RESEARCH PAPER

Proof of Work Mining Realities

Publicly available data on Bitcoin's proof of work mining mechanism, its energy profile, and its relationship with renewable energy and grid infrastructure

Rhode Island Bitcoin Policy Initiative | June 2026

This paper compiles publicly available data on Bitcoin's proof of work (PoW) mining mechanism, its energy profile, and its relationship with renewable energy and grid infrastructure. All data points are sourced from government agencies, academic institutions, and verified corporate disclosures. The objective is to provide policymakers with a single reference for the empirical record, separating verified facts from contested or outdated claims.

52.4%	~138 TWh	~0.5%	99.9%
Sustainable energy share (Cambridge, 2025)	Annual network electricity (Cambridge 2025)	Share of global electricity (Cambridge 2025)	Crusoe flare-gas combustion efficiency

1. WHAT IS PROOF OF WORK?

Proof of Work is Bitcoin's consensus mechanism. Miners compete to solve a cryptographic puzzle; the winner adds the next block of transactions to the blockchain, receiving a block subsidy of newly minted Bitcoin plus transaction fees. The mechanism serves three functions:

- **Security.** Attacking or rewriting the transaction history requires controlling more than 50% of global mining power, which would cost an attacker billions of dollars and produce no economic benefit if detected.
- **Decentralization.** Anyone with hardware and electricity can participate. No single entity controls the network.
- **Issuance discipline.** New Bitcoin is distributed through competitive work rather than discretionary issuance, mimicking the production-cost discipline of precious metals.

2. THE ENERGY PROFILE

2.1 Total consumption

The Cambridge Centre for Alternative Finance (CCAF), the most widely cited independent authority on Bitcoin network energy data, estimates total network electricity consumption at approximately 138 TWh annually as of the April 2025 Digital Mining Industry Report. This represents approximately 0.5% of global electricity consumption.

The earlier estimate of ~170 TWh, which appears in older RIBPI materials and external sources, reflects pre-2025 CCAF methodology. The current figure (~138 TWh) reflects revised methodology accounting for hardware efficiency improvements.

2.2 Sustainable energy share

CCAF's April 2025 report places sustainable energy share at 52.4% (42.6% renewables plus 9.8% nuclear), up from approximately 37.6% in 2022. Coal's share has declined from 36.6% in 2022 to 8.9% in 2025. The sustainable energy share has grown at a faster rate than the U.S. electricity grid overall.

Energy Mix	2022	2025	3-Year Change
Sustainable (renewables + nuclear)	37.6%	52.4%	+14.8 pp
Coal	36.6%	8.9%	−27.7 pp
Natural gas	Substantial	Substantial	Roughly stable
Other	Residual	Residual	—

2.3 Hydroelectric is the largest single source

Hydroelectric power is the single largest source for Bitcoin mining globally, accounting for over one-quarter of all network electricity. Major hydroelectric mining regions include the U.S. Pacific Northwest, Quebec, Iceland, and Sichuan (China) prior to that region's mining ban.

3. STRANDED AND WASTE ENERGY MONETIZATION

3.1 Flare gas mitigation

A meaningful share of U.S. mining is co-located with stranded energy sources that would otherwise be wasted. Crusoe Energy's flare gas mitigation program reports combustion efficiency of approximately 99.9% at its co-located mining sites, substantially reducing the methane emissions intensity associated with otherwise vented or flared natural gas. Methane's warming potency is approximately 80 times that of CO2 over a 20-year horizon; flare mitigation has substantial climate value independent of its mining application.

3.2 Curtailed renewables

Solar and wind generation regularly produces electricity in excess of grid demand during specific weather and time-of-day windows. This "curtailed" electricity is typically wasted. Mining co-located with curtailed-prone renewable sites can absorb this surplus generation, improving the economics of

renewable buildout.

4. GRID STABILIZATION THROUGH FLEXIBLE LOAD

Texas's ERCOT grid operator has integrated Bitcoin miners as flexible load ("large flexible load," or LFL). Projected approved LFL capacity reached approximately 9,500 MW by end-2025, up from 5,479 MW the prior year. Miners reduce or shut down operations during peak demand events and absorb surplus generation during low-demand windows.

