



WEBINAR





# Managing Renewables and Storage in Modern Energy Portfolios

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cQuant.io



NAEMA Webinar  
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# Session Outline

- What makes an energy portfolio “modern”?
- Complexity, risk, and diversification.
- Analytical techniques for the modern portfolio.



# cQuant.io – Analytics on Demand

**cQuant provides superior analytic tools in a cloud-native web platform.**

*Choose your models, design your workflow.*

*Take control of your analytics!*

## cQuant works with:

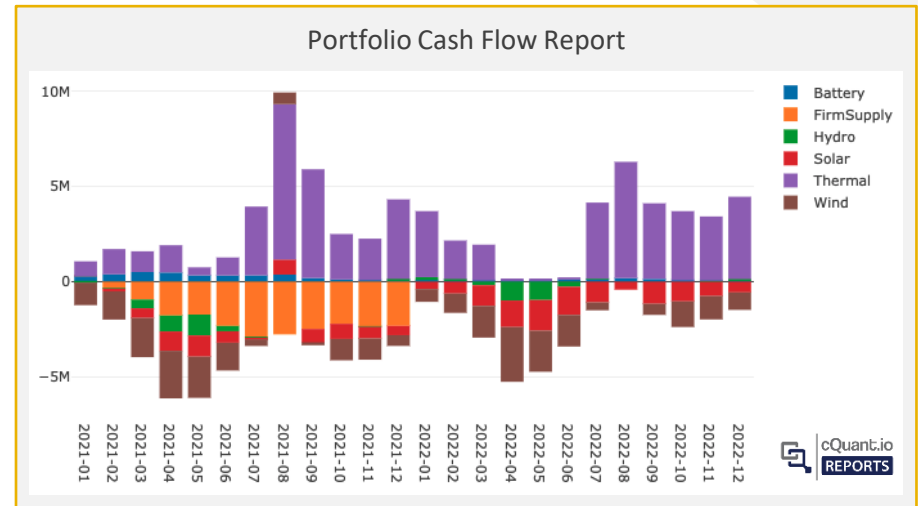
- Municipal Utilities & LSEs
- Merchant Power Producers
- Trading Organizations
- Corporate PPA Buyers
- Renewable Developers
- Consultancies

## cQuant Capabilities:

- Market Forecasting & Simulation
- Asset Valuation
- Renewables & Storage Analysis
- Risk Management
- Hedge Optimization
- **Total Portfolio Analysis**

## cQuant Benefits:

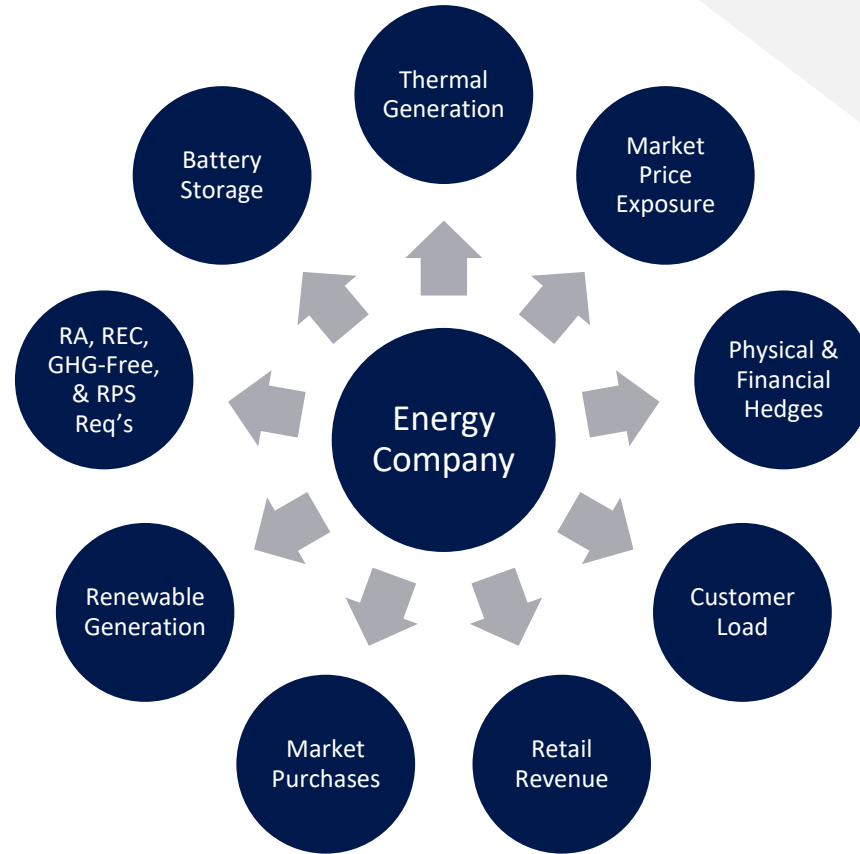
- ✓ Powerful analytics for energy portfolios
- ✓ Access to a team of PhD quants
- ✓ Fastest time to ROI
- ✓ Cloud-native – no hardware, software, or upgrades



# What Makes an Energy Portfolio “Modern”?

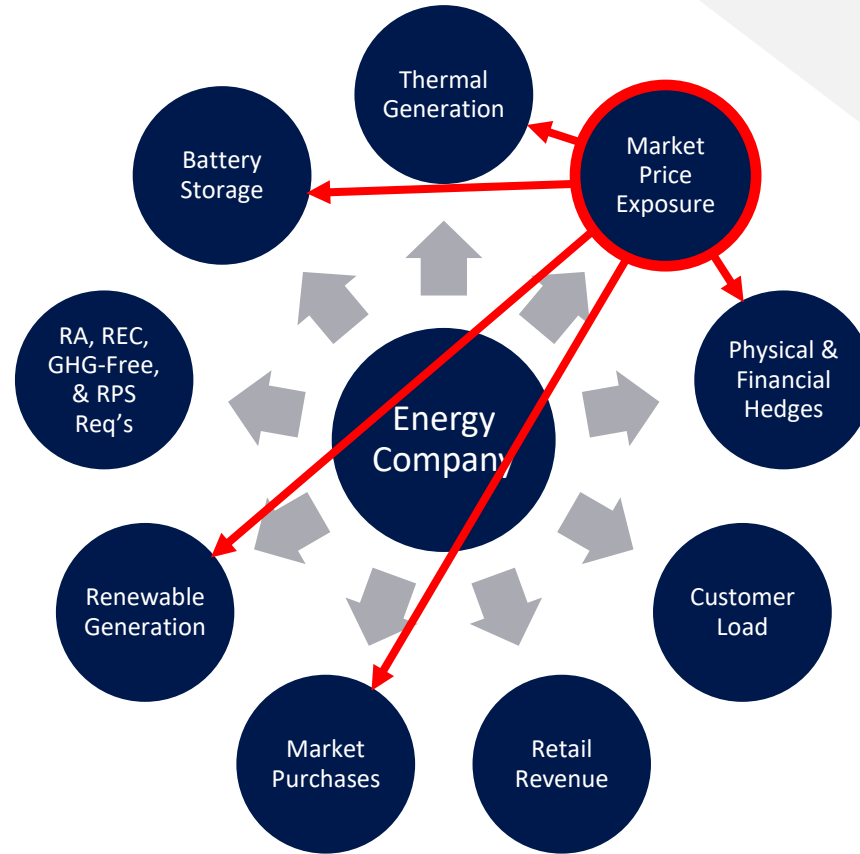
- Significant (and growing) amount of non-dispatchable/intermittent generation and increasing feasibility of energy storage.
- Many geographically diverse assets of different types instead of a small number of centralized generating stations.
- Exposure to hyper-volatile electricity markets, rapidly-changing regulatory requirements, and generation technology/grid dynamics evolving at record pace.
- Access to a broader range of financial products than ever before.
  - Virtual PPAs, proxy gen/revenue swaps, bespoke HRCOs/RPOs, exotic derivatives, etc.
- Management of more than just energy and cash flows.
  - RECs (PCC1-3), GHG-Free, Resource Adequacy (flex, local, system), etc.

