Forecasting Tail Events and Impact on Energy Price

Jennifer Newman
VP of Atmospheric Science Research, REsurety
June 13, 2024

Outline

- **REsurety Overview**
- How REsurety Forecasts Power Prices
- Impact of Extreme Weather on Power Prices
- Challenges in Forecasting Tail Events
- Opportunities for Forecasting Tail Events

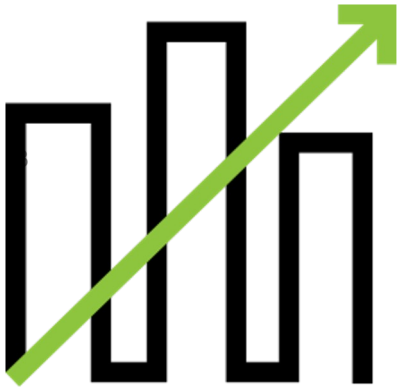
REsurety Introduction

Operating at the intersection of weather, power markets, and financial modeling, REsurety enables the industry's key decision makers with best-in-class value and risk intelligence.

It starts with science.

Translating weather into value.

Quantifying and managing risk.

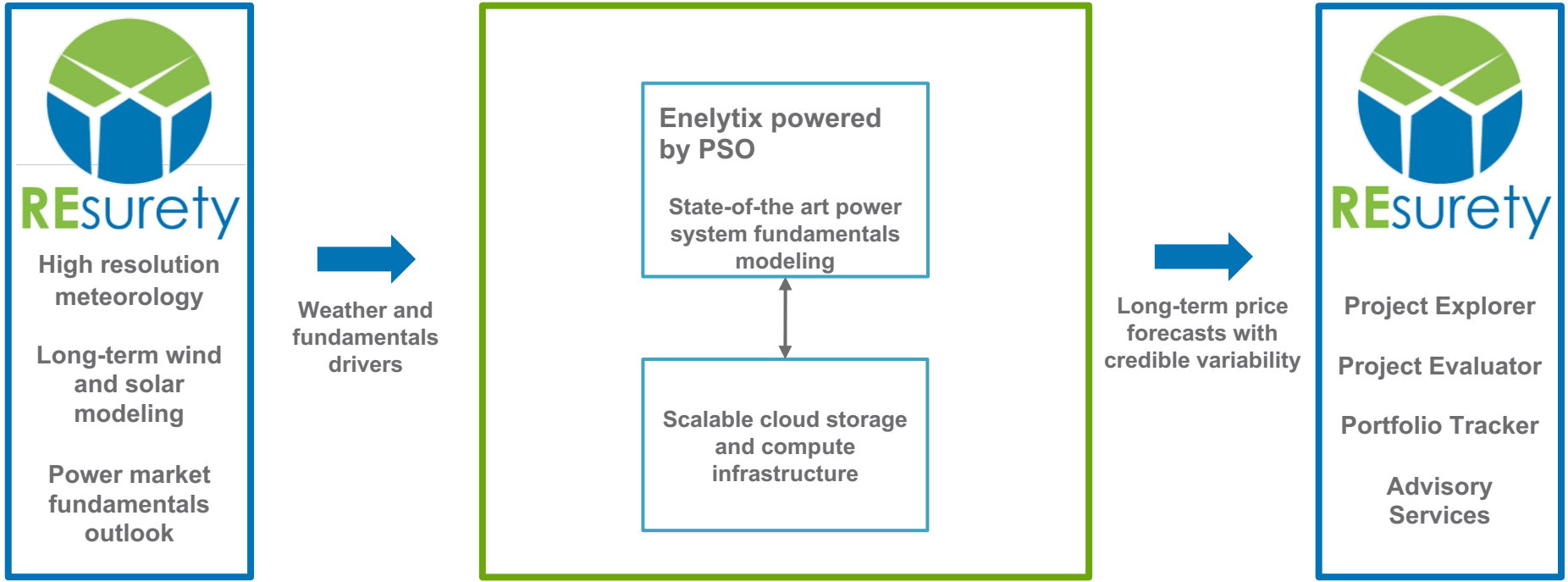


Outline

- REsurety Overview
- **How REsurety Forecasts Power Prices**
- Impact of Extreme Weather on Power Prices
- Challenges in Forecasting Tail Events
- Opportunities for Forecasting Tail Events

Price Forecasting at REsurety

REsurety uses a fundamentals-based forecasting approach to produce long-term (20-year) power price forecasts that reflect 40 years of weather variability.



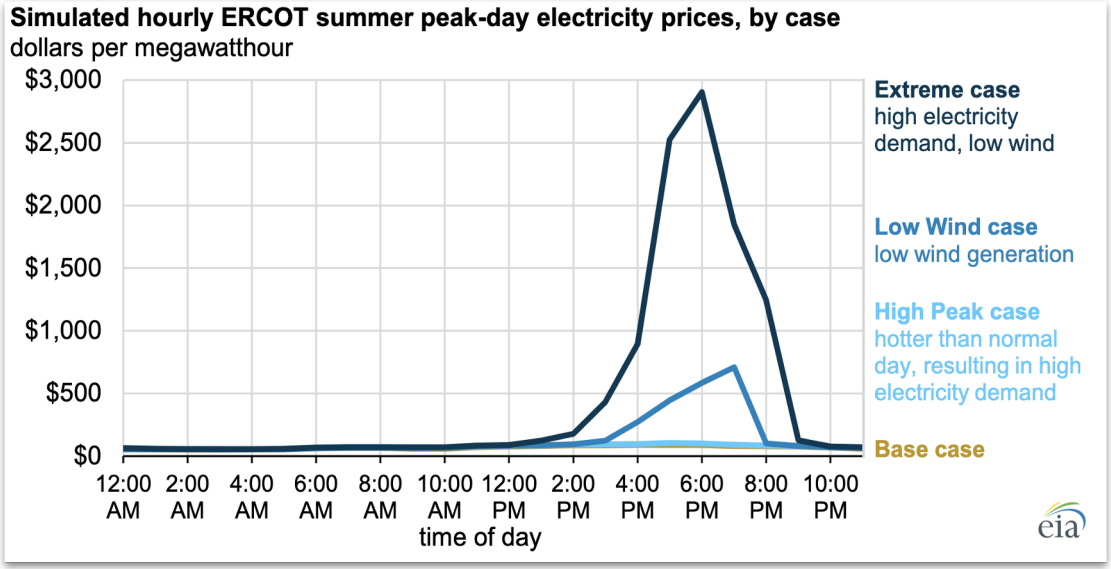
Outline

- REsurety Overview
- How REsurety Forecasts Power Prices
- **Impact of Extreme Weather on Power Prices**
- Challenges in Forecasting Tail Events
- Opportunities for Forecasting Tail Events

How Does Weather Affect Power Prices?

Power prices are inherently tied to the weather, especially when the weather is extreme. For example:

- **Demand**: Very hot and cold temperatures drive a need for energy to power warming and cooling, which increases prices
- **Generation**: Low wind speeds and clouds reduce renewable supply and also increase prices



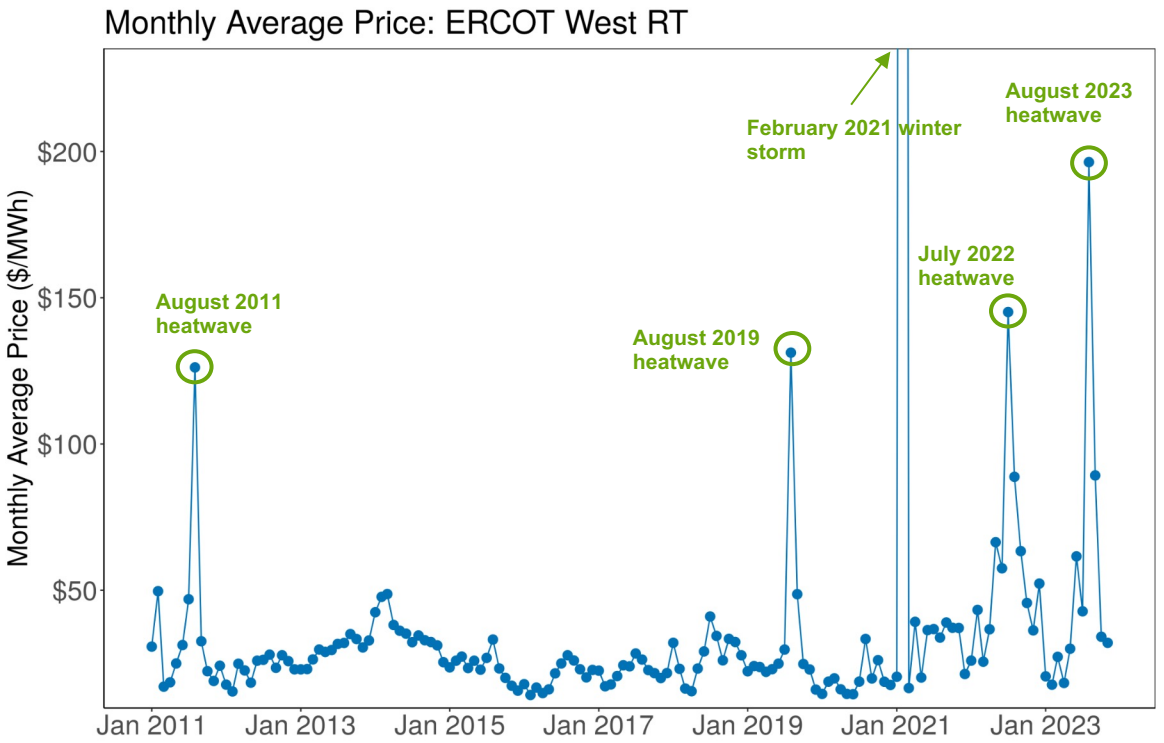
Data source: U.S. Energy Information Administration, *Sources of Price Volatility in the ERCOT Market*

