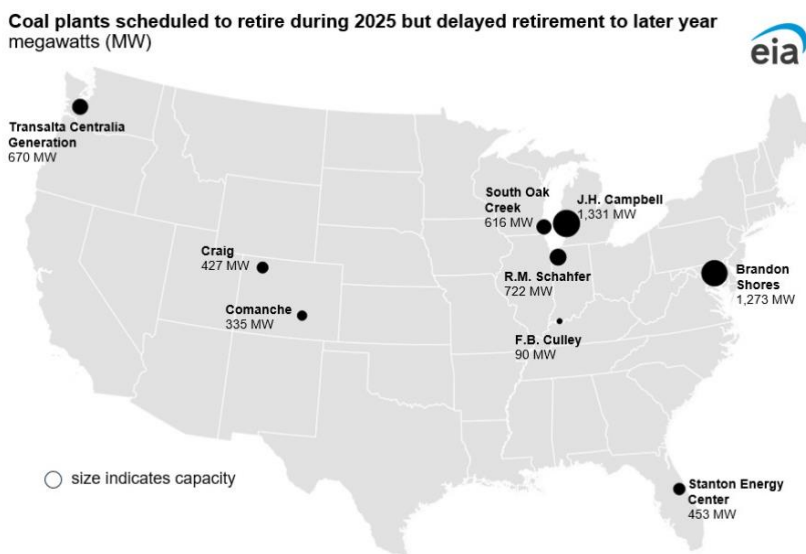


Image 3. Coal plants scheduled to retire during 2025 but delayed retirement to a later year. Source: U.S. Energy Information Administration (EIA), *Preliminary Monthly Electric Generator Inventory*, December 2025

FUTURE U.S. COAL FLEET MODERNIZATION STRATEGY

U.S. coal fleet modernization will deliver the greatest value when it is applied selectively, with close attention to plant conditions, regional reliability needs, replacement resource timing, and the broader policy environment. EIA’s *Annual Energy Outlook 2026* indicates that the future of coal capacity remains highly sensitive to policy, market conditions, and system needs. That makes

modernization best understood not as a one-size-fits-all proposition, but as a practical tool for preserving dependable capacity where it continues to provide clear operational and strategic value. Some units are better positioned than others for life-extension investments, based on their age, size, operating performance, maintenance profile, environmental controls, workforce availability, fuel access, and role in supporting the surrounding grid. In many cases, the strongest candidates are plants located in reliability-critical areas, plants with strategic value, or units that can be upgraded quickly and cost-effectively.

CONCLUSION

Coal-plant modernization is becoming an increasingly consequential part of the U.S. electricity outlook. In a period of rising demand, tighter reserve margins in some regions, and slower-than-expected infrastructure buildout, targeted retrofits and digital upgrades can improve the efficiency, reliability, and operational value of existing plants that are already built, interconnected, and strategically located. The central question is not whether every plant merits the same approach, but where modernization can deliver the greatest reliability benefit and make the best use of existing energy infrastructure. Viewed in that light, coal modernization is best understood as a practical, targeted strategy to enhance performance, preserving system security, and support firm generation.

THE UNITED STATES ENERGY ASSOCIATION (USEA) Founded in 1924, the United States Energy Association (USEA) is a nonprofit, nonpartisan, and non-lobbying organization that serves as a neutral forum for dialogue across the global energy sector. USEA’s mission rests on two pillars: first, convening stakeholders to exchange insights on policy, regulation, science, technology and finance to advance reliable, affordable energy for economic growth and prosperity; and second, partnering with the U.S. Government, members, and international allies to expand access to U.S. energy resources and technology to strengthen energy security worldwide.

With over 100 member organizations, USEA’s members include government agencies, utilities, architect and engineering firms, nonprofits, think tanks, academic institutions, Fortune 500 companies, and leading engineering consultancies that span the breadth of energy sources and technology. As an industry convener, USEA provides a trusted, nonpartisan, and technology-neutral forum to inform policy discussions, highlight innovation, and chart pathways for strengthening U.S. energy leadership. USEA also hosts flagship events, webinars, briefings, and workshops to advance dialogue on emerging energy issues.

USEA’s team of international specialists partners with U.S. federal agencies, including the Department of Energy (DOE), Department of State, and other government entities, to strengthen U.S. competitiveness and open opportunities for U.S. businesses in global energy markets, including grid-enhancing technologies, liquified natural gas (LNG) exports, small modular reactors, and cybersecurity.

Beata Bialy
Non-Resident Fellow
United States Energy Association

Beata Bialy is a Non-Resident Fellow with the United States Energy Association, where she produces research and publications on energy policy, and the strategic role of domestic energy resources in supporting U.S. economic competitiveness and energy security.

