ARTIFICIAL INTELLIGENCE FOR CLIMATE CHANGE MITIGATION ROADMAP (SECOND EDITION)

CHAPTER 16:

GOVERNMENT POLICY

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Governments play an important role in the use of artificial intelligence (AI) for climate change mitigation. Governments collect environmental data used to train AI models, fund clean energy research programs that use AI tools, establish policies that shape the use of AI in the power and transport sectors, and facilitate international cooperation on AI for climate action. Other examples abound.

European Parliament -- Strasbourg, France

Governments are playing an increasing role in addressing risks from AI, including content risks (such as bias, invasions of privacy and misinformation/disinformation), resource risks (such as increased greenhouse gas (GHG) emissions, strains on the power grid and water stress) and safety/security risks. These risks may affect the use of AI for climate change mitigation, diminishing the impact of AI tools designed to help reduce greenhouse gas emissions and/or undermining public trust in AI more broadly.

These policies and programs have important impacts. Yet governments could do much more, using their convening powers, vast spending, regulatory authorities and other tools to speed and steer the use of AI for climate change mitigation.

This chapter explores government's role in AI for climate change mitigation. After a background section on government AI policies broadly, we pose two broad questions:

1. What can governments do to promote the use of AI for climate change mitigation?
2. What can governments do to address risks related to the use of AI for climate mitigation.

We conclude with recommendations.

A. General AI Policies

Government policies with respect to AI are evolving rapidly. Policymakers around the world are considering a range of AI topics, including liability rules, labeling requirements, intellectual property protections, data privacy restrictions, workforce training programs, security and safety standards and data sovereignty issues.

AI first began to receive widespread attention from policymakers during the latter part of the 2010s, due in part to the growing capabilities of AI models and emergence of applications such as facial recognition and autonomous vehicles. The release of ChatGPT in fall 2022 focused extraordinary public attention on AI, with rapid recognition of AI's revolutionary potential and serious risks. This recognition has led to unprecedented interest in AI from policymakers. Important recent policy developments include:

- the European Union's *Artificial Intelligence Act* (May 2024)[1];
- the Biden administration's *Executive Order on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence* (October 2023)[2];
- the *G7 Hiroshima Process International Guiding Principles* (October 2023)[3] and
- the *Shanghai Declaration on Global AI Governance* (July 2024).[4]

The text box at the end of this chapter summarizes recent AI policy developments in key jurisdictions around the world.

AI policies around the world vary widely, reflecting different political cultures. Europe's approach to regulating digital issues (including AI) has been called "rights-driven," emphasizing privacy, data protection and ethical standards; the US approach has been called "market-driven," emphasizing innovation with minimal regulatory constraints; and China's approach has been called "state-driven," emphasizing government oversight and control to help achieve national security and economic objectives. (The terms are from Anu Bradford's *Digital Empires* (2023).)[5]

Although government policies with respect to AI are evolving rapidly, those policies tend to change much more slowly than AI technologies themselves. Government institutions in many countries tend to move slowly, and many policy makers lack basic familiarity with AI. Finding ways for government policies to respond to fast-moving developments in AI is a challenge.[6,7]

Still, government policies can play an important role in shaping AI for positive social outcomes. Governments can, for example, incentivize development of AI technologies that promote public goods by offering innovators grants or tax breaks. Governments can adopt regulations to prevent premature deployment of AI in mission-critical settings, which poses privacy and security risks. By setting clear ethical standards and requiring transparency in AI development, governments can mitigate biases and discrimination that might arise from poorly designed AI systems.

For AI to achieve its full potential in benefiting society, key stakeholders must trust AI systems where appropriate and also critically evaluate their strengths and weaknesses. Yet the varying quality of AI systems, coupled with concerns about job displacement, privacy, algorithmic bias and energy use, have led to varying levels of trust and willingness to use AI-based systems.

Governments can play a pivotal role in promoting trust in well-functioning AI systems and a questioning attitude about AI more broadly. By setting standards to minimize risks, governments can enhance the trustworthiness of AI systems. By implementing transparency measures, governments can help foster public understanding of AI. Governments can both promote open-source models, helping mitigate concerns about "black box" algorithms, and set transparency standards for closed-source models, allowing the public to scrutinize the models' training data, identify potential biases and improve the models' performance.

At the G7 Summit in June 2024, the heads of state held a "Special Session on Artificial Intelligence." Pope Francis delivered remarks that concluded with the statement "It is up to everyone to make good use of [artificial intelligence], but the onus is on politics to create the conditions for such good use to be possible and fruitful."[8]

B. Realizing AI's Potential for Climate Mitigation

AI is already contributing significantly to climate mitigation and has the potential to contribute much more. Today, for example, AI algorithms play a central role in monitoring methane emissions and help increase productivity of solar and wind power plants. Large language models (LLMs) help summarize and interpret climate-related documents from governments, financial institutions and others.[9] In the years ahead, AI could accelerate discovery of new materials for batteries and biofuels, dramatically increase the capacity of transmission lines, reduce emissions from traffic congestion and much more.[10,11] (Chapters 3–13 of this roadmap explore these topics in greater detail.)

As opportunities to use AI for climate mitigation grow in the years ahead, the role of governments will be important. Some AI projects will have emissions reductions benefits but little, if any, near-term commercial return, requiring governments to help move the projects forward. Other AI projects will have commercial returns but will not be designed to achieve optimal climate change benefits. Investing in projects to help maximize social benefits (such as those related to climate change) is a classic and important governmental function.

Realizing AI's full potential to contribute to climate mitigation will not be easy. Available, accessible, high-quality and interoperable data are essential. So are people with the skills to develop AI tools and the vision to identify the many ways AI can help accelerate decarbonization. Computing power is needed to train and run AI models, institutions must adapt to transformational new technologies, and funding is required for all this work. Government policies could help overcome barriers in all these areas.

i. Data

Data are essential for AI models. Complete, representative and reliable data provide a foundation for models that can support and accelerate the transition to net-zero emissions. Partial, unrepresentative and unreliable data produce bad models that could complicate or slow the transition. Unavailable or inaccessible data (especially from the global south), biased data and the lack of interoperable data can all cause problems.

U.S. Capitol -- Washington, DC, USA

Governments can play an important role in addressing these challenges in at least three areas: collecting data, standardizing data and making it interoperable, and addressing the digital divide.

a) Data collection

Governments collect significant amounts of data related to climate change. The European Space Agency (ESA), the US National Aeronautics and Space Administration (NASA), the Japan Meteorological Agency and the China Meteorological Administration, for example, all collect large amounts of historical and current weather data. Several government programs, including ESA's Climate Change Initiative and NASA's Climate Data Service, specifically focus on ways that weather data can contribute to understanding climate change.

Government agencies collect other types of data related to climate mitigation as well. NASA collects data on forest loss.[12] The Japan Meteorological Agency collects data on sea-level rise.[13] Hundreds of cities around the world collect traffic data.[14] Most national governments—as well as the World Bank, the International Monetary Fund (IMF) and the Organization for Economic Co-operation and Development (OECD)—collect economic data.[15] The UN Climate Framework Convention on Climate Change (UNFCCC), UN Environment Program (UNEP),UN Office for Disaster Risk Reduction (UNDRR) and others collect data on countries' GHG emissions and climate action.

In addition, governments support collection of climate-related data sets by others. Many universities, for example, rely on government grants for data collection and analysis with respect to climate change. The United States, European Union, Japanese and Chinese governments, among others, provide extensive grant funding for climate change and clean-energy research, which often involves data collection.[16-18]

More and better data could contribute to climate change mitigation. Priorities include LiDAR data for topography, flood maps for urban planning, and more frequent and granular economic and emissions data. (Climate Change AI has published a Dataset Wishlist that includes considerable detail on data sets that would be helpful.[19]) Further, some of the currently available data suffer from quality problems and biases.

