Integrating Large Flexible Loads While Maintaining Grid Reliability

Agee Springer
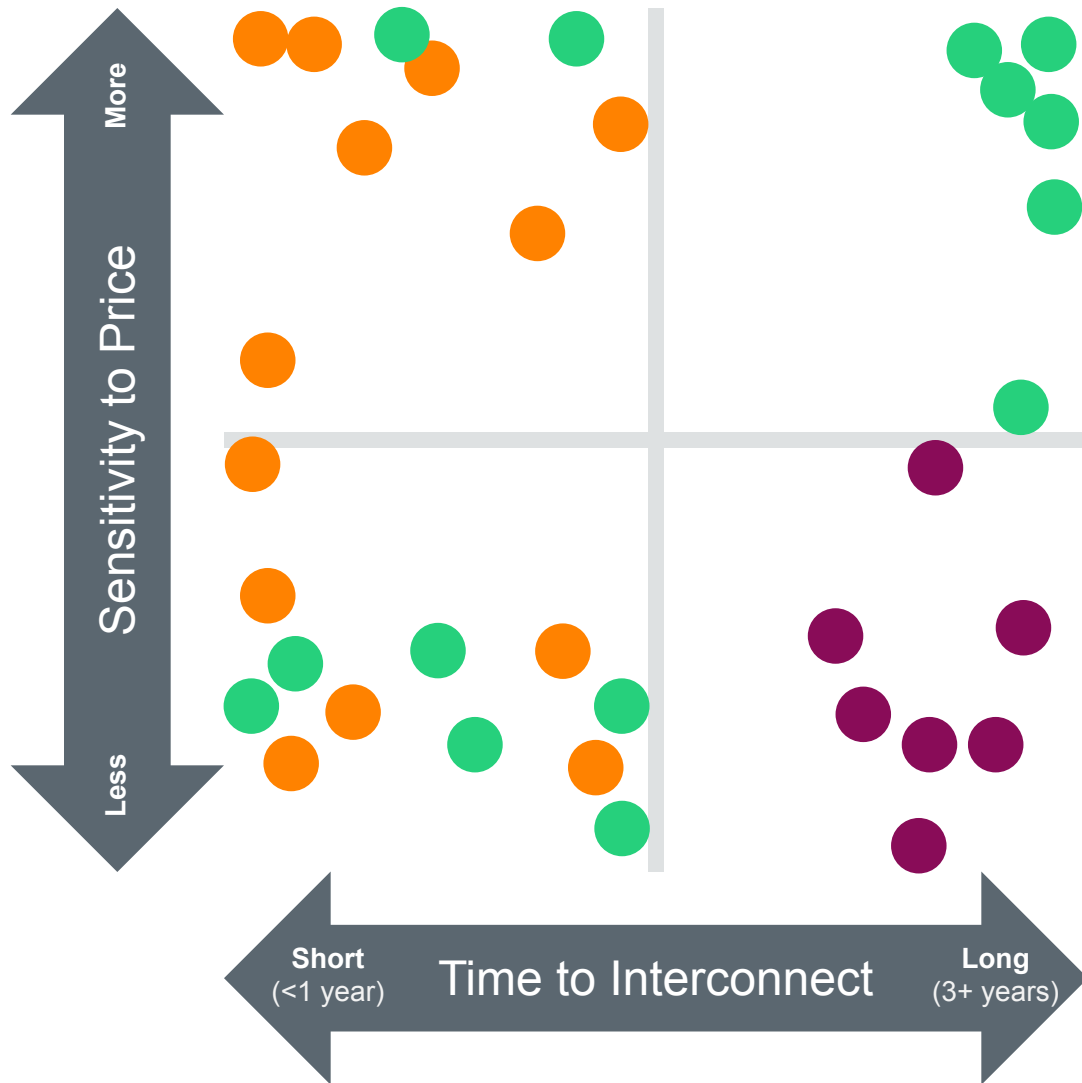Manager, Large Flexible Load Interconnection

