ACP PEAK
PERFORMANCE, MODELING & ASSESSMENT CONFERENCE

Portfolio Analysis: Going Beyond Gaussian P50/P99

Time is Money

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AMERICAN CLEAN POWER

Pattern

Agenda

- Overview of typical Industry Project and Portfolio Level Energy and Revenue Modeling
- Contrast with Operational Reality
- ~~Grand Unifying Solution~~ I mean… Call to Action!
- Examples: why time-dependent modeling matters
- Key Takeaways

Industry Practices for Energy and Revenue Modeling

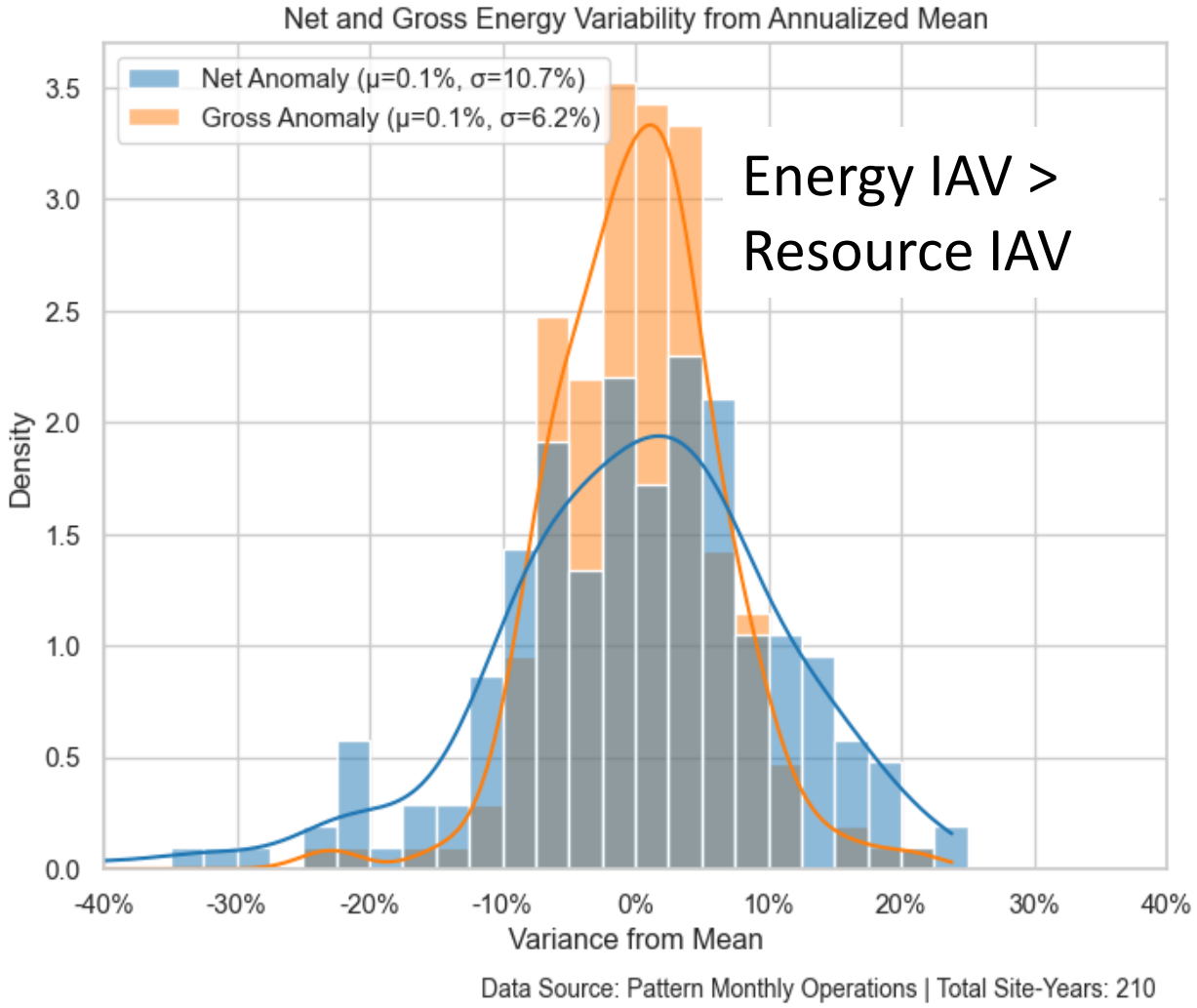
Project Level

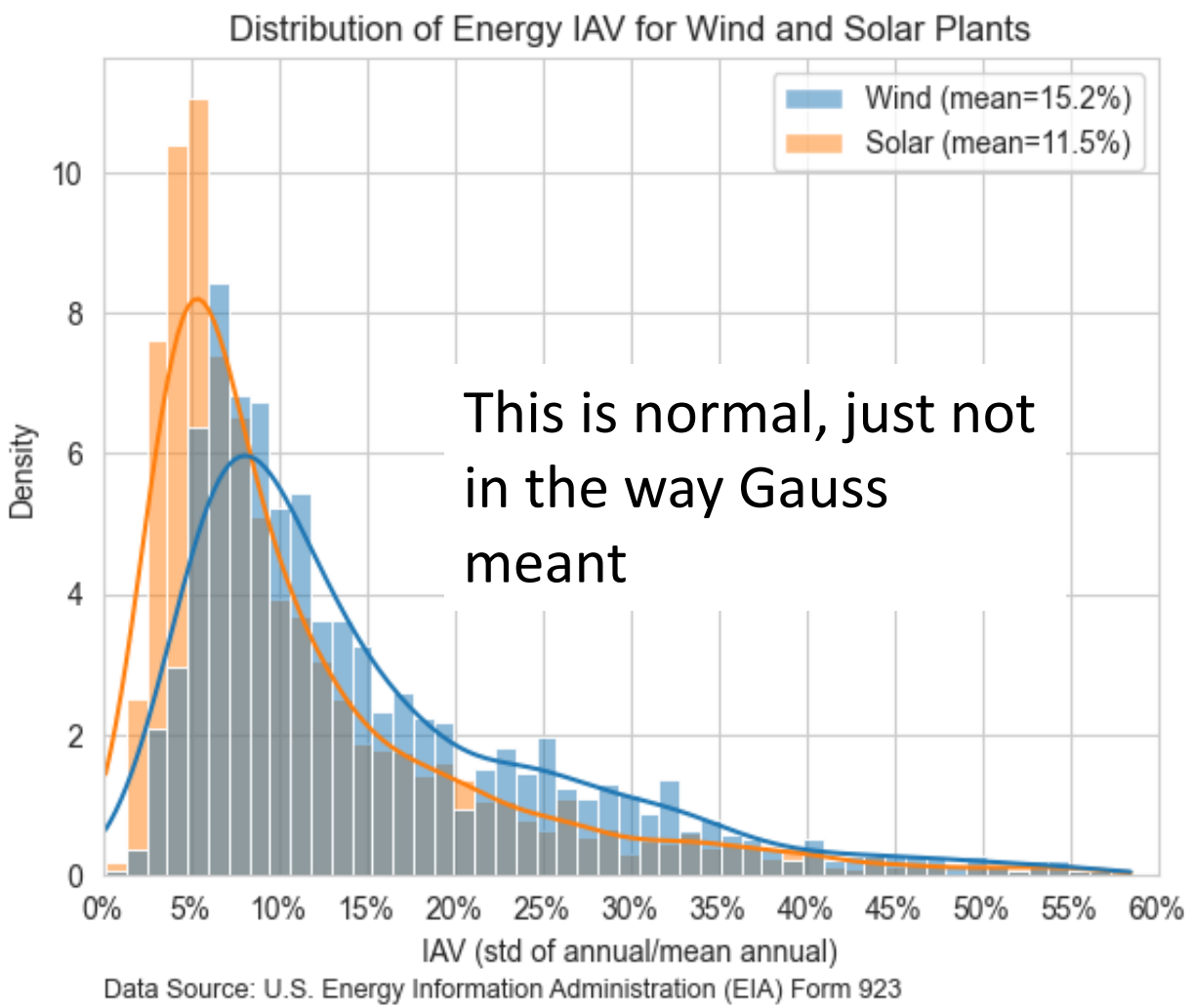
- Energy Assessment
  - Gaussian normal assumption of uncertainties
  - Energy forecast by year assuming degradation
  - 12x24 and 8760 reflect *only* resource variability of a *typical* (LT P50) year
- Revenue Modeling
  - LT Average Energy * Price on a 12x24 or 8760 basis
  - Energy and Price forecast by year
  - Decoupled uncertainty analysis

