

# *The Real-World Costs of the Digital Race for Bitcoin*

Bitcoin mines cash in on electricity — by devouring it, selling it, even turning it off — and they cause immense pollution. In many cases, the public pays a price.



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Gabriel J.X. Dance traveled to Texas and North Dakota, interviewed Bitcoin miners, energy experts, scientists and politicians and analyzed thousands of records detailing mining operations for this story.

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Texas was gasping for electricity. Winter Storm Uri had knocked out power plants across the state, leaving tens of thousands of homes in icy darkness. By the end of Feb. 14, 2021, nearly 40 people had died, some from the freezing cold.

Meanwhile, in the husk of a onetime aluminum smelting plant an hour outside of Austin, row upon row of computers were using enough electricity to power about 6,500 homes as they raced to earn Bitcoin, the world's largest cryptocurrency.

The computers were performing trillions of calculations per second, hunting for an elusive combination of numbers that Bitcoin's algorithm would accept. About every 10 minutes, a computer

somewhere guesses correctly and wins a small number of Bitcoins worth, in recent weeks, about \$170,000. Anyone can try, but to make a business of it can require as much electricity as a small city.

In Texas, the computers kept running until just after midnight. Then the state's power grid operator ordered them shut off, under an agreement that allowed it to do so if the system was about to fail. In return, it began paying the Bitcoin company, Bitdeer, an average of \$175,000 an hour to keep the computers offline. Over the next four days, Bitdeer would make more than \$18 million for not operating, from fees ultimately paid by Texans who had endured the storm.

The New York Times has identified 34 such large-scale operations, known as Bitcoin mines, in the United States, all putting immense pressure on the power grid and most finding novel ways to profit from doing so. Their operations can create costs — including higher electricity bills and enormous carbon pollution — for everyone around them, most of whom have nothing to do with Bitcoin.

Until June 2021, most Bitcoin mining was in China. Then it drove out Bitcoin operations, at least for a time, citing their power use among other reasons. The United States quickly became the industry's global leader.

Since then, precisely how much electricity Bitcoin mines are using in America and their effect on energy markets and the environment have been unclear. The Times, using both public and confidential records as well as the results of studies it commissioned, put the most comprehensive estimates to date on the largest operations' power use and the ripple effects of their voracious demand.

Riot Platforms  
Bitdeer  
Austin One dot equals one household  
College Station  
Rockdale GA. ILL. IND. KY. MONT. NEB. N. Y. N. C. N. D. OHIO PA. S. C. TENN. TEXAS  
WASH.  
15 miles



200 feet



200 feet

Pictometry

The computers in these buildings in **Kearney, Neb.**, use about as much electricity as the 73,000 homes around them.

Aerial view showing rows of buildings in a complex that is surrounded by tan bare dirt.

An operation in **Dalton, Ga.**, is using nearly as much power as the surrounding 97,000 households.

Aerial view showing rows of buildings in a lot surrounded by large industrial structures and wooded areas.

And Riot Platforms' mine in **Rockdale, Texas**, uses about the same amount of electricity as the nearest 300,000 homes, making it the most power-intensive Bitcoin mining operation in America.

Aerial view showing rows of industrial-scale buildings in a cleared lot surrounded by a body of water and extensive wooded areas in the distance.

**Riot's** operation is less than a mile away from the **Bitdeer** mine.

Combined, they use more power than all of the households within a 40-mile radius.

HOUSEHOLD DENSITY →

Map shows dots representing the households surrounding Rockdale, Texas, that use an equivalent amount of energy as the Riot Platforms and Bitdeer mines. The households that use an equivalent amount of energy stretch from Austin to College Station.

Each of the **34 operations** The Times identified uses at least 30,000 times as much power as the average U.S. home.

Map shows the locations of major Bitcoin mines in the United States. States with the most mines include Texas, Georgia, New York, Pennsylvania and North Dakota.

Altogether, they consume more than 3,900 megawatts of electricity.

**Circles sized according to power usage**

Map shows bitcoin mines sized according to power usage. The Riot Platforms mine in Rockdale, Texas, uses 450 megawatts per hour.

