The State of the Art in Renewable Energy Risk Mitigation: A Case Study

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Guiding Questions:

- What are the primary risk drivers for renewable energy assets and contracts?
- How do you mitigate risk for an asset you can’t control?

Who is cQuant?

We are:

- A SaaS energy analytics provider
- A trusted analytical partner

We work with:

- Utilities & IPPs
- Renewable & Storage Developers
- Corporate PPA buyers
- Consultancies
- Any organization with energy market exposure

We can help you with:

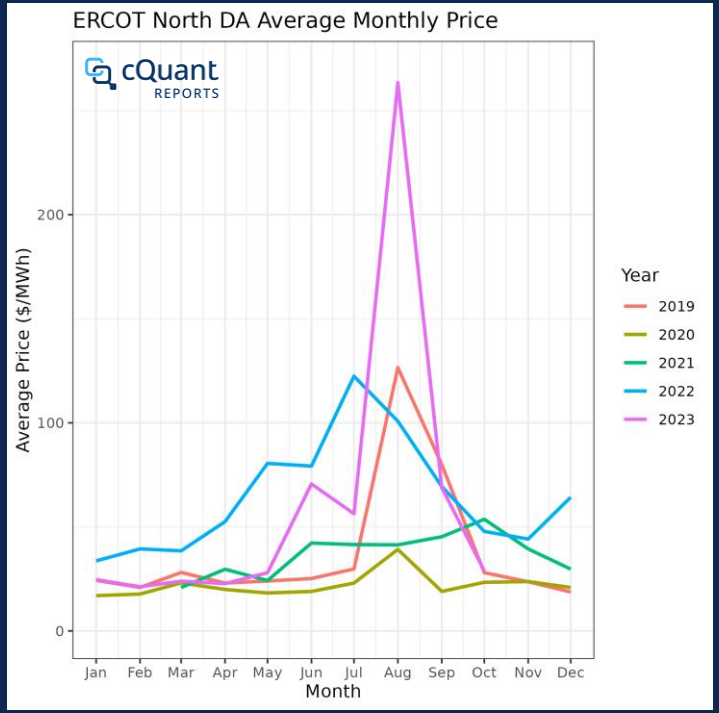
- *Risk & portfolio management*
  - Net position at risk (NPaR)
  - Hedging strategy optimization
  - Market & credit risk
  - Attribute tracking (RECs, RA, etc.)
- *Origination & asset valuation*
  - Asset development
  - Deal structuring
  - Mergers & acquisitions

Renewable Energy Risk Drivers

- Price Level
- Hourly Shape
- Covariance
- Basis
- Other
  - Total production volume
  - Operational uncertainty
  - Counterparty credit exposure

