PIT OPTIMISATION EXERCISE FOR JORC 2012 RESOURCE AND RESERVE ESTIMATION AND HOW TO ESTIMATE COAL PRICE

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PT **BRITMINDO**

Professional Mining Services

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JORC 2012 Keys Outcome

- Clause 20 - All reports of Mineral Resources must satisfy the requirement that there are **reasonable prospects for eventual economic extraction,** as well as requirements about the way the analysis of the prospects for eventual economic extraction have been analysed.

- Clause 22 & 23 - 'Measured and Indicated Resources' should now include scope for Modifying Factors to support mine planning and **final evaluation of the economic viability** of the deposit.

- Clause 29 - **At least Pre-Feasibility Study** will have been carried out prior to determination of the Ore Reserves. The studies will have determined a mine plan and production schedule that is technically achievable and economically viable and from which the Ore Reserves can be derived.

- Clauses 2, 5, 19, 27, 35, and the introduction to Table 1 - JORC 2012 is required to be on an **'if not, why not'** basis – which means that if the Competent Person has no comment to make about a relevant individual Table 1 criterion, then **the report should explain why that criterion is not relevant to the understanding of the Public Report.**

Reporting Mineral Resource

JORC 2004

The term 'reasonable prospects for eventual economic extraction' **implies a judgement** (albeit preliminary) by the Competent Person in respect of the technical and economic factors likely to influence the prospect of economic extraction, including the approximate mining parameters. In other words, a Mineral Resource is not an inventory of all mineralisation drilled or sampled, regardless of cut-off grade, likely mining dimensions, location or continuity. It is a realistic inventory of mineralisation which, under assumed and justifiable technical and economic conditions, might, in whole or in part, become economically extractable.

