CASTLE ISLAND
VENTURES

Bitcoin Mining in Texas

Texas Blockchain Summit • 10/08/2021

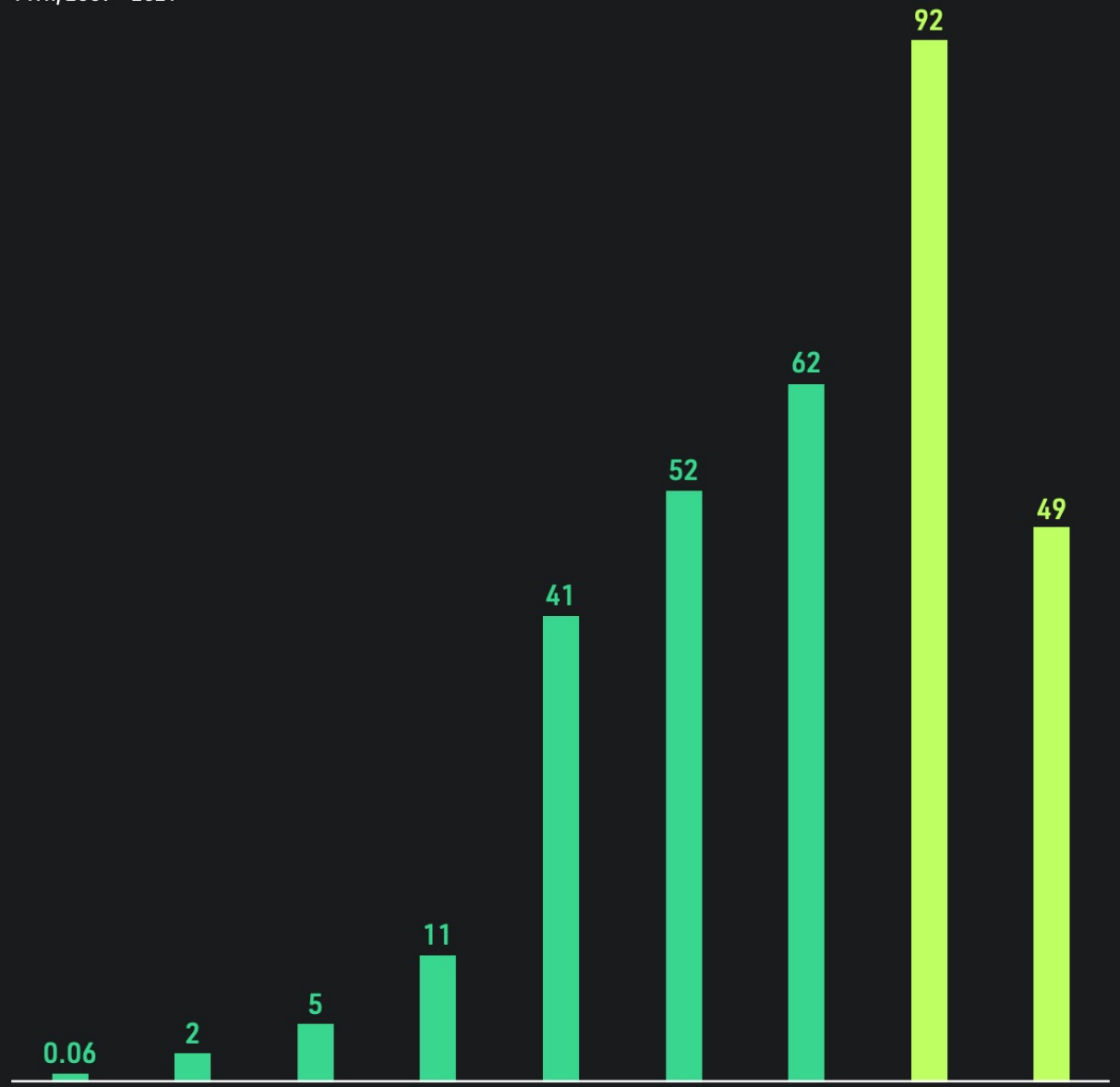
About me

- Invest in blockchain startups at Castle Island VC
- Advisor to the Square Bitcoin Clean Energy Initiative
- Coauthor of 'Bitcoin Net Zero' with Ross Stevens & NYDIG

CASTLE ISLAND VENTURES

BITCOIN CLEAN ENERGY INITIATIVE

CHART 11:
Annual electricity consumption of Bitcoin mining
TWh, 2009 – 2021



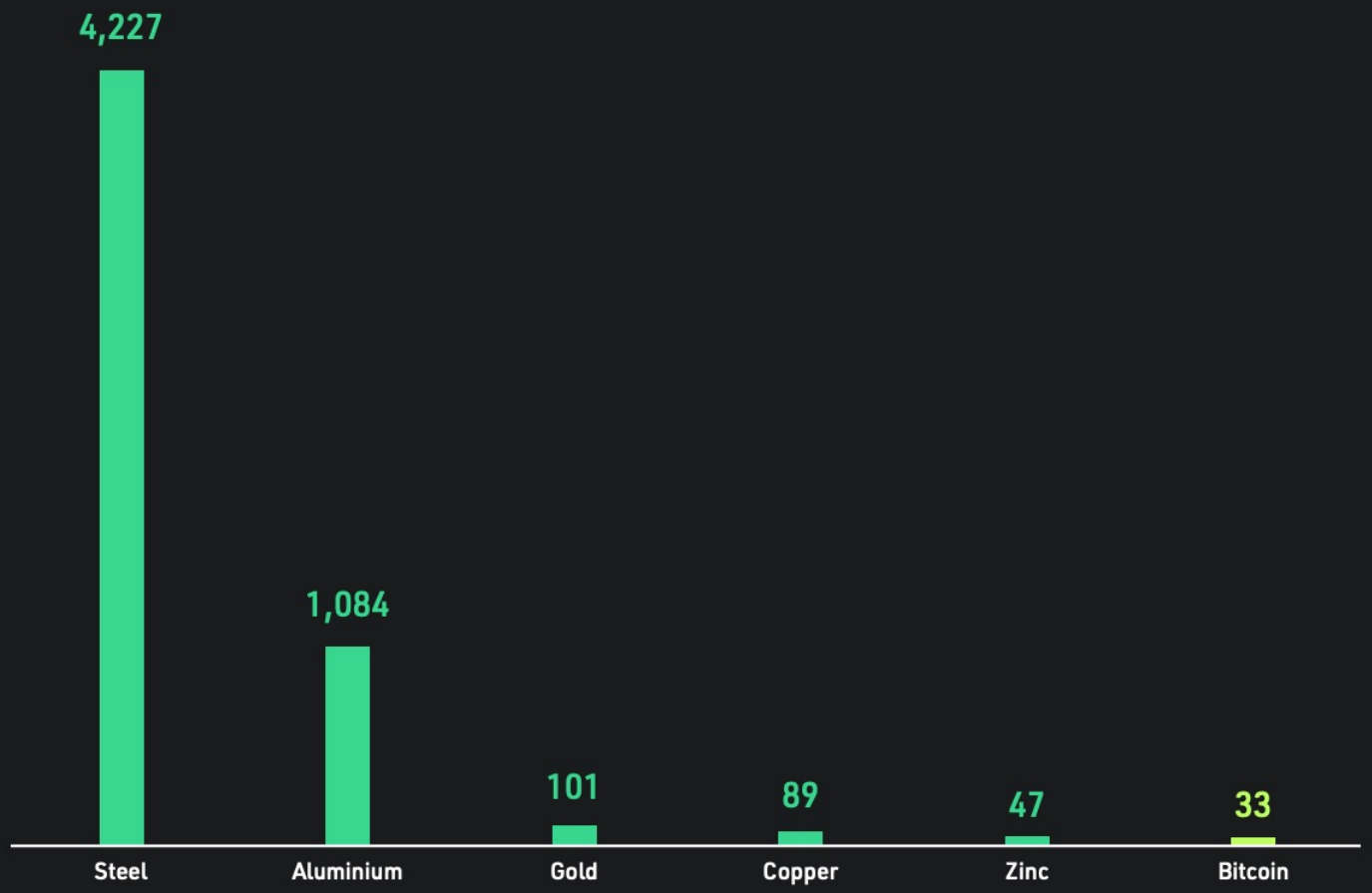
Source: Bitcoin Net Zero, NYDIG

Bitcoin mining by the numbers

Bitcoin mining accounts for ~100 TWh annualized electricity consumption

Its 2020 consumption is equivalent to **0.04 percent** of global primary energy consumption and **0.2 percent** of global electricity generation

CHART 16:
Carbon emissions of Bitcoin mining versus major mined products and steel production
$MtCO_2e$, 2020



Sources: London Metal Exchange, Coindesk, Fitch, NYDIG analysis

Source: Bitcoin Net Zero, NYDIG

Bitcoin mining by the numbers

The estimated emissions of Bitcoin mining compare to those associated with zinc extraction

Unlike physical metal extraction, Bitcoin mining can be rendered **fully renewable**

Forget ‘digital gold’. Think *digital aluminum*

Bitcoin mining market recap

HOMETOWN › BRAZOS COUNTY

New developments made in bitcoin mining companies located in decommissioned Alcoa power plant [Source]

Whinstone facility in Rockdale, TX

Riot Blockchain

Coinmint facility in Massena, NY

Trustnodes (link)

An old Alcoa plant in Upstate New York is going to be converted into one of the world’s largest bitcoin mining centers

