

Palisade User Conference Las Vegas 2010

Perspectives on Decision Analysis
Applied in the Nuclear Power Industry

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Agenda

- Introduction to PA Consulting
- Use of Decision Analysis in the energy industry
- Nuclear power in the US
- Using @risk to analyze nuclear decisions
- Conclusions

About PA Consulting Group

PA Consulting Group (PA) is a leading management, system and technology consulting firm founded in 1943.



- **PA is global:** we employ over 2,100 consultants operating from 25 offices in more than 10 countries
- **PA is experienced:** our advice is founded in deep sector and industry expertise across a wide range of consultancy services
- **PA is innovative:** we have proven hands-on experience in bringing innovative ideas and technology successfully to market

Consulting Service Lines

- Strategy Consulting
- Business Transformation
- Information Technology
- Supply Chain Management

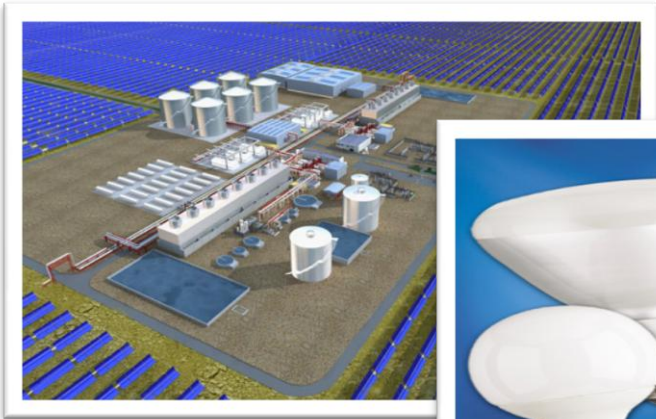
Nuclear Specific Expertise

- Business Case Development
- Capital Project Prioritization
- Cost and Schedule Risk Modeling
- Plant Life Extension Assessment
- Regional Economic Impact Analysis
- Strategic Sourcing and Procurement
- Operations Rightsizing
- Contract Review

When can Decision Analysis be applied to the energy sector?

The energy industry is experiencing significant change. Decision analysis can and has been effectively employed across a wide array of capital projects, programs and initiatives.

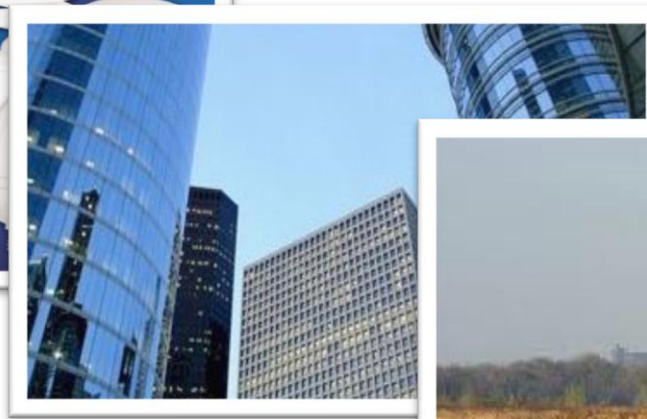
Solar Power



Energy Efficiency



Real Estate



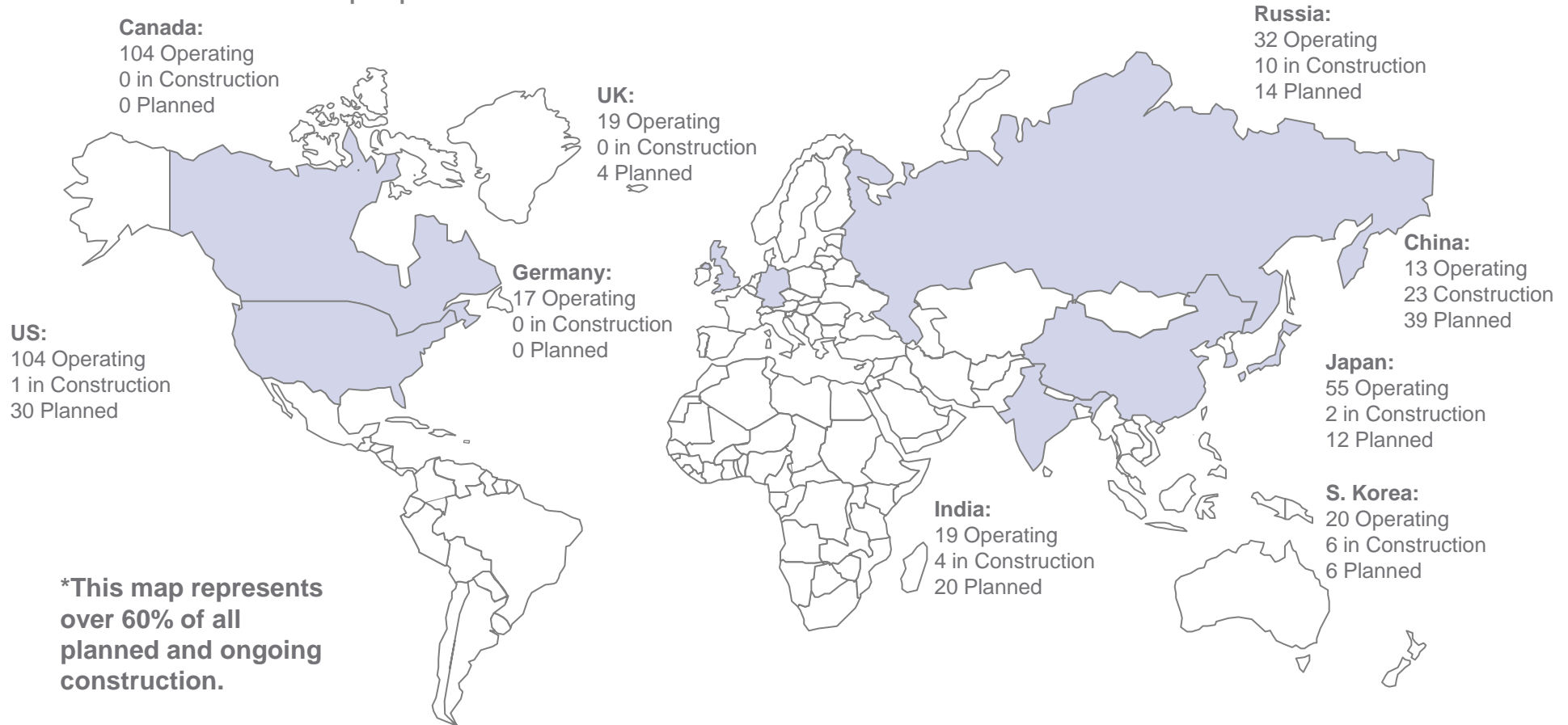
Nuclear Power



With any Estimate, Schedule or Plan there are only a finite number of things that can go right, but there are an infinite number of things that can go wrong.

