Fundamentals of Asset Mixing

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Current Power Supply Situation

Behind the Wheel: Management Focus

- Typical facilities supplied by local utility for both natural gas and electricity
- Distributed generation only as emergency backup power
- With changes in regulation and advancements in technology, potential to use additional generation assets now economically viable

Grid Connection Attributes

- Regulated by Utility Commissions
- Easy to use – plug and play
- Slow to respond to changing infrastructure needs
- Lack of flexibility

Distributed Energy Solution Attributes

- User is responsible for energy assets
- Designed to meet specific needs of facility
- Feedstock fuel source major concern
- Backup and reliability concerns

Typical Distributed Generation Applications

Behind the Wheel: Management Focus

- On-site CHP
- PV
- Wind
- Geothermal heatpump

DG Design Considerations

Behind the Wheel: Management Focus

- Determination of loads to connect to system
- Ability to use power and/or heat when produced
- Interconnections with utility
- Site selection
- Environmental Concerns
- Reliability

DG Economics

- Understanding the true cost of generation
  - Land value
  - Construction Costs
  - Fuel Cost
  - Ongoing Operations and Maintenance Costs
  - Back-up power costs (Stand-by generation)

Understanding Utility Energy Costs

Behind the Wheel: Management Focus

- Multiple Cost Components
  - Customer charges
  - Usage (kWh)
    - Peak, mid-peak, off-peak
  - Capacity or Demand (kW)
    - May have components set monthly and once/year
  - Other charges
    - Equipment rentals
    - Reactive demand

Energy Cost Example Facility in Yorktown,VA

Behind the Wheel: Management Focus

- Blended utility rates not accurate for many project decisions

Utility Meter Information	
Metered Information	**Value**
Consumption (kWh)	1,291,200
Demand (kW)	2,381

Rate Calculation		
Rate Category	**Rate**	**Value**
Consumption ($/kWh)	0.0192	$24,805
Fuel Adjust ($/kWh)	0.0030	$3,874
First 1500 kW of Demand ($/month)	15,347	$15,347
Additional Demand ($/kW)	9.889	$8,712
Total Costs		$52,738

	$52,738 / 1,291,200
Blended Rate ($/kWh)	**0.0408**
	0.0192 + 0.003
Consumption Rate ($/kWh)	**0.0222**

