Environmental Sustainability & the Generative AI Value Chain

Policy Network on AI (PNAI) Workshop

AI and Environment Sub-Group

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Introduction

- Generative AI (Gen-AI) technologies have the potential to enhance efficiencies, but the **environmental burden** often **disproportionately** affects poorer regions that do not benefit equally.

- Decisions around the deployment and regulation of Gen-AI are typically made by high-income countries and large corporations, sidelining marginalized communities. The lack of inclusion in many global climate governance frameworks further perpetuates **multidimensional inequality.**

- Although sustainable AI has emerged to address environmental justice issues associated with AI development, there is limited focus on the **Gen-AI value chain,** specifically for the Global Majority.

- Expanding on research from the 2023 PNAI Report, this discussion paper aims to foster multistakeholder dialogue, emphasizing the need for **policy interventions** to support sustainable practices across the Gen-AI value chain, through case studies and global insights.

Comparing Gen-AI vs. Traditional AI environmental impacts

Aspect	Generative AI (Gen-AI)	Traditional AI	Environmental Applications & Impact
Core Functionality	Creates new content (e.g., images, text, videos) from large datasets.	Analyzes existing data to make predictions, decisions, or classifications.	Gen-AI requires significantly larger datasets and compute power, leading to higher energy consumption and resource use.
Model Complexity	Typically involves larger, more complex models (e.g., GPT, DALL-E).	Uses simpler, task-specific models (e.g., recommendation systems, classifiers).	Larger models require more computational power, leading to greater carbon emissions during training and deployment.
Energy Consumption	High energy demand due to the need for massive GPU/TPU clusters during both training and inference.	Energy consumption varies, often lower, with more efficient task-specific models.	Gen-AI's intensive training processes result in higher carbon footprints, contributing to environmental degradation.
Data Requirements	Requires extensive and diverse datasets for effective model training.	Generally requires smaller, more specific datasets.	Gen-AI's demand for large datasets exacerbates resource extraction for data storage and processing infrastructure.
Deployment Needs	Ongoing compute power needed for real-time generation of new content.	Often requires less real-time computation after deployment.	Gen-AI's continuous content generation uses more energy during deployment, increasing overall carbon emissions.
E-Waste	High due to frequent hardware upgrades and obsolescence, especially in data centers.	Relatively lower, depending on hardware requirements.	The fast turnover of hardware in Gen-AI models contributes to increased electronic waste (e-waste).
Environmental Mitigation Potential	Limited in direct environmental applications but can support creativity in climate awareness.	More practical for operational tasks like optimizing resource efficiency or energy grids.	Traditional AI can be more directly applied in reducing energy consumption, optimizing resources, and monitoring ecosystems.
Sustainability Practices	Largely undeveloped, with limited focus on energy optimization.	Some established practices for energy-efficient algorithms and hardware use.	Traditional AI systems are more likely to incorporate energy-saving mechanisms, while Gen-AI is still evolving in this regard.

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Source: Authors own adapted from various sources

Mapping the Environmental toll of the Gen-AI Value Chain

Computer hardware
Accelerator chips optimized for training and running the models

Cloud platforms
Platforms to provide access to computer hardware

Foundation models
Core models on which generative AI applications can be built

Model hubs and MLOps
Tools to curate, host, fine-tune, or manage the foundation models (FM)(eg, storefronts between applications and FM)

Applications
B2B or B2C products that use foundation models either largely as is or fine-tuned to a particular use case

Services
Services around specialized knowledge on how to leverage generative AI (eg, training, feedback, and reinforcement learning.

Impacts

- Resource strain: critical minerals
- Energy consumption
- Water usage
- Pollution & waste

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Source: Adapted from Harlin et al.,2023

Priorities for Environmental Sustainability & Responsible Global Gen-AI Governance Initiatives

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Source: Adapted from CODES., 2022