The Nuclear Industry Overview - International

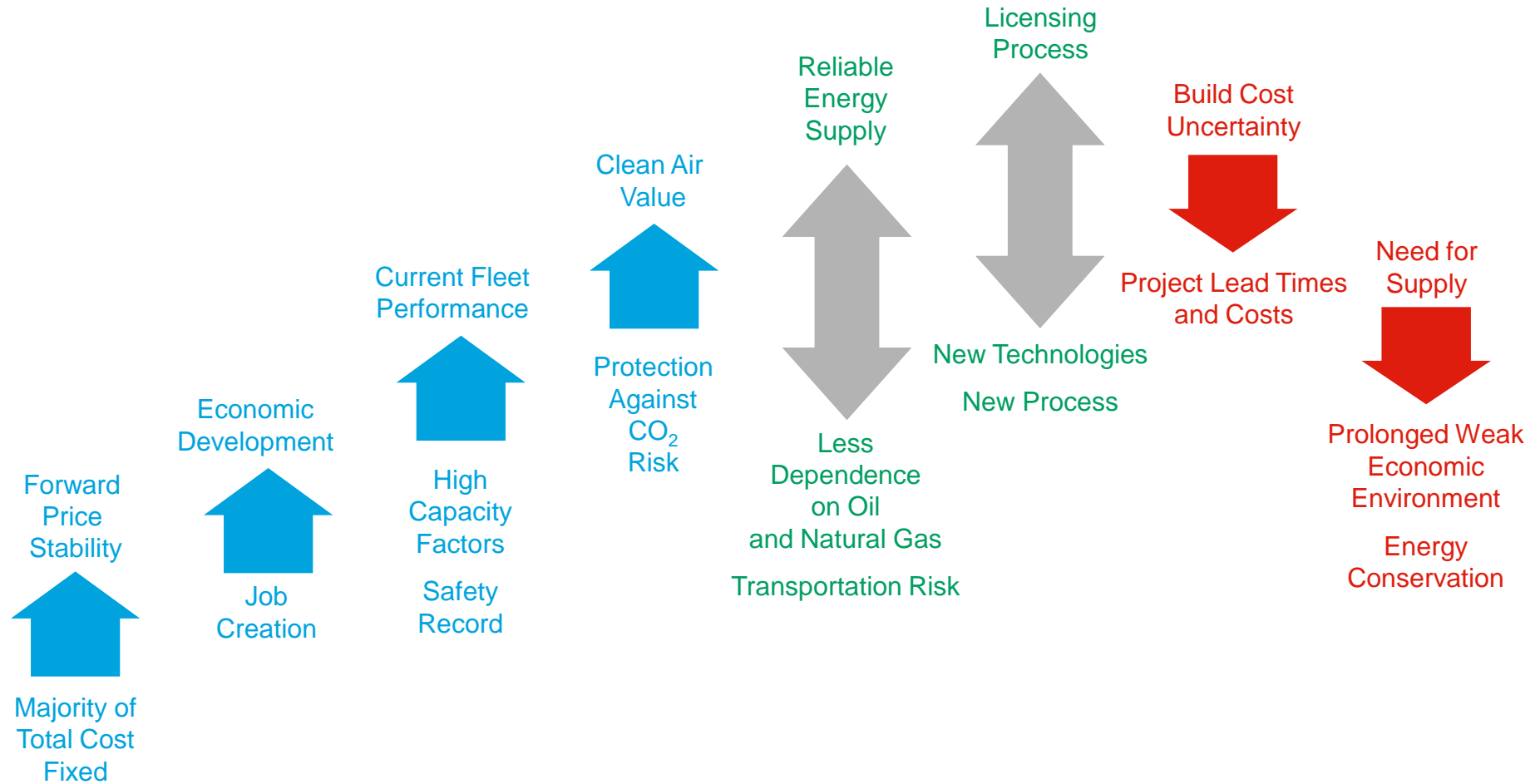
Nuclear energy is undergoing a renaissance around the world. Globally, 58 new reactors are under construction, and 148 new reactors are planned to be in operation before 2030.* An additional 331 reactors have been proposed.



Source: World Nuclear Association October 2010,
<http://www.world-nuclear.org/info/reactors.html>

The Nuclear Decision

Given the inherent challenges surrounding constructing a nuclear plant, it is important that the decision to build a nuclear power plant carefully consider all the factors that influence this major investment of resources.



Using Risk Analysis to Evaluate the Nuclear Decision

One individual decision can have multiple significant effects—impacting the entire industry and spreading externalities to a frustrated customer base.

If the wrong decision is made, whose burden is it?

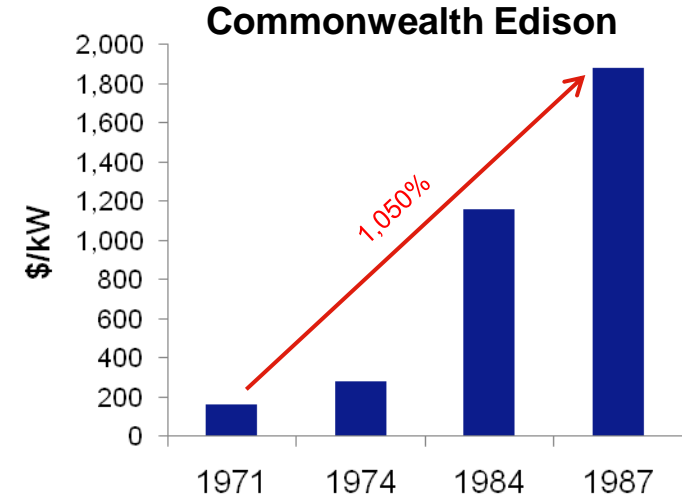
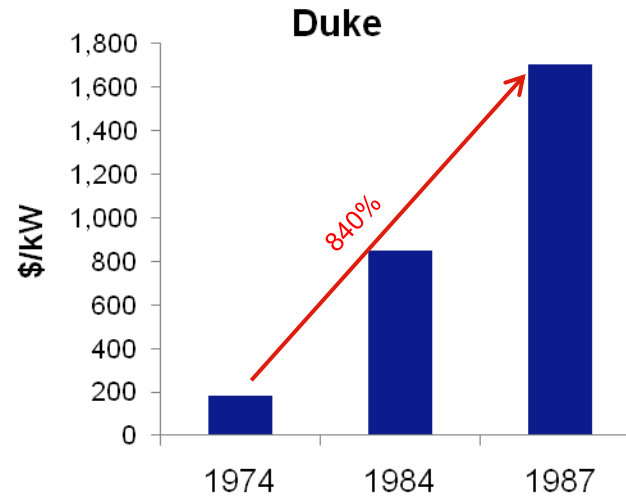
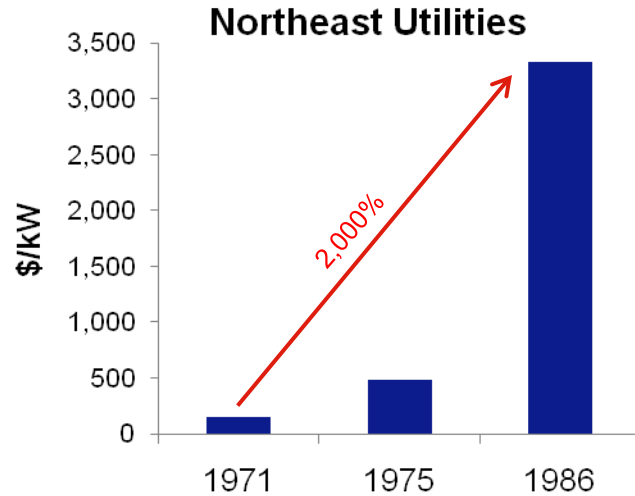
- Cost of wrong decisions in pharmaceutical industry is passed to consumers
- Dry hole cost in oil and gas industry is passed to motorists
- Wrong policy decisions by government will be passed to taxpayers
- **Ratepayers in some states are paying today for nuclear plants expected in operation in 2020**

Aside from cost, why are nuclear decisions so complex?

