# Solea Renewable Asset Optimization

## Case Study

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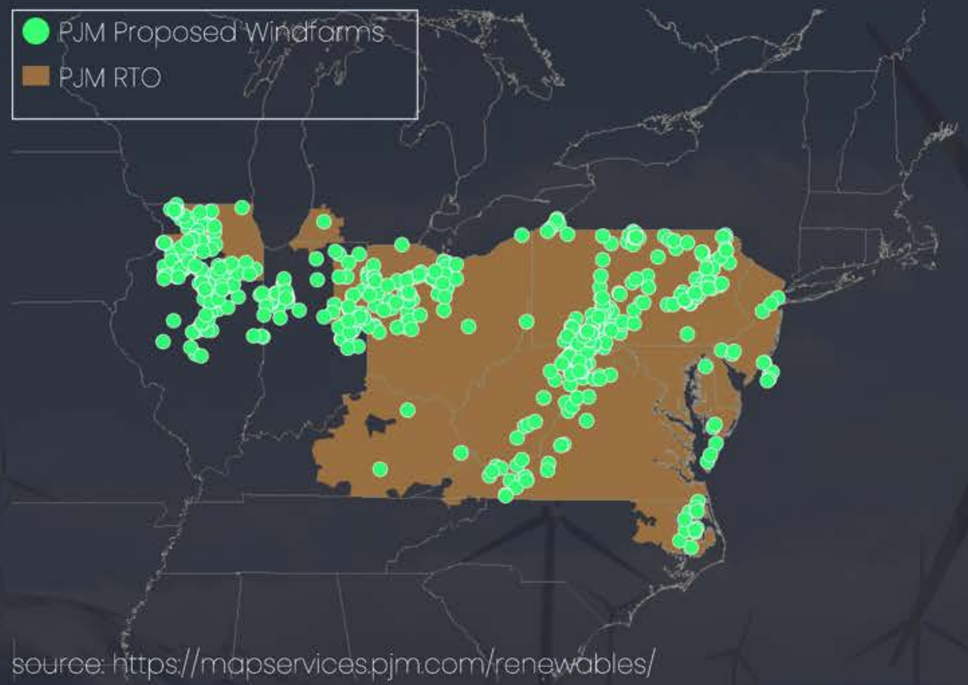
# Problem Setup

**Market:** PJM
**Nameplate Capacity:** ~150 MW
**Asset type:** Wind Farm




source: https://mapservices.pjm.com/renewables/

**Objective**

Maximize virtual market component of asset revenue, subject to risk limitations.

**Constraints**

**Price taking** - we can only submit a schedule, not prices, to the ISO.

**Not speculating** - bid sizes are bounded by 10th and 90th percentiles of generation forecast.

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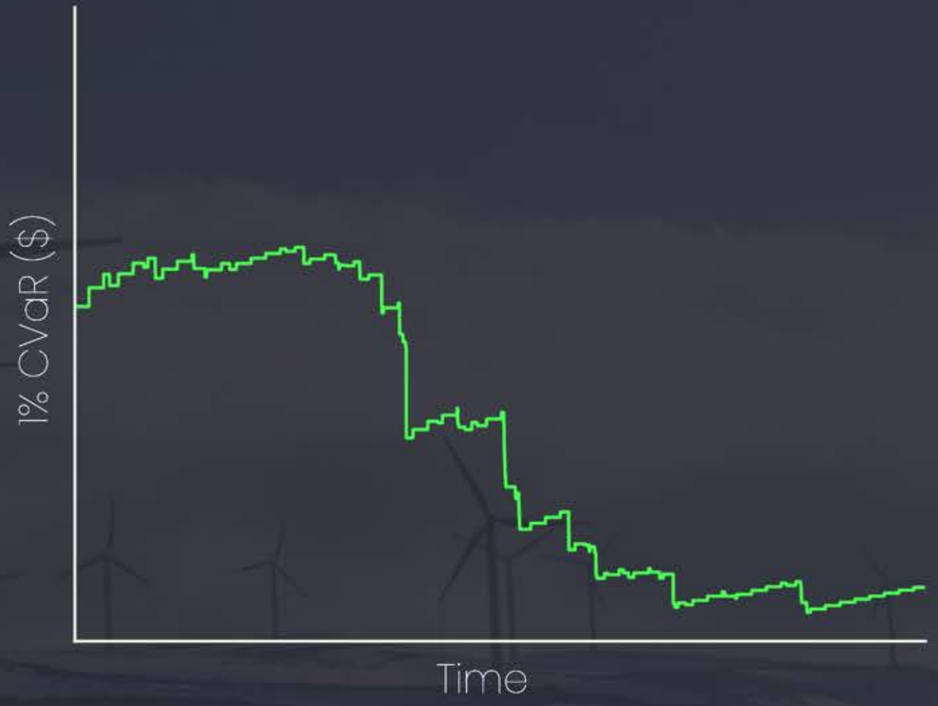
# Baseline Bidding Strategy

