



POLARIS
SYSTEMS OPTIMIZATION

Getting the Tails into Economic Planning:
Do Traditional Tools Work with the Changing
Resource Mix?

Russ Philbrick
ESIG Spring Meeting
March 16, 2021

Why do the tails matter?

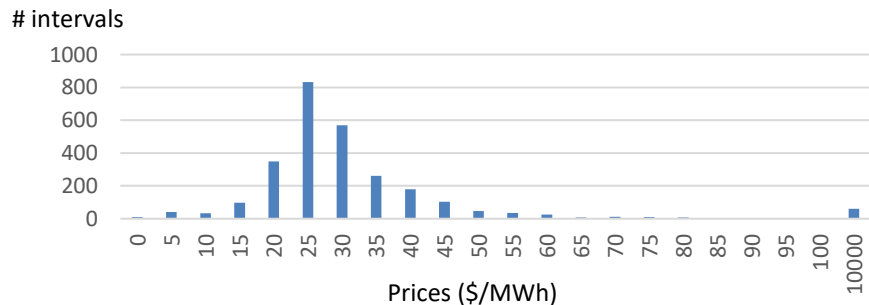
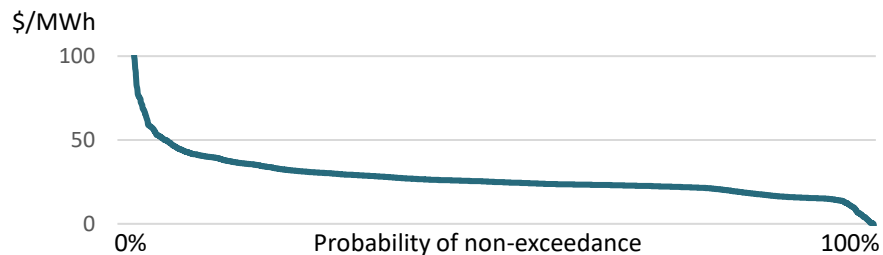
- **Tails identify the most-costly extreme events (economics and reliability)**
- **Impact of tails depend on operations**
- **System conditions are changing: past simplifications not valid**
- **Need appropriate models, otherwise answers are wrong!!**

Using a range of different project results, we will review each of these topics to identify the planning problems.

What are the tails?

Extremes in size or rate of change in load or generating capacity. In markets, these may result in high or low prices.

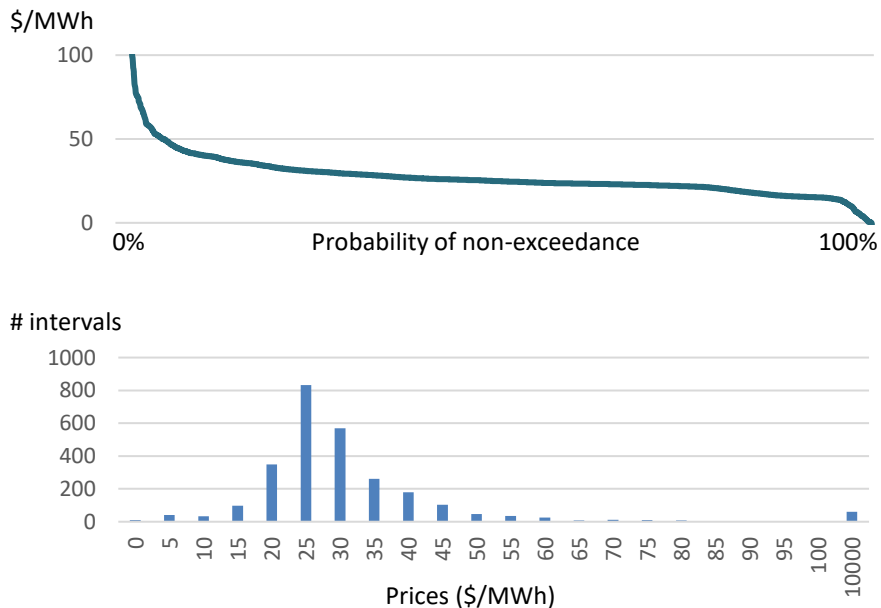
Example: ERCOT Real Time prices, February 2011



What are the tails?

Extremes in size or rate of change in load or generating capacity. In markets, these may result in high or low prices.

Example: ERCOT Real Time prices, February 2011



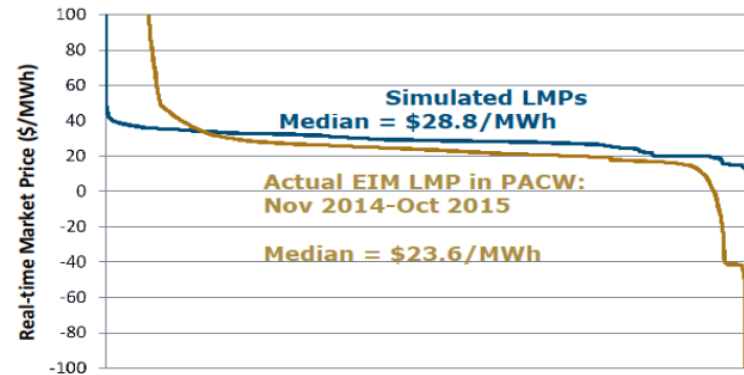
Simulating the impact of tails can be difficult.