That is nearly the same amount of electricity as the **three million households** that surround them.

**HOUSEHOLD DENSITY →**

Map shows three million dots surrounding each of the largest Bitcoin mines in the United States, representing households that use an equivalent amount of energy. The Merkle Standard mine in Usk, Wash., uses about the same amount of electricity as the 75,000 households surrounding it.

It is as if another New York City's worth of residences were now drawing on the nation's power supply, The Times found.

In some areas, this has led prices to surge. In Texas, where 10 of the 34 mines are connected to the state's grid, the increased demand has caused electric bills for power customers to rise nearly 5 percent, or \$1.8 billion per year, according to a simulation performed for The Times by the energy research and consulting firm Wood Mackenzie.

The additional power use across the country also causes as much carbon pollution as adding 3.5 million gas-powered cars to America's roads, according to an analysis by WattTime, a nonprofit tech company. Many of the Bitcoin operations promote themselves as environmentally friendly and set up in areas rich with renewable energy, but their power needs are far too great to be satisfied by those sources alone. As a result, they have become a boon for the fossil fuel industry: WattTime found that coal and natural gas plants kick in to meet 85 percent of the demand these Bitcoin operations add to their grids.

Their massive energy consumption combined with their ability to shut off almost instantly allows some companies to save money and make money by deftly pulling the levers of U.S. power markets. They can

avoid fees charged during peak demand, resell their electricity at a premium when prices spike and even be paid for offering to turn off. Other major energy users, like factories and hospitals, cannot reduce their power use as routinely or dramatically without severe consequences.

In some states, notably New York, Pennsylvania and Texas, Bitcoin operators' revenue can ultimately come from other power customers. The clearest example is Texas, where Bitcoin companies are paid by the grid operator for promising to quickly power down if necessary to prevent blackouts. In practice, they rarely are asked to shut down and instead earn additional money while doing exactly what they would have been doing anyway: seeking Bitcoin. Five operations have collectively made at least \$60 million from that program since 2020, records show.

Several of the companies are being paid through these agreements a majority of the time they operate. Most years, they are asked to turn off for only a few hours, at which point they are paid even more.

The windfall for Bitdeer during Winter Storm Uri came through this program, in exchange for a fraction of the power it typically used. The company did not respond to requests for comment. Another Bitcoin company made tens of millions of dollars reselling electricity during the storm — and ultimately stands to earn as much as \$125 million — according to its financial filings, which were previously reported by the [Tech Transparency Project](#). A third company [told investors](#) that another natural disaster like Uri could be a significant business opportunity.

“Ironically, when people are paying the most for their power, or losing it altogether, the miners are making money selling energy back to Texans at rates 100 times what they paid,” said Ed Hirs, who teaches energy economics at the University of Houston and has been critical of the industry.

In interviews and statements, many of the companies said they were no different from other large power users except for their willingness to shut off quickly to benefit the grid. Several objected to the method The Times and WattTime used to estimate their emissions, which calculated the pollution caused by the additional power generated to satisfy the mines’ demand, showing it to overwhelmingly come from fossil fuels.

The companies said this method held them to an unfair standard.

“The analysis cited could be used to attack any industry that consumes power,” said David Fogel, the chief executive of Coinmint, which operates in upstate New York. “I think the entire notion of singling out specific industries like this is unfair.”

But WattTime’s method is the one many energy and climate experts recommend for measuring the environmental effects of increased power use by any industry, particularly one that grows so large so suddenly.

Some in the industry have pushed back against suggestions that it is directly responsible for any environmental harm.

A May 2022 [letter](#) to the Environmental Protection Agency, signed by many of the biggest companies, said their operations “released” no

pollutants. “Bitcoin miners have no emissions whatsoever,” it said. “Associated emissions are a function of electricity generation.”

Nic Carter, a partner at a crypto-focused venture capital firm and a prominent Bitcoin advocate who told *The Times* he was the letter’s primary author, said he was playing a “language game” when he wrote that Bitcoin mining has no emissions. At the time, he said, he felt the industry was being unfairly singled out.