Credit: Jessica Tomaszewski, Hot Grid Summer: Unpacking ERCOT's Unusually Warm Summer of 2023

Extreme Price Events in Recent History: ERCOT

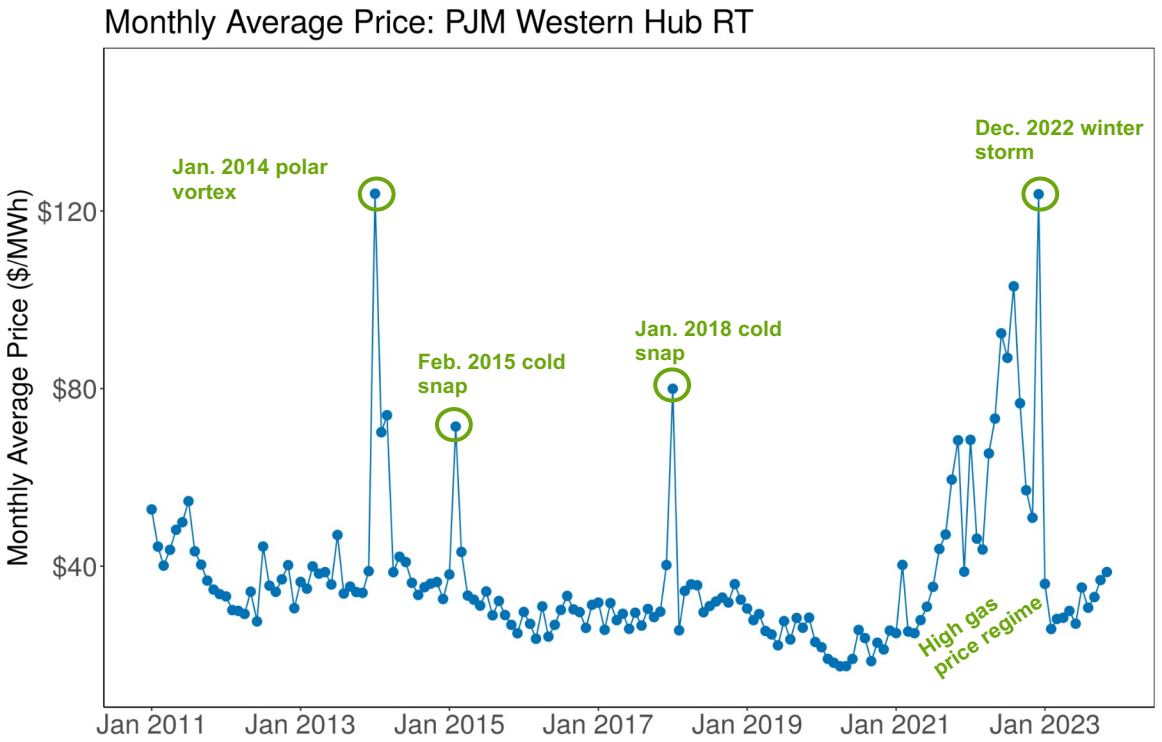
Extreme price events in ERCOT over the last 15 years can all be tied to extreme weather events.

Most of these extreme prices have occurred during heat waves, but extreme prices are becoming more frequent during cold snaps as well.



Extreme Price Events in Recent History: PJM

Extreme price events in the Northeast markets are largely tied to cold weather events (although high prices during heat waves aren't unprecedented).



Outline

- REsurety Overview
- How REsurety Forecasts Power Prices
- Impact of Extreme Weather on Power Prices
- **Challenges in Forecasting Tail Events**
- Opportunities for Forecasting Tail Events

Challenges in Forecasting Tail Events

Weather Data

- It's difficult to determine what's a tail weather event vs. the "new normal"
- Long-term weather models often underestimate variability

Grid Conditions

- The grid is rapidly changing - so even if we've experienced similar weather conditions in the past, we may not have experienced similar grid conditions
- There's a lot of uncertainty in future demand and renewable build-out

Fundamentals Modeling

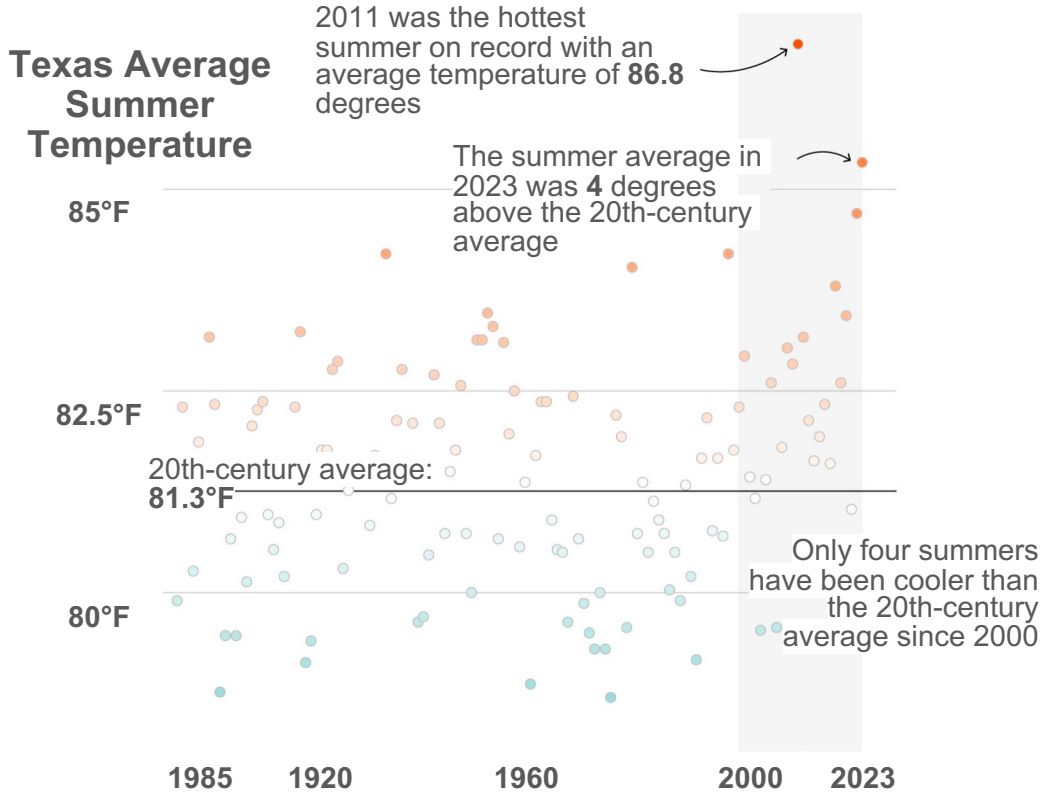
- Fundamentals models can't capture everything

Tail Event or the New Normal?

The summer of 2023 was historically hot for Texas, second only to 2011.

Only four summers have been cooler than the 20th-century average since 2000.

So was last summer a tail event or is this part of the **new normal**?