June 14, 2023

Agenda

- Overview of large loads coming to ERCOT
- Interim Interconnection Process
- Load Forecasting – Challenges in the near and long term

Large Loads Coming to ERCOT

Historical Large Loads

- Typically industrial facilities
- Long timelines to interconnect can be studied by traditional planning processes
- Little price sensitive behavior in real-time

Current Wave of Large Loads

- Mostly cryptomining, data centers, some oil field load
- Much shorter timeline to interconnect (months rather than years)
- Some loads are extremely sensitive to price

Projected Future Large Loads

- Hydrogen/electrofuel production, data centers, some cryptomining
- Range of interconnection timelines and price sensitivity

Large Loads Coming to ERCOT
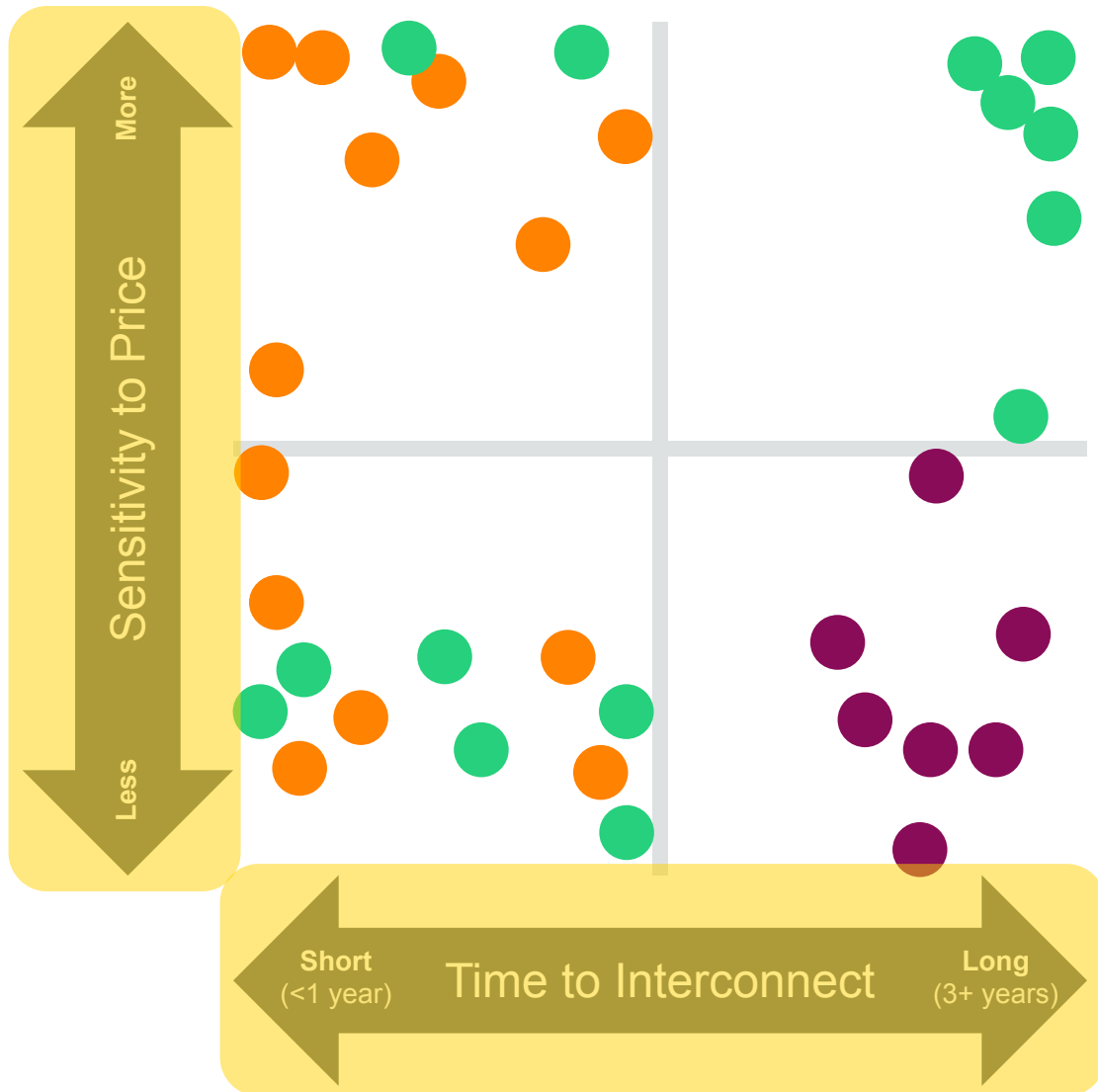
These large loads present 2 distinct challenges