SOURCES

United States Government and Federal Agencies

U.S. Energy Information Administration (EIA). Press Release: EIA Forecasts Strongest Four-Year Growth in U.S. Electricity Demand Since 2000, Fueled by Data Centers (January 13, 2026)

<https://www.eia.gov/pressroom/releases/press582.php>

U.S. Energy Information Administration (EIA). Today in Energy: U.S. Coal-Fired Generating Capacity Retired in 2025 Was the Least in 15 Years (April 13, 2026)

<https://www.eia.gov/todayinenergy/detail.php?id=67427>

U.S. Energy Information Administration (EIA). Today in Energy Archive

<https://www.eia.gov/todayinenergy/archive.php>

U.S. Energy Information Administration (EIA). Today in Energy – Coal Topic Page

<https://www.eia.gov/todayinenergy/index.php?tg=coal>

U.S. Energy Information Administration (EIA). Annual Energy Outlook 2026

<https://www.eia.gov/outlooks/aeo/>

U.S. Energy Information Administration (EIA). Annual Energy Outlook 2026 Narrative

https://www.eia.gov/outlooks/aeo/pdf/AEO_Narrative.pdf

U.S. Energy Information Administration (EIA). Assumptions to the Annual Energy Outlook 2026: Electricity Market Module (EMM Assumptions)

https://www.eia.gov/outlooks/aeo/assumptions/pdf/EMM_Assumptions.pdf

U.S. Energy Information Administration (EIA). Electricity Explained: Electricity in the United States

<https://www.eia.gov/energyexplained/electricity/electricity-in-the-us.php>

U.S. Energy Information Administration (EIA). Preliminary Monthly Electric Generator Inventory

<https://www.eia.gov/electricity/data/eia860m/>

U.S. Energy Information Administration (EIA). Electric Power Plant Operations Report (Form EIA-923)

<https://www.eia.gov/electricity/data/eia923/>

U.S. Department of Energy (DOE). Energy Department Announces \$175 Million to Modernize Coal Plants, Keeping Affordable Reliable Power Online for Americans (February 11, 2026)

<https://www.energy.gov/articles/energy-department-announces-175-million-modernize-coal-plants-keeping-affordable-reliable>

Recommissioning and Modernization

U.S. Department of Energy (DOE). Funding Notice: Restoring Reliability Through Coal
Recommissioning and Modernization

<https://www.energy.gov/hgeo/funding-notice-restoring-reliability-coal-recommissioning-and-modernization>

U.S. Department of Energy (DOE). FY 2027 Budget in Brief

<https://www.energy.gov/documents/doe-fy-2027-budget-brief>

U.S. Department of Energy (DOE). Funding Notice: Improving Efficiency, Reliability, and Flexibility of
Coal-Based Power Plants

<https://www.energy.gov/hgeo/funding-notice-improving-efficiency-reliability-and-flexibility-coal-based-power-plants>

U.S. Department of Energy (DOE). NETL eXCHANGE: DE-FOA-0003606 Improving Efficiency,
Reliability, and Flexibility of Coal-Based Power Plants

<https://netl-exchange.energy.gov/>

U.S. Department of Energy (DOE). 2025 DOE 202(c) Orders

<https://www.energy.gov/ceser/2025-doe-202c-orders>

U.S. Department of Energy (DOE). 2026 DOE 202(c) Orders

<https://www.energy.gov/ceser/2026-doe-202c-orders>

Reliability and Grid Institutions

North American Electric Reliability Corporation (NERC). 2025 Long-Term Reliability Assessment

<https://www.nerc.com/pa/RAPA/Pages/default.aspx>

North American Electric Reliability Corporation (NERC). 2025 Long-Term Reliability Assessment (PDF)

https://www.nerc.com/globalassets/our-work/assessments/nerc_ltra_2025.pdf

North American Electric Reliability Corporation (NERC). 2025 Long-Term Reliability Assessment
Infographic

https://www.nerc.com/globalassets/our-work/assessments/ltra_infographic_2025.pdf

North American Electric Reliability Corporation (NERC). 2025 State of Reliability – Technical
Assessment

https://www.nerc.com/globalassets/programs/rapa/pa/nerc_sor_2025_technical_assessment.pdf

North American Electric Reliability Corporation (NERC). Reliability Assessments and Performance Analysis (RAPA)

<https://www.nerc.com/pa/RAPA/Pages/default.aspx>

Environmental and Regulatory Policy

U.S. Environmental Protection Agency (EPA). Steam Electric Power Generating Effluent Guidelines – Deadline Extensions Rule

<https://www.epa.gov/eg/steam-electric-power-generating-effluent-guidelines-deadline-extensions-rule>