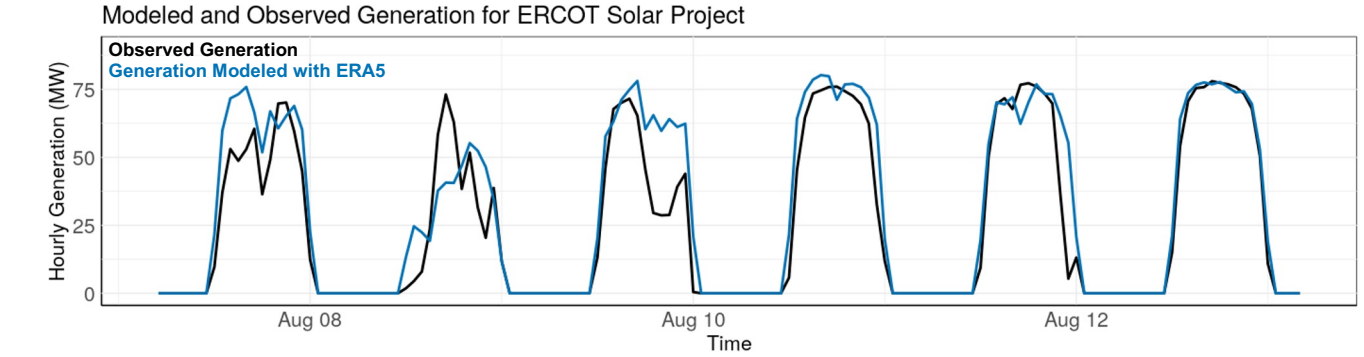


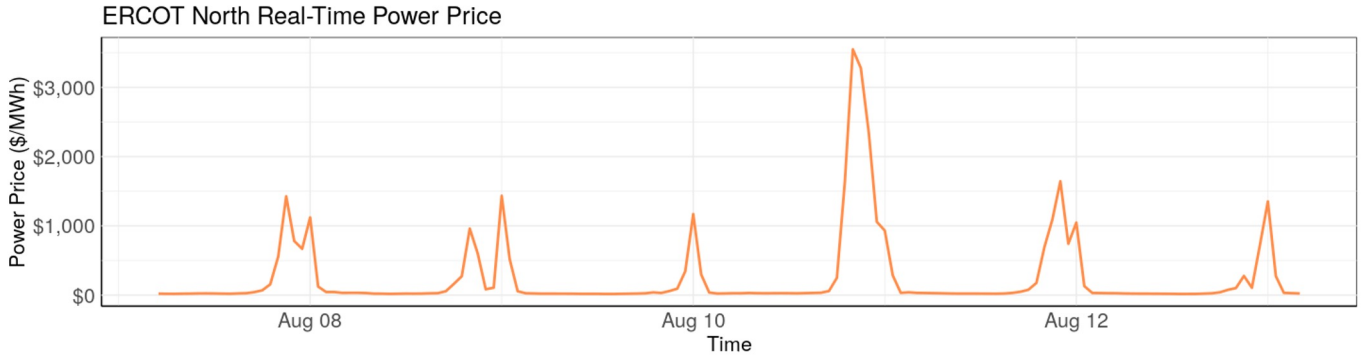
Sources: National Oceanic and Atmospheric Administration (1985-2022); John Nielsen-Gammon, Texas state climatologist (2023 estimate) – image adapted from the Texas Tribune

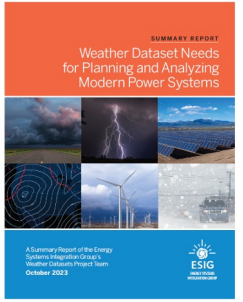
Credit: Jessica Tomaszewski, Hot Grid Summer: Unpacking ERCOT's Unusually Warm Summer of 2023

Weather Models May Underestimate Variability

Long-term re-analysis datasets (e.g., ERA5) don't have sufficient spatial resolution to capture small-scale weather patterns. These models often struggle to depict cloud cover, which has a large impact on solar generation.



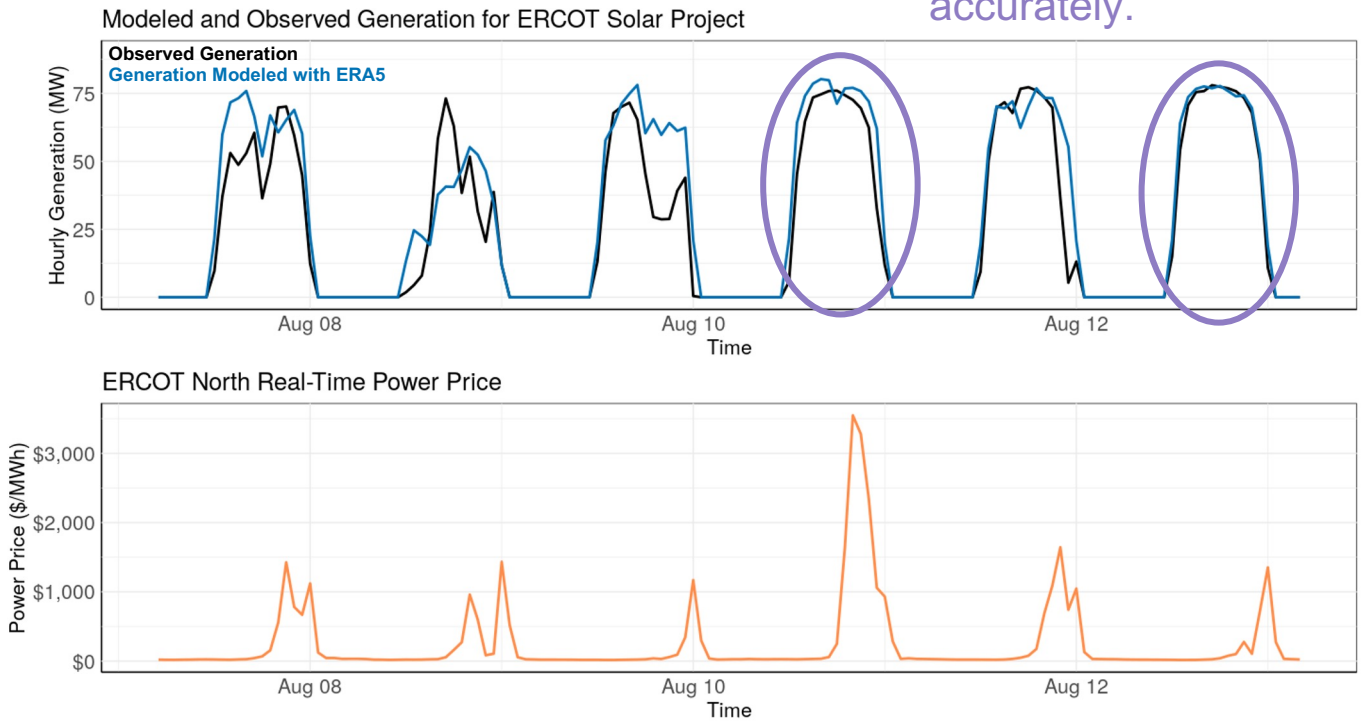




See the report for more detail!

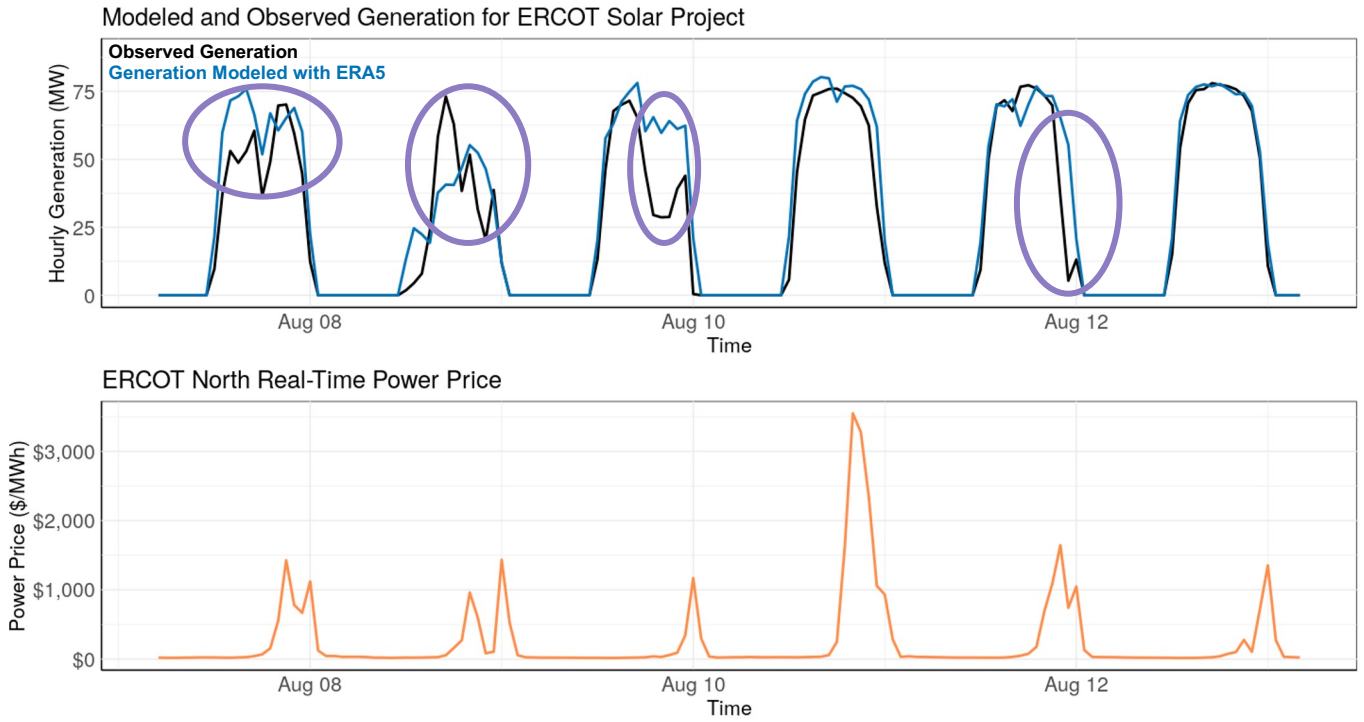
Weather Models May Underestimate Variability

On sunny days, ERA5 is able to depict generation fairly accurately.