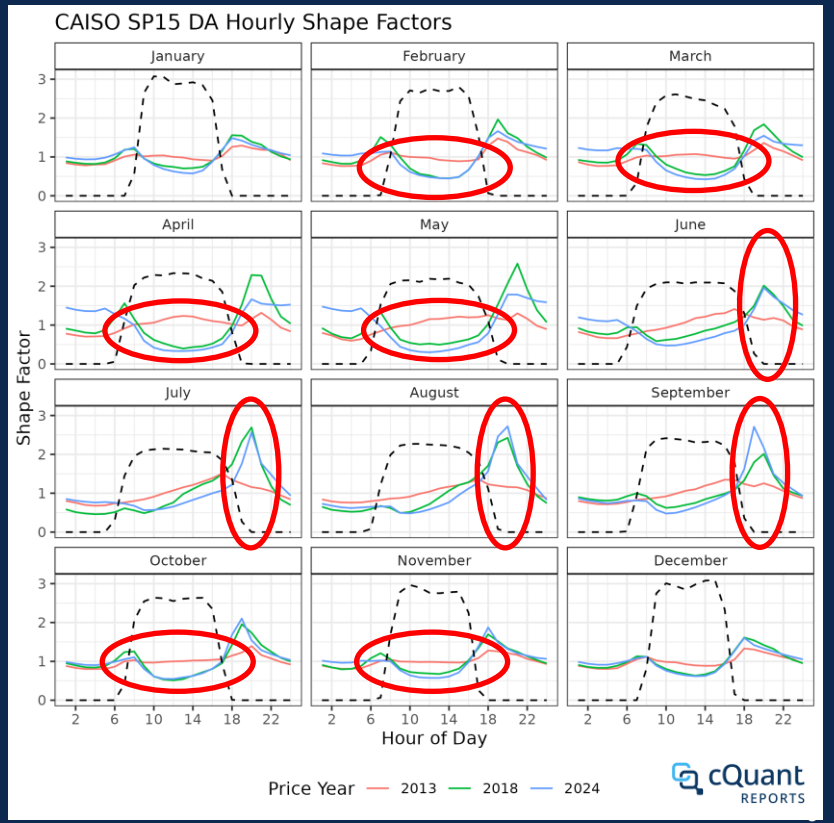
Renewable Risk – Power Price Level

- *Think*: price level → monthly average price.
- Intermittent renewables are price takers.
  - High prices → good
  - Low prices → bad
- Many factors drive overall power price level:
  - Natural gas prices
  - Supply stack and load
  - Transmission availability
  - Many others…
- But you can't just look at monthly prices to value renewable energy….



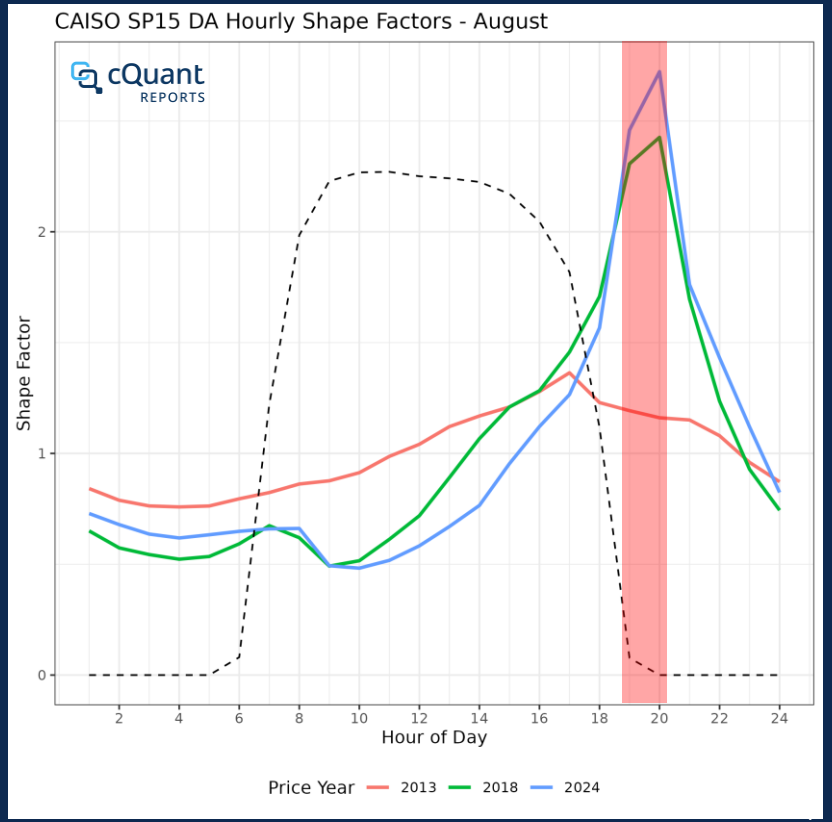
Renewable Risk – Hourly Shape

- Expected hourly shapes of generation and power prices have a primary impact on renewable capture price.
- The “Duck Curve” has *dramatically* changed hourly price shapes in CAISO.
  - Summer peak price hour: HE17 → HE20
  - Mid-day prices have dropped.