# Modern Portfolio Complexity



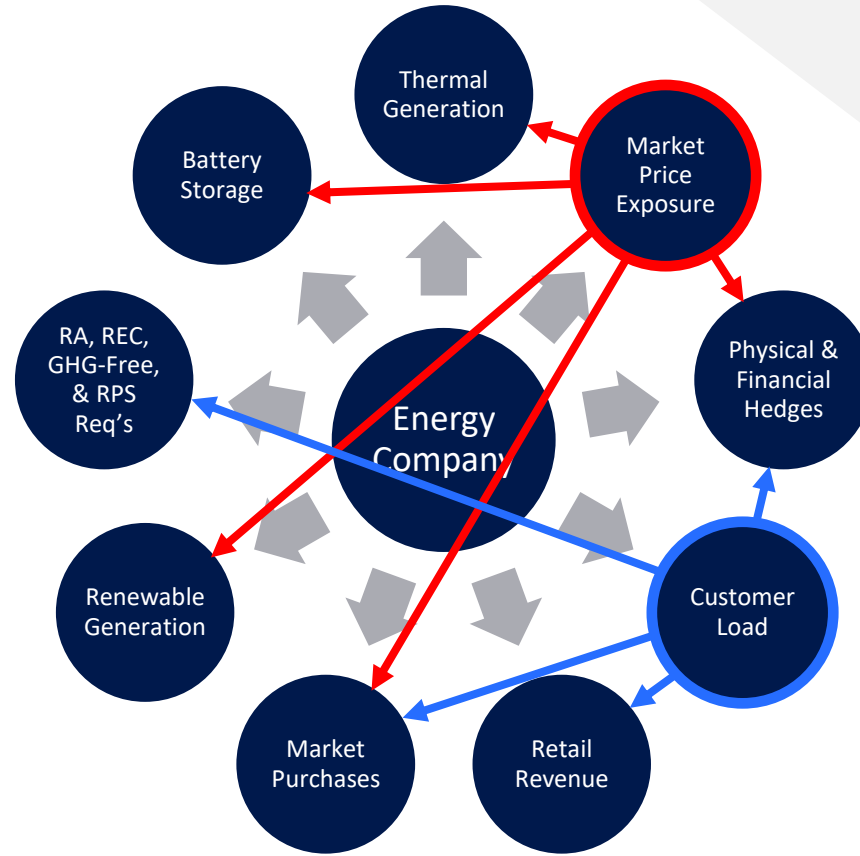
# Modern Portfolio Complexity

- ▶ Multiple components exposed to market prices in different ways.
- ▶ Price determines physical volumes produced by economically dispatchable assets.



# Modern Portfolio Complexity

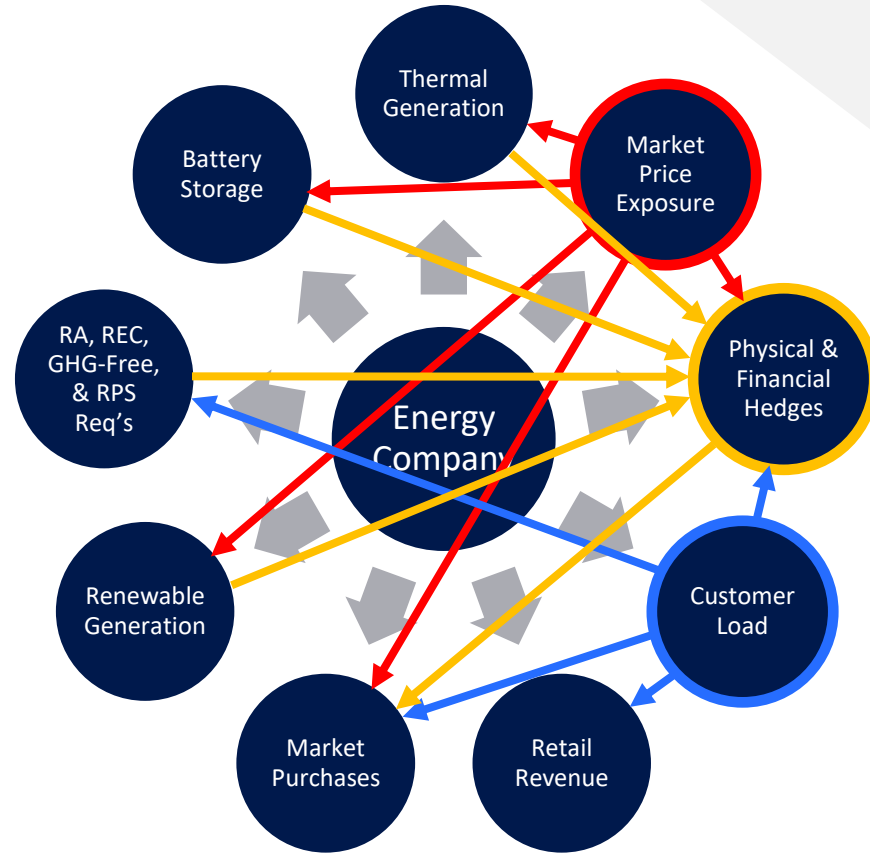
- ▶ Load impacts retail revenue, hedging strategies, market purchases, and attribute targets.
- ▶ Load itself is uncertain and timing can be highly variable.