Governments play an important role in helping address these gaps. Government policies can include:

- Collecting, curating and hosting climate-related data;
- Funding the collection, curation and hosting of climate-related data by others with grants, tax incentives or other fiscal tools;
- Developing governance mechanisms for climate-related data on topics such as IP rights, legacy data, protection from deletion, data provenance and interoperability;
- Convening task forces or similar groups to encourage standardization and interoperability of climate-related data and
- Adopting regulations that encourage or require disclosure of climate-related data.

b) Data standardization and interoperability

Governments play a growing role in promoting standardization and interoperability of data for climate change mitigation. Current initiatives focused specifically on climate change and energy data include:

- The ESA Climate Change Initiative's Data Standards, which set forth requirements "to ensure consistency, harmonization and ease of use" of varied climate data sets[20]
- The UK Energy Data Task Force, established in 2019 as a collaboration between government, industry and academia, which develops standards and best practices with respect to data quality, interoperability and data sharing protocols in the energy sector.[21]

Broader data initiatives with a climate change component include:

- The German Standardization Roadmap, which establishes "data infrastructure and data quality standards for the development and validation of AI systems," specifically noting that "[data] standardization contributes to Germany's transformation into a climate-neutral industrialized country"[22];
- Global Open Data for Agriculture and Nutrition (GODAN), which brings together governments, organizations and individuals to advocate for data standardization, sharing and interoperability[23];
- The Open Government Partnership, a government–civil society collaboration aimed at enhancing data transparency, civic participation and public accountability, including with respect to climate-related data and
- The European Telecommunications Standards Institute (ETSI), a European standard-setting organization supported in part by the European Union that sets Internet of Things (IoT) standards, including those for "achieving the green and digital transformation."[24]

Governments could do more to help increase standardization and interoperability of climate data. Steps governments could take include:

- Recommending stakeholders follow data management guidelines, such as the "FAIR Guiding Principles" (Findability, Accessibility, Interoperability and Reusability)25;
- Imposing data standardization and harmonization requirements in connection with government-funded research and development (R&D) and tax incentives;
- Enacting regulations to ensure transparency, including access to metadata and core data;
- Providing funding for data standardization organizations and activities, including for developing standards and raising awareness and
- Fostering collaboration and knowledge-sharing among stakeholders, thereby promoting standardization and harmonization of climate-related data.

Government participation in standardization bodies and initiatives focused on data for climate mitigation can be especially helpful. By joining international organizations—such as the International Standards Organization (ISO)—and supporting industry-specific groups, governments contribute to development of data standards, protocols and best practices. Governments can also provide resources, expertise and endorsements to encourage adoption of these standards by industries and organizations.[24]

c) Addressing the digital divide

Finally, governments can take steps to address the global digital divide. Today, more than 2.5 billion people globally are not connected to the Internet, and roughly half the world's population lacks access to high-speed broadband.[26] That creates two problems with respect to using AI for climate change mitigation. First, the lack of digital connectivity significantly limits data creation on a range of topics relevant to climate change mitigation, including energy usage, travel patterns and more.[27] Second, the lack of digital connectivity prevents businesses and others from accessing AI tools that could help cut emissions.(Of course, connecting people to high-speed Internet has wide-ranging economic and social benefits and should be pursued for many reasons beyond those related to climate change mitigation.)

Some intergovernmental bodies and government programs currently work to address the digital divide. These programs include:

- The International Telecommunication Union, a UN agency whose mission is "connecting the world"[28]
- The World Bank's Digital Development Partnership, which works to "to leverage digital technologies and data as a means to accelerate green, inclusive and resilient social and economic development"[29]
- The US Infrastructure Investment and Jobs Act (IIJA) of 2021, which allocated $42 billion to close the digital divide in the US by improving broadband access.[30]

Additional steps governments can take include providing more funding for broadband infrastructure in remote and underserved areas; establishing public WiFi hotspots in community centers, libraries and schools; launching digital literacy training programs to teach basic digital skills; and sharing best practices with other governments concerning policies and programs in this area.[31]

ii. People

Developing AI tools for climate change mitigation requires a diverse team of professionals. Data scientists, climate scientists, data engineers, software engineers, designers, product managers, climate policy experts and others may all have roles. These professionals must work together, often bridging differences in professional backgrounds and approach.

One of the principal barriers to using AI for climate change mitigation is a lack of trained personnel. Trained data scientists and engineers are in short supply. (LinkedIn data suggest a 74% increase in the demand for AI specialists in the past four years.[32,33]) In addition, many professionals working on climate issues lack basic familiarity with AI. They may miss opportunities for AI to contribute significantly to their work and/or be unable to utilize AI tools for maximum advantage.

Governments could help overcome these barriers in several ways.[33]

First, governments could launch skills-development programs for professionals working on AI and climate issues. Some programs would target professionals with climate expertise, teaching them about AI; other programs would target professionals with AI expertise, teaching them about climate.

The programs could be workshops, short lecture series or full courses. Government agencies could run such programs or fund others to do so.

Second, governments could launch AI-climate fellowship programs. The programs would identify promising university graduates (perhaps focusing on those from developing countries) and fund residential fellowships to study topics related to AI and climate change. Governments could explore partnerships with leading foundations for these programs.[34-36]

Third, governments could pay for the education of university students learning skills related to using AI for climate mitigation. In some countries, paying the tuition and living expenses of university students developing such skills could help significantly increase enrollment in relevant courses.

Fourth, governments could integrate AI and climate change–related topics into educational curricula at all levels. AI skills rest on a foundation of science, technology, engineering and math (STEM) education, with a curriculum that includes quantitative reasoning, logic, computer programming and related topics. Governments could commit to strengthening STEM education as a platform for developing a new generation prepared for AI-specific education/training, with particular applications related to climate change.

Fifth, government agencies working on climate mitigation could systematically review the capabilities of their own staff with respect to AI and launch programs to ensure their staff remain up-to-date regarding AI developments. This could be especially beneficial for grant managers, helping them ensure government funds are disbursed with an up-to-date understanding of AI's potential and attention to AI-related data management practices.

Great Hall of the People -- Beijing, China

Sixth, governments could commit extra funds to recruiting and retaining skilled AI professionals. AI specialists often command high salaries in the private sector, making it challenging for government agencies to hire them. Providing government human resources (HR) departments with the authority and resources to compete (at least partially) with the private sector for the best AI professionals could deliver significant benefits.

Finally, as a core feature of education and training programs for AI and climate change, governments could pay attention to the global digital divide. As noted, billions of people globally currently lack Internet connectivity. Education and training programs focusing on basic digital skills in many regions will contribute enormously to a workforce able to fully utilize AI for climate change mitigation over the long-term.

iii. Computing power

AI projects require computing power—for training models, running models and storing data. Lack of adequate computing power can be a barrier to AI projects related to climate change, especially in training foundation models that require enormous compute. Governments can take several steps to address this challenge.

Governments could help increase the availability of computing power for climate change–related AI projects by (1) investing in its own computing infrastructure; (2) making its computing infrastructure available for projects that use AI for climate change mitigation and (3) funding research organizations, civil society and private sector companies working on climate change–related projects to use computing infrastructure owned by others.

Governments already play an important role in this regard. Within the US Department of Energy (DOE), for example, some of the world's most powerful supercomputers support a global network of partners as part of the Earth System Grid Federation (above). In connection with this project, Oak Ridge National Laboratory (ORNL), Lawrence Livermore National Laboratory (LLNL) and other US DOE National Labs provide computational services for climate change modeling and analysis—including simulations and projections—in part using AI tools.[37-39]

Government investment could take several forms. Governments could invest in their own computing infrastructure, provide grants for others to develop such infrastructure and/or provide tax incentives to encourage development. The approaches that work best will vary from country to country.

One powerful tool could be to (1) solicit proposals for projects that use AI for climate change mitigation and then (2) make computing power available without cost for the proposals that offer the greatest potential benefits. Microsoft AI for Earth and other private companies already do this[40]; governments could play an important role as demand for computing time increases in the years ahead. Government high-performance computing (HPC) facilities could expand their review process and reviewer pool to include more AI expertise and emphasize allocating HPC time for AI-enabled research with direct impacts on climate mitigation.[41]

iv. Cost

Cost is a cross-cutting barrier, relevant to each of the three barriers discussed above (data, people and computing power). Each of these three barriers could be mostly addressed, at least in the medium-term, with greater funding.

As noted above, many climate change–related AI projects will have little if any near-term commercial return, making government funding essential. Many advances in using AI for climate mitigation will depend on government funding in the years ahead.

A key question will be how such government funding for AI will be allocated. Some governments may focus funding on new and innovative AI methods, including open foundational models. Other governments may prioritize GHG reductions, which will often be achievable with existing AI methods. The allocation of funding between these two types of projects—those investigating new AI methods and those targeting maximum emission reduction—could have a significant impact.[42]

Governments also have an important role in ensuring that electric utilities that use AI tools to reduce emissions receive compensation for such projects. Electric utilities that are paid a regulated return based on their capital spending may lack the incentive to invest in AI tools that reduce emissions and costs. Unless regulators approve rules that provide compensation for the value created by AI, electric utilities may not pursue emissions-reducing projects, such as those for demand response or vehicle-grid integration.[43]

National Diet Building – Tokyo, Japan

v. Institutions

Institutional structures will play a significant role in realizing AI's potential for climate mitigation.