PUBLISHED TUE, JUN 5 2018•4:42 PM EDT | UPDATED TUE, JUN 5 2018•8:11 PM EDT

Kate Rooney
@KROONEY

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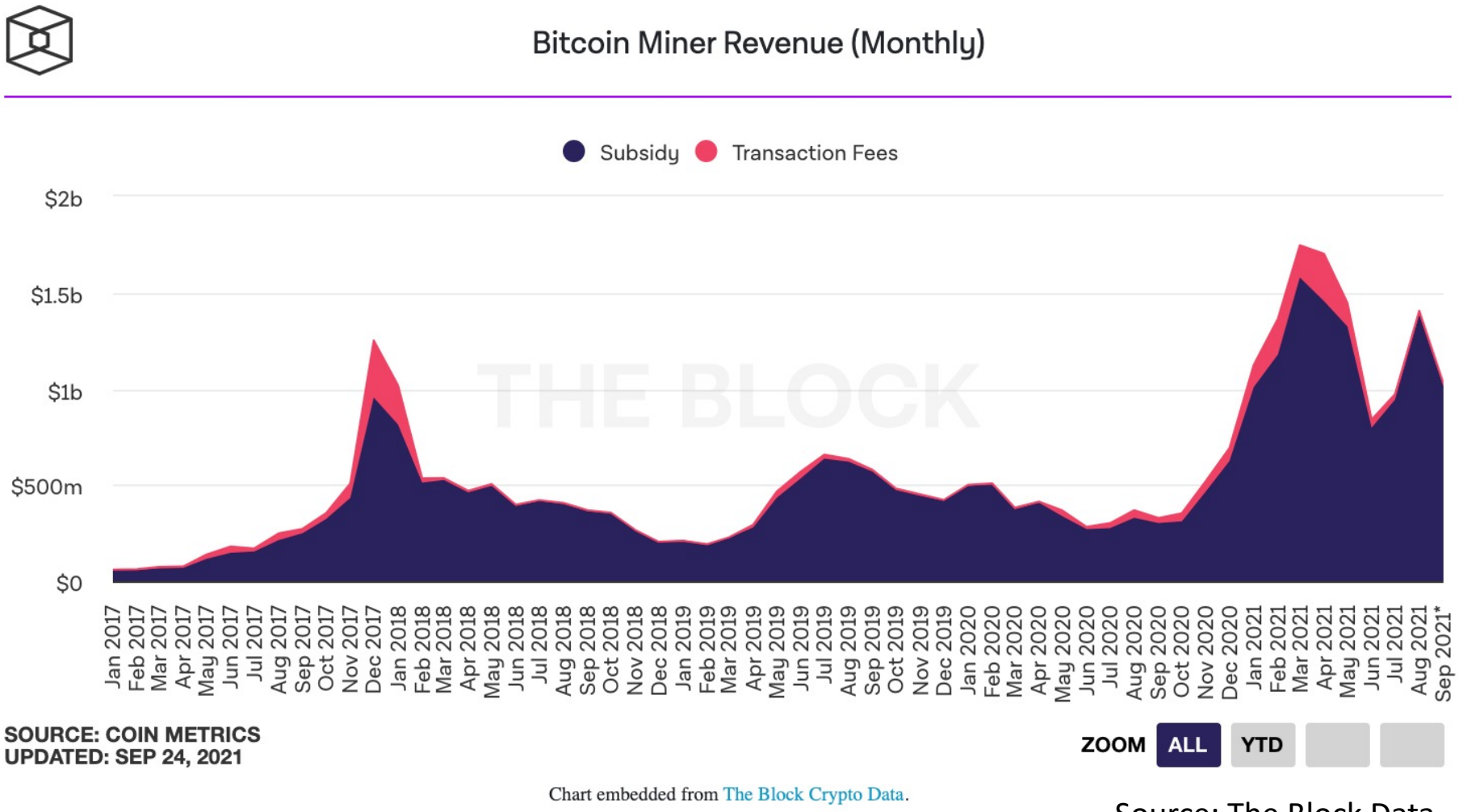
Bitcoin mining market recap

Bitcoin mining is a $15b/year industry

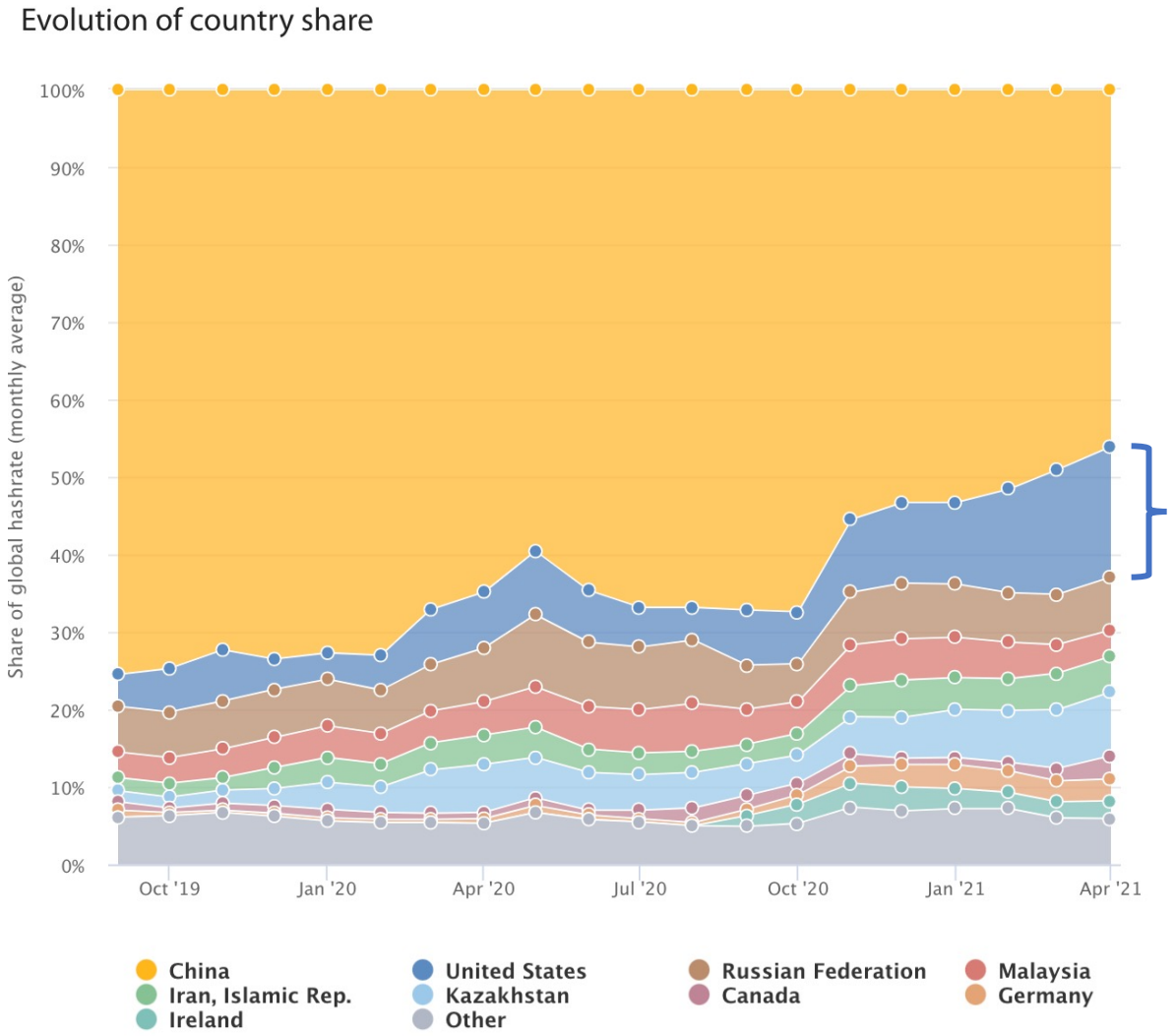


Ethereum mining adds another $17b/year of miner rewards, not to mention other up and coming ‘mineable’ coins

Source: The Block Data

Bitcoin mining is rapidly becoming a U.S. industry

Bitcoin mining market recap



USA share, Apr. 2021

- Vast majority of new ASIC deliveries are headed to the U.S.
- U.S. accounts for a plurality of Bitcoin mining due to massive public market appetite for miners & low cost of capital
- Today, USA hashrate is estimated at 1/3 of total

Source: Cambridge Center for Alternative Finance (Link)

