

Emissions, impacts, and embodiment: A techno-economic sustainability analysis of AI data centers

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Good afternoon. Matthew Heun and I have been considering AI through a sustainability lens. I am going to present some thoughts about AI, incorporating the 3 pillars of sustainability: environmental, social, and economic. As usual, I'm trying to cover a lot of ground with this talk, and in the process, I am assuming some background knowledge. If I've assumed too much, there will be opportunity during the question period to circle back. This conference is called "Wisdom in the age of AI" so am going to begin with working definitions for "wisdom" and "AI."

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Wisdom, in the bible, encompasses three distinct traits. First is prudence, which is the application of logical principles to make good decisions from available data. The book of Proverbs calls those have prudence "shrewd" and those that lack it "simple." Prudence considers constraints, cost/benefit analysis, risk, and prioritization.

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The second kind of Biblical wisdom is discernment, which involves spiritual perception. Proverbs contrasts those who can recognize truth with those who can't. We might call bold truth-tellers "prophets." Proverbs calls those who deal in lies and half truths "mockers" or "scoffers."

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The book of Proverbs most emphasizes the third type of wisdom, self-control, which is an exercise of the will towards righteous living. Proverbs contrasts the disciplined and the sluggard. Two keys for self-control are “can I do the good thing I have already decided to do” and “can I avoid avoidable temptation?” With those definitions for wisdom, let’s turn next to defining AI for this talk.

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There is a tendency to think --- because “intelligence” is in the name --- that Artificial Intelligence is disembodied. Nothing could be further from the truth. AI is embodied in grid-scale infrastructure [*click*]. Here we see a proposed 100-MW data center for the small town of Gibraltar, Michigan. It’s a massive, physical building. But a machine without energy is just an expensive statue.

AI is a computing machine, that is, a massive construction, that uses substantial energy, for the purpose of manipulating information. We’re going to look, particularly, at the sustainability implications of AI energy use.

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This Sankey diagram shows the flow of energy from left to right. The amount of energy is represented by the width of each line.

Of the 100 MW of electricity [click] fed to a data center about 75 MW is used by the servers and about 25 MW is used for cooling. [click]

The Michigan electrical grid is fed with a mix of coal, natural gas, and nuclear power plants (PP), with small amounts of renewable energy and oil. [click] Ultimately, energy is dissipated as heat, either from the data center itself, from the electrical grid as transmission losses, or within the powerplants that generate electricity. [click]

270 MW of primary energy is needed to supply 100 MW for the AI data center. 68 MW of Coal power generates 200K tonnes of carbon dioxide per year. 107 MW of natural gas power generates 175K tonnes of CO2 per year. And cooling uses 180 Million gallons of water per year. All of this is for just one data center.

[click]

Currently, there are more than 1300 data centers operating in the US using about 60 GW of power. About 2200 more are coming soon with a total power rating of an additional 390 GW. For context, the Michigan electricity grid is about 32 GW, so that's about 12 more Michigan electrical grids. The trend toward "more" and "bigger" is called Hyperscaling.

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Currently, data centers use 1-3% of electricity globally. Within 10 years, hyperscaling will increase electricity used by data centers by a factor of 2-6. Electricity is only one of our sources of final energy. (Some others include refined petroleum for transportation and natural gas for residential heating.) Even with dramatic increases for DIRECT AI data center ELECTRICITY use, direct CO2 emissions for DATA CENTERS are a relatively small fraction of total CO2 emissions.

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The real impact of AI on the environment depends on the impact of AI on the economy. EN-ROADS is a climate simulator put out by MIT. The comparison on this slide is between a business-as-normal 2% PER YEAR economic growth through the end of the century VERSUS AI-accelerated economic growth. Two percent growth has been the average since 1950. On the left is the amount of GLOBAL energy

used, with coal on the bottom, then oil, gas, and renewables in green. It may be a little hard to see, but with AI-accelerated economic growth, we're using [**click**] an EXTRA 230 exajoules per year by 2100, an increase of almost 21%. That results in about an extra 15 Gigatons of CO₂ per year in the last half of the century. In 2100, for instance, from 75 GT/yr to about 90. The EXTRA carbon emissions result in 0.3 degrees C of extra warming by the end of the century.

I'm NOT claiming the EN-ROADS model is gospel truth. It's DIRECTIONALLY correct and it is illustrative of the broader point that the economy's use of resources, energy in particular, causes global climate change. This sort of economic growth is the intentional goal of hyperscaling. Because no one is responsible for the environmental effects.

OK, now let's return to the wisdom piece of the talk.

[**click**]

Remember that prudence applies logical thinking to make good decisions from available information by asking questions about such things as cost/benefit, constraints, priorities, and risk.

Basically, "Is this is a good idea?"

I don't have time to examine all of these areas or to give definitive answers for AI. Instead, I want to define risk and look at each of the 3 legs of the sustainability triangle, social, economic, and environmental, and see what prudential judgement about AI might tell us.