Portfolio Level

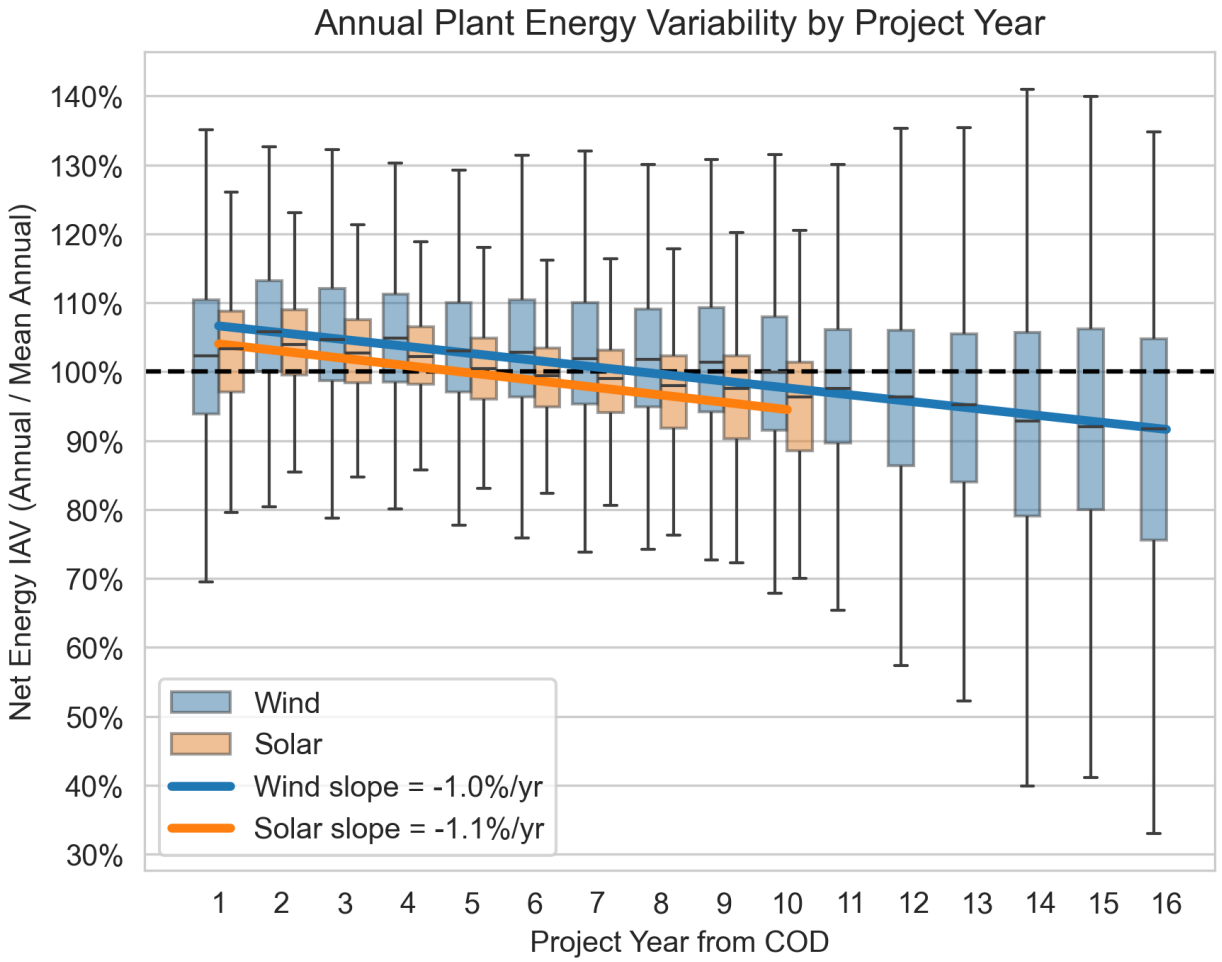
- Energy Assessment
  - Gaussian normal assumption of uncertainties and aggregations of uncertainties
  - Quantified resource correlation, everything else is qualitative
  - “portfolio benefit” on a LT or 1-year basis, applied uniformly
  - 12x24 and 8760 rarely concurrent between projects
- Revenue Modeling
  - Aggregate Project Level Revenue
  - Top-side adjustment of energy portfolio benefit