- Public/hostile environment
- Dated experience
- Shifting environment
- Resource scarcity
- Asymmetric information
- Various stakeholders
- Multiple & competing objectives

The Cost of New Nuclear – What Happened?

Since the beginning of the initial wave of commercial nuclear plant construction in the early 1970's, costs have escalated wildly, making nuclear plants very expensive to build.



The trend of severe escalation has continued today:

- Florida Light and Power, Southern Company, and TVA all expect to spend around \$3,000/kw for new plants.
- South Texas Project units 3 & 4 cost estimates range from \$12 - \$17 billion.

The Cost of New Nuclear – What Happened?

Since Three Mile Island, the NRC has continued to “ratchet” up safety regulations. This continual process of enhancement has resulted in continually increasing operating costs and unprecedented increases in the cost of a new plant.

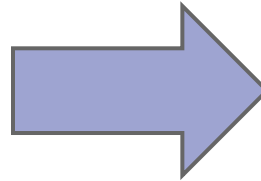
1970 Ford Pinto



Features: optional mirrors, windshield wipers, locks, emergency brake

Cost: \$1,850

How much does a Pinto cost today?
More safety costs money.



2011 Ford Fiesta



Features: traction control, anti-lock disc brakes, 6 airbags

Cost: \$17,400

Even discounting 40 years of inflation, the 2011 model is twice as expensive as the 1970 vehicle.

What's the Problem?

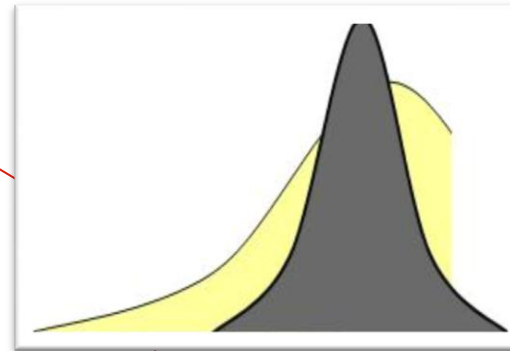
When dealing with billion dollar, multi-year projects, a single point estimate is not going provide credibility to the project manager or instill confidence in stakeholders.

A Nuclear Case Study: New Build Risk Analysis

In an effort to determine the expected cost and schedule

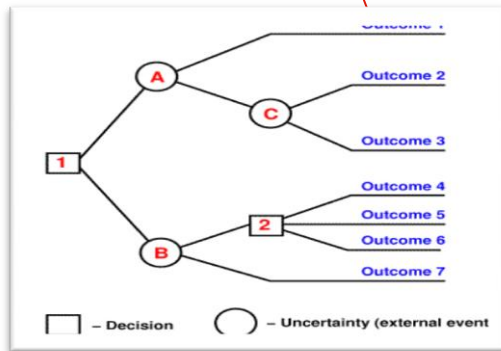


Establish Baseline
Project Schedule
Project Budget
Allocation of Cost

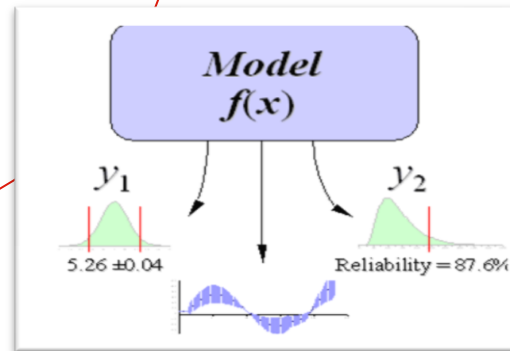


Identify & Quantify Risks

Analyze Results:
Range of possibilities
Sensitivities
Critical risks



Perform Monte Carlo Analysis



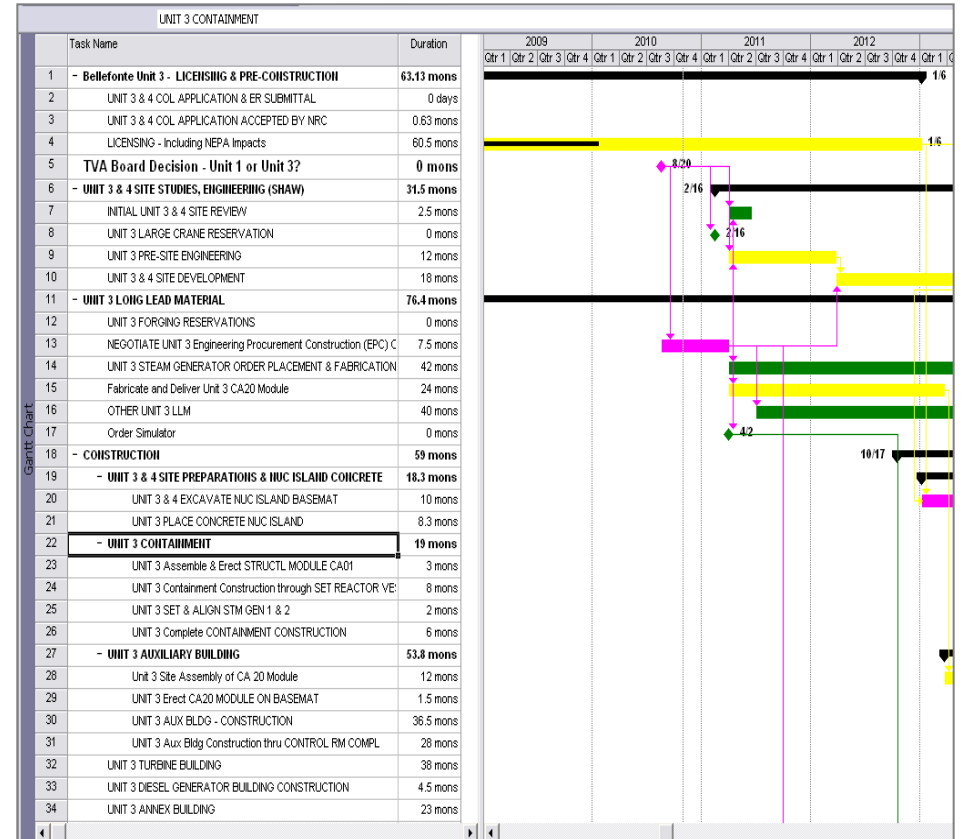
Modeling Techniques: Determining the Base Case

Define Project Cost Estimate

	A	F	H
	Single Unit Estimate in Nov 2007\$		Single Unit Estimate in Dec 2009\$
AP 1000 Estimate Area			
1			
2	Standard Plant	4,507,077	\$48,204,738
3	Equipment	6,882,409	7,260,942
4	Transportation	1,859,319	1,961,582
5	Proj Mgmt	1,066,047	1,124,680
6	Engineering	8,838,086	9,324,181
7	Purchasing	5,134,051	5,416,424
8	Construction Directs	1,246,942	1,315,524
9	Construction Indirects	5,703,154	6,016,827
10	QA	3,613,824	3,812,584
11	Insurance	770,057	812,410
12	Other	7,761,920	8,188,825
13		Subtotal	\$42,875,809
14	Contingency	\$2,815,886	\$2,970,759
15			
16	Site Specific	\$35,775,123	\$37,742,755
17	Equipment	2,961,129	3,123,991
18	Transportation	1,738,964	1,834,607
19	Project Management	2,290,885	2,416,884
20	Engineering	261,214	275,581
21	Construction Direct	4,808,125	5,072,572
22	Construction Indirect	5,620,697	5,929,836
23	QA	8,749,770	9,231,008
24	Insurance	6,651,930	7,017,786
25		Subtotal	\$33,082,716
26	Contingency	\$2,692,407	\$2,840,490
27			
28	Other Plant Costs	\$34,011,685	\$35,882,328
29	Simulator	7,802,403	8,231,536
30	Startup	4,604,792	4,858,055
31	Import Duty	2,303,977	2,430,696

Determine costs by line item or WBS.
Costs by individual activity may muddy the picture

Define Project Schedule



Determine baseline project schedule and expected critical path activities

Modeling Techniques: Establishing the Risk Framework

Key drivers and uncertainties must be identified to build the model. Some examples include:

Technologies to be considered

- ABWR
- APWR
- AP 1000
- EPR
- Modular (NuStart, mPower, etc.)