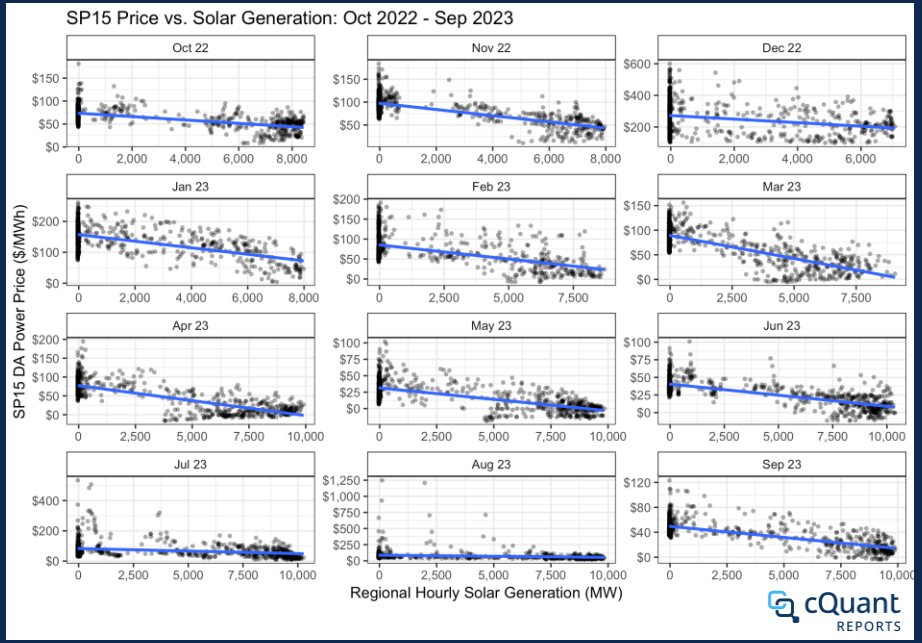
Renewable Risk – Hourly Shape

- Expected hourly shapes of generation and power prices have a primary impact on renewable capture rate.
- The “Duck Curve” has *dramatically* changed hourly price shapes in CAISO.
  - Summer peak price hour: HE17 → HE20
  - Mid-day prices have tanked.
- The “Duck Curve” is now occurring everywhere.
  - ERCOT summer peak is now HE19.
  - Northeastern markets are following suit.



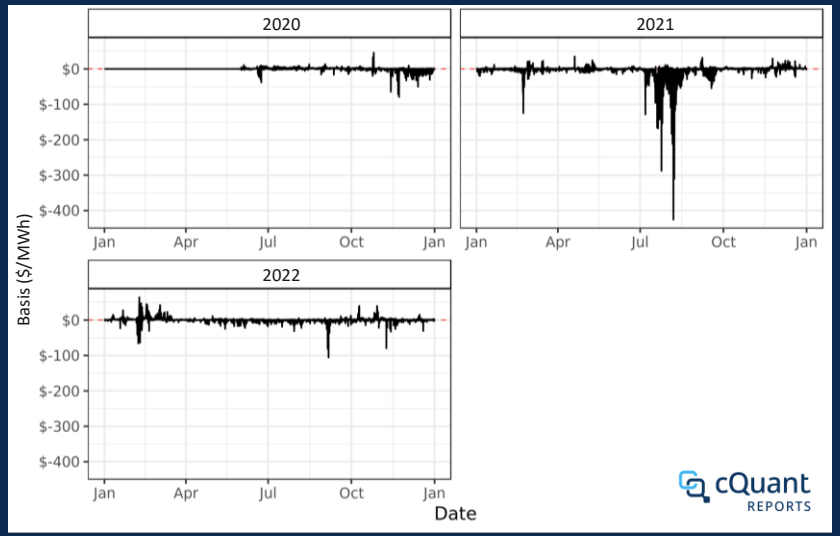
Renewable Risk – Covariance

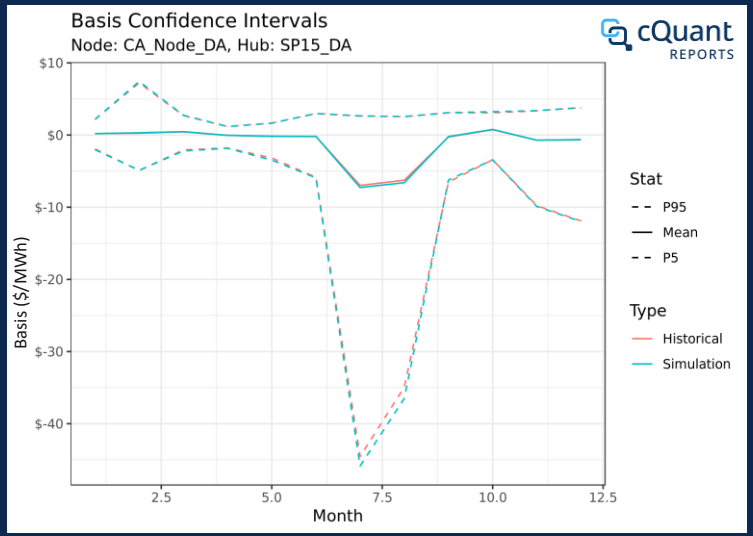
- Renewable generation is strongly anti-correlated with price.
  - More gen → lower price
- This is more than just shape; it's structure in the uncertainty.
  - Higher-than-expected gen aligns with lower-than-expected price.
- Negative price-gen covariance reduces the effectiveness of renewables as a hedge against load.



