The Consequences of the xAI Data Center

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Introduction

Data centers are becoming more prevalent across the world as countries seek to further develop AI; however, the creation of data centers have wider implications than simply being facilities to store and power AI-based machines. Recently, in Memphis, Tennessee, a data center was built with the purpose of generating energy to further AI development and power the xAI chatbot, Grok. Given the uproar about the facility being built, it begs the question: what are the major controversies surrounding the xAI data center in Memphis, Tennessee? This question is best explored through an interdisciplinary approach; by seeking to understand the mindset behind those in the computer science, environmental science, and political science fields. Computer science explains the necessity of data centers and the issues that arise because of them. Environmental science helps to explain the toll data centers are taking on the areas they are placed in and the impacts of their prolonged activity. Political science aims to achieve balance between environmental health and computer science necessities. By looking at this issue through an interdisciplinary lens, it helps to provide nuance into the situation and to create common ground between disciplines that are seemingly working against each other's best interests. Other than the physical and technical security concerns that data centers create, data centers and their impacts on the community is relevant to cybersecurity because the way people interact with technology is a core principle of cybersecurity. As data centers continue to be built across the country, it is important to understand the various concerns that come with them.

Some key terms are artificial intelligence (AI), data center, hardware, firmware, software, brown energy, and green energy. Dustin Edwards, Zane Griffin Talley Cooper, and Mel Hogan outline data centers as an interdisciplinary study where *data centers* can be described as internet infrastructure and a "conceptual anchor point" that combines its physical infrastructure with "the

politics and ecologies of data and computation" (Edwards et al., 2024, p. 430). *Artificial Intelligence* can be defined as "a massive scale auto-complete system" (Edwards et al., 2024, p. 440). Daniel Mange (1993), a member of the Institute of Electrical and Electronics Engineers (IEEE), defines *firmware* as "the technique of transforming hardware into software and vise versa" and the "bridge between" the two different sides to computer science, hardware and software: *hardware* being the physical components "such as logic and digital systems" and *software* as "procedural programming" (p. 152). Heidi Garrett-Peltier, who is an author in the environmental sciences, juxtaposes *brown energy*, energy that comes from "fossil fuels" and contribute to the rising "global carbon emissions [that] have reached unsustainable levels", from *green energy*, by integrated methods that are "transforming the energy sector by increasing efficiency and use of renewables" (Garrett-Peltier, 2017, p. 439).

Computer Science

Artificial intelligence is being prioritized by many leaders in the tech industry, and data centers are an integral part to AI advancement. One of the main reasons why AI is being highlighted is because of its speed. While speed is an important aspect of AI development, it also creates cybersecurity issues. The nature of data centers is to work as fast as possible, but there are security tradeoffs that come with prioritizing speed. James Petrie and Onni Aarne lead research to find ways Frontier AI, a leader in AI development, can enhance their specialized hardware through hardware, software, and firmware modifications to hasten production time; although, these modifications come with security tradeoffs. Data centers are already a cybersecurity issue, and for Frontier especially, their "AI models can pose serious risks to public safety and international security" (Petrie & Aarne, 2025, p. 2). These are risks all data centers take for the sake of speedy production, and because of the universal use of data centers,

companies that run them need to be able to make guarantees that the information these data centers house are secure.

Another issue that arises because of data centers are their energy consumption and the methods that are used to cool the hardware that runs them. The hardware in data centers tends to overheat, and to remedy that, data centers use excessive amounts of water to cool down the hardware causing water pollution. Proceeding a workshop done to "bring people closer to the material reality of computing in local places", Eshta Bhardwaj, Rowan O. A. Munson, Han Qiao, and Christoph Becker add the context that the air pollution comes from the use of brown energy to power data centers, as well as obscured impacts of labor exploitation and land displacement, creates a connection between "data centers and ecological and social burdens" (2025, p. 831). "The material reality of computing in local places" is that data centers tend to coincide with labor exploitation, environmental distress, and social impacts for local communities, but "Big Tech" often tries to redirect the focus to jobs created and the productivity of data centers instead of the unintended consequences (Bhardwaj et al., 2025, p. 833). The energy inefficiency issue is one that is being studied in hopes that changes in hardware can help to, at least, make data centers more flexible with the type of energy they consume. Currently, data centers primarily use brown energy because the amount of power that is required from the hardware outpaces renewable energy production, and while data centers cannot run only on only on renewable energy sources, their "dynamic infrastructure and power consumption" has the potential to allow dual energy sources to power them (Kirpes & Klingert, 2016, p. 1). Kirpes and Klingert discuss how data centers can reduce their carbon footprint by consuming energy, preferably from low carbon sources, when it is readily available without adding pressure to the power grid (2016, p. 1). This can be done by implementing demand response strategies, which is a "long tradition in the US"

that makes the power demand of big consumers more flexible (Kirpes & Klingert, 2016, p. 1). These changes come down to studying the characteristics of data center architecture to see where energy consumption can be cut back and companies ability to implement demand response strategies.