“Maybe the more sincere point is like, we’re already fully aware of the emissions associated with utilities generating grid power,” he said.

Many academics who study the energy industry said Bitcoin mining was undoubtedly having significant environmental effects.

“They’re adding hundreds of megawatts of new demand when we already face the need to rapidly cut fossil power,” said Jesse Jenkins, a Princeton professor who studies electrical grid emissions.

“If you care about climate change,” he added, “then that’s a problem.”

## **Flooding Into America**

Bitcoin, conceived in 2008, introduced most of the world to the concept of cryptocurrencies. Instead of trusting banks to track the value of accounts, the system publishes transactions on a public ledger called a blockchain. Proponents said that cutting out middlemen would free people from financial institutions, government oversight and fees.



So-called mining is a fundamental part of the system: When a computer guesses correctly, it updates the ledger and collects six and a quarter new Bitcoins. Then the guessing game begins again.

Initially, hobbyists could win with personal computers, but as the value of each Bitcoin soared — from under \$1,000 in 2017 to above \$60,000 in 2021 — mining increasingly became an industrial endeavor. (The price has since dropped and, as of publication, was roughly \$28,000.)

The only way for miners to better their odds is to add computing power, which requires more electricity. But as the number of guesses increases, the algorithm makes the game more difficult. This has created an energy arms race.

The mines' scale can draw gasps from people in the power industry. A one-megawatt mine consumes more energy each day than a typical U.S. home does in two years. The electricity coursing through a 100-megawatt operation at a given moment could power about half the homes in Cleveland, according to federal data.

To offset the emissions created each year from the power use of the **Bitdeer mine in Rockdale, Texas**, nearly **12 million trees** would have to be planted and grown for a decade.

1 of 9 [Show another](#)

Aspects of the industry have previously been [reported](#) in news articles and [government](#) and [nonprofit white papers](#), including broad estimates of the environmental effects. But The Times cross-referenced financial disclosures, land records and satellite imagery to create the first national accounting of the biggest operations. The analysis includes mines operating at approximately 40 megawatts or higher, although dozens more exist below that threshold.

Of course, other industries, including metals and plastics manufacturing, also require large amounts of electricity, causing pollution and raising power prices. But Bitcoin mines bring significantly fewer jobs, often employing only a few dozen people once construction is complete, and spur less local economic development.

Their financial benefit flows almost exclusively to their owners and operators. In 2021, the year Bitcoin's price peaked, 20 executives at five publicly traded Bitcoin companies together received nearly \$16 million in salary and over \$630 million in stock options, records show.

The industry has been less profitable since then, as Bitcoin's value has dropped and electricity prices have climbed. Two of the largest United States-based companies have filed for bankruptcy. Still, new mines continue to open across the country

There are ways to operate a cryptocurrency using far less electricity. Last year, Ethereum, the second-most-popular cryptocurrency, reduced the electricity needed to power the network by more than 99 percent by switching its algorithm. Now it rewards people and trusts them to update the ledger because they are willing to put up their own money as collateral, not because they have spent money to power guessing computers, as Bitcoin does.

But Bitcoin advocates oppose changing their algorithm, saying that it has proved resistant to attacks for longer and at a greater scale than any other approach. In practice, they say, the more computers making guesses, the safer the network.



Ninety-two percent of the power demand of the **Genesis Digital Assets mine in Pyote, Texas**, is met by fossil fuel plants, causing **546,000 tons of carbon pollution** each year.

Aerial view showing ten large buildings next to rows of smaller structures surrounded by dirt and sparse plants.

As Bitcoin mining has spread, countries around the world have found that operations strained their power grids. In 2019, China declared the industry “[undesirable](#)” and banned it in 2021. Many operations moved to [Iran](#) and [Kazakhstan](#), which also enacted restrictions.

And shipping pallets piled high with Bitcoin-mining computers [started arriving in America](#), where some states welcomed them in.

