CIBO 30th Annual Meeting

Decision and Risk Analysis

A Methodology for Making Decisions in the Face of Uncertainty

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Overview of D&RA

Background

Dealing with uncertainty in decision making

What is Decision and Risk Analysis (D&RA)?

Evaluating Case Economics

Summary of D&RA process

Reflections on process

Background

Making strategic decisions is difficult

Uncertainties often cloud judgment

- "What will our market share be in 3 years?"
- "What will it cost to bring Product X to market?"

The realm of power and utilities is no different

- What happens to our business if gas goes >$15/MCF?
- What will it cost to scrub our coal-fired boilers?
  - Should we switch to gas if we have to scrub?
- Should we generate or buy power?
- How would we be impacted by climate change policy, e.g., a carbon/CO2 tax or fee?
  - What, if anything, should we do about it?
- What is the potential value of selling emissions credits/excess allowances?

How to Deal with Uncertainty?

To make good decisions, we need a way to deal explicitly with uncertainty

DuPont uses a methodology called "Decision and Risk Analysis" (D&RA)

This overview describes how D&RA can address uncertainty in decisions such as:

- Should we generate or buy electricity?
- Should we switch boiler fuel from coal to natural gas to avoid capital expenditures for pollution abatement equipment?

What is D&RA?

Decision and Risk Analysis (D&RA) is:

- A structured methodology...
- For making business decisions…
- That leads to consensus by addressing uncertainties

D&RA produces:

- A quantitative financial assessment of various options…
- Including NPV or NPC of investment(s)...
- As well as a “sensitivity analysis” of critical variables
- Consensus and confidence among decision makers, implementers and others impacted by the decision

D&RA Process Overview

Assemble a multi-disciplined team

Frame the problem: “Issues and Uncertainties”

- What options can improve financial performance?
- What uncertainties exist?

Develop cases to study

- Develop Strategy Tables and Case Definitions
- Write “Objective” and “Rationale” statements

Create “Influence Diagram” to model cash flow

Assess uncertainties which impact cash flow

Build a spreadsheet model to evaluate strategies

Present results for decision and implementation

Evaluating Case Economics

To evaluate options, we need to compare the economics of each Case

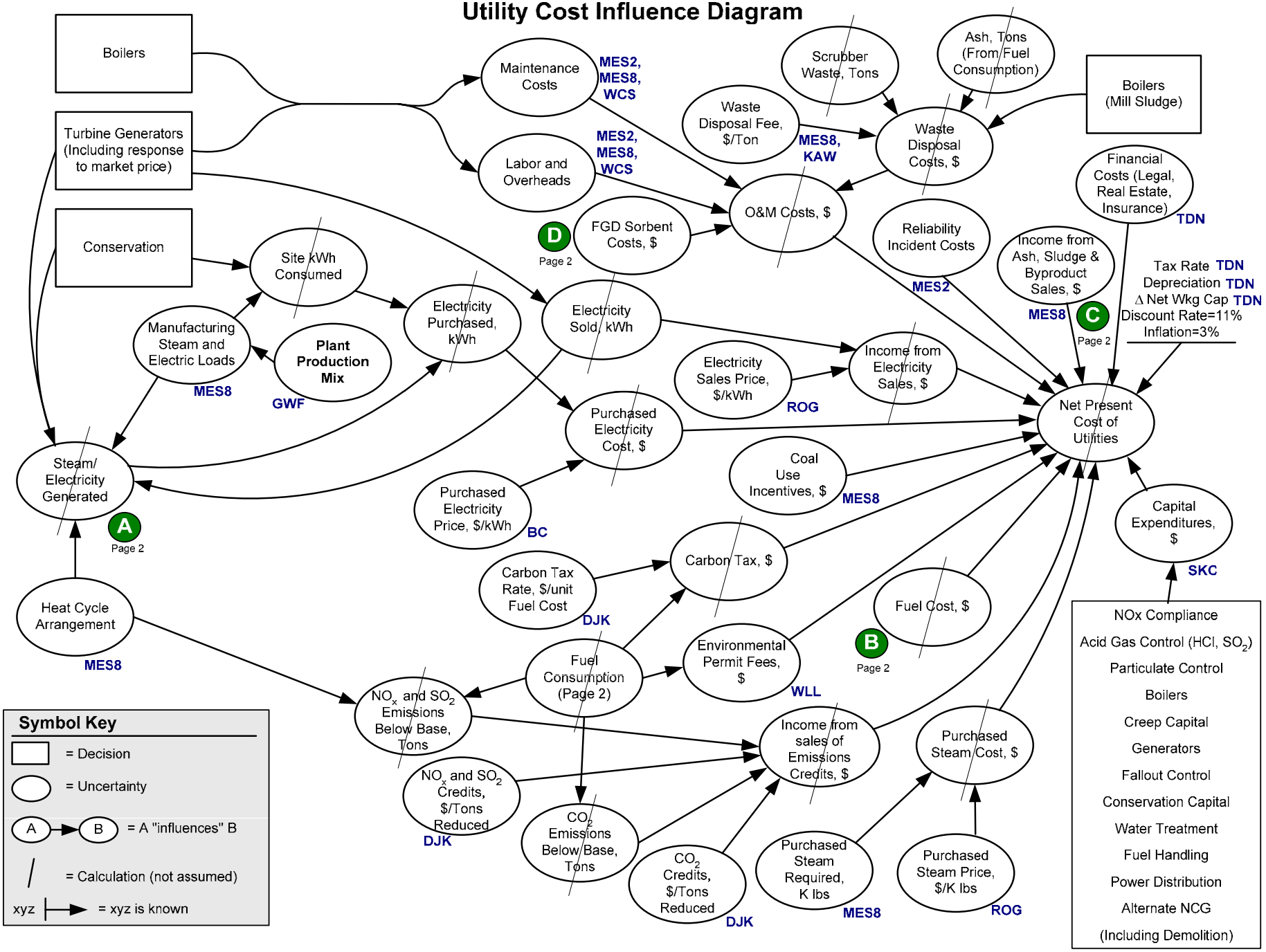
Case economics must consider many variables