Fuel Prices

- Natural Gas
- Coal
- Nuclear

Environmental Regulation

- Carbon
- SO₂
- Hg
- Flyash
- Other

Retirement of Existing Facilities

- Which plants?
- What sequence?
- What schedule?

New Nuclear Capital Costs

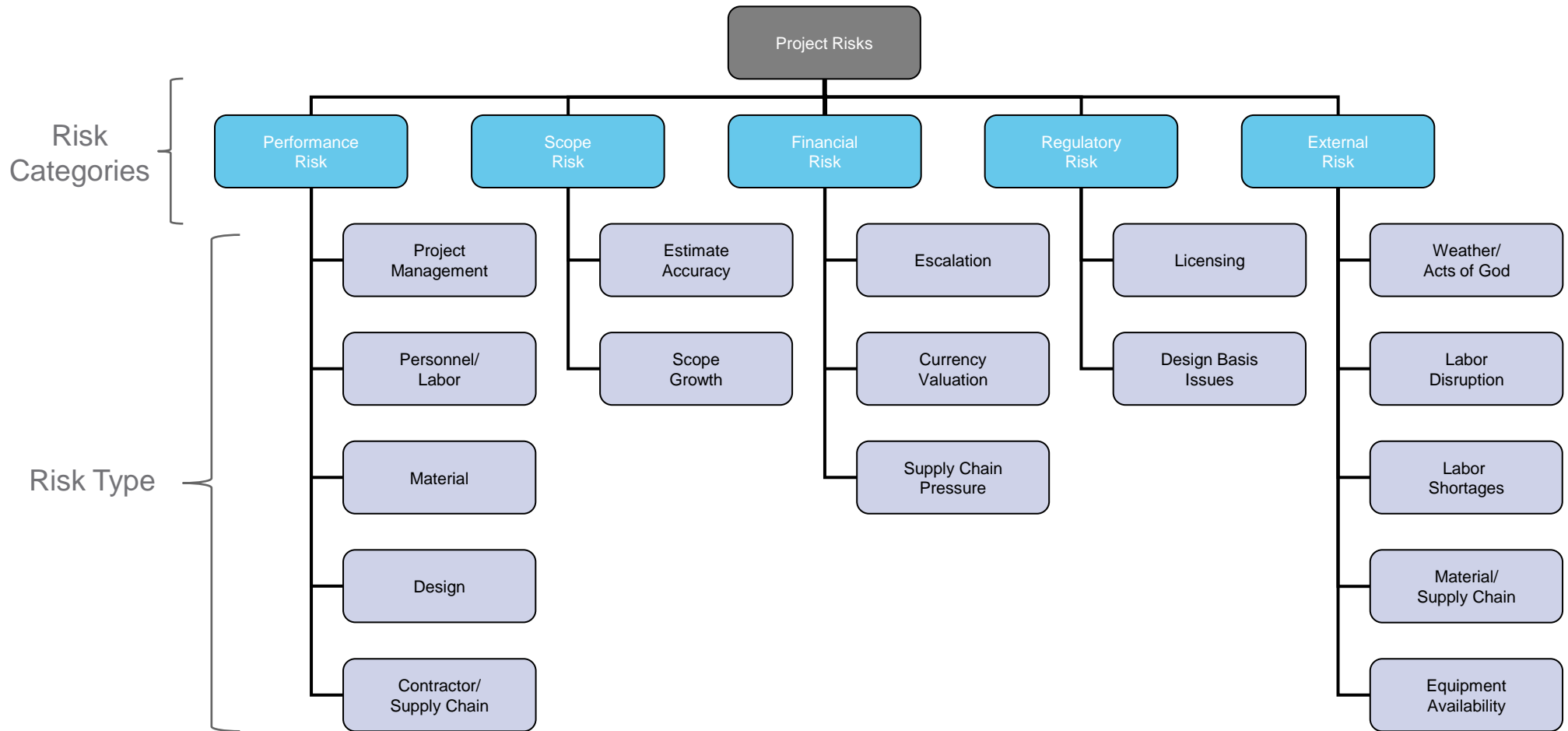
- Siting
- Design/Engineering
- Procurement
- Materials
- Labor

New Nuclear Operating Costs

- O&M
- Fuel
- A&G

Licensing, Development & Construction Timeline and Decision Points

Modeling Techniques: Building the Risk Register



Modeling Techniques: Building the Risk Register

Once identified, risks are appropriately defined, categorized and compiled in a risk register.

Risk Category	Risk Type	Risk Item	Input	Iteration Input	Input	Ouput	Input	Input
			Distribution Type	Distribution Percentile	Probability of Occurance	Occurrence Decision	Cost Impact	Schedule Impact
External	Availability of Qualified Labor	Unspecified Risk	Riskpertalt	69%	100%	1	x	x
External	Equipment Availability	Unspecified Risk	Riskpertalt	67%	100%	1	x	x
External	Labor Disruption	Unspecified Risk	Riskpertalt	69%	5%	0	x	x
External	Material Availability	Unspecified Risk	Riskpertalt	46%	100%	1	x	x
External	Weather Force Majuer	Unspecified Risk	Riskpertalt	51%	5%	0	x	x
Financial	Currency Valuation	Severe economic recession within in next year	Riskpertalt	39%	0%	0	x	
Financial	Currency Valuation	Unspecified Risk	Riskpertalt	47%	100%	1	x	
Financial	Escalation	Expediting Costs	Riskpertalt	25%	0%	0	x	
Financial	Escalation	Unspecified Risk	Riskpertalt	41%	0%	0	x	
Performance	Contractor Supply Chain	EPC Contract	Riskpertalt	84%	100%	1	x	x
Performance	Contractor Supply Chain	Obsolete Components and/or parts	Riskpertalt	36%	0%	0		x
Performance	Contractor Supply Chain	Late Identification of Procurement Needs	Riskpertalt	72%	0%	0		x
Performance	Contractor Supply Chain	Availability of Expediters	Riskpertalt	83%	100%	1	x	x
Performance	Contractor Supply Chain	Unspecified Risk	Riskpertalt	61%	100%	1		x
Performance	Design	Field Changes	Riskpertalt	76%	100%	1	x	x
Performance	Design	Design Changes	Riskpertalt	39%	100%	1	x	
Performance	Design	Unspecified Risk	Riskpertalt	33%	100%	1	x	
Performance	Material	Component Failures	Riskpertalt	68%	100%	1	x	
Performance	Material	Equipment Operability Issues	Riskpertalt	68%	100%	1	x	
Performance	Material	Unspecified Risk	Riskpertalt	49%	100%	1	x	

Modeling Techniques: Building the Risk Register

Once identified, risks are appropriately defined, categorized and compiled in a risk register.