## The Land of Coal and Oil

Video



Applied Digital Bitcoin mine in Jamestown, N.D. Credit: Credit... Video by Tim Wallace

Just north of Jamestown, N.D., the land is flat, trees are scarce and, in winter, snow drifts can easily top 10 feet. Even when brisk prairie winds blow, the shrill whine of the fans within Applied Digital's Bitcoin mine can be heard a half-mile away.

They are working to cool more than 30,000 computers, stacked two stories high, stretching for hundreds of feet alongside signs that read "Danger — High Voltage." The radiating heat melts the snow on one side of each of the operation's eight buildings.

The mine has 33 employees and uses nearly 10 times as much electricity as all the homes in the 16,000-person town. It is one of three mines in the state that together consume nearly as much power as every home in North Dakota.

Few other states have been as welcoming to Bitcoin companies. In October 2021, Gov. Doug Burgum presented an [economic development award](#) to local officials and a power provider for bringing

a mine to Grand Forks. Months later, he announced the development of a \$1.9 billion Bitcoin operation in Williston. And last spring, he [flipped](#) a switch at the Jamestown mine's ribbon-cutting ceremony.

The Bitcoin operations' effect on the state's economy is simple, said Josh Teigen, the commerce commissioner: "They are propping up our fossil fuel industry, and that's exactly what we want."

North Dakota has an abundance of lignite, a type of coal primarily used to generate electricity. Mr. Teigen said the state hopes to ultimately capture the carbon from fossil fuel power plants and store it underground, reducing emissions while keeping the coal industry alive.

The state also has a large amount of wind power, which is what attracted Applied Digital, said Wes Cummins, its chief executive.

His company is not alone. Many Bitcoin businesses promote their ability to operate in rural areas where renewable energy is abundant.

But those claims have hit a hard reality: A vast majority of that renewable energy would be used even in the absence of the mines, so fossil fuel plants almost always need to produce additional electricity as a result of their operations.

For example, the Jamestown mine's power demand causes coal or natural gas energy providers to generate electricity more than 90 percent of the time, WattTime found.

Using a technique known as [marginal emissions analysis](#), WattTime examined each mine's location and power use, identified which types of power plants had generated the additional energy needed, and estimated the resulting pollution. That method, and WattTime in

particular, were recommended in a report by the Crypto Climate Accord, an initiative to reduce the industry's carbon footprint supported by more than 200 cryptocurrency companies.

The analysis found that the 34 mines' power use was causing nearly 16.4 million tons of carbon pollution each year.

### **All 34 Bitcoin Mines and the Emissions They Cause**

The nonprofit tech company WattTime used data provided by The Times to calculate how much of the additional electric generation the operations required was met by fossil fuel plants, and the carbon emissions that resulted.

<b>Bitcoin mine</b>	<b>Power</b>	<b>Fossil fuel</b>	<b>Emissions CO2/year</b>
Riot Platforms Rockdale, Texas	450 MW	96%	1,918,000 tons
Atlas Power Williston, N.D.	240 MW	79%	1,043,000 tons
Cipher Mining Odessa, Texas	207 MW	92%	837,000 tons
US Bitcoin Upton County, Texas	200 MW	92%	809,000 tons
Rhodium Enterprises Temple, Texas	185 MW	90%	739,000 tons
Bitdeer Rockdale, Texas	170 MW	96%	725,000 tons
Coinmint Massena, N.Y.	150 MW	72%	457,000 tons
Core Scientific Calvert City, Ky.	150 MW	91%	783,000 tons
Viking Data Centers Akron, Ohio	150 MW	99%	705,000 tons

Bitcoin mine	Power	Fossil fuel	Emissions CO2/year
Core Scientific Dalton, Ga.	142 MW	78%	627,000 tons

Show more

Source: WattTime analysis, New York Times research. Power levels are as of March 9 and based on information from each company or its most recent prior public statement. Fossil fuel percentages do not include energy imported from other states, the type of which is unknown; that results in low numbers for the Merkle Standard mine in Usk, Wash., and the Atlas Power mine in Butte, Mont.