Bitcoin mining market recap

BTC mining will be huge in the U.S. – and TX

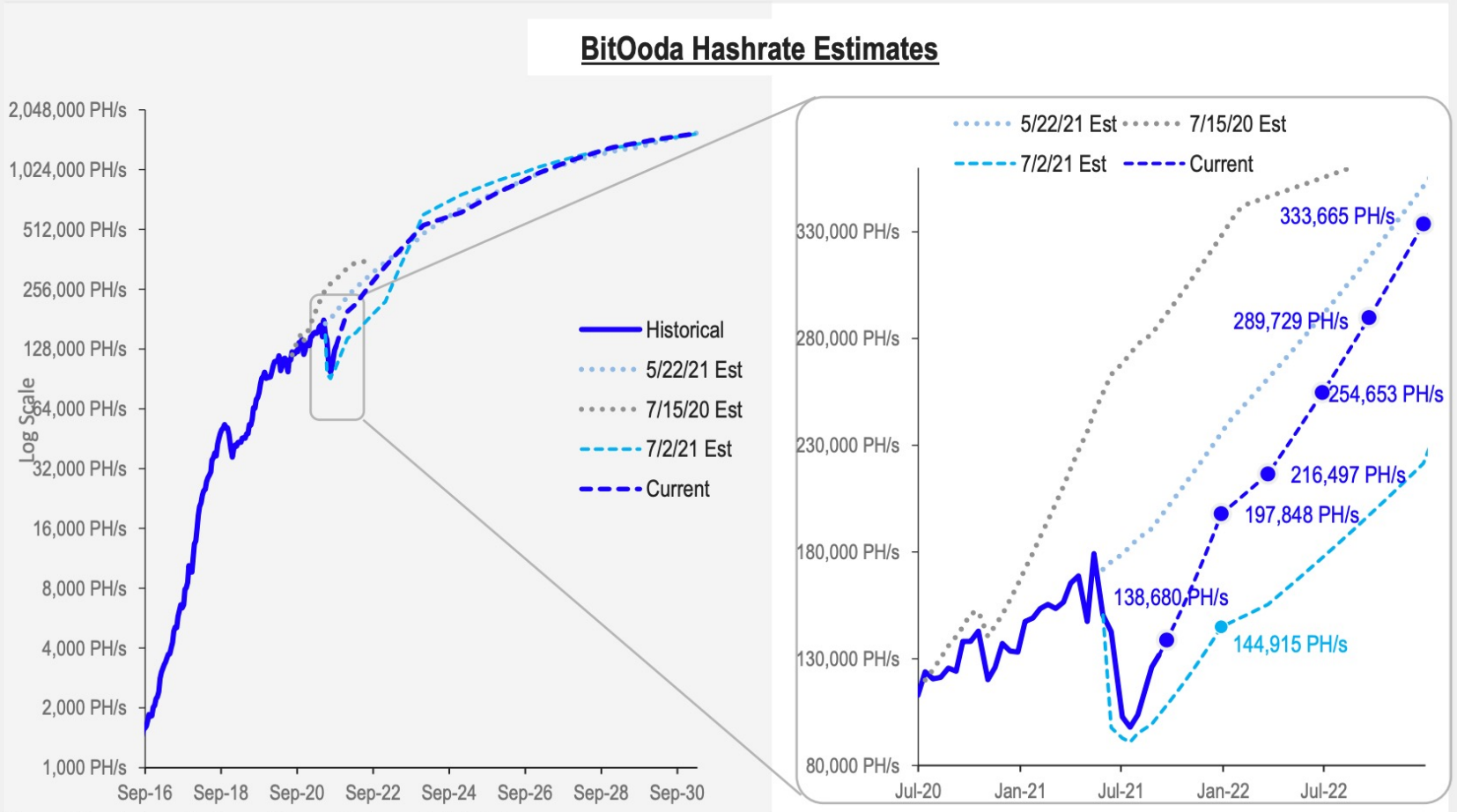


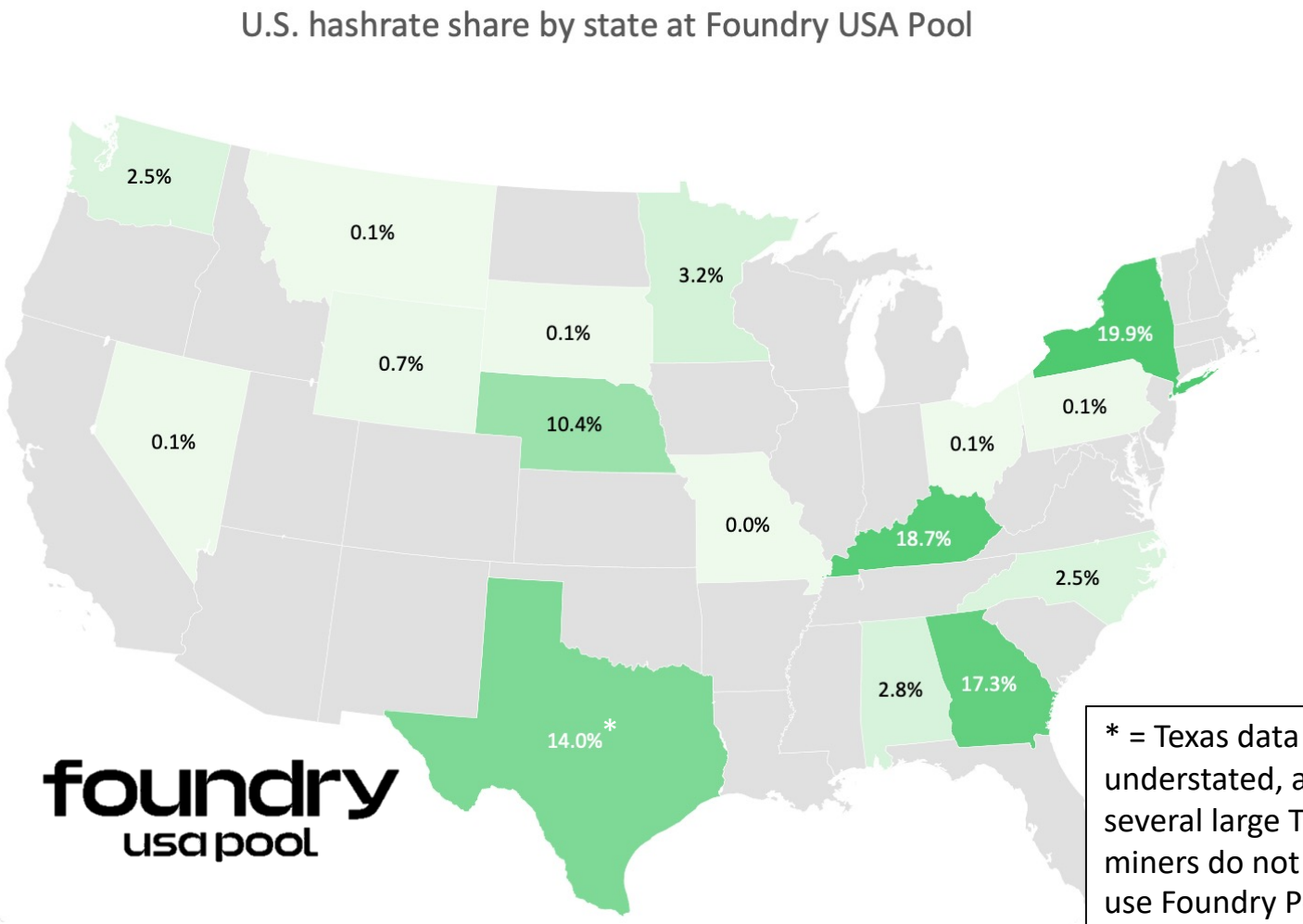
Figure: Historical and Estimated Target Hashrate 2017-2030
Historical as of 9/7/21; Estimates as of current, 7/2/21, 5/22/21, and 7/15/20

Source: BitOoda estimates, CoinMetrics

With U.S. at 30% of the global market and TX growing to 50% of U.S., TX could host **2-3GW of BTC mining** by EOY ‘22

Source: BitOoda, Year End Hashpower Estimates

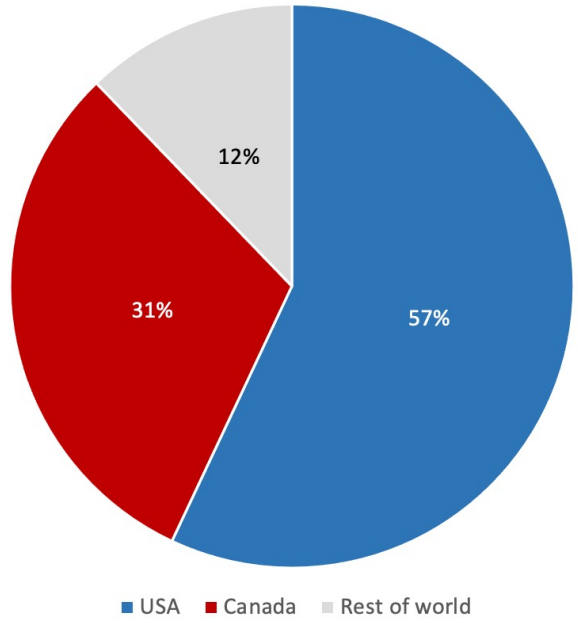
Texas is becoming the heartland of U.S. mining



* = Texas data is understated, as several large TX miners do not use Foundry Pool

Data courtesy of Foundry. Note: 7.5% is unattributed. Foundry Pool accounted for 13.5 exahash on 10/05/21 (9% of hashrate)

- USA is ~1/3 of global hashrate
- Texas among the largest mining states already



Foundry client hashrate by country

Bitcoin mining market recap

U.S. Bitcoin miners are aggressively expanding

Additional orders since October 2020

Buyer	Hardware Model	Unit	Additional ~PH/s	Source
Argo	AntMiner S19/S19 Pro	4,500	450	5-Nov-20
Marathon	AntMiner S19j Pro	10,000	1,100	9-Dec-20
Core Scientific	AntMiner S19/S19 Pro	58,000	5,800	17-Dec-20
Riot	AntMiner S19/S19 Pro	15,000	1,530	21-Dec-20
Marathon	AntMiner S19	70,000	6,650	28-Dec-20
Compute North	WhatsMiner M30S	14,000	1,200	13-Jan-21
HIVE	Avalon A1246	6,400	576	19-Jan-21
Hut 8	WhatsMiner M30S	5,400	475	22-Jan-21
Blockstream	WhatsMiner M30S	EST ~10,000 ($25 million worth)	~879	27-Jan-21
Core Scientific		6,000	540	7-Feb-21
Blockcap	AntMiner S19	10,000	950	16-Feb-21



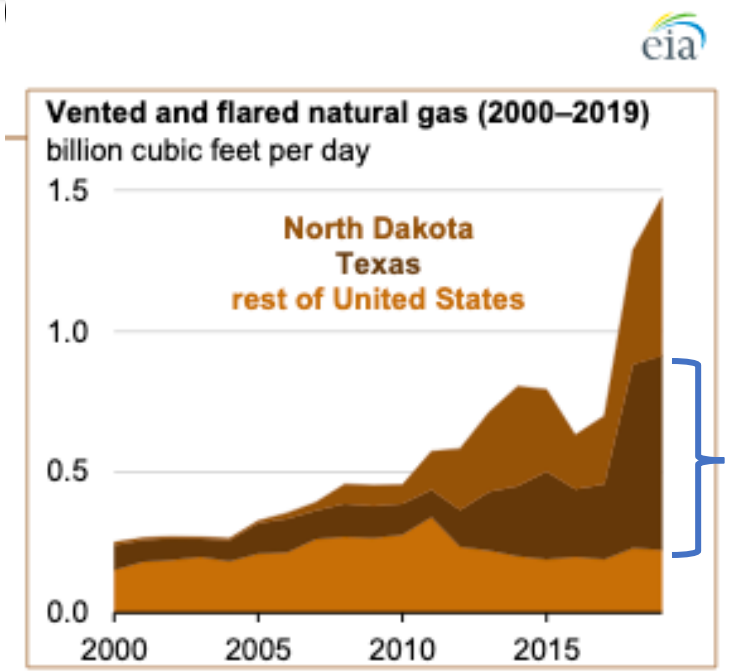
Has a presence in Texas

Source: Wolfie Zhao, The Block Crypto (Feb. 2021)

Introduction to ERCOT

Why is Texas suitable for Bitcoin mining?

- Deregulated grid with real time spot pricing
- Cheap, capacious grid
- Aligned policymakers
- Significant excess energy, especially renewable
- Significant stranded or flared natural gas
- Development of immersion mining will eliminate cooling issues