Environmental Science

One of the central issues surrounding data centers is their energy consumption and its impact on the environment. Ziyang Chen and Mingxin Zhu were speakers at the 2025 International Conference on Computer Information and Big data applications, where they asserted that AI data centers are "energy-intensive, requiring a significant amount of power to operate the servers and water to cool the servers", and this rate of energy consumption has "aroused public concern" (Cheng & Zhu, 2025, p. 1053). These public concerns are in part because "... Big Tech companies locate data centers to certain locations to increase efficiency and reduce latency and data traffic…"; these locations rely on a "climatic promise" where data centers have ready access to cool air temperatures and water to help "decrease computational heat" and an "infrastructural promise", where access to "fiber optic cables, renewable energy sources, and future growth" are possibilities for the company (Edwards et al., 2024, p. 437). Coincidentally, many of the areas that are "perfect" locations for data centers tend to be in close proximity to cities, creating concerns in areas like South Memphis, where residents are already subjected to air pollution from other local industries; "Elon Musk's artificial intelligence company is belching smog-forming pollution into an area of South Memphis that already leads the state in emergency department visits for asthma" (Wittenberg, 2025). The xAI supercomputer is powered by "thirty-five methane gas turbines", none of which are "equipped with pollution controls typically required by federal rules" (Wittenberg, 2025). The methane gas turbines have

caused concern in the community due to the lack of regulations at the xAI plant because of the nitrogen oxides that are released in the air; “health officials in Memphis, Tennessee are being urged to investigate turbines at xAI’s data center over claims that the devices installed by Elon Musk’s company could leave residents breathing poorer quality air” (Gooding, 2024).

Political Science

The current AI boom is in part due to government involvement, and the creation of the xAI data center is partly due to the technological arms race among governments worldwide. The xAI data center in Memphis wasn’t just developed as a power and storage facility for X’s AI, Grok. As stated by Doug Matty, the Chief of the Department of Defense’s Artificial Intelligence Office, it was also created to help advance the Office’s knowledge and development of AI in hopes of “transforming the Department’s ability to support our warfighters and maintain strategic advantage over our adversaries” (Capoot, 2025). AI data center development transcends administrations, a Biden era executive order outlined the environmental standards, geographic placement, and public health measures for Frontier AI to adhere to to build data centers for the Department of Defense and the Department of Energy (Warin et al., 2025, p. 3-5). The recent grants strive to help advance AI and integrate it into more high-stakes situations and shows that the federal government is readily assisting technical companies to reach that goal.

Common Ground

While each discipline prioritizes different things, the energy inefficiency issue is one that computer science, environmental science, and political science all addresses. Even though each discipline may recognise energy inefficiency for different reasons, they each come to the conclusion that change can be done to reduce data centers’ energy consumption. Environmentalists emphasize the water and air pollution that secrete from data centers and how

the increased carbon emissions impact the Earth while providing ways to mitigate the issue. For example, building AI data centers in strategic places that are “rich [in] renewable energy sources” will reduce their carbon footprints (Cheng & Zhu, 2025, p. 1053). This method still allows data centers to be built in countries that want to invest in them, but the overall method that Cheng and Zhu describe is an “optimization strategy” that focuses on countries that are rich in renewable energy sources while using time zone differences to “dynamically allocate workloads through algorithm models to maximize the use of renewable energy” (Cheng & Zhu, 2025, p. 1054). Computer science focuses on researching hardware, software, and firmware changes that can be made to lessen energy consumption; although this won’t be an immediate solution, it is a step towards energy preservation (Kirpes & Klingert, 2016, p. 1). Political science is integrating the two disciplines, and usually this leads to both disciplines having to make concessions; to do this, the government can expedite the development of data centers while creating environmental standards to be enforced (Warin et al., 2025, p. 3). Governments also have to keep in mind the health and well-being of residents in their jurisdiction, and this can be done by enforcing environmental policies on data centers while still encouraging technological growth.