Renewable Risk – Basis

- Nodal basis is typically strongly negative.
- Basis creates slippage in hedge effectiveness.
- Basis risk is strongly location-dependent and constantly evolving.





So…

How do you mitigate risk for an asset you can’t control?

Now for the fun stuff…

Case Study: Solar Risk Management

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Goal: Optimally hedge merchant solar asset exposure across three markets for calendar year 2024.

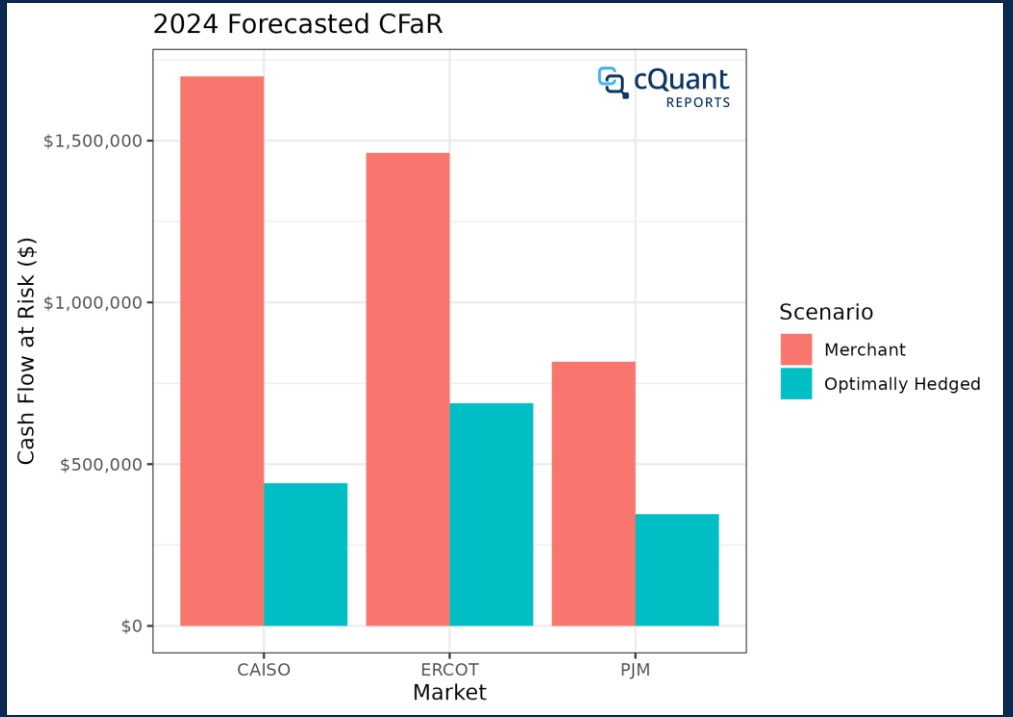
- Markets: CAISO, ERCOT, PJM
- Assets: 100 MW solar farms
- Hedge Products: 7x16 block, 12x24 hourly shape
- Batteries (Financial): TB2 contracts

Analytical Approach

- Simulate risk factors into the future.
  - Price and generation (hourly).
  - Account for seasonality, hourly shape, covariance, basis, etc.
- Compute payoffs of assets and hedges to simulated risk factors.
  - That is, “shadow settle” the assets/contracts.
- Model will automatically select the hedging strategy and volumes that minimize risk, as measured by a 95% cash flow at risk (CFaR).
- Compare, contrast, and interpret results.

Results: Optimal CFaR Reduction in 2024

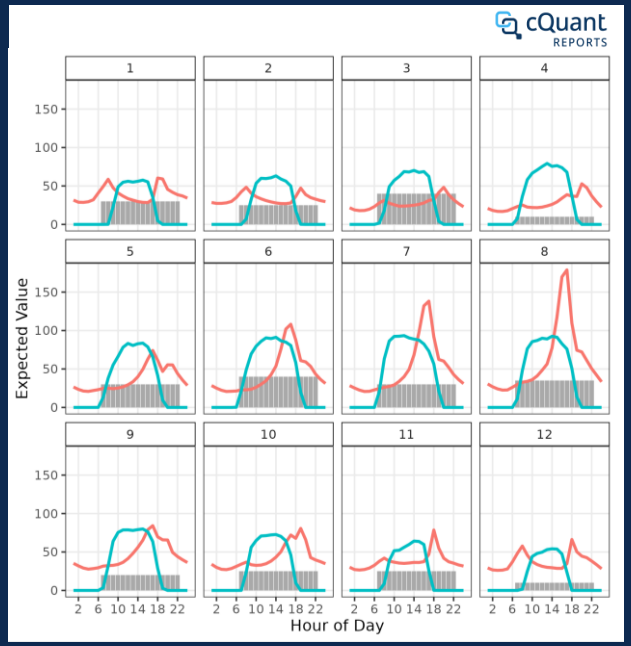
- Merchant risk is highest in CAISO, but risk reduction is also greatest under an optimal hedging strategy.
- Residual risk is greatest in ERCOT.
- PJM's overall risk is lowest, but that market is furthest behind in its "Duck Curve" journey.



