THIRD WAY

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Unlocking AI's Grid Modernization Potential

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Summary

Surging energy demand and increasingly frequent extreme weather events are bringing new challenges to the forefront of electric grid planning, permitting, operations, and resilience. These hurdles are pushing our already fragile grid to the limit, highlighting decades of underinvestment, stagnant growth, and the pressing need to modernize our system.

While these challenges aren't new, they are newly urgent. The society-wide emergence of artificial intelligence (AI) is bringing many of these challenges into sharper focus, pushing the already

increasing electricity demand to new heights and cementing the need for deployable, scalable, and impactful solutions. Fortunately, many transformational and mature AI tools provide near-term pathways for significant grid modernization.

This policy memo builds on foundational research from the US Department of Energy's (DOE) *AI for Energy* (2024) report to present a new matrix that maps these unique AI applications onto an "impact-readiness" scale. Nearly half of the applications identified by DOE are high impact and ready to deploy today. An additional ~40% have high impact potential but require further investment and research to move up the readiness scale. Only 2 of 14 use cases analyzed here fall into the "low-impact / low-readiness" quadrant.

Unlike other emerging technologies, AI's potential in grid modernization is not simply an R&D story, but a deployment one. However, with limited resources, the federal government should invest in use cases that show **high-impact potential and demonstrate feasible levels of deployment readiness**. The recommendations in this memo target regulatory actions across the Federal Energy Regulatory Commission (FERC) and the Department of Energy (DOE), data modernization programs at the Federal Permitting Improvement Steering Council (FPISC), and funding opportunities and pilot projects at and the DOE and the Federal Emergency Management Agency (FEMA).

Thoughtful policy coordination, targeted investments, and continued federal support will be needed to realize the potential of these applications and pave the way for further innovation.

Challenge and Opportunity

Surging Load Growth, Extreme Events, and a Fragmented Federal Response

Surging energy demand and more frequent extreme weather events are bringing new challenges to the forefront of grid planning and operations. Not only is electric load growing at rates not seen in decades, but extreme weather events and cybersecurity threats are becoming more common and costly. All the while, our grid is becoming more complex to operate as new sources of generation and grid management tools evolve. Underlying these complexities is the fragmented nature of our energy system: a patchwork of regional grids, localized standards, and often conflicting regulations.

The emergence of artificial intelligence (AI) has brought many of these challenges into sharper focus. However, the potential of AI to mitigate, sidestep, or solve these challenges is also vast. From more efficient permitting processes to more reliable grid operations, many unique AI use cases for grid modernization are ready to deploy today and have high-impact potential.

The federal government has a unique role to play in both meeting these challenges and catalyzing these opportunities by implementing AI solutions. However, the current federal landscape is

fragmented, unaligned, and missing critical opportunities for impact. Nearly a dozen federal agencies and offices are engaged across the AI grid modernization ecosystem (see FAQ #2), with few coordinating in the absence of a defined federal strategy.

To prioritize effective and efficient deployment of resources, recommendations for increased investments (both in time and capital) should be based on a solid understanding of where the gaps and opportunities lie. Historically, program offices across DOE and other agencies have focused efforts on early-stage R&D and foundational science activities for emerging technology. For AI, however, the federal government is well-positioned to support further deployment of the technology into grid modernization efforts, rather than just traditional R&D activities.

AI Applications for Grid Modernization

AI's potential in grid modernization is significant, expansive, and deployable. Across four distinct categories—grid planning, siting and permitting, operations and reliability, and resilience—AI can improve existing processes or enable entirely new ones. Indeed, the use of AI in the power sector is not a new phenomenon. Industry and government alike have long utilized machine learning (ML) models across a range of power sector applications, and the recent introduction of "foundation" models (such as large language models, or LLMs) has opened up a new suite of transformational use cases. While LLMs and other foundation models can be used in various use cases, AI's potential to accelerate grid modernization will span both traditional and novel approaches, with many applications requiring custom-built models tailored to specific operational, regulatory, and data environments.

The following 14 use cases are drawn from *DOE's AI for Energy* (2024) report and form the foundation of this memo's analytical framework.

Grid Planning

- **Capital Allocations and Planned Upgrades**: Use AI to optimize utility investment decisions by forecasting asset risk, load growth, and grid needs to guide substation upgrades, reconductoring, or distributed energy resource (DER)-related capacity expansions.

- **Improved Information on Grid Capacity**: Use AI to generate more granular and dynamic hosting capacity, load forecast, and congestion data to guide DER siting, interconnection acceleration, and non-wires alternatives.

