Choosing Among Monte Carlo, Sensitivity Analysis, and Scenario Analysis

The Answer is Yes!

Palisade 2019 Annual Conference
November 13-14
San Antonio, Texas

PALISADE

Experience on Demand

Overview

- Introduction
- The Issue
- Definitions
- Examples
- Observations & Recommendations
- Case Study

Introduction

Experience on Demand

People ▪ Process ▪ Results

- Formed in 2008, based in Chesterfield, Missouri
- Currently 17 persons, including 7 Senior Partners who own the firm
- Successfully served over 200 clients
- Broad experience ***across*** multiple industries
- Deep technical expertise ***within*** multiple industries

Experience on Demand

People ▪ Process ▪ Results

Mission

- Experience on Demand provides comprehensive services to help our clients tackle today's problems and achieve tomorrow's opportunities.
- We partner with our clients, "roll up our sleeves," and focus on results.

Distinctives

- Our Partners are "hands on" experts, highly skilled in performing technical work
- We pride ourselves in exceedingly responsive customer service
- We are highly flexible in designing work scope and pricing structures to meet our clients' exact needs
- We continuously strive to maximize net value delivered

Professional Background

- Senior Partner, Experience on Demand
  Energy & Utilities Practice Leader
- 33 Years consulting and industry experience
  - Completed over 100 projects across all forms of electric utilities in U.S. and Canada
- Deloitte & Touche, LLP
  - Director, Governance, Risk, and Regulatory Strategy
- R. W. Beck, Inc.
  - National Practice Leader - Energy Risk Management
  - National Practice Leader - Energy Markets Consulting
- Ameren Corporation
  - Director, Transmission Capital & Risk Management
  - Supervising Engineer, Corporate Planning
  - Multiple other roles
- BS Nuclear Engineering
- MBA with honors
- Executive Education – The Wharton School

Career Path

BSNE

Union Electric
Nuclear Fuel Engineer

MBA

Ameren
Energy Marketing & Trading

R. W. Beck
Risk and Energy Markets Consulting Practices

Deloitte
Global Energy Markets / GRRS

Ameren
Transmission Capital & Risk Management

Experience on Demand
Management Consulting

Investor-Owned Utilities

All forms of Electric Utilities, Banks

Energy
Utilities
Government
Infrastructure
Manufacturing

The Issue

The Issue

- Many organizations are resistant to Monte Carlo analysis

The "cloud" of results is hard to understand and explain

We prefer to study discrete scenarios

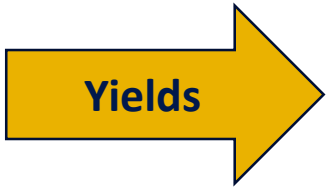
We prefer to study individual "what if" cases

We want to directly control the results

The Issue

- This is unfortunate because Monte Carlo not only provides more dependable expected values for most business decisions, but also provides richer and more useful sensitivity and scenario analysis capabilities

Monte Carlo Simulation



More Information

+

Better Information

Definitions

Definitions

- Monte Carlo Simulation

The process of running a model (such as a spreadsheet) many times in a row. Each run (iteration) uses a different set of inputs. The values used for each input conform to an assumed probability distribution and an assumed correlation with the other inputs. Results from each iteration are recorded.

The result of the simulation is obtained by taking th
This becomes the expected result of the model. In r
more dependable in reflecting "reality" than a single
most-likely value for each input*.

* This relates to what is known as Jensen's Inequality

Mathematically, $E[f(x,y)] \neq f[E(x),E(y)]$

This holds true for most (but not all) business problems.

Definitions

- Sensitivity Analysis

Understanding the key drivers of a model by performing “what ifs” on each input variable individually. Goal is to identify the inputs that have the largest impact on results.

Definitions

- Scenario Analysis

Understanding the behavior of a model for various combinations of inputs.

Or conversely, studying selected ranges of results to understanding the combinations of inputs leading to the selected results.