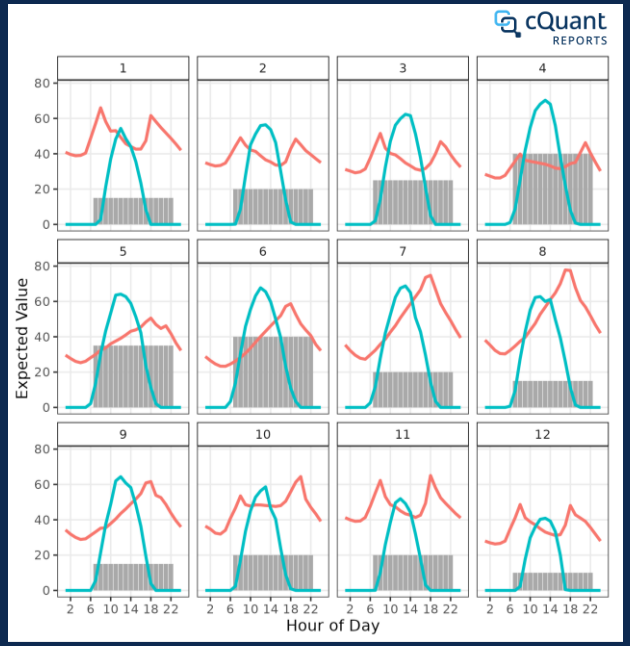
Optimal 7x16 Hedges Differ Across Markets

CAISO

ERCOT



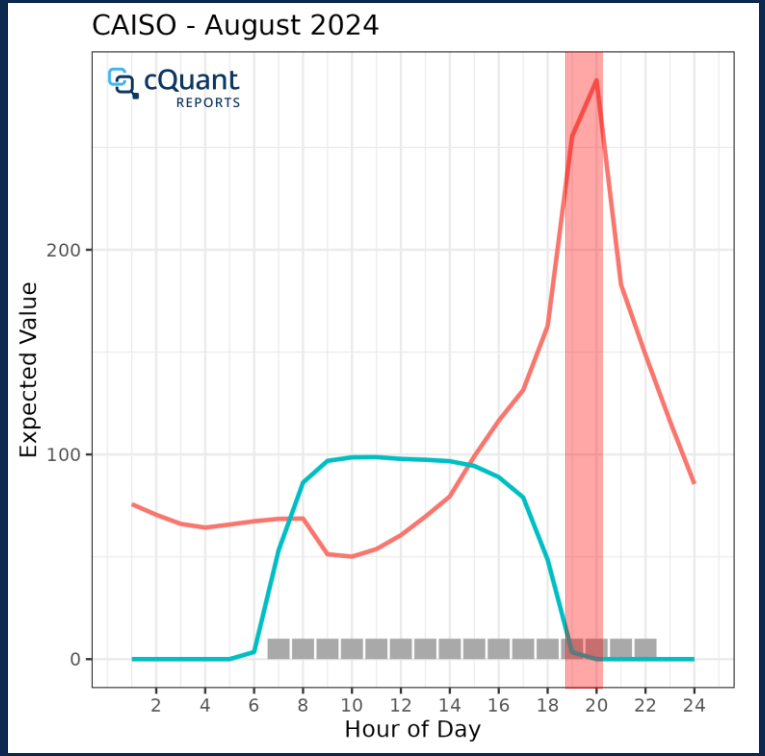
PJM



Nodal Price ($/MWh) Solar Generation (MWh) Optimal Hedge Volume

Focus on August 7x16 Hedge in CAISO

- August has lowest hedge volume, but one of the highest solar productions…why?
- Short hedge position carries downside when prices are high.
- No solar to offset the hedge during highest priced hours.



