

ARTIFICIAL INTELLIGENCE FOR CLIMATE CHANGE MITIGATION ROADMAP (SECOND EDITION)

CHAPTER 17: FINDINGS AND RECOMMENDATIONS

*David Sandalow, Colin
McCormick, Alp Kucukelbir, Julio
Friedmann and Michal
Nachmany*

November 2024



CHAPTER 17:

FINDINGS AND RECOMMENDATIONS

David Sandalow, Colin McCormick, Alp Kucukelbir, Julio Friedmann and Michal Nachmany

A. Findings

1. **Artificial intelligence (AI) is contributing to climate change mitigation in important ways.** AI tools are helping integrate solar and wind power into electric grids, improve the energy efficiency of industrial operations, monitor methane emissions and deforestation, implement sustainable agricultural practices, speed innovations in battery chemistry and reduce greenhouse gas (GHG) emissions in many other ways.
2. **AI has the potential to make very significant contributions to climate change mitigation in the years ahead.** This includes incremental gains in many areas (e.g., renewable energy generation and building energy management) and transformational gains in other areas (e.g., materials innovation).
3. **The principal barriers to using AI for climate change mitigation are (i) the lack of available, accessible and standardized data and (ii) the lack of trained personnel.**
 - Successful AI applications are built on data that are available, accessible and standardized. Poor data limit the quality of AI development.
 - Policymakers, business leaders, factory operators and many others with a role in climate mitigation need greater familiarity with the potential for AI to contribute to their work. More computer programmers and data engineers with the skills to create AI applications for climate change mitigation are needed as well.
4. **Other barriers to using AI for climate mitigation include cost, lack of available computing power and institutional issues.** More resources are needed for training programs, RD&D (research, development and demonstration) and other purposes. Some promising ideas may falter from lack of access to the computing power needed to fully develop them. Many organizations working on climate mitigation—including government agencies, businesses and nongovernmental organization (NGOs)—are only beginning to incorporate AI into their operations and organizational structures.
5. **GHG emissions from AI computation are currently less than 1%—and perhaps much less than 1%—of the global total.** Better data collection and assessment methodologies are needed to provide a more precise estimate with high confidence.
6. **GHG emissions from AI computation will very likely rise in the near-term.** Sharply growing demand for AI computation will very likely lead to increased GHG emissions in the near-term. Efficiency improvements in AI hardware and software, as well as use of low-carbon energy in the AI supply chain, will constrain but not prevent this growth in emissions.



7. **In the medium- to long-term, AI could result in either net increases or net decreases in GHG emissions. In part because AI is a transformational technology in the early stages of deployment, the range of uncertainty is enormous.** Future GHG emissions from AI depend on a number of factors, including (i) growth in demand for AI, (ii) improvements in the energy efficiency of AI hardware, (iii) improvements in the energy efficiency of AI software, (iv) the use of low-carbon electricity in computation for AI, (v) the use of AI to reduce production costs in the fossil fuel sector, and (vi) the use of AI to reduce GHG emissions throughout the economy—such as the many AI applications discussed in this Roadmap. Each of these factors is highly uncertain and interacts with the others in complex ways.
8. **Only a tiny fraction of GHG emissions associated with AI operations are related to AI applications for climate change mitigation.** There is little to no risk that using AI applications to reduce GHG emissions will increase GHG emissions from AI operations in amounts that would meaningfully reduce the GHG benefits of those applications.
9. **Trust in AI is essential for AI to deliver substantial benefits in mitigating climate change. To earn this trust, AI must undergo risk assessments that address a range of concerns. Risks related to safety, security, model accuracy, misinformation and disinformation require the closest attention.**
 - Safety and security risks arise when AI is used in real-time in some industrial operations, but they can be addressed by keeping “humans-in-the-loop” at key stages.
 - Hallucinations and other inaccurate results from AI models can cause problems, but they can be addressed with education on how best to use AI models and their results.
 - Misinformation/disinformation can undercut political support for climate change mitigation but arise mainly in the context of large language models (LLMs) and not in most applications of AI for climate change mitigation discussed in this Roadmap.
10. **Open-source foundation models have the potential to contribute to climate change mitigation by providing more organizations opportunities to access AI tools.** Foundation models dramatically lower the computational power required to use AI in new contexts because they only need minimal “fine tuning” to be useful and avoid redundant re-training by multiple organizations.
11. **Significant resources and sustained focus—by governments, corporations, philanthropies and other stakeholders—will be required for AI to reach its potential in helping mitigate climate change.** Providing the human resources needed will require hiring and mission priority. Expansion of both funding and personnel are essential for delivering climate solutions at scale, as well as for building institutional knowledge, practice and processes.
12. **Several recommendations in last year’s ICEF Artificial Intelligence for Climate Change Mitigation Roadmap have been adopted by key stakeholders.** For example, in March 2024, US Vice President Kamala Harris announced a directive requiring all federal agencies to name a chief AI officer¹ (as suggested in Recommendation 6 in last year’s Roadmap). Also, member countries in the Clean Energy Ministerial (CEM) have launched an AI initiative under the CEM (as suggested in Recommendation 8A in last year’s Roadmap).