- Very short timelines to interconnect (months rather than years)
  - This is faster than traditional planning processes can accommodate

- Sensitivity to prices and rapid response times
  - Load can ramp hundreds of MWs in seconds to a few minutes
  - Significant challenge to forecasting reliability

Tracking Large Loads with Short Timelines to Interconnect
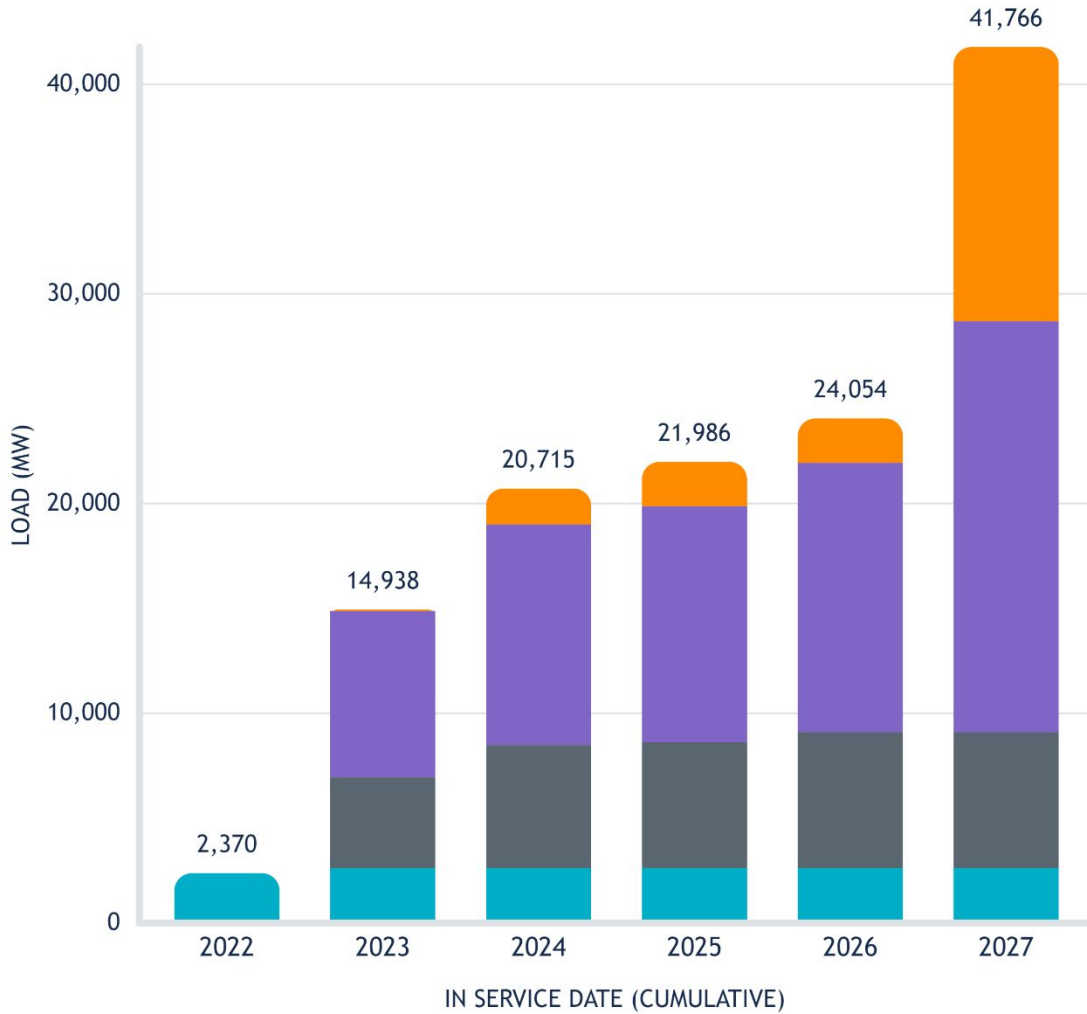
Project Status	2022	2023	2024	2025	2026	2027
🟠 No Studies Submitted	-	62	1,715	2,115	2,115	13,082
🟣 Under ERCOT Review	-	7,932	10,527	11,252	12,852	19,597
⬤ Planning Studies Approved	-	4,324	5,853	5,999	6,467	6,467
🔵 Approved to Energize	2,370	2,620	2,620	2,620	2,620	2,620
Total (MW)	**2,370**	**14,938**	**20,715**	**21,986**	**24,054**	**41,766**