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- Short hedge position carries downside when prices are high.
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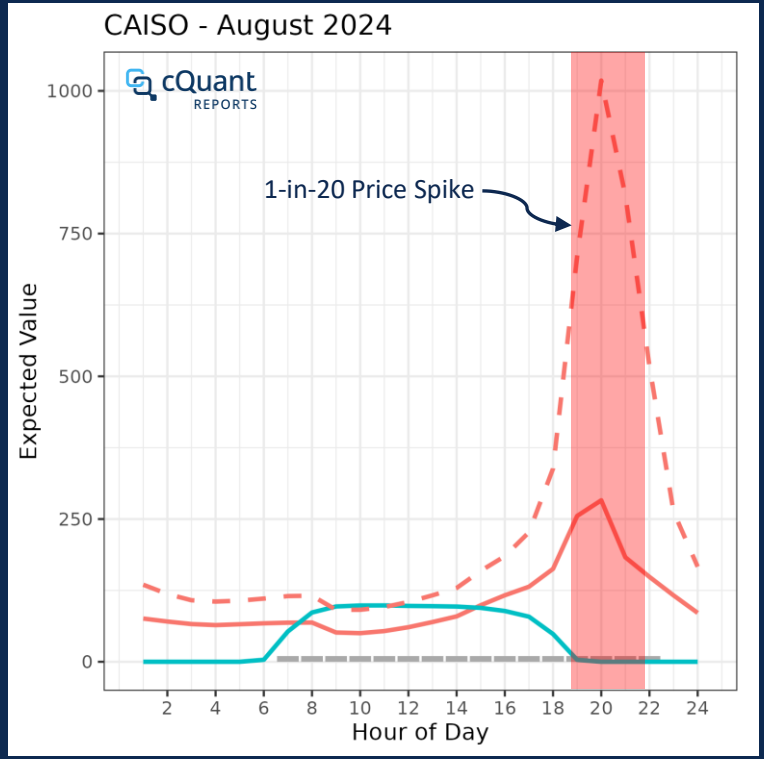
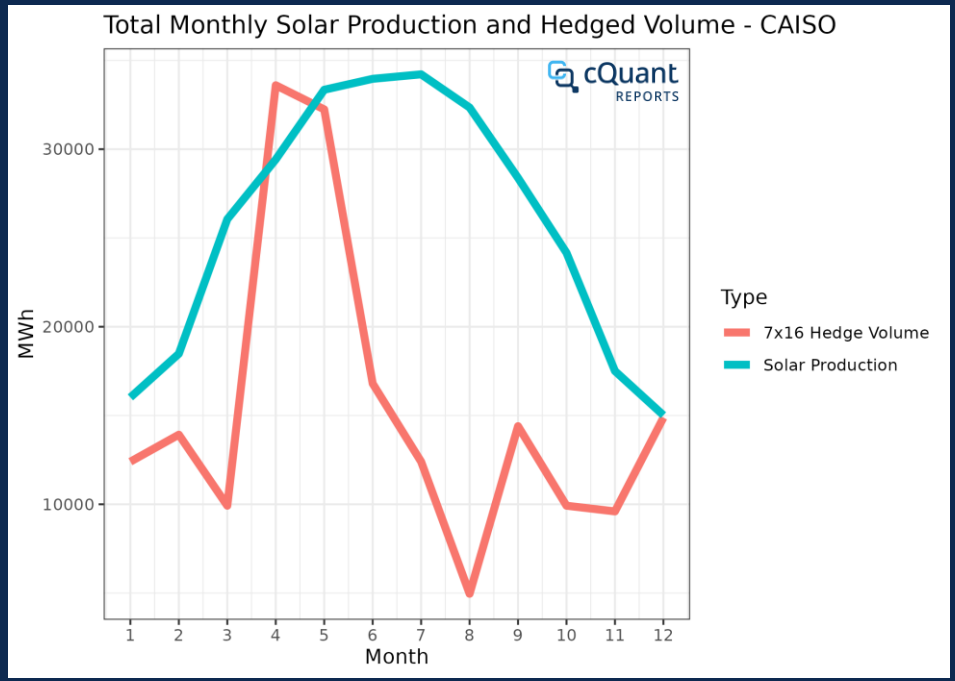
- Highest *volatility* hours also lack solar gen to offset hedge position.