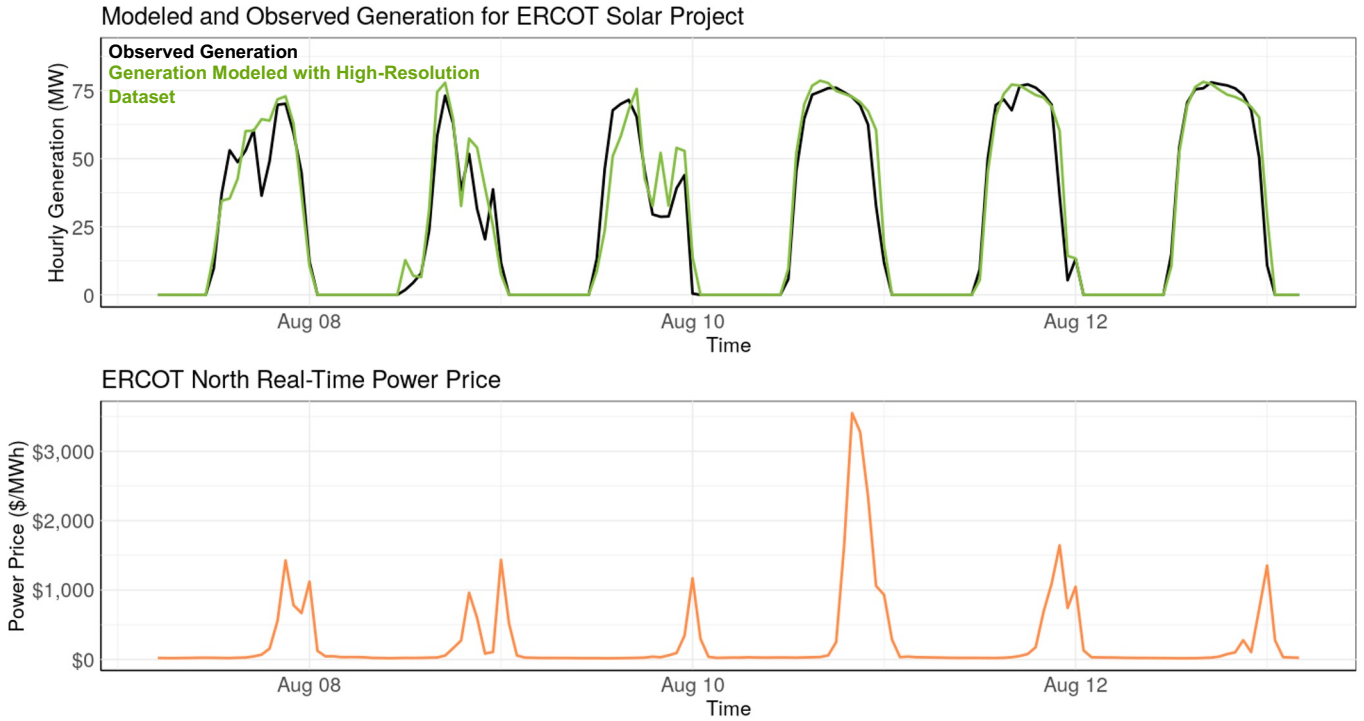
Weather Models May Underestimate Variability

On days with cloud cover, ERA5 often overestimates generation. These ramps in solar generation can have a significant impact on price during extreme events.



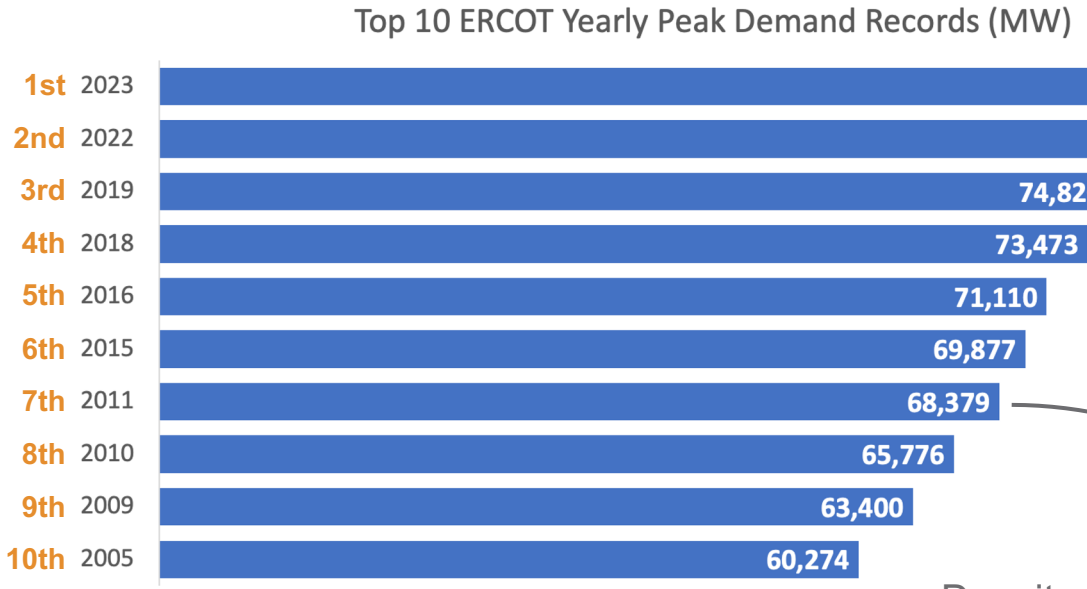
Weather Models May Underestimate Variability

High-resolution datasets are much better at capturing short-term generation variability due to cloud cover - but often don't have a record length long enough to capture the full range of historical weather variability.



We Don’t Have a Precedent

Even if we’ve experienced similar weather conditions in the past, we may not have experienced similar grid conditions.



ERCOT’s peak demand reached 85,508 MW on August 10, 2023 – a 7% jump from the highest-demand day last year and a new all-time demand record.

Despite 2011 having the hottest summer in Texas history, its annual peak demand ranks 7th, indicating a large increase in energy demand over the last 12 years.

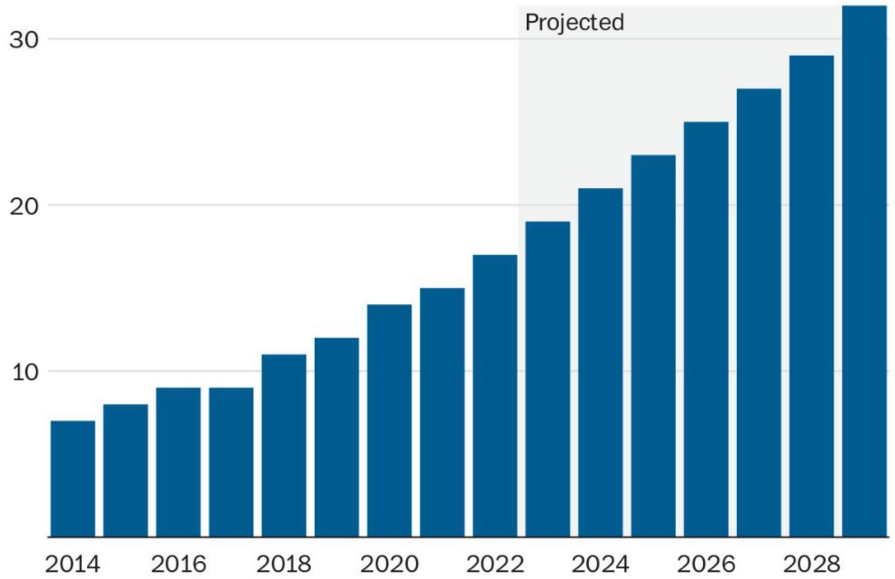
Credit: Jessica Tomaszewski, Hot Grid Summer: Unpacking ERCOT’s Unusually Warm Summer of 2023

Demand is Rapidly Increasing

- Significant data center-driven load growth is expected over the next several years
- There are many open questions about how the grid will serve that load
  - Can demand be served by current planned resources?
  - Will data centers operate with a flat load profile or will they follow incentives to operate when prices (or emissions) are low?