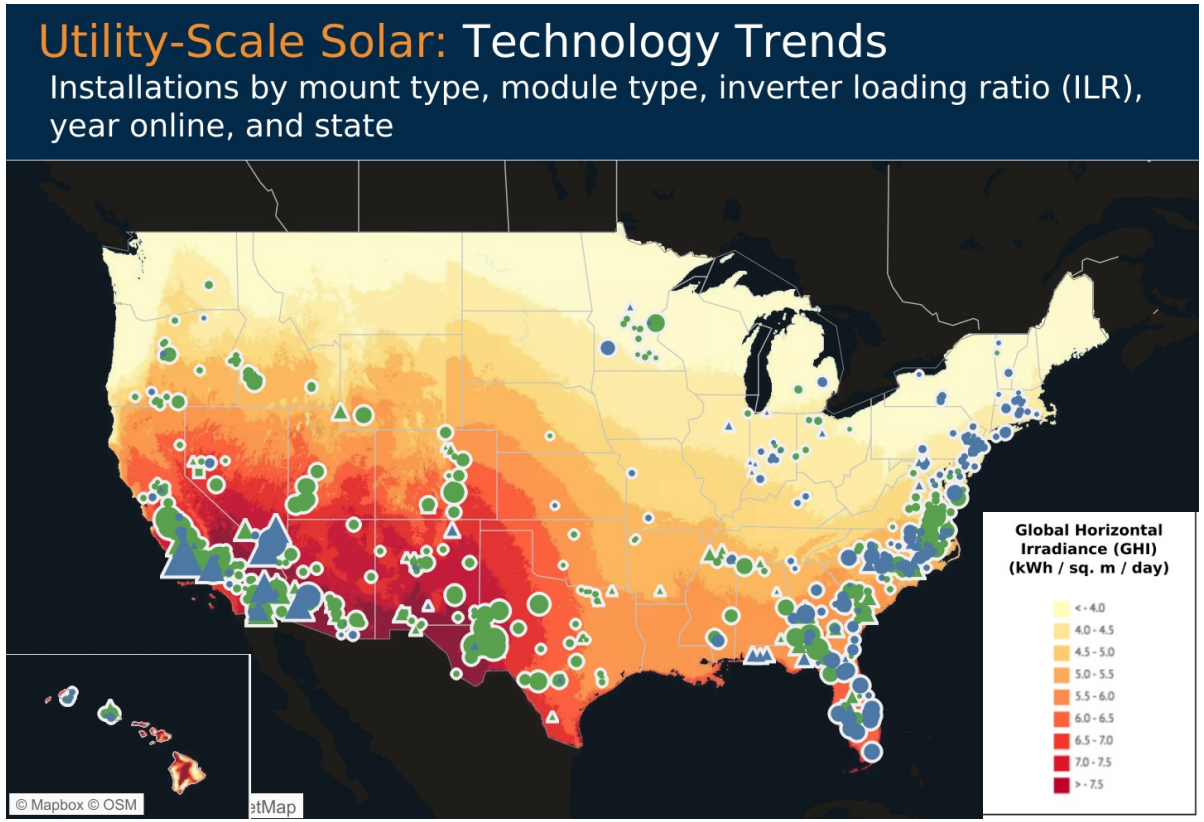


Source: EIA

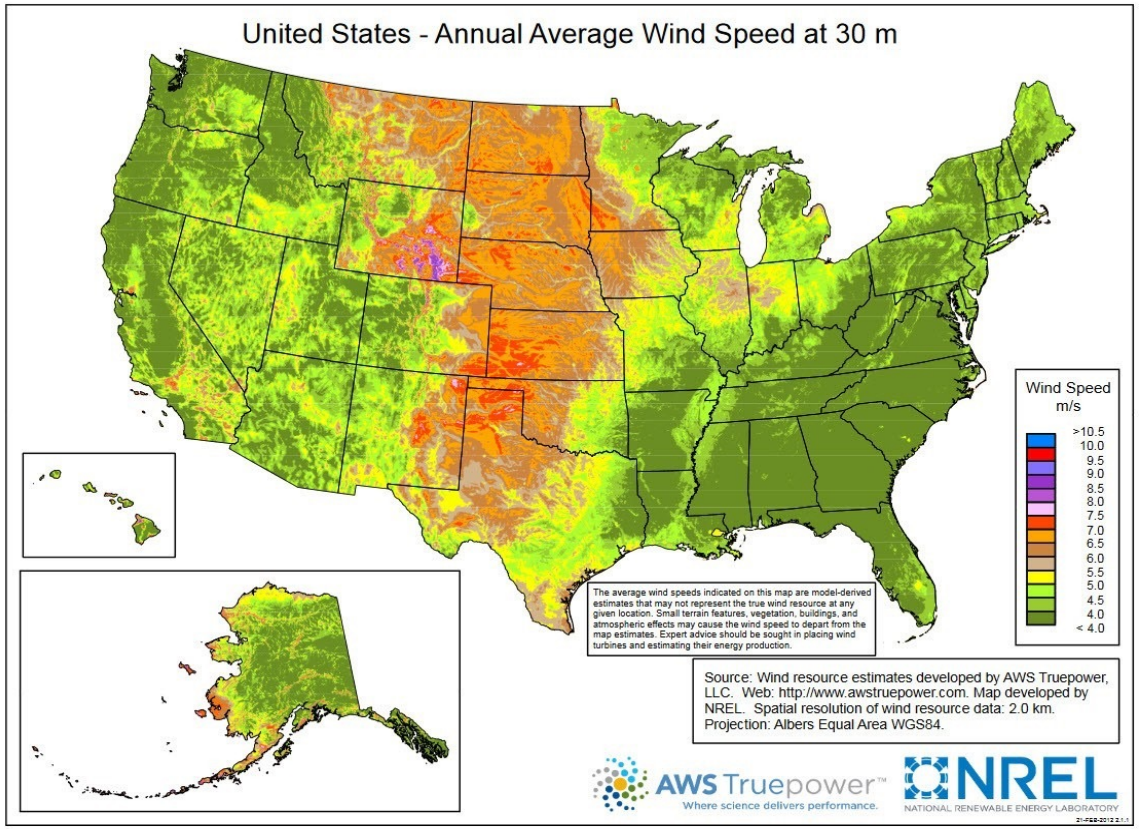
TX accounts for 47% of national flared gas

Introduction to ERCOT

Texas leads the nation in wind & solar suitability



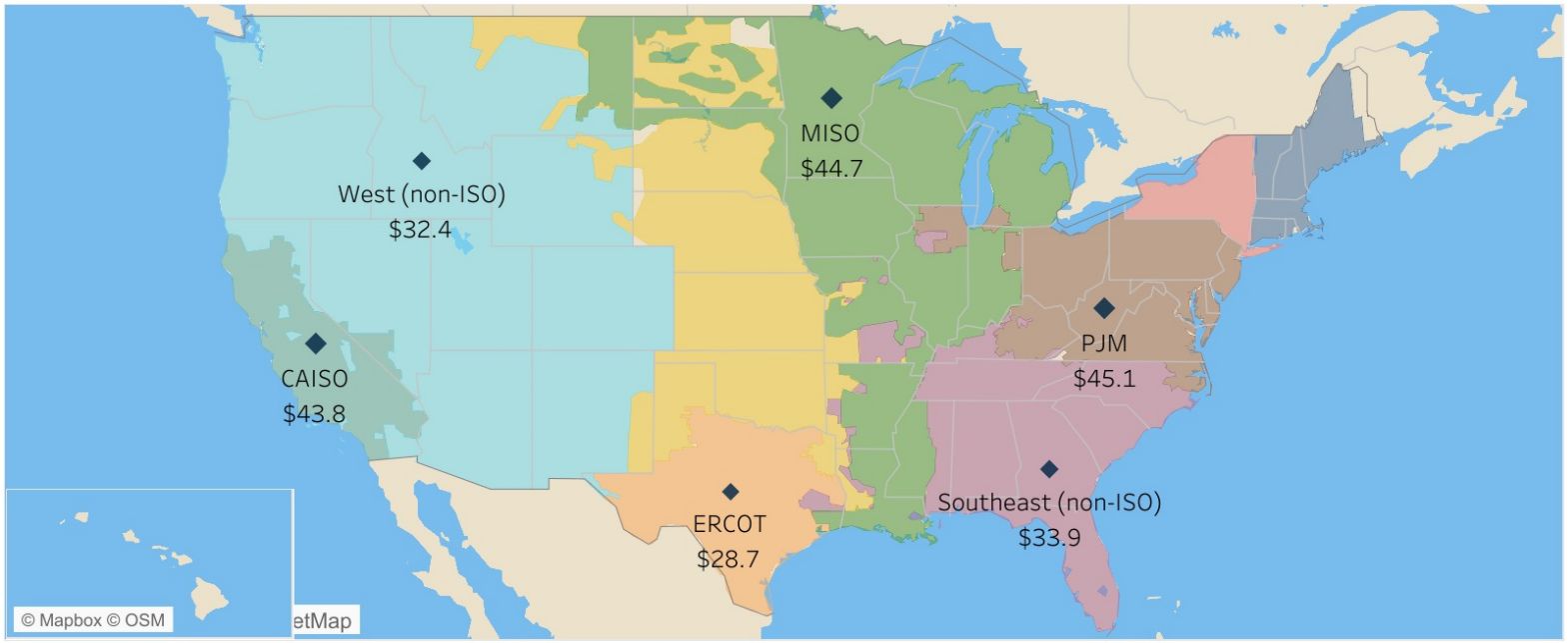
Source: Berkeley Electricity Markets and Policy (link)



Source: US Dept. of Energy (link)

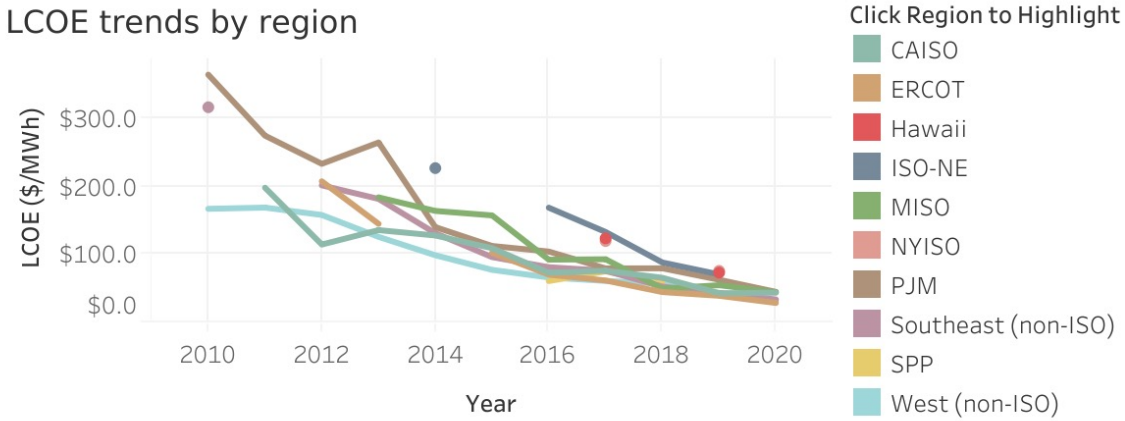
Renewable prices have come down precipitously

Introduction to ERCOT



ERCOT has the cheapest utility-scale solar in the nation at 2.8c/KWh

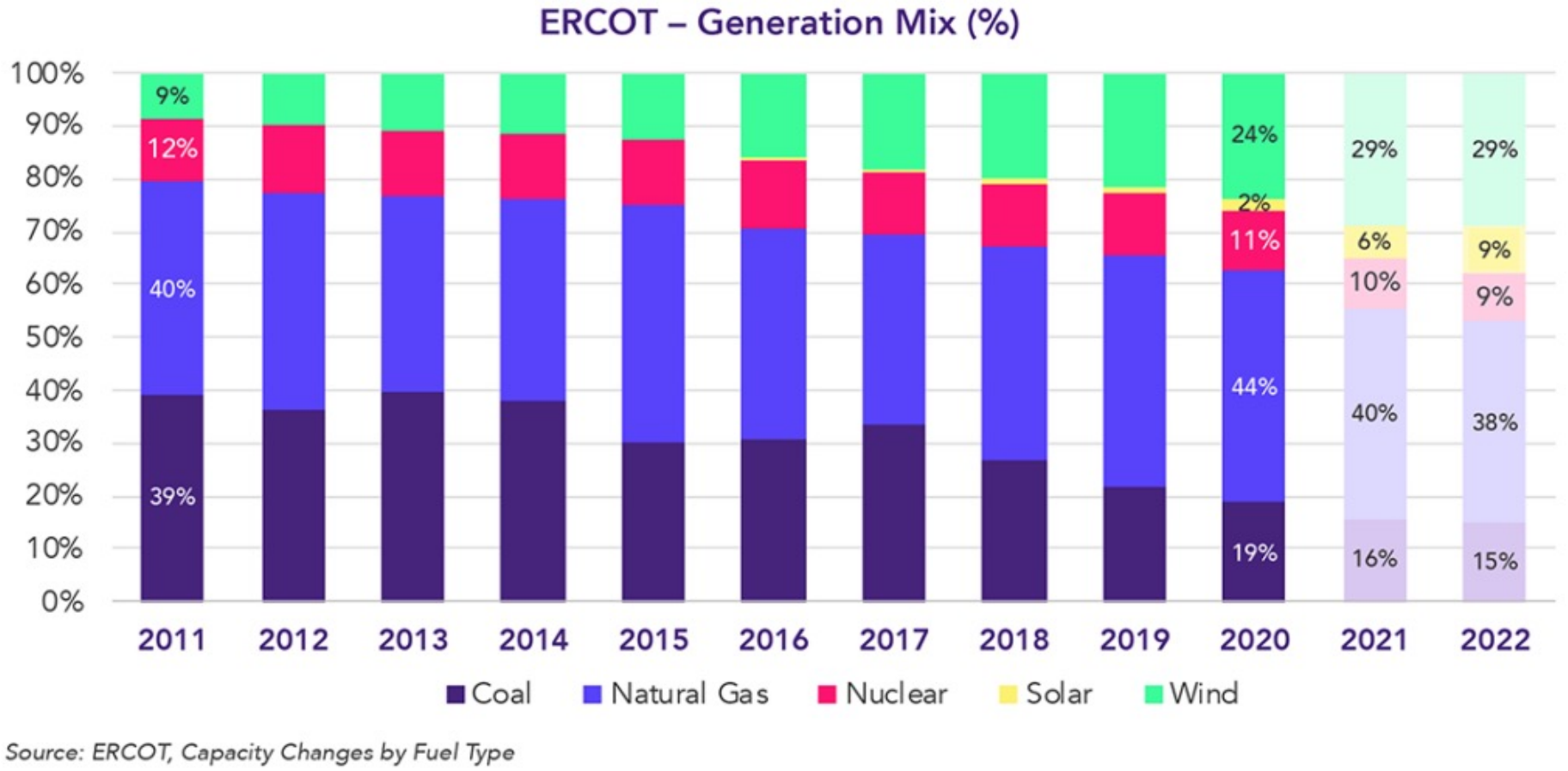
Year
2020



Source: Berkeley Lab, Utility-Scale Solar 2021, http://utilityscalesolar.lbl.gov

Source: Berkeley Electricity Markets and Policy (link)