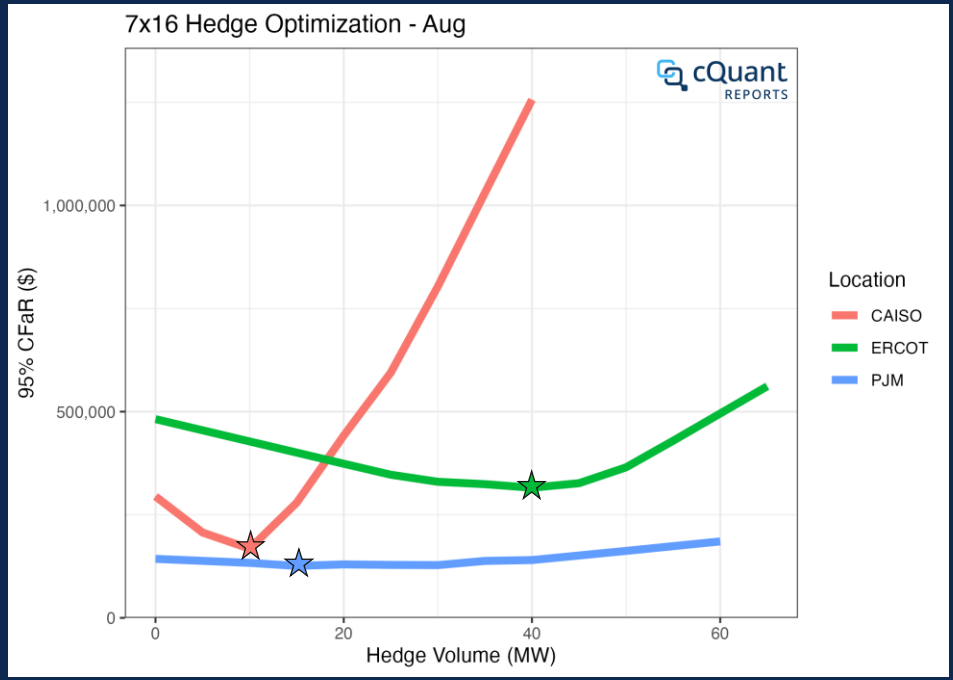
Focus on August 7x16 Hedge in CAISO

…All this means that CAISO's optimal hedge volumes are anti-correlated with production volumes in the latter half of the year.



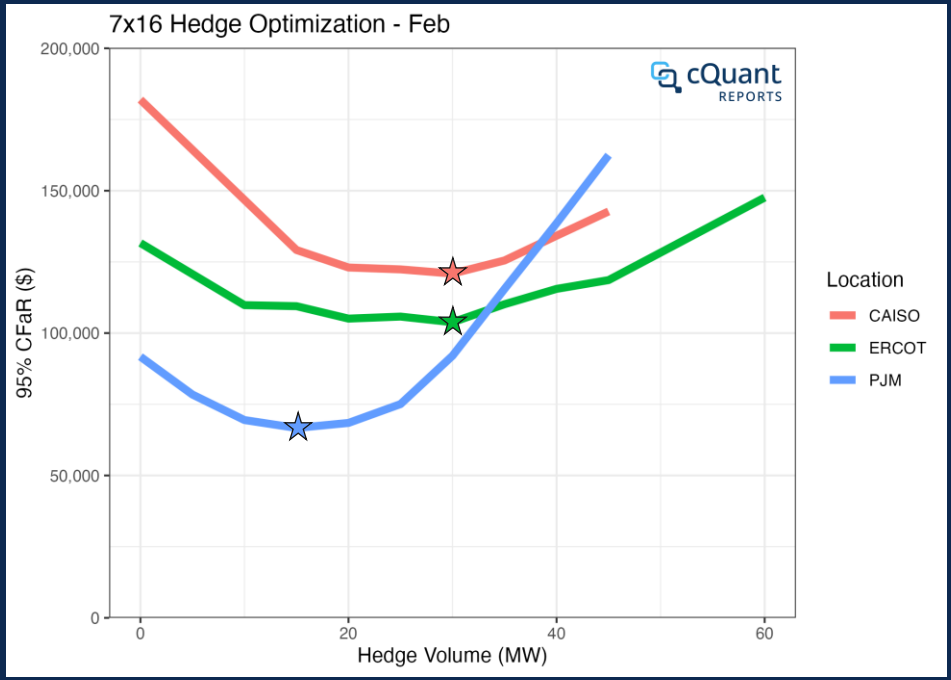
Hedge Optimization - August

- CAISO: August hedge performance is extremely sensitive to volume.
- ERCOT: Accommodates a much higher hedge volume than CAISO.
- PJM: Least sensitive to hedge volume. Exposure in non-solar hours is offset by risk reduction during the solar peak.



