Metrics Drive Progress. Are we focused on the right ones?

Adam Wierman, Caltech & Verrus

> " A key driver for [efficiency] improvements was the creation of the power usage effectiveness (PUE) metric. "

- Data Center Power and Energy Management: The Past, Present, and Future.
by Bianchini, Belady, Sivasubramaniam

$$\text{Power Usage Effectiveness (PUE)} = \frac{\text{data center energy usage}}{\text{IT energy usage}}$$

$$\text{Carbon Usage Effectiveness (CUE)} = \frac{\text{data center carbon emissions}}{\text{IT energy usage}}$$

$$\text{Water Usage Effectiveness (WUE)} = \frac{\text{data center water usage}}{\text{IT energy usage}}$$

What about the efficiency of compute? Operational vs. embodied carbon? PPA vs On-site? Site vs source water usage? Flexibility?

Unsustainable, resource-hungry and loud: Why Chandler wants to ban more data centers.

A utility promised to stop burning coal. Then Google and Meta came to town.

An energy crunch forces continued coal burning in a low-emissions area as data centers strain the regional power supply.

POWER GRAB

Fighting back against data centers, one small town at a time

As the tech industry pushes to build more of the giant facilities, projects...

REAL ESTATE

Electric grids need upgrades thanks to data centers. Guess who helps pay for that.

Daniel Geiger and Eben Thomas

- Amazon is seeking an electricity discount in Ohio that could heap costs on other ratepayers.

- Surging data center development could require huge utility upgrades costing billions of dollars.

- Advocates worry that consumers will end up subsidizing tech giants and Wall Street titans.

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Despite progress, local populations are increasingly unhappy about data centers moving in.

Health costs of data centers are significant and local.

- **The health costs of data centers in the US will soon rival those of on-road emissions of largest states.** The health impact of data centers in the US is projected to exceed that of on-road emissions in California by 2030.

- **The health cost of training an AI rivals the electricity cost.** Depending on the location, health costs of training a model of the scale of Llama 3.1 are between 30% and 120% of the electricity costs.

- **The health costs of data centers vary widely across regions and are often felt most by low-income communities.** Some communities experience 200x larger health costs than others, and 9 of 10 most impacted counties are low-income communities.

*These are from preliminary analyses in collaboration between Caltech and UC Riverside.

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What metric(s) will drive progress in the next decade?