ERCOT is rapidly adding wind and solar



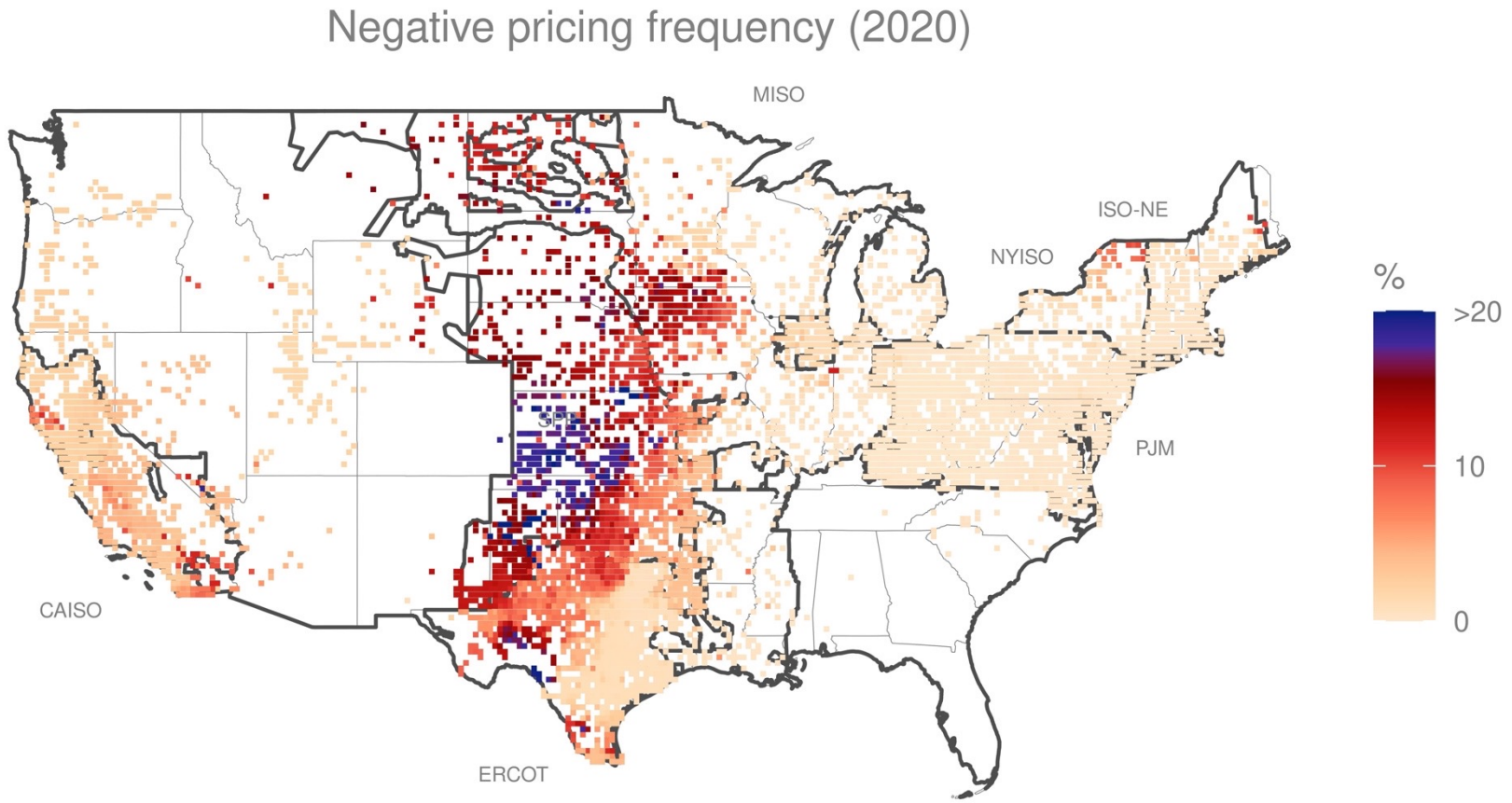
Source: ERCOT, Capacity Changes by Fuel Type

- Wind and solar have grown to 26% of the grid from a 9% in 2011
- By 2026, 90GW of additional solar and 23 GW of wind are planned

Source: Enel X Energy Market Outlook (link)

But intermittency of wind and solar leads to supply-demand mismatches

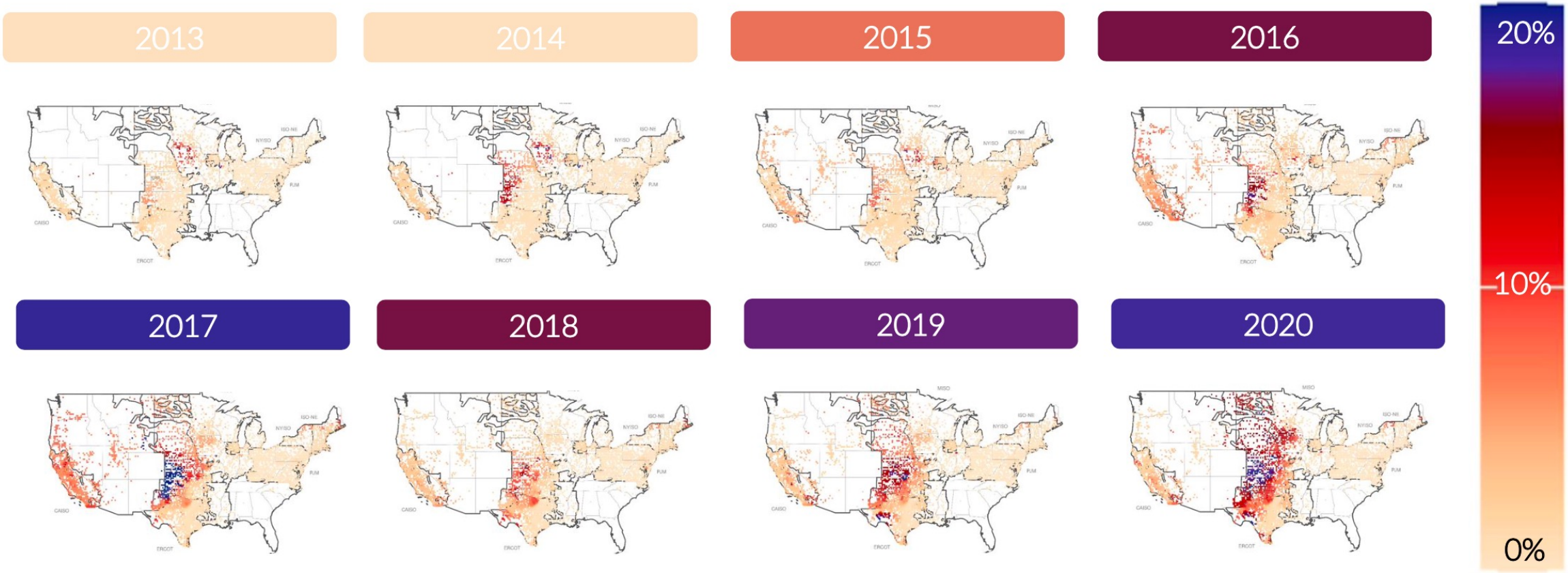
Introduction to ERCOT



- Negative pricing events occur when solar and wind production outpace demand
- Suppliers are incentivized to negatively price energy due to renewable energy credits or the production tax credit (wind)

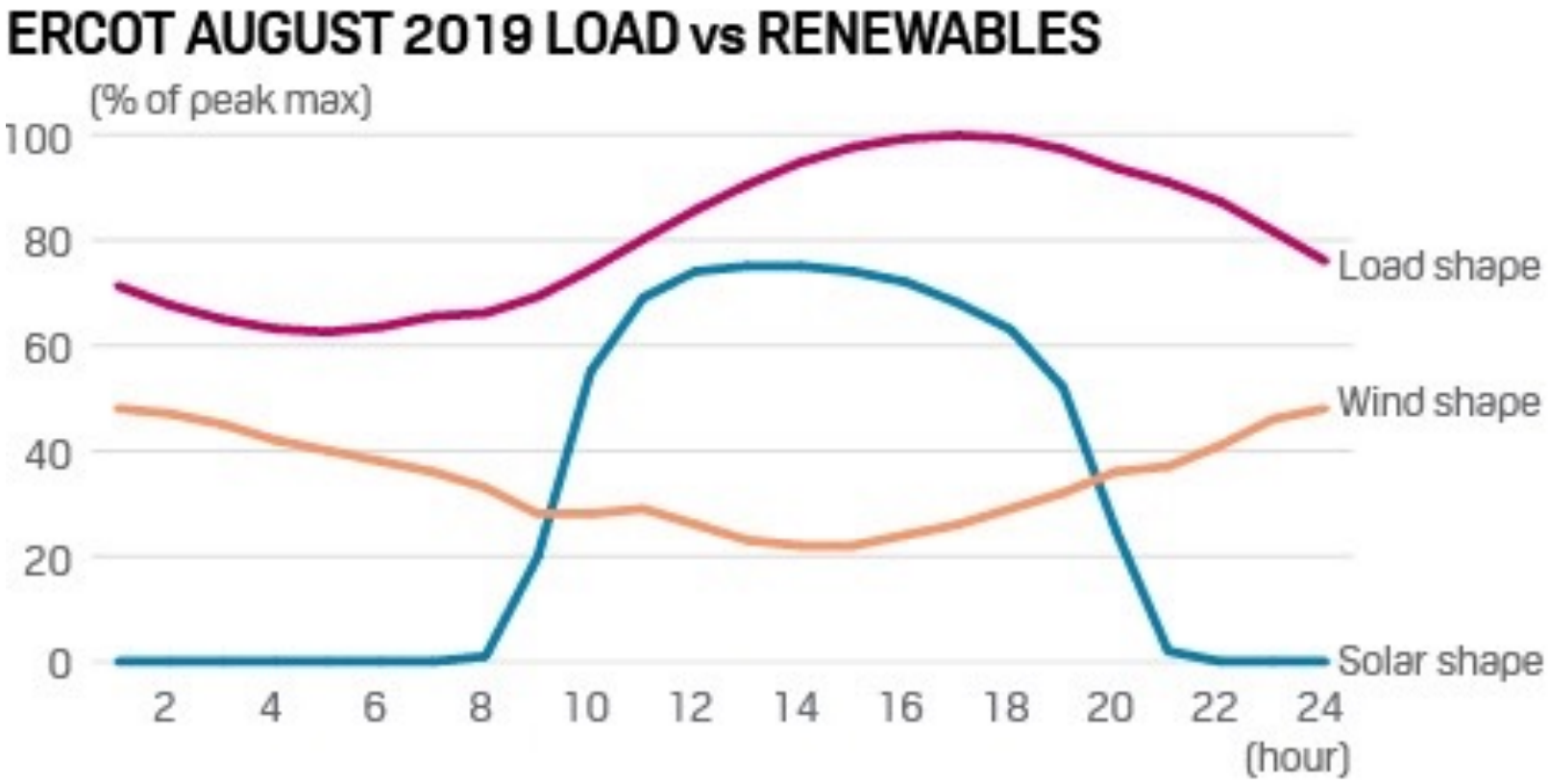
Source: Berkeley Electricity Markets and Policy (link)