We compare all results in this document to a baseline that reflects the actual virtual market revenue generated by the plant over the duration of the study.


## 1% CVaR

Also called the expected shortfall, the 1% CVaR is the average of the worst 1% of hours over the time period. We had some flexibility to take on more risk than the baseline strategy, but aimed to exceed the 1% CVaR by under 10%.



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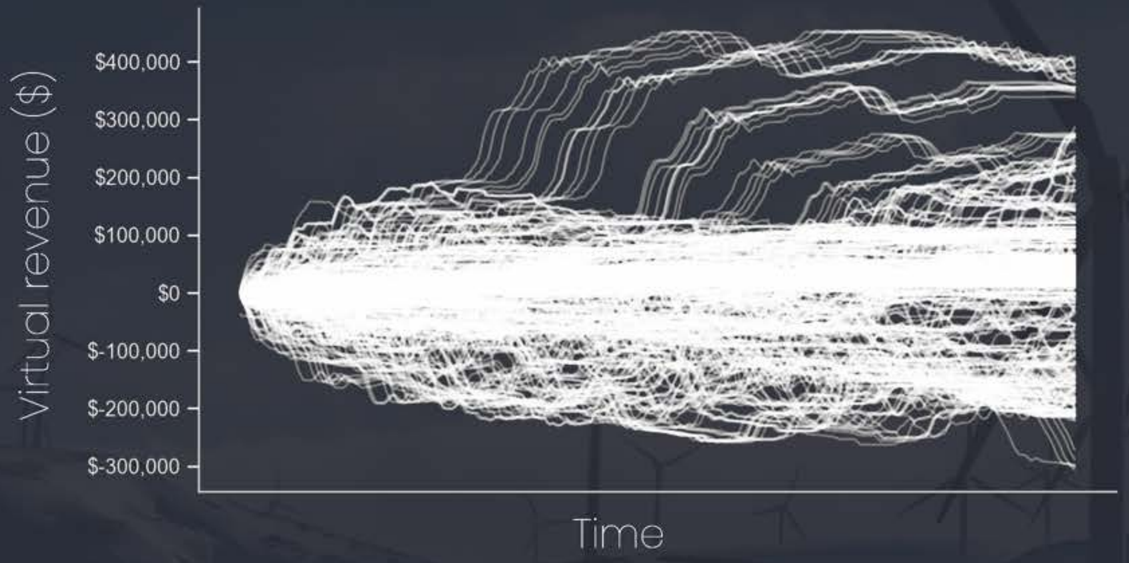
# **Baseline Bidding Strategy**
# Simulation Study




To understand the uncertainty inherent in the process we conduct a simulation study whereby we simulate 1,000 4-week periods from the available data. These results provide an indication for the range and probabilities of monthly revenue using the baseline strategy. The figure and table below provide some summary statistics.

| | Min | 10th percentile | Mean | 90th percentile | Max |
|---|---|---|---|---|---|
| Revenue | -$304,000 | -$162,000 | $34,000 | $151,000 | $409,000 |
| Annualized Sharpe | -18.9 | -11.0 | 4.4 | 18.7 | 29.9 |
| 1% Hourly CVaR | -$14,000 | -$12,000 | -$8,000 | -$3,000 | -$2,000 |
| Revenue ($/MWh) | -5.6 | -3.3 | 1.3 | 5.7 | 9.2 |