- **Improved Transportation and Energy Planning Alignment**: Use AI-enabled joint forecasting tools to align EV infrastructure rollout with utility grid planning by integrating traffic, land use, and load growth data.

- **Interconnection Issues and Power Systems Models**: Use AI-accelerated power flow models and queue screening tools to reduce delays and improve transparency in interconnection studies.

Siting and Permitting

- **Zoning and Local Permitting Analysis**: Use AI to analyze zoning ordinances, land use restrictions, and local permitting codes to identify siting barriers or opportunities earlier in the project development process.

- **Federal Environmental Review Accelerations**: Use AI tools to extract, organize, and summarize unstructured and disparate datasets to support more efficient and consistent reviews.

- **AI Models to Assist Subject Matter Experts in Reviews**: Use AI and document analysis tools to support expert reviewers by checking for completeness, inconsistencies, or precedent in technical applications and environmental documents.

Grid Operations and Reliability

- **Load and Supply Matching**: Use AI to improve short-term load forecasting and optimize generation dispatch, reducing imbalance costs and improving integration of variable resources.

- **Predictive and Risk-Informed Maintenance**: Use AI to predict asset degradation or failure and inform maintenance schedules based on equipment health, environmental stressors, and historical failure data.

- **Operational Safety and Issues Reporting and Analysis**: Apply AI to analyze safety incident logs, compliance records, and operator reports to identify patterns of human error, procedural risks, or training needs.

Grid Resilience

- **Self-healing Infrastructure for Reliability and Resilience**: Use AI to autonomously isolate faults, reconfigure power flows, and restore service in real time through intelligent switching and local control systems.

- **Detection and Diagnosis of Anomalous Events**: Use AI to identify and localize grid disturbances such as faults, voltage anomalies, or cyber intrusions using high-frequency telemetry and system behavior data.

- **AI-enabled Situational Awareness and Actions for Resilience**: Leverage AI to synthesize grid, weather, and asset data to support operator awareness and guide event response during extreme weather or grid stress events.

- **Resilience with Distributed Energy Resources**: Coordinate DERs during grid disruptions using AI for forecasting, dispatch, and microgrid formation, enabling system flexibility and backup power during emergencies.

However, not all applications are created equal. With limited resources, the federal government should prioritize use cases that **show high-impact potential and demonstrate feasible levels of deployment readiness**. Additional investments should also be allocated to high-impact / low-readiness use cases to help unlock and scale these applications.

Unlocking the potential of these use cases requires a better understanding of which ones hit specific benchmarks. The matrix below provides a framework for thinking through these questions.

Using the use cases identified above, we've mapped AI's applications in grid modernization onto a *"readiness-impact"* chart based on six unique scoring scales (see appendix for full methodological and scoring breakdown).

1. **Technical Readiness**: Is the AI solution mature, validated, and performant?

2. **Financial Readiness**: Is it cost-effective and fundable (via CapEx, OpEx, or rate recovery)?

3. **Regulatory Readiness**: Can it be deployed under existing rules, with institutional buy-in?

Impact Scale Questions

1. **Value**: Does this AI solution reduce costs, outages, emissions, or delays in a measurable way?

2. **Leverage**: Does it enable or unlock broader grid modernization (e.g., DERs, grid enhancing technologies (GETs), and/or virtual power plant (VPP) integration)?

3. **Fit**: Is AI the right or necessary tool to solve this compared to conventional tools (i.e., traditional transmission planning, interconnection study, and/or compliance software)?

Each AI application receives a score of 0-5 in each category, which are then averaged to determine its overall **readiness** and **impact** scores. To score each application, a detailed rubric was designed with scoring scales for each of the above-mentioned six categories. Industry examples and experience, existing literature, and outside expert consultation was utilized to then assign scores to each application.

When plotted on a coordinate plane, each application falls into one of four quadrants, helping us easily identify key insights about each use case.

High-Impact / High-Readiness use cases → Deploy now

High-Impact / Low-Readiness → Invest, unlock, and scale

Low-Impact / High-Readiness → Optional pilots, but deprioritize federal effort

Low-Impact / Low-Readiness → Monitor private sector action

Once plotted, we can then identify additional insights, such as where the clustering happens, what barriers are holding back the highest impact applications, and if there are recurring challenges (or opportunities) across the four categories of grid modernization efforts.