- Capital expenditures and timing
- Operating and Maintenance expenses
- Fuel and electricity costs
- Cost of process interruptions caused by power failures
- Impact of future environmental cash flows

We use Net Present Cost (NPC) to roll up these costs

We model NPC with an “Influence Diagram”

Utility Cost Influence Diagram



Dealing with Uncertainties

Influence Diagram acts as a "blueprint" for building the Cash Flow Model in Excel

Some quantities on the diagram are known

- Tax rate, depreciation, discount rate, etc.

Some quantities can be calculated

- Boiler load, coal consumption, etc.

Other quantities are "uncertain"

- Coal price, capital expenditures, utility loads, etc.

How can you calculate NPC with uncertainties?

Answer: Use probabilities to assign values

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Assessing Uncertainties

D&RA deals with uncertainties by using probabilities

Subject matter experts are asked to estimate the probability of a given uncertainty such that

- There is a 1-in-10 chance the actual result will be this low
- The actual result is equally likely to be above or below
- There is a 1-in-10 chance the actual result will be this high

These assessments are called "10-50-90's"

"50" - 50% probability that a given outcome will occur

- Ex: 50/50 chance that coal cost will be $3.00/MM Btu

"10" - 10% probability that outcome will be below this value

"Best"

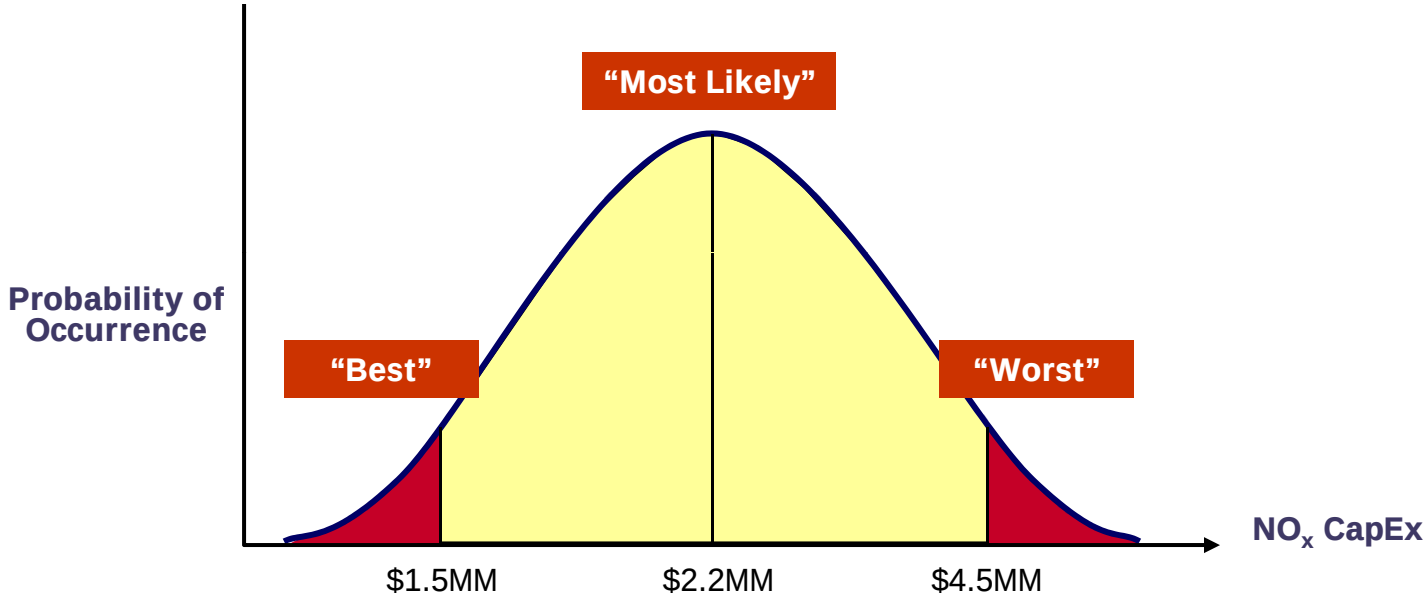
- Ex: 1 in 10 chance that coal cost will fall as low as $2.00/MM Btu