Simulated Prices Fail to Capture Real-World Volatility

Modeled:
68% of intervals within +/- \$5/MWh from median; 93% of intervals within \$10/MWh

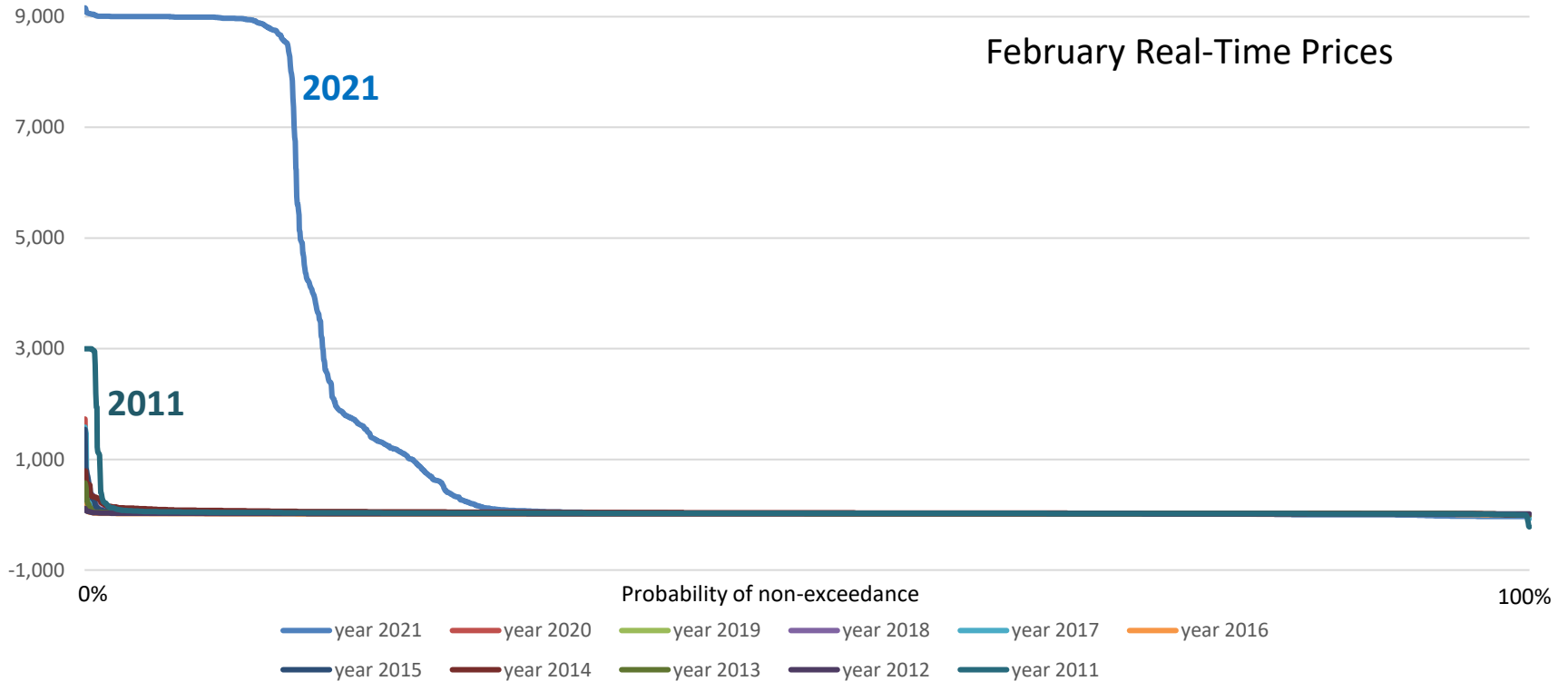
Actual:
54% of intervals within +/- \$5/MWh from median; 73% within \$10/MWh