Negative pricing events are getting more common as renewables grow their share



Source: Berkeley Electricity Markets and Policy / Lancium

The generation curve of wind/solar doesn't match household demand profiles

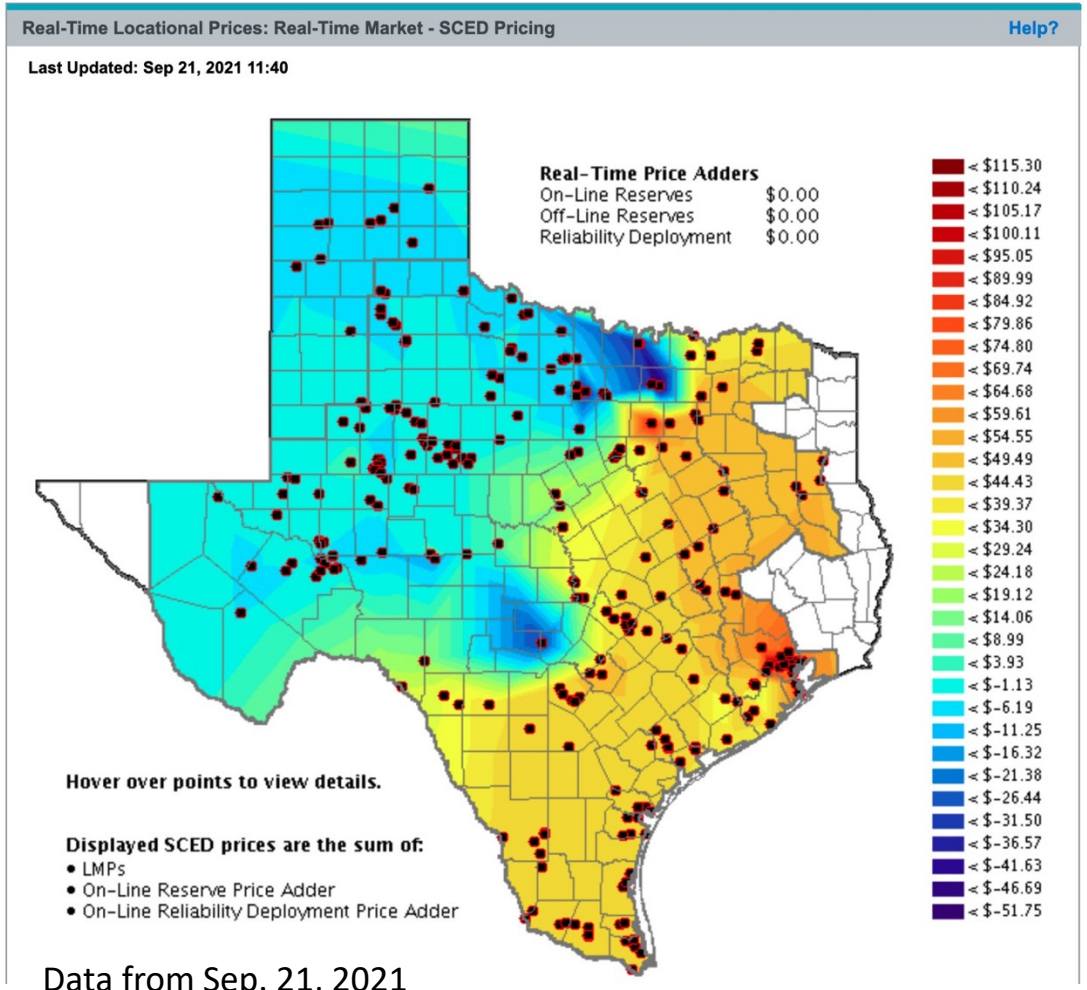


- It's well understood that the profile of wind/solar generation does not match typical household demand
- Renewables must be paired with thermal energy, batteries, or energy storage

Source: S&P Global Platts Analytics, ERCOT

Introduction to ERCOT

Inefficiencies create surplus in West Texas



Data from Sep. 21, 2021

Source: ERCOT

- West Texas has 32GW worth of generation (mostly wind/solar), but only 5GW worth of load
- Only 12GW can be exported to south east Texas through high-voltage transmission
- Supply is growing rapidly, unmatched by supply

How does Bitcoin help?

Flared gas mitigation

Flexible offtake solution

Demand response & controllable load

Mining Bitcoin with otherwise-flared gas.
Courtesy of Upstream Data

Flared gas mitigation

Flared gas mitigation

- Mining bitcoin with flared gas is far more profitable than capturing it, especially when pipelines aren't available
- Initial production generates a huge, short term burst of methane – often not worth building pipelines

GREAT AMERICAN MINING

upstream DATA

JAI ENERGY

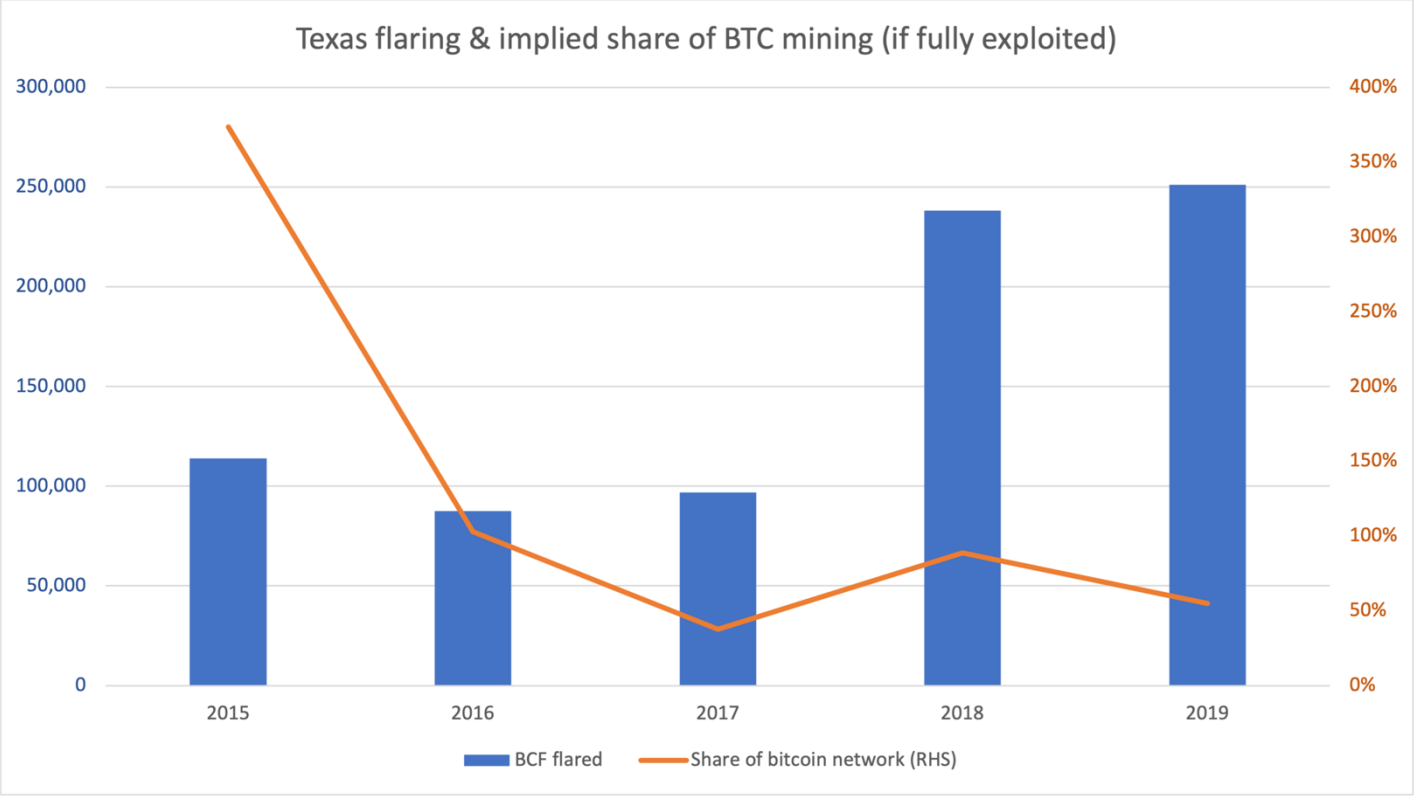
Crusoe

NAKAMOTOR PARTNERS

Mining with otherwise-flared gas is carbon negative

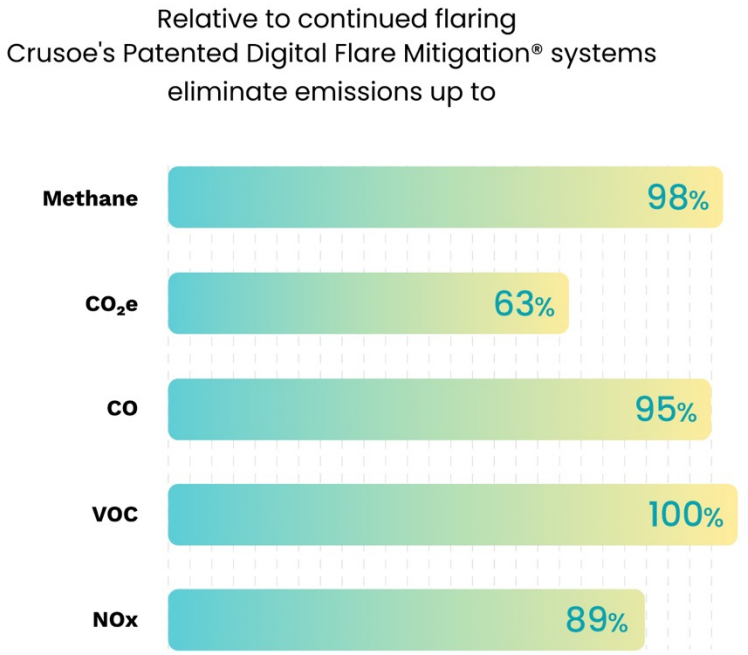
Flared gas mitigation

If fully exploited, flared gas in TX could power **34% of the Bitcoin network** today



Source: EIA, CBECI, own calculations. Assumes 7 heat rate generators (7m BTU/MWh)

Capturing gas **produces fewer emissions** than flaring



Source: Crusoe

Crusoe

How does Bitcoin help?

