

Research Gaps in Energy Efficiency and Sustainability of HPC Data Centers

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This document summarizes the key research gaps identified by comparing the paper 'Towards Sustainability and Energy Efficiency Using Data Analytics for HPC Data Centers' with other recent studies on HPC data center energy efficiency and optimization.

1. Lack of Holistic AI Integration

Current studies address specific optimization areas separately (cooling, workload, or energy consumption). There is a need for a comprehensive AI-based framework that optimizes all operational aspects of HPC data centers simultaneously.

2. Limited Real-Time Adaptive Control

Most models use historical data to predict behavior rather than dynamically adjusting based on real-time sensor feedback. Future research should focus on developing real-time adaptive systems that respond instantly to changing conditions.

3. Scalability and Generalization Problems

Existing models are trained for specific clusters like CRESCO6 and may not perform well in different environments. Research is needed to build generalized, scalable models applicable to various HPC infrastructures.

4. Lack of Integration with Renewable Energy

Current optimizations often assume conventional energy sources. Research should explore integrating renewable energy sources like solar and wind into AI-based energy management frameworks.

5. Missing Economic and ROI Analysis

There is minimal assessment of the financial implications of implementing AI solutions. Future studies should conduct detailed cost-benefit and return-on-investment (ROI) analyses to support practical deployment.