“I’m very surprised,” Mr. Cummins said, when told the estimates for Applied Digital’s Jamestown operation. He said his operation uses the electricity that is available on the grid and cannot control whether it comes from clean or dirty sources, which is affected by all customers’ demand. The miners generally prefer calculating emissions based on that mix of power.

Using that method, WattTime estimated that they consume 54 percent fossil fuel-generated power, resulting in nearly 10.4 million tons of carbon.

Lee Bratcher, president of the Texas Blockchain Council, a Bitcoin lobbying group, said in an email that the industry incentivizes the development of new renewable and natural gas plants. But power industry experts say that while some current wind farms may be benefiting modestly, renewable generation takes years to build and usually requires commitments from customers who can guarantee that they will buy power for a decade or more.

According to Dr. Jenkins at Princeton, the Bitcoin operations’ near-constant power demand is more likely to keep fossil fuel plants in business than to lead to more renewable energy.



Ninety-nine percent of the power demand of the **Stronghold Digital Mining operation in Nesquehoning, Pa.**, is met by fossil fuel plants, causing **192,000 tons of carbon pollution** each year.

Aerial view showing rows of buildings within three cleared areas surrounded by green grass and trees.

This proved true in upstate New York, where a gas-powered plant reopened and now powers a Bitcoin mine. Three other large operations are run by companies that also own the fossil fuel plants where they operate, including two burning waste coal in Pennsylvania.

Some of the Bitcoin companies that WattTime found to be causing the most pollution have held themselves out as supporting renewables.

For example, Riot Platforms' chief executive described Bitcoin mining as "uniquely beneficial and supportive of renewable energy." Ninety-



six percent of the power demand added by the company's mine was met by fossil fuels, the WattTime analysis showed.

## **Bitcoin Miners' Power Play**

Mining Bitcoin produces steady revenue, but using so much electricity can also be a business model.

Moments of extreme weather provide especially stark examples. Take June 23, 2022 — the eighth straight day of near-100-degree temperatures around Austin, which allowed Riot Platforms to demonstrate several ways they can turn electricity into money.

Like many industrial buyers, the company had prepurchased its power at a fraction of the price available to residential customers. Riot's mine runs at 450 megawatts — the largest in the country.

Each day that June, its computers' guesses were winning Bitcoin worth an average of about \$342,000. But the company had two additional ways to improve its profit margins.

First, it had signed up for the Responsive Reserve Service, a Texas power grid program that offers a way to quickly reduce strain if the grid becomes overloaded, acting as insurance against blackouts. The program pays miners, and other companies, for promising to stop using electricity upon request. In reality, they are rarely asked to shut down, but are still paid for making the pledge.

From midnight to nearly 4 p.m. on June 23, Riot earned more than \$42,000 from the program while continuing to mine Bitcoin. (Overall in 2022, Riot made nearly \$9.3 million from participating in the program nearly 85 percent of the time, the data shows, though the grid

operator asked companies to actually lower their use for about 3.5 hours.)

Around that time, the company switched to the second technique: avoiding fees that Texas charges to maintain and strengthen the power grid. It did so by briefly shutting off almost completely.

To incentivize big customers to conserve electricity, those fees are based on how much electricity they use during several peak summer moments. Riot reduced its power use by more than 99 percent.

By 6:30 p.m., the company had resumed mining. If Riot had been fully operating all day, it would have incurred an estimated \$5.5 million in fees — costs that are largely made up by other Texans. Over the course of the year, this saved Riot more than \$27 million in potential fees.

The company's actions were described in data published by the Texas grid operator, the Electric Reliability Council of Texas, or ERCOT. Though the records refer to power suppliers by pseudonyms, The Times was able to identify six of the 10 Texas operations in the data.

One final mechanism lets some companies make extra money when electricity prices spike: They can stop mining and resell electricity to other customers. That earned Riot roughly \$18 million last year.

From Bitcoin mining, the company earned \$156.9 million last year.

Five of the six Texas mines in the power grid data participate in the Responsive Reserve program. All six chose to turn off nearly every time fees were assessed in 2022, saving an estimated \$62 million in fees.