Disciplinary Conflicts

While political science, environmental science, and computer science are all working towards a cleaner way to have data centers, each discipline still faces conflicts with each other. Political science is supposed to integrate computer and environmental science; however, the issue of enforcing environmental policies creates conflict between all of the disciplines. The federal government can create environmental policies that data centers need to adhere to, but if those policies are not enforced, then data centers can be placed in areas where the technology

and pollution can harm communities. This is what happened with the xAI data center, where the state and federal governments prioritize AI data center development over the wellness of the South Memphis residents and the environment. This has created environmental conflict, where the xAI data center is increasing carbon emissions in the city, and results in a political issue where the residents in South Memphis are being subjected to air and water pollution because the data center hasn't made any technological advancements to make the hardware less environmentally hostile. In this particular case, due to where the xAI data center is located, there is racial conflict: the xAI data center is built in South Memphis, which is a lower income, working class, historically black community that doesn't have the influence to fight back against its development. This area in particular has a high elderly population and the pollution is causing more health problems for the community. The Tennessee state government is largely ignoring this situation even though there is public uproar from both residents and local community leaders.

Ch. 12: "Constructing a More Comprehensive Understanding or Theory"?

Artificial intelligence is currently at the forefront of technological advancement, and, to fuel that, data centers are being built around the country. Sequential integration can help to explain the cause-and-effect relationship that encompasses the controversies surrounding the xAI data center in Memphis, Tennessee (Repko 2021, p. 335). Data centers being built are encouraged by state and federal government because AI is being integrated into more government services because AI is seen as a way to "engage with other countries on accelerating the global buildout of AI infrastructure" (Warin et al., 2025, p.3). However, what is important to note is the amount of energy data centers require and the type of energy they consume; the energy that many data centers use is from brown energy sources, like the methane gas turbines

that power the xAI data center in Memphis (Brabenec et al., 2025). While research is being done to make the hardware in data centers more energy efficient, the current state of the xAI data center "draws enough electricity to power approximately 100,000 homes" and is causing "nitrogen oxides and poisonous formaldehyde" smog that is "linked to respiratory and cardiovascular disease" (Brabenec et al., 2025). Sequential integration helps to demonstrate the causes to the various issues created by the data center: state and federal governments prioritize AI development without encouraging or investing in energy efficient hardware for data centers, which leads to local communities, like South Memphis, "beginning to look like 'sacrifice zones,' or poor, predominantly Black communities that are willfully poisoned and polluted for the interests of power and wealth" (Brabenec et al., 2025).

Ch. 13: "Reflecting On, Testing, and Communicating the Understanding or Theory"?

The implications of data centers are slowly coming to the surface, especially since many are being built to help integrate AI services. What is specifically interesting about the xAI data center is its location and its clash with the local community. While there are many theories on how to make data centers more energy efficient, possible measures to implement that would theoretically help local residents, discourse about data center placement and the carbon emissions they release into the environment, the best way to handle the onslaught of issues created by the xAI data center is to experiment with the theories and find what works best. This can be done by monitoring data center hardware in hopes of finding ways to implement a flexible system outlined by Kirpes and Klingert, state and federal governments making conditions for their grants that pressure owners of data centers to invest in energy conservation or to enforce pre-existing environmental, geographic, and public health standards outlined in previous executive orders (Warin et al., 2025, p. 3-5). Overall, because of how new the circumstances are,

there is more research than needs to be done specifically in creating hardware that is less harmful to the environment. This is important as more data centers are rapidly being built near residential areas, and the focus needs to broaden to include long term public safety.

Conclusion

The issues seen from the xAI data center in Memphis, Tennessee can become a reality for more people as data centers are continuously built to advance AI, and it is important to understand the various nuances that surround their imposition. Data centers are not new, but AI development has made data centers more important in computer science, but detrimental to the environment and local communities. There is more research to be done towards data centers and ways of making them more efficient, but, until then, research about their environmental and health impacts will continue to dominate the conversation. State and federal governments prioritizing the development of data centers without enforcing environmental standards or pushing research into creating energy efficient hardware will reflect poorly as technological development is considered more important than health and environmental wellness.

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