U.S. data centers tax the power grid

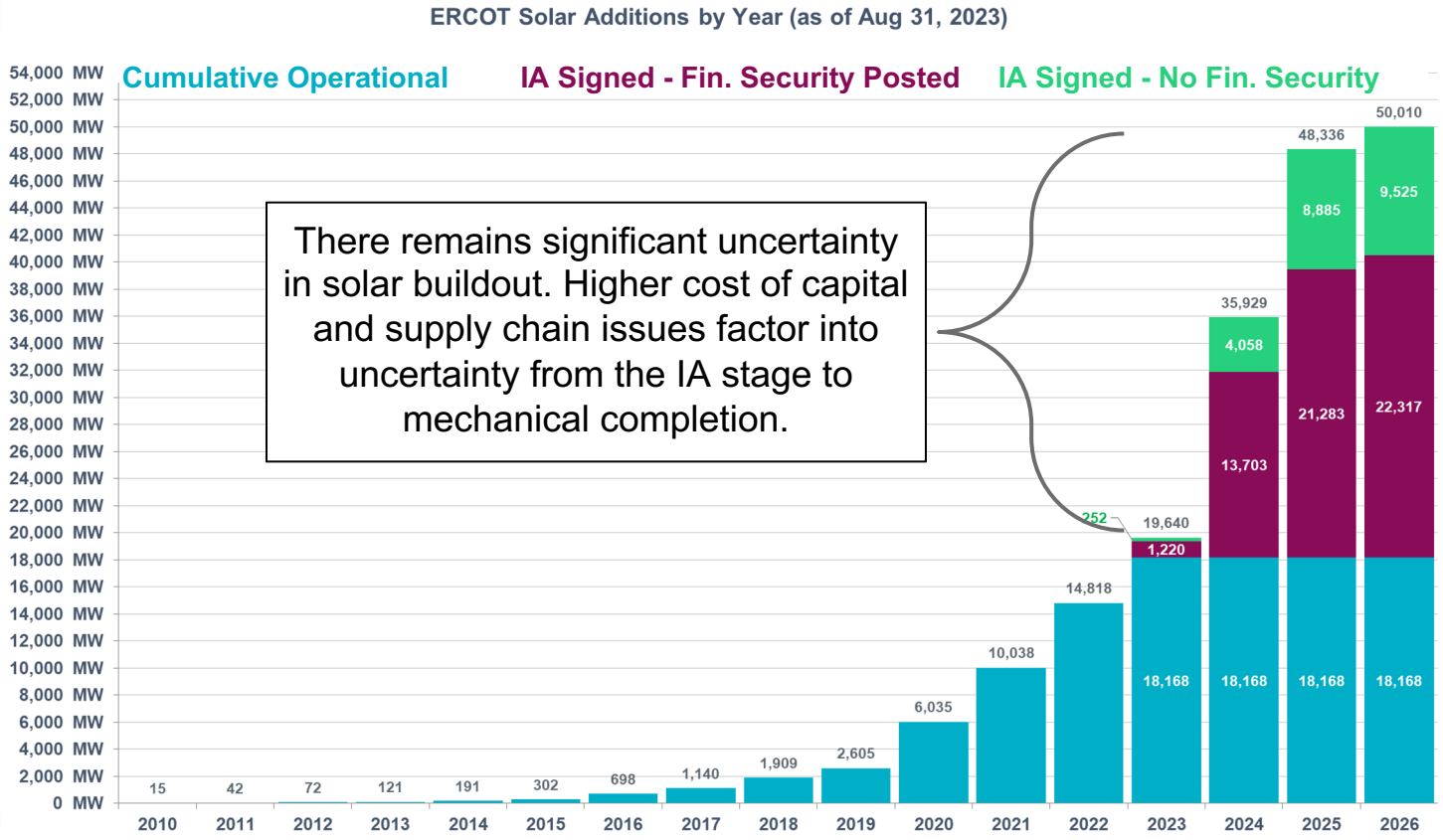
Data center energy demand, in gigawatts. Each gigawatt is roughly the amount of power generated by a large nuclear plant.



Source: McKinsey and Company, January, 2023.

More information: Amid explosive demand, America is running out of power

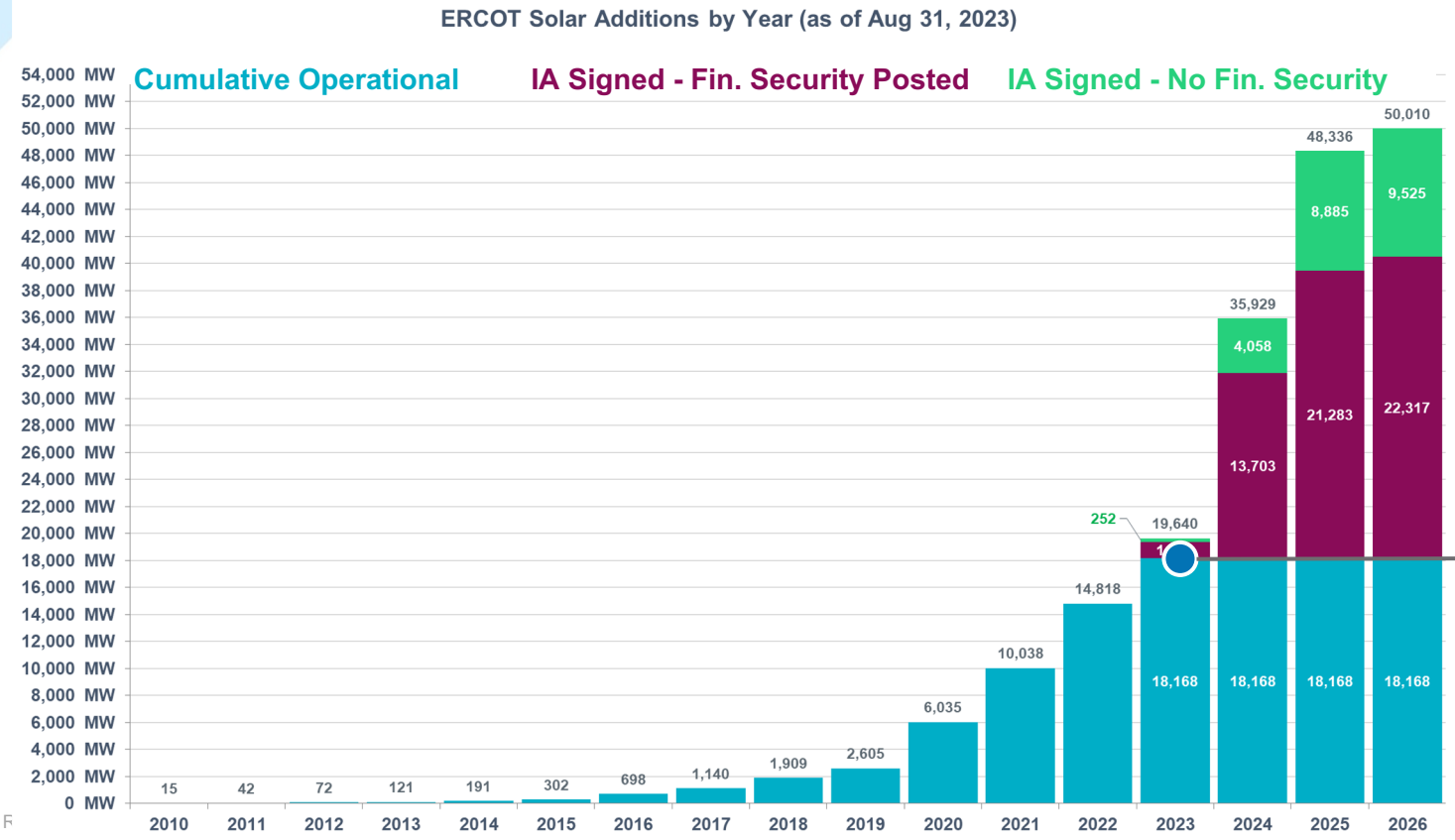
Getting Supply Right is Tricky



Credit: Amit Ranjan & DL Oates, Unpacking ERCOT Solar Capture Rates in REsurety's Weather-Smart Forecasts