Risk Category	Risk Type	Risk Item	Distribution Type	Decision Period	Probability of Occurrence	Output Decision	Input Impact	Input Mitigation
External	Availability of Qualified Labor	Unspecified Risk	Riskpertait		100%	1	x	x
External	Equipment Availability	Unspecified Risk	Riskpertait		100%	1	x	x
External	Labor Disruption	Unspecified Risk	Riskpertait		EN	0	x	x
External	Material Availability	Unspecified Risk	Riskpertait		100%	1	x	x
External	Weather Force Major	Unspecified Risk	Riskpertait		1	0	x	x
Financial	Currency Valuation	Severe economic recession within in next year	Riskpertait		47%	100%	1	x
Financial	Escalation	Expediting Costs	Riskpertait		25%	0%	0	x
Financial	Escalation	Unspecified Risk	Riskpertait		41%	0%	0	x
Performance	Contractor Supply Chain	EPC Contract	Riskpertait		84%	100%	1	x
Performance	Contractor Supply Chain	Check Components and/or Parts	Riskpertait		30%	0%	0	x
Performance	Contractor Supply Chain	Late identification of Procurement Issues	Riskpertait		72%	0%	0	x
Performance	Contractor Supply Chain	Availability of Expeditors	Riskpertait		23%	100%	1	x
Performance	Contractor Supply Chain	Unspecified Risk	Riskpertait		61%	100%	1	x
Performance	Design	Real Changes	Riskpertait		70%	100%	1	x
Performance	Design	Design Changes	Riskpertait		39%	100%	1	x
Performance	Design	Unspecified Risk	Riskpertait		37%	100%	1	x
Performance	Internal	Component Failure	Riskpertait		66%	100%	1	x
Performance	Internal	Equipment Quality Issues	Riskpertait		66%	100%	1	x
Performance	Internal	Unspecified Risk	Riskpertait		69%	100%	1	x

Risk Category	Risk Type	Risk Item	Input Distribution Type	Iteration Input Distribution Percentile
External	Availability of Qualified Labor	Unspecified Risk	Riskpertait	69%
External	Equipment Availability	Unspecified Risk	Riskpertait	67%
External	Labor Disruption	Unspecified Risk	Riskpertait	69%
External	Material Availability	Unspecified Risk	Riskpertait	46%
External	Weather Force Major	Unspecified Risk	Riskpertait	51%
Financial	Currency Valuation	Severe economic recession within in next year	Riskpertait	39%
Financial	Currency Valuation	Unspecified Risk	Riskpertait	47%
Financial	Escalation	Expediting Costs	Riskpertait	25%
Financial	Escalation	Unspecified Risk	Riskpertait	41%
Performance	Contractor Supply Chain	EPC Contract	Riskpertait	84%

Note that at this point, we have not quantified any risks, simply aggregated and qualified.

Combine Category, Type & Item to define a unique risk

Designate distribution type and bounding

Define "Correlations"

Modeling Techniques: Building the Risk Register

Once identified, risks are appropriately defined, categorized and compiled in a risk register.

Risk Category	Risk Type	Risk Item	Input Distribution Type	Input		Output		Input	Input
				Distribution	Probability of Occurrence	Cost	Schedule		
External	Availability of Qualified Labor	Unspecified Risk	Reported	Binomial	100%	1	x	x	
External	Equipment Availability	Unspecified Risk	Reported	Binomial	100%	1	x	x	
External	Labor Disruption	Unspecified Risk	Reported	Binomial	5%	0	x	x	
External	Material Availability	Unspecified Risk	Reported	Binomial	100%	1	x	x	
External	Weather Force Major	Unspecified Risk	Reported	Binomial	5%	0	x	x	
Financial	Currency Valuation	Severe economic recession within in next year	Reported	Binomial	0%	0	x		
Financial	Currency Valuation	Unspecified Risk	Reported	Binomial	100%	1	x		
Financial	Escalation	Expediting Costs	Reported	Binomial	0%	0	x		
Performance	Contractor Supply Chain	EPC Contract	Reported	Binomial	100%	1	x	x	
Performance	Contractor Supply Chain	Obtain Components and/or parts	Reported	Binomial	0%	0	x		
Performance	Contractor Supply Chain	Late identification of Procurement needs	Reported	Binomial	75%	0	0	x	
Performance	Contractor Supply Chain	Availability of Expeditors	Reported	Binomial	100%	1	x	x	
Performance	Contractor Supply Chain	Unspecified Risk	Reported	Binomial	100%	1	x	x	
Performance	Design	Cost Changes	Reported	Binomial	70%	100%	1	x	x
Performance	Design	Design Changes	Reported	Binomial	35%	100%	1	x	x
Performance	Internal	Component Failure	Reported	Binomial					
Performance	Internal	Equipment Durability Issues	Reported	Binomial					
Performance	Internal	Unspecified Risk	Reported	Binomial					

Risk Category	Risk Type	Risk Item	Input	Ouput	Input	Input
			Probability of Occurance	Occurrence Decision	Cost Impact	Schedule Impact
External	Availability of Qualified Labor	Unspecified Risk	100%	1	x	x
External	Equipment Availability	Unspecified Risk	100%	1	x	x
External	Labor Disruption	Unspecified Risk	5%	0	x	x
External	Material Availability	Unspecified Risk	100%	1	x	x
External	Weather Force Major	Unspecified Risk	5%	0	x	x
Financial	Currency Valuation	Severe economic recession within in next year	0%	0	x	
Financial	Currency Valuation	Unspecified Risk	100%	1	x	
Financial	Escalation	Expediting Costs	0%	0	x	
Financial	Escalation	Unspecified Risk	0%	0	x	
Performance	Contractor Supply Chain	EPC Contract	100%	1		x

Note that at this point, we have not quantified any risks, simply aggregated and qualified.

Define probability that the risk occurs

Binomial function deciding occurrence

Designate whether risk will impact cost or schedule

Modeling Techniques: Quantifying Individual Risks

In consultation with project experts, possible risk impacts are identified, likelihoods assessed and impact magnitudes assigned.

