February 2, 2024

U.S. Department of Commerce
National Institute of Standards and Technology (NIST)

Re: NIST RFI (NIST–2023–0309) on Executive order on Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence issued on October 30, 2023

Thank you for the opportunity to provide input on implementation of the Executive order on Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence. We urge NIST to consider the climate and environmental risks from AI and to work on creating technical standards for assessing the energy and resource use of AI technologies. The executive order on *Safe, Secure, and Trustworthy Development and Use of AI* states, "Harnessing AI for good and realizing its myriad benefits requires mitigating its substantial risks." AI can be used for climate change solutions but also exacerbate societal risks by using large amounts of energy and water and generating pollution that contributes to climate change, which, as President Biden said, "is the ultimate threat to humanity."[1]

NIST is tasked with seeking information about risk management and evaluation for generative AI and, "establish guidelines and best practices in order to promote consensus industry standards in the development and deployment of safe, secure, and trustworthy AI systems." Guidelines for reporting energy and resource use of AI is part of ensuring safe and secure systems, and an often overlooked but pressing risk from AI. Given the large-scale threat from climate change and challenges of energy transitions, it is incumbent for NIST to work with other federal agencies in creating reporting and assessment guidelines to track and ultimately mitigate the environmental risks from AI along with threats to privacy, data security, democracy, and discrimination.

Currently data centers represent 1-1.5% of global electricity use, but that could grow significantly with rising demand for computational power driven by the boom in AI.[2] Other environmental impacts from AI include extensive water use and the consumption of metals and minerals like lithium in the computer hardware that also becomes waste.[3] Clear, robust, and systematic disclosure standards are needed for companies and organizations developing AI in order to ensure transparency and enable informed policy-making and efforts to limit energy use, associated carbon emissions, and other environmental impacts.

Generative AI tools that use large language models (LLMs), such as ChatGPT or Microsoft's AI-enhanced Bing, require lots of computing power and thus, electricity.[4] According to people working in the industry, a data center running AI tasks could consume three to five times more energy than traditional data centers.[5]

The energy consumption from generative AI occurs during two phases - "training" or creating an AI model and then "inference" or the use of an AI model. Training a LLM requires feeding it

huge datasets to process, which can take several weeks to several months and requires tens of thousands of advanced micro-chips called graphics processing units (GPUs). Researchers from University of California-Berkeley and Google found that training just one model, GPT-3, took 1,287 gigawatt hours which is as much electricity as 120 U.S. homes use in a year, and generated 552 tons of carbon which is equivalent to emissions from 110 gas-powered cars on U.S. roads in a year.[6] Another academic research team estimated that training GPT-3 consumed about 185,000 gallons of water — equivalent to what about 2,200 average Americans consume in their homes over a year.[7] That is just one AI model, but many other companies and researchers are developing their own AI systems that are even more complex, relying on more computing power.

Yet, training is only the first step. Using generative AI models also requires electricity, potentially much more than what is used in the training phase. Google analysts estimate that training was only about 40% of the energy used by their generative AI while the other 60% came from running queries, although this will change depending on the popularity of the AI model and its complexity.[8] The energy to run the millions and billions of queries that popular programs like Chat GPT receive adds up quickly. An article in *Joule* estimated that OpenAI uses 564 MWh per day to support the use of Chat GPT-3 which would take only three days to surpass the estimated 1,287 MWh used in training GPT-3.[9]

Researchers have attempted to estimate the current and future energy, carbon, and water footprint of AI. A scenario in an academic paper finds AI servers could use between 85 and 134 terawatt hours annually by 2027 which is comparable to what Argentina or Sweden uses annually, and about 0.5 percent of current global electricity consumption.[10] In many locations, much of this electricity creates carbon emissions since it's powered by fossil fuels.[11] A team of academics from UC-Riverside and UT-Arlington predict that global AI water demand could reach 4.2–6.6 billion cubic meters of water by 2027, which is half of the United Kingdom.[12]

While researchers and industry analysts have identified the potential energy use from AI, there are still many questions and unknowns. Better data and documentation, and greater transparency is needed to accurately measure AI’s electricity use and evaluate the climate and environmental risks. Currently, such estimates are hampered by a lack of quality data, opaque company operations, and the absence of industry standards around energy use and reporting. Systematic guidelines for assessing energy and resource consumption will enable better comparisons between LLM models and benchmarking to evaluate changes over time. NIST can also lead creation of global standards and best practices that are essential since the development and use of AI models transcends national boundaries. Potential factors to incorporate in reporting include: training time; computational resources required for training, inference, and tuning models; technical specifications of hardware used; location of data centers and energy sources; estimates of scope1, 2, and 3 carbon emissions; and water used for cooling. Better reporting from hardware

manufacturers on energy use could also help companies assess the efficiency of their AI models.[13]

Many factors influence how much energy and water is used by AI and the rate at which it grows. The electricity required depends on the design of the model, the type of processors used, and the data center facility. Carbon emissions also depend on the fuel sources powering data centers and where they are located. Google and University of California-Berkeley researchers found that using more efficient model architecture, equipment, and greener data centers could reduce the carbon footprint of an AI model by 100 to 1,000 times.[14] When and where AI models are trained also impacts the water intensity and smart decisions can reduce water use.[15] NIST should lead efforts to determine key factors that influence the energy and water use of AI models which would help create guidelines for designing efficient technologies and inform policies to encourage cleaner AI models. This should include best practices for AI model training and inference.

NIST should assist in creating guidelines and best practices for AI efficiency to direct federal agencies in developing, procuring, and using AI technologies in-line with carbon emission reduction and other sustainability goals. Reporting standards about energy and resource use can be used to assess selection of different AI models for use by federal agencies, and can help guide agencies who are directly, or indirectly, involved in developing new AI technologies. Federal funding for AI development must prioritize energy efficiency and green-computing principles.

AI has potential to help address the climate crisis with applications in areas like smart grids and renewable energy technologies, but it could also drive-up emissions if there is weak oversight and a lack of standards.[16] In order for AI systems to be designed and deployed in ways that minimize environmental impacts, more transparency and reporting of energy consumption and emissions will be needed. NIST should therefore help develop standards and guidelines that ensure quality reporting and comparable methods for assessing energy use.

Thank you for your time and consideration.

Erik Kojola, PhD, Senior Research Specialist
Charlie Cray, Senior Strategist
Johanna Fornberg, PhD, Data Specialist
Greenpeace USA
1300 Eye Street, NW
Suite 1100 East
Washington, D.C. 20005

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