Typical Project Cost Factors

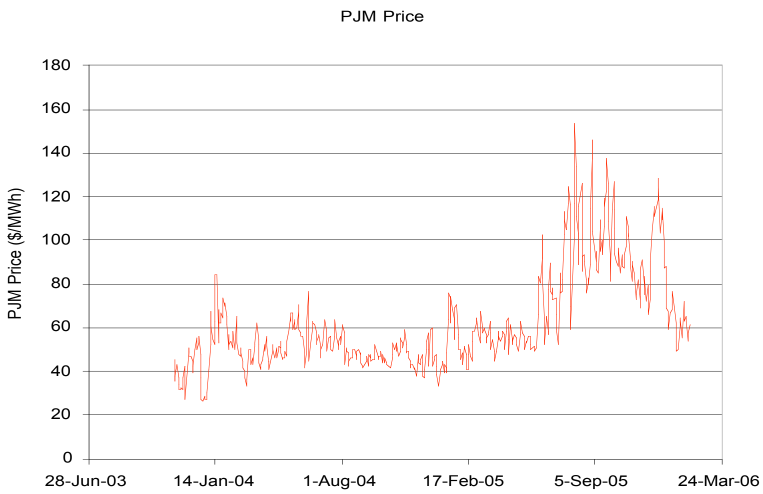
Behind the Wheel: Management Focus

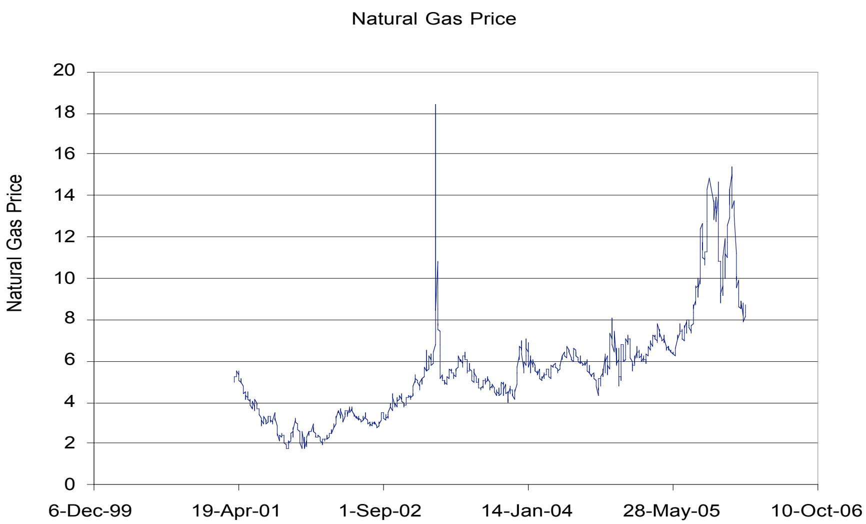
- Capital
- Operations and Maintenance
- Energy Savings
  - Energy Unit Cost
  - Hours of operations
  - Equipment Efficiency

General Energy Market Trends

Behind the Wheel: Management Focus

- Need to plan for volatility in economic evaluations





Financial Analysis Methods

Behind the Wheel: Management Focus

- Need to look at life-cycle costs
  - With variable risk factors, deterministic models are inadequate
  - Use of a probabilistic method provides broader range of potential results with multiple variables

Quantitative Uncertainty Analysis

Behind the Wheel: Management Focus

- Using a Monte-Carlo simulation, able to assign the probability of major variables to determine the certainty level of potential outcomes
- In simple terms, provide a realistic view of actual project economics even with multiple variables

Uncertainty Analysis – Example

- Alternatives Analysis for Cogeneration system (compared to taking electricity from local municipality)
  - Reciprocating engine
  - Microturbine
  - Fuel Cell

Uncertainty Analysis – Example Cost Estimate

Behind the Wheel: Management Focus

Electrical Rate ($/kWh)	Availability			Discount Rate
	Fuel Cell	Microturbine	Reciprocating Engine	
0.1100	97%	95%	95%	6.30%

Alternative	Description	Initial Capital Cost (including rebates)	Annual O&M Cost	Major Repair (annualized)	Annual Cost Savings	Annual Energy Savings (kWh)	Simple Payback (years)	Net Present Value (10 Yr)
1	Fuel Cell (2@200kW)	$ 2,691,809	$ 53,213	$ 69,000	$ 373,877	3,398,880	10.7	$ (900,191)
2	Microturbine (8@30kW)	$ 1,519,057	$ 24,950	$ 6,960	$ 219,701	1,997,280	8.1	$ (203,762)
3	Reciprocating Engine (1@380kW)	$ 1,236,004	$ 97,606	$ -	$ 347,860	3,162,360	4.9	$ 541,149

