Off-Grid Renewable Energy Crypto Mining Analysis

Nate Houston | November 18, 2024 | natewellmanhouston@gmail.com

Can you build an off-grid solar farm in rural Texas, plug in a bunch of GPUs, and mine bitcoin like hell while the sun shines? Here is an analysis.

A Pure-DC Solar + Starlink + Compute Setup I Made in Oregon (Added + Updated Feb 2026)

This analysis is split into 5 parts:

1. Revenue-per-unit-energy analysis of crypto mining approaches
2. Econo-physics of Installing Solar
3. Total system-wide costs
4. Sample Calculation & Conclusion

Profitability of Mining Cryptocurrency

First, I need to get a ballpark estimate of what GPUs or ASICs are used in bitcoin mining, and what their $/kWh are. I'll also assume that the farm initially will be all aftermarket compute machines, with a preference for GPU>ASICs so that the farm can be repurposed for non-crypto applications. I'll also assume we can purchase used compute devices to reduce upfront cost.

Some datapoints:

- Ndivia RTX 4090 @ $0.21/kWh
- Aleo Mining on GeForce RTX 4080 Super for $1.07/day @ 210W => $0.212/kWh
- NVIDIA Tesla A100 for $0.91/day @ 200W => $0.19/kWh
- BITMAIN AntMiner L9 (16Gh) for $59.03/day @ 3360W => $0.73/kWh
- ElphaPex DG 1+ for $63.00/day @ 3920W =>$0.67/kWh

So it appears ASIC miners (the last two) are about 3.5x more profitable per unit-energy than GPUs, and among ASIC and GPU classes, prices are pretty constant, even after surfing around multiple websites and looking at multiple GPU/ASICs. For the rest of the analysis I'll call this **$0.20/kWh** for GPU and **$0.70/kWh** for ASIC

Features of Installed Solar
Installed solar capacity is dropping rapidly, but a competitive rate for a medium/large off-grid farm could be on the order of **$0.50/Watt** (here's an article that agrees with this assumption; actually it would consider this estimate very conservative)

Global Solar Atlas suggests some land in Texas can do **2484kWh/m^2/year** in Global Tilted Irradiance (GTI), which means a non-orientation-controlled panel farm can do that. Multiple by typical panel efficiency of 0.2 and we get **497kWh/m^2/year**

Total System-Wide Costs
Cost of Land

A few reddit threads suggest wasteland in Texas with no aquifers underneath can be as low as **$300/acre**

Cost of Solar

Solar is $0.50/Watt, and solar irradiance on earth's surface is 1000W/m^2 with typical panel efficiencies of 20%, so 1m^2 costs:

(1000W/m^2)(20% efficiency)($0.50/Watt) = **$100/m^2**
(Or on a power basis, $0.50/Watt, as mentioned above)

Cost of GPUs

An RTX 4090 is ~$2k new, and does ~200W. Say it is is half-off (used), which comes out to:
($2000/200W)(50% used-discount) = **$5/watt (GPU)**
A Bitmain AntMiner L9 is ~$10k new, and does ~3500W. At half off, that's:
($10k / 3500W) (50% used-discount) = **$1.42/watt (ASIC)**

IE, GPUs are 10x more expensive per watt than solar panels; so compute cost is the most important factor to optimize)

Sample Calculation
Now we have all the information we need to calculate the business-case for an off-grid solar-powered crypto farm. Say 1km^2, since this is motherf%$*in Texas so you Go Big or Go Home

Installed Capacity of Solar:
1E6m^2 * (1000W/m^2) (20% panel efficiency) = **200MW**

Cost of 1km^2 of land:
1km^2 * (247 acre / 1km^2) ($300 / acre) = **$75,000**

Cost of 1km^2 of solar:
(200MW) (1E6W/MW) ($0.50/W) = **$100M**

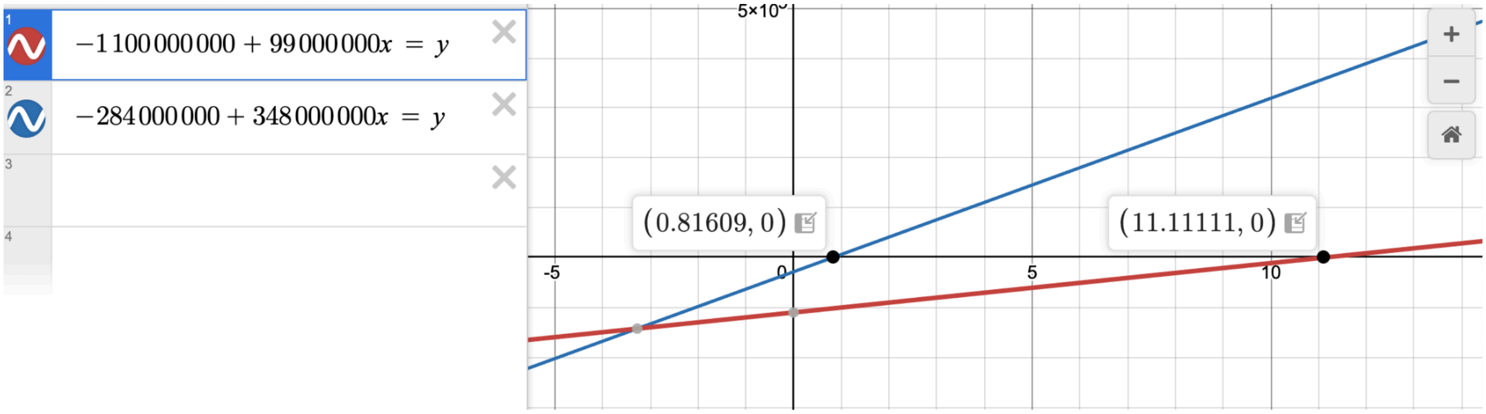
Energy generated by 1km^2 of solar:
(2484kWh/m^2/year) (1E6m^2)(20% panel efficiency) = **497 GWh/year**

Cost of GPUs or ASICs needed to serve 200MW of power (*divide peak-solar production by $/watt of compute*):
GPU: (200MW) (1E6W/MW) ($5/watt) = **$1B**
ASIC: (200MW) (1E6W/MW) ($1.42/watt) = **$284M**

Revenue/year from $1B GPUs or $284M ASICs:

GPU: (497GWh/year) * (1,000,000kWh/GWh) ($0.20/kWh) = **$99M**
ASIC: (497GWh/year) * (1,000,000kWh/GWh) ($0.70/kWh) = **$348M**

PNL Graph (ignoring TVM) of ASIC (Blue) and GPU (Red) Farms



Y-axis is revenue/loss, x-axis is time. Both trajectories start negative, at $-1.1B and $-284M. The GPU trajectory (red) breaks even at 11.1 years. The ASIC case breaks even much sooner, at 0.81 years.

That is actually a legitimate business opportunity. Pays for itself in under a year with ASICs!