SESSION: FIRM PERFORMANCE AND CORPORATE GOVERNANCE

THE AI ENERGY GOVERNANCE PARADOX: RECONCILING ARTIFICIAL INTELLIGENCE'S SUSTAINABILITY PROMISE WITH ITS GROWING POWER DEMAND

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Abstract

Artificial intelligence (AI) is increasingly positioned as a key enabler of global sustainability transitions, supporting energy optimization, climate modeling, and resource-efficient industrial processes. However, the rapid expansion of AI systems introduces a growing contradiction: the computational intensity of modern AI models drives substantial energy consumption, potentially offsetting their environmental benefits. This study conceptualizes this tension as the AI Energy Governance Paradox, the conflict between AI's sustainability promise and its escalating power demand. Using a governance-informed mixed-methods design, the research combines quantitative scenario modeling, empirical benchmarking of AI workloads, rebound elasticity simulations, and qualitative interviews with AI engineers, policymakers, and sustainability officers. Three trajectories are compared: efficiency-only, governance-regulated, and business-as-usual. The findings show that technological efficiency measures such as model pruning and carbon-aware scheduling can reduce per-task energy use by 22–35%, but rebound effects may erase these gains when governance mechanisms are absent. In contrast, governance-regulated scenarios, including mandatory energy reporting and carbon pricing, reduce projected energy growth by 28% and suppress rebound elasticity below 0.3. The study demonstrates that AI sustainability cannot be achieved through technical optimization alone. Instead, multi-level governance frameworks, spanning corporate carbon accountability, national digital policy integration, and global standards coordination, are required to align AI innovation with climate objectives. Governance thus determines whether AI becomes a climate solution or an additional environmental burden.

1. INTRODUCTION

Artificial intelligence (AI) has become integral to addressing global sustainability challenges, from energy optimization and climate forecasting to circular manufacturing. However, AI's increasing computational demand presents a serious contradiction: the same systems designed to accelerate environmental progress are themselves large consumers of energy.

As model sizes and data volumes grow, the energy and cooling requirements of data centers have surged. At the same time, governments and enterprises are under pressure to align AI expansion with net-zero commitments, creating a governance dilemma. Policymakers must balance innovation with regulation, ensuring that AI's climate benefits outweigh its carbon costs. This tension defines what we term the AI Energy Governance Paradox.

This study investigates how governance mechanisms, including standards, reporting frameworks, and policy incentives, can reconcile the paradox, enabling AI's sustainable growth without deepening its energy burden.

2. LITERATURE REVIEW

2.1. Literature review

AI's scalability will test the limits of existing energy infrastructure and call for global governance coordination to ensure energy-efficient AI development (World Economic Forum, 2025). Also, the AI electricity use could double by 2026 and triple by 2030, potentially consuming over 1% of global power without proper oversight (Senyapar & Bayindir, 2025)

Technological efficiency alone cannot ensure sustainability due to Jevons-type rebound effects, emphasizing the need for governance interventions to limit unrestrained AI use (Luccioni et al., 2025), and a governance-relevant strategy, model sobriety, demonstrating that adopting smaller models could cut global AI energy consumption by up to 27.8% (Da Silva et al., 2025).

Meanwhile, AI's governance gap is that although AI assists environmental policy implementation, its own regulatory frameworks for energy transparency remain underdeveloped (Pachot & Patissier, 2025).

2.2. Problem statement

AI's growing energy demand exposes a governance vacuum. Despite isolated reporting initiatives, there are no universal standards for measuring or disclosing AI-related energy and carbon footprints. Consequently, policymakers, investors, and citizens lack transparency on AI's true environmental impact, undermining accountability and sustainability efforts.

2.3. Research hypotheses

The hypothesis of this research is that AI's environmental benefits can only surpass its energy costs when efficiency technologies are coupled with governance mechanisms such as energy disclosure standards, carbon budgets, and usage policies.

H1: Technological interventions (model pruning, lightweight architectures, carbon-aware scheduling) can reduce AI energy use by ≥ 20-30%.

H2: Without governance controls, rebound elasticity above 0.5 will erase these gains, resulting in higher net consumption.

3. RESEARCH METHODOLOGY

This study employs a governance-informed mixed-methods design.

Quantitative modeling: Modeled AI energy trajectories under three scenarios: 1) efficiency-only, 2) governance-regulated, and 3) business-as-usual. Governance variables included reporting mandates and carbon pricing.

Empirical measurement: Benchmarked graphics processing unit and tensor processing unit power consumption for AI workloads, applying model pruning and scheduling interventions.

Governance case studies: Conducted interviews with AI engineers, policymakers, and sustainability officers to assess the adoption of energy governance frameworks.

Rebound modeling: Simulated the elasticity of AI demand growth under different regulatory conditions (e.g., voluntary vs mandatory energy reporting).

4. RESULTS OF THE RESEARCH

Below the quantitative results, empirical findings, and qualitative insights are presented.

Quantitative results:

- The governance-regulated scenario achieved a net 28% reduction in projected energy growth compared to business-as-usual by 2030.
- Efficiency-only interventions improved performance-per-watt but failed to reduce total energy due to rebound behavior.
- Mandatory reporting and energy caps (governance levers) curbed rebound elasticity to below 0.3.

Empirical findings:

- Model pruning and quantization reduced consumption by 22–35%, consistent with prior findings.
- Transparent dashboards influenced developer behavior. Teams adhering to reporting standards conducted 25% fewer redundant runs.
- Interviewees noted that policy compliance and stakeholder visibility were strong motivators for energy-efficient design.

Qualitative insights:

- Organizations lacking governance guidelines showed limited awareness of AI energy impact.
- Participants favored global standards akin to ISO 14001 for AI carbon accountability.
- Policymakers cited a need for harmonized frameworks linking AI ethics, energy policy, and climate regulation.

5. DISCUSSION

The results confirm that technological efficiency must be embedded in a governance ecosystem to prevent the AI energy paradox from worsening.

Governance as an enabler:

Governance mechanisms, including energy disclosure mandates, model-level carbon audits, and environmental, social, and governance (ESG)-linked incentives, translate sustainability rhetoric into enforceable practice. These measures reshape institutional behavior and create accountability loops missing in purely technical approaches.

Rebound control through policy:

Efficiency alone triggers rebound, governance (via reporting and carbon pricing) internalizes environmental costs, moderating demand.

Multi-level governance perspective:

• Corporate level: Firms adopt carbon budgets and sustainability dashboards for AI operations.

• National level: Governments integrate AI energy metrics into digital policy frameworks.

• Global level: Multilateral bodies (e.g., Organisation for Economic Co-operation and Development, United Nations, World Economic Forum) coordinate standards for AI energy disclosure.

Ethical and societal dimensions:

Transparency in AI energy governance aligns with principles of environmental justice, ensuring that the benefits of AI do not come at disproportionate ecological or regional costs.

6. CONCLUSION

The AI Energy Governance Paradox encapsulates a defining challenge of our technological era: the tension between innovation and sustainability. This study demonstrates that efficiency-oriented technical solutions are necessary but insufficient. Only when paired with robust governance, including being anchored in transparency, accountability, and shared responsibility, can AI deliver net environmental benefits.

The path forward involves developing AI energy governance frameworks that mandate measurement, disclosure, and regulation of AI's carbon footprint. AI can serve as both a climate ally and a climate burden, governance determines which path prevails.

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