Source

Getting Supply Right is Tricky

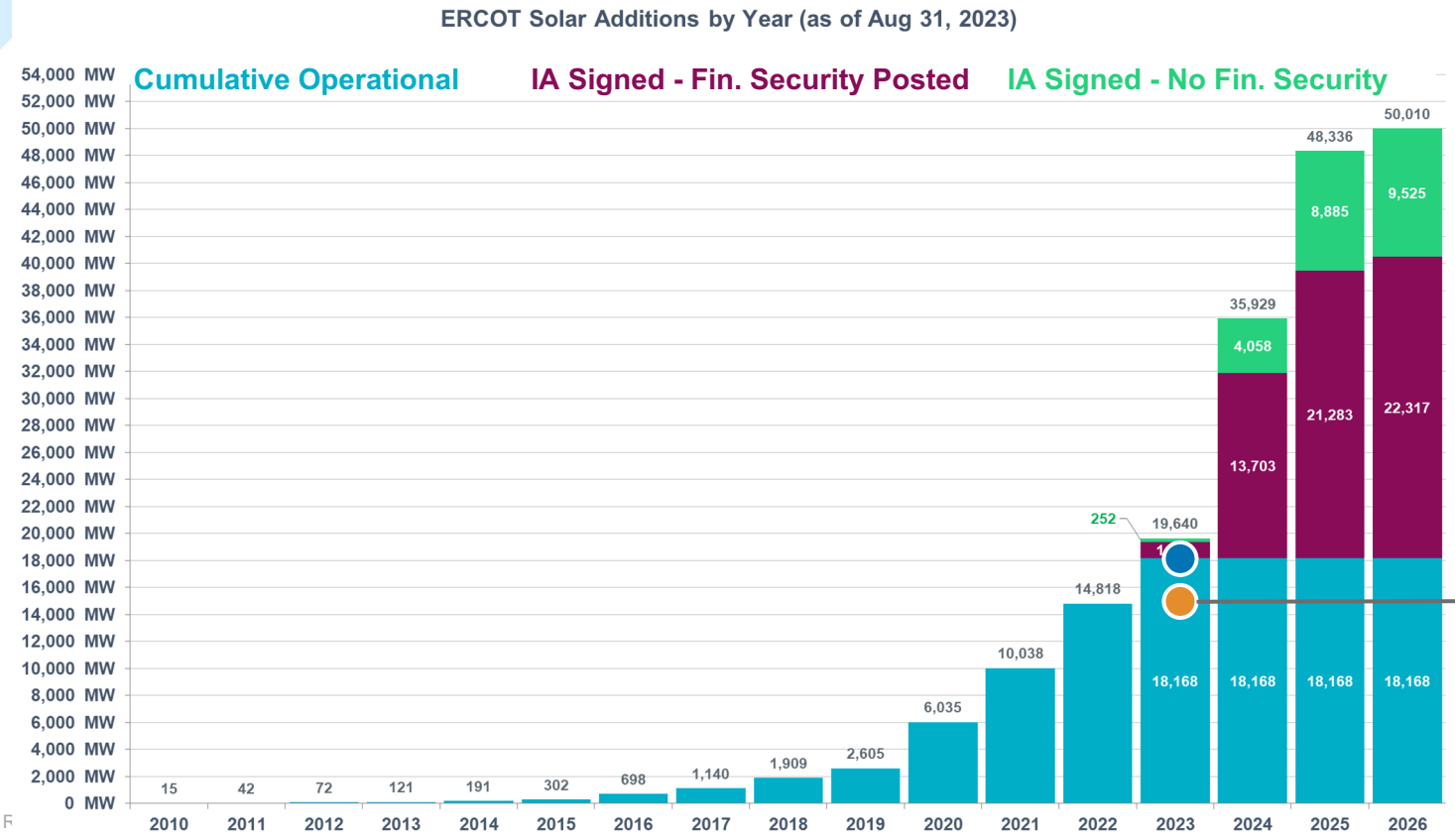


At the start of 2023, ERCOT solar capacity was forecasted to exceed 18 GW, with most of that capacity coming online prior to the summer.

Credit: Amit Ranjan & DL Oates, Unpacking ERCOT Solar Capture Rates in REsurety's Weather-Smart Forecasts

Source

Getting Supply Right is Tricky



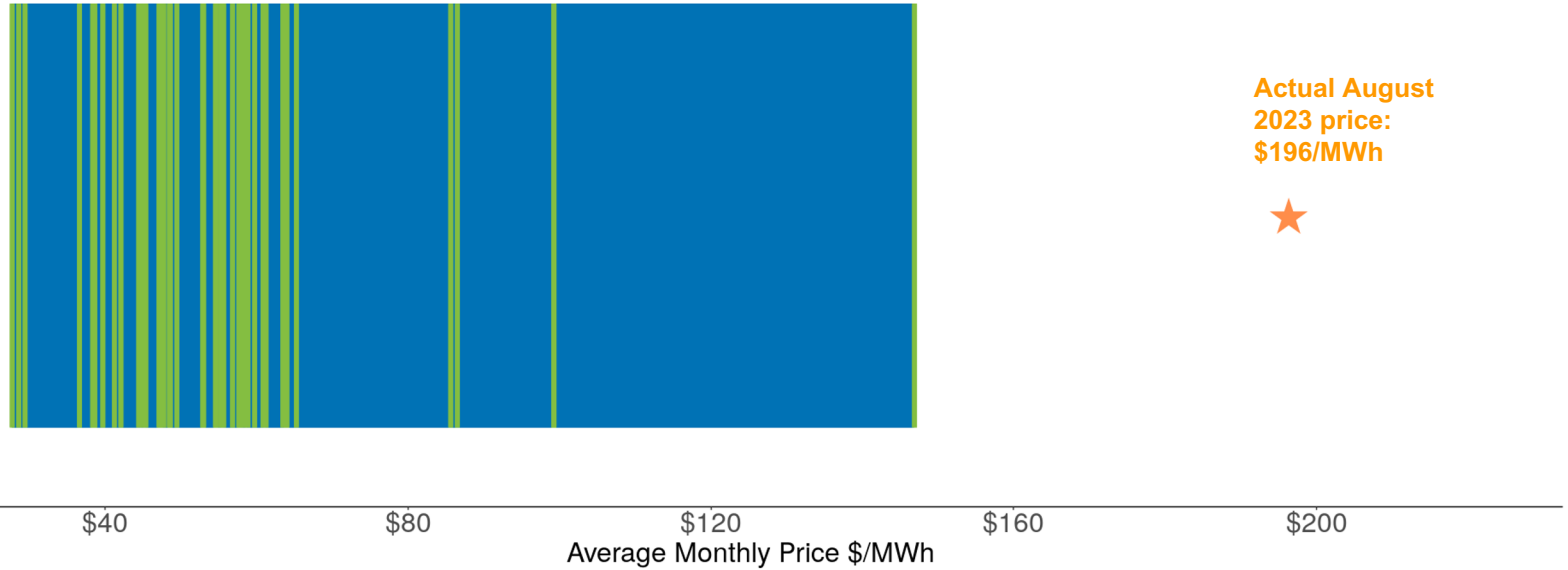
Maximum solar output in summer 2023 was closer to 14 GW.

Credit: Amit Ranjan & DL Oates, [Unpacking ERCOT Solar Capture Rates in REsurety's Weather-Smart Forecasts]

[Source]

Forecasted Prices for August 2023: 18 GW Installed Solar

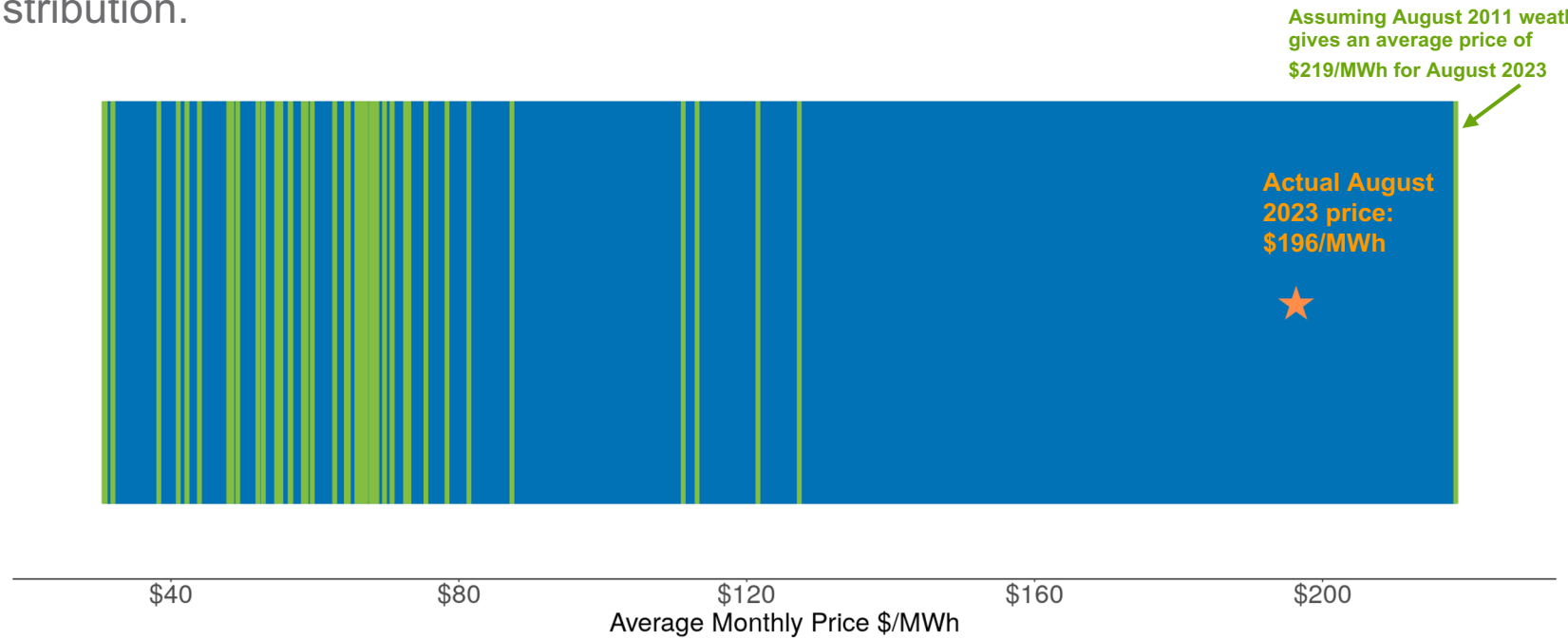
If we assumed the forecasted 18 GW of solar capacity all came online by the summer, our ERCOT West forecasted prices for August 2023 prices would have ranged from $28 to $147. The actual average August 2023 price would have been outside the distribution.