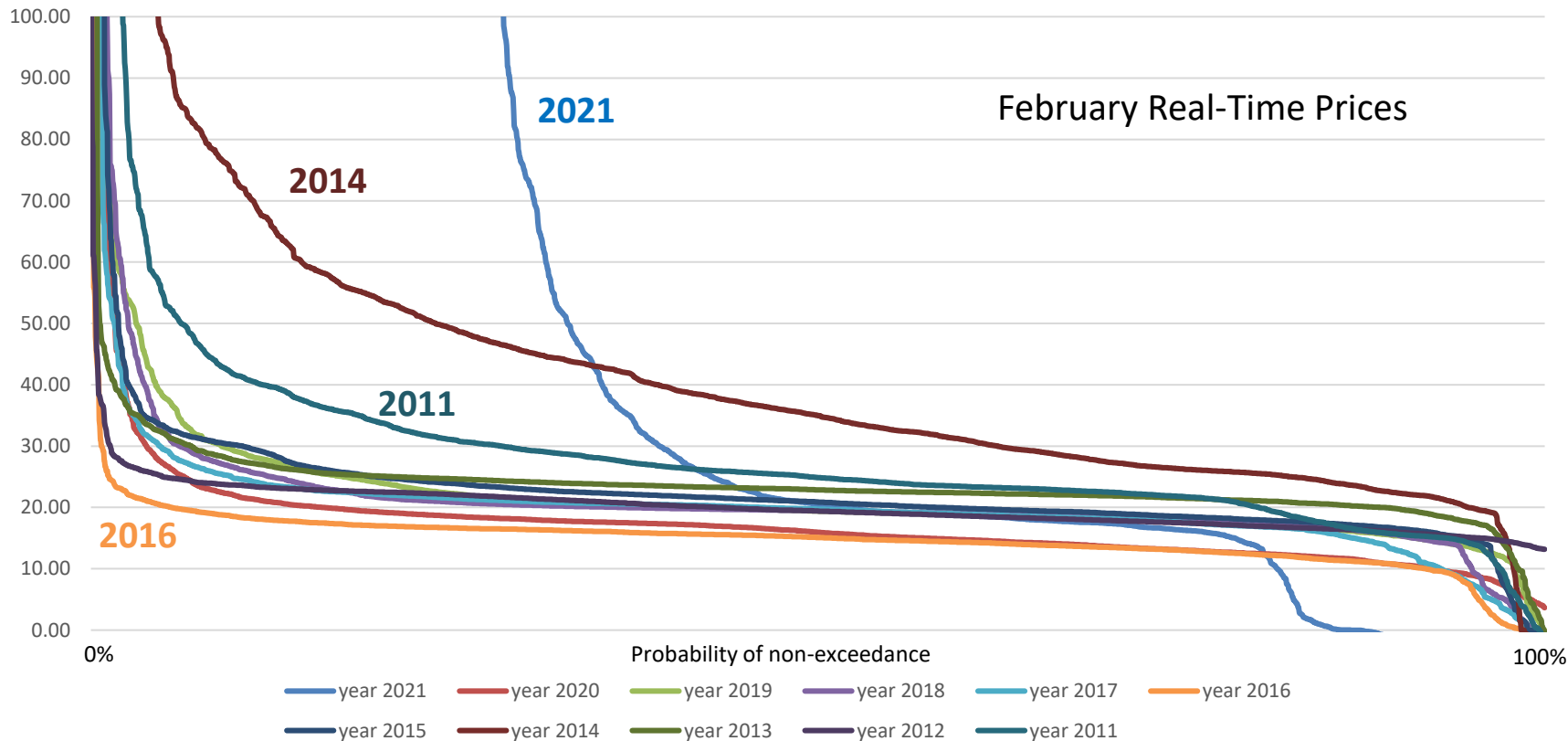
Energy Environmental Economics

Nick Schlag, E3, ESIG Spring Workshop, April 26, 2016, Sacramento, CA.