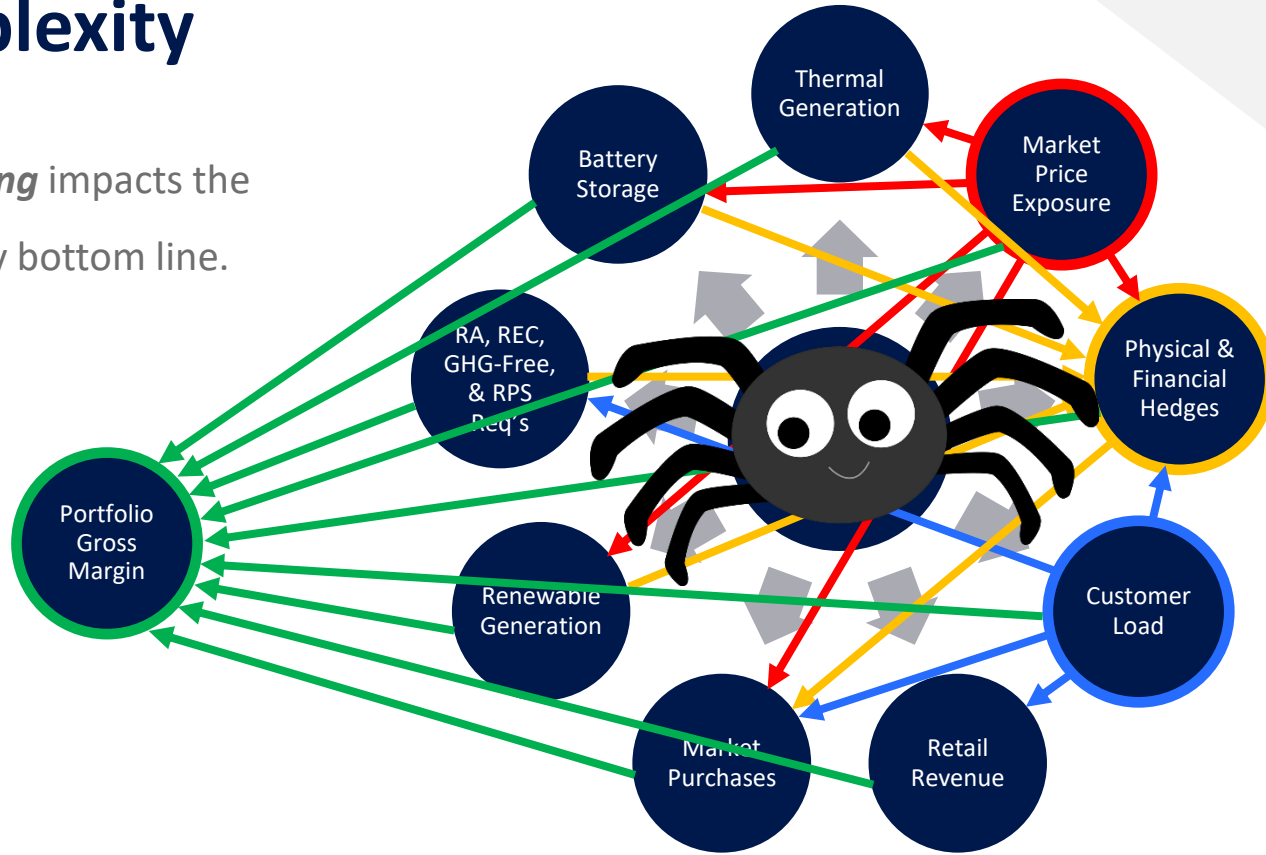
# Modern Portfolio Complexity

- ▶ Physical generation, storage, and load impact hedging strategy.
- ▶ Hedging strategy impacts market purchases.



# Modern Portfolio Complexity

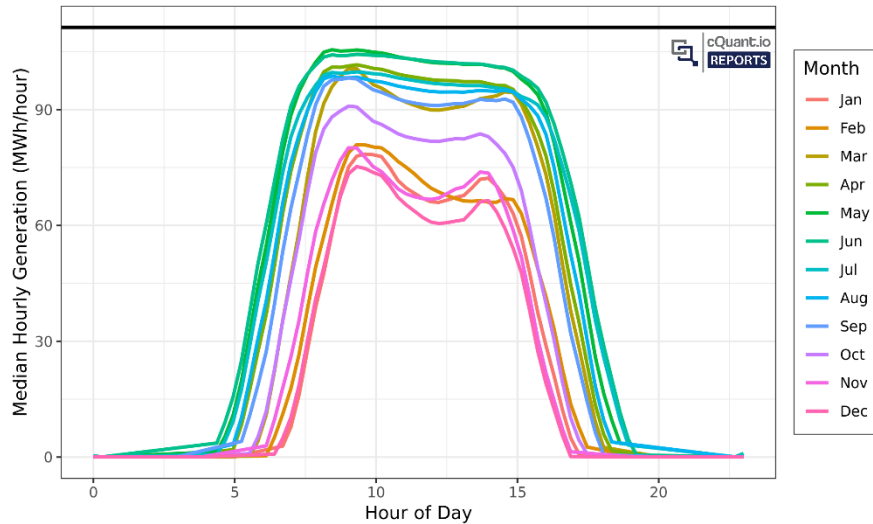
- *Everything* impacts the company bottom line.



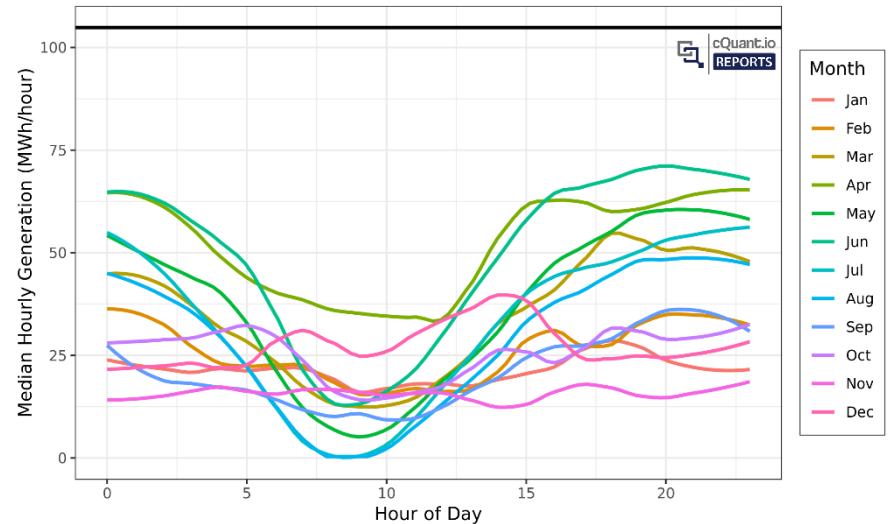
# Geographically Diverse Non-Dispatchable Generation

- Locational dynamics affect renewable resource density/availability, asset value, and both volumetric and market price risk.