Reality: Gaussian Normal assumptions aren't always great

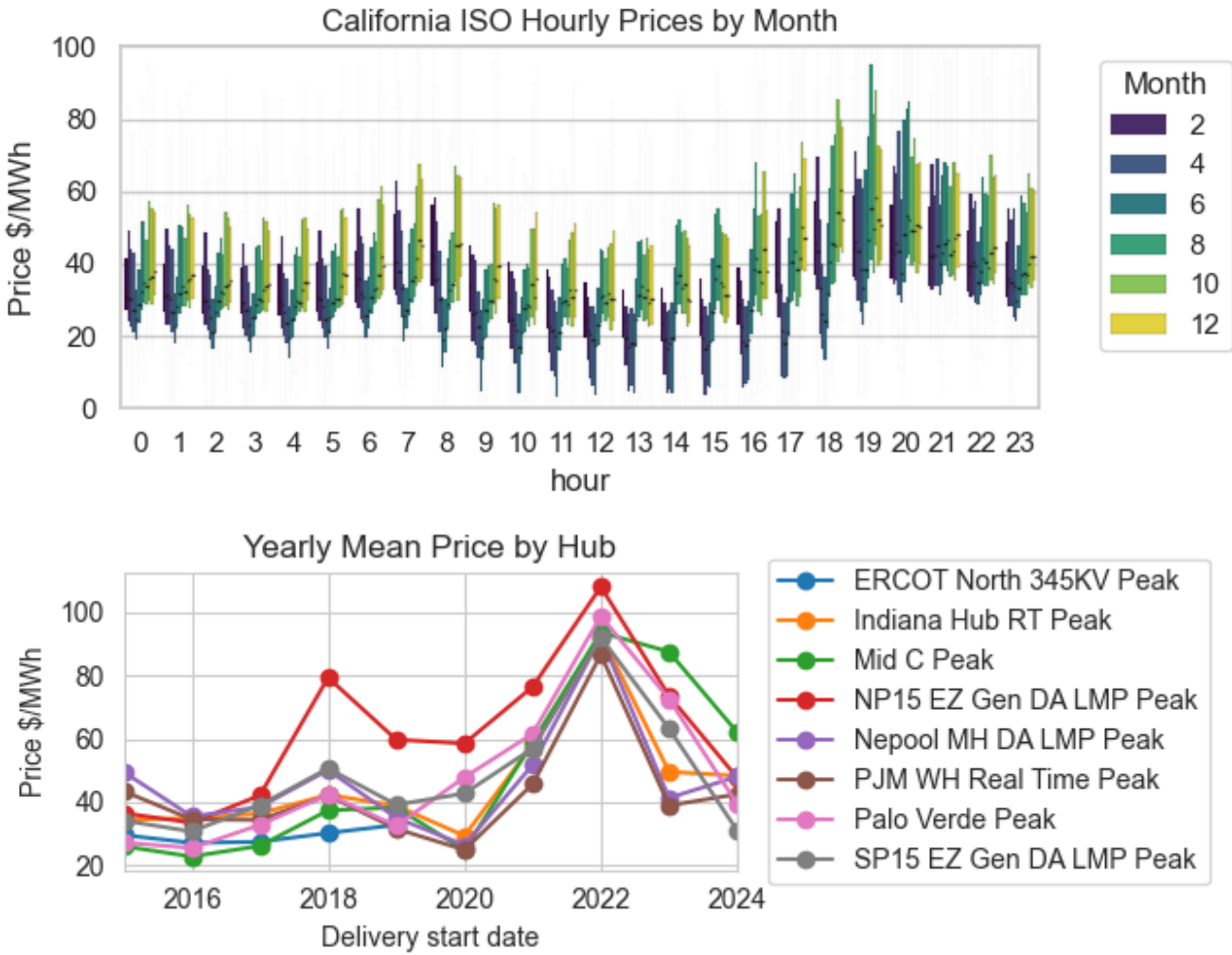




Reality: Both Energy and Pricing are not static through time

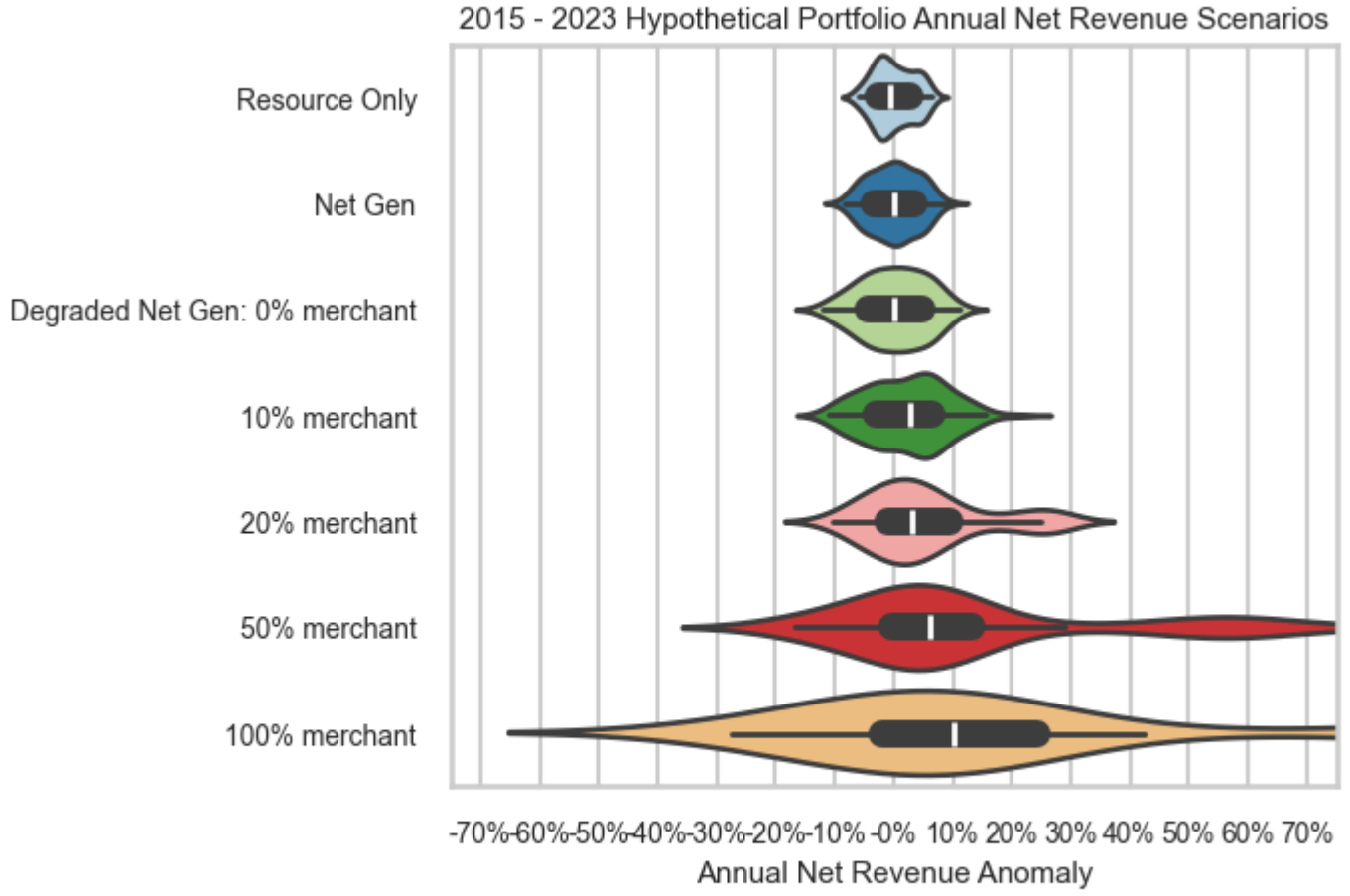


Data Source: U.S. Energy Information Administration (EIA) Form 923
Project Years with >20% of max



Example: Hypothetical Portfolio Risk Assessment

- Methodology
  - 2015 – 2023 historical pricing (EIA) and weather (VCE RARE)
  - Apply energy loss degradation from EIA, Pattern Loss IAV
  - Simulate 30 random portfolios of 30 wind and solar projects in the USA
- Energy
  - Losses skew the distributions
- Revenue
  - >20% merchant: pricing IAV term dominates revenue IAV
  - >50% merchant: revenue IAV ~ pricing IAV
  - NOTE: Historical pricing IAV is not indicative of future pricing IAV



Energy Source: VCE RARE https://zenodo.org/records/17065118
Historical Pricing: EIA https://www.eia.gov/electricity/wholesale/
30 portfolios of 30 wind and solar power plants

Key Takeaways

- Typical industry practices are limited and not a good proxy of reality
  - We need better tools!
- Resource IAV < Energy IAV < Revenue IAV
  - Need to unify resource, energy and revenue modeling using time series to preserve correlations
- Nor is project or portfolio IAV necessarily Gaussian Normal
  - Don’t be afraid to learn from reality
- Both energy and revenue P50 and uncertainty are not static through time
  - Pricing dominates revenue risk even at moderate merchant %
- Explore yourself!
  - VCE RARE Dataset: https://zenodo.org/records/17065118
  - Presentation Source Code: https://github.com/srlightfoote/ACP-Peak-2025-Portfolio-Analysis

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Thank you!