- **Approved to Energize –** Projects that have received Approval to Energize from ERCOT Operations. NOTE: not all MWs in this category have been observed to be operational (see next slide)

- **Planning Studies Approved –** Projects that have received ERCOT approval of required interconnection studies. Any MWs that were not approved are reclassified as No Studies Submitted.

- **Under ERCOT Review –** Projects that have studies under review by ERCOT

- **No Studies Submitted –** Projects that are tracked by ERCOT but that have not yet provided sufficient information for ERCOT to begin review. Additionally, MWs that were not approved by ERCOT after review of planning studies are included in this category until a path to interconnect these MWs is identified or the customer cancels the interconnection request.

Interconnecting Large Loads with Short Timelines to Interconnect

The Interim Process

Large Loads with Short Timelines to Interconnect

- As of May 2023, ERCOT is tracking 41,766 MW of large load with a likely or confirmed timeline to interconnect of 2 years or less

- This rapid pace of interconnection is faster than can be studied under ERCOT's traditional planning processes

- To address this limitation, ERCOT established an **interim** large load interconnection process with a market notice issued on March 25, 2022

Interim Interconnection Process

- The need for the interim process stems from the **accelerated interconnection timelines** desired by these loads and <u>not</u> from their ability to flexibly respond to prices

- The interim process does **not** add any new interconnection requirements