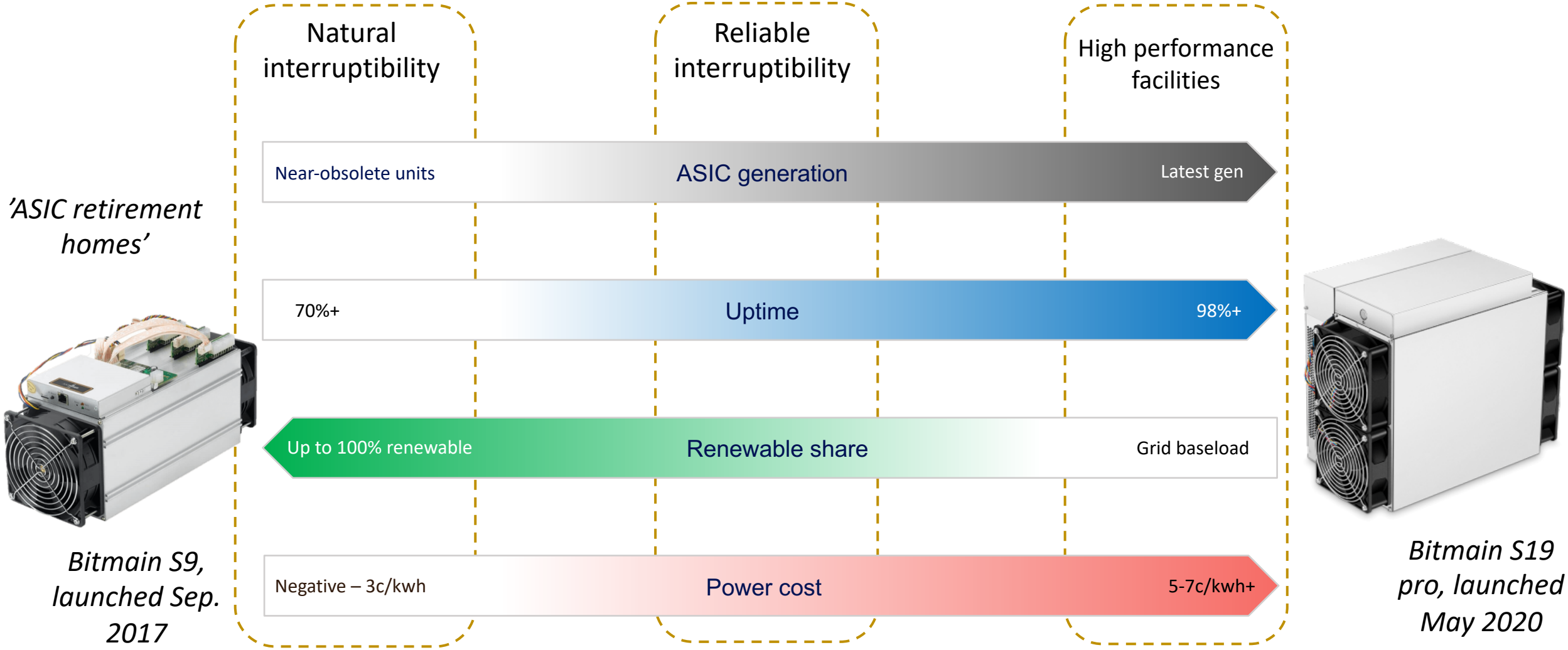
Flared gas mitigation

Flexible offtake solution

Demand response & controllable load

‘Lifecycle mining’ applies older ASICs to intermittent, renewable sources of energy

Flexible offtake



’ASIC retirement homes’

Bitmain S9, launched Sep. 2017

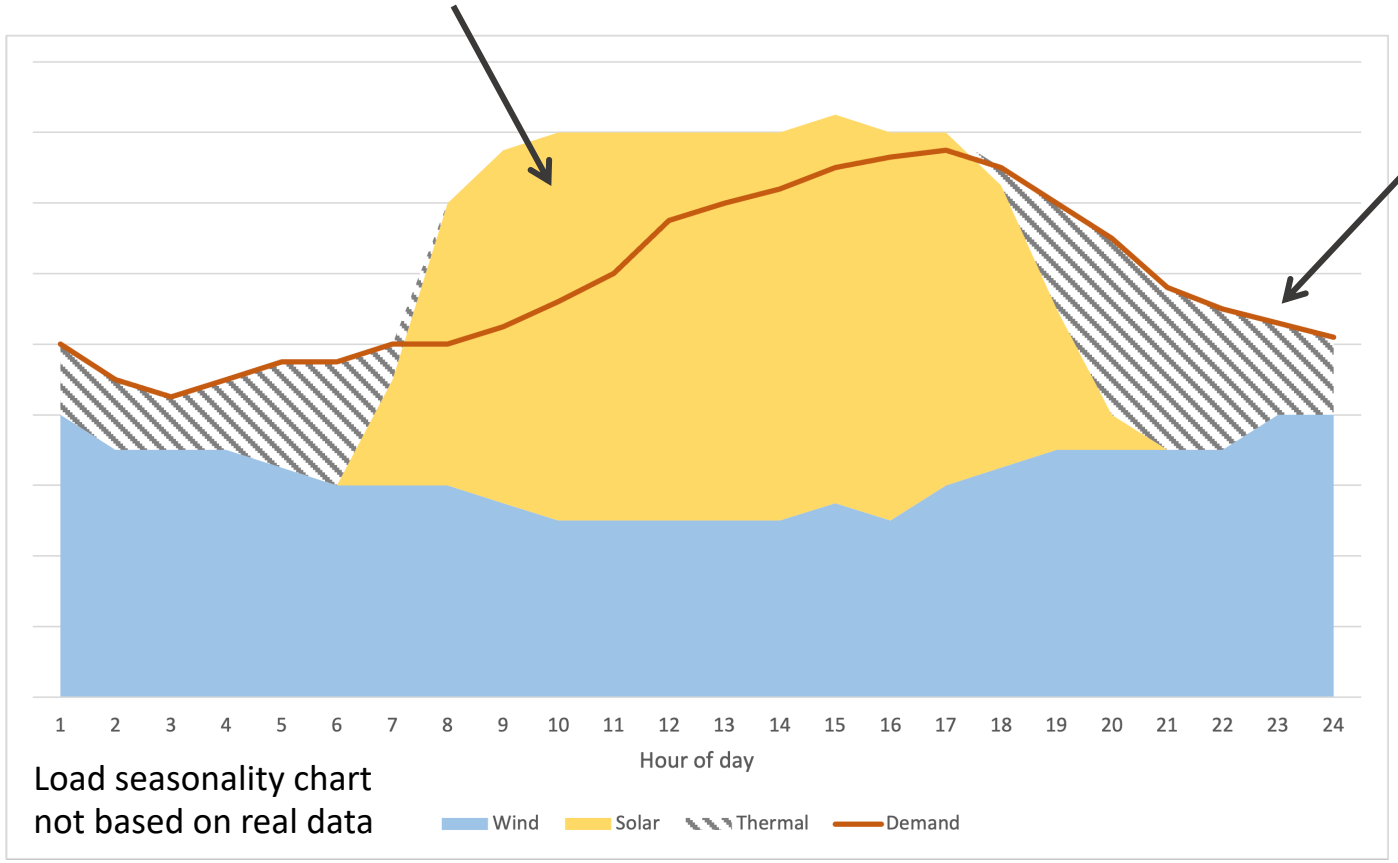
Bitmain S19 pro, launched May 2020

Based on the talk by Ro Shirole, Compute North

Heavily renewable grids create supply imbalances

Flexible offtake

Unmonetized excess energy during peak generation hours – must be curtailed / negatively priced



Load seasonality chart not based on real data

Energy shortfall means thermal energy must compensate when renewables fall short

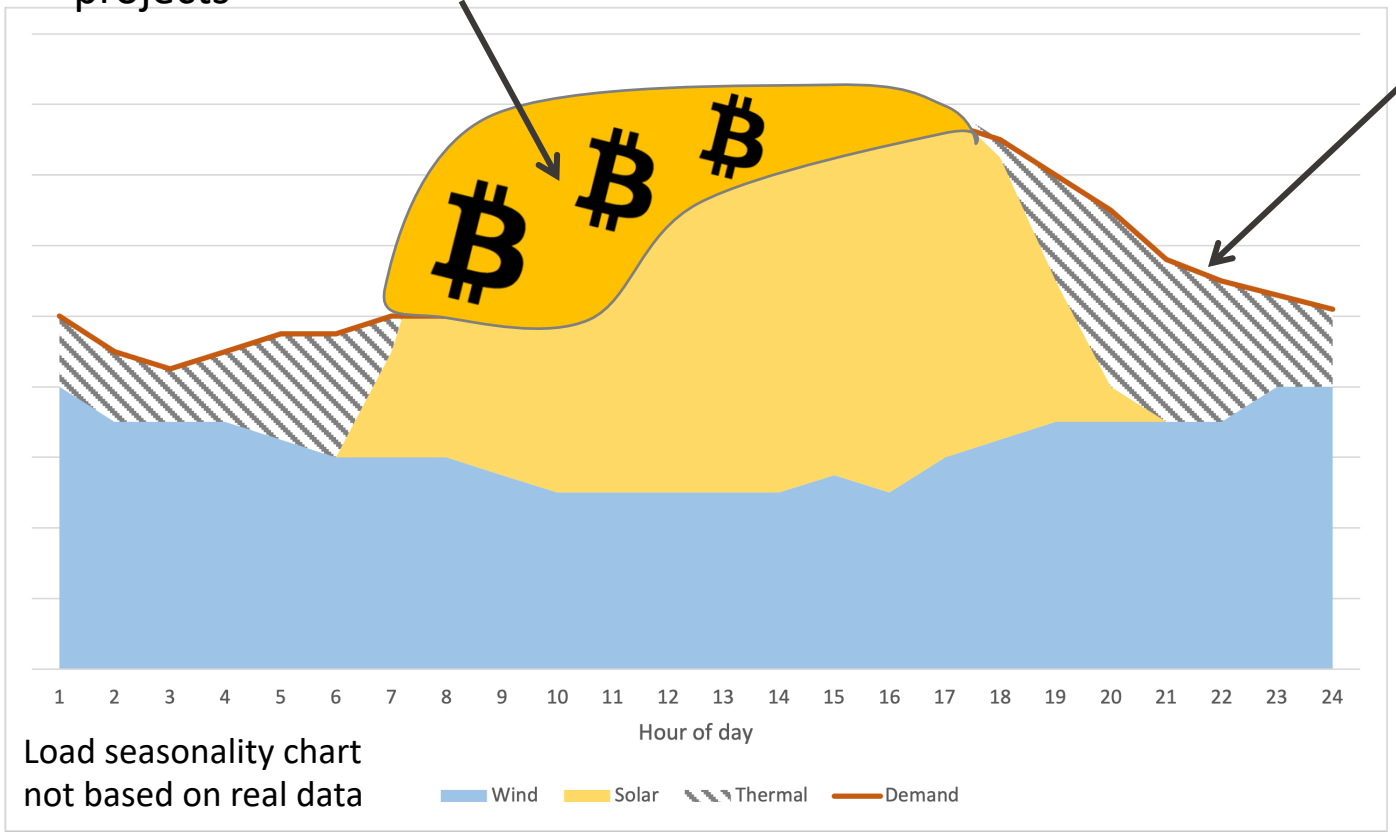
- Wind and solar are fundamentally unpredictable and cannot alone provide sufficient base load
- A more renewable grid will end up creating **massive excesses** of supply

