The Computing Research Association (CRA)'s Computing Community Consortium (CCC) Response to the Department of Energy (DOE)'s Request for Information (RFI) Related to Responsibilities on Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence

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This response is from Computing Research Association (CRA)'s Computing Community Consortium (CCC). CRA is an association of nearly 250 North American computing research organizations, both academic and industrial, and partners from six professional computing societies. The mission of the CCC, a subcommittee of CRA, is to enable the pursuit of innovative, high-impact computing research that aligns with pressing national and global challenges.

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Introduction

We overall applaud DOE for putting together a substantial list of areas of focus and opportunities in AI application.

Novel and emerging capabilities in artificial intelligence have the potential to be transformative in the sustainability domain with potential applications ranging from modeling to resilient and efficient infrastructure to advanced materials. While many of these advances in computing technologies and tools can help mitigate the climate crisis, they can also be a contributor to climate change, so it is crucial to invest in developing sustainable approaches to computing and to consider the potential negative impacts. This response considers both potential benefits and pitfalls of AI.

The authors emphasize that there are a lot of areas of computing beyond AI that have significant potential to change the course of the climate crisis, as outlined in the CCC Whitepaper, “Computing Research for the Climate Crisis”[1].

The rest of this response is organized into the three different topics provided by DOE: (1) AI to improve the security and reliability of grid infrastructure and operations and their resilience to disruptions, (2) AI to improve planning, permitting, and investment in the grid and related clean energy infrastructure, and (3) AI to help mitigate climate change risks.

Topic 1. AI to improve the security and reliability of grid infrastructure and operations and their resilience to disruptions

Large scale compute/grid infrastructure operations

An opportunity we would like to see added to the list is large-scale compute/grid infrastructure operations. There is a greater need for data centers than can realistically be supported in many areas of the US, for example in Northern Virginia. Especially with the added use of AI in grid design, there is a massive incoming construction load that is anticipated in the coming years. This will likely result in the general public seeing rates increase in their energy bills, and could lead to catastrophe where the society is paying for power infrastructure increases that are not driven by their energy usage, but rather by the construction of AI-driven infrastructure. This has already been seen abroad in Ireland and the Netherlands.

We recommend investing in software solutions designed to reduce the costs associated with accessing and using data remotely, particularly in locations where resources are more cost-effective. Such solutions can mitigate the challenges of moving and managing data, which can be power-intensive or impractical. The proposed software solutions, including data fabric, software stacks, and data representation, should maintain accuracy while reducing power consumption and ensuring fast data transfer. For example, adopting the IDX format for images is more efficient than the traditionally used TIFF format, especially for accessing and using scientific data. Implementing these solutions can lead to a more dynamic system, enabling remote access to data more efficiently.

We also recommend programs that work jointly with utilities and datacenter hyperscalers to incentivize developing compute infrastructure outside of peak regions. Right now it is standard practice to set up data centers in places where there is existing infrastructure because it is cheaper and data movement is easier, but there needs to be research into technology improvements that move away from that mode of operation because it is not sustainable.

[1] https://cra.org/ccc/climate_crisis_paper

This needs to be an interdisciplinary effort across computing scientists and engineers for the sake of the sustainability of these resources, engagement and development of new software, data input, flow, etc.

Understanding carbon impact

An underfunded area of research is using AI to understand the carbon impact of computing, especially at the local, regional level. This could entail using AI to predict renewable energy availability and to determine where marginal carbon contributions are on different parts of the grid in order to modulate operation charging, discharging, usage, economic incentives, skiffing, etc. This is especially important at the regional level where the impact of decisions can be felt more immediately and strongly, and there is great potential for local positive impacts like moving from coal to natural gas. Each region has different needs and different potential for green energy supplements, so there needs to be investments in understanding these nuances. This would also help communities understand the impact of their usage on neighboring generators and is crucial for the effective use of new distributed energy resources (DER) like EVs, data centers, grid-level storage, etc.

Quantification and consideration of risks of AI use

There is a need for context-specific uncertainty quantification tools to understand when and to what degree you can trust the advice/prediction from AI. There need to be guardrails built into these tools, especially LLMs and reinforcement learning (RL), because at the extent that this plan proposes implementing them, there is a dire need for them to work 100% of the time, and that is not the model for which AI is designed in other domains. There is a considerable risk factor in deploying AI-driven tools in this way, so there is a lot of work to be done before modern AI tools like foundation models can safely and reliably run a power system.

There are also huge security risks associated with using an AI system to manage grid resilience. Safeguards must be in place to prevent sensitive information from being recovered. AI can disrupt security as much as it can improve security, and significant consideration must be given to ways that it can be compromised.

Importance of AI considering economic impacts

While the topics and opportunities provided extensively focused on operation control and the use of AI, the management of power systems requires integration between economics and engineering. There is significant danger in optimizing just the engineering of these systems because of the potential to impact market structures negatively. If AI is managing strategic behavior, it needs to know how markets impact data and the potential impact of future decisions on the market. AI needs to be integrated very carefully because of the opportunity for market manipulation, and there needs to be research devoted to this area.

Knowledge transfer of similar AI deployment

Integrating AI into existing infrastructure is a strategy successfully applied in various sectors, such as rail infrastructure. These sections share critical objectives with the proposed plan for enhancing energy grid infrastructure, including the need for continuous monitoring, improving operational efficiency, and bolstering resilience against disruptions. Grid infrastructure operation objectives align closely with other infrastructural project strategies. Consequently, DOE has a significant opportunity to engage in a broad knowledge transfer and best practices within a vast network of projects dedicated to infrastructure enhancement.