Diurnal Curves by Month  
 ID: PPA\_Solar, Capacity: 106.0 MW



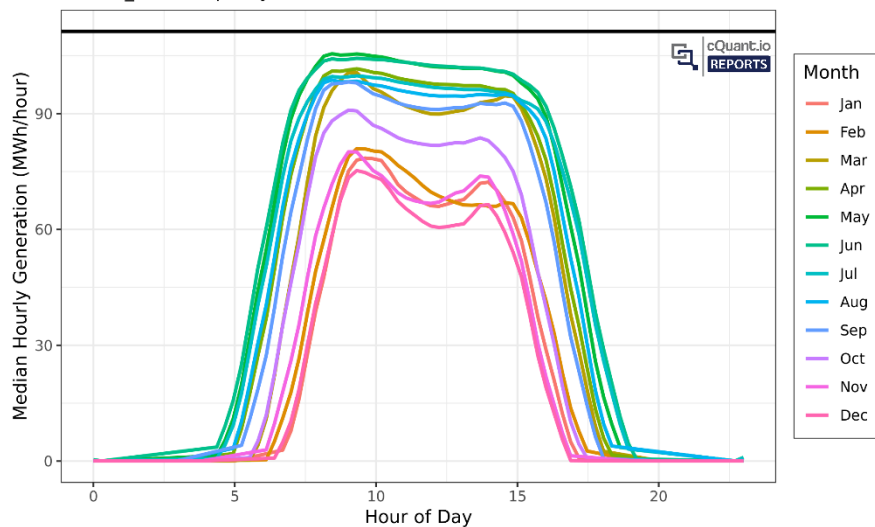
Diurnal Curves by Month  
 ID: PPA\_Wind, Capacity: 99.9 MW



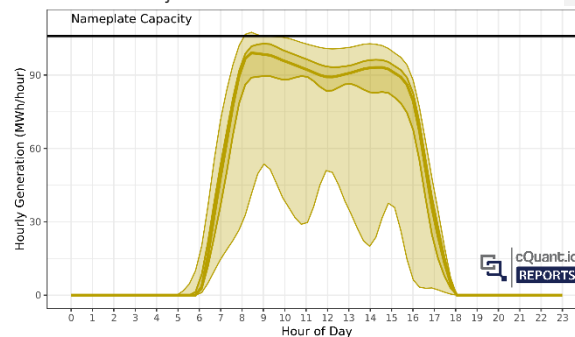
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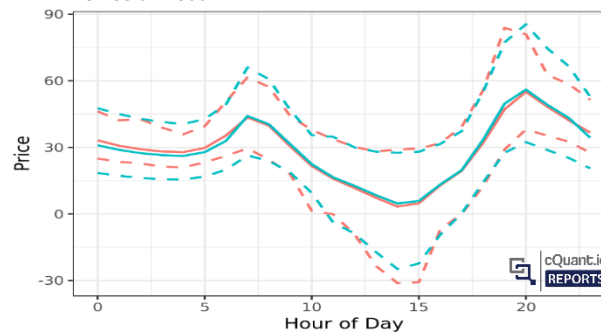
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March Solar Diurnal Variability  
CA Solar Project

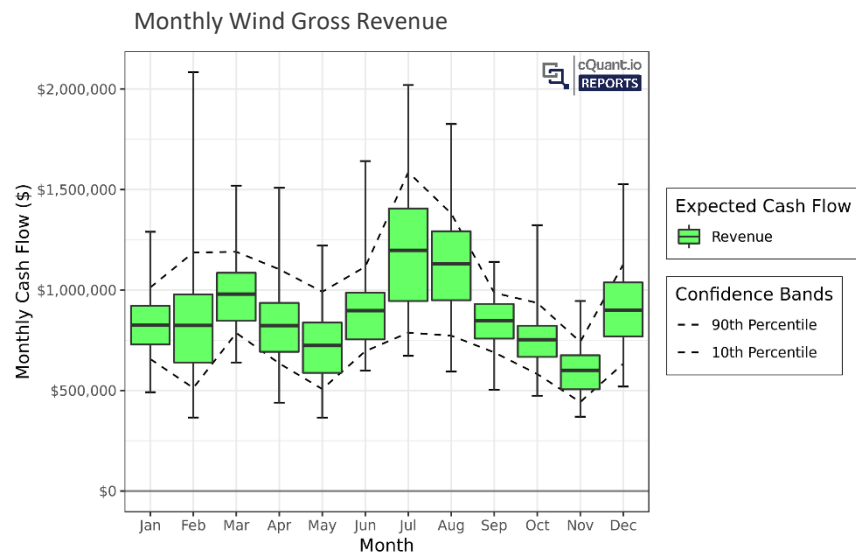
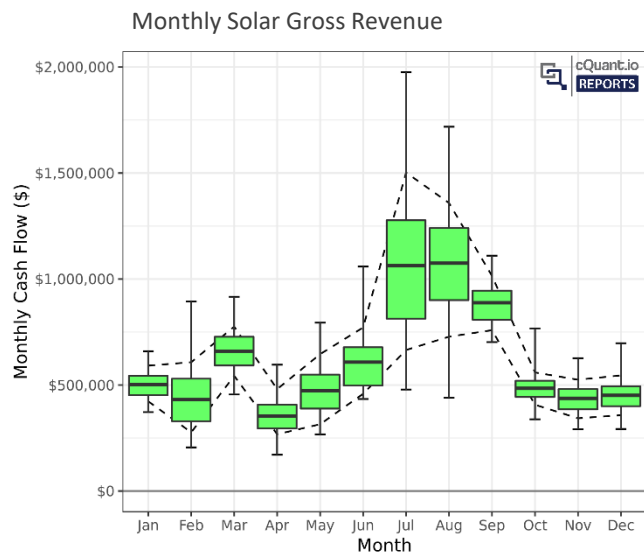


March Electricity Price Confidence Intervals  
CA Solar Nodal LMP



# Geographically Diverse Non-Dispatchable Generation

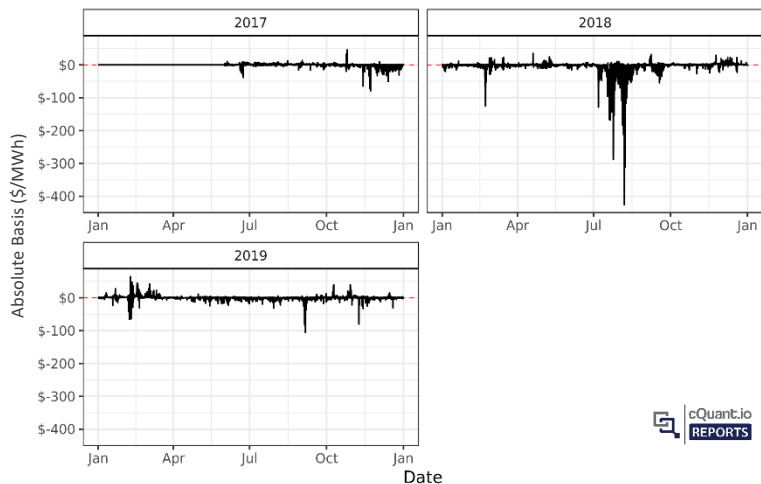
- Cash flow can vary considerably month-to-month.
- Uncertainty is *not always* a bad thing....