Flexible offtake

Bitcoin mining is an energy sponge

Bitcoin mining soaks up excess supply during offpeak periods, improving economics of renewable energy projects

Miners curtail load when prices are high, giving households better access during times of heavy demand



Load seasonality chart not based on real data

- Low capacity factors mean wind/solar must be *overbuilt* – as a flexible offtake solution, miners help **finance this expansion**
- Miners can consume renewable energy when an **economic buyer does not exist** and be interrupted during times of peak load

Mining improves economics for underutilized energy assets

Flexible offtake

Nuclear	Talen Energy Corporation Announces Zero-Carbon Bitcoin Mining Joint Venture with TeraWulf Inc. Oklo and Compass Secure 20-Year Commercial Partnership to Launch Advanced Fission-Powered Bitcoin Mining
Solar	Square to invest $5 mln in Blockstream's solar-powered bitcoin mining facility
Recycled tires	PRTI makes cryptocurrency from old car tires in Northern Carolina
Industrial waste	Stronghold Digital Mining Raises $105M to Turn Waste Coal Into Bitcoin

...and many more to be announced

How does Bitcoin help?

Flared gas mitigation

Flexible offtake solution

Demand response & controllable load

Demand response & controllable load

Demand response

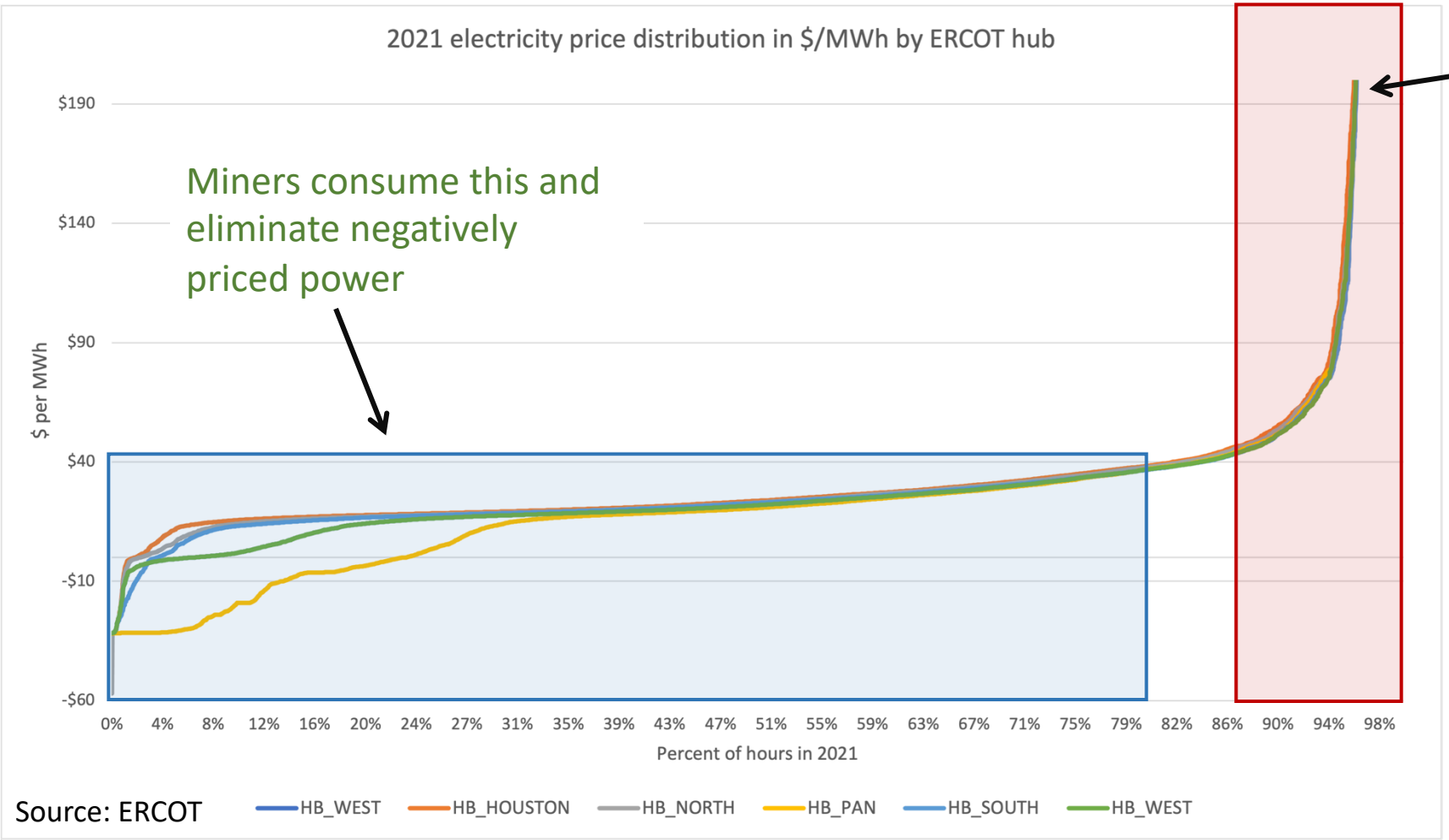
- Binary – load centers are either on or off
- Exists informally, as miners organically cut back when prices get high (“economic dispatch”), and via formal programs

Controllable load resources

- Configurable and high frequency
- Data centers scale up and down their consumption in line with grid requests to stabilize the grid

Bitcoin mining alters the electricity price distribution

Demand response & controllable load



Source: ERCOT

Bitcoin mining **chops off the tails of the distribution** by providing demand response during peak stress and buying energy during off-peak periods

Demand response & controllable load

‘Interruptible load’ benefits grid sustainability

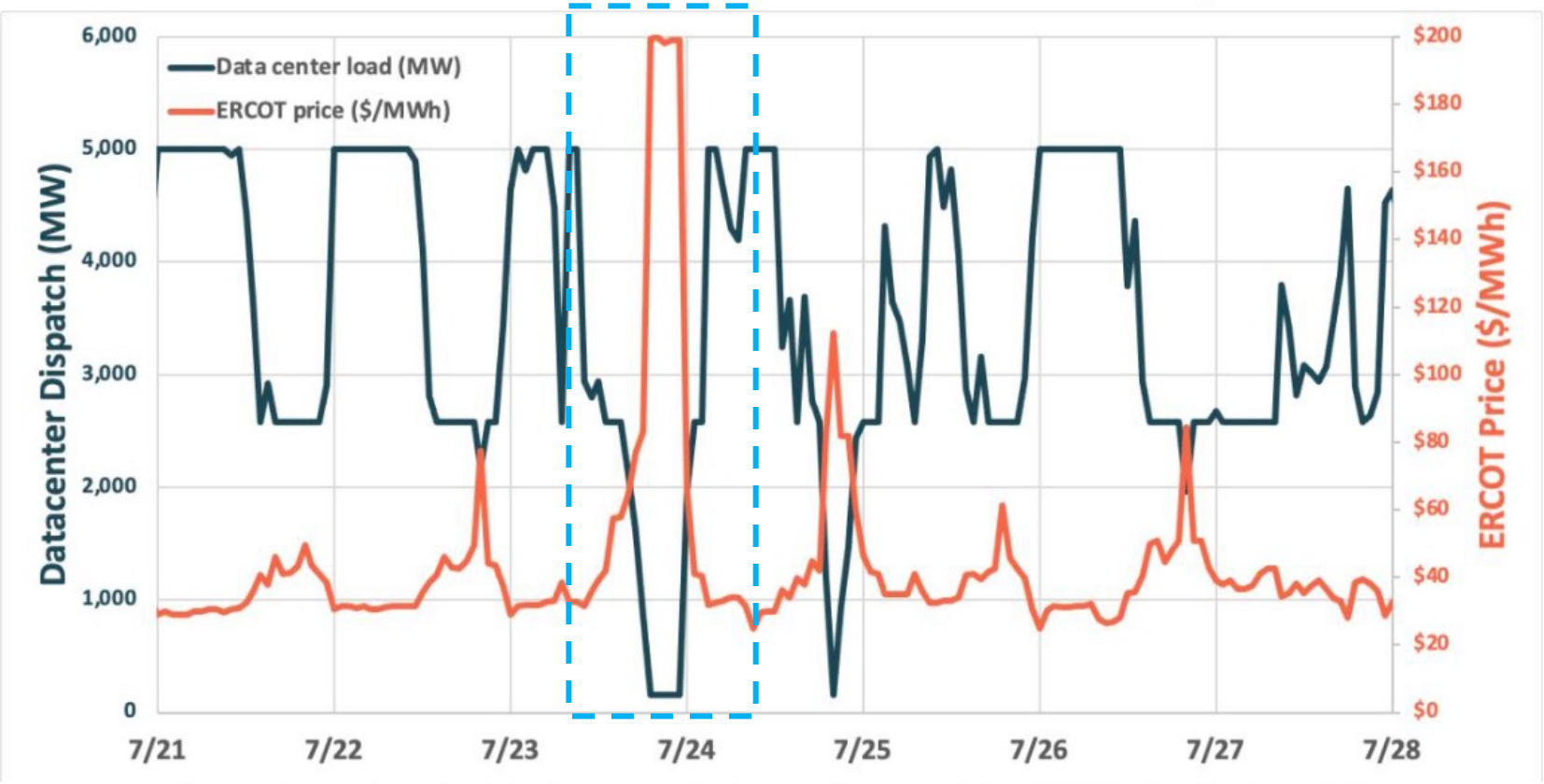


Figure 4: Example week of the data center load responding to real-time ERCOT prices for Scenario 3.

Miner datacenters can behave **counter-cyclically**, reducing load when the grid is short on supply

Source: Impacts of Large, Flexible Data Center Operations on the Future of ERCOT, Ideasmiths LLC / Lancium

Thank you