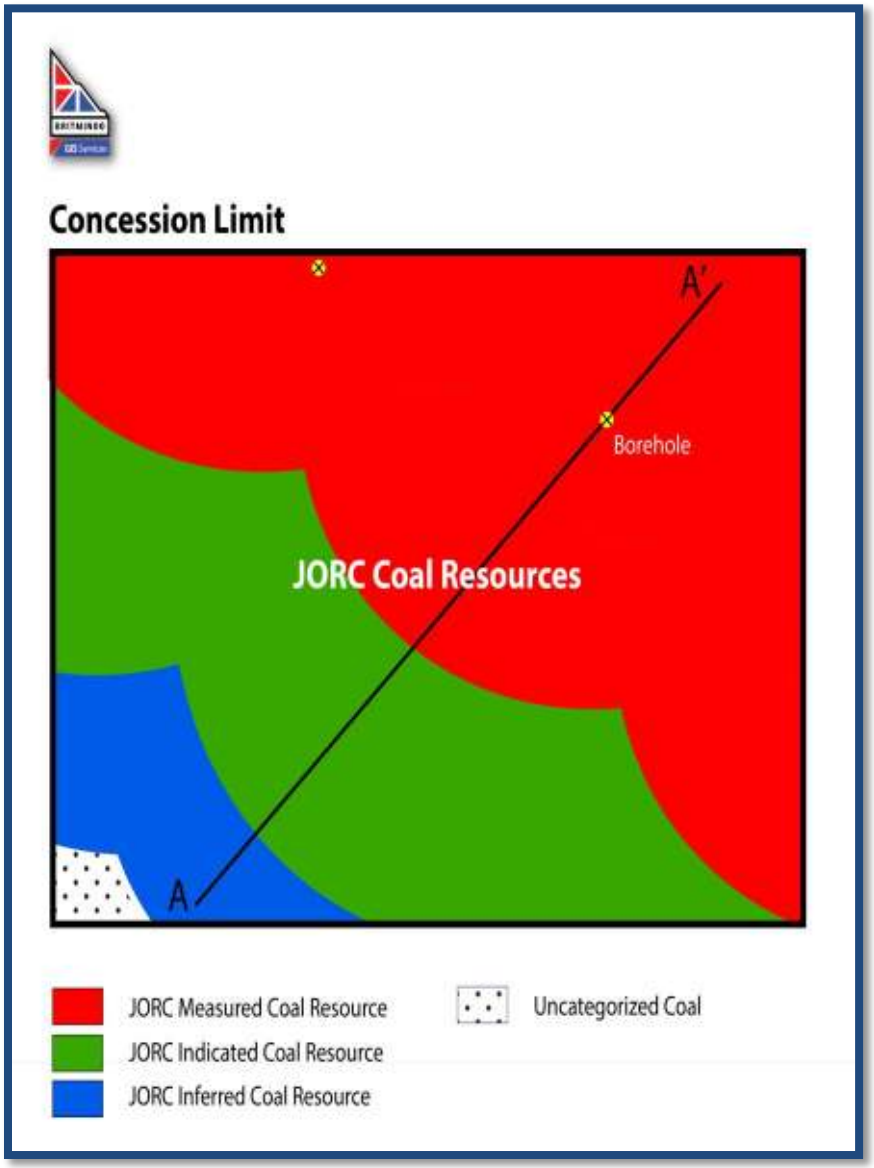
JORC 2012

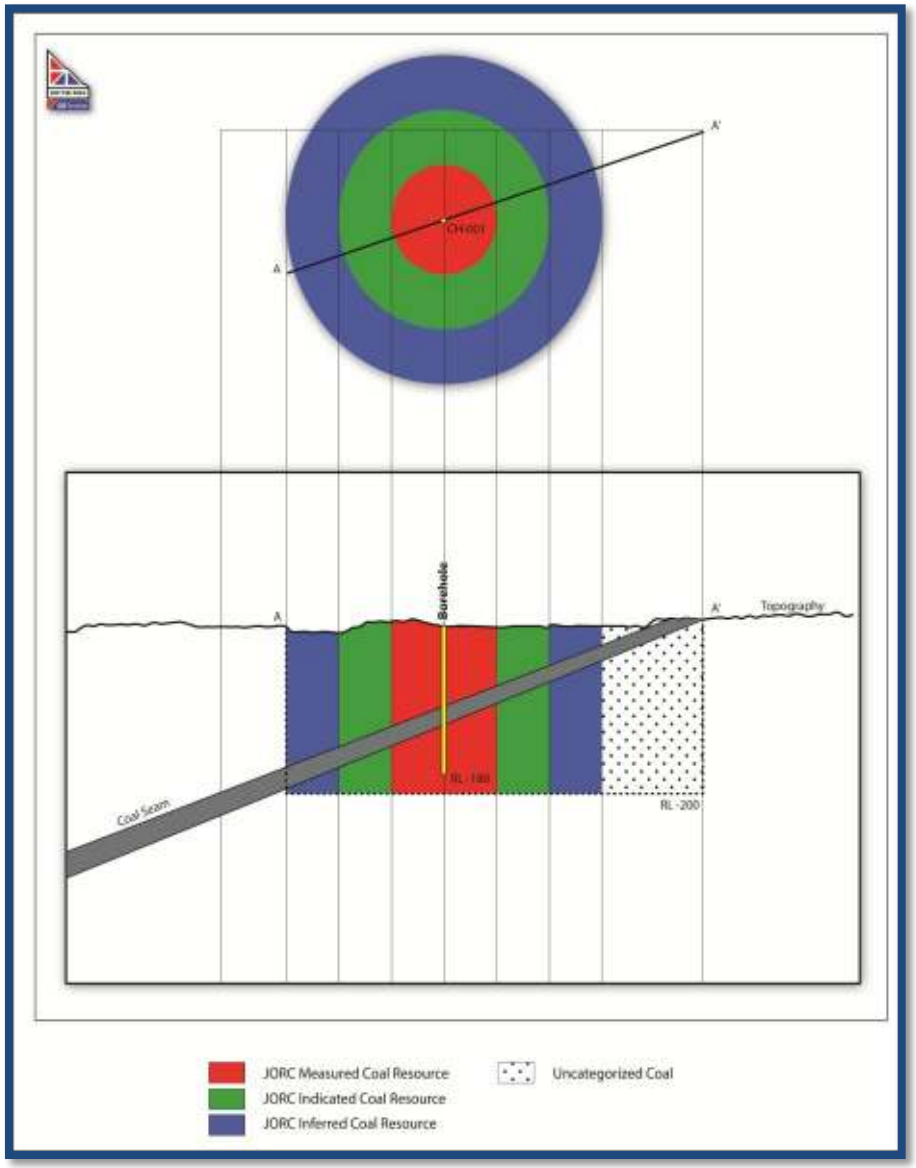
The term 'reasonable prospects for eventual economic extraction' **implies an assessment** (albeit preliminary) by the Competent Person in respect of all matters likely to influence the prospect of economic extraction including the approximate mining parameters. In other words, a Mineral Resource is not an inventory of all mineralisation drilled or sampled, regardless of cut-off grade, likely mining dimensions location or continuity. It is a realistic inventory of mineralisation which, under assumed and justifiable technical, economic and development conditions, might, in whole or in part, become economically extractable.