Some recent history provides useful background. The modern computing era began in the 1960s, as mainframe computers became increasingly central to many business functions. But the term "Chief Information Officer" was not coined until 1981. Until the 1980s, few large organizations had executives solely responsible for information and communications technologies in their top leadership teams.[44]

In a similar manner, despite significant recent advances in AI, many institutions are only beginning to incorporate AI into their organization and mission. They could do so in a number of ways. For government agencies with responsibility for climate change mitigation, possible steps include:

- creating an Artificial Intelligence Office, with responsibility for assessing opportunities, barriers and risks with respect to AI in all aspects of the agency's mission;[45]
- hiring a Special Advisor responsible for advising the head of the agency on all matters related to AI;
- creating a unit to improve AI skills throughout the agency; and/or
- launching a strategic planning process to consider ways that topics related to AI can best be addressed within the agency on an ongoing basis.

Several governments are taking steps in these directions. In March 2024, for example, US Vice President Kamala Harris announced that all US government agencies would be required to name a chief AI officer.[46]

Governments can also create or help create public-private partnerships or other stakeholder groups, bringing together diverse groups to discuss and implement opportunities for using AI for climate mitigation. Governments could help fund such public-private partnerships and/or provide the convening power to help assemble and sustain such groups.

Finally, intergovernmental organizations can play an important role in AI for climate mitigation. The International Energy Agency (IEA) produces leading research and convenes important meetings on AI/energy issues.[47-49] The U.N. Framework Convention on Climate Change has an Initiative on AI for Climate Action.[50] The Clean Energy Ministerial and Mission Innovation are launching an initiative on using AI to promote clean energy. The World Meteorological Organization (WMO) is using AI to improve understanding of Earth systems.[51] These and other programs can help support the use of AI for climate mitigation.

C. Managing Risks

Risks related to using AI include content risks (such as bias, invasions of privacy and misinformation/disinformation), resource risks (such as increased GHG emissions, strains on the power grid and water stress) and safety/security risks.

These risks arise from using AI generally, not from using AI for climate change mitigation in particular. Yet, there are two reasons why addressing these risks is important to successfully using AI for climate change mitigation. First, failure to address these risks could undermine public trust and confidence in AI, making adoption of AI for climate change mitigation less likely. Second, failure to address these risks could diminish the impact of AI tools designed to help mitigate climate change.

In this section we discuss risks of using AI, government policies that could help address these risks and steps taken by governments to date.

i. Bias

Unrepresentative data, poorly designed algorithms and other factors create risks of bias in many AI applications. These biases can distort AI recommendations on a range of topics, including (for example) on infrastructure siting. An AI algorithm trained on historical data might suggest that new polluting infrastructure be located in low-income communities and new electric vehicle (EV) charging infrastructure be located in high-income communities because that is where such infrastructure is found in existing data sets. AI can produce poor or inaccurate results when developers fail to realize that data collected from one socioeconomic group is not representative of patterns in another socioeconomic group.

These biases often result from uneven data availability across regions. For example, LLMs are trained on vast amounts of data, but these data are overwhelmingly from the Global North and primarily in English—the prevalent language on the Internet. This imbalance can lead to LLMs that are biased toward Western perspectives and struggle to understand or respond appropriately to languages and cultures from the global south.[27]

Governments can address risks of bias with a range of tools:

- Data collection standards. Governments could set data collection standards for AI models, highlighting the importance of diverse and representative data sets. These standards could be binding or non-binding.

- Transparency. Similarly, governments could set standards with respect to transparency in developing AI models, giving all stakeholders a better opportunity to identify possible biases. These standards could be binding or non-binding. For example, disclosure requirements could be established for training and evaluation data sets.
- Third-party audits. Governments could recommend or require that AI developers retain third party auditors to assess any bias in their products and establish accreditation standards for organizations conducting such audits.
- Legal accountability. Governments could establish legal frameworks that hold entities accountable for biased or discriminatory outcomes resulting from AI applications.
- Convening. Governments could convene diverse stakeholders to evaluate AI products, bringing people with a wide range of views together and making sure all are heard.
- Education and training. Governments could offer AI developers, data scientists and other stakeholders training programs on the importance of bias recognition and mitigation
- Research and development (R&D). Governments could allocate funding for research into reducing bias in AI generally and for climate mitigation.

There is emerging regulation attempting to address bias in AI. For example, the US Federal Trade Commission (FTC) and Equal Employment Opportunity Commission have introduced initiatives aimed at establishing guardrails around AI and its potential impact on the constituencies those agencies are charged with protecting.[52] The FTC has already taken enforcement action against using biased data.[53] The EU's AI Act specifically addresses bias, requiring data governance and management practices for AI systems classified as high-risk—including human oversight and risk management practices to mitigate likely risks to fundamental rights. The Act does not prevent deploying biased systems.[54]

ii. Privacy

Privacy risks related to using AI for climate mitigation include surveillance, personal identification and data sharing. First, increasing use of sensors, drones and IoT devices to monitor environmental change and human behaviors related to carbon emissions creates a risk that some data could be used for unauthorized surveillance. Second, when data from multiple sources are aggregated (such as smart meter data and property records), individuals who were previously anonymous in isolated datasets could become identifiable. Third, data on energy consumption patterns or other topics could be shared with third parties, either by the host of that data or as the result of a cyberattack.

Governments can address these risks with policies including:

- Data protection regulations. Governments could enact laws requiring organizations to ensure the privacy and protection of personal data, provide transparency on how data are processed and give individual's rights to access, correct and delete their data. The EU's General Data Protection Regulation (GDPR) is widely considered to be the strongest such law passed globally to date.[55]

- Privacy by design for all AI models. Governments could require that privacy considerations be expressly integrated in the design of AI models throughout development and during use.
- Cybersecurity standards. Governments could mandate cybersecurity measures for organizations that collect, process or store climate-related data.
- Anonymization. Governments could require use of techniques that render personal data less identifiable.
- Oversight and governance bodies. Governments could establish independent oversight boards or agencies responsible for monitoring and ensuring privacy protections related to AI and climate mitigation.

Some of these policies are already being incorporated into national laws:

- Some data protection law frameworks, while not addressing AI specifically, lay a foundation for managing AI-related risks. The EU *General Data Protection Regulation* is an example.
- AI-specific privacy regulation is emerging in multiple countries. In some countries, this is done by integrating explicit AI provisions into existing general data protection measures. Examples include Brazil's *General Data Protection Law* (LGPD), South Africa's *Protection of Personal Information Act (POPIA)* and India's draft *Personal Data Protection Bill.*
- In addition, privacy provisions can be introduced into AI regulation, such as integrating data protection measures into the EU AI Act.

iii. Misinformation/disinformation

Misinformation is false or misleading information. Disinformation is false or misleading information spread deliberately to deceive or cause harm. (Critically, misinformation or disinformation can include the omission of information necessary for statements to be complete and accurate.)[56]

AI enables creation and dissemination of misinformation and disinformation at an unprecedented scale. Advanced AI technologies can generate fake text, images and videos that are difficult to distinguish from authentic content. These tools can be exploited to spread false narratives, manipulate public opinion and undermine trust in legitimate sources of information.

AI contributes to misinformation and disinformation in other ways as well. AI-driven algorithms on social media platforms exacerbate the spread of misinformation by prioritizing content that maximizes user engagement without regard to whether the information is authentic. This creates echo chambers where users are exposed primarily to information that confirms their existing beliefs, further entrenching misinformation and making it harder to correct false narratives. In addition, incomplete data or flawed weights in AI models can lead to "algorithmic bias," causing AI tools to spread false or misleading information.[27]

AI-driven misinformation and disinformation is a potentially serious problem with respect to climate change mitigation. Misinformation and disinformation can erode public confidence in scientific judgments that are at the core of effective climate change policies, create false or polarizing

narratives that undercut public support for climate change policies and create significant impediments to sustaining climate change policies over the medium- to long-term.[57-59]

There are no easy solutions to AI-driven misinformation and disinformation. Having governments serve as the arbiter of truth creates significant risks—arguably greater than allowing AI-based misinformation and disinformation to proceed unchecked.[60]

Policies designed to mitigate AI-driven misinformation and disinformation include:

- Labeling requirements for manipulated text, images or video;
- Requirements that media platforms provide prompts or warnings suggesting that users consider the credibility of content before sharing or engaging with it;
- Media literacy education in schools, equipping students with skills to critically evaluate information;
- Government-led and independent watchdog fact-checking organizations and
- Prohibitions on content that governments consider to be misinformation or disinformation.[61]

Governments have begun to adopt policies in this area. The EU AI Act requires AI systems intended to inform the public on a matter of public interest to disclose when text has been manipulated, subject to some exceptions, including when human editors have reviewed and taken responsibility for the content.[62] Several countries have established government-funded fact-checking entities to combat misinformation, including AFP in France[63] and Singapore's Fact Check Media.[64] The G7 has established a Rapid Response Mechanism on Disinformation.[65] The Chinese government prohibits dissemination of information it considers to be false or misleading, with initiatives that focus on AI-driven content in particular.[66,67] (Strong disagreements between the Chinese government and many Western governments on what constitutes false or misleading information underscores the challenges of government regulation on this topic.)

iv. Greenhouse gas (GHG) emissions

At present, GHG emissions from AI operations are less than 1% of total GHG emissions—and perhaps much less.[68,69] Yet as the use of AI grows in the years ahead, GHG emissions from AI operations could increase significantly. (This topic is explored in detail in Chapter 15 of the Roadmap.)

