HUMAN-CENTERED APPROACHES TO MONITORING SUSTAINABLE AI INFRASTRUCTURE

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ABSTRACT

The rapid integration of Artificial Intelligence (AI) and High-Performance Computing (HPC) into daily life and critical institutions underscores the need for sustainable practices. This research applies human-centered design principles to develop monitoring systems that enhance usability and accessibility for sustainability metrics like energy use and room temperature. By defining user-friendly metrics and proposing design guidelines, the study aims to balance the technical needs of AI/HPC developers with the usability needs of everyday consumers, ensuring sustainability insights are actionable for all stakeholders.

INTRODUCTION

As the environmental impact of AI and HPC infrastructure grows, effective sustainability monitoring is increasingly important. However, existing solutions often fail to engage non-technical stakeholders due to complexity while also lacking the technical precision required by developers. This research addresses this gap by improving how sustainability metrics such as Power Usage Effectiveness (PUE) and carbon emissions are contextualized. By making these metrics more accessible, the study seeks to bridge the divide between granular technical data and intuitive insights, fostering sustainable decision-making in AI and HPC-driven organizations using a human-centered approach.

LITERATURE REVIEW

Recent studies highlight the environmental challenges of AI infrastructure, emphasizing the need for sustainable practices. Research by Raman et al. (2024) and Leuthe et al. (2024) underscores the importance of energy reporting and green AI methodologies. However, current approaches often neglect human-centered design, limiting their accessibility. Pazienza et al. (2024) and Barbierato and Gatti (2024) advocate for user-friendly solutions, aligning with this study's focus on usability and accessibility. This research builds on these insights to explore how sustainability metrics can be effectively communicated to diverse stakeholders. Additionally, empirical research from Vatin et al. (2024) examines the impact of AI use on sustainability metrics, such as a 6% decrease in carbon emissions from industry after utilizing AI metrics for optimization in multiple sectors. This study will help to define the scope of our research and provide a guideline for future development & research.

METHODOLOGY

The research employs a mixed-methods approach, combining qualitative stakeholder consultations, quantitative data analysis to define human-centered sustainability metrics for AI infrastructure, and adherence to regulatory frameworks such as the EU AI Act, the "Do No Significant Harm" (DNSH) Directive, and the United Nations Sustainable Development Goals (UN SDGs). The study begins with an initial stakeholder consultation, engaging AI infrastructure managers, data scientists, sustainability officers, and other relevant stakeholders to understand how current sustainability metrics are perceived and utilized in the field, in order to identify key challenges, gaps, and opportunities for improvement.

Next, the research will leverage a data cluster to ethically collect, clean, and process sustainability-related data. The evaluation will focus on metrics like energy use, carbon emissions, and resource efficiency, ensuring they are both technically robust and meaningful for diverse stakeholders.

Following the data evaluation, a secondary stakeholder consultation will be conducted. This phase will combine the insights from the initial consultation with the results of the data analysis to refine and finalize a set of sustainable AI metrics. The refined metrics will be reviewed and validated in collaboration with the supervisor and stakeholders, ensuring they are practical, actionable, and aligned with human-centered design principles. Finally, the findings will be reported, providing a framework for monitoring sustainable AI infrastructure that balances technical accuracy with user accessibility and regulatory compliance.

EXPECTED RESULT

The study expects to deliver a set of human-centered design principles and guidelines for presenting sustainability metrics in AI infrastructure. These guidelines will address challenges in user understanding and engagement, making metrics like energy use and carbon emissions accessible to both technical and non-technical stakeholders. By focusing on usability and accessibility, the research aims to empower stakeholders to interpret and act on sustainability data effectively, fostering informed decision-making and promoting sustainable practices in AI operations.

CONCLUSION & FUTURE WORK

Future work will explore the implementation of the proposed design principles in real-world AI infrastructure settings, evaluating their impact on user engagement and decision-making. Additional research will investigate how these principles can be adapted for emerging technologies, such as edge computing, decentralized AI systems, and human-robot interaction. Collaboration with industry leaders and policymakers will be pursued to standardize sustainability metrics and promote global adoption. Finally, the study will examine the long-term effects of human-centered monitoring systems on organizational behaviour and environmental outcomes.