"90" - 10% probability that outcome will be above this value

"Worst"

- Ex: 1 in 10 chance that coal cost will be as high as $5.00/MM Btu

10-50-90's: The "80/20" Rule

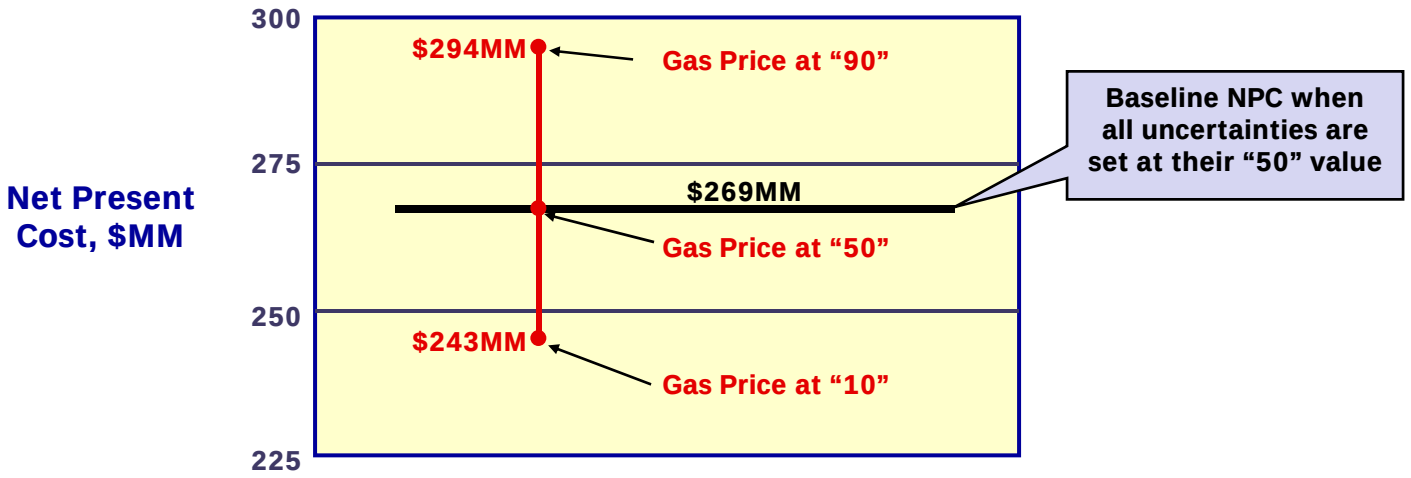


- 80% of the possible outcomes are within the 10 and 90 values
- By bounding the uncertainty this way, we can calculate NPC for the "best," "most likely," and "worst" scenarios simply by using the "10-50-90" values in the cash flow model

Uncertainties Give NPC "Range"

Once we "know" the value of each uncertainty, we can calculate a range of NPC's for each Case