Risk Category	Risk Type	Risk Item	Risk Occurred?	% Chance	Low Percentile	Most Likely Percentile	High Percentile	Engineering Design							
								Direct				Indirect			
								Low	Most Likely	High	Distribution	Low	Most Likely	High	Distribution
Construction	Availability of Engineering and Construction Lab	Unspecified Risk	1	100%	10%	M. Likely	90%	(1,800,000)	0	4,500,000	3,066,608	0	1,250,000	3,800,000	666,564
Construction	Commodity Price Increases	Unspecified Risk	0	0%	10%	M. Likely	90%								
Construction	Commodity Price Increases	Currency	1	100%	10%	M. Likely	90%								
Construction	Commodity Price Increases	Escalation Beyond CPI	1	100%	10%	M. Likely	90%								
Construction	Forgings, tubing and shop availability	Unspecified Risk	0	0%	10%	M. Likely	90%								
Construction	Forgings, tubing and shop availability	Steam Generator Fabrication and Delivery	1	100%	10%	M. Likely	90%								
Construction	General Uncertainties not included elsewhere	Unspecified Risk	0	5%	10%	M. Likely	90%								
Construction	Material & Equipment Availability	Unspecified Risk	0	0%	10%	M. Likely	90%								
Construction	Material & Equipment Availability	Unspecified Risk	1	100%	10%	M. Likely	90%								
Construction	Material & Equipment Availability	Unspecified Risk	1	1%	10%	M. Likely	90%								
Construction	Material & Equipment Availability	Unspecified Risk	1	50%	10%	M. Likely	90%					0	2,000,000	5,000,000	4,020,352
Construction	Obsolescence Issues	Unspecified Risk	1	0%	10%	M. Likely	90%								
Construction	Project Scope	Unspecified Risk	1	0%	10%	M. Likely	90%								
Construction	Project Scope	Unspecified Risk	1	0%	10%	M. Likely	90%								
Construction	Project Scope	Unspecified Risk	1	100%	10%	M. Likely	90%	(4,500,000)	0	9,100,000	4,106,843	(6,325,000)	0	12,560,000	2,958,051
Construction	Project Scope	Unspecified Risk	1	0%	10%	M. Likely	90%								
Construction	Project Scope	Unspecified Risk	1	0%	10%	M. Likely	90%								
Construction	Project Scope	Unspecified Risk	1	100%	10%	M. Likely	90%								
Construction	Records / Document Management	Unspecified Risk	0	5%	10%	M. Likely	90%								
Construction	Records / Document Management	API Packages (ASME Restatement Requirements)	0	0%	10%	M. Likely	90%								
Construction	Seismic Issues	Unspecified Risk	1	100%	10%	M. Likely	90%	0	5,000,000	1,773,750	0	2,000,000	5,000,000	3,034,342	
Construction	Technical Issues	Unspecified Risk	1	100%	10%	M. Likely	90%	0	4,576,600	893,120					
Construction	Technical Issues	Alloy 600 Remediation Issues	0	0%	10%	M. Likely	90%								
Construction	Technical Issues	Design Evaluation of ERCW System (Resizing Pumps)	0	0%	10%	M. Likely	90%								
Construction	Technical Issues	Fire Protection Requirements	0	0%	10%	M. Likely	90%								
Construction	Technical Issues	Ground Water Intrusion - Licensing Concerns	0	0%	10%	M. Likely	90%								
Construction	Technical Issues	HVAC System	0	0%	10%	M. Likely	90%								
Construction	Technical Issues	Low Level Radioactive Waste	0	0%	10%	M. Likely	90%								
Construction	Technical Issues	Reactor Coolant Pump Motors	0	0%	10%	M. Likely	90%								
Construction	Technical Issues	Steam Dumps	0	0%	10%	M. Likely	90%								
Construction	Technical Issues	Underground Piping	1	100%	10%	M. Likely	90%	1,000,000	1,750,000	2,500,000	1,793,491				
Construction	Technical Issues	Waste Ponds	0	0%	10%	M. Likely	90%								
Financial	Business Case "Threshold of Comfort" Broken	Unspecified Risk	0	0%	10%	M. Likely	90%								
Financial	Business Case "Threshold of Comfort" Broken	Energy Efficiency and Demand Reduction	0	0%	10%	M. Likely	90%								
Financial	Business Case "Threshold of Comfort" Broken	Forward Gas Prices	0	0%	10%	M. Likely	90%								
Financial	Business Case "Threshold of Comfort" Broken	Reduced Demand due to Economic Downturn	0	0%	10%	M. Likely	90%								
Financial	Business Case "Threshold of Comfort" Broken	Uncertainty around Carbon	0	0%	10%	M. Likely	90%								

Determine all possible risk impacts based on risk register (combinations of categories, types, items)

Tie probabilities of occurrence from risk register

Modeling Techniques: Quantifying Individual Risks

In consultation with project experts, possible risk impacts are identified, likelihoods assessed and impact magnitudes assigned.

Risk Category	Risk Type	Risk Item	Risk Occurred?	% Chance	Low Percentile	Most Likely Percentile	High Percentile	Engineering Design							
								Direct				Indirect			
								Low	Most Likely	High	Distribution	Low	Most Likely	High	Distribution
Construction	Availability of Engineering and Construction Lab	Unspecified Risk	1	100%	10%	M. Likely	90%	(1,800,000)		4,500,000	3,066,608	0	1,250,000	3,800,000	666,564
Construction	Commodity Price Increases	Unspecified Risk	0	0%	10%	M. Likely	90%								
Construction	Commodity Price Increases	Currency	1	100%	10%	M. Likely	90%								
Construction	Commodity Price Increases	Escalation Beyond CPI	1	100%	10%	M. Likely	90%								
Construction	Forgings, tubing and shop availability	Unspecified Risk	0	0%	10%	M. Likely	90%								
Construction	Forgings, tubing and shop availability	Steam Generator Fabrication and Delivery	1	100%	10%	M. Likely	90%								
Construction	General Uncertainties not included elsewhere	Unspecified Risk	0	5%	10%	M. Likely	90%								
Construction	Material & Equipment Availability	Unspecified Risk	0	0%	10%	M. Likely	90%								
Construction	Material & Equipment Availability	Consortium Construction Demand/Vendor Cap	1	100%	10%	M. Likely	90%								
Construction	Material & Equipment Availability	Counterfeit Parts	0	1%	10%	M. Likely	90%								
Construction	Material & Equipment Availability	Long Lead Procurement	0	50%	10%	M. Likely	90%					0	2,000,000	5,000,000	4,020,352
Construction	Obsolescence Issues	Unspecified Risk	0	0%	10%	M. Likely	90%								
Construction	Project Scope	Unspecified Risk	0	0%	10%	M. Likely	90%								
Construction	Project Scope	B&W Lessons Learned	0	0%	10%	M. Likely	90%								
Construction	Project Scope	Estimate Accuracy	1	100%	10%	M. Likely	90%	(4,500,000)	0	9,100,000	4,106,843	(6,325,000)	0	12,560,000	2,958,051
Construction	Project Scope	Evolving Project Scope	0	0%	10%	M. Likely	90%								
Construction	Project Scope	Power Uprate Evaluation	0	0%	10%	M. Likely	90%								
Construction	Project Scope	PSQ Scope (Switchyard & Transmission)	1	100%	10%	M. Likely	90%								
Construction	Records / Document Management	Unspecified Risk	0	5%	10%	M. Likely	90%								
Construction	Records / Document Management	API Packages (ASME Restatement Requireme	0	0%	10%	M. Likely	90%								
Construction	Seismic Issues	Unspecified Risk	1	100%	10%	M. Likely	90%	0	2,000,000	5,000,000	1,773,750	0	2,000,000	5,000,000	3,034,342
Construction	Technical Issues	Unspecified Risk	1	100%	10%	M. Likely	90%	0	1,830,640	4,576,600	899,120				
Construction	Technical Issues	Alloy 600 Remediation Issues	0	0%	10%	M. Likely	90%								
Construction	Technical Issues	Design Evaluation of ERCW System (Resizing P	0	0%	10%	M. Likely	90%								
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Construction	Technical Issues	Steam Dumps	0	0%	10%	M. Likely	90%								
Construction	Technical Issues	Underground Piping	1	100%	10%	M. Likely	90%	1,000,000	1,750,000	2,500,000	1,799,491				
Construction	Technical Issues	Waste Ponds	0	0%	10%	M. Likely	90%								
Financial	Business Case "Threshold of Comfort" Broken	Unspecified Risk	0	0%	10%	M. Likely	90%								
Financial	Business Case "Threshold of Comfort" Broken	Energy Efficiency and Demand Reduction	0	0%	10%	M. Likely	90%								
Financial	Business Case "Threshold of Comfort" Broken	Forward Gas Prices	0	0%	10%	M. Likely	90%								
Financial	Business Case "Threshold of Comfort" Broken	Reduced Demand due to Economic Downturn	0	0%	10%	M. Likely	90%								
Financial	Business Case "Threshold of Comfort" Broken	Uncertainty around Carbon	0	0%	10%	M. Likely	90%								