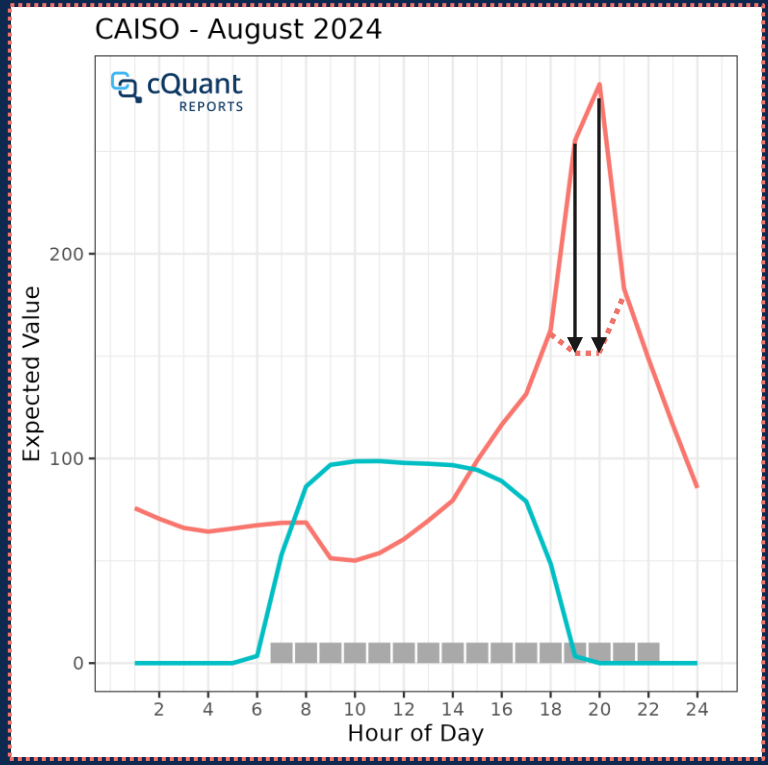
Hedge Optimization - February

- These dynamics vary considerably by month.



What is the Role of (Financial) Batteries?

- A TB2 contract exchanges the lowest priced two-hour period for the highest priced period.
- This naturally hedges exposure to high hourly prices within a day.
- The TB2 enables an increase in the 7x16 hedge volume for August in CAISO.



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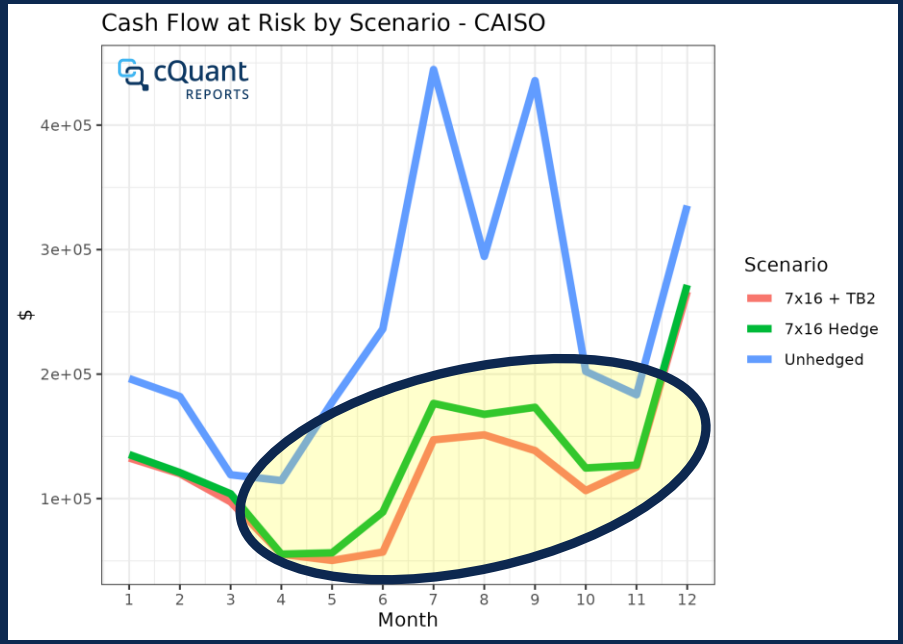
- Overall risk is further reduced.



Conclusions

- Significant risk reductions can be achieved for renewable energy portfolios with the right analytical approach.
- Optimal hedges must be constructed on a case-by-case basis; each project/location is different.
- Effective hedging strategies should consider generation, price, and the covariance between the two.
- For assets you can’t control, sound risk management relies on the statistical properties of generation and price.

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Thank you!

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