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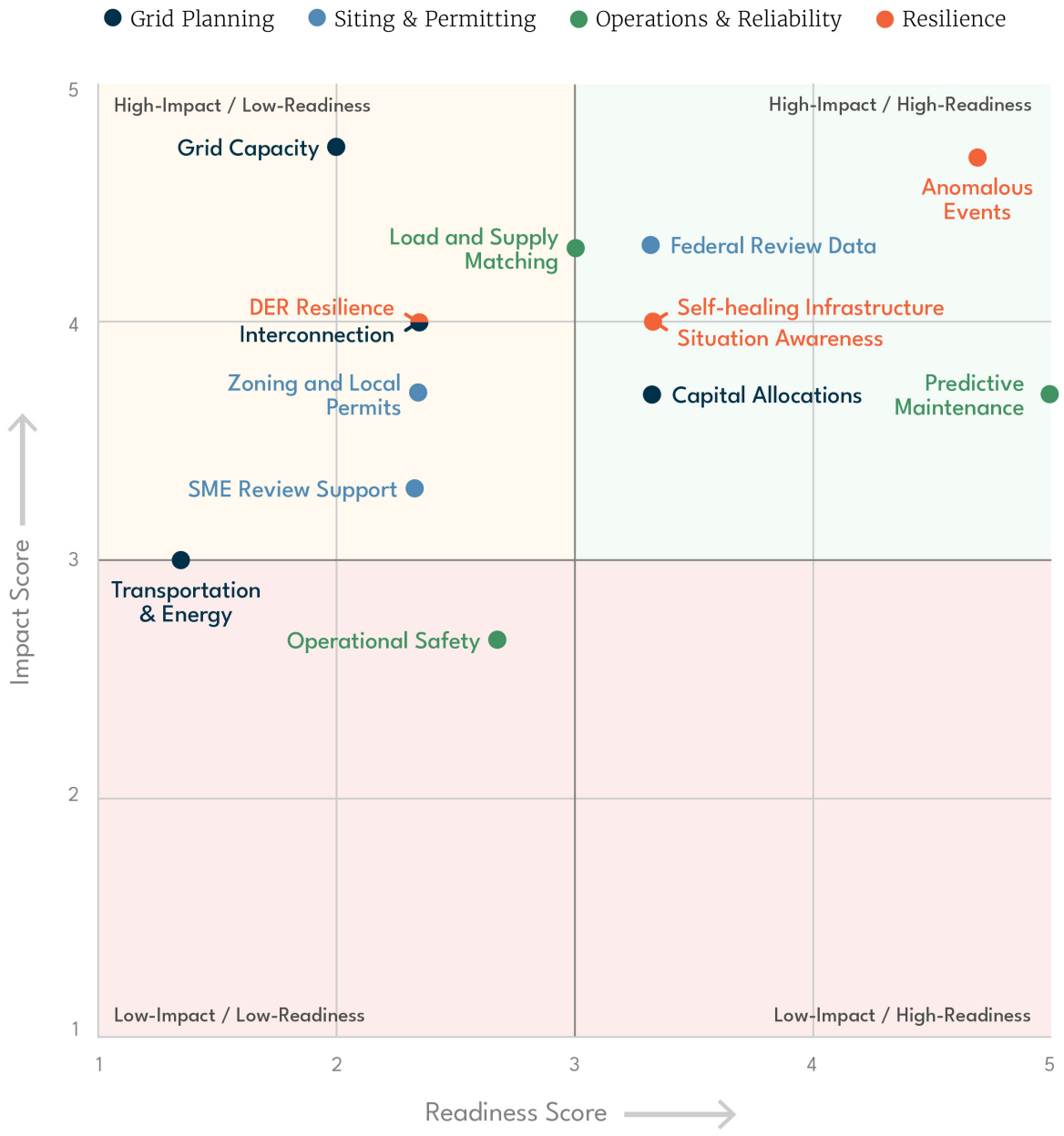
AI Applications for Grid Modernization



Note: Each AI application was scored across six criteria—three measuring readiness (technical maturity, financial viability, and regulatory feasibility) and three measuring impact (value, leverage, and fit). Scores (0–5) were averaged to position each AI application on the chart. Quadrants signal deployment guidance: **top right:** deploy now; **top left:** invest and scale; **bottom right:** optional pilots; **bottom left:** monitor only.

Source: Author's Calculations.