Reporting Mineral Resource

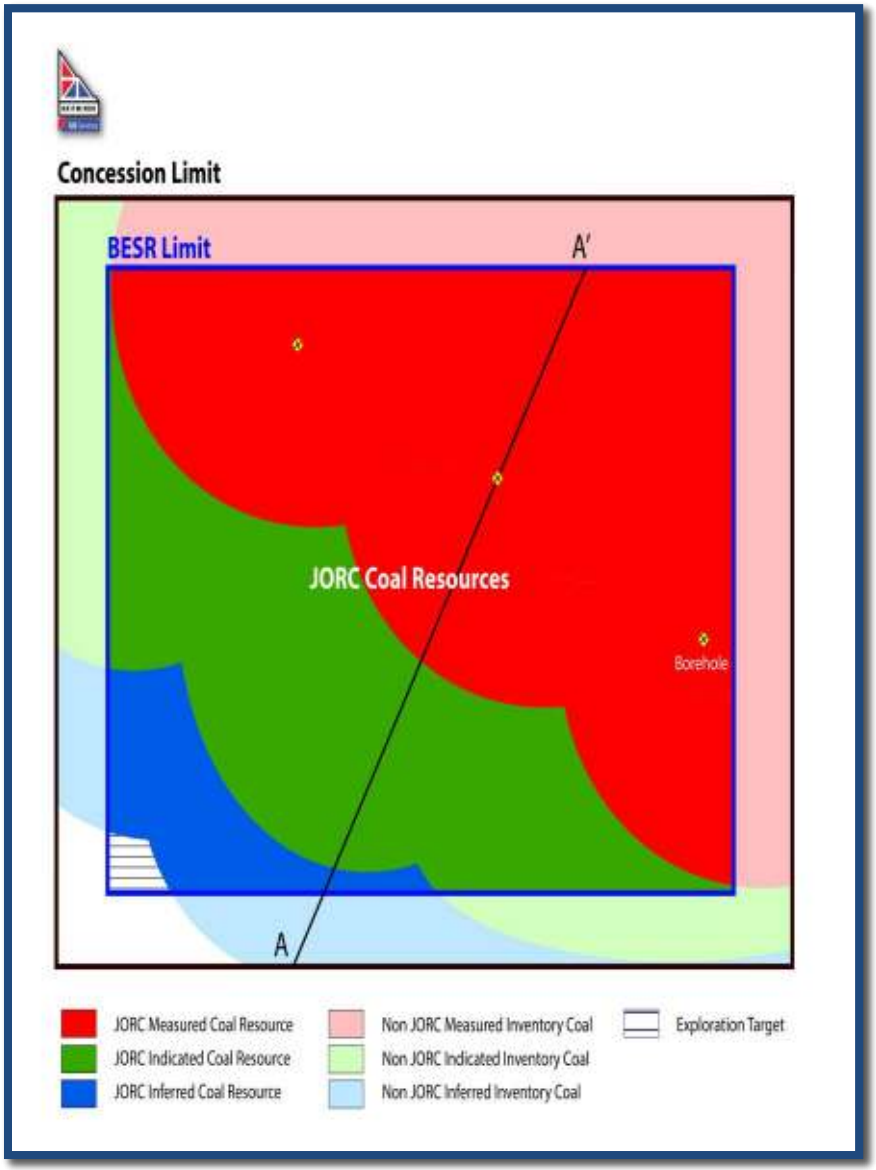
Pit Optimisation or Break Even Strip Ratio exercise must be undertaken to determine economic limit and mining depth.