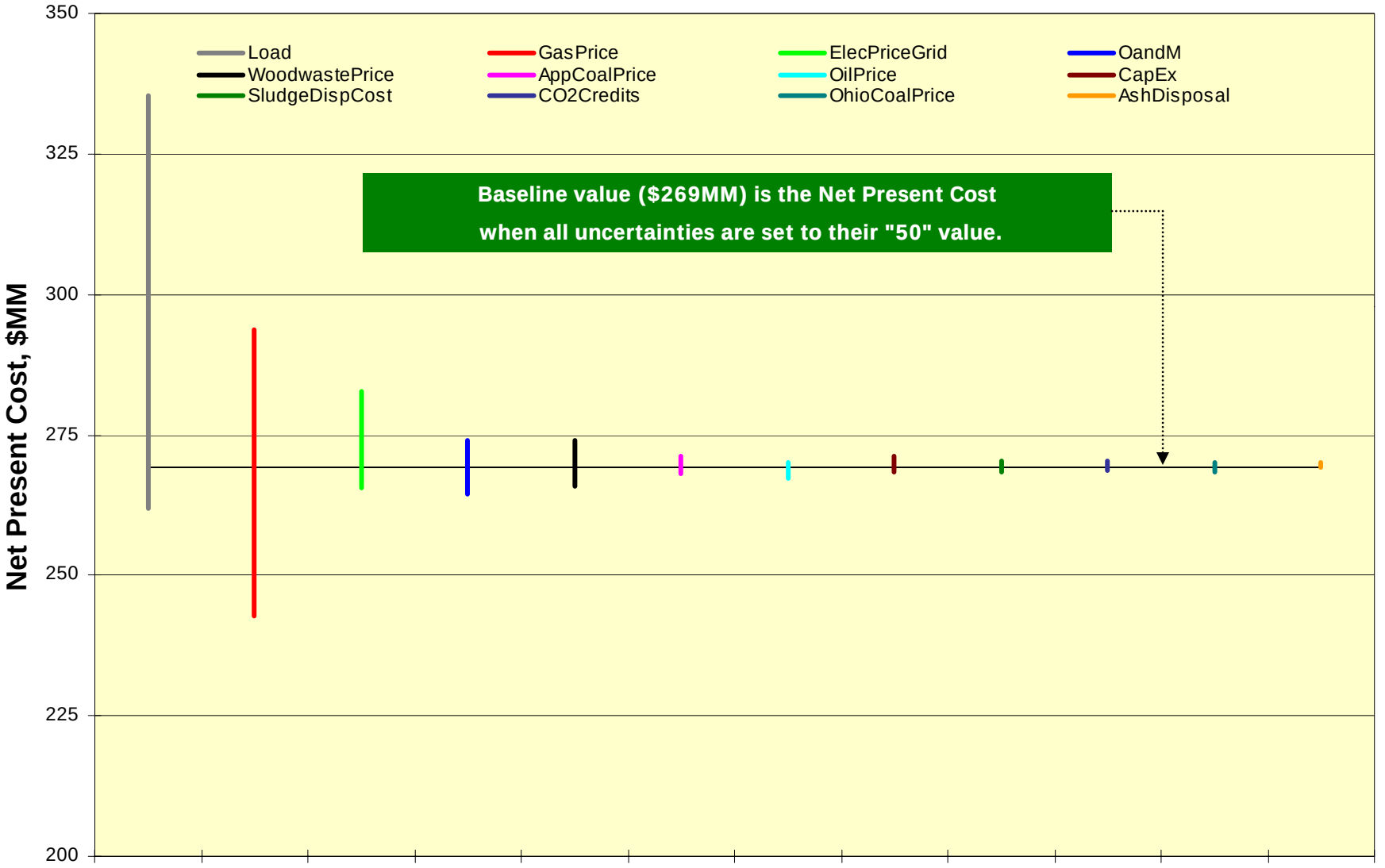
- We just plug in the "50" / "10" / "90" values for each uncertainty and recalculate the NPC for each value, leaving all other uncertainties at their "50" values



- This is called a "Sensitivity" chart because it shows the sensitivity of NPC to each individual uncertainty