B. Recommendations

1. *Every organization working on climate change mitigation should consider opportunities for AI to contribute to its work. This process should receive high priority within the organization. Government agencies should explore ways AI could contribute to policy making, funding decisions and permitting processes. Businesses should explore ways AI could contribute to sustainability programs and low-carbon product development. Universities and non-governmental organizations should explore ways AI could contribute to research and public outreach.*
2. *Governments, businesses and philanthropies should fund fora in which AI experts and climate change experts jointly explore ways AI could contribute to climate change mitigation. Sessions should be dedicated to potential AI applications, data requirements, personnel training and timelines to deployment, among other topics.*
3. *Governments should assist in developing and sharing data for AI applications that mitigate climate change.*
 - a. *Governments should systematically consider opportunities to generate and share data that may be useful for climate mitigation. This should include data with respect to weather patterns, electricity generation and use, manufacturing, crop and livestock production, hydrocarbon production and consumption, and transport.*
 - b. *Governments should establish policies to promote standardization and harmonization of climate and energy-transition data. These policies should include (i) data management guidelines, such as the “FAIR Guiding Principles” (Findability, Accessibility, Interoperability and Reusability); (ii) data standardization and harmonization requirements in connection with government-funded RD&D; (iii) measures to ensure transparency, including access to metadata and core data and (iv) funding for data standardization organizations and activities.*
 - c. *Governments should establish climate data task forces composed of key stakeholders and experts. The UK’s Energy Data Task Force provides a good model. Climate data task forces should start by inventorying data gaps and identifying potential barriers to data access. They should plan ways to federate, share and anonymize data for AI applications relevant to climate mitigation.*
4. *Companies with datasets relevant to climate change mitigation should consider sharing portions of these datasets publicly. Public release of a company’s datasets can provide direct benefits to that company by encouraging development of algorithms helpful to the company, attracting AI talent and facilitating integration with related datasets. Public release may provide broader social benefits, as well. In releasing datasets, companies must anonymize and strictly protect personally identifiable information.*