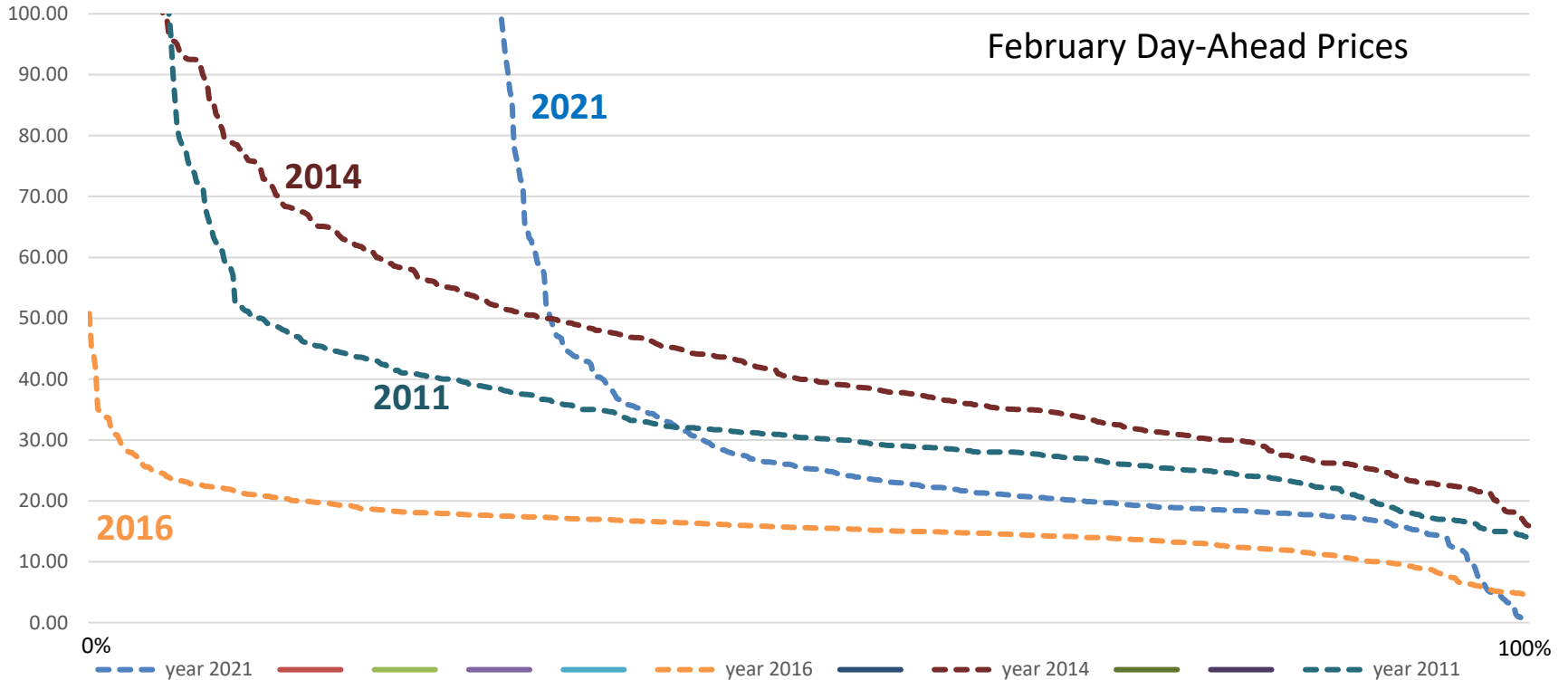
ERCOT Real Time Prices 2010 to 2021



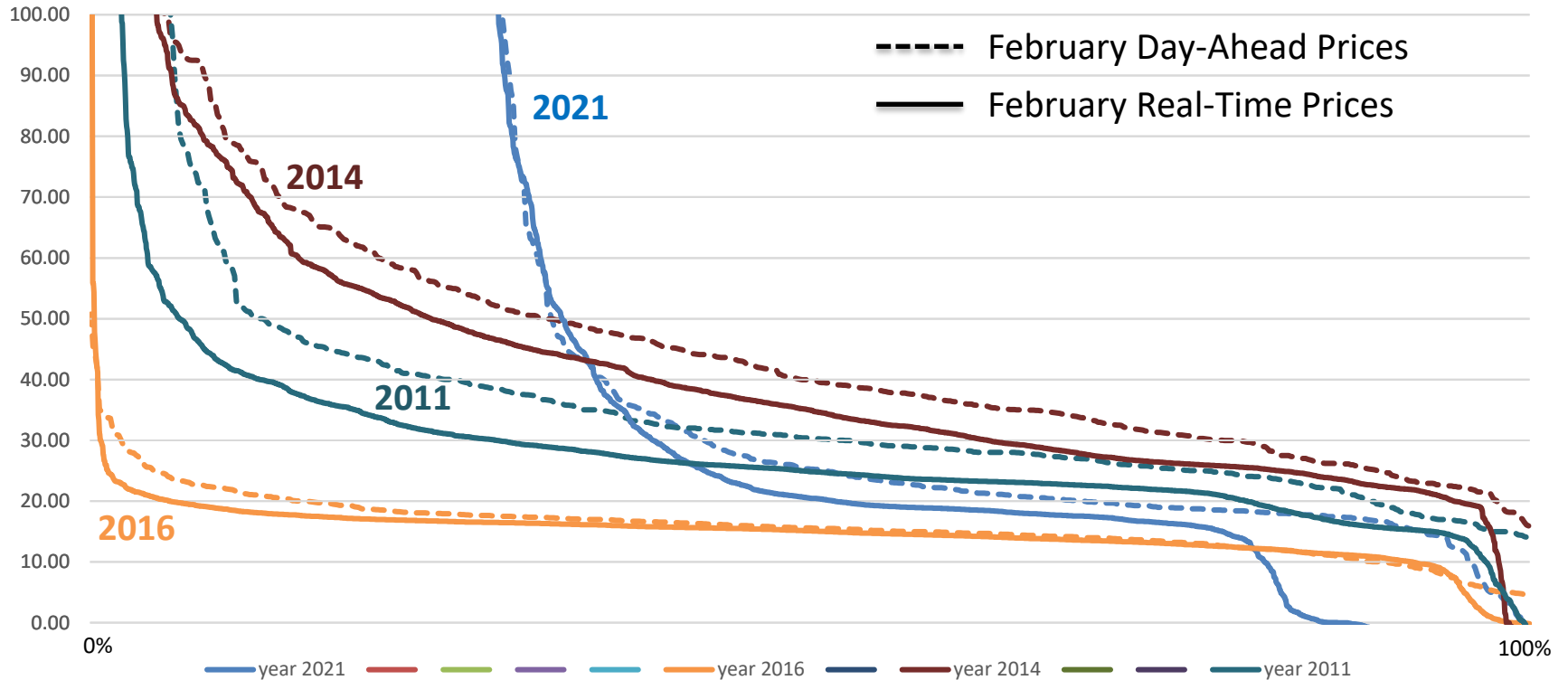