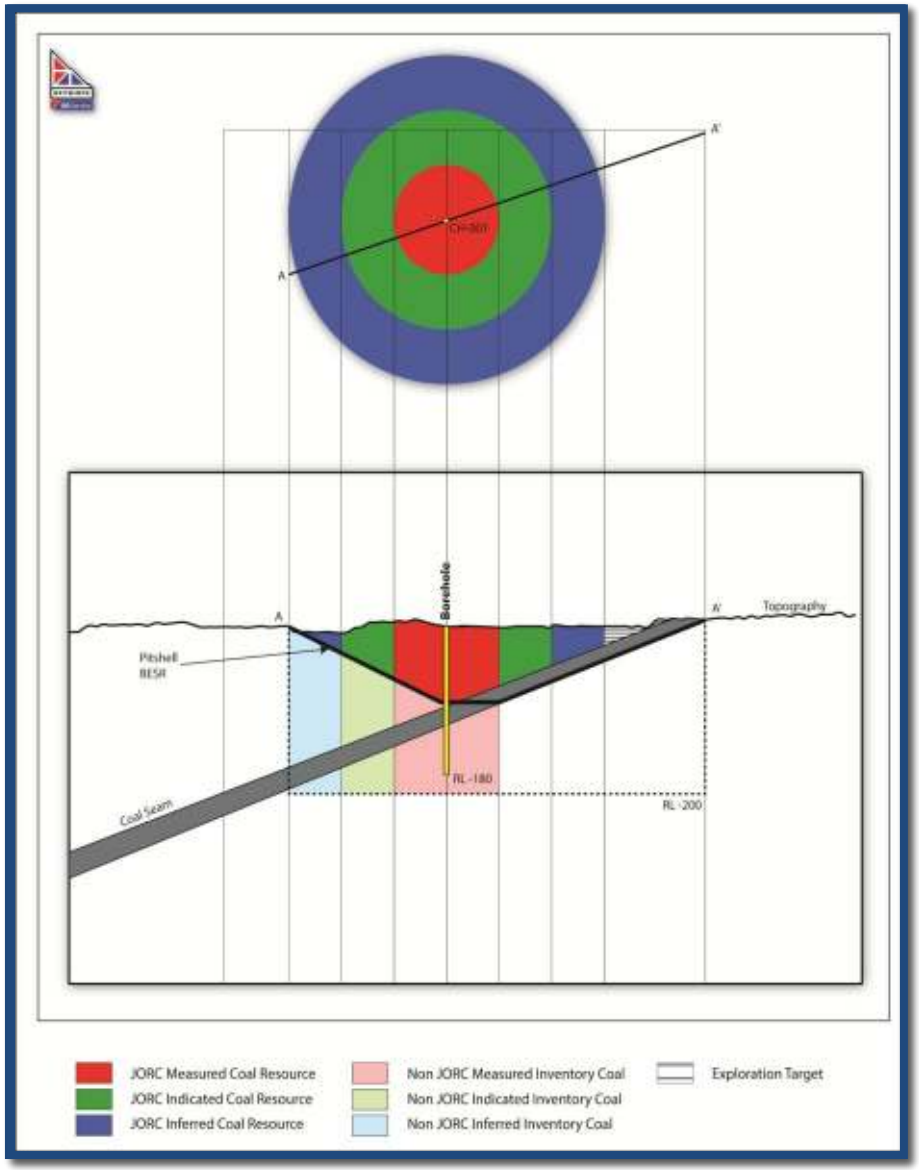
JORC 2004 vs 2012 Resources Estimation





JORC 2004 vs 2012 Resources Estimation





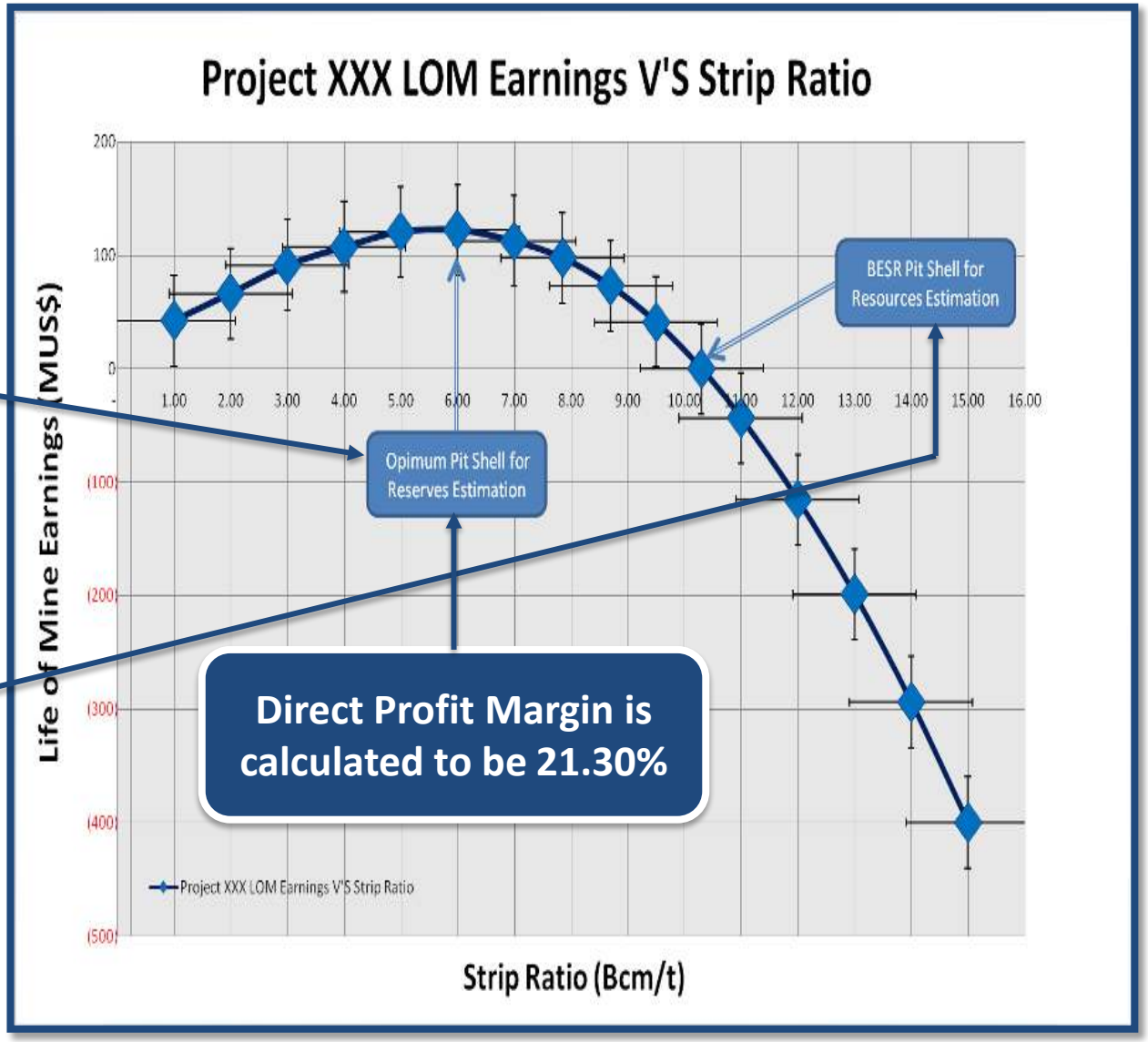
Case Study 1 : Export Scheme

Operating Cost for Resource and Reserve Estimation

Activity	Unit	Quantity	Unit Cost (US$)	Total Cost (US$)
O/B removal	bcm	10.30	1.80	18.55
Coal Mining and Hauling to ROM	t	1.00	1.00	1.00
Total Cost to Product Stockpile	**US$/t**			**19.55**
Coal Haulage ROM to Port	t/km	10.00	0.15	1.50
Barge Loading and Port Stockpiling	t	1.00	1.00	1.00
Barging Cost	t	1.00	10.00	10.00
Floating Crane & Stevedoring	t	1.00	1.50	1.50
Total Coal Transportation Costs	**US$/t**			**14.00**
Overhead Cost	t	1.00	0.25	0.25
G & A Cost	t	1.00	0.50	0.50
Community Development	t	1.00	0.25	0.25
Reclamation	t	1.00	0.10	0.10
Government Royalty (5 %)	t	5%	40.00	2.00
VAT 10%	10%	0.10	33.55	3.35
Total Other Costs	**US$/t**			**6.45**
Total Operating Cost	**US$/t**			**40.00**
Estimated Coal Sale Price	**US$/t**			**40.00**

Case Study 1 : Export Scheme

Coal (Mt)	SR (Bcm/t)	LOM Earnings (MUS$)
40.00	1.00	42.22
110.00	3.00	91.15
150.00	4.00	107.28
200.00	5.00	120.35
250.00	6.00	122.07
300.00	7.00	112.44
350.00	7.85	97.42
400.00	8.70	72.76
450.00	9.50	41.00
500.00	10.30	0.00
550.00	11.00	(43.50)
600.00	12.00	(115.53)
650.00	13.00	(198.92)
700.00	14.00	(293.65)
750.00	15.00	(399.73)



Case Study 2 : Mine Mouth Power Plant Project (MMPP) Scheme

Lampiran Keputusan Direktur Jenderal Mineral dan Batubara
Nomor : 579.K/32/DJB/2015
Tanggal : 20 April 2015