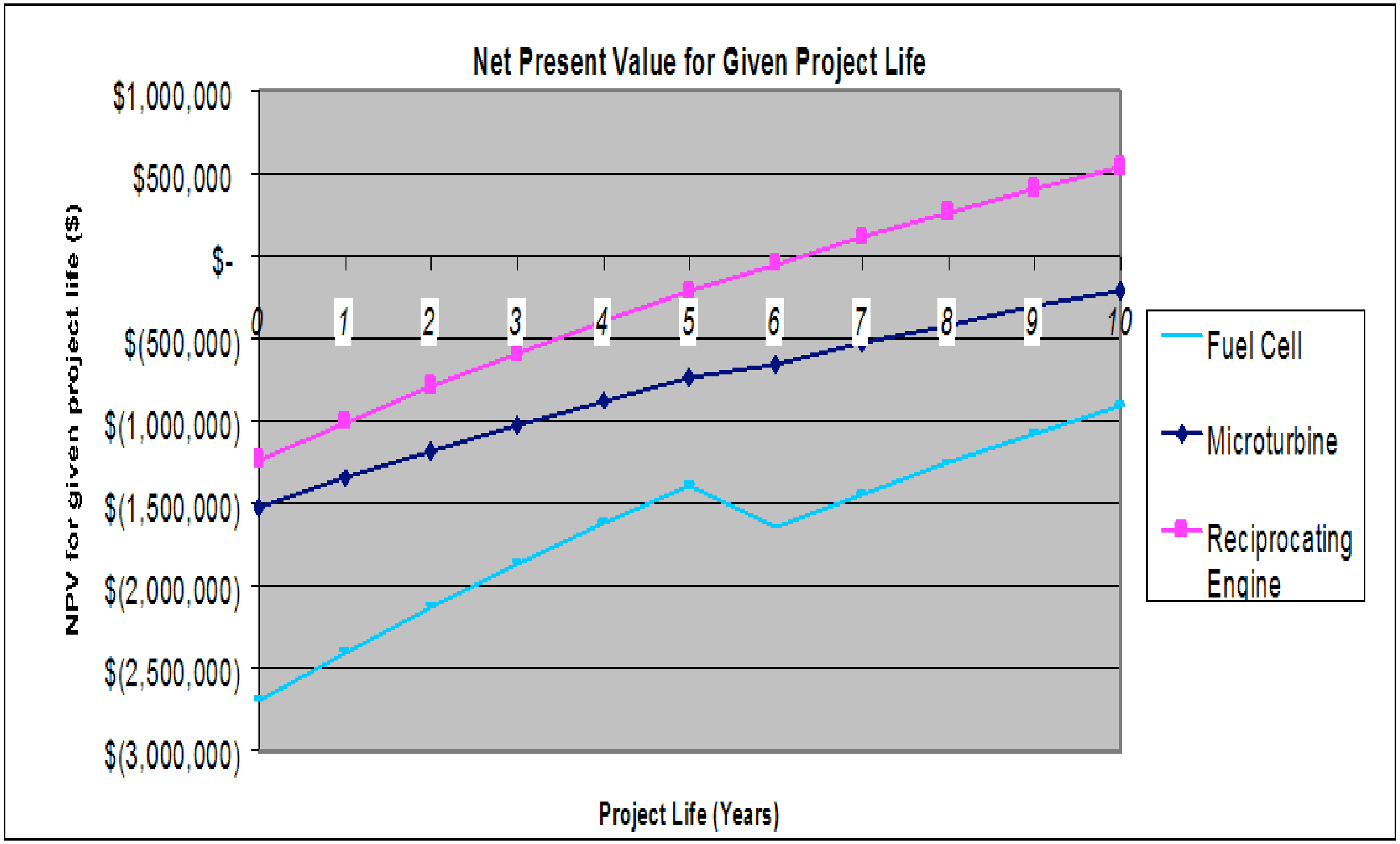
Uncertainty Analysis – Example Assumptions

Behind the Wheel: Management Focus

Factor	Simulation Mean	Distribution Type	Fifth Percentile	Ninty Fifth Percentile	Range
Electrical Rate ($/kWh)	0.1364	Lognormal	0.1000	0.1800	0.0000 to 0.22
Availability - Fuel Cell	79%	Lognormal	65%	97%	0% to 100%
Availability - Microturbine	76%	Lognormal	60%	96%	0% to 100%
Availability - Reciprocating Engine	72%	Lognormal	55%	95%	0% to 100%
Discount Rate	5.09%	Lognormal	3.00%	8.00%	0.00% to 12.00