ERCOT Real Time Prices: A Closer Look



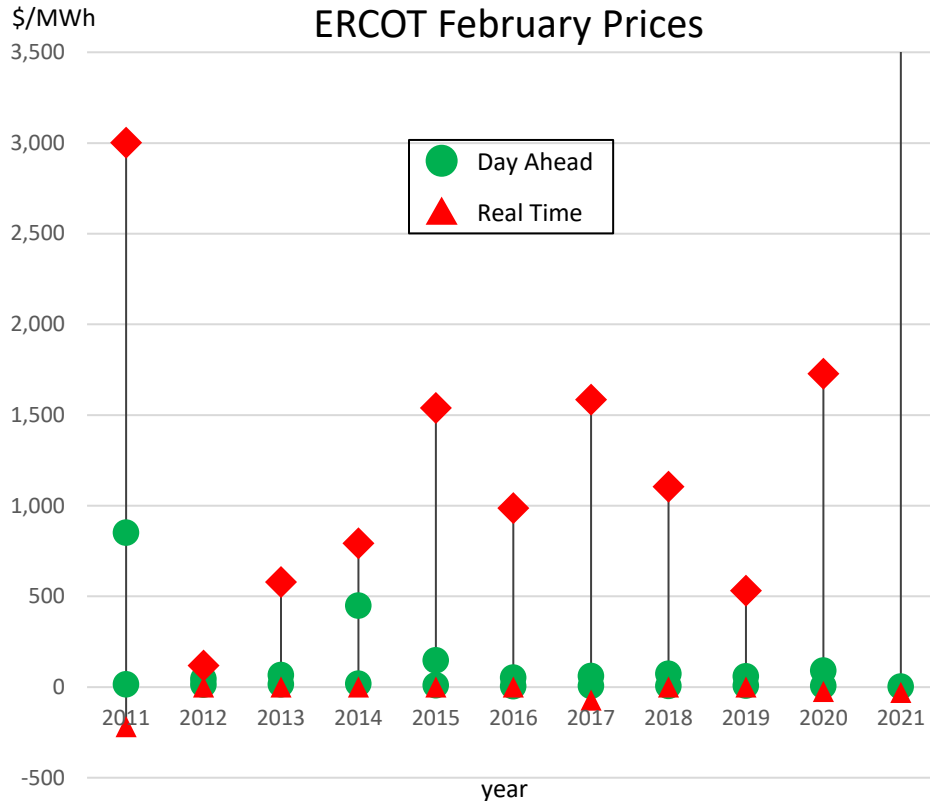
Day-Ahead prices are similar



... but different: Why?

