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Mining for Sustainability: ESG Opportunities in Pakistan's Crypto Landscape

Pakistan has emerged as one of the leading countries globally in cryptocurrency adoption and usage. With plans to formalize the sector through specialized electricity tariffs and the establishment of a regulatory authority, the focus is no longer on whether cryptocurrency should be regulated, but on how its growth may impact Pakistan's already constrained energy resources, rising carbon emissions, and ESG commitments.

Pakistan's Energy Baseline, Emissions Profile, and Bitcoin's Materiality

Pakistan's total annual electricity consumption is approximately **132.32 terawatt-hours (TWh)**, reflecting a power system already under strain from capacity payments, affordability concerns, and supply instability. Within this constrained energy envelope, Bitcoin accounts for an estimated **65.16%** of crypto-related electricity demand associated with Pakistan, making it the dominant source of crypto-related energy intensity.

According to the Cambridge Bitcoin Electricity Consumption Index (CBECI), Pakistan's annual carbon emissions from Bitcoin mining stand at **43.943** million tons of CO₂ (MtCO₂), placing the country **18th** among the world's most polluting economies. This underscores how energy-intensive digital activities can become climatically material for countries with constrained energy systems.

Bitcoin relies on the Proof-of-Work (PoW) consensus mechanism, one of the most energy- and carbon-intensive blockchain systems. When mapped onto Pakistan's fossil-fuel-heavy electricity mix, this creates embedded carbon emissions, increasing risks to climate commitments and energy-sector reform objectives.

Electricity Tariffs, Surplus Power, and Mining Incentives

To make productive use of surplus electricity, Pakistan is designing specialized tariffs to incentivize cryptocurrency

mining and blockchain-based data center operations. The policy objective is to utilize surplus electricity at marginal cost, without direct subsidies, while easing the fiscal burden of capacity payments. Stakeholder consultations are ongoing to design tariffs suitable for emerging digital industries.

Globally, electricity costs represent **60–70%** of Bitcoin miners' operating expenses, making power pricing the primary determinant of mining location decisions. Pakistan's surplus capacity offers a potential comparative advantage provided supply remains stable.

International experience highlights the risks of poorly designed incentives. Bitcoin mining consumes over **130 TWh** of electricity annually worldwide, exceeding the total electricity consumption of several countries. China banned crypto mining due to environmental and energy concerns; Kazakhstan imposed higher tariffs and taxes following shortages; Iran permits mining but frequently suspends operations during peak demand; while El Salvador links mining to geothermal energy to reduce carbon intensity.

These examples demonstrate that electricity pricing alone is insufficient and must be accompanied by environmental and grid-stability safeguards.

Governance and Regulatory Developments

Pakistan has begun strengthening its institutional framework to address crypto-related risks. The Economic Coordination Committee (ECC) approved an **Rs. 800** million Technical Supplementary Grant for the Pakistan Virtual Asset Regulatory Authority (PVARA) to enhance regulatory capacity and develop a formal framework for virtual assets aligned with international standards, including FATF requirements.

PVARA is mandated to oversee the licensing and supervision of digital asset service providers, with a focus on investor protection, AML/CFT risk mitigation, and responsible innovation. This signals growing recognition of virtual assets as part of the formal financial system.

Parallel discussions between the Power Ministry and the Pakistan Crypto Council (PCC) have focused on leveraging surplus electricity for Bitcoin mining. High-level engagement involving financial and regulatory authorities has underscored the need for regulatory clarity, pilot programmes, and alignment with international obligations.

Despite progress, Pakistan currently lacks binding requirements for energy-use disclosure, emissions reporting, or climate risk assessment for crypto mining operations, leaving a significant ESG governance gap.

ESG Implications: Opportunities for Climate and Sustainable Development

AI for Energy Efficiency: “Green AI” can optimize energy consumption in industries, including crypto mining. AI algorithms predict demand, streamline electricity use, and dynamically allocate computing resources, preventing unnecessary energy consumption. Predictive models allow miners to adjust operations during peak or low-demand periods, reducing carbon emissions.

Energy Reporting & Load Management: Pakistan can enhance its grid stability and regulatory oversight by adopting transparent energy reporting, implementing the BC-DETS blockchain consortium framework for decentralized energy trading and demand response, integrating IEEE 2030.5 and IEC 61850 standards for interoperability, leveraging Layer-2 blockchain for secure and scalable transactions, and applying real-time energy allocation models, which simulations indicate can achieve up to 35% efficiency gains and 40% higher demand response participation.

Monitoring and Reducing Carbon Emissions: AI-powered platforms track blockchain carbon footprints in real time, offering actionable strategies like shifting workloads to periods of renewable energy availability. Projects such as Crypto Carbon Rank provide transparency on emissions, enabling developers and users to make greener choices.

Blockchain for Carbon Markets: Blockchain ensures transparency and integrity in carbon credit markets. Platforms like Toucan Protocol and CarbonX tokenize carbon credits, providing tamper-proof, traceable records that prevent double counting and increase market efficiency. Combined with AI, blockchain enables automated verification and accurate monitoring of emission reductions.

Renewable-Powered Crypto Mining: Bitcoin and other PoW networks are increasingly adopting renewable

energy. Mining in regions with surplus solar, wind, or hydro stabilizes grids while reducing fossil fuel reliance. Globally, about 40% of Bitcoin mining now uses renewables, lowering emissions and operational costs.

Energy-Efficient Consensus Mechanisms: Emerging blockchain models such as Proof-of-Stake (PoS) drastically reduce energy consumption. Networks like Ethereum (PoS), Cardano, and Solana demonstrate that smart contracts and dApps can operate efficiently without compromising environmental goals.

Nature-Based and Carbon Offset Solutions: Initiatives like SavePlanetEarth (SPE) use blockchain to support reforestation and afforestation, tokenizing carbon credits linked to these projects. This offsets mining emissions while advancing biodiversity conservation and ecosystem restoration.

Blockchain in Renewable Energy Grids: Blockchain facilitates peer-to-peer energy trading, allowing solar-equipped households and businesses to sell excess energy securely and transparently. Projects such as Power Ledger and LO3 Energy promote renewable adoption, improve grid efficiency, and align energy markets with ESG principles.

Global Carbon Market Integration: Blockchain allows tokenized carbon credits to be traded across borders, enhancing transparency, accountability, and liquidity. This supports international climate agreements and fosters collaboration between governments, corporations, and environmental organizations.

Conclusion

Pakistan’s move to formalize cryptocurrency mining and allocate surplus electricity for digital industries presents both economic opportunity and ESG risk. While leveraging idle power to attract investment and innovation can help diversify the economy, the energy-intensive nature of Bitcoin mining, high electricity demand, and lack of binding emissions or climate-risk disclosure frameworks highlight significant environmental and governance challenges. To align this digital expansion with sustainable development goals, Pakistan must strengthen regulatory oversight, require transparent energy and carbon reporting, and promote cleaner, renewable-linked mining solutions — ensuring that growth in the crypto sector supports rather than undermines the country’s climate and ESG commitments.

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