Power and Utilities D&RA - Case 9: Convert to Gas

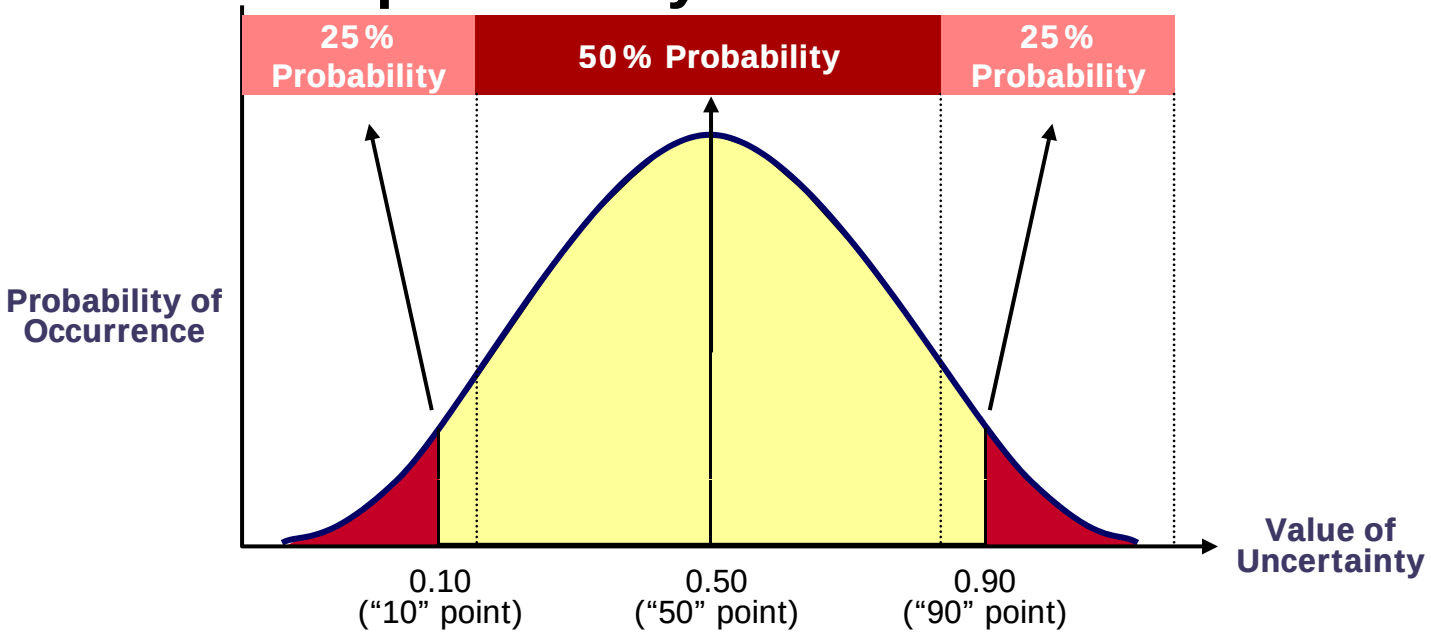
NPC Sensitivity to Key Variables



Assessing Multiple Uncertainties

There is little likelihood that the outcome will occur with all but one uncertainty at the "50" value

So we assume that the "10" and "90" values have a 25% probability of occurring while the "50" value has a 50% probability of occurrence



Multiple Uncertainties – Cont'd

Now we can apply the probability percentages to every uncertainty and calculate a probability "tree"

Example

- We have 2 uncertainties, each with 10-50-90 values that have been assigned 25%-50%-25% probabilities
- There are 9 possible outcomes with probabilities as follows :

Uncertainty No. 1	×	Uncertainty No. 2	=	Probability
"10" 0.25	→	0.25 "10"		0.0625
	→	0.50 "50"		0.125
	→	0.25 "90"		0.0625
"50" 0.50	→	0.25 "10"		0.125
	→	0.50 "50"		0.25
	→	0.25 "90"		0.125
"90" 0.25	→	0.25 "10"		0.0625
	→	0.50 "50"		0.125
	→	0.25 "90"		0.0625

$\Sigma = 1.0$

Multiple Uncertainties – Cont'd

When probabilities and NPC's for each combination of uncertainties are multiplied and summed, we arrive at the "Expected Value" for the Case

Uncertainty No. 1	Uncertainty No. 2	Probability		NPC for Combination	Expected Value
"10"	"10"	0.0625	×	$125 MM	
	"50"	0.125	×	$128 MM	
	"90"	0.0625	×	$132 MM	
"50"	"10"	0.125	×	$131 MM	
	"50"	0.25	×	$136 MM	Σ = $135 MM
	"90"	0.125	×	$139 MM	
"90"	"10"	0.0625	×	$134 MM	
	"50"	0.125	×	$142 MM	
	"90"	0.0625	×	$150 MM	

- Expected Value may or may not be equal to NPC in the "All 50" Case

Cash Flow Spreadsheet Model

Built in Microsoft Excel

Computes NPC from discounted 10-year cash flow

Incorporates all items from Influence Diagram

- Fuel and purchased electricity use (from Energy Balance)
- Operating and Maintenance (O and M) cost
- Capital expenditures and depreciation
- Taxes, insurance and legal fees
- Reliability cost penalties or benefits
- Sales of utilities and/or emission credits
- Changes in working capital
- Tax rate and discount rate