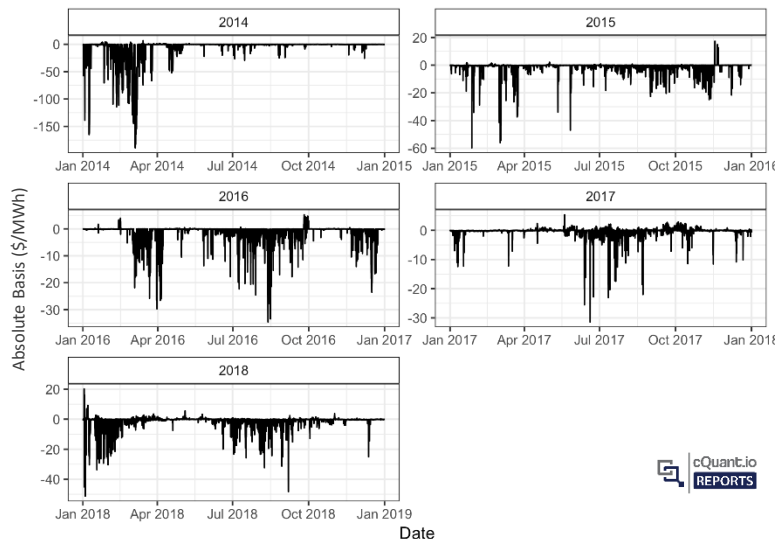
# Geographically Diverse Non-Dispatchable Generation

- Basis risk can be detrimental to both individual asset cash flows and to hedge effectiveness (i.e., “slippage”).

Historical Basis Time Series  
CA Solar Node to CAISO NP15 DA

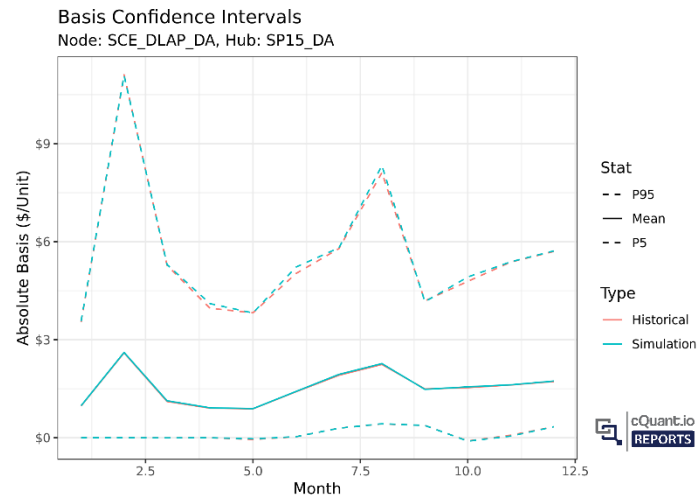
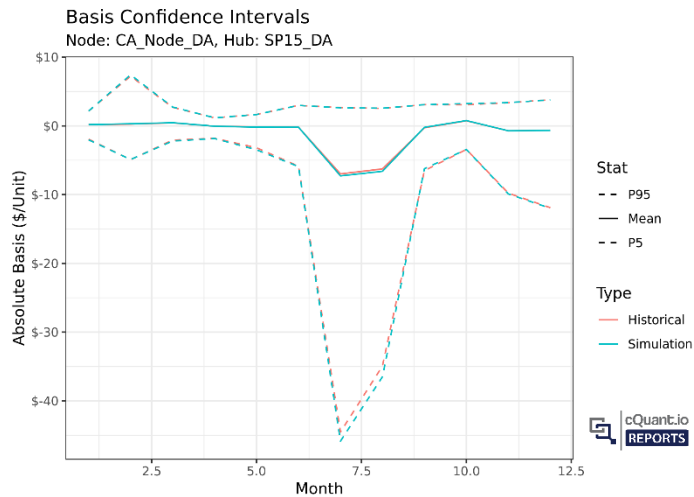


Historical Basis Time Series  
NY Thermal Generator Node to NYISO Zone J DA



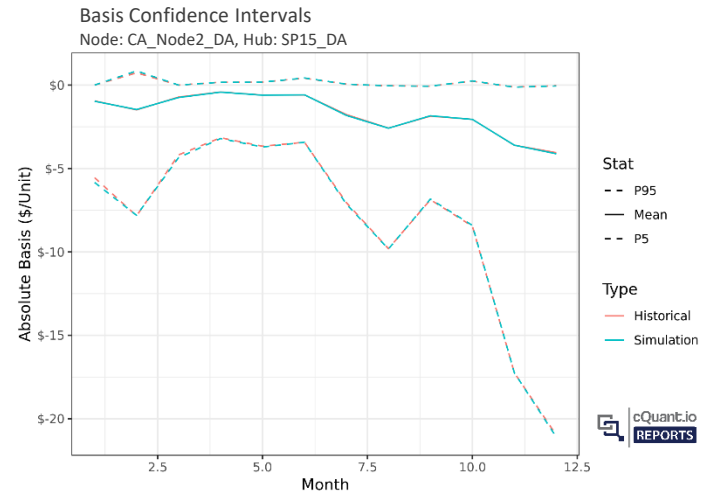
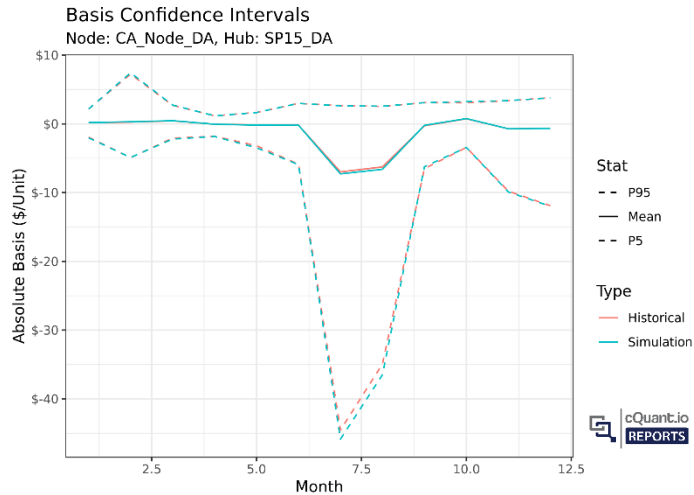
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# Geographically Diverse Non-Dispatchable Generation

- Basis risk can be detrimental to both individual asset cash flows and to hedge effectiveness (i.e., “slippage”).
- Basis dynamics vary *widely* by location.