U.S. Environmental Protection Agency (EPA). Mercury and Air Toxics Standards (MATS) – Main Program Page

<https://www.epa.gov/stationary-sources-air-pollution/mercury-and-air-toxics-standards>

U.S. Environmental Protection Agency (EPA). MATS Final Fact Sheet – Repeal of 2024 Amendments (February 2026)

https://www.epa.gov/system/files/documents/2026-02/mats-final-fact-sheet_repeal-of-2024-amendments_feb2026.pdf

U.S. Environmental Protection Agency (EPA). Final Repeal: National Emission Standards for Hazardous Air Pollutants: Coal- and Oil-Fired Electric Utility Steam Generating Units

<https://www.epa.gov/system/files/documents/2026-02/6716.4-mats-final-preamble-and-rule-20260218.pdf>

U.S. Environmental Protection Agency (EPA). Analysis of the Final Repeal of the Mercury and Air Toxics Standards Amendments

<https://www.epa.gov/power-sector-modeling/analysis-final-repeal-mercury-and-air-toxics-standards-amendments>

U.S. Environmental Protection Agency (EPA). Fact Sheet: Proposal to Repeal Greenhouse Gas Standards for Fossil Fuel-Fired Power Plants (June 11, 2025)

<https://www.epa.gov/system/files/documents/2025-06/6.11.25-fact-sheet-ghg-standards-proposed-repeal-final.pdf>

U.S. Environmental Protection Agency (EPA). News Release: EPA Proposes Repeal of Regulations for Power Plants (June 11, 2025)

<https://www.epa.gov/newsreleases/epa-proposes-repeal-biden-harris-epa-regulations-power-plants-which-if-finalized-would>

Coal Plant Modernization, Technology, and Operations

U.S. Department of Energy (DOE). Office of Coal – Conversion & Products / Power & Capture / Mining & Processing

<https://www.energy.gov/hgeo/office-coal>

U.S. Department of Energy (DOE). Funding Notice: Improving Efficiency, Reliability, and Flexibility of Coal-Based Power Plants

<https://www.energy.gov/hgeo/funding-notice-improving-efficiency-reliability-and-flexibility-coal-based-power-plants>

National Energy Technology Laboratory (NETL). NETL eXCHANGE Funding Opportunities

<https://netl-exchange.energy.gov/>

U.S. Energy Information Administration (EIA). Assumptions to the Annual Energy Outlook 2026: Electricity Market Module

https://www.eia.gov/outlooks/aeo/assumptions/pdf/EMM_Assumptions.pdf

U.S. Department of Energy (DOE). Office of Coal – Artificial Intelligence, Robotics, Automation, and Digital Twins

<https://www.energy.gov/hgeo/office-coal>

Energy Infrastructure and Power Sector Data

U.S. Energy Information Administration (EIA). Form EIA-860M Preliminary Monthly Electric Generator Inventory

<https://www.eia.gov/electricity/data/eia860m/>

U.S. Energy Information Administration (EIA). Form EIA-860 Annual Electric Generator Report

<https://www.eia.gov/electricity/data/eia860/>

U.S. Energy Information Administration (EIA). Form EIA-923 Power Plant Operations Report

<https://www.eia.gov/electricity/data/eia923/>

U.S. Energy Information Administration (EIA). Electric Power Monthly

<https://www.eia.gov/electricity/monthly/>

Background / Supplemental Federal Context

U.S. Department of Energy (DOE). CESER Orders and Emergency Authorities

<https://www.energy.gov/ceser>

U.S. Department of Energy (DOE). Order Addressing Arguments Raised on Rehearing, DOE Order No. 202-25-7B

<https://www.energy.gov/documents/order-addressing-arguments-raised-rehearing-202-25-7b>

U.S. Environmental Protection Agency (EPA). Fact Sheet: Bolstering American Energy Dominance by Providing Compliance Flexibility to Coal-Fired Power Plants (September 2025)

<https://www.epa.gov/system/files/documents/2025-09/steam-electric-2025-dfr-and-nprm-fact-sheet-final.pdf>

IMAGE SOURCES

Image 1. U.S. Energy Information Administration (EIA). Today in Energy: U.S. Coal-Fired Generating Capacity Retired in 2025 Was the Least in 15 Years (April 13, 2026)

<https://www.eia.gov/todayinenergy/detail.php?id=67427>

Image 2. North American Electric Reliability Corporation (NERC). 2025 Long-Term Reliability Assessment Infographic (January 2026)

https://www.nerc.com/globalassets/our-work/assessments/ltra_infographic_2025.pdf

Image 3. U.S. Energy Information Administration (EIA). Preliminary Monthly Electric Generator Inventory, December 2025 and December 2024

<https://www.eia.gov/electricity/data/eia860m/>