Example & Results

Example and Results

- Potential power plant investment
- If power price is above marginal operating cost, then plant runs and produces margin
  - Marginal cost = Fuel price x energy conversion factor + variable O&M
- However, fixed costs are always incurred

Inputs			
	Generator Size	500	MW
	Heat Rate	7.0	MMBtu/MWhr
	Variable O&M	2.00	$/MWh
	Availability	90%	
	Fixed Monthly Cost	$2,500,000	$/Month
	Ave Fuel Price	$3.00	$/MMBtu
	Fuel Price Volatility	20%	
	Ave Power Price	30.00	$/MWhr
	Power Price Volatility	20%	
	Gas Forward Purchase Qty	-	MMBtu/Day
	Power Forward Sale Qty	-	MWhr/Hr
	Days in Period	31	

Example & Results

Model in Action

Example & Results

Initial Expected Values

- Standard approach

Daily Profit	$	(5,045)

- Monte Carlo using @Risk

Mean Daily Profit	$	1,261

Example & Results

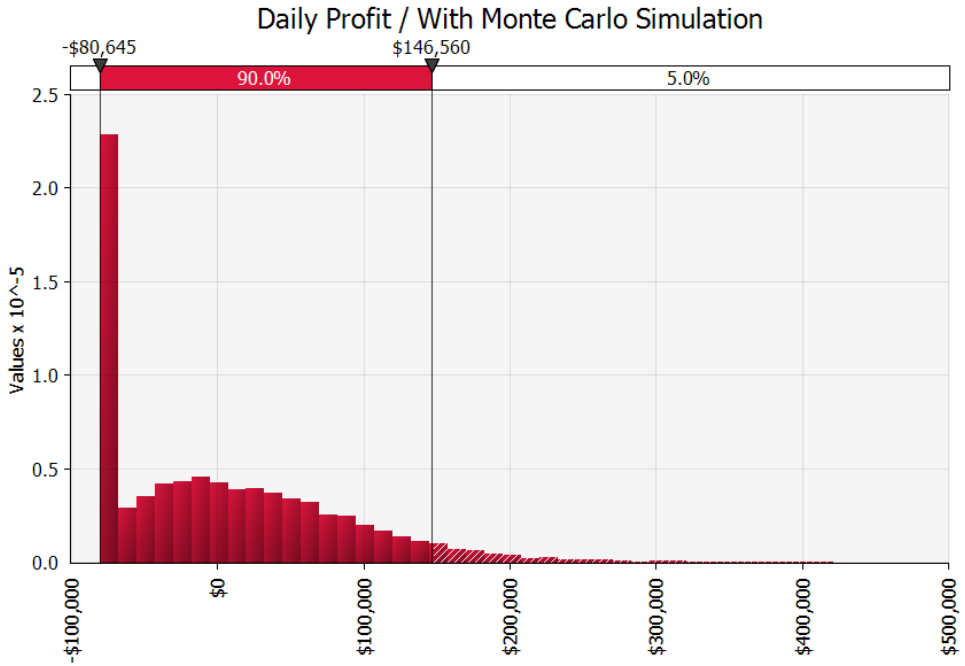
Richness of Information

- Standard approach

Daily Profit $ (5,045)