A number of policies can help limit growth in GHG emissions from AI operations in the years ahead. Those include the following:

- Research & development (R&D). Governments could invest in R&D on energy-efficient AI algorithms and hardware. That could include research on methods that require less data or computational power for training AI models, such as few-shot learning or transfer learning.
- Low-carbon data centers. Governments can promote data centers that emit little or no carbon dioxide (CO_2) through a range of measures, including (1) tax incentives or subsidies for data centers powered with zero-carbon electricity (renewables, nuclear or fossil generation with carbon capture), (2) regulations requiring data centers to use a certain percentage of zero-

carbon power, (3) guidelines and incentives for energy-efficient data centers and (4) measures to increase supply of clean electricity (such as accelerated permitting).

- Disclosures. Governments could require AI companies to disclose GHG emissions associated with their operations on a full life-cycle basis. Disclosure requirements can apply to model cards (fact sheets that include information about how models are trained) and AI applications.
- Government procurement. Governments can prioritize AI systems with low GHG emissions when procuring AI solutions for their own use.

Recent legislation on these topics includes Germany's Energy Efficiency Act of 2023, which requires data centers to use 50% renewable energy by early 2024, rising to 100% by 2027.[70] In 2024, the EU Commission introduced a new regulatory framework mandating sustainability reporting for data centers consuming 0.5 MW or more. Beginning in 2026, operators must disclose total electricity consumption and the proportion sourced from renewable energy, including on-site generation and grid-supplied renewable energy backed by Guarantees of Origin.[71,72]

In the United States, Senator Ed Markey and several co-sponsors introduced the "Artificial Intelligence Environmental Impacts Act of 2024."[73] This act mandates that the Environmental Protection Agency (EPA) conduct a comprehensive study on the environmental impacts of AI, including energy consumption, pollution and electronic waste. The bill also requires that the National Institute of Standards and Technology (NIST) establish a consortium to develop standards and a voluntary reporting system for the environmental impacts of AI.

v. Strains on the power grid

In the past year, data center owners and operators have submitted a record number of requests for electricity interconnections in many places around the world. These requests are due in significant part to increasing demand for AI.[74,75] Due to uncertain prospects for approvals, many data center operators have submitted more interconnection requests than they need. Yet even accounting for this "application frenzy," data center power demand is still rising rapidly.[76,77] (This topic is explored in detail in Chapter 15B of the Roadmap.)

In many locations, electric utilities are unable to provide sufficient electric power to meet data center demand. In some locations, electric utilities do not anticipate being able to meet this demand for many years. Data center power demand is creating challenges with respect to resource adequacy (the ability of a power system to ensure sufficient generation capacity and other resources to reliably meet electricity demand at all times). Problems with resource adequacy increase risks of blackouts and brownouts, can lead to higher electricity prices, and compromise the reliability of an electric grid.

Government policy can play an important role in responding to these challenges. Potential approaches include:

- Construction moratoria halting approvals of new data centers until resource adequacy concerns are fully addressed;

- Suspension of data center tax incentives, slowing development that could raise resource adequacy concerns;
- Permitting reforms that streamline approval processes for new projects, allowing faster deployment of generation and transmission infrastructure;
- Locational incentives, such as zonal pricing and zoning rules for new data centers;
- Demand response programs, which reduce peak load on the grid by incentivizing consumers to lower their energy usage during high-demand periods[78];
- Proactive transmission planning to anticipate future energy needs and strategically develop transmission networks that accommodate load growth from data centers and
- Approval of infrastructure upgrades, such as expanding transmission lines and enhancing substations, thus increasing the grid's capacity to handle higher loads and reducing the risk of blackouts and brownouts.[78]

Regulators and utilities are starting to adopt some of these measures. Ireland, Singapore and the Netherlands have each at times imposed construction moratoria on data centers to prevent grid-related problems.[79,80] The state of Georgia in the United States suspended a tax break for data centers pending analysis of power demand issues.[81]

vi. Water stress

Data centers are critical infrastructure for the digital economy, powering everything from cloud storage to AI computations. However, some data centers consume significant amounts of water, primarily for cooling the servers, which generate substantial heat. This water usage can strain local water resources, especially in regions already facing water scarcity. The impact on local water resources can be severe, leading to competition between industrial and municipal water needs and potentially exacerbating existing water stress. To mitigate this impact, some data centers are exploring alternative cooling methods, such as using recycled or non-potable water or adopting more efficient air-cooling technologies that reduce water dependency.[82,83]

To address the environmental impacts of water consumption by data centers, governments can implement the following policy measures:

- Mandatory water usage reporting. Enforce transparent reporting of both direct and indirect water usage by data centers on AI model cards. The EU Data Center Directive includes water usage reporting.
- Water efficiency standards and targets. Establish water efficiency standards and clear targets for data center operations, mandating adoption of water-saving technologies like advanced cooling systems.
- Water pricing mechanisms. Implement tiered water pricing systems that reflect the true cost of water, encouraging data centers to optimize their water use and reduce unnecessary consumption.

- Location-based restrictions. Impose restrictions on the location of new data centers in water-scarce regions, directing development toward areas with abundant water resources to prevent strain on local water supplies.
- Water recycling and reuse mandates. Mandate or promote using recycled or non-potable water for cooling purposes in data centers.

Current examples of these policies include the EU-wide delegated regulation for rating sustainability of data centers,[71] which includes mandatory water usage reporting for data centers, and the Singapore Building and Construction Authority's Green Mark Certification scheme, which includes water efficiency criteria for data centers.[84]

vii. Safety/security

AI systems can create safety risks when they fail to operate as intended or have unintended consequences. Risks are especially acute when AI is used not only to inform human decision making, but to make decisions with limited or no human oversight. This can be especially dangerous in real-time operations in industrial facilities, the power grid and autonomous vehicles. In addition, AI tools are subject to attack by hackers or others with malicious intent, creating security risks. AI systems expand the "attack surface" for hackers beyond that found in conventional hardware and software, increasing security risks.[85,86]

Government policy can play an important role in addressing AI safety and security risks:

- Regulatory frameworks. Governments can establish regulations that require safety assessments, security protocols and risk management procedures for AI systems, as well as independent testing and verification to ensure these standards are met before AI systems are deployed.
- Certification and compliance. Governments can implement certification processes for AI systems that meet safety and security criteria.
- Public-private partnerships. Governments can collaborate with industry stakeholders and research institutions to develop best practices, guidelines and tools for ensuring AI safety and security, funding research focused on AI safety and security.
- Global cooperation and governance. Governments can engage in dialogue and cooperate with other governments around the world to establish global norms and standards for AI safety and security.
- Public awareness and education. Governments can initiate public awareness campaigns and educational programs about the potential safety and security risks of AI.

D. Recommendations

1. *Governments should prioritize development of a climate-relevant data ecosystem. This should include the following:*
    a. *Governments should invest significant funds in data collection, curation and standardization. The climate-relevant data collected by governments should be easily accessible by all stakeholders. In developing climate-relevant data, governments should particularly focus on data-gathering from underrepresented regions and sectors, as well as on data types that have previously been unavailable or insufficient.*
    b. *Governments should adopt and promote data interoperability standards and invest in secure, scalable infrastructure for storing and disseminating climate-relevant data. Governments should also adopt clear data governance frameworks to ensure data privacy, security and ethical use.*
    c. *Governments should employ a combination of direct funding, low-interest loans, tax incentives, advanced market commitments and regulatory frameworks to help.*
2. *Governments should help fund large-scale open-source foundational models tailored to addressing 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 using existing open-source models and investing in new open-source models, governments can accelerate innovation, foster public-private partnerships and help develop solutions to pressing climate issues. International collaboration in funding and research will be essential to maximizing the impact of these models.*
3. *Governments should incentivize AI applications that contribute to climate mitigation with (1) regulatory frameworks that prioritize climate-friendly AI; (2) financial incentives, such as grants, tax breaks and procurement preferences and (3) public recognition programs. In connection with these programs, governments should establish clear evaluation criteria to assess the climate impact of AI systems to help ensure that incentives are targeted effectively.*
4. *Governments should invest in education and training programs to develop a skilled AI workforce. This should include supporting AI research, curriculum development and upskilling programs for both students and professionals.*
5. *In shaping policies and programs on AI and climate change, governments should seek input from and work closely with a wide range of stakeholders, including technology companies, energy companies, academia and civil society.*
6. *Governments should facilitate knowledge-sharing and collaboration between experts in climate mitigation and experts in AI. Governments should use their convening power (by organizing roundtables, task forces, advisory bodies and hackathons) and other tools for this purpose.*