Bar: Range of values from Q3 Weather-Smart forecast
Lines: Individual weather year outcomes

Forecasted Prices for August 2023: 14 GW Installed Solar

Using the actual maximum solar output of 14 GW increases the tail of the forecasted price distribution significantly and shows that the August 2023 outcome does fall within the distribution.

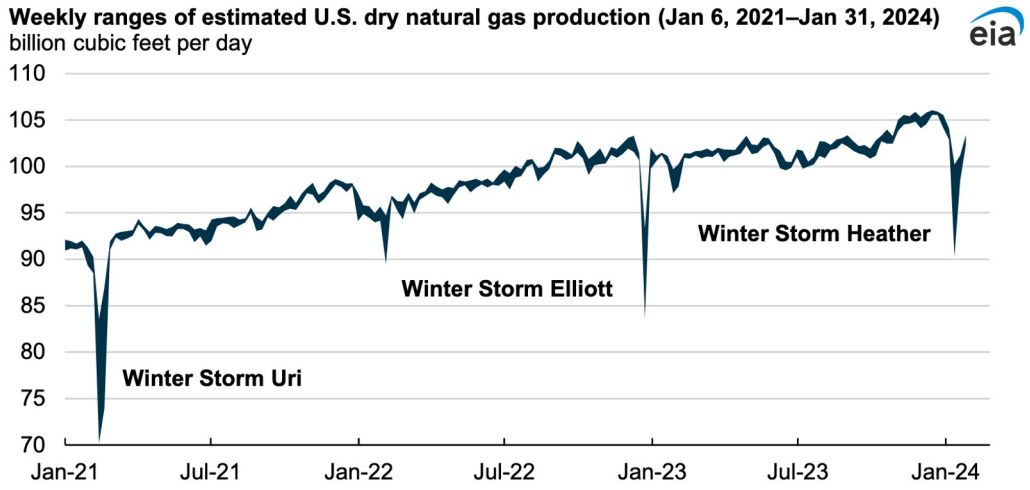


Bar: Range of values from Q3 Weather-Smart forecast
Lines: Individual weather year outcomes

Fundamentals Models Can’t Capture Everything

- Fundamentals models are used to simulate the operation of power markets - but they can’t capture everything with 100% accuracy

- For example:
  - Widespread impacts of cold weather on natural gas production and transportation
  - Effectiveness of demand response programs



Data source: S&P Global Commodity Insights

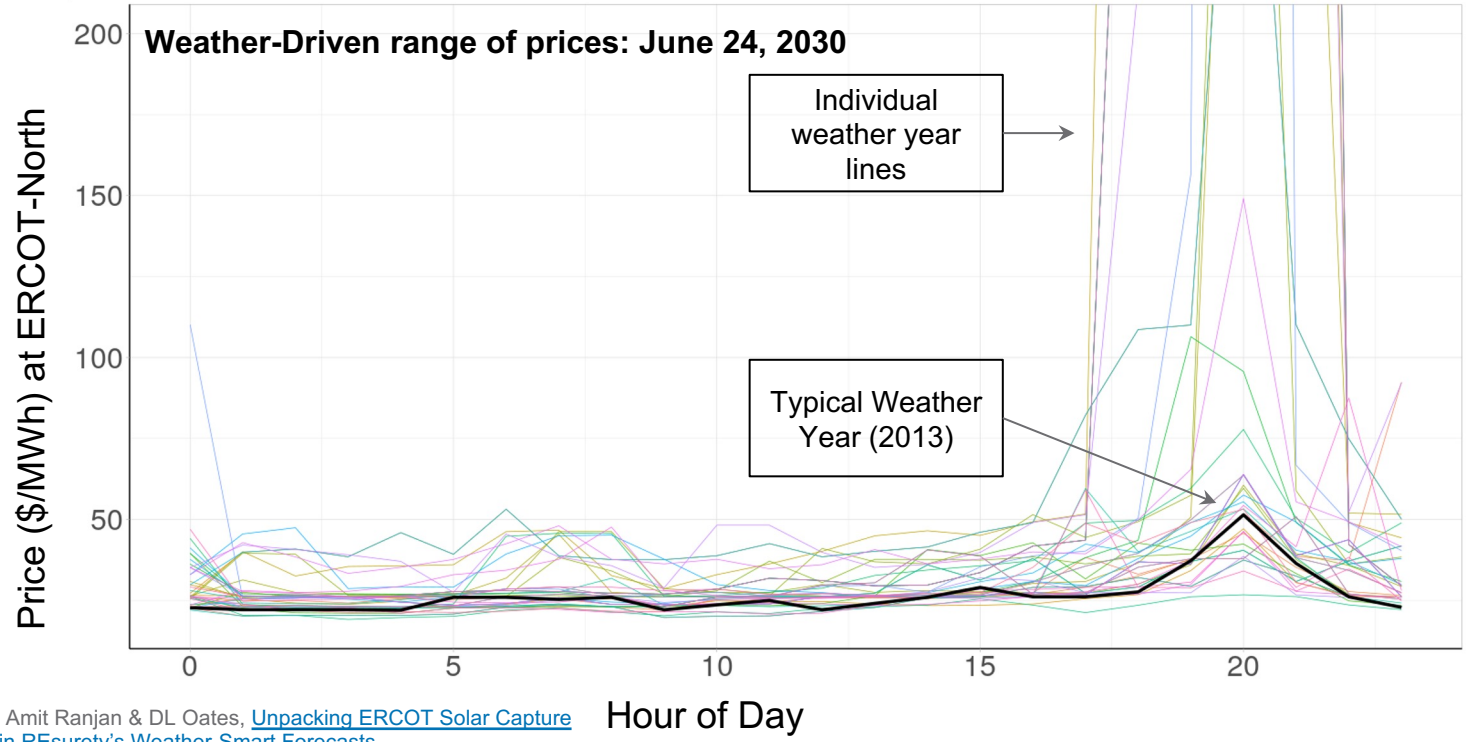
Source: Winter storms have disrupted U.S. natural gas production

Outline

- REsurety Overview
- How REsurety Forecasts Power Prices
- Impact of Extreme Weather on Power Prices
- Challenges in Forecasting Tail Events
- **Opportunities for Forecasting Tail Events**

Incorporate Weather Variability into Forecasts

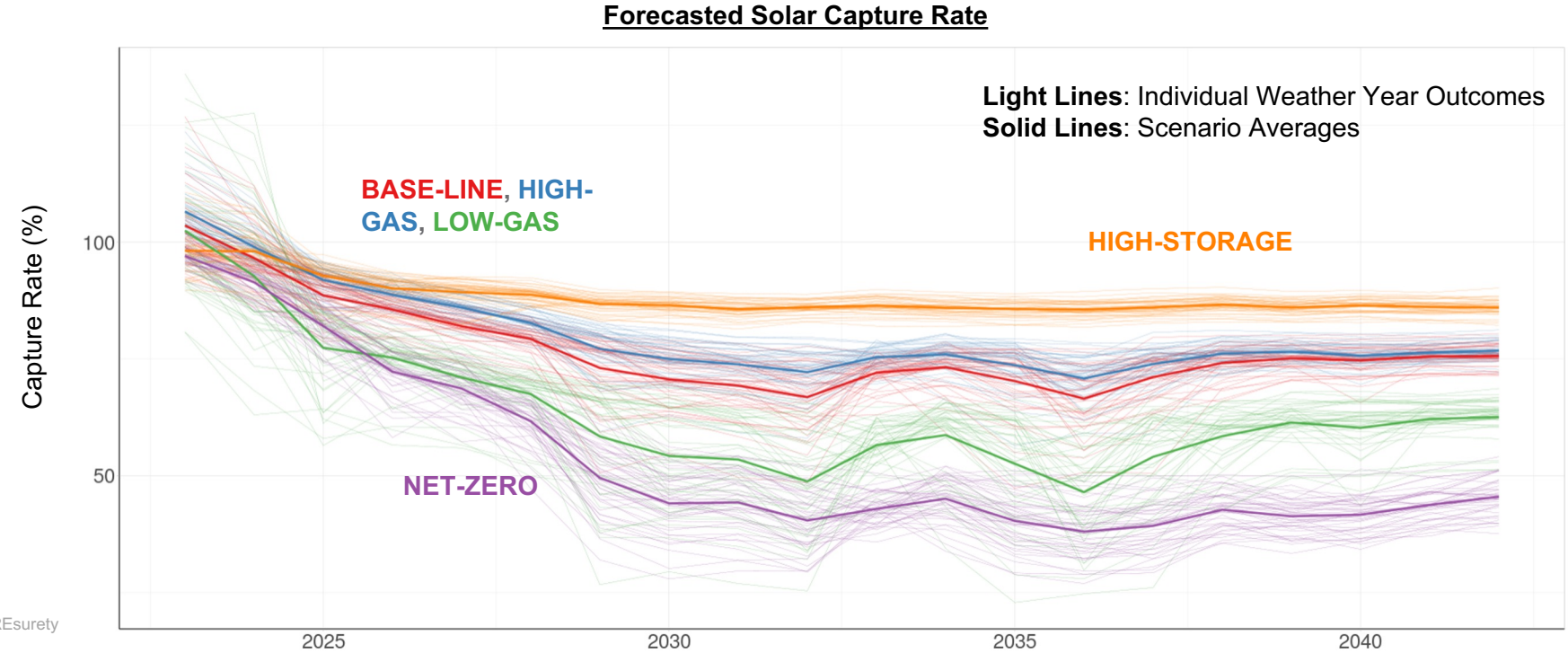
In order to capture tail events, it's necessary to simulate demand and generation under a variety of weather conditions.