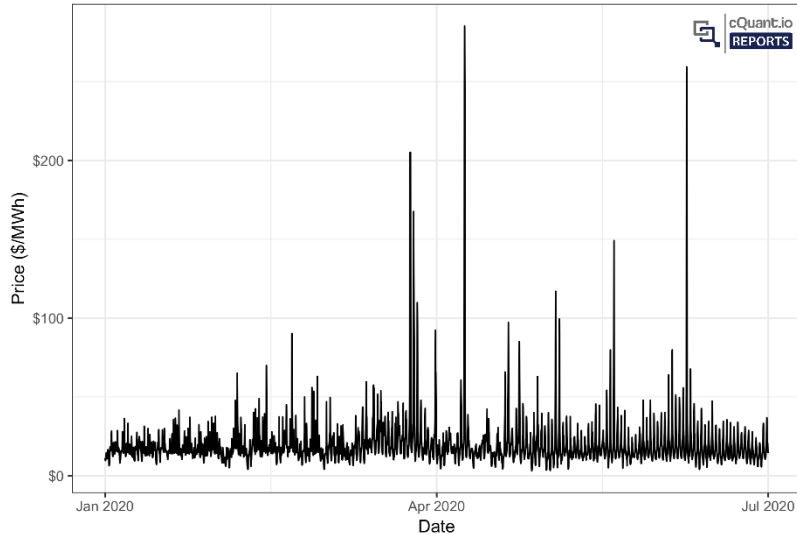




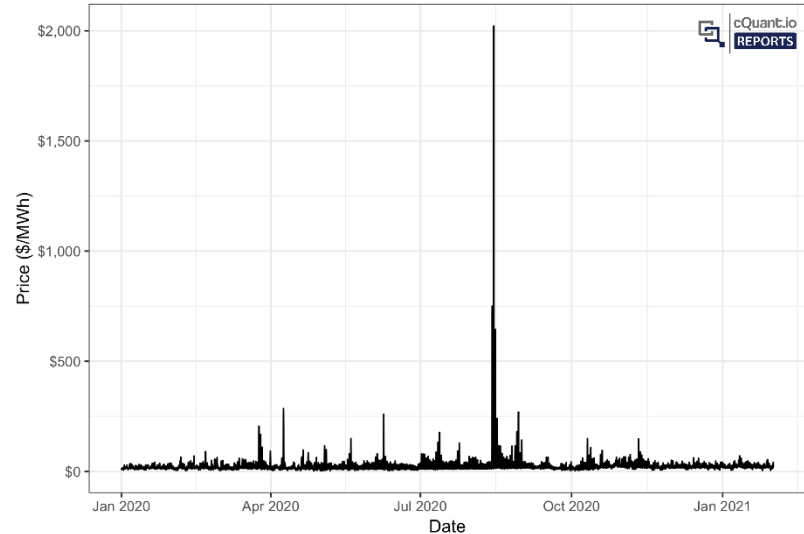
# Extreme Market Price Volatility

- ERCOT North DA prices show daily/weekly shaping, short-lived spikes.
- August scarcity event elevated prices by an order of magnitude.

ERCOT North DA LMP Before Summer 2020



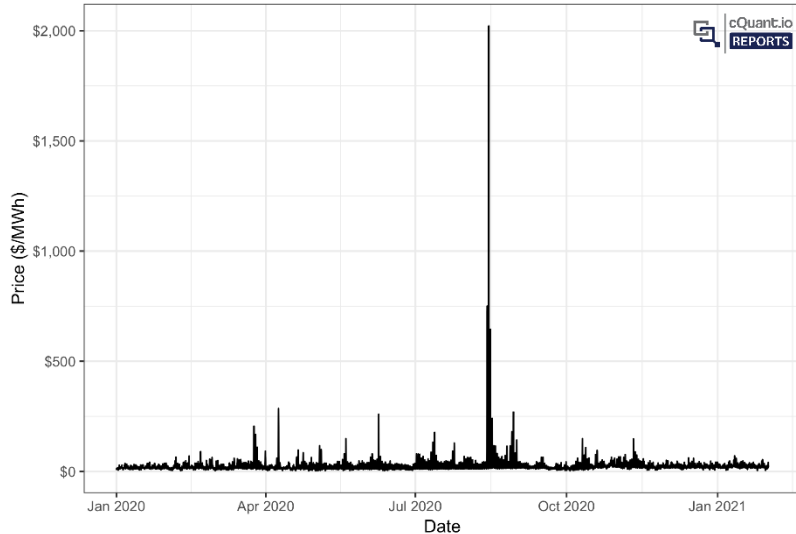
ERCOT North DA LMP prior to 2021 Deep Freeze



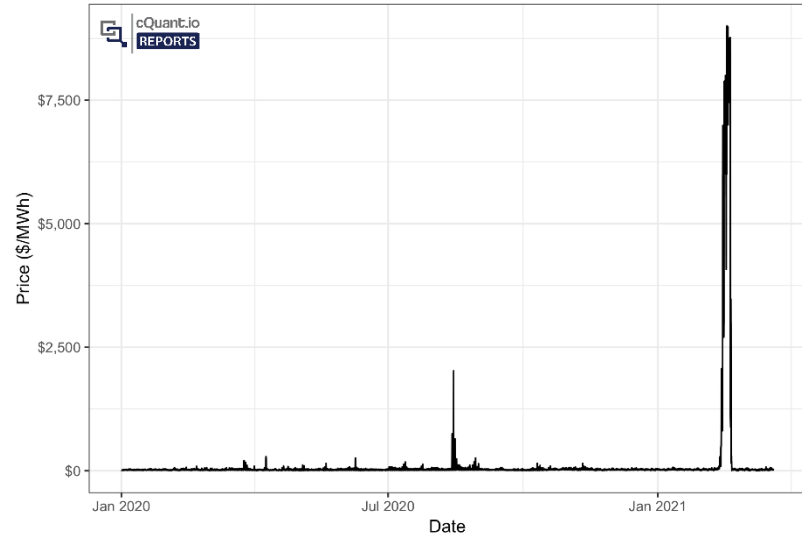
# Extreme Market Price Volatility

- What about the February 2021 deep freeze in Texas??
  - Day-ahead prices averaged **over \$5600 for an entire week!**
  - Virtually all other price history is dwarfed by comparison.

ERCOT North DA LMP prior to 2021 Deep Freeze

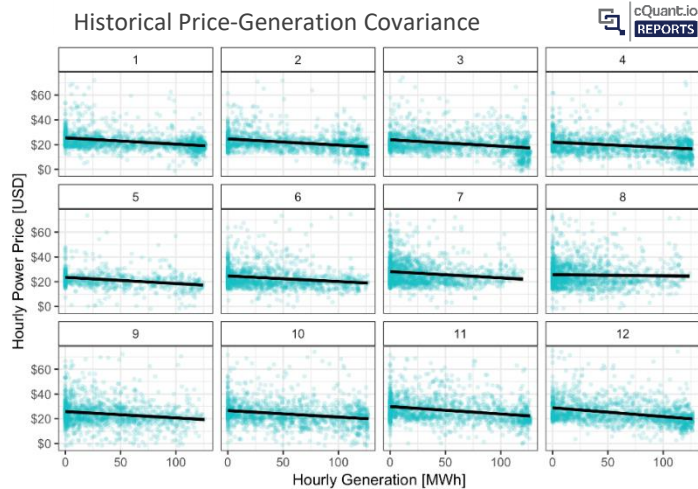


ERCOT North DA LMP Through 2021 Deep Freeze



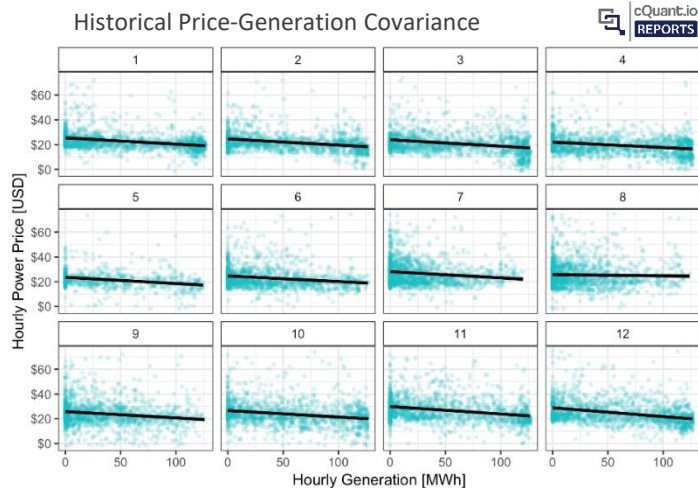
# Extreme Market Price Volatility

- Negative price-generation covariance can erode value *nonlinearly*. That is, a few isolated events can materially impact overall value.