7. *Governments should establish ethical guidelines for developing and deploying AI applications to help foster the trust and confidence in AI that will be important for using AI in climate change mitigation. These guidelines should address issues such as data privacy, bias, transparency, truthfulness and accountability. Governments should develop these guidelines in collaboration with industry, civil society and academia.*

RECENT AI POLICIES IN BRIEF

as of November 2024

UNITED STATES

Leading AI policy announcements from the US federal government include:

- The *Executive Order on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence*, released in October 2023, which requires developers of large AI models to share information about their products with the US government, streamlines visa processes for noncitizens working on AI and directs federal agencies to issue AI guidelines, among dozens of provisions[2];
- The *AI Risk Management Framework,* released by NIST in January 2023 to help "manage risks to individuals, organizations, and society associated with artificial intelligence"[87] and
- The *Blueprint for an AI Bill of Rights*, released by the White House in October 2022 to guide design and use of AI with five principles—safe and effective systems; algorithmic discrimination protection; data privacy; notice and explanation; and human alternatives, considerations and fallback.[88]

In July 2023, President Biden met at the White House with the CEOs of leading AI companies, who pledged "to develop and deploy advanced AI systems to help address society's greatest challenges," including climate change.[89]

In May 2024, the Bipartisan Senate Artificial Intelligence Working Group released its *Roadmap for Artificial Intelligence Policy in the US Senate*.[90] The roadmap recommends that the federal government spend up to $32 billion for annual nondefense AI R&D and encourages Congressional committees to consider legislation on a wide range of AI topics including workforce training, transparency of AI systems, liability of AI developers and standards for using AI in critical infrastructure.

In the past several years, many bills on AI have been introduced in the US Congress:

- The Artificial Intelligence Environmental Impacts Act of 2024, which would mandate several measures to ensure environmental consequences of AI are thoroughly studied and reported[91];
- The CREATE AI Act of 2023, which would establish the National Artificial Intelligence Research Resource (NAIRR)[92] and

- The AI Labeling Act of 2023, which would require all generative AI systems to include a clear and conspicuous disclosure that identifies content as AI-generated.[93]

EUROPEAN UNION

The European Union's Artificial Intelligence Act entered into force on August 1, 2024. The Act comprehensively regulates AI in Europe, applying a risk-based approach. High-risk AI systems are subject to the most stringent controls. Activities considered to be especially risky—including live facial recognition and scraping of biometric data from social media platforms—are prohibited.[1,94]

The European Union's Energy Efficiency Directive, adopted in 2023, requires data centers with more than 500 kW of power demand to report energy consumption, renewable energy use, water use and related topics.[95] Germany's revised Energy Efficiency Act, also adopted in 2023, incorporates the EU reporting obligations, requires data centers to buy 50% of their power from renewable sources (rising to 100% by 2027) and sets other standards for data center operations.[70]

In September 2022, the European Commission proposed the AI Liability Directive, which is intended to ensure that AI operators can be held liable for damages caused by AI systems. (In the absence of such a directive, the lack of transparency and complexity of AI systems could make recovery of damages difficult.) The European Parliament and Council of the European Union have not yet acted on the European Commission's proposal. If the AI Liability Directive is adopted, EU Member States would then be required to incorporate its terms into national laws.[96-101]

Other important EU AI policies include (1) the Coordinated Plan on Artificial Intelligence, updated in 2021, which aims to accelerate investments in AI technologies and align AI throughout the European Union[102] and (2) the General Data Protection Regulation (GDPR) of 2016. AI is not explicitly mentioned in the GDPR, but many of its provisions—including those on purpose limitation, data minimization, the special treatment of "sensitive data" and limitations on automated decisions—are relevant to AI.[103,104]

CHINA

In July 2023, the Cyberspace Administration of China (CAC) and other entities published the Provisional Regulations on Management of Generative Artificial Intelligence Services. The Provisional Regulations require that any generative AI technologies used to provide services to the public in the China "reflect socialist core values" and prohibit content that "may harm national security and hurt the national image."[67]

In June 2023, China's State Council announced that it will submit a draft AI law to the Standing Committee of the National People's Congress by the end of the year.[105] This would be China's first national AI legislation.

In the past several years, the Chinese government has released a number of binding policy documents on AI:

- *Provisions on the Administration of Deep Synthesis Internet Information Services*, released by the CAC, the Ministry of Industry and Information Technology (MIIT) and the Ministry of Public Security (MPS) in November 2022. This policy document requires the labeling of synthetically generated content and prohibits AI tools from generating "fake news information."[106]
- *Provisions on the Management of Algorithmic Recommendations in Internet Information Services*, released by CAC, MIIT, MPS and the State Administration for Market Regulation in December 2021. This document includes provisions for content control and worker protection and created China's "algorithm registry," an online database. Developers are required to submit information to the registry on the training and deployment of their algorithms.[107,108]

JAPAN

In their May 2023 meeting in Hiroshima, Japan, G7 heads of state agreed to launch an initiative to strengthen collaboration on governance of generative AI. The initiative will be known as the "Hiroshima AI process."[109] Also in May 2023, the Japanese government held the first meeting of its Artificial Intelligence Strategy Council, attended by Prime Minister Fumio Kishida.[110]

In April 2023, Japan's governing Liberal Democratic Party released an *AI White Paper* with more than two dozen recommendations for promoting and managing the development of AI in Japan:

- "Accelerate applied research and development by accumulating domestic knowledge on foundation models"
- "Immediately initiate multiple pilot projects with visible results in a short period of time as specific examples of utilizing AI for basic administrative services"
- "Provide strong support for AI-based smart city initiatives by local governments"
- "Position the improvement of AI literacy in the public education curriculum in anticipation of the AI native era, when active use of AI in daily socioeconomic activities will be the norm"[111,112]

The *AI White Paper* builds on Japan's *AI Strategy 2022*, released in April 2022 by the Secretariat of Science, Technology and Innovation Policy within the Cabinet office. The *AI Strategy 2022* sets forth five strategic objectives for AI development in Japan:

- "A technological infrastructure that will enable Japan to protect its people in the face of imminent crises such as pandemics and large-scale disasters"
- "Japan should become the world's most capable country in the AI era by developing human resources"
- "Japan should become a top runner in the application of AI in real-world industries"
- "In Japan, a series of technology systems to realize a sustainable society with diversity is established and a mechanism to operate them is realized"
- "Japan should lead in building an international network in the AI field for research, education and social infrastructure"[111,113]

INDIA

In April 2023, India's Ministry of Electronics and Information Technology announced that the Indian government "is not considering bringing a law or regulating the growth of artificial intelligence in the country." The ministry referred to AI as a "kinetic enabler of the digital economy."[114,115] In February 2023, the Indian government announced the establishment of three new Centers of Excellence for Artificial Intelligence.[116]

In 2021, Nitii Ayog published a Responsible AI/AIforALL report, proposing seven "principles for the responsible management of AI systems: (1) safety and reliability, (2) equality, (3) inclusivity and non-discrimination, (4) privacy and security, (5) transparency, (6) accountability and (7) protection and reinforcement of positive human values."[117]

In 2018, Nitii Ayog released an AI Strategy calling for investment in education and training, privacy protections, and use of AI across the value chain.[117] The Indian Government maintains an AI website at https://indiaai.gov.in/.[118,119]

E. References

1 The Artifical Intelligence Act. *Homepage;* https://artificialintelligenceact.eu/ (Accessed September 2023).

2 The White House. *Executive Order on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence;* https://www.whitehouse.gov/briefing-room/presidential-actions/2023/10/30/executive-order-on-the-safe-secure-and-trustworthy-development-and-use-of-artificial-intelligence/ (2023).

3 G7 Hiroshima Summit. *Hiroshima Process International – Guiding Principles for Organizations Developing Advanced AI System;* https://www.mofa.go.jp/files/100573471.pdf (2023).

4 Ministry of Foreign Affairs – The People's Republic of China. *Shanghai Declaration on Global AI Governance;* https://www.fmprc.gov.cn/eng/wjdt_665385/2649_665393/202407/t20240704_11448349.html (2024).

5 Anu Bradford. *Digital Empires – The Global Battle to Regulate Technology*. (Oxford University Press, Oxford, UK, 2023, https://global.oup.com/academic/product/digital-empires-9780197649268?cc=us&lang=en&).

6 Tom Wheeler. *The three challenges of AI regulation;* The Brookings Institute, Washington, D.C., https://www.brookings.edu/articles/the-three-challenges-of-ai-regulation/ (2023).

7 Isabelle Bousquette. *AI Is Moving Faster Than Attempts to Regulate It. Here's How Companies Are Coping;* The Wall Street Journal, New York, New York, https://www.wsj.com/articles/ai-is-moving-faster-than-attempts-to-regulate-it-heres-how-companies-are-coping-7cfd7104 (2024).