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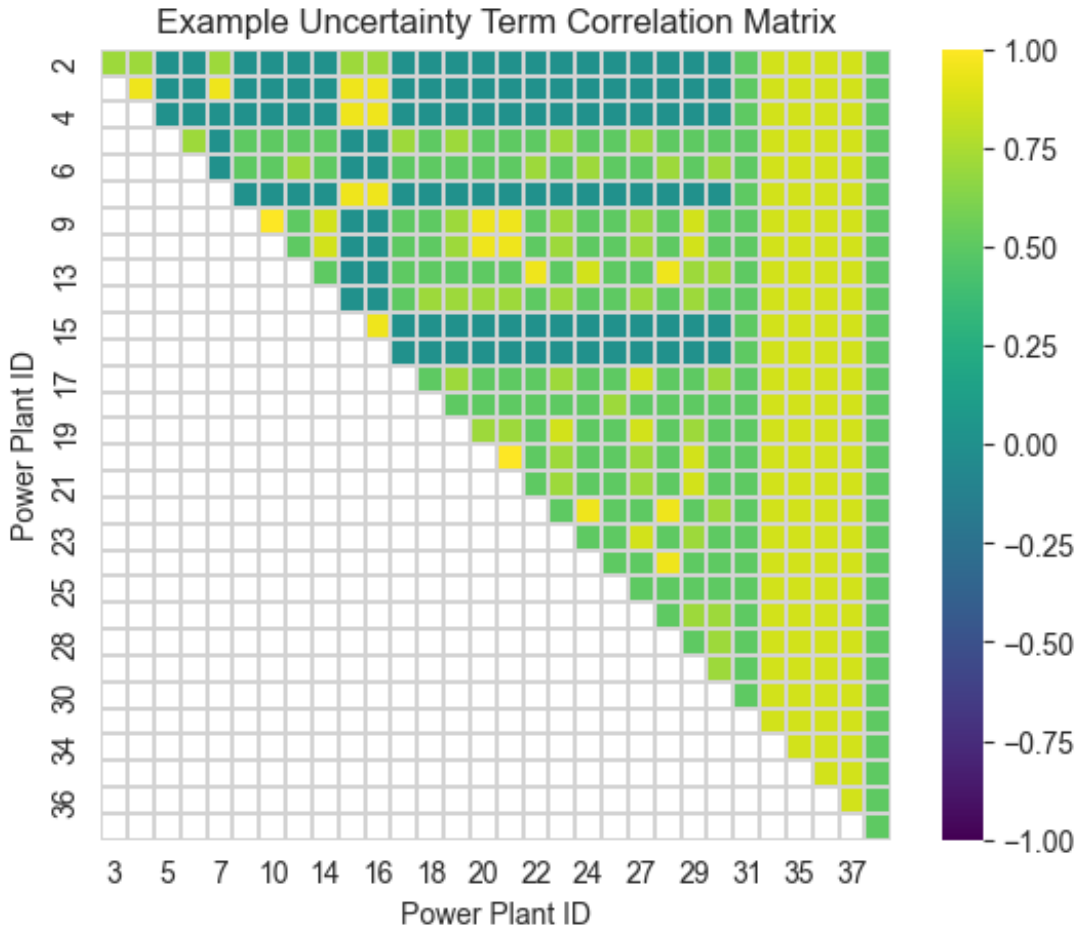
