Networks

Course blog for INFO 2040/CS 2850/Econ 2040/SOC 2090

Stabilizing the Texas Power Grid: An Explanation of the Nash Equilibriums between ERCOT & Texas Bitcoin Miners

Recently, popular media has heavily criticized bitcoin miners and their energy consumption, especially after the Biden administration published a report titled "Climate and Energy Implications of Crypto-Assets in the United States." However, I would like to present an alternative view, highlighting the value of bitcoin miners and how their power demand is critical to stabilizing power grids.

Context:

Texas provides a particularly interesting example to examine the relationship between bitcoin miners and power grids and the resulting Nash Equilibriums. In Texas, 90% of power comes from an independent power grid controlled by ERCOT, The Electric Reliability Council of Texas; however, the rest of the US receives power from either the Western or Eastern Interconnection power grids.

Key Numbers:

- Texas Power Grid Available Generation Capacity: **85 GW**
- Bitcoin (BTC) Miner Consumption: **1.5-2GW**
- City of Houston Consumption: **5-6 GW**
- Total Bitcoin Energy Consumption Globally: **15 GW**

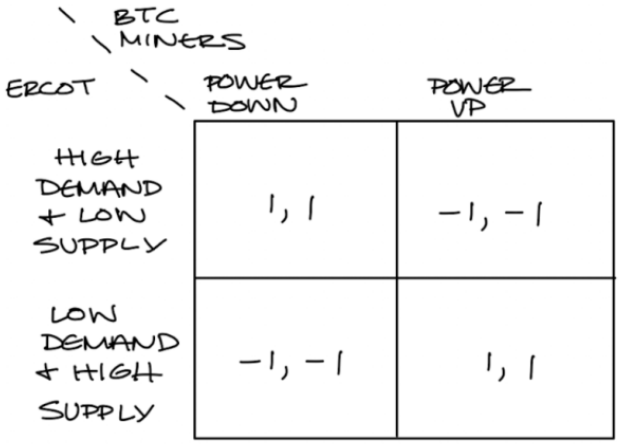
Essentially, through bitcoin miners, a power demand equal to ⅓ of the power demand from the entire city of Houston, 4th largest city in the US, can be shut off in 10 minutes, AND miners are more than willing to comply. The relationship between ERCOT and bitcoin miners is mutually beneficial. Imagine the inefficiency and how unethical it would be for ERCOT to curtail power for 784,788 (2,378,146 *.33) Houstonians. In times of crisis, efficiency is key. Bitcoin miners provide a flexible load in a way no other industrial use case can.

Figure 2 - Interruptibility: Bitcoin Miner vs. Data Center vs. Steel Plant

	Cost of reacting	Reaction time	Availability	Granularity
Bitcoin miner	Low	Quick	High	High
Data center	High	Quick	High	Moderate
Steel plant	Moderate	Slow	Low	Low

Source: Arcane Research

Examining the Relationship:



While I believe bitcoin miners do act with the good of others in mind, the financial incentives and their relationship with ERCOT result in two Nash Equilibrium sustaining this relationship. The Nash Equilibrium are: (LS, PD) & (HS, PU).

- LS = Low Supply (& High Demand)
- HS = High Supply (& Low Demand)
- PD = Power Down
- PU = Power Up

Players:

- ERCOT
- BTC Miners (Riot Blockchain, Rhodium Enterprises, Marathon Digital, Individuals, etc.)

Payoffs:

- ERCOT: Degree to which they can successfully maintain an equilibrium of supply and demand of power (mandate fulfillment payoff); maximize the extent to which they can sell power without over-stressing the grid (profit payoff).
- BTC Miners: The cheaper the energy, the more they will consume and the more BTC they can mine, increasing their odds of winning a block reward (BTC payoff); Incentivized to shut down when the power grid is experiencing high demand (cash/credit payoff).

Strategies:

- ERCOT:
  - High Demand For Power & Low Supply (LS):
    - Pay bitcoin miners even "a penny more than they would have made from mining in any given hour, [and] they'll gladly power down." Within 10 minutes, operators at ERCOT are in a much better position to maintain equilibrium and continue supporting the 26~ million Texans who rely on ERCOT.
  - Low Demand for Power & High Supply (HS):
    - When power is going unused and the prices are low, ERCOT can sell the surplus to bitcoin miners, buyers of first and last resort. While the prices are still low, bitcoin miners will power up. Then, they will proportionally reduce demand and power down as prices rise and steady out.

- BTC Miners:
  - Power Down (PD):
    - This past February, when a winter storm headed for Houston, Riot Blockchain "decreased [their] power consumption by 98%-99%." Furthermore, during a brownout in Texas this past summer, Riot Blockchain earned "9.5 million dollars in power credits to be credited against their future power invoices," which, in July, was about "439 BTC" and equal to or more than what they otherwise would have earned.
  - Power Up (PU):
    - Bitcoin miners cannot mine bitcoin without power, so when prices are low, sometimes even negative, miners are eager to power up and "'soak up" some of that…power" until "the cost of electricity gets slightly higher than what they're willing to pay for it (around $100)."

Nash Equilibrium

- 1. ERCOT experiencing high demand and low supply; BTC miners power down (LS, PD).
  - ERCOT restores equilibrium between supply and demand, avoiding grid overload. BTC miners receive power credits and second-order benefits such as respect for their moral actions.
- 2. ERCOT experiencing low demand and high supply; BTC miners power up (HS, PU).
  - ERCOT restores equilibrium between supply and demand, avoiding grid under-usage and lost profits. BTC miners use and get more, cheaper, and otherwise wasted power until prices level out.

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