8 Pope Francis Attends the G7 Session on Artificial Intelligence. *Address of his Holiness Pope Francis;* Borgo Egnazia (Puglia), https://www.vatican.va/content/francesco/en/speeches/2024/june/documents/20240614-g7-intelligenza-artificiale.html (2024).

9 Climate Policy Radar. *Building the evidence base for evidence-based decision-making;* London, UK, https://climatepolicyradar.org/ (Accessed August 2024).

10 Columbia Univerity: Climate Earth and Society. *Landscape Assessment of AI for Climate and Nature (Report);* Columbia University and Bexos Earth Fund with University at Albany (SUNY) and Environmental Systems Research Institute, Inc. (ESRI), New York, New York, https://www.climate.columbia.edu/ai-climate-nature-landscape-assessment (2024).

11 David B. Olawade *et al.* Artificial intelligence potential for net zero sustainability: Current evidence and prospects. *Next Sustainability* 4, 100041 (2024). https://doi.org/10.1016/j.nxsust.2024.100041.

12 Kate Ramsayer. *Global Forest Cover, Loss, and Gain 2000-2012;* NASA Scientific Visualization Studio, https://svs.gsfc.nasa.gov/11393 (2023).

13 Japan Meteorological Agency. *Sea level (around Japan);* https://www.data.jma.go.jp/gmd/kaiyou/english/sl_trend/sea_level_around_japan.html (2023).

14 Data World. *Traffic Datasets;* https://data.world/datasets/traffic (Accessed September 2023).

15 University of California (UC) San Diego. *Economics: Country Statistics & Data Sources;* https://ucsd.libguides.com/econguide/countrydata (2023).

16 Environmental Protection Agency (EPA). *Climate Change Research Grants* https://www.epa.gov/research-grants/climate-change-research-grants (Accessed September 2023).

17 Earth and Environmental Systems Modeling (EESM). *DOE Announces Funding for Climate Resilience Centers;* https://climatemodeling.science.energy.gov/news/doe-announces-funding-climate-resilience-centers (2022).

18 National Institutes of Health. *Funding Opportunities: Notice of Special Interest (NOSI): Climate Change and Health NOT-ES-22-006;* https://www.nih.gov/climateandhealth#funding-opportunities (Accessed September 2023).

19 Climate Change AI. *Climate Change AI Dataset Wishlist;* Pittsburgh, Pennsylvania, https://www.climatechange.ai/dataset-wishlist.pdf (Accessed August 2024).

20 The European Space Agency (ESA) Climate Office. *ESA CCI data standards;* https://climate.esa.int/en/explore/esa-cci-data-standards/ (Accessed September 2023).

21 GOV.UK. *Energy Data Taskforce* https://www.gov.uk/government/groups/energy-data-taskforce (2019).

22 Deutsches Institut für Normung (DIN). *Second edition of the German Standardization Roadmap AI;* https://www.din.de/en/innovation-and-research/artificial-intelligence/ai-roadmap (Accessed September 2023).

23 Global Open Data for Agriculture and Nutrition (GODAN). *Harnessing Open Data to Achieve Global Food Security;* https://www.godan.info/ (Accessed September 2023).

24 Sophia Antipolis. *ETSI IoT conference: standards are key to achieving green and digital transformation;* European Telecommunications Standards Institute (ETSI), https://www.etsi.org/newsroom/news/2258-etsi-iot-conference-standards-are-key-to-achieving-green-and-digital-transformation (2023).

25 Mark D. Wilkinson *et al.* The FAIR Guiding Principles for scientific data management and stewardship. *Scientific Data* 3, 160018 (2016). https://doi.org/10.1038/sdata.2016.18.

26 Landry Signé. *Fixing the global digital divide and digital access gap;* Brookings Institution, https://www.brookings.edu/articles/fixing-the-global-digital-divide-and-digital-access-gap/#:~:text=While%20this%20growth%20indicates%20that,of%20compounding%20negative%20effects%20in (2023).

27 Ramit Debnath *et al.* Harnessing human and machine intelligence for planetary-level climate action. *npj Climate Action* 2, 20 (2023). https://doi.org/10.1038/s44168-023-00056-3.

28 International Telecommunication Union (ITU). *About International Telecommunication Union (ITU);* Geneva, Switzerland, https://www.itu.int/en/about/Pages/default.aspx (Accessed August 2024).

29 Digital Development Partnership (DDP). *About DDP;* Administered by World Bank Group, Washington, D.C., https://www.digitaldevelopmentpartnership.org/about.html (Accessed August 2024).

30 Marc S. Martin & Tyler D. Robbins. *How the New Infrastructure Act Aims to Bridge the Digital Divide;* Perkins Coie, Washington, D.C., https://www.perkinscoie.com/en/news-insights/how-the-new-infrastructure-act-aims-to-bridge-the-digital-divide.html (2021).

31 Digital Development Partnership and World Bank Group. *Launch of the Guinea-Bissau Digital Economy Diagnostic;* https://www.digitaldevelopmentpartnership.org/index.html?ddp=news-10-11-01 (2022).

32 Stewart Townsend. *The Growing Demand for AI Experts: The Shortage of Workers in 2024;* Medium – AI for the next century, San Francisco, California, https://medium.com/ai-for-the-next-century/the-growing-demand-for-ai-experts-the-shortage-of-workers-in-2024-37727134b4b7 (2024).

33 Team DigitalDefynd. *Is There a Shortage of AI Engineers? How to Fix It? ;* San Francisco, California, https://digitaldefynd.com/IQ/how-to-fix-ai-engineers-shortage/ (2024).

34 US Department of State. *Fellowships;* https://www.state.gov/subjects/fellowships/ (Accessed September 2023).

35 Marshall Scholarships. *Homepage;* https://www.marshallscholarship.org/ (Accessed September 2023).

36 Schwarzman Schoalrs. *Homepage;* https://www.schwarzmanscholars.org/ (Accessed September 2023).

37 Anne M. Stark. *Earth System Grid Federation launches effort to upgrade global climate data system;* Lawrence Livermore National Laboratory (LLNL), https://www.llnl.gov/archive/news/earth-system-grid-federation-launches-effort-upgrade-global-climate-data-system (2022).

38 Lawrence Livermore National Laboratory (LLNL). *ESGF: Supporting Climate Research Collaboration;* Livermore, California, https://computing.llnl.gov/projects/esgf-supporting-climate-research-collaboration (Accessed August 2024).

39 US Department of Energy (DOE). *Digital Climate Solutions Inventory;* https://www.energy.gov/sites/default/files/2022-09/Digital_Climate_Solutions_Inventory.pdf (Accessed September 2023).

40 Microsoft AI. *AI for Earth;* https://www.microsoft.com/en-us/ai/ai-for-earth (Accessed September 2023).

41 Argonne National Laboratory. U.S. Department of Energy's INCITE program seeks proposals for 2024 to advance science and engineering at U.S. leadership computing facilities https://www.anl.gov/article/us-department-of-energys-incite-program-seeks-proposals-for-2024-to-advance-science-and-engineering (2023).

42 Peter Clutton-Brock *et al.* Climate Change and AI: Recommendations for Government Action. (Global Partnership on AI (GPAI), Climate Change AI, and Centre for AI & Climate, 2021; https://www.gpai.ai/projects/climate-change-and-ai.pdf).

43 World Economic Forum, BloombergNEF & Deutsche Energie-Agentur. Harnessing Artificial Intelligence to Accelerate the Energy Transition (White Paper). (2021; https://www3.weforum.org/docs/WEF_Harnessing_AI_to_accelerate_the_Energy_Transition_2021.pdf).

44 Jonathan Huer. *A Brief History of the CIO;* Educase Review, https://er.educause.edu/articles/2018/8/a-brief-history-of-the-cio (2018).

45 Office of Critical and Emerging Technologies. *Artificial Intelligence and Technology Office;* US Department of Energy (DOE), Washington, D.C., https://www.energy.gov/ai/artificial-intelligence-technology-office (Accessed August 2024).

46 Emilia David. *Every US federal agency must hire a chief AI officer;* The Verge (A Vox Media Network), New York, New York, https://www.theverge.com/2024/3/28/24114105/federal-agencies-ai-responsible-guidance-omb-caio (2024).

47 International Energy Agency (IEA). *Electricity 2024: Analysis and forecast to 2026* Paris, France, https://www.iea.org/reports/electricity-2024 (2024).

48 Thomas Spencer & Siddharth Singh. *What the data centre and AI boom could mean for the energy sector;* International Energy Agency (IEA), Paris, France, https://www.iea.org/commentaries/what-the-data-centre-and-ai-boom-could-mean-for-the-energy-sector (2024).