5. *Every organization working on climate mitigation should prioritize AI skills-development and capacity-building.*
 - a. *Governments and foundations should launch AI-climate fellowship programs.* These programs should identify promising students (from developing countries and underrepresented communities, in particular) and fund fellowships in AI and climate-focused topics.
 - b. *Government agencies with responsibility for climate issues should regularly review the capabilities of their staff with respect to AI.* The goals should be to continually enhance these capabilities and to ensure that opportunities for AI to advance their mission are recognized and accurately evaluated.
 - c. *Every organization working on climate change mitigation should require minimum AI literacy from a broad cross-section of employees.* Understanding of AI's capabilities and experience working with AI will contribute to employees' impact and effectiveness in the years ahead.
6. *Educational institutions should offer courses that provide familiarity with AI and its uses in climate mitigation.* Primary and secondary schools should teach basic skills. Universities and continuing education programs should offer courses, fellowships, internships and certification programs.
7. *Governments should adopt policies to minimize GHG emissions from AI's computing infrastructure, including requiring AI developers and data center operators to disclose GHG emissions associated with their operations on a full lifecycle basis.* Governments should (i) work with standard-setting bodies, AI developers and data center operators to standardize GHG emissions reporting protocols, (ii) prioritize AI systems with low GHG emissions when procuring AI solutions; (iii) invest in RD&D on energy-efficient AI algorithms and hardware, (iv) promote data centers that emit minimal GHGs through a range of measures, including regulations, guidelines and/or financial incentives; and (v) implement ambitious emissions-reduction programs that incentivize all companies, including AI and data center operators, to reduce their GHG emissions.
8. *Organizations that use AI for climate change mitigation should assess and address potential risks of AI tools.* These organizations should pay close attention to (i) safety and security risks, especially if AI is being used in real-time operations in industrial settings or grid management and (ii) AI model accuracy, especially with AI systems that require up-to-date data to function correctly. Organizations should address the risk of misinformation and disinformation from LLMs, with worker training and adhering to best practices around adopting and using LLMs.
9. *All government agencies with responsibility for climate change, including environment and energy ministries, should create an Artificial Intelligence Office, responsible for assessing opportunities, barriers and risks with respect to AI in all aspects of the agency's mission.* These agencies should also consider (1) hiring an advisor to the head of the agency who has responsibility for advising on all matters related to AI, (2) creating a unit to improve AI skills throughout the organization and



(3) launching a strategic planning process to consider ways that topics related to AI can best be addressed within the ministry on an ongoing basis.

10. Governments should provide substantial funding for developing and applying AI applications for climate mitigation.
 - a. Governments should fund AI for climate change mitigation programs with a focus on emissions reduction potential, not just new AI methods. Innovations in AI methodologies are important but may not be required for high-impact climate mitigation programs. Some funding programs should prioritize emissions-reduction potential using AI as a selection criterion.
 - b. Governments should help increase the availability of computing power for AI projects related to climate change mitigation. They should do so by (i) investing in computing infrastructure, (ii) soliciting proposals for projects that use AI for climate change mitigation and (iii) making computing power available without cost for proposals that offer the greatest potential benefits. This could include solicitations from the private sector in partnership with governments.
11. Governments, philanthropies and information technology companies should play a pivotal role in funding development of large-scale open-source foundation models tailored to address climate challenges. These models, in domains such as climate science, energy systems, food security and oceanography, could serve as the bedrock for a new generation of climate mitigation applications. By investing in this critical infrastructure, governments can accelerate innovation, foster public-private partnerships and create a fertile environment for developing solutions to pressing climate issues. International collaboration in funding and research will be essential for maximizing the impact of these models.
12. Governments should launch international platforms to support cooperative work on AI for climate change mitigation.
 - a. Member countries in the Clean Energy Ministerial (CEM) and Mission Innovation (MI), as well as other stakeholders, should participate actively in the CEM/MI AI initiative.
 - b. The United Nations Framework Convention on Climate Change (UNFCCC), International Energy Agency (IEA) and Food and Agriculture Organization of the United Nations (FAO), among other organizations, should build AI-for-climate issues centrally into their work programs.
 - c. One or more global organizations should be tasked with helping reconcile any conflicting AI-enabled data on GHG emissions. The International Methane Emissions Observatory (IMEO) could fulfill this role with respect to methane emissions. The World Meteorological Organization (WMO) and FAO could fulfill this role for CO₂ and some other GHG emissions datasets.



C. References

- 1 The White House. *Fact Sheet: Vice President Harris Announces OMB Policy to Advance Governance, Innovation, and Risk Management in Federal Agencies' Use of Artificial Intelligence*; Washington, D.C., <https://www.whitehouse.gov/briefing-room/statements-releases/2024/03/28/fact-sheet-vice-president-harris-announces-omb-policy-to-advance-governance-innovation-and-risk-management-in-federal-agencies-use-of-artificial-intelligence/> (2024).