ERCOT's experience suggests that mining-as-flexible-load is a viable mechanism for grid stabilization. The Public Utility Commission of Texas has published multiple proceedings analyzing the rate impact and stability impact of mining load integration. Rate impact analysis indicates that flexible mining load can reduce rates for non-mining ratepayers by participating in demand response, though specific impacts depend on contract structure.

Why this matters for grid policy

As renewable buildout accelerates, intermittency and curtailment become operational constraints. Mining is one of a small number of demand-response mechanisms operating at megawatt-to-gigawatt scale with sub-hour response time. This is structural infrastructure value, not just an emissions story.

5. WHAT THE DATA DOES NOT SAY

Public discussion of Bitcoin mining energy use frequently misstates the record. This section addresses the most common misconceptions.

5.1 Bitcoin is not the largest single user of electricity

At approximately 0.5% of global electricity, Bitcoin consumes less than household gas-burning appliances (~5% globally), residential air conditioning (~10% globally), and traditional banking infrastructure. Comparisons that claim Bitcoin consumes more electricity than entire G20 countries reflect outdated estimates or confused units.

5.2 Mining is not concentrated in fossil-fuel countries

Following China's 2021 mining ban, U.S. mining share rose to approximately 38–40% of global network hashrate. U.S. mining is disproportionately located in regions with high renewable or nuclear shares (Texas wind/solar, Pacific Northwest hydro, Pennsylvania nuclear).

5.3 Mining is not getting more energy-intensive over time

Per-hash energy intensity has declined approximately 43% per generation of mining hardware. While total network energy use has grown alongside Bitcoin's adoption, energy per unit of security has improved dramatically.

6. POLICY IMPLICATIONS

6.1 Federal regulatory posture

Following the GENIUS Act (P.L. 119-27, signed July 18, 2025), federal policy has shifted from energy-restriction proposals (Senate cryptocurrency mining caps in 2023–2024) toward integration. The Department of Energy's recent assessments treat mining as flexible load infrastructure rather than a regulatory target.

6.2 Rhode Island and New England

Rhode Island's offshore wind buildout creates curtailment dynamics similar to those Texas has used mining to address. ISO-NE periodically experiences negative pricing during high-wind, low-demand windows. Mining co-location at former industrial sites with retained electrical infrastructure could monetize this curtailment.

7. RECOMMENDATIONS

1. Treat mining as flexible-load infrastructure for grid policy purposes, not as a regulatory target.
2. Authorize a joint study by the Office of Energy Resources and the Public Utilities Commission on mining co-location as a curtailment-monetization mechanism for offshore wind.
3. Engage with ISO-NE on demand-response program eligibility for mining-scale flexible loads.
4. Include mining-as-grid-stabilization analysis in the Blockchain Study Commission's mandate (S.2198 Sub A) if enacted.

APPENDIX: SOURCES AND REFERENCES

Energy Data — Primary Sources

- Cambridge Centre for Alternative Finance, Digital Mining Industry Report (April 2025); Cambridge Bitcoin Electricity Consumption Index (CBECI)
- U.S. Energy Information Administration, Bitcoin mining electricity briefs
- International Energy Agency, world electricity consumption data

- Bitcoin Mining Council, quarterly sustainability reports (industry-collected; reads with caution as self-reported)

Grid and Flexible Load

- ERCOT, Large Flexible Load reports (2024–2025)
- Public Utility Commission of Texas, Docket No. 54822 and related LFL proceedings
- Lawrence Berkeley National Laboratory, demand-response research

Industry Disclosures (Treated as Self-Reported)

- Crusoe Energy, methane combustion efficiency disclosures
- Riot Platforms, Inc., 10-K filings and Rockdale site reporting
- Coinmint, Massena facility statements

Federal Policy Context

- GENIUS Act, P.L. 119-27, signed July 18, 2025
- Department of Energy, AI/mining electricity demand assessments
- Federal Reserve, Banking System and Crypto Asset interim guidance

* * *

End of Report