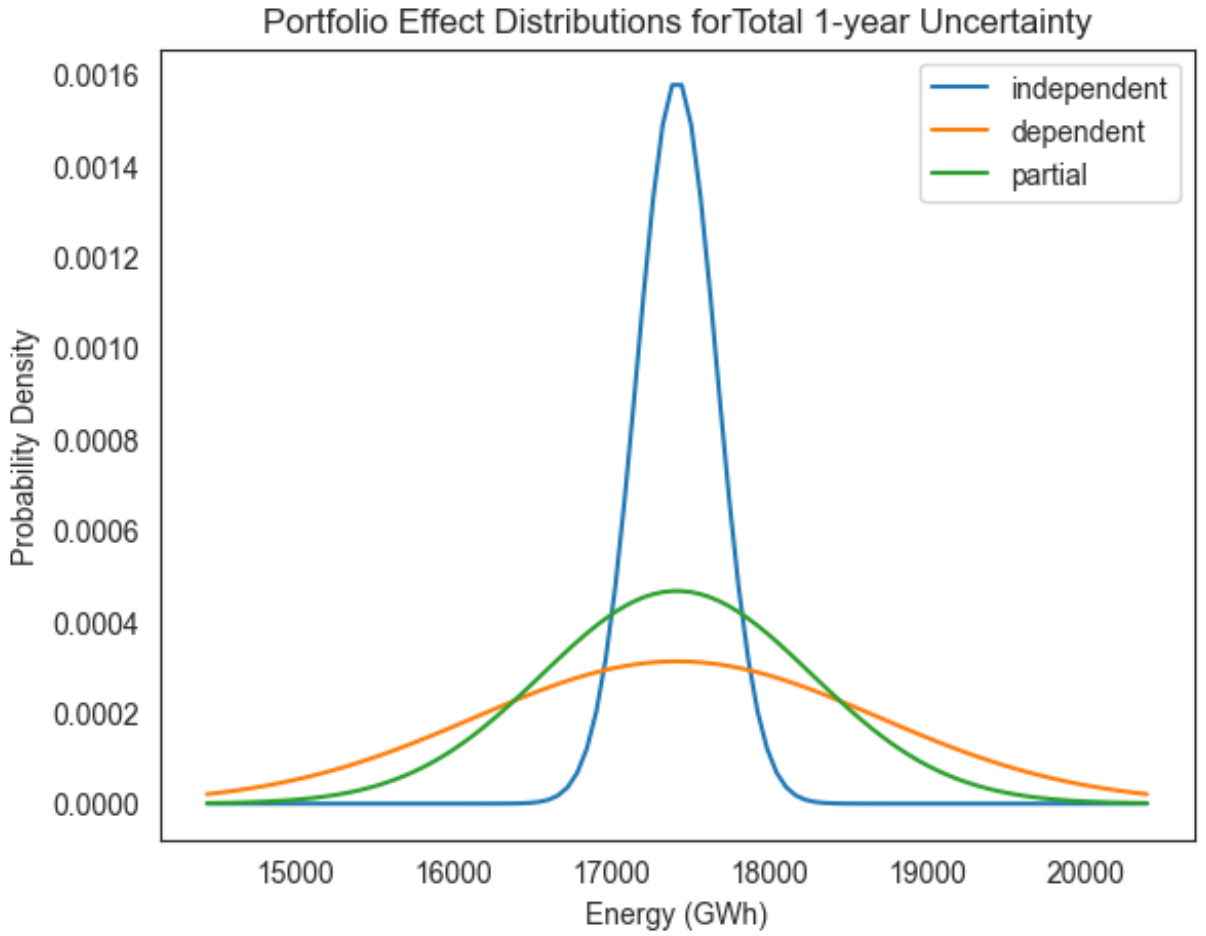
Industry Practices: Portfolio Analysis