- Monte Carlo using @Risk

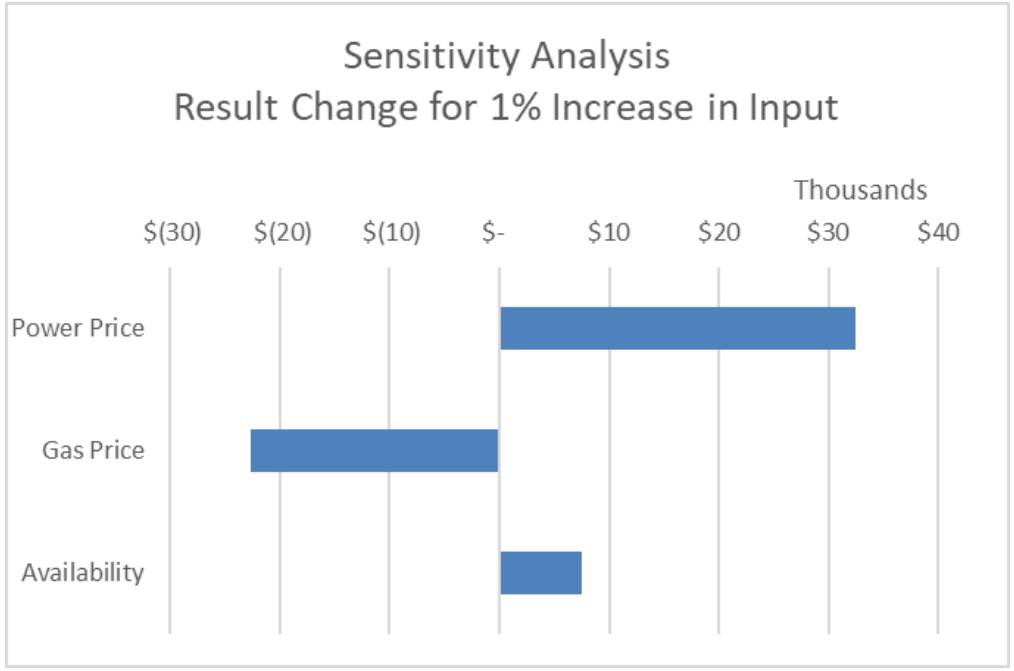
Mean Daily Profit $ 1,261



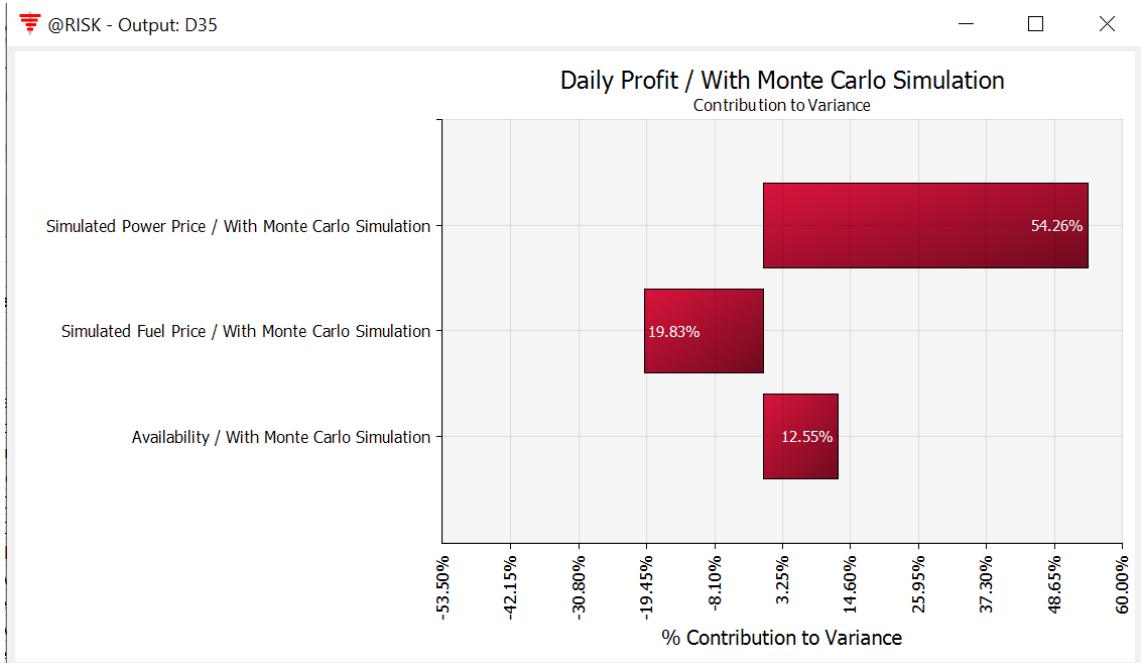
Example & Results

Sensitivity Analysis

- Standard approach



- Monte Carlo using @Risk



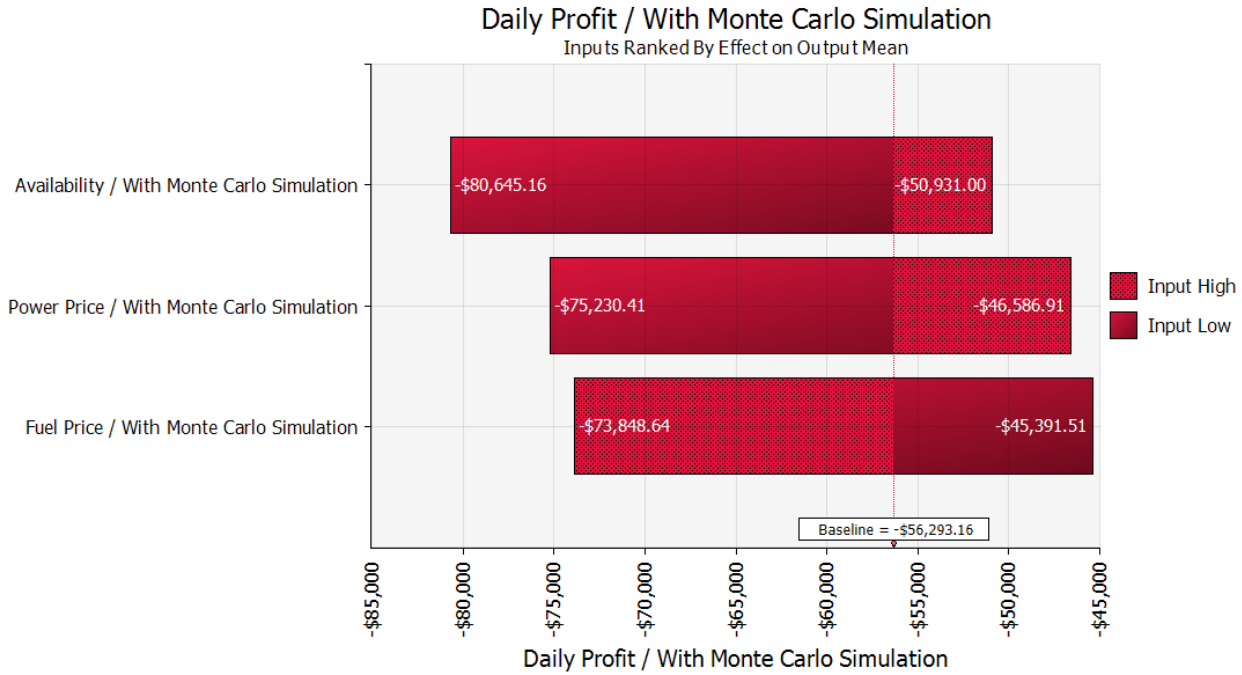
Example & Results

Scenario Analysis

- Standard approach

	Scenario States			Scenario Input Values			
Scenario	Power Price	Gas Price	Availability	Power Pric	Gas Price	Availabilit	Scenario Result
1	Most Likely	Most Likely	Most Likely	30	3	0.9	-5045.16129
2	Most Likely	Most Likely	High	30	3	0.95	-845.1612903
3	Most Likely	Most Likely	Low	30	3	0.5	-38645.16129
4	Most Likely	High	Most Likely	30	4	0.9	-80645.16129
5	Most Likely	High	High	30	4	0.95	-80645.16129
6	Most Likely	High	Low	30	4	0.5	-80645.16129
7	Most Likely	Low	Most Likely	30	2	0.9	70554.83871
8	Most Likely	Low	High	30	2	0.95	78954.83871
9	Most Likely	Low	Low	30	2	0.5	3354.83871
10	High	Most Likely	Most Likely	50	3	0.9	210954.8387
11	High	Most Likely	High	50	3	0.95	227154.8387
12	High	Most Likely	Low	50	3	0.5	81354.83871
13	High	High	Most Likely	50	4	0.9	135354.8387
14	High	High	High	50	4	0.95	147354.8387
15	High	High	Low	50	4	0.5	39354.83871
16	High	Low	Most Likely	50	2	0.9	286554.8387
17	High	Low	High	50	2	0.95	306954.8387
18	High	Low	Low	50	2	0.5	123354.8387
19	Low	Most Likely	Most Likely	20	3	0.9	-80645.16129
20	Low	Most Likely	High	20	3	0.95	-80645.16129
21	Low	Most Likely	Low	20	3	0.5	-80645.16129
22	Low	High	Most Likely	20	4	0.9	-80645.16129

- Monte Carlo using @Risk



Summary

- Monte Carlo using @Risk
  - Dependable expected value immediately available
  - Richer information
  - Meaningful sensitivity results