49 International Energy Agency (IEA). *Global Conference on Energy & AI;* Paris, France, https://www.iea.org/events/global-conference-on-energy-and-ai (December 2924).

50 United Nations Framework Convention on Climate Change (UNFCCC). *Workplan for the Technology Mechanism Initiative on AI for Climate Action (2024–2027);* Bonn, Germany,

https://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/artificial_intelligence_cms_slot/e1673478d26041fb84b40a1b4c0ddb5d/cc306226d72e4dc9b52a1604bdf49a09.pdf (Accessed October 2024).

51 World Meteorological Organization (WMO). *Advancing Earth System Science with Artificial Intelligence;* Geneva, Switzerland, https://wmo.int/media/magazine-article/advancing-earth-system-science-artificial-intelligence (2024).

52 US Equal Employment Opportunity Commission (EEOC). *Artificial Intelligence and Algorithmic Fairness Initiative;* Washington, D.C., https://www.eeoc.gov/ai (Accessed August 2021).

53 Federal Trade Commission (FTC). Rite Aid Banned from Using AI Facial Recognition After FTC Says Retailer Deployed Technology without Reasonable Safeguards (Press Release); Washington, D.C., https://www.ftc.gov/news-events/news/press-releases/2023/12/rite-aid-banned-using-ai-facial-recognition-after-ftc-says-retailer-deployed-technology-without (2023).

54 European Parliament. *EU AI Act: first regulation on artificial intelligence;* Strasbourg, France, https://www.europarl.europa.eu/topics/en/article/20230601STO93804/eu-ai-act-first-regulation-on-artificial-intelligence (2023 (Accessed August 2024)).

55 Ben Wolford. *What is GDPR, the EU's new data protection law?;* GDPR.eu (Horizon 2020 Framework Programme of the European Union and Proton AG). Plan-les-Ouates , Switzerland, https://gdpr.eu/what-is-gdpr/ (Accessed August 2024).

56 Aspen Digital. *Commission on Information Disorder – Final Report;* Tsim Sha Tsui East, Hong Kong, https://www.aspeninstitute.org/wp-content/uploads/2021/11/Aspen-Institute_Commission-on-Information-Disorder_Final-Report.pdf (2021).

57 Tushar Choudhary. *The Climate Misinformation Crisis*. (Hopespring Press, Rosenberg, Texas, 2024, https://www.amazon.com/Climate-Misinformation-Crisis-mistruths-smarter/dp/B0CR9Q6YJ4).

58 Katie Worth. *Miseducation: How Climate Change Is Taught in America*. (Columbia Global Reports, New York, New York, 2021, https://globalreports.columbia.edu/books/miseducation/).

59 Naomi Oreskes & Erik M. Conway. *Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Climate Change*. (Bloomsbury Press, New York, New York, 2011, https://www.amazon.com/Merchants-Doubt-Handful-Scientists-Obscured/dp/1608193942).

60 Daniel Lyons. *Government-Funded Blacklist Highlights Danger of Regulating "Disinformation";* American Enterprise Institute (AEI) – AEIdeas, Washington, D.C., https://www.aei.org/technology-and-innovation/government-funded-blacklist-highlights-danger-of-regulating-disinformation/ (2023).

61 Jon Bateman & Dean Jackson. *Countering Disinformation Effectively: An Evidence-Based Policy Guide;* Carnegie Endowment for International Peace, Washington, D.C., https://carnegieendowment.org/research/2024/01/countering-disinformation-effectively-an-evidence-based-policy-guide?lang=en (2024).

62 Gernot Fritz, Theresa Ehlen & Tina Fokter Cuvan. *EU AI Act unpacked #8: New rules on deepfakes;* Freshfields Bruckhaus Deringer, London, UK, https://technologyquotient.freshfields.com/post/102jb19/eu-ai-act-unpacked-8-new-rules-on-deepfakes (2024).

63 Agence France-Presse (AFP) Fact Check. *Home page;* AFP, Paris, France, https://factcheck.afp.com/ (Accessed August 2024).

64 Factually. *Home page;* Singapore Government, Singapore, https://www.gov.sg/factually (Accessed August 2024).

65 Ministero degli Affari Esteri e della Cooperazione Internazionale. *G7 Working Group Meeting on disinformation at the Farnesina (Press Release);* Italian Government, Rome, Italy,

https://www.esteri.it/en/sala_stampa/archivionotizie/comunicati/2024/07/riunione-alla-farnesina-del-gruppo-di-lavoro-g7-su-disinformazione/ (2024).

66 Hayley Wong. *China steps up crackdown on 'misleading' AI-generated content, 'troubling phenomena';* South China Morning Post, Beijing, China, https://www.scmp.com/news/china/politics/article/3255578/china-steps-crackdown-misleading-ai-generated-content-troubling-phenomena (2024).

67 Latham & Watkins Privacy and Cyber Practice. *China's New AI Regulations (Client Alert Commentary);* https://www.lw.com/admin/upload/SiteAttachments/Chinas-New-AI-Regulations.pdf (2023).

68 Amy Luers *et al.* Will AI accelerate or delay the race to net-zero emissions? *Nature* 628(8009), 718–720 (2024). https://doi.org/10.1038/d41586-024-01137-x.

69 Lynn H. Kaack *et al.* Aligning artificial intelligence with climate change mitigation. *Nature Climate Change* 12, 518-527 (2022). https://doi.org/10.1038/s41558-022-01377-7.

70 Carlos Robles y Zepf & Philipp Schaefer. *Sustainable data centers—The German Energy Efficiency Act: What data center operators need to consider now and in the future;* Mayor Brown, Frankfurt, Germany, https://www.mayerbrown.com/en/insights/publications/2024/02/sustainable-data-centers-the-german-energy-efficiency-act-what-data-center-operators-need-to-consider-now-and-in-the-future (2024).

71 European Commission. *Data centres in Europe – reporting scheme;* https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13818-Data-centres-in-Europe-reporting-scheme_en (Act adopted 2024).

72 Directorate-General for Energy. *Commission adopts EU-wide scheme for rating sustainability of data centres;* European Commission, Brussels, Belgium, https://energy.ec.europa.eu/news/commission-adopts-eu-wide-scheme-rating-sustainability-data-centres-2024-03-15_en (2024).

73 Congress.gov. *Text – S.3732 – 118th Congress (2023–2024): Artificial Intelligence Environmental Impacts Act of 2024;* https://www.congress.gov/bill/118th-congress/senate-bill/3732/text (2024).

74 Goldman Sachs. *AI is poised to drive 160% increase in data center power demand;* New York, New York, https://www.goldmansachs.com/insights/articles/AI-poised-to-drive-160-increase-in-power-demand (2024).

75 Ethan Howland. *MISO: 49 GW has received interconnection approval, but projects face major delays;* Utility Drive (Operated by Industry Dive), Washington, D.C., https://www.utilitydive.com/news/midcontinent-miso-interconnection-queue-supply-chain-transmission-expansion-mtep/693652/ (2023).

76 Shayle Kann. Under the hood of data center power demand in *Catalyst. (Latitude Media, 2024)* *https://podcasts.apple.com/lu/podcast/under-the-hood-of-data-center-power-demand/id1593204897?i=1000658881876.*

77 Vijay V. Vaitheeswaran. *Big tech's great AI power grab;* The Economist, London, UK, https://www.economist.com/business/2024/05/05/big-techs-great-ai-power-grab (2024).

78 HDR Inc. *Overcoming Data Center Power Interconnection Challenges;* Omaha, Nebraska, https://www.hdrinc.com/insights/rethinking-data-center-power (2023).

79 Kenddrick Chan *et al. Greening AI: A Policy Agenda for the Artificial Intelligence and Energy Revolutions;* Tony Blair Institute for Global Change (TBI), London, UK, https://www.institute.global/insights/climate-and-energy/greening-ai-a-policy-agenda-for-the-artificial-intelligence-and-energy-revolutions (2024).

80 Alexandra Gorin, Roberto Zanchi & Mark Dyson. *How Data Centers Can Set the Stage for Larger Loads to Come;* Rocky Mountain Institute (RMI), Basalt, Colorado, https://rmi.org/how-data-centers-can-set-the-stage-for-larger-loads-to-come/ (2024).

81 Lulu Ramadan & Sydney Brownstone. *Data Centers Demand a Massive Amount of Energy. Here's How Some States Are Tackling the Industry's Impact;* ProPublica's Local Reporting Network and The Seattle Times, New York, New York, https://www.propublica.org/article/data-centers-power-usage-washington-virginia (2024).

82 Pengfei Li *et al.* Making AI Less "Thirsty": Uncovering and Addressing the Secret Water Footprint of AI Models. arXiv:2304.03271 (2023). https://ui.adsabs.harvard.edu/abs/2023arXiv230403271L.