Determine the areas where cost is to be allocated

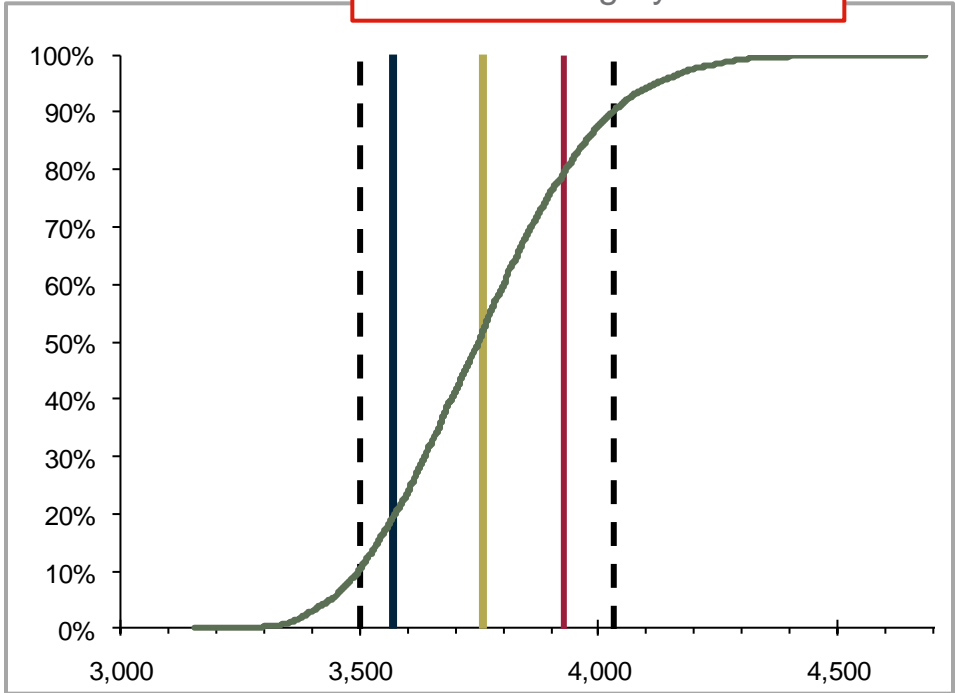
Calculate distributed value. Tie distribution type from risk register

Modeling Techniques: Calculating the Result

Spend Categories	Projected		Engineering Design		Construction Work		Comp & SU Testing		Comp Dept QA/QC	
	Start Task	End Task	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect
Project Initiation & Site-Specific Design	5	9	13,603,849	446,561	11,587,223	965,554	5,905	11,286,264	5,539,763	10,934,401
Site Preparation	10	20	13,603,849	777,718	9,831,936	1,193				9,745,300
Engineering & Procurement	5	16	68,019,246	724,320	7,214,191	6,862				10,788,128
Construction	21	46	27,207,698	535,956	5,406,639	6,598				9,457,896
Startup	44	48	13,603,849	820,168	12,388,426	7,687				1,427,479
			136,038,492	3,304,724	46,428,415	23,307				42,353,203

Create summary level risk-adjusted cost allocations for each spend category

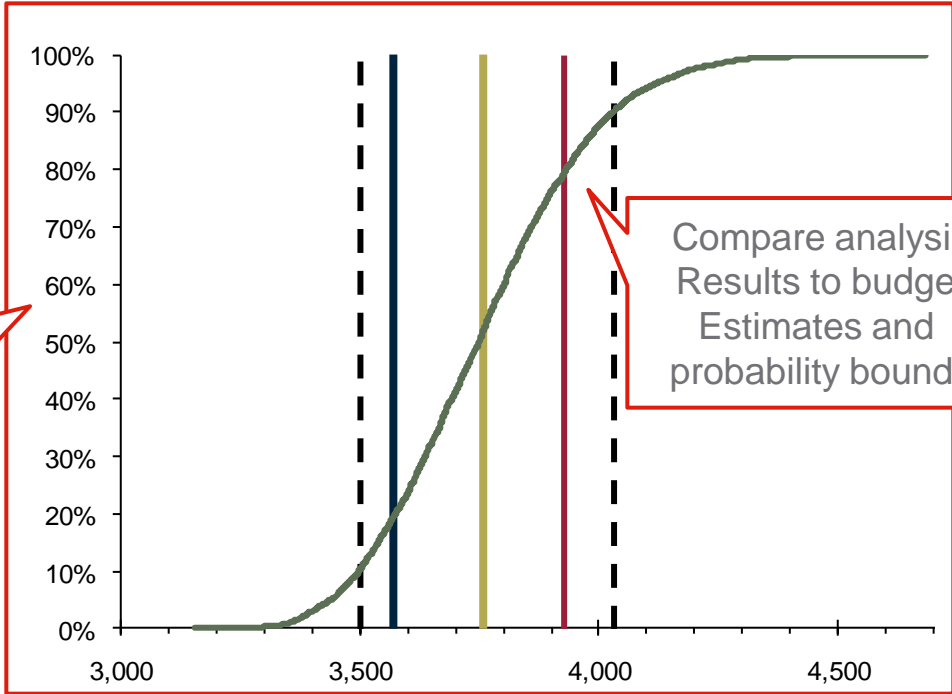
If cost risks must be tied directly to scheduled activities, allocate spend accordingly



Modeling Techniques: Calculating the Result

Spend Categories	Projected		Engineering Design		Construction Work		Comp & SU Testing		Comp Dept QA/QC	
	Start Task	End Task	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect
Project Initiation & Site-Specific Design	5	9	13,603,849	446,561	11,587,223	965,554	7,015,805	11,286,264	5,539,763	10,934,401
Site Preparation	10	20	13,603,849	777,718	9,831,936	1,193,546	547,699	10,137,831	5,217,649	9,745,300
Engineering & Procurement	5	16	68,019,246	724,320	7,214,191	6,862,923	568,152	8,742,695	9,647,345	10,788,128
Construction	21	46	27,207,698	535,956	5,406,639	6,598,325	12,264,655	4,158,186	1,888,476	9,457,896
Startup	44	48	13,603,849	820,168	12,388,426	7,687,403	8,126,476	5,832,361	9,762,253	1,427,479
			136,038,492	3,304,724	46,428,415	23,307,750	28,522,787	40,157,337	32,055,485	42,353,203

