

# Climate Impacts of Bitcoin Mining in the U.S.

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*Opinions regarding the climate impacts of Bitcoin mining deviate fundamentally between scholars and Bitcoin proponents. We validate arguments from both sides and provide empirical evidence that at least 38% of all Bitcoin mining activity has migrated to the U.S. and Canada as of the end of 2022. Furthermore, we show that the carbon emissions caused by the 13 analyzed publicly listed miners in the U.S. alone add up to 7.2 MtCO<sub>2</sub> per annum. At the same time, the financial incentives of the Bitcoin network may, for instance, subsidize the sealing of orphaned wells and thereby reduce methane emissions at scale. The growing transparency on locations and energy sources of large publicly listed Bitcoin miners may help dismantle unsupported industry claims, improve assumption-based academic models, and point regulators to areas where Bitcoin mining may bring climate benefits.*

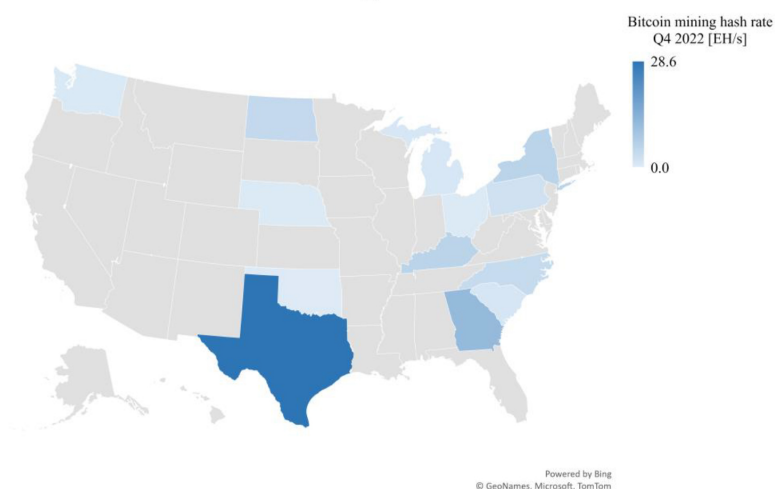
Bitcoin mining is renowned for its energy intensity. As of March 25th, 2023, Bitcoin miners' power demand amounts to 15.4 gigawatts (GW). In the Bitcoin network, so-called miners compete in a computational puzzle to add blocks to the chain and validate coin ownership and transactions included in the blocks. To participate in the process, miners use specialized hardware devices which consume electricity.

And while scholars and Bitcoin proponents agree that miners consume vast amounts of electricity, opinions regarding the climate impacts of Bitcoin mining deviate fundamentally. Critics view Bitcoin's electricity consumption as a calamity, while proponents perceive it as a feature rather than a bug. A growing body of academic studies compares Bitcoin's carbon footprint to the emission levels of mid-sized countries. Concurrently, Bitcoin proponents highlight potential climate benefits from grid balancing services, support of renewable energy expansion, methane emissions reductions via flare gas utilization or sealing of orphaned wells, and use of waste heat from mining hardware for ancillary activities.

Notably, during the winter storm Elliott in North America in December 2022, Bitcoin miners curtailed as much as 100 Exahashes per second (EH/s) – equivalent to 38% of the total Bitcoin network hashrate on that day. This number provides empirical evidence that at least 38% of all Bitcoin mining activity was located in the U.S. and Canada by December 2022.

We validate arguments from both sides and provide empirical evidence for the extent and energy sources of Bitcoin mining in the U.S., based on data from 13 publicly listed mining companies that account for one-fourth of the total network hashrate as of the end of 2022. Using the grid average emission factors, we find that the carbon intensity of electricity consumed by the 13 miners included in our analysis of 397 gCO<sub>2</sub>/kWh is nearly equivalent to the U.S. grid average of 387 gCO<sub>2</sub>/kWh. Furthermore, we find that the annual emissions of 7.2 MtCO<sub>2</sub> caused by the 13 analyzed publicly listed miners in the U.S. alone surpass the carbon emissions of the State of Vermont.

## U.S. Bitcoin mining hash rate distribution



State	Number of mining facilities	Hash rate Q4 2022 [EH/s]
Texas	17	28.6
Georgia	6	11.9
New York	5	5.7
Kentucky	1	5.6
North Dakota	3	4.2
North Carolina	1	3.9
Pennsylvania	3	2.3
South Carolina	1	1.2
Michigan	1	1.1
Washington	1	0.6
Nebraska	1	0.3
Ohio	1	0.3
Oklahoma	1	0.0
<b>Total</b>	<b>42</b>	<b>65.5</b>

Bitcoin miner	Computing power		Power load		Carbon intensity/emissions	
	Q4 2022* [EH/s]	Expansion plans [EH/s]	Q4 2022* [MW]	Expansion plans [MW]	Grid emission factor [gCO <sub>2</sub> /kWh]	Total emissions [ktCO <sub>2</sub> ]
Core Scientific	22.5	31.0	606	1,000	494	2,620
Riot	9.7	12.5	300	387	388	1,021
Marathon	7.0	23.0	245	805	416	893
Cipher Mining	5.2	8.2	173	267	388	589
CleanSpark	6.2	16.0	198	510	309	535
New Hut	3.1	-	135	-	365	432
Stronghold	2.3	3.0	105	138	330	304
Argo Blockchain	2.4	4.1	82	140	388	279
Greenidge	2.4	-	76	-	232	154
BitNile	1.1	2.7	36	91	455	144
Bit Digital	1.2	-	40	-	328	116
TeraWulf	1.9	5.5	50	150	207	90
Bitfarms	0.6	-	20	-	92	16
<b>Total</b>	<b>65.5</b>	<b>106.0</b>	<b>2,067</b>	<b>3,487</b>	<b>397</b>	<b>7,194</b>

\*Or latest available data

**Figure 1: Locations of mining facilities and carbon emissions of mining operations of publicly listed mining companies in the U.S.**

With 17 facilities and a computing power of 28.6 Exahashes per second [EH/s], almost half of the U.S. activities of publicly listed miners are located in Texas. The combined hashrate of publicly listed miners in the U.S. of 65.5 EH/s represents 24% of the total Bitcoin network computing power as of December 31, 2022. It is noteworthy that one company alone – Core Scientific – provides 22.5 EH/s via facilities with 606 MW rated power and that all miners have communicated plans to expand their facilities.

These findings, based on grid average emission factors, stand in contrast to industry claims that the majority (58.9%) of Bitcoin mining is fueled by sustainable energy as the share of non-fossil electricity from renewables (21.5%) and nuclear (18.2%) in the U.S. generation mix is significantly lower. At the same time, we find that the potential climate benefits of Bitcoin mining also warrant closer attention. Financial incentives of the Bitcoin network may, for instance, subsidize the sealing of orphaned and unplugged wells, and thereby, reduce methane emissions at scale.

The growing transparency on locations and energy sources of large publicly listed Bitcoin miners highlights the value of disclosure obligations and may help dismantle unsupported industry claims, improve assumption-based academic models, and point regulators to areas where Bitcoin mining may bring climate co-benefits.



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# References

Stoll C., Klaaßen L., Gallersdörfer U., Neumüller A. (2023) "Climate Impacts of Bitcoin Mining in the U.S." [MIT CEEPR Working Paper 2023-11](#), June 2023.

## About the Authors



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