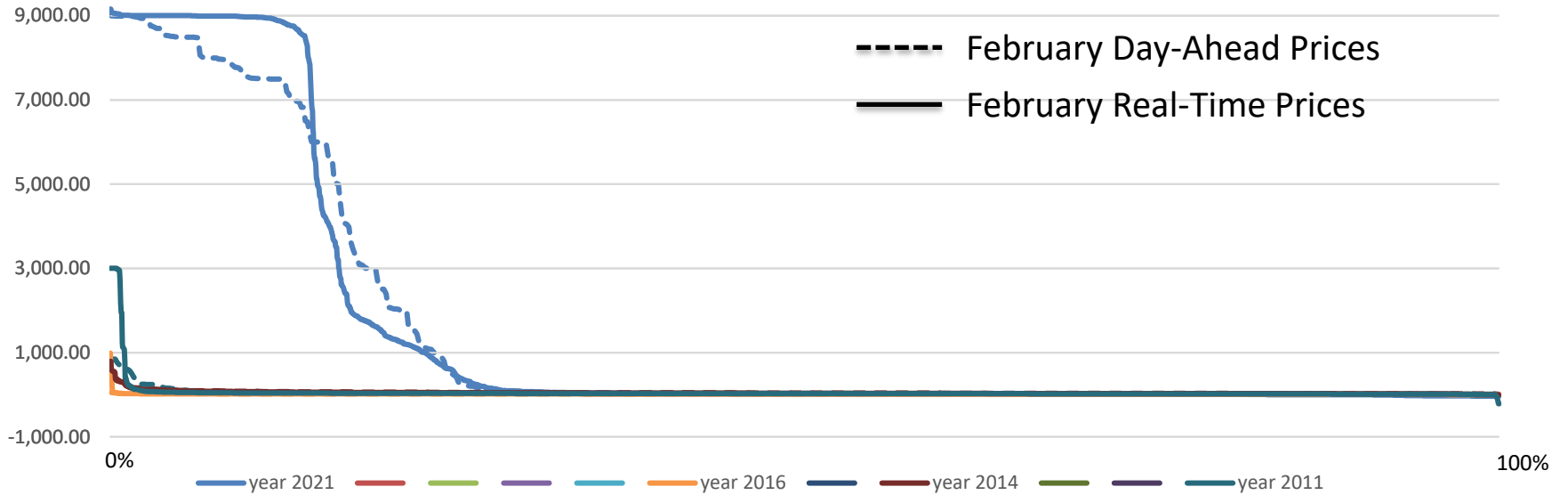


DA and RT Minimum and Maximum Prices

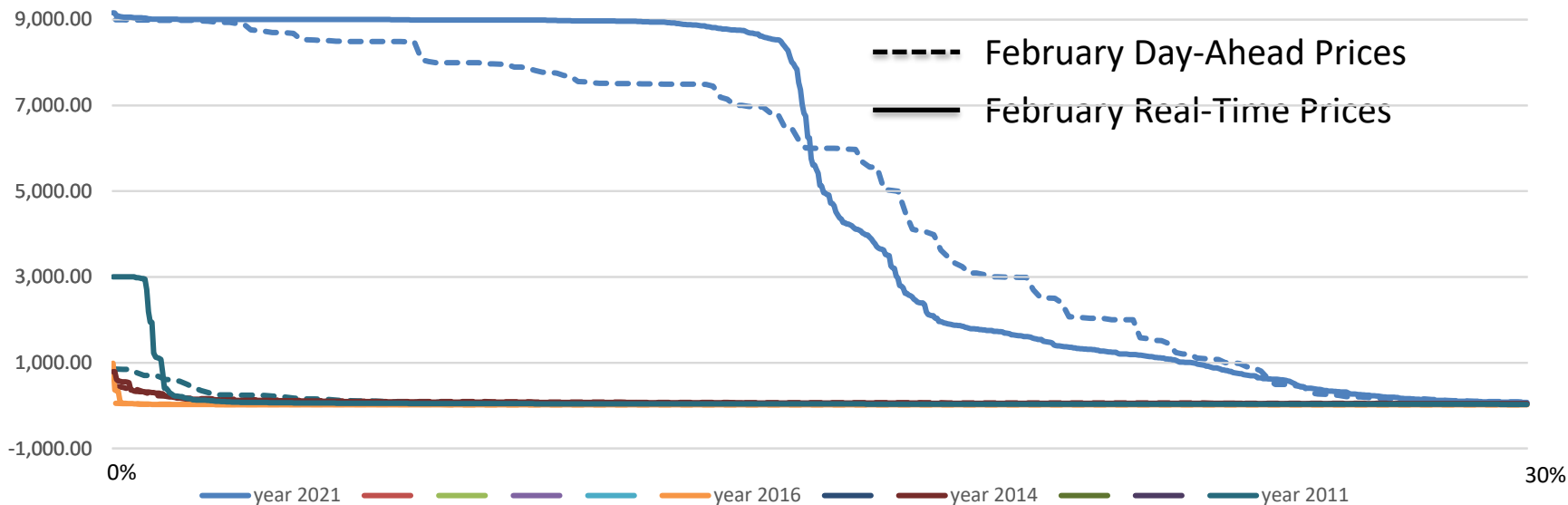


- Median prices higher in DA
- More extreme prices in RT
- Total revenues roughly similar (due to virtual trading)

DA and RT Prices: It's all about the tails



DA and RT Price Duration Curves



Observations:

- Median prices higher in DA
- More extreme prices in RT
- Total revenues roughly similar (due to virtual trading)

Who manages the tails?



The largest and oldest *power* cooperative in *Texas* is filing for *bankruptcy* protection, citing last month's winter storm that left millions without ...

Who manages the tails?

In short ... **EVERYONE!**

- Tails are a result of the collective impact of all parties: loads, generators, operators, planners, traders, regulators, states, federal agencies, ...
- ... and everyone has a role in managing the tails

However, **NOT everyone has an equal role**

- Risk management is difficult. There is a reason we buy insurance
- Those who can manage risk should be allowed to, but we should not insist on this
 - “buyer beware” not sufficient when folks do not have information and bandwidth
- Impacts of failures depend on planning and operations

“It’s the **process**, not the people”