Multi-stakeholder Recommendations for Policy Action

Data Governance with an Environmental Focus

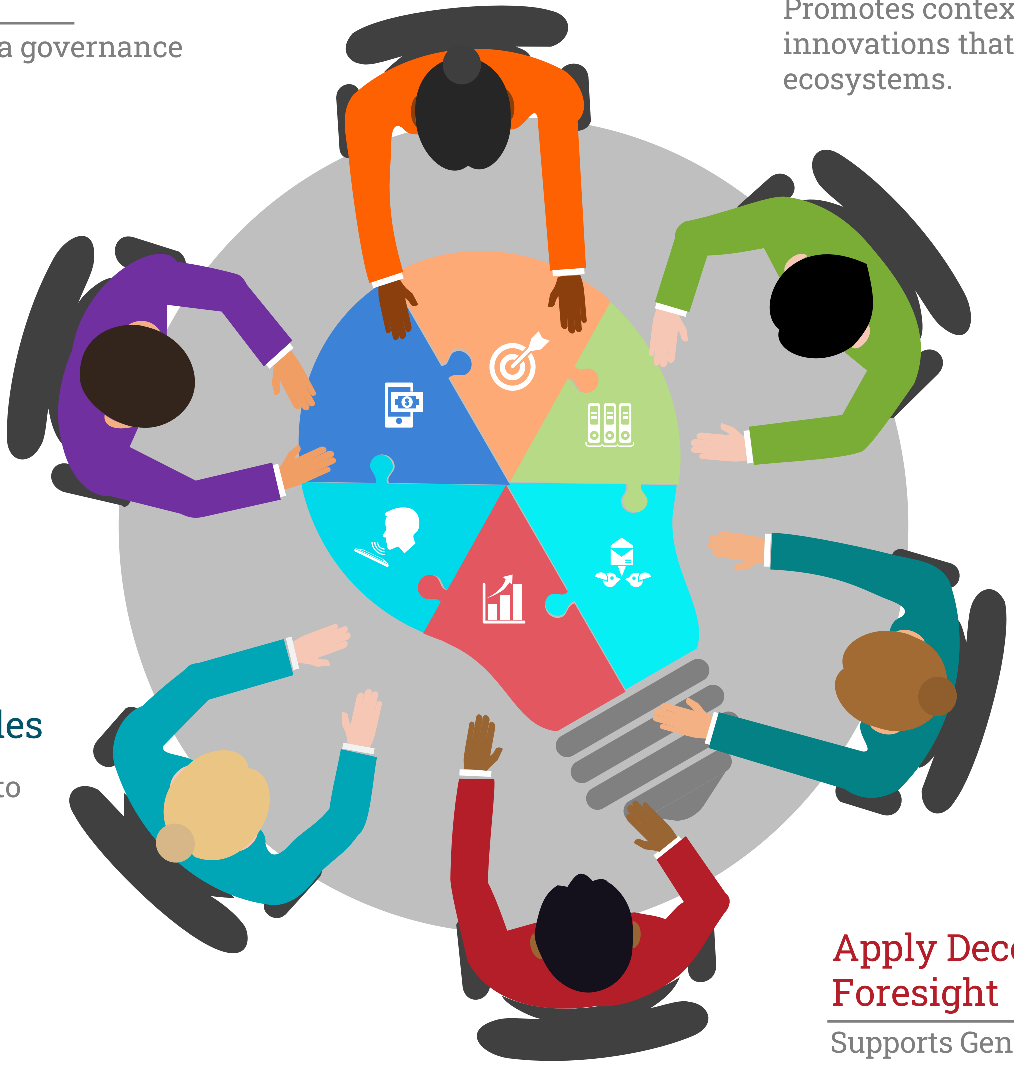
Holistic approach to data governance

Support Regionally Relevant Innovation Ecosystems

Promotes contextually relevant innovations that support sustainable ecosystems.

Strengthen Inclusive Global AI Governance Frameworks

Promotes human rights and sustainable development.



Develop Comprehensive Sustainability Metrics for Gen-AI

Ensures evidence base to support policy interventions

Leverage official development assistance (ODA) for sustainable Gen-AI ecosystems

Improves ownership and sustainability of Gen-AI ecosystems in Global Majority

Integrate Circular Economy Principles

Fosters sustainable and impactful outcomes to reduce e-waste and promotes regenerative practices

Apply Decolonial Socio-Technical Foresight

Supports Gen-AI futures rooted in local socio-technical contexts, promoting autonomy, sustainability, and intergenerational justice.

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Thank You!

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