Credit: Amit Ranjan & DL Oates, Unpacking ERCOT Solar Capture Rates in REsurety's Weather-Smart Forecasts

Incorporate Fundamentals Variability into Forecasts

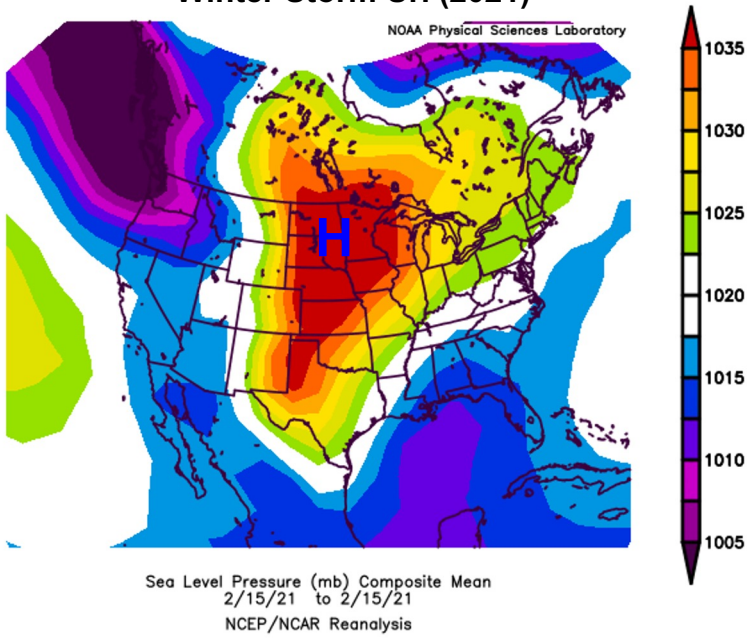
Fundamentals variability also drives variability in power prices and impacts the sensitivity of prices to different weather conditions.



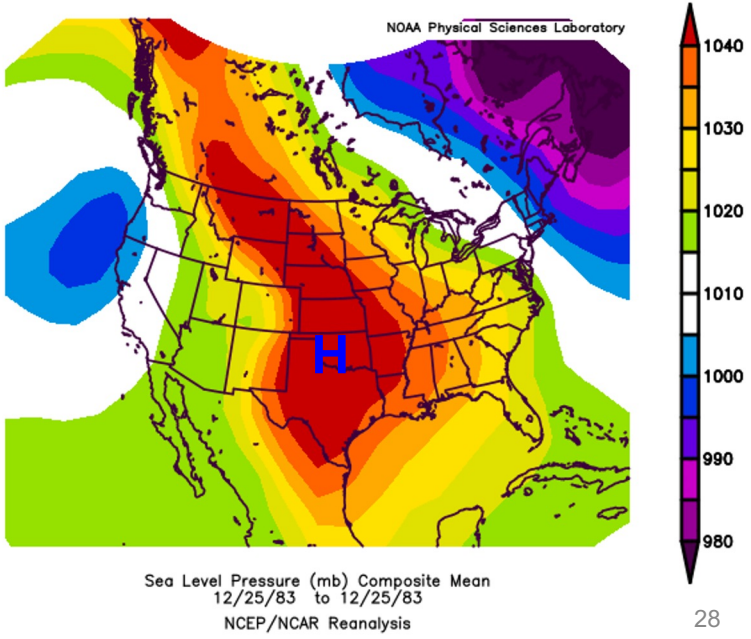
Account for Impact of Extreme Weather on Renewable Generation

The meteorological conditions that lead to extremes in demand can have adverse impacts on renewable generation - so it's important to understand these events and plan for them.

Winter Storm Uri (2021)

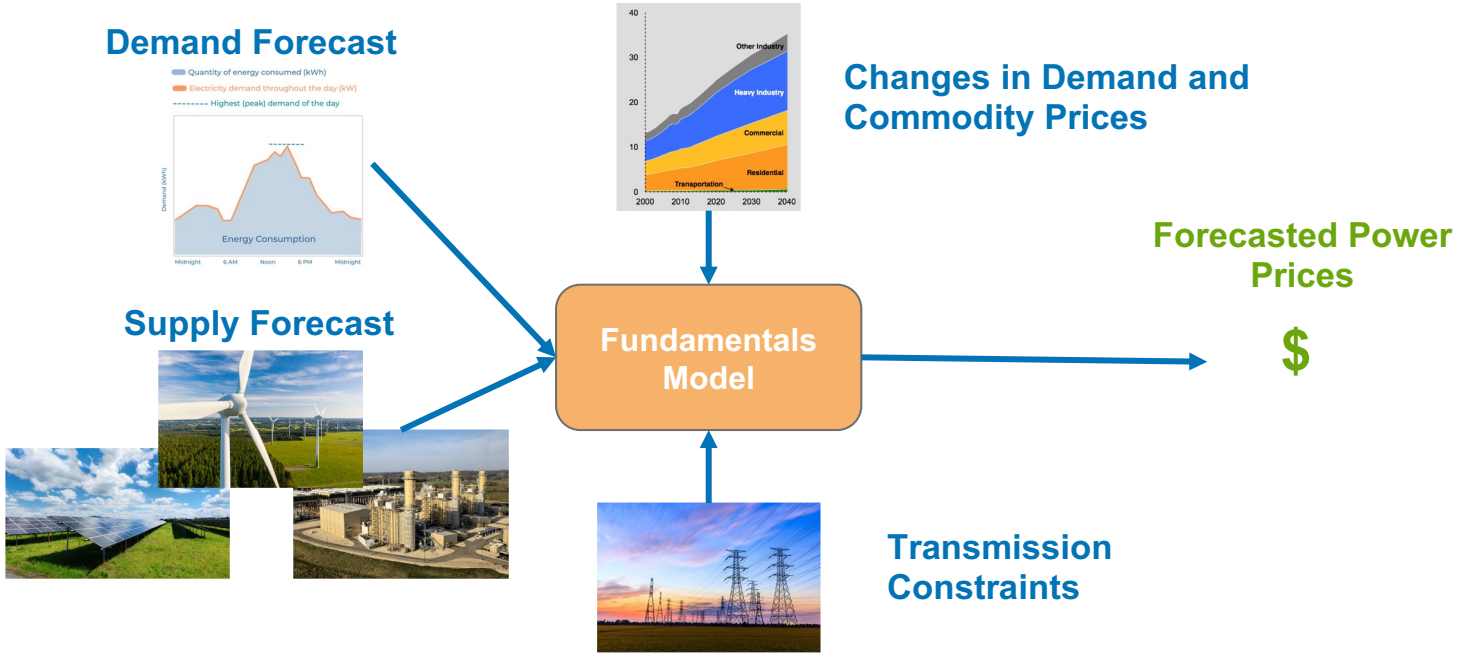


December 1983 Arctic Outbreak



Summary

- Uncertainty in supply and demand makes it challenging to forecast tail price events
- In a grid that's increasingly impacted by the weather, it's more important than ever to consider the impacts of weather and fundamentals variability on power prices



Jennifer Newman
jnewman@resurety.com

Contact us at info@resurety.com
or visit resurety.com to learn more

Disclaimer

DISCLAIMER: This presentation contains information related to REsurety, Inc. and the commodity interest derivatives services and other services that REsurety, Inc. provides. Any statements of fact in this presentation are derived from sources believed to be reliable, but are not guaranteed as to accuracy, nor do they purport to be complete. No responsibility is assumed with respect to any such statement, nor with respect to any expression of opinion which may be contained herein. The risk of loss in trading commodity interest derivatives contracts can be substantial. Each investor must carefully consider whether this type of investment is appropriate for them or their company. Please be aware that past performance is not necessarily indicative of future results.

All information, publications, and reports, including this specific material, used and distributed by REsurety shall be construed as a solicitation. REsurety does not distribute research reports, employ research analysts, or maintain a research department as defined in CFTC Regulation 1.71.