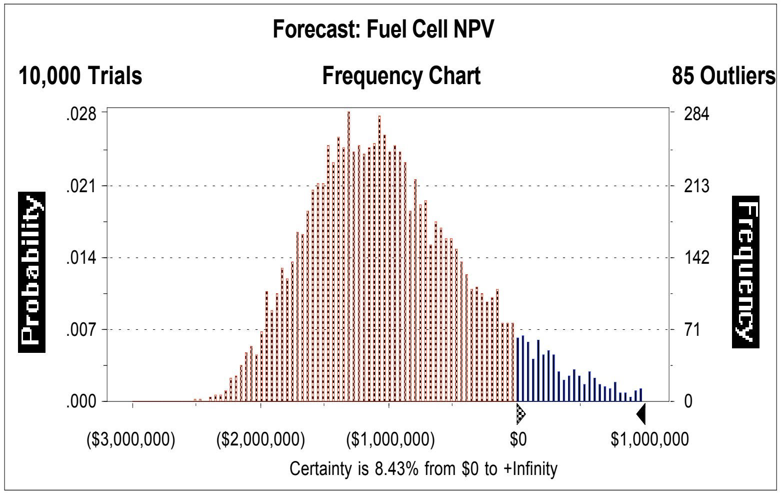
Uncertainty Analysis – Example Outputs

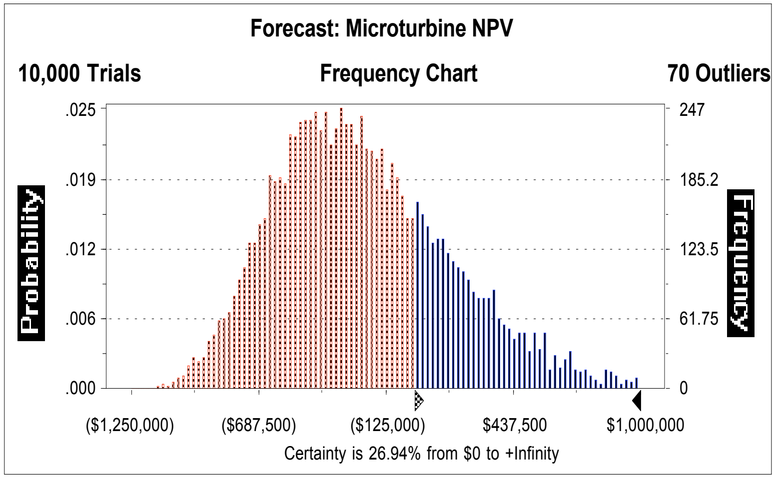
Behind the Wheel: Management Focus

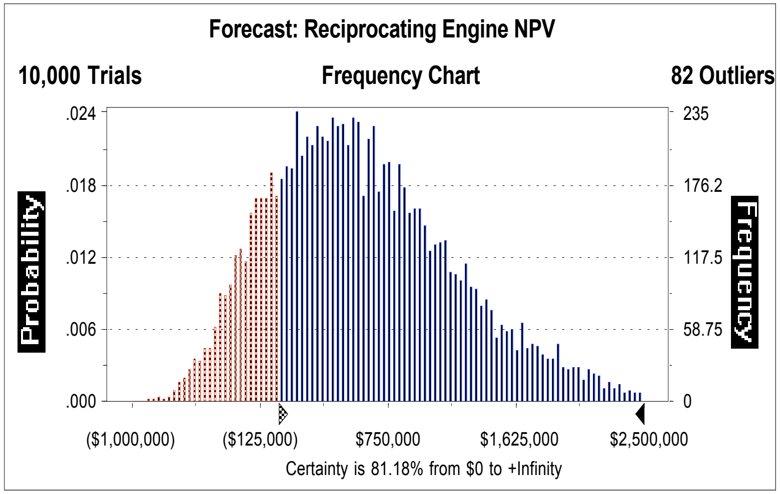


Uncertainty Analysis – Example Results

Behind the Wheel: Management Focus







Uncertainty Analysis – Example Interpretation

Behind the Wheel: Management Focus

- Overall Results
  - Fuel Cell – 12% certainty of being economical.
  - Microturbine – 32% certainty of being economical.
  - Reciprocating Engine – 80% certainty of being economical.
- Overall, only reciprocating engine likely to yield positive economic results

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Summary

Behind the Wheel: Management Focus

- Distributed generation can provide increased control and flexibility but analysis can be complicated
- As technologies are embraced, prices will continue to decrease
- In future, a mix of utility supplied and self-generated energy will provide optimal mix

Contact Information

Behind the Wheel: Management Focus

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