Time horizon typically set at 10-15 years

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Putting It All together

Cash Flow Model calculates NPC of Cases

NPC is calculated for the full spectrum of uncertainty values

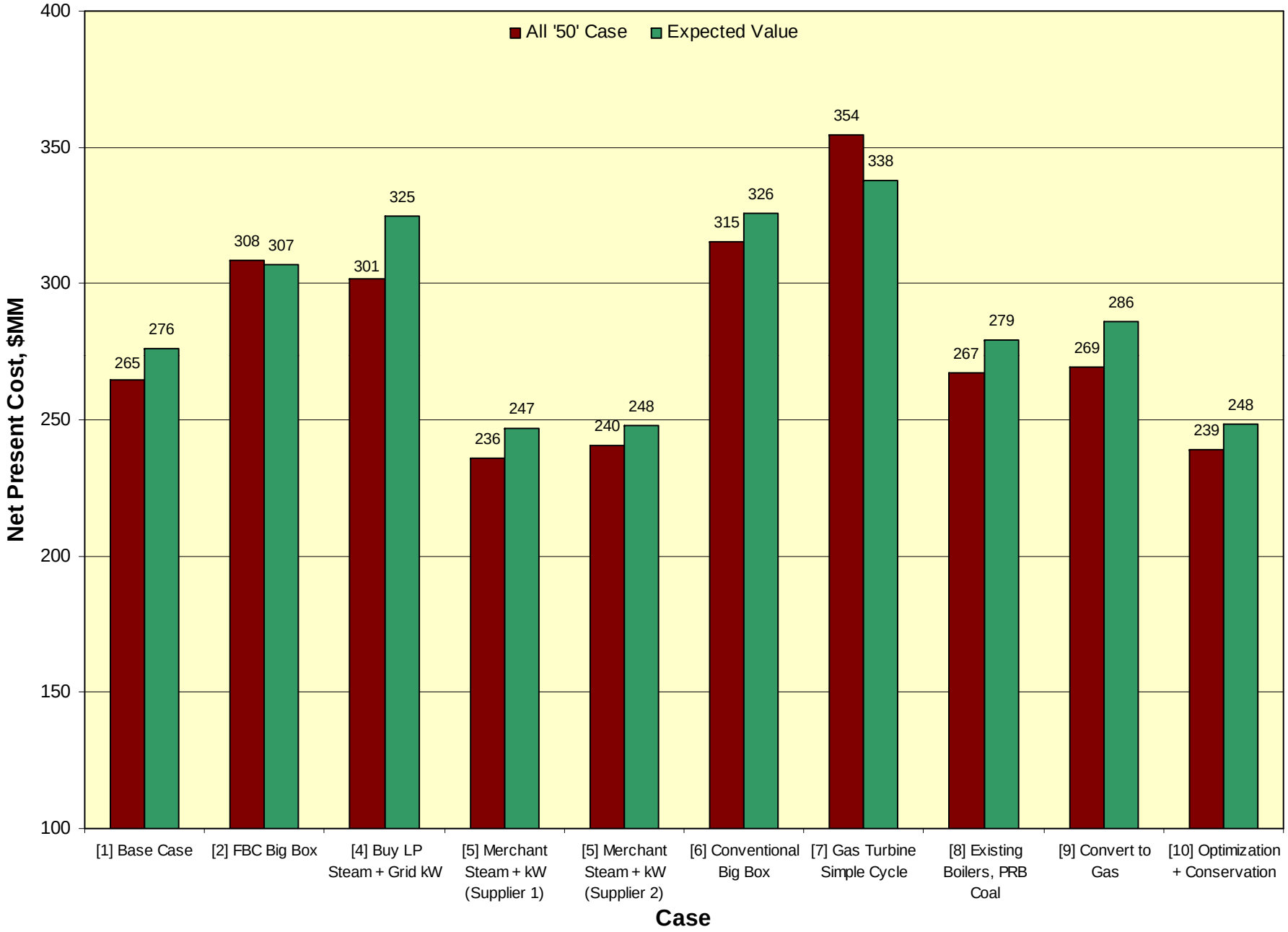
- Calculations incorporate probability of occurrence
- Results are plotted on various charts to compare Cases
  - NPC Bar Chart
  - Sensitivity Charts (impact of individual uncertainties)
  - Cumulative Probability Charts (overall case performance)

Team assesses results, develops recommendations

- Other criteria can be used to call a “winner” in case of tie
  - CapEx of Cases
  - Customer “Critical to Quality” surveys
  - Six Sigma “Pugh Matrix”