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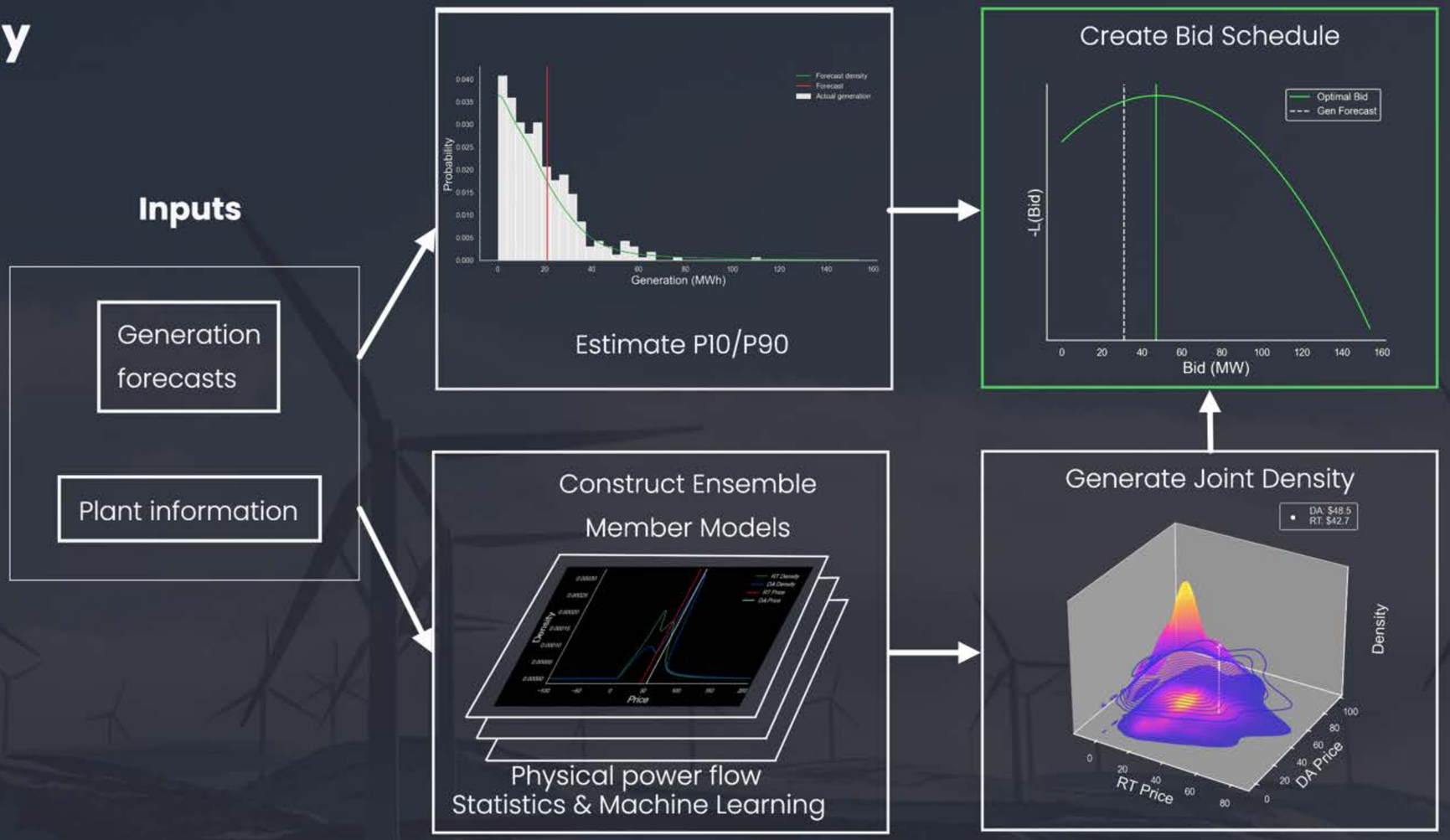
# Solea Bidding Strategy

The crux of Solea's methodology relies on our treatment of risk throughout the process. There is uncertainty in every forecast: generation, load, weather, prices and outages are all indeterminate and can have a profound impact on returns.