Plan of Action

Grid Planning

Average Readiness Score: 2.3
Average Impact Score: 3.8

1. AI use cases in grid planning face the highest **financial** and **regulatory** hurdles of any category. Reducing these barriers can unlock high-impact potential.

2. These tools are **high-leverage** use cases. Getting these deployed unlocks deeper grid modernization activities system-wide, such as grid-enhancing technology (GETs) integration.

3. While many of these AI tools are **technically mature**, adoption is not yet mainstream.

Policy Recommendation #1: The Federal Energy Regulatory Commission (FERC) should clarify the regulatory pathway for AI use cases in grid planning.

Regional Transmission Organizations (RTOs), utilities, and Public Utility Commissions (PUCs) require confidence that AI tools are approved and supported before they deploy them at scale. They also need financial clarity on viable pathways to rate-basing significant up-front costs. Building on Commissioner Rosner's Letters Regarding Interconnection Automation, FERC should establish a FERC-DOE-RTO technical working group on "Next-Gen Planning Tools" that informs FERC-compliant AI-enabled planning, modeling, and reporting standards. Current regulations (and traditional planning approaches) leave uncertainty around the explainability, validation, and auditability of AI-driven tools.

Thus, the working group should identify where AI tools can be incorporated into planning processes without undermining existing reliability, transparency, or stakeholder-participation standards. The group should **develop voluntary technical guidance on model validation standards, transparency requirements, and procedural integration to provide a clear pathway for compliant adoption across FERC-regulated jurisdictions**.

Siting and Permitting

Average Readiness Score: 2.7
Average Impact Score: 3.8

1. Zoning and local permitting tools are promising, but adoption is fragmented across state, local, and regional jurisdictions.

2. Federal permitting acceleration tools score high on **technical** readiness but face institutional distrust and a complicated regulatory environment.

3. In general, tools in this category have **high value** but limited transferability beyond highly specific scenarios (**low leverage**). Even if unlocked at scale, they have narrower application potential than other tools analyzed in this memo.

Policy Recommendation #2: The Federal Permitting Improvement Steering Council (FPISC) should establish a federal siting and permitting data modernization initiative.

AI tools can increase speed and consistency in siting and permitting processes by automating the review of complex datasets, but without structured data, standardized workflows, and agency buy-in, their adoption will remain fragmented and niche. Furthermore, most grid infrastructure data (including siting and permitting documentation) is confidential and protected, leading to industry skepticism about the ability of AI to maintain important security measures alongside transparent workflows. To address these concerns, FPISC should launch a coordinated initiative that creates structured templates for federal permitting documents, pilots AI integration at select agencies, and develops a public validation database that allows AI developers to test their models (with anonymous data) against real agency workflows. Having launched a $30 million effort in 2024 to improve IT systems across multiple agencies, FPSIC is well-positioned to take those lessons learned and align deeper AI integration across the federal government's permitting processes. Coordination with the Council on Environmental Quality (CEQ), which was recently called on to develop a Permitting Technology Action Plan, is also encouraged. Additional Congressional appropriations to FPISC can unlock further innovation.

Operations and Reliability

Average Readiness Score: 3.6
Average Impact Score: 3.6

1. Overall, this category has the **highest average readiness** across technical, financial, and regulatory scales. These use cases are clear "ready-now" wins.

2. They also have the **highest fit component** of impact**,** representing unique opportunities for AI tools to improve on existing systems and processes in ways that traditional tools cannot.

Policy Recommendation #3: Launch an AI Deployment Challenge at DOE to scale high-readiness tools across the sector.

From the SunShot Initiative (2011) through the Energy Storage Grand Challenge (2020) to the Energy Earthshots (2021), DOE has a long history of catalyzing the deployment of new technology in the power sector. A dedicated grand challenge—funded with new Congressional appropriations at the Grid

Deployment Office—could deploy matching grants or performance-based incentives to utilities, co-ops, and municipal providers to accelerate adoption of proven AI tools.

Grid Resilience

Average Readiness Score: 3.4
Average Impact Score: 4.2

1. As a category, resilience applications have the **highest overall impact** score, including a perfect **value** score across all four use cases. There is significant potential in deploying AI tools to solve these challenges.

2. Alongside operations and reliability use cases, these tools also exhibit the highest **technical** readiness, demonstrating technical maturity alongside high value potential.

3. Anomalous events detection is the **highest-scoring use case** across all 14 applications, on both readiness and impact scales. It's already been deployed and is ready to scale.