- Rather, it ensures that existing requirements set by ERCOT and NERC Reliability Standards are being met
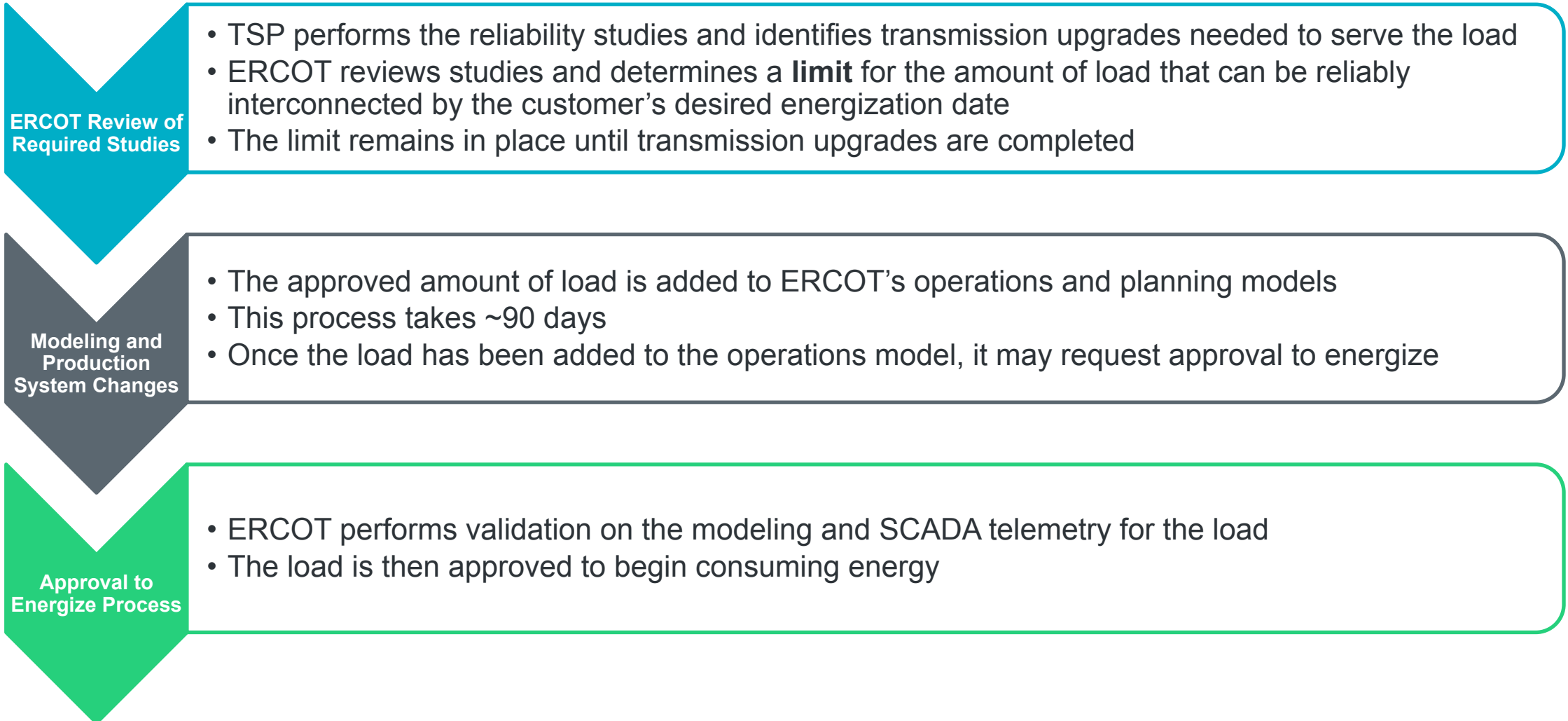
Interim Interconnection Process – Applicability

Per the market notice, loads that meet the following criteria are subject the interim process

1. The load has not been modeled and studied in a completed RTP, FIS, or RPG review

2. The load is one of the following
   - A new standalone with total demand ≥ 75 MW in the next two years
   - An existing standalone load increasing total demand by ≥ 75 MW in the next two years
   - A new load co-located with a Resource with total demand ≥ 20 MW in the next two years
   - An existing load co-located with a Resource increasing total demand by ≥ 20 MW in the next two years

Interim Interconnection Process – Overview

- The interim process consists of 3 phases

ERCOT Review of Required Studies
- TSP performs the reliability studies and identifies transmission upgrades needed to serve the load
- ERCOT reviews studies and determines a **limit** for the amount of load that can be reliably interconnected by the customer's desired energization date
- The limit remains in place until transmission upgrades are completed

Modeling and Production System Changes
- The approved amount of load is added to ERCOT's operations and planning models
- This process takes ~90 days
- Once the load has been added to the operations model, it may request approval to energize

Approval to Energize Process
- ERCOT performs validation on the modeling and SCADA telemetry for the load
- The load is then approved to begin consuming energy