We propagate the uncertainty through every step, leading to a bid schedule that accounts for forecast risk as well as modeling risk.

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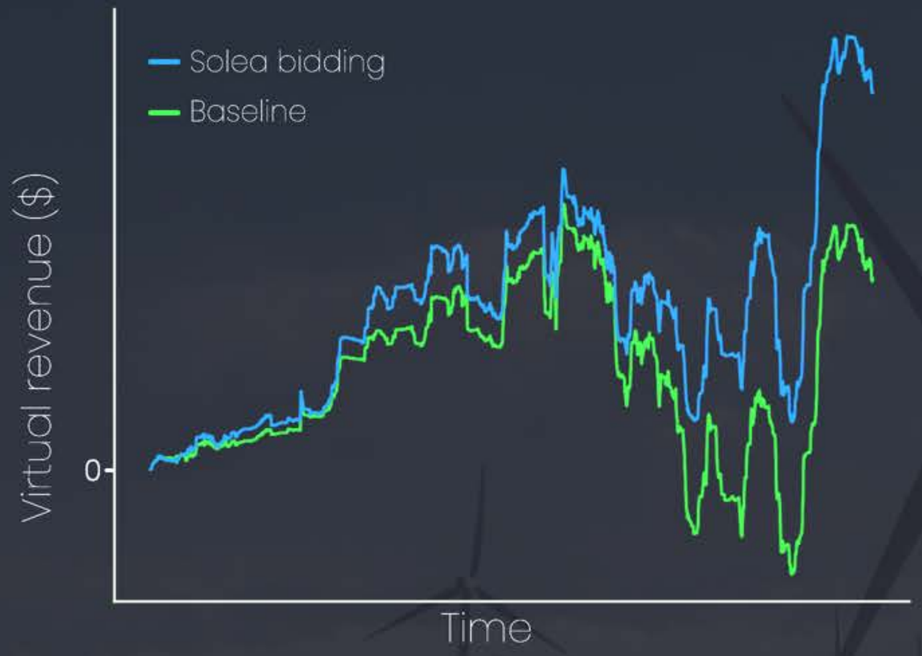
# Solea Bidding Strategy





Consistent with the guidelines laid out for by the customer, Solea increased the 1% CVaR over the period by under 10%. In return for taking on this additional risk, Solea's strategy increased revenue by 98% for the generator over the period.

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# Solea Bidding Strategy

| | Baseline | | | | | Solea | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Min | 10th percentile | Mean | 90th percentile | Max | Min | 10th percentile | Mean | 90th percentile | Max |
| Revenue | -$304,000 | -$162,000 | $34,000 | $151,000 | $409,000 | -$206,000 | -$110,000 | $51,000 | $221,000 | $456,000 |
| Annualized Sharpe | -18.9 | -11.0 | 4.4 | 18.7 | 29.9 | -13.4 | -7.1 | 5.4 | 16.9 | 30.3 |
| 1% Hourly CVaR | -$14,000 | -$12,000 | -$8,000 | -$3,000 | -$2,000 | -$16,000 | -$14,000 | -$8,000 | -$4,000 | -$3,000 |
| Revenue ($/MWh) | -5.6 | -3.3 | 1.3 | 5.7 | 9.2 | -3.9 | -2.0 | 2.00 | 7.00 | 10.10 |

While the baseline bidding strategy yields profitable results on average, our simulations show that a 10th percentile month has the ability to offset almost five average months. Note that such a month is anticipated to happen at least once a year, and indeed did occur during our test period (Nov, 2021)

Solea's results are skewed to the upside, with a better risk/return ratio and more revenue for approximately the same amount of risk. Observe that a month performing in the 10th percentile only offsets about 2 average months, while the worst case in the simulations can be anticipated to be offset by the 90th percentile, which we expect to observe about once per year.