When asked whether Bitcoin companies are disproportionately able to take advantage of both programs, ERCOT said in a statement that it “does not discriminate based on the type or activity” of the companies that sign up.



Ninety-two percent of the power demand of the **Core Scientific mine in Denton, Texas**, is met by fossil fuel plants, causing **501,000 tons of carbon pollution** each year. Aerial view showing a building complex with rows of large structures surrounded by brown ground and green plants.

It is not unusual for companies in Texas to be able to anticipate moments when fees will be assessed and to reduce their demand, but unlike Bitcoin miners, most can stop using on average 5 percent to 30 percent of their electricity, industry consultants say.

In a statement, Riot said it reducing its power load helped all power customers.

“The company’s decision to actively reduce its load during anticipated times of peak demand adds to grid reliability and ultimately helps to reduce peak power prices,” the statement said.

Mr. Bratcher of the Texas Blockchain Council said the benefits outweigh the cost.

“In addition to providing jobs and positive economic impact, Bitcoin miners turn off when power prices rise and that power is then available for commercial and residential users,” he said.

Others say the companies are capitalizing on weaknesses in programs designed for very different industries.

“I think they’re exploiting the system,” said Severin Bornstein, a professor at the University of California, Berkeley, who studies electricity pricing. “But they will say, ‘You know, the system was already there,’ and I’m sympathetic to that in some ways.”

After accounting for the savings and revenue from each of the strategies, Riot told investors its electricity cost in 2022 was 2.96 cents per kilowatt-hour.

By comparison, the average price for other industrial businesses in Texas was 7.2 cents. For residents, it was 13.5 cents.

## **‘Texas Will Be the Crypto Leader’**

These opportunities have led some of the country’s largest Bitcoin operations to choose Texas.

Houston San Antonio Dallas Austin El Paso Amarillo Midland TEXAS

The 10 Texas mines identified by The Times use more than 1,800 megawatts of energy combined, forcing more expensive power generators to run.

#### **Circles sized according to energy usage**

Map shows Bitcoin mines in Texas. About half of the mines are in West Texas near Midland.

That has increased power bills in the state by \$1.8 billion a year, according to the Wood Mackenzie simulation.

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#### **Increase in total electricity costs by region**

Map shows the increase in total power bill costs by region due to Bitcoin mines' electricity demand. In the North Central region, total power bill costs increased by 592 million dollars.

In West Texas, where several Bitcoin mines have settled, bills have increased by nearly 9 percent.

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#### **Percentage increase by region**

Map shows the percentage increase in power bills by region, with the highest increase of nearly 9 percent in West Texas.