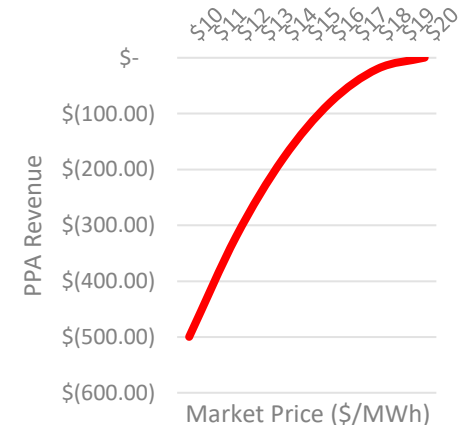


# Extreme Market Price Volatility

- Negative price-generation covariance can erode value *nonlinearly*. That is, a few isolated events can materially impact overall value.
- Results in “risk magnification” or “negative gamma”.



Generation (MWh)	Power Price (\$/MWh)	PPA Revenue (\$)
0	\$20	\$0
10	\$18	\$(20)
20	\$16	\$(80)
30	\$14	\$(180)
40	\$12	\$(320)
50	\$10	\$(500)



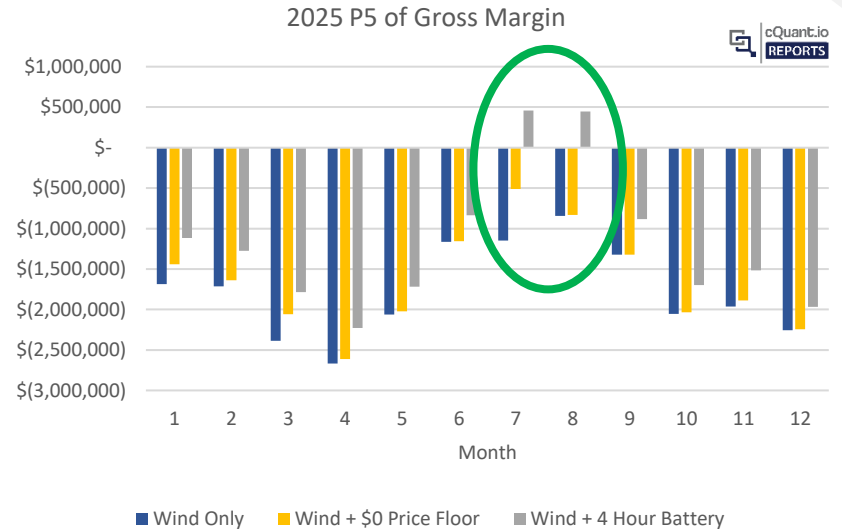
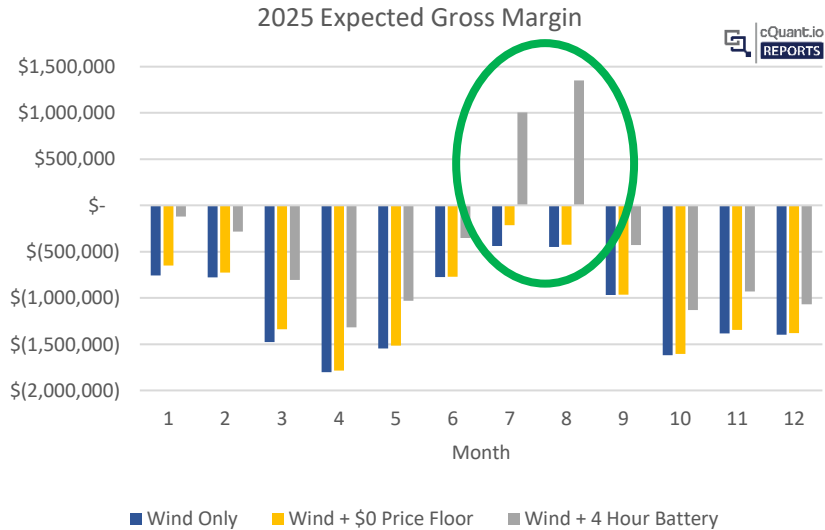
# Innovative Financial Products and Battery Storage

- New contracting structures can reduce risk and/or shape volumes for individual renewable PPAs.
- These structures provide a benefit, but come at a cost (think: insurance premium).

Contract Structure	Risk Mitigation Benefits
Hub Settlement	Reduces basis risk and associated hedge slippage. Mitigates regional long-term price degradation.
Bundled Renewable + Battery	Energy-shifting capability to reduce shape risk (e.g., Duck Curve).
Floors, Collars, Revenue Shares	Limits hourly downside price/basis/shape risk.
Volume-Firming Agreements	Mitigates intermittency risk and covariance risk.
Other: Proxy generation swaps, proxy revenue swaps, revenue puts	Address operational risk, price risk, basis risk, shape risk, and others.

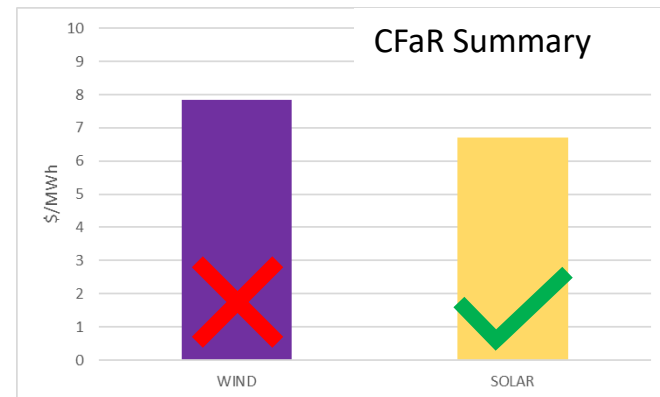
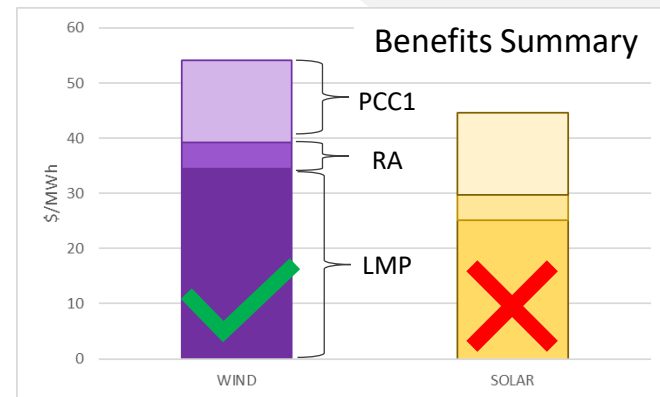
# Innovative Financial Products and Battery Storage

- PPA contracting structures can provide risk mitigation.
- Batteries can add margin and stabilize cash flows.