Interim Interconnection Process – Challenges

- Tracking of load ramping schedules is very ad-hoc
  - No requirement that ramping schedule be provided or validated outside of planning models
  - No single place for that information to be provided to ERCOT
  - No standardized method for tracking increases tied to transmission improvements

- Transition from the interim process to traditional planning processes still being defined

- No ERCOT interconnection fee for large loads
  - Many duplicate/frivolous requests

Large Loads with Longer Interconnection Timelines

- Additional large load with interconnection dates further in the future under study by TSPs
  - This includes 10.5 GW of hydrogen and electrofuels production[1]

- These loads will be evaluated through existing planning processes

- ERCOT may require additional data from these loads in the future

[1]Based on TSP responses to an ERCOT RFI issued in Nov 2022

Load Forecasting

Recap - Key Information is Unknown to ERCOT

Interconnection Phase

- Interconnection requests are often for amounts designed to "test" a POI

- ERCOT has no way to distinguish "real" projects from frivolous requests or duplicates

- Unclear timelines for load increases as new equipment is added

In Operation

- Price(s) at which the load will curtail consumption

- Rate at which consumption can be curtailed

- PPAs or other agreements that might impact "flexible" behavior

Forecasting Large Flexible Loads

There are two primary challenges that make forecasting large flexible loads difficult

The **growth** of the load is hard to predict

The **behavior** of the load is hard to predict

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Forecasting Large Flexible Loads - Growth

- Actual load growth from LFLs lags the amount approved in the interim interconnection process

- Nearly all large load currently in approved by the interim process are bitcoin mining loads or data centers

- These loads are highly modular, scaling with the number of machines installed
  - Potentially could monitor supply chain for insight on actual growth capabilities (BTC mining rigs)

Forecasting Large Flexible Loads - Behavior

- Nearly all **flexible** load approved by the interim process is bitcoin mining.

- At surface level, bitcoin mining operations are sensitive to a strike price which is dependent on several external variables:

  - **Block Rewards**
    - # of BTC awarded per block (6.25)
    - Price of bitcoin
    - Transaction fees

  - **Network Difficulty**
    - Total network hashrate

- In 2022 strike prices for common mining ASICs ranged from:
  - S19 ◻ $68/MWh to $308/MWh
  - **Mining Hardware** $149/MWh to $490/MWh
    - ASIC efficiency

Forecasting Large Flexible Loads - Behavior

- By understanding the intricacies of the BTC mining economic model, ISOs **potentially** can build out machine learning algorithms to help forecast their consumption.

- Similar models might be developed for other LFL industries in the future:
  - Hydrogen production

- **However**, there are many site-specific nuances that also need to be considered when these loads are not registered a Controllable Load Resources (CLR):
  - 3rd party hosting agreements
  - Power Purchase Agreements (PPAs)
  - Temperature driven curtailment (over/under clocking)
  - Interactions with ancillary service markets

Forecasting LFLs – Long Term Load Forecast

- ERCOT's 2022 Long Term Load Forecast (LTLF) is projecting 700 MW annual growth in LFLs, resulting in approximately 5,000 MW connected by 2027

- The demand contribution of LFLs at the time of ERCOT's Summer Peak is forecasted to be 10% of their total demand based on the observed behavior of ERCOT-tracked LFLs during 2022 Summer Peak conditions.

- This forecast methodology can be improved with more historical data on load behavior. Having more loads register as CLRs would also aid forecasting.

Forecasting LFLs – Short Term Load Forecast

- ERCOT currently is not making any explicit adjustment to the short-term load forecast to account for behavior of LFLs
  - However, the forecast model likely is picking up their behavior to some extent

- ERCOT has an early-stage initiative to develop a specific LFL hourly forecast that would cover the next 168 hours

- Registration of LFLs and provision of additional data to ERCOT would greatly improve short term forecasting

Questions?