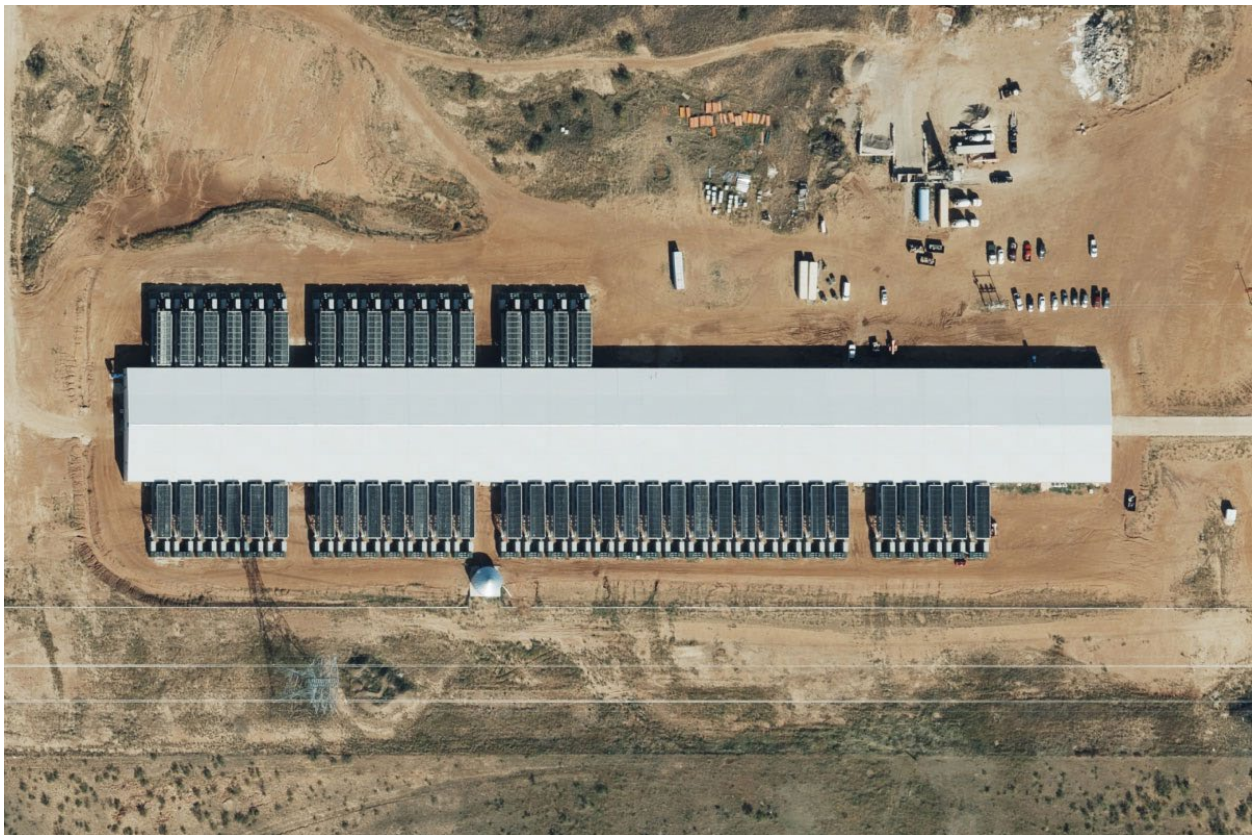
“It’s a massive financial burden to Texans,” said Ben Hertz-Shargel, who leads grid-related research at Wood Mackenzie, and was part of the team that conducted the market-based simulation for The Times based on historical ERCOT data. Because of how the Texas market operates, the increases are steepest for residential customers, said Mr. Hertz-Shargel, who has previously criticized Bitcoin’s dependence on electricity as “inessential.”

Others say increased prices will incentivize the development of cheaper types of power generation.

“Expanding Texas generation is crucial, and allowing different energy sources to compete in the market will help drive down prices,” said Gideon Powell, chief executive at Cholla, an energy exploration company in Texas that is developing Bitcoin mines.

As of last month, ERCOT had approved plans to connect an additional [4,000 megawatts](#) of Bitcoin operations this year, which would nearly triple their consumption in Texas.

In Congress, Democrats have called for a precise inventory of operations' power use and resulting emissions. Republicans have largely supported the industry, including by introducing a congressional resolution last month affirming its importance to the country's energy goals and economy.



Ninety-two percent of the power demand of the **Galaxy mine in Afton, Texas**, is met by fossil fuel plants, causing **400,000 tons of carbon pollution** each year.

Aerial view showing a large building with a white roof and rows of attached rectangular structures surrounded by dirt.

And in Texas, the companies have powerful allies. Gov. Greg Abbott said in a [tweet](#) that “Texas will be the crypto leader” and [hosted](#) the Texas Blockchain Council at the governor’s mansion. The grid’s former interim chief executive declared himself “pro Bitcoin,” and the current vice chair of the grid’s board is a former adviser to the Texas Blockchain Council. Still, in March, three Republican state senators joined in [sponsoring a bill](#) that would restrict tax breaks for miners and place strict limits on their participation in programs like the Responsive Reserve.

In Rockdale, where two of the largest mines in the country operate just outside the city limits, the city manager, Barbara Holly, told The Times that the town used to be “a fairly wealthy little community.” She said that changed when a large industrial plant that had provided thousands of jobs closed more than a decade ago. “It just cut the legs out from under this community,” she said.

It was the old aluminum smelter, now home to the Bitdeer mine.

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