  - Meaningful scenario results
  - 30 minutes + fun
- Standard approach
  - Undependable value results
  - Limited information
  - Unclear sensitivity results
  - Unclear scenario results
  - 6 hours + Tylenol

Observations & Recommendations

Observations

- Monte Carlo analysis using Palisade @Risk
  - Provides more dependable results for decision-making
  - Is **significantly** less time-intensive for performing proper sensitivity and scenario analysis
  - Features for exploring results are very powerful, yet easy to use once you learn them
  - Even for those ingrained in standard sensitivity and scenario analysis, @Risk's benefits should be compelling

Recommendations

- Take the time to explore @Risk's features, especially relating to sensitivity analysis and scenario analysis

- When dealing with skeptics…
  - Use @Risk's features to "follow the bread crumbs" to demonstrate to skeptics that @Risk is actually automating the same sensitivity and scenario analyses that are traditionally done manually

Case Study

Case Study

- Texas municipal utility
- We assisted them to develop a highly-flexible Energy Portfolio Analysis model (X-EPM) based on @Risk
- In fourth year of active use
  - Fuel & purchased energy (F&PE) cost forecasting
  - F&PE rate-setting
  - Mid-term hedging analysis
  - Long-term contract analysis
- Model and analytic processes have been catalysts leading to more and better questions on actual versus projected results
- Discovered significant lost value relating to operating practices which is now being captured

Thank You.

P. Glen Justis, Senior Partner

314-619-3430

glen.justis@experience-on-demand.com

www.experience-on-demand/enr-util