Correlations between terms are often qualitatively ascribed

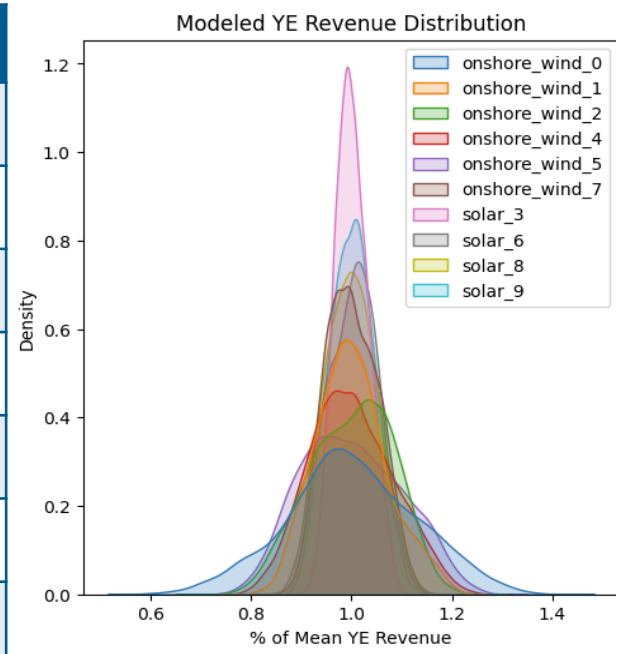


Assumes a gaussian normal distribution for each term

Can we do better?

- **Copula**: multivariate cumulative distribution function for which the marginal probability distribution of each variable is uniform on the interval [0, 1].
- Used correctly the approach has potential to unify resource, losses, degradation and pricing, preserving correlations

	Industry Norm	Copula-Based
Gaussian Normal Distribution	☑	☑
Correlation between terms	☑	☑
Flexible Distribution Modeling	☒	☑
Flexible Time Horizon (sub-annual)	☐	☑
Jointly Model Energy x Price x whatever	☒	☑
Univariate and Multivariate Sampling	☒	☑
Integrated Toolset	☒	☑
Can model autocorrelation between samples	☒	☒



https://sdv.dev/Copulas/

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