U.S. DEPARTMENT OF
ENERGY

Secretary of Energy Advisory Board

Recommendations on Harnessing Artificial Intelligence to Accelerate Clean Energy Deployment

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Introduction

The transition to a clean energy future requires accelerated deployment of clean electricity generation along with modernization and expansion of the grid. In recent years, lengthy permitting processes, backlogged generation interconnection queues, and disputes over transmission planning, costs, and benefits have resulted in delay or prevented projects from being built. Although DOE does not control these permitting and regulatory processes, it has long provided technical support to the entities responsible for permitting, generator interconnection, and transmission planning, and can play a central role in supporting the AI tools, data development, and processes needed to accelerate progress.

Over the past two months, the SEAB Working Group, chaired by Arun Majumdar, has examined how AI could help support clean energy deployment. In accordance with 15 U.S.C. § 9401(3), AI refers to a machine-based system that can, for a given set of human-defined objectives, make predictions, recommendations, or decisions influencing real or virtual environments. AI systems use machine- and human-based inputs to perceive real and virtual environments, abstract such perceptions into models through analysis in an automated manner, and use model inference to formulate options for information or action.

The Working Group focused on accelerating existing processes rather than changing them, e.g., how to streamline and improve analysis, review, and communication with stakeholders in existing processes. In this report, the Working Group discusses its (1) methodology, (2) findings, (3) opportunities, (4) challenges, and (5) recommendations. AI appears to have far reaching potential to accelerate clean energy deployment, while improving reliability. DOE can also play a key role in promoting the identification and development of useful AI tools.

Methodology

Findings and recommendations in this report are based upon input from SEAB members and their institutions and interviews of subject matter experts on the grid, clean energy deployment, permitting and interconnection processes, public policy, and AI tool development. The subject matter experts included individuals at the following organizations or companies:

- Government: DOE Office of Policy
- Technology Company: Microsoft
- Trade Association: Americans for a Clean Energy Grid (ACEG)
- Consultant: Analysis Group
- Renewables Developers: EDF Renewables, Invenergy, and Avangrid
- Independent System Operator: California ISO

- Research Organization: Electric Power Research Institute, Inc. (EPRI)

Findings

1. Use of modern AI (deep learning, generative, etc.) in the energy industry is still early stage. Interest levels are high, but many stakeholders are trying to understand AI and to identify use cases for it.

2. In part because of the reliability imperative, electric utilities tend to be slow to adopt innovative technologies. As a result, it is critical that AI tools be developed carefully to build trust in them and to ensure that they do not create new risks.

3. Because of the complex permitting processes for infrastructure, the large number of projects in interconnection queues around the United States (2600 GW in 2023), the need for additional transmission capacity, the iterative technical studies that must be performed for interconnection purposes, and a shortage of power systems engineers, the potential benefit of AI for clean energy deployment is far reaching.

4. Management of the grid is also becoming more complicated with a diverse and dynamic mix of resources, including variable energy resources, battery energy storage systems, demand response, and distributed energy resources. Extreme weather events are becoming more frequent and severe. Load is also increasing across the United States. Creating automated tools that have forecasting capabilities, improved situational awareness, and instantaneously help manage or balance supply and load will enhance reliability and facilitate the integration of all resources.

5. Beyond identifying the highest value use cases, AI tools must then be developed, tested, and deployed.

6. AI tools will assist and augment, not replace, the exercise of a subject matter expert's technical judgment.

Potential Use Cases

AI offers significant opportunities to accelerate permitting and interconnection processes through automation, document creation, data management, stakeholder engagement or communication, and other applications. Specific applications that were highlighted include:

- Streamline Permitting. AI can assist application development, application screening and review, data analysis, and stakeholder engagement. It may be particularly useful in reviewing, summarizing, and responding to large volumes of comments in regulatory proceedings. With multiple federal, state and local entities requesting unique inputs, evaluating, and seeking public input in permitting processes, AI tools could improve efficiency, provide rapid access to information, and promote consistency. One interviewee estimates that the standard NEPA review process of 4.5

years could be shortened by one year by AI tools while concurrently increasing public engagement.