# Holistic Portfolio Management: Energy, Attributes, Cash Flows

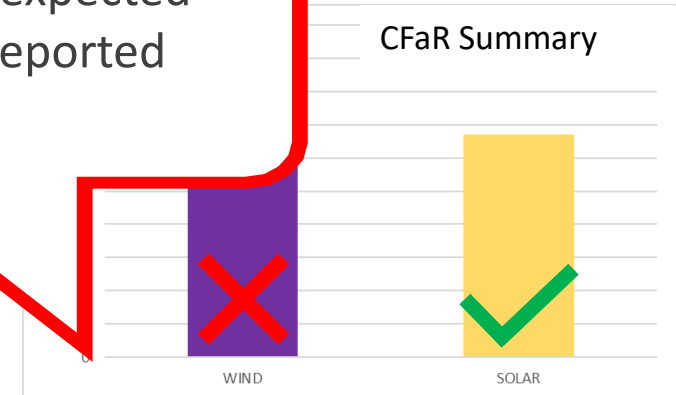
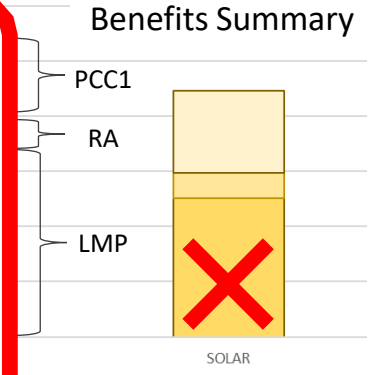
- Individual contract benefits: expected market revenue, RA, PCC1 (RECs), etc.
- Along with benefits, contract price determines economics.
- But what about the contract's *risk*?
  - Cash Flow at Risk (CFaR)
  - Gross Margin at Risk (GMaR)
- Effect on the total portfolio may differ from the view of a single contract alone.
  - Diversification



# Holistic Portfolio Management: Energy, Attributes, Cash Flows

- Individual components: revenue, RA, LMP
- Along with broader market economics.
- But what about risk?
  - Cash Flow at Risk (CFaR)
  - Gross Margin at Risk (GMaR)
- Effect on the overall view of a single asset
  - Diversification

Cash Flow at Risk (CFaR) – The largest downside deviation from expected cash flow that is likely to be realized with some specified probability. We will use a 95% CFaR, meaning 19 times out of 20 we expect the downside deviation from our expected cash flow to be smaller than the reported CFaR value.

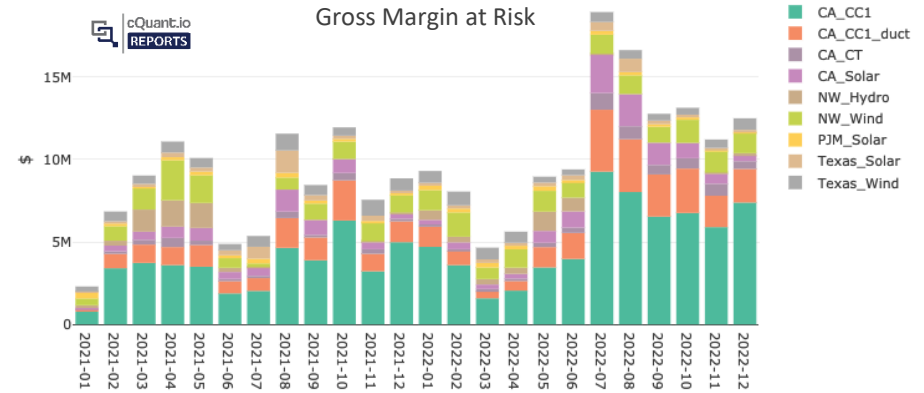
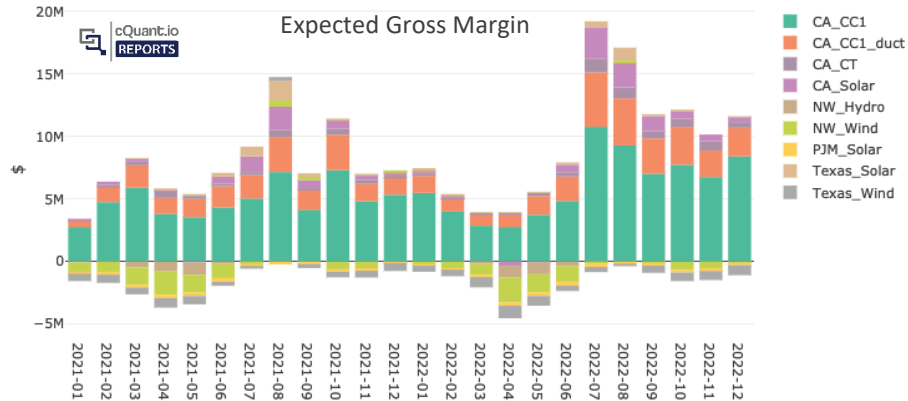
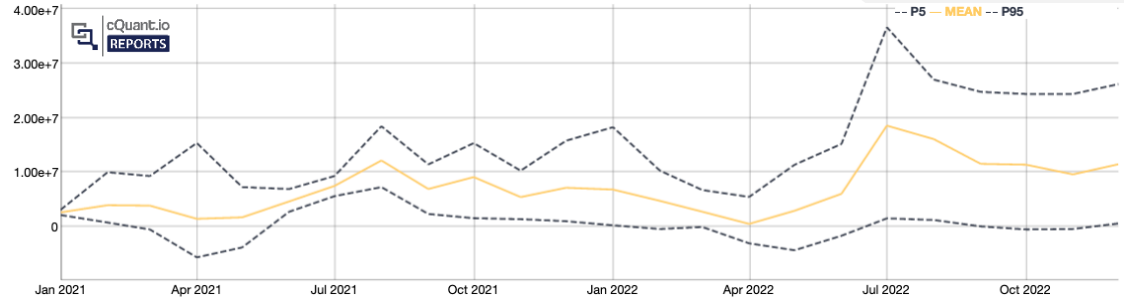




# Holistic Portfolio Management: Energy, Attributes, Cash Flows

- A portfolio-wide view is critical for today's energy portfolios.

Cash Flow Confidence Intervals



# Conclusions

- Modern energy portfolios are faced with a unique set of challenges and opportunities:
  - Significant intermittent/non-dispatchable generation.
  - Diversity in geography, technology, and contracting.
  - Rapidly evolving market conditions and regulatory landscapes.
  - A need to manage a variety of different portfolio-level “attributes”.
- Modern energy portfolios require modern analytical approaches and active management.
- A detailed and flexible portfolio-level view of value and risk is essential for long-term success.

# Thank you!

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