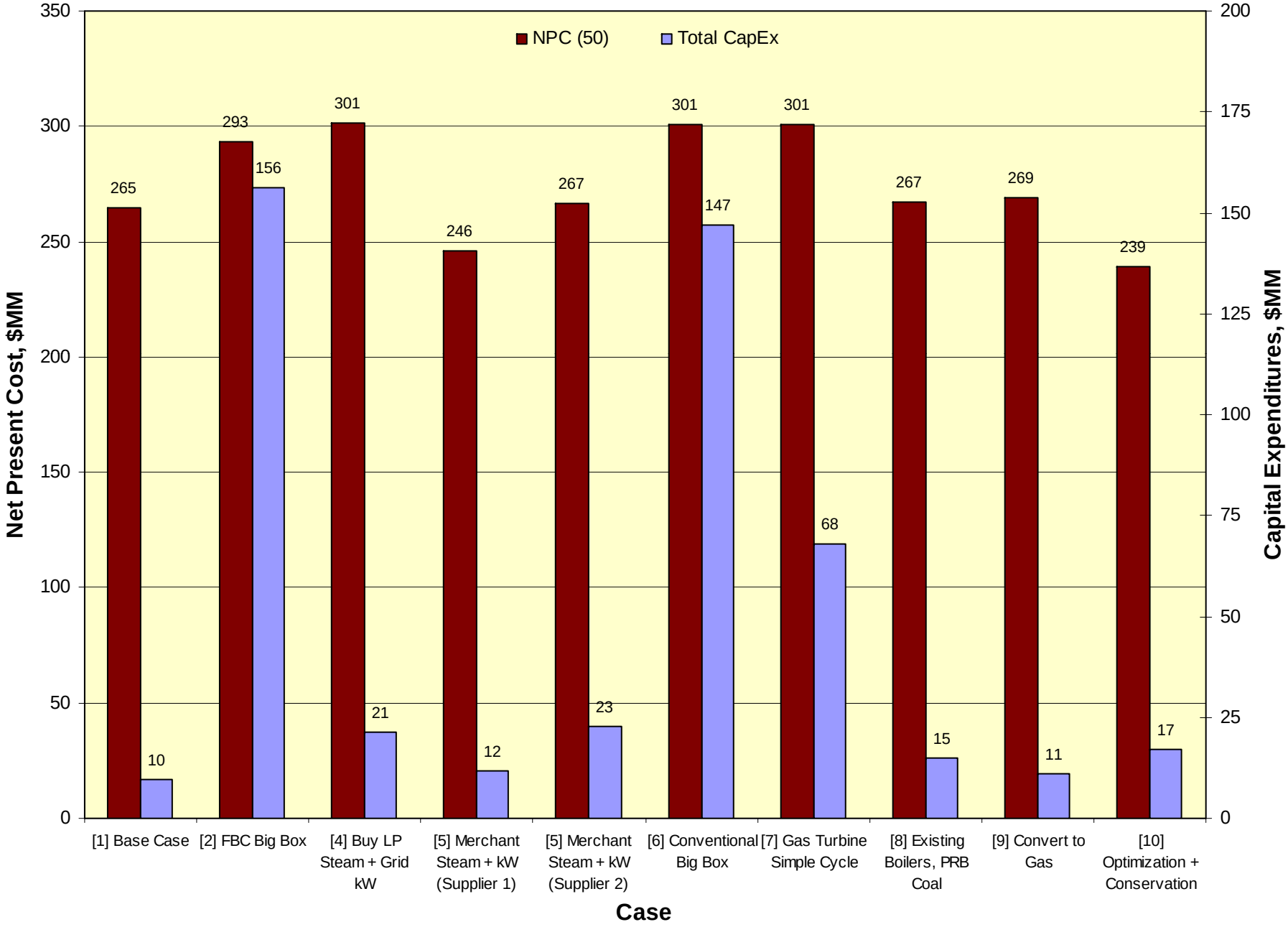
Power and Utilities D&RA

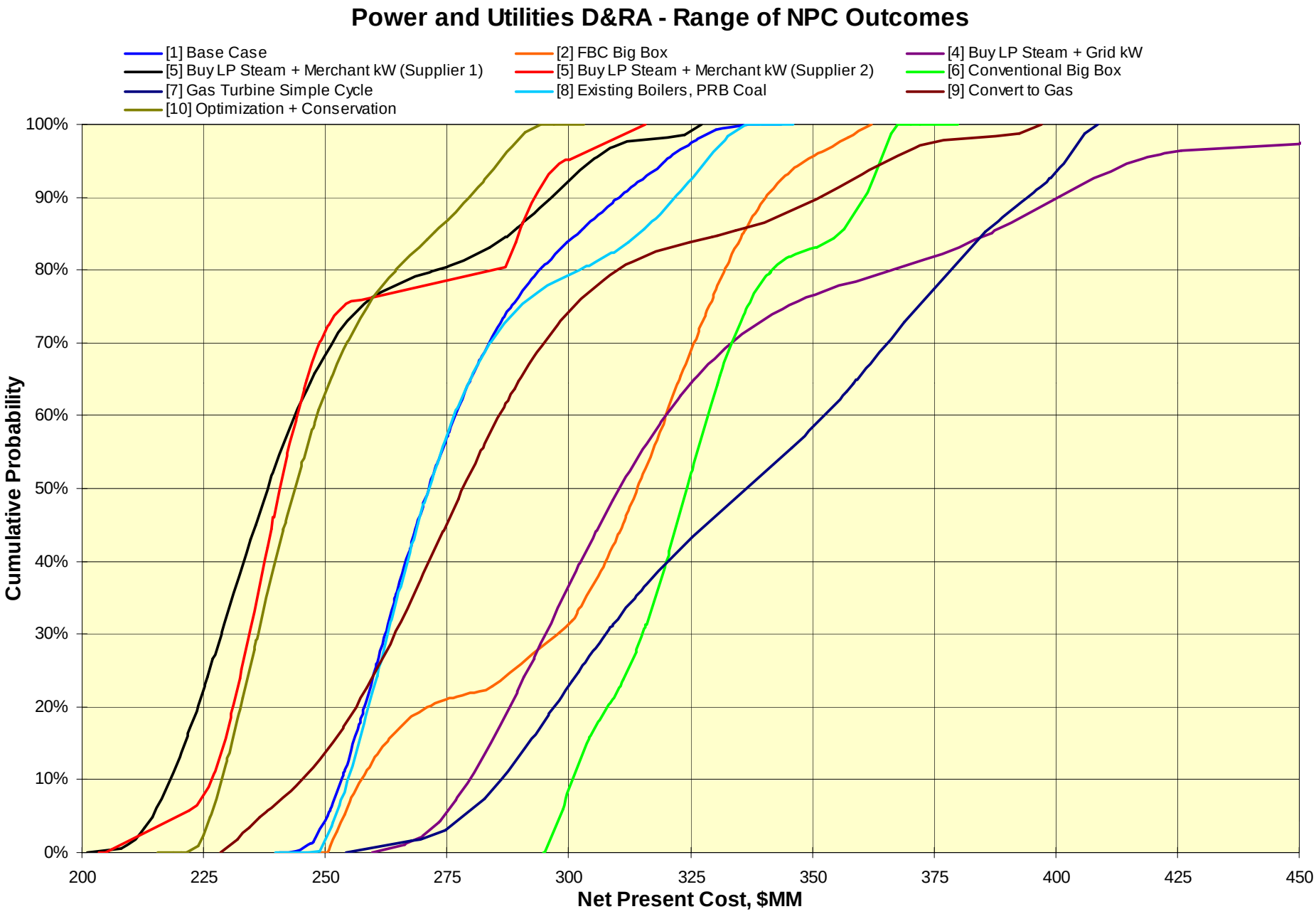
Net Present Cost of Cases (All '50') vs. Expected Values



Power and Utilities D&RA

Net Present Cost (All '50') vs. CapEx (All '50')




Power and Utilities D&RA - Range of NPC Outcomes
[1] Base Case
[2] FBC Big Box
[4] Buy LP Steam + Grid kW
[5] Buy LP Steam + Merchant kW (Supplier 1)
[5] Buy LP Steam + Merchant kW (Supplier 2)
[6] Conventional Big Box
[7] Gas Turbine Simple Cycle
[8] Existing Boilers, PRB Coal
[9] Convert to Gas
[10] Optimization + Conservation
Cumulative Probability
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
200
225
250
275
300
325
350
375
400
425
450
Net Present Cost, $MM

D&RA Process Summary

Framing

- Brainstorm the Issues
- List Decisions, Uncertainties, and Facts
- Develop Strategy Tables and Case Definitions
- Write “Objective” and “Rationale” statements

Create Influence Diagram

Assess Uncertainties

Build Cash Flow Model

Run Model and assess results

Develop recommendations

Reflections

The D&RA methodology enables us to

- Get all of the relevant issues and uncertainties out on the table so we can objectively assess options
- Evaluate various options which, under the right conditions, each could be “best”
- Converge on a decision that best improves business performance
- Get comfortable with the decision because all relevant uncertainties have been explicitly addressed
- Implement the decision with confidence

Questions??