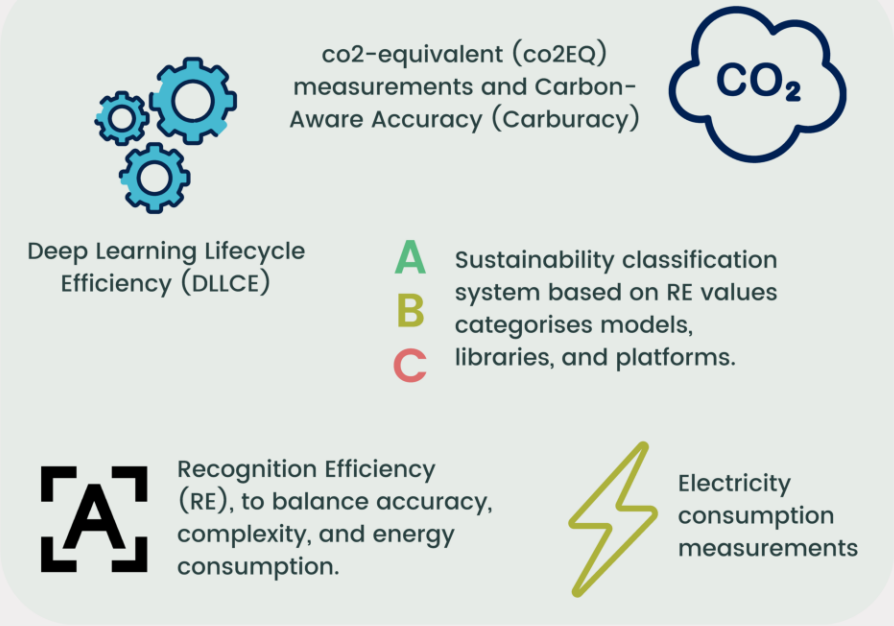

Fig.1. Current Solution

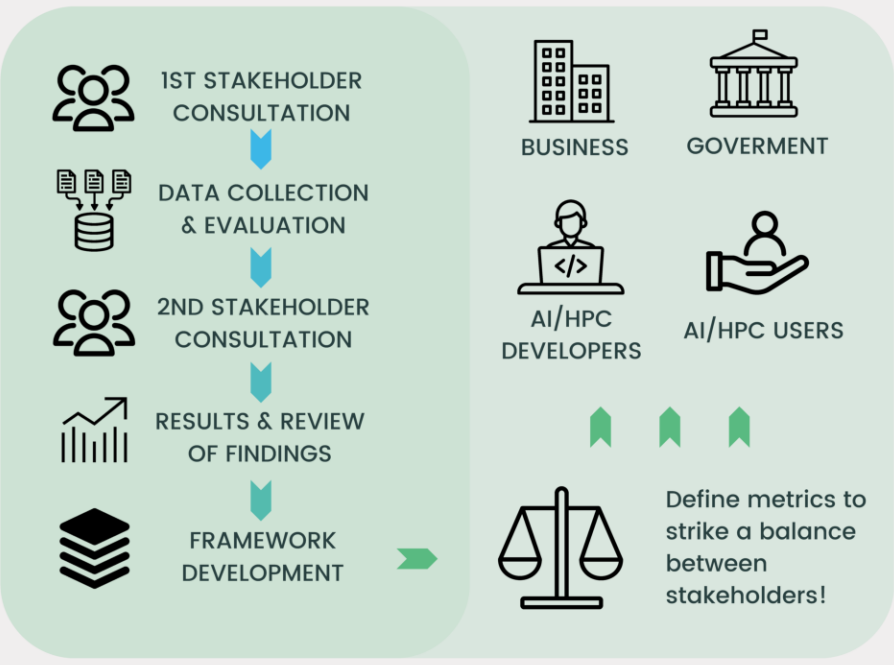

Fig.2. Proposed Solution

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