Managing tails begins with planning

... **outcomes** depend on **operations**

... **operations** depend on **planning**

... **planning** depends on simulations of future **outcomes**



Managing tails begins with planning

... **outcomes** depend on **operations**

... **operations** depend on **planning**

... **planning** depends on simulations of future **outcomes**

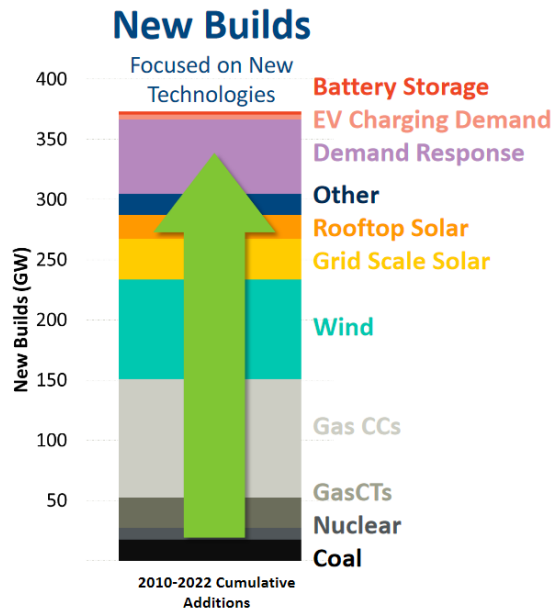
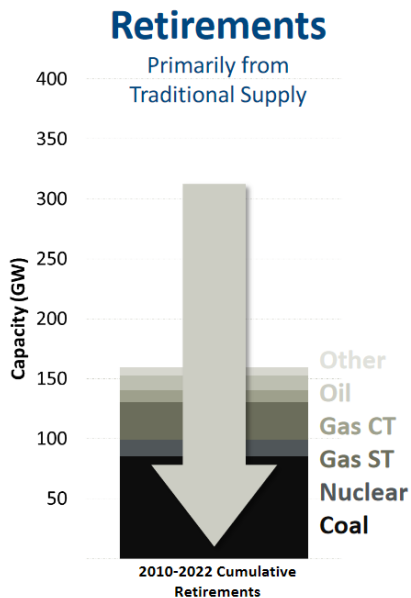


This impacts all planning processes

- Transmission expansion
- Generation expansion
- Asset valuation
- Resource adequacy
- Maintenance scheduling
- Production-cost modeling
- Market Design
- “Week-ahead” scheduling
- Day-ahead scheduling
- Reliability scheduling
- Real-time scheduling

Traditional planning assumptions are no longer valid

New Technologies & Engaged Customers
Are Rapidly Overtaking Traditional Supply



Data Source: Energy Velocity Suite (US and Canadian generation) and Brattle research (US-only distributed resource and storage).

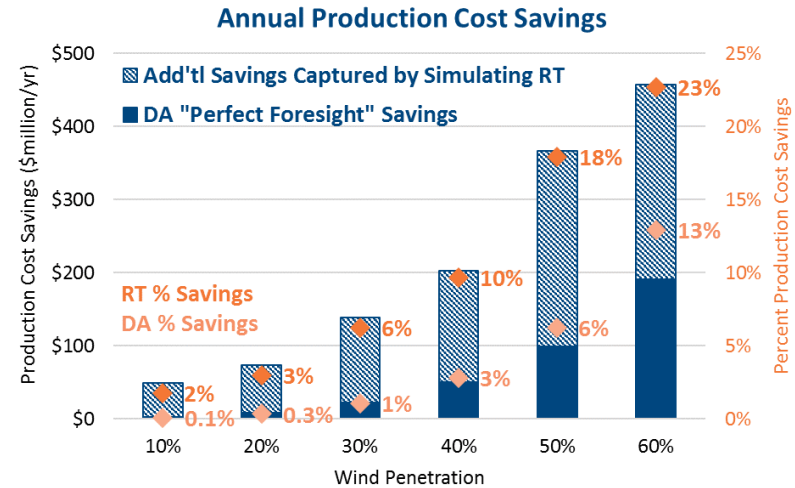
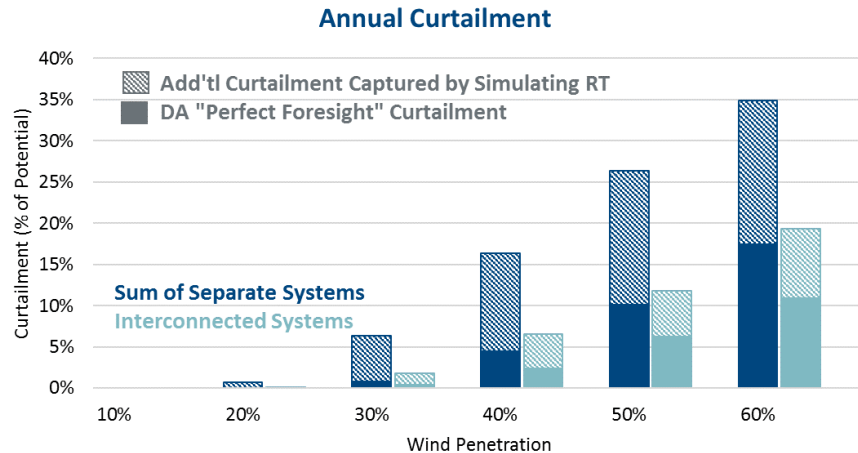
brattle.com | 2

Kathleen Spees, The Brattle Group, The Cutting Edge in Resource Planning, Solar Energy Industries Association, November 12, 2018

Traditional planning misses operational impacts

Impact on value of new transmission

“When real-time uncertainties of renewable generation are taken into consideration, the benefit of geographic diversification through the transmission grid are 2 to 20 times higher than benefits quantified only based on “perfect forecasts” under day-ahead market conditions.”