83 Shaolei Ren. *How much water does AI consume? The public deserves to know;* OCED (Organisation for Economic Co-operation and Development) AI Policy Observatory (OCED AI), Paris, France, https://oecd.ai/en/wonk/how-much-water-does-ai-consume (2023).

84 Building and Construction Authority (BCA). *Green Mark Certification Scheme;* Singapore, https://www1.bca.gov.sg/buildsg/sustainability/green-mark-certification-scheme (Accessed August 2024).

85 Daniel Miessler. *The AI Attack Surface Map v1.0: A visual map for understanding attacks against AI and AI systems;* Unsupervised Learning, San Francisco Bay Area, California, https://danielmiessler.com/p/the-ai-attack-surface-map-v1-0 (Accessed August 2024).

86 Krishnakumar Kottekkat. *Connectsecure: Your Solution to Reducing Attack Surface in an AI-driven World;* ConnectSecure, Tampa, FL, https://connectsecure.com/blog/connectsecure-your-solution-to-reducing-attack-surface-in-an-ai-driven-world (2024).

87 Natonal Institute of Standards and Technology (NIST) Information Technology Laboratory (ITL). *AI Risk Management Framework;* https://www.nist.gov/itl/ai-risk-management-framework (Accessed September 2023).

88 The White House. *Blueprint for an AI Bill of Rights: Making Automated Systems Work for the American People;* https://www.whitehouse.gov/ostp/ai-bill-of-rights/ (Accessed September 2023).

89 The White House. FACT SHEET: Biden-Harris Administration Secures Voluntary Commitments from Leading Artificial Intelligence Companies to Manage the Risks Posed by AI https://www.whitehouse.gov/briefing-room/statements-releases/2023/07/21/fact-sheet-biden-harris-administration-secures-voluntary-commitments-from-leading-artificial-intelligence-companies-to-manage-the-risks-posed-by-ai/ (2023).

90 The Bipartisan Senate AI Working Group *et al. A Roadmap for Artificial Intelligence Policy in the U.S. Senate;* US Senate, Washington, D.C., https://www.young.senate.gov/wp-content/uploads/One_Pager_Roadmap.pdf (Accessed August 2024).

91 Ed Markey. Markey, Heinrich, Eshoo, Beyer Introduce Legislation to Investigate, Measure Environmental Impacts of Artificial Intelligence (Press Release); Washington, D.C., https://www.markey.senate.gov/news/press-releases/markey-heinrich-eshoo-beyer-introduce-legislation-to-investigate-measure-environmental-impacts-of-artificial-intelligence (2024).

92 US Senate Artificial Intelligence Caucus. *CREATE AI Act of 2023;* Martin Heinrich Website, Washington, D.C., https://www.heinrich.senate.gov/imo/media/doc/create_ai_act_fact_sheet1.pdf (2023).

93 Brian Schatz. *Schatz, Kennedy Introduce Bipartisan Legislation To Provide More Transparency On AI-Generated Content (Press Release);* Washington, D.C., https://www.schatz.senate.gov/news/press-releases/schatz-kennedy-introduce-bipartisan-legislation-to-provide-more-transparency-on-ai-generated-content (2023).

94 Wilson Sonsini Goodrich & Rosati. *10 Things You Should Know About the EU Artificial Intelligence Act;* https://www.wsgr.com/a/web/5mGbBqgzQyQoCFJz72ZYCC/10-things-eu-artificial-intelligence-act.pdf (2023).

95 Directorate-General for Energy. *New Energy Efficiency Directive published;* European Commission, Brussels, Belgium, https://energy.ec.europa.eu/news/new-energy-efficiency-directive-published-2023-09-20_en (2023).

96 European Commission. DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on adapting non-contractual civil liability rules to artificial intelligence (AI Liability Directive); https://commission.europa.eu/system/files/2022-09/1_1_197605_prop_dir_ai_en.pdf (2022).

97 European Parliament. *Artificial intelligence liability directive;* https://www.europarl.europa.eu/RegData/etudes/BRIE/2023/739342/EPRS_BRI(2023)739342_EN.pdf (2023).

98 Giangiacomo Olivi & Chiara Bocchi. *Regulating AI in EU: three things that you need to know, and three reasons why you have to know them!;* Dentons, https://www.dentons.com/en/insights/articles/2023/february/1/regulating-ai-in-eu-three-things-that-you-need-to-know (2023).

99 European Institute of Public Administration. *An In-Depth Look at the EU's AI Regulation and Liability Directive;* https://www.eipa.eu/blog/an-in-depth-look-at-the-eus-ai-regulation-and-liability/ (2023).

100 Simon Bollans. *EU Artificial Intelligence Liability Directive* Stephenson Harwood, https://www.shlegal.com/insights/eu-artificial-intelligence-liability-directive#:~:text=The%20AI%20Liability%20Directive%20would,alleged%20to%20have%20caused%20damage. (2023).

101 Cynthia Kroet. *Incoming European Parliament to work on AI liability rules, despite tech lobby concerns;* Euronews, Lyon, France, https://www.euronews.com/next/2024/07/12/incoming-parliament-to-work-on-ai-liability-rules-despite-tech-lobby-concerns (2024).

102 European Commission. *Coordinated Plan on Artificial Intelligence* https://digital-strategy.ec.europa.eu/en/policies/plan-ai (Accessed September 2023).

103 European Parliament. *The impact of the General Data Protection Regulation (GDPR) on artificial intelligence;* https://www.europarl.europa.eu/RegData/etudes/STUD/2020/641530/EPRS_STU(2020)641530_EN.pdf (2020).

104 European Commission. *A European approach to artificial intelligence;* https://digital-strategy.ec.europa.eu/en/policies/european-approach-artificial-intelligence (Accessed September 2023).

105 Liu Caiyu. *Draft AI law to be reviewed by China's top legislature;* People's Daily Online, http://en.people.cn/n3/2023/0609/c90000-20029571.html (2023).

106 China Law Translate. *Provisions on the Administration of Deep Synthesis Internet Information Services;* https://www.chinalawtranslate.com/en/deep-synthesis/ (2022).

107 China Law Translate. *Provisions on the Management of Algorithmic Recommendations in Internet Information Services;* https://www.chinalawtranslate.com/en/algorithms/ (2022).

108 Matt Sheehan. *China's AI Regulations and How They Get Made;* Carnegie Endowment for International Peace, https://carnegieendowment.org/research/2023/07/chinas-ai-regulations-and-how-they-get-made?lang=en (2023).

109 Kazuaki Nagata. *G7 aims to beef up collaboration for AI governance;* The Japan Times, https://www.japantimes.co.jp/news/2023/05/21/business/generative-ai/ (2023).

110 The Japan News. *Japan's Artificial Intelligence Strategy Council Holds 1st Meeting with Aim to Create Rules for AI Use;* https://japannews.yomiuri.co.jp/politics/politics-government/20230511-109145/ (2023).

111 Japanese Cabinet Office. *AI Strategy 2022;* https://www8.cao.go.jp/cstp/ai/aistratagy2022en.pdf (2022).

112 LDP Headquarters for the Promotion of Digital Society Project Team on the Evolution and Implementation of AIs. *The AI White Paper: Japan's National Strategy in the New Era of AI;* https://www.taira-m.jp/ldp%e2%80%99s%20ai%20whitepaper_etrans_2304.pdf (2023).

113 Secretariat of Science. *AI Strategy 2022;* Government of Japan – Technology and Innovation Policy Cabinet Office, Tokyo, Japan, https://www8.cao.go.jp/cstp/ai/aistratagy2022en_ov.pdf (2022).

114 Manish Singh. *India opts against AI regulation;* TechCrunch, https://techcrunch.com/2023/04/05/india-opts-against-ai-regulation/ (2023).

115 Indian Bureaucracy. *AI will be kinetic enabler of India's Digital Economy says Rajeev Chandrasekhar;* https://www.indianbureaucracy.com/ai-will-be-kinetic-enabler-of-indias-digital-economy-says-rajeev-chandrasekhar/ (2023).

116 Verdict.co.uk. *India: AI centers of excellence will boost the start-up ecosystem;* https://www.verdict.co.uk/india-ai-centers-of-excellence/ (2023).

117 Government of India: NITI Aayog. *Responsible AI: #AIFORALL;* https://www.niti.gov.in/sites/default/files/2021-02/Responsible-AI-22022021.pdf (2021).

118 Umesh Rathod. *AI policies across the world: Key lessons for India;* Forbes India, https://www.forbesindia.com/article/isbinsight/ai-policies-across-the-world-key-lessons-for-india/85163/1#:~:text=Unlike%20other%20countries%2C%20India%20has,adoption%20of%20AI%20in%20India (2023).

119 Jibu Elias. *AI for All: How India is carving its own path in the global AI race* Organisation for Economic Co-operation and Development (OECD) AI, https://oecd.ai/en/wonk/india (2023).