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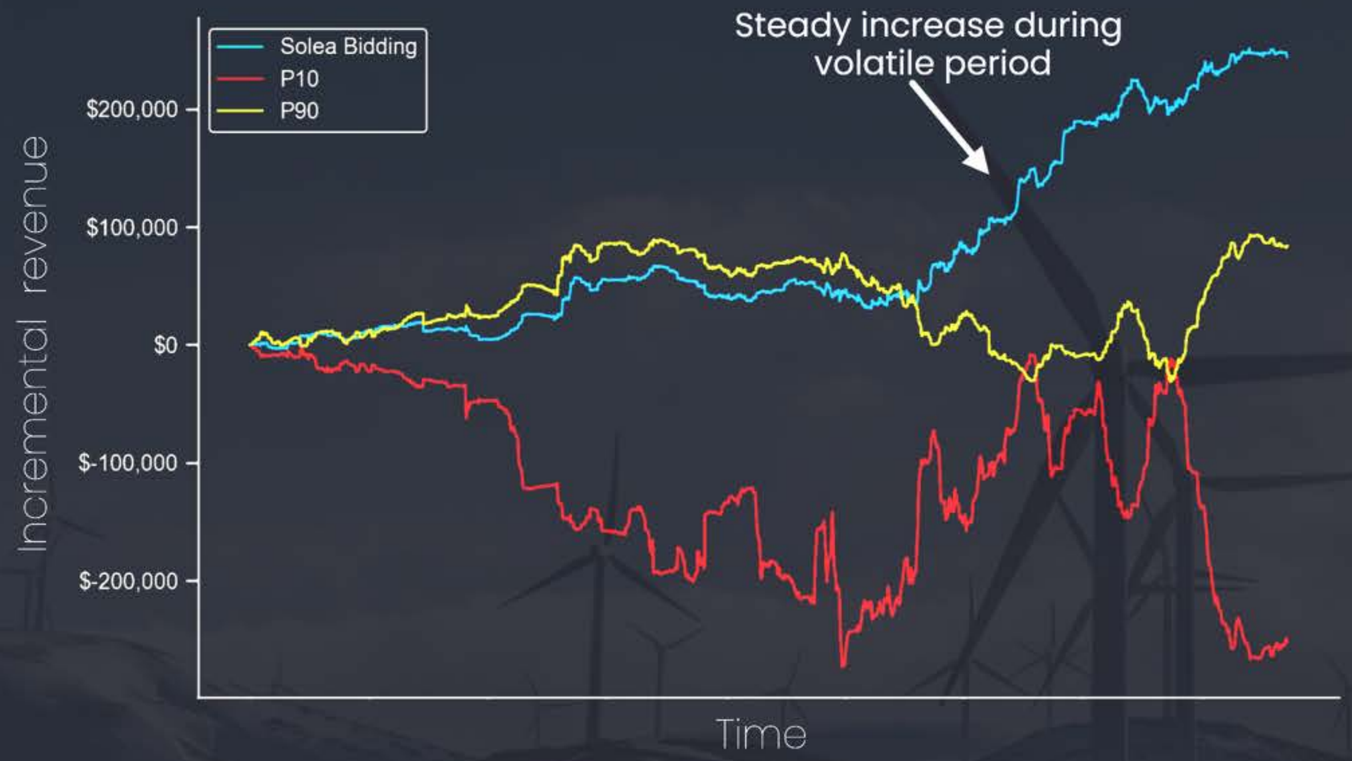
# Bidding Strategy Comparison




Here, we probe the profitability of consistently scheduling the maximum and minimum allowable volume. While incremental revenue - the revenue above/below the baseline - is postive for the P90 forecast over the time period of the study, it is clearly more volatile and less productive than Solea's optimized bidding strategy, losing most of its gains in a two month period. In contrast, Solea's strategy adapted to the changing market conditions and yielded strong and consistent returns over the volatile period.

# Get in touch!

Solea is ready to optimize renewable assets in MISO, PJM, SPP, and ERCOT with work underway to enable participation in the remaining US RTOs. Our onboarding process is straightforward and because the entire process is algorithmic we can rapidly deploy our optimization to all of your assets.

Solea is also actively recruiting pilot participants for our battery storage optimization and basis risk management projects. The pilot program results in free algorithmic recommendations for participating assets for the duration of the pilot and will allow the participant to collaborate on the output of the product.

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