[**click**]

Ignorance is the absence of knowledge. Uncertainty is impartial knowledge. Neither is the same as risk, which is likelihood

multiplied by consequences. If we give a preschooler a chainsaw, we should not claim ignorance about what will happen. While it's technically true that "anything could happen" and that we don't "absolutely know" what will happen, there's a fair likelihood of significant injuries to body and/or property. A preschooler with a chainsaw is unacceptably risky. Let's pull apart our sustainability triangle and apply examples of ignorance, uncertainty, and risk to the 3 pillars of sustainability.

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There are concerns about rogue AI, because AI is new and we don't KNOW what WILL happen. More extreme versions of this fear include Skynet, from the Terminator franchise, or the machine overlords from the Matrix movies. It's really fear of the unknown that fundamentally drives these concerns, hence why the nature of the threat might be classified as speculative fiction. Let's put this in the SOCIAL sphere.

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If you've been following any of the business news lately about AI, there are questions about the massive investment in the build out of AI data centers, the IPOs of AI-centric companies, and the market power of those companies. These concerns are based in part about the unknown future, but also in present knowledge and stated future intentions. We read the news and see the headlines. We *wonder* whether AI will be "worth it" so let's connect uncertainty to our economic sphere.

[click]

Environmentally, the RISK of climate change is high because the consequences are severe, long lasting, and widespread. The

likelihood that AI will accelerate economic growth seems reasonably high because the goal of hyperscaling is growth and we've already invested significant dollars into the effort.

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Proverbs 14:15 says "The simple believe anything, but the prudent give thought to their steps." Let's not worry about science fiction.

[click]

In the economic realm, there are lots of credible questions about the massive amounts of money being spent on AI and whether there will, or even can, ever be a payback. This is not investment advice, but I would say that AI looks like a risky bet in October 2026.

Environmentally, we can't afford to "go on" as we have been, let alone accelerate economic growth. The several previous slides demonstrated the environmental consequences of hyperscaling. Regardless of whether AI is "worth it," in a financial sense we CAN'T afford, environmentally, to hyperscale our economy.

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Discernment is about recognizing the truth of a situation. There has been a lot of popular backlash against AI recently. Why?

Let me give you TWO LIES and THREE TRUTHS that I think help illustrate what's "really going on" in our society and our economy. We've been told by AI companies that AI will do two things for us: 1) it will accelerate the information superhighway and bring us more truth faster.

Second, that AI is generative. In contrast, we ALL have direct experience that both of these promises fail to live up to expectations. AI hallucinates. AI slop is a thing. Large language

models, by definition, aren't "creative" because they deliver that which is "MOST STATISTICALLY LIKELY."

[**click**]

And yet. Businesses are eager to replace workers with AI, not because AI is better – Artificial Intelligence is demonstrably WORSE than human intelligence – but because AI is CHEAPER. And people resent being told how little they are worth.

AI has become a tool to widen the gap, in our society and our economy, between the "haves" and the "have nots."

[**click***richMan+Lazarus]

AI is the power behind not just Surveillance pricing algorithms, it has now been deployed for Surveillance wages. [**click***Balance]

Michigan Public Act 233 (2023) instead of promoting green energy, has become a tool for utilities and AI companies to prevent locals from having any control over data center projects. This means AI and utility companies are the ones making decisions [**click***self-regulation] about new power infrastructure without regard to the effects on climate, water, or energy prices to the consumer. AI isn't bad. These problems aren't caused by AI. The problems come from humans and human systems. AI is a powerful tool in the hands of sinful people that inhabit a broken and sinful world.

[**click**]

The third aspect of Biblical wisdom involves the exercise of the WILL to do good. As Christians, we are called to not only personal righteousness, but also communal righteousness within our convent community.

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We could call individual self-control “virtue” but what does corporate self-control look like? I think that’s a harder question to answer. Let’s agree that, at least, it could begin with justice. That is, just laws justly applied. But what do we do when we live in a society where there is injustice and where we aren’t seeing the shalom we would like to see?

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Ancient wisdom literature suggests answers, because the questions of injustice are not new. We can lament. We can speak the truth (with discretion). And we can organize to work together.

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In Proverbs, self-control often involves forgoing a short-term pleasure for a long-term gain. In Proverbs 19:24 the sluggard is too lazy to even eat. If only he could postpone sleep just a little to finish eating, then he would be OK. There’s a proper time and place for both sleeping and eating. Prudential judgement is about a right ordering of priorities. Adultery is a somewhat different matter. It has both moral (Prov 5:5) and practical consequences (v. 10). Both prudence and discernment play into the analysis. Don’t you see what’s going on here? Forego momentary sweetness of a lifetime of rewards. The remedy, according to Proverbs, is to stay away (5 verse 8). Just avoid the situation.

Our current climate crisis is exactly the same lack of self-control. It’s not that we don’t know how to prevent climate change. We do know and have known for 40 or 50 years. It’s just that securing our long-term future would require forgoing fossil fuels (and the associated economic growth) in the present day. We’ve failed to live in accordance with our own long-term interests both individually

and corporately. And at every scale in between. We have decades of failure to exercise self-control with respect to climate change. Will we also fail with AI?