Aggregate all risk impacted cost categories and generate an @Risk output



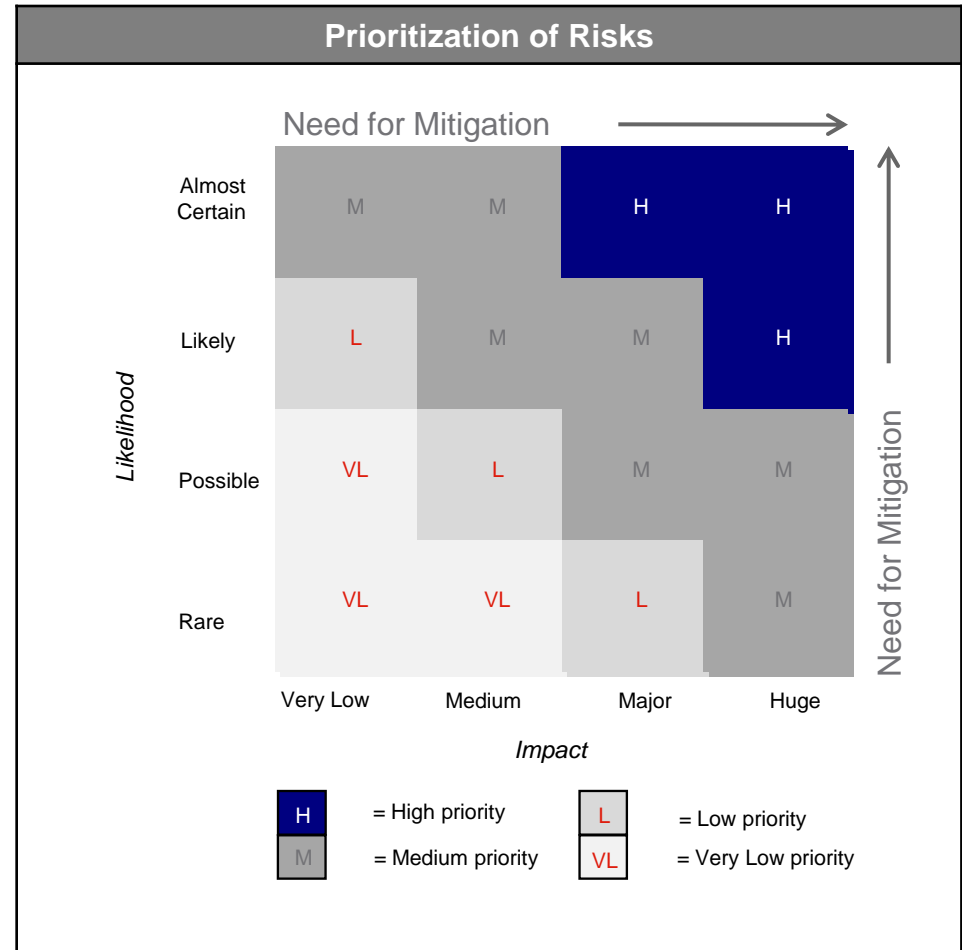
Model Results: Risk Prioritization Method

All unmitigated risks must be prioritized based on impact and probabilities, with the focus of mitigation being on the high priority risks.

Assessment of Impacts: Characteristics
<ul style="list-style-type: none"> Types of Impact <ul style="list-style-type: none"> – Direct/indirect – Physical/economic Timing of impact <ul style="list-style-type: none"> – Short/long term Financial implication Magnitude of impact Aggregation of exposure to same drivers

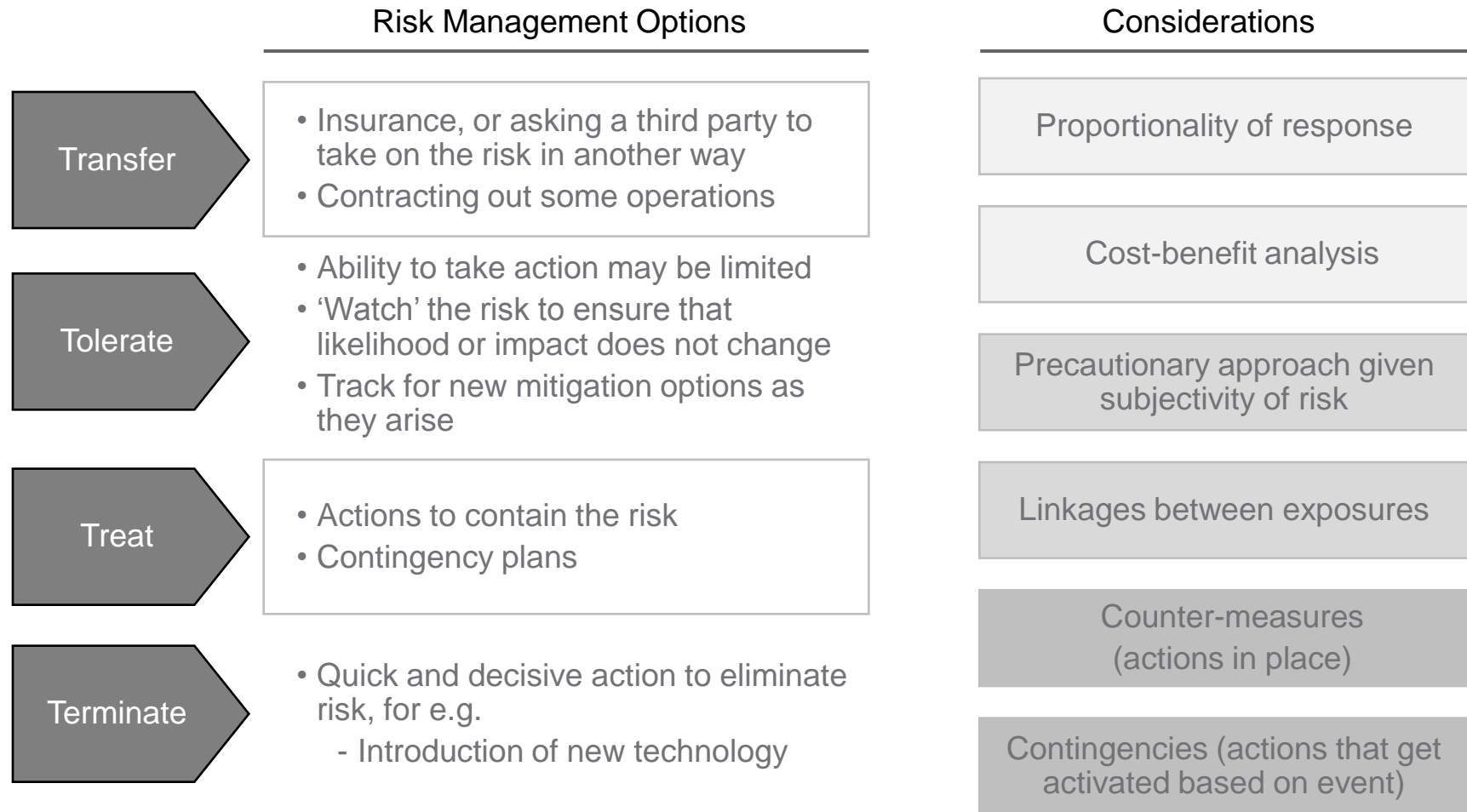
Assessment of Impacts: Impact
<ul style="list-style-type: none"> Probability of incidence Timing and/or frequency of incidence Data for analysis varies by type of risk

Assessment of Impacts: Mitigation
<ul style="list-style-type: none"> Extent that the company can control and mitigate each risk individually



Model Results: Risk Mitigation

With the understanding gained of the highest priority risks, a risk management strategy is developed to effectively manage project risk.



Conclusions

- Decision analysis techniques offer flexible and adaptable methods for decision-making and management that can be applied to almost any situation where risk and risk impacts are concerns.
- Decision analysis techniques are proven and useful tools to aid executives in arriving at decisions on high cost, complex investments such as new nuclear plants, nuclear plant life extensions and power uprates.
- Due to their complexity and vast number of variables associated with nuclear plant capital decisions, the decision analysis methodology offers significantly more useful results than deterministic (point value) methodologies can offer.
- The outputs of decision analysis models can be extremely useful in helping managers to identify the most important risks and cost drivers and to apply their resources accordingly to mitigate them.