Policy Recommendation #4: DOE, the Federal Emergency Management Agency (FEMA), and FERC should create an AI for Resilience Program that funds and validates AI tools that support cross-jurisdictional grid resilience.

AI for resilience applications often require coordination across traditional system boundaries, from utilities to DERs, microgrids to emergency managers, as well as high levels of institutional trust. Federal coordination can catalyze system integration by funding demo projects, developing integration playbooks, and clarifying regulatory pathways for AI-automated resilience actions.

Congress should direct DOE and FEMA, in consultation with FERC, to establish a new program (or carve out existing grid resilience funds) to: (1) support demonstration projects where AI tools are already being deployed during real-world resilience events; (2) develop standardized playbooks for integrating AI into utility and emergency management operations; and (3) clarify regulatory pathways for actions like DER islanding, fault rerouting, and AI-assisted load restoration.

Conclusion

Managing surging electric load growth while improving the grid's ability to weather more frequent and extreme events is a once-in-a-generation challenge. Fortunately, new technological innovations combined with a thoughtful approach from the federal government can actualize the potential of AI and unlock a new set of solutions, ready for this era.

Rather than technological limitations, many of the outstanding roadblocks identified here are institutional and operational, highlighting the need for better federal coordination and regulatory

clarity. The readiness-impact framework detailed in this memo provides a new way to understand these challenges while laying the groundwork for a timely and topical plan of action.

By identifying which AI use cases are ready to scale today and which require targeted policy support, this framework can help federal agencies, regulators, and legislators prioritize high-impact actions. Strategic investments, regulatory clarity, and collaborative initiatives can accelerate the deployment of proven solutions while innovating and building trust in new ones. By pulling on the right policy levers, AI can improve grid planning, streamline permitting, enhance reliability, and make the grid more resilient, meeting this moment with both urgency and precision.

FAQ

How are scores tabulated? What methods underpin this analysis?

Scoring categories (readiness & impact) were selected based on the literature of challenges to AI deployment in the power sector. An LLM (OpenAI's GPT-4o model) was utilized to refine the 0-5 scoring scale after careful consideration of the multi-dimensional challenges across each category, based on the author's personal industry experience and additional consultation with outside technical experts. Where applicable, existing frameworks underpin the scales used in this memo: technology readiness levels for the 'technical readiness category' and adoption readiness levels for the 'financial' and 'regulatory' readiness categories. A rubric was then designed to guide scoring.

Each of the 14 AI applications were then scored against that rubric based on the author's analysis of existing literature, industry examples, and professional experience. Outside experts were consulted and provided additional feedback and insights throughout the process.

What federal agencies, offices, and programs are currently engaged in AI applications to support grid modernization efforts?

Below is a comprehensive, though not exhaustive, list of the key Executive Branch actors involved in AI-driven grid modernization efforts. A detailed overview of the various roles, authorities, and ongoing efforts can be found here.

Executive Office of the President

- Office of Science and Technology Policy (OSTP)
- Council on Environmental Quality (CEQ)

Department of Commerce

- National Institute of Standards and Technology (NIST)

Department of Defense

- Energy, Installations, and Environment (EI&E)
- Defense Advanced Research projects Agency (DARPA)

Department of Energy

- Advanced Research Projects Agency-Energy (ARPA-E)
- Energy Efficiency and Renewable Energy (EERE)
- Grid Deployment Office (GDO)
- Office of Critical and Emerging Technologies (CET)
- Office of Cybersecurity, Energy Security, and Emergency Response (CESER)
- Office of Electricity (OE)
- National Laboratories

Department of Homeland Security

- Cybersecurity and Infrastructure Agency (CISA)

Federal Energy Regulatory Commission (FERC)

Federal Permitting Improvement Steering Council (FPISC)

Federal Emergency Management Agency (FEMA)

National Science Foundation (NSF)

What are some examples of AI tools that are already being developed or deployed today?

A full database of how the federal government is using AI across agencies can be found at the 2024 Federal Agency AI Use Case Inventory. A few additional examples of private sector applications, or public-private partnerships are provided below.

Grid Planning

- EPRI's Open Power AI Consortium
- Google's Tapestry
- Octopus Energy's Kraken

Siting and Permitting

- Pacific Northwest National Laboratory's PermitAI
- Paces
- FlyPix AI

Operations and Reliability

- Schneider Electric's One Digital Grid Platform
- Cammus
- Amperon

Grid Resilience

- Southwire's Digital Grid Assessment
- Think Power Solutions
- DOE's North American Energy Resilience Model (NAERM)