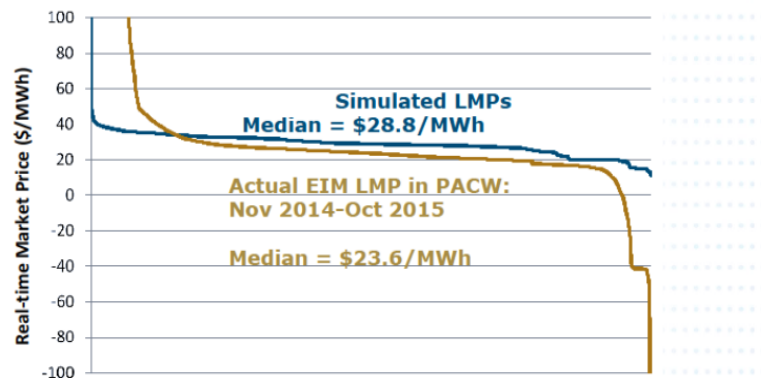
How do operations impact tail events?



Simulated Prices Fail to Capture Real-World Volatility

Modeled:
68% of intervals within +/- \$5/MWh from median; 93% of intervals within \$10/MWh

Actual:
54% of intervals within +/- \$5/MWh from median; 73% within \$10/MWh

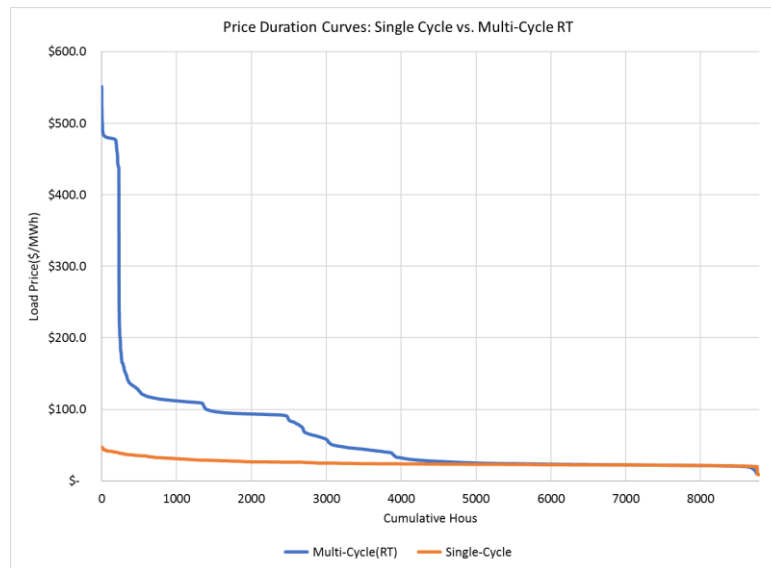


Energy+Environmental Economics

1

Nick Schlag, E3, ESIG Spring Workshop, April 26, 2016, Sacramento, CA.

- Missing simulation of operational process
- Missing impacts of uncertainty on operations



Results courtesy of EPRI and TCR

- Extreme prices (“tails”) seen in real-time prices of a multi-cycle simulation are not seen in a single-cycle simulation
- RT sees ramping of units responding to DA forecast errors (e.g., loads, wind, solar, outages)
- RT sees deployments and violations of reserves

Planning Problem: “Operations Not Included”

Control-room decisions have evolved but planning has not kept up

- Range of decision processes: week-ahead, day-ahead, real-time, intra-day, ...
- Procurement and deployment of reserves
- Recourse and non-recourse decisions (i.e., provisional and final decision)

Traditional planning often does not simulate **operational impacts**

- Zonal vs nodal (e.g., missing transmission “security constraints”)
- Simplified metrics (e.g., peak capacity)

“Multi-Cycle” Modeling is one of the critical elements needed to model operational impacts (see results presented earlier).

- This is how you simulate cost of caution on planning decisions
- ... and the success of those decisions in operations

Challenging Questions

What are benefits of

- Transmission expansion?
- Flexible transmission control? (FACTS, DLR, active switching, ...)
- Peaking vs Baseload generation?
- Different types of storage?
- Load response and/or price-responsive load?
- Energy efficiency?
- Better forecasts?
- Changing how we operate the grid ?

If you don't capture impact in planning, answers are wrong!!