- Accelerate Interconnection Studies. AI can significantly reduce the time required for processing model input data, model parameterization, and analysis of model outputs. This will allow for faster and more efficient processing of interconnection queues. Most of the time used in performing interconnection studies is for model setup and analysis of results rather than model run time. AI tools could help in both areas.

- Enhance Transmission Planning. AI can support the creation of comprehensive models that incorporate both long-term needs and economic value (e.g., including reliability benefits). This will ensure that transmission development effectively supports all new deployments, including clean energy. AI can also help analyze expanded use of existing rights-of-way, evaluate transmission benefits and alternatives, and explore cost allocation.

- Support Public Participation and Community Engagement. AI can enhance communication, facilitate feedback, identify potential concerns early in the process, and evaluate the potential benefits and impact of infrastructure so as to further more inclusive and informed decision-making.

- Improving Reliability. AI can improve forecasting of weather and system conditions, including generation and load, and enhance situational awareness in real time. AI may be especially helpful with respect to aggregating data on distributed energy resources and forecasting supply and load imbalances between the distribution and transmission systems. AI may also enhance existing Grid Enhancing Technologies or lead to the development of new ones.

Challenges

Private companies are investigating some of these opportunities in specific applications, but the efforts are generally viewed as low-level or exploratory. Effective development of AI tools must address significant challenges, including:

- Data Access and Security. AI tools are only as good as the data on which they rely. Data privacy, competitive business information, and other constraints on data sharing require a robust data security framework and measures to anonymize sensitive information.

- Applicability. The myriad groups responsible for permitting and interconnection decisions need tailor-made AI tools that recognize their context and procedures. Tools developed with a common grounding and fine-tuned to meet the specific context of each permitting entity can provide a measure of consistency while meeting individual needs.

- Trust and Acceptance. Entities involved in permitting need to see pilots that demonstrate successful application of AI technologies to gain the confidence to adopt them. Public stakeholders need to be convinced of AI's benefits and assured that its implementation is transparent and equitable.

- AI Deployment Incentives. Given the many potential uses of AI and its relative newness to the energy industry, it is possible that at present the market for some potentially helpful AI tools is unclear or limited despite the value they can provide. DOE support for the development of AI tools would be beneficial.

Recommendations

1. Foster Increased Data Transparency and Standardized Data Platforms. Develop a standardized, secure data platform for the energy industry, ensuring compatibility across different regions and systems. This will facilitate AI development and data analysis, while allowing for more comprehensive and accurate modeling.

2. Engage the National Labs and Use DOE's Status as a Convener. Leverage the technical prowess of the National Laboratories to identify and to help develop the most feasible and high value AI use cases. Convene meetings of academics, engineers, industry experts, and policymakers to explore the ways in which AI can support clean energy deployment.

3. Encourage DOE Funding. DOE should support appropriate funding opportunities for companies developing AI tools. This could happen through ARPA-E or other DOE programs. Consider creating a prize program for particularly promising AI tools.

4. Develop AI Pilot Projects. The pilot projects should provide foundational capabilities, demonstrate how to tailor those capabilities to specific context, and apply the tools in a real-world application to test both technical capabilities and stakeholder engagement.

5. Encourage Public-Private Collaborative R&D Initiatives. Support collaborative research and development efforts among the energy industry, technology companies, regulators, and government agencies to accelerate the development of specialized AI tools tailored to the unique needs of the energy industry.

6. Launch Public Engagement Campaigns. The campaigns can raise awareness about new, more accessible opportunities for effective engagement in decision processes where AI tools have been adopted and address concerns about AI's potential impacts. These campaigns are also valuable to ensure that diverse stakeholders can learn more about the benefits of AI tools and have a voice in their development and implementation.

7. Focus on Human-Centered AI. Ensure that AI solutions are developed and implemented with a human-centered approach, recognizing that AI is a tool to augment human capabilities, not replace them. This includes providing training and support for users, promoting transparency in AI decision-making processes, and ensuring that AI solutions are designed to complement human expertise and judgment.