Need for digital twins

One of the key areas that needs to be supported is publicly accessible, robust, and detailed digital twins. Making use of AI in the domains listed requires detailed digital twins to be available for research and testing/validation. Developing those twins is a research task of its own that needs to be prioritized and valued independently. Digital twins would also be very useful in addressing Topics 2 and 3.

Topic 2. AI to improve planning, permitting, and investment in the grid and related clean energy infrastructure

Understanding the impacts of AI-recommended clean energy investments

There needs to be a continuation of research into the impacts of following recommendations made by AI in using wind and solar energy. AI is being used to project, predict, and optimize the use of these technologies, and there needs to be an understanding of how well it did and if it was worth using. This is another opportunity area for the use of digital twins.

Strategic placement of data centers to limit harm to communities and the environment

Building upon the opportunity listed about the unnecessary disproportionate impacts on disadvantaged communities, it is essential to consider the impacts of data centers on communities. They have a significant impact on the power grid, and their location, orientation, large-scale storage generation placement, etc. needs to be heavily considered. These factors are only going to be more significant with AI increasing the energy demand. There are already disproportionate impacts on some communities, and in certain areas, a data center coming in would have devastating consequences on the prices of water and electricity in addition to environmental concerns like pollution. An example of an area that is already seeing the negative effects of a data center hub is Phoenix because of its high demand for water in a drought-heavy area. This is projected to have a major impact on the water usage, price and availability in the area in the coming years[2].

There is also a need for these considerations in the placement of large solar plants, wind farms, etc., because of the environmental and community factors.

Need for specific use case AI
AI can have disastrous consequences if it is deployed in a setting that it was not trained for. There needs to be significant investment in LLMs for specific purposes that have specialized training data that is related to the area where it is going to be used. For instance, deploying an LLM that has never been exposed to supervisory control and data acquisition (SCADA) is probably not going to work well for modulating and protecting the grid immediately.

Need for cyberinfrastructures for data accessibility and use
The convergence of High-Performance Computing (HPC) with Cloud Computing is critical for broadening equitable access to data. The convergence underscores the importance of investing in infrastructure and technologies that allow for seamless remote data access, thereby minimizing the energy footprint associated with data movement. Integrating AI can optimize this convergence, enabling more efficient data processing and analysis methods. AI's potential to automate and enhance data handling processes offers significant opportunities to reduce energy consumption and ensure data accessibility is not only faster but also more sustainable.

Topic 3. AI to help mitigate climate change risks
When forecasting climate-driven extreme events, it is crucial to account for the operations and planning for these events rather than just the outcome. Cross-cutting, sociotechnical, systems-level work from design to implementation should be prioritized.

The CCC published a whitepaper on Computing Research for the Climate Crisis[1] that highlights the role of computing research in addressing climate change-induced challenges. The authors outline six key impact areas in which these challenges will arise—energy, environmental justice, transportation, infrastructure, agriculture, and environmental monitoring & forecasting—and identify specific ways in which computing research can mitigate these significant challenges. Below are examples the authors provide of the ways that AI, robotics, and/or algorithms can help make progress in each key impact area:

- Energy: Planning, optimization, and decision support for production, distribution, and consumption of energy; AI-enabled materials science for renewables.

[2] https://hai.stanford.edu/sites/default/files/2024-02/Exploring-Impact-AI-Black-Americans.pdf

- Environmental Justice: Modeling and decision-support strategies that leverage those data and manage cascading risks.
- Transportation: Spatiotemporal planning strategies to optimize the routing of flows in the network.
- Infrastructure: Optimization and decision support of flows of energy, goods, water, vehicles, people, power, etc.; AI-enabled materials science for green materials.
- Agriculture: Algorithms that leverage rich sensor data, together with real-time information about economic factors and transportation networks, for planning and risk assessment.
- Environmental Monitoring & Forecasting: Uncertainty quantification; system-level, risk-sensitive modeling, planning, and optimization strategies for climate variables, at all scales.

In addition to AI/Robotics/Algorithms, the whitepaper describes three other broad areas of computing research that could make progress in the key impact areas above: devices & architectures, software, and sociotechnical computing. These areas of computing together have the potential to make incredible strides in mitigating the climate crisis, but achieving the potential requires interdisciplinary teams that bring computing researchers together with engineers, as well as professionals from the social, behavioral, economic, and physical sciences.

Conclusion

DOE's list of areas of focus and opportunities in AI application is robust, and there is potential for AI to significantly improve the course of the climate crisis. The significance and scale of these impacts means that there needs to be dedicated efforts to gain public trust in the AI systems being deployed. There needs to be community outreach and an explanation of the way AI is being used and the way it will improve planning, the security risks, and mitigations being taken, etc.[3]

We also encourage DOE to collaborate with other federal agencies on these efforts, especially those that have significant security implications like grid resilience. The Department of Homeland Security, Department of Defense, the National Science Foundation, ARPA-E, and others need to be looped in on matters like these that impact the security of the country.

[3] Recommendation 5.1.d. of the Community Driven Approaches to Research in Technology & Society CCC Workshop Report (https://cra.org/ccc/wp-content/uploads/sites/2/2024/03/CDARTS-Workshop-Report_Final.pdf)