ACUAN BIAYA PRODUKSI BATUBARA
PADA SISTEM PENAMBANGAN TERBUKA

No.	Jenis Biaya	Satuan	Biaya
	Biaya Produksi Langsung		
1	Pengupasan *Overburden*	USD/bcm	2,41
2	Pengangkutan *Overburden*	USD/ton/km	1,74
3	Penggalian Batubara	USD/ton	1,70
4	Pengangkutan Batubara dari lokasi tambang sampai lokasi pengolahan	USD/ton/km	0,28
5	Pengangkutan Batubara dari lokasi pengolahan ke *stockpile* PLTU	USD/ton	Kesepakatan Perusahaan Tambang dengan pemegang IUPTL
	Biaya Produksi Tak Langsung		
6	Pengolahan Batubara	USD/ton	1,98
7	Amortisasi, Pembebasan/ Penggantian Tanah dan Depresiasi	USD/ton	6,88
	Biaya Umum dan Administrasi		
8	• Pemantauan dan Pengelolaan Lingkungan, Reklamasi, dan Pasca Tambang • Keselamatan dan Kesehatan Kerja • Pengembangan dan Pemberdayaan Masyarakat	USD/ton	0,55
9	*Overhead*	USD/ton	2,07
10	Iuran Tetap	USD/ton	0,11
11	Asumsi Iuran Produksi/ Royalti	USD/ton	20,3%
12	Margin	USD/ton	25%

Keterangan:
a) Harga dasar batubara adalah total biaya produksi ditambah margin.
b) Total biaya produksi adalah penjumlahan biaya butir 1 s/d 12.
c) Biaya pengangkutan *overburden* adalah biaya butir 2 dikalikan dengan jarak angkut dalam kilometer.
d) Biaya pengangkutan batubara dari lokasi tambang ke lokasi pengolahan adalah biaya butir 4 dikalikan dengan jarak angkut dalam kilometer.
e) Asumsi iuran produksi adalah 20,3% dari jumlah biaya butir 1 s/d 10.
f) Margin adalah 25% dari jumlah biaya butir 1 s/d 11.

LAMPIRAN
PERATURAN MENTERI ENERGI DAN SUMBER DAYA MINERAL REPUBLIK INDONESIA
NOMOR : 03 TAHUN 2015
TENTANG
PROSEDUR PEMBELIAN TENAGA LISTRIK DAN HARGA PATOKAN PEMBELIAN TENAGA LISTRIK DARI PLTU MULUT TAMBANG, PLTU BATUBARA, PLTG/PLTMG, DAN PLTA OLEH PT PLN (PERSERO)

HARGA PATOKAN TERTINGGI PEMBELIAN TENAGA LISTRIK

1. PLTU Mulut Tambang

Kelas Kapasitas Unit Netto (MW)	100	150	300	600
Harga (cent USD/kWh)	8.2089	7.6520	7.1862	6.9012
Asumsi:				
Availability Factor (AF)	80%			
Masa Kontrak	30 tahun			
Heat rate Kkal/kwh	3200	3000	2900	2700
Calorific Value (gar) Kkal/kg	3000			
Harga Batubara USD/ton (CIF)	30			

Case Study 2 : Mine Mouth Power Plant Project (MMPP) Scheme

Operating Cost for Resources Estimation

Cost Structure	Unit	Quantity	Unit Cost (US$)	Total Cost (US$)
Direct Operating Cost				
O/B removal	bcm	4.68	2.41	11.29
Overburden Hauling	bcm	1.00	1.74	1.74
Coal Mining	t	1.00	1.70	1.70
Coal Hauling to Processing Location	t	1.00	0.28	0.28
Total Direct Operating Costs	**US$/t**			15.01
Indirect Operating Cost				
Coal Processing (Handling at ROM & Crushed Stockpile Management)	t	1.00	1.98	1.98
Amortization, Land Compensation, and Depreciation	t	1.00	6.88	6.88
Total Indirect Operating Costs	**US$/t**			8.86
General & Administration Cost				
Environmental, Reclamation, Rehabilitation	t	1.00	0.55	0.55
Occupational, Safety, and Health				
CSR				
Overhead expenses	t	1.00	2.07	2.07
Fixed Retribution	t	1.00	0.11	0.11
Government Production Retribution / Royalty	t	20.30%	26.60	5.40
Margin Target	t	25.00%	32.00	8.00
Total Overhead Costs	**US$/t**			16.13
Total Costs	**US$/t**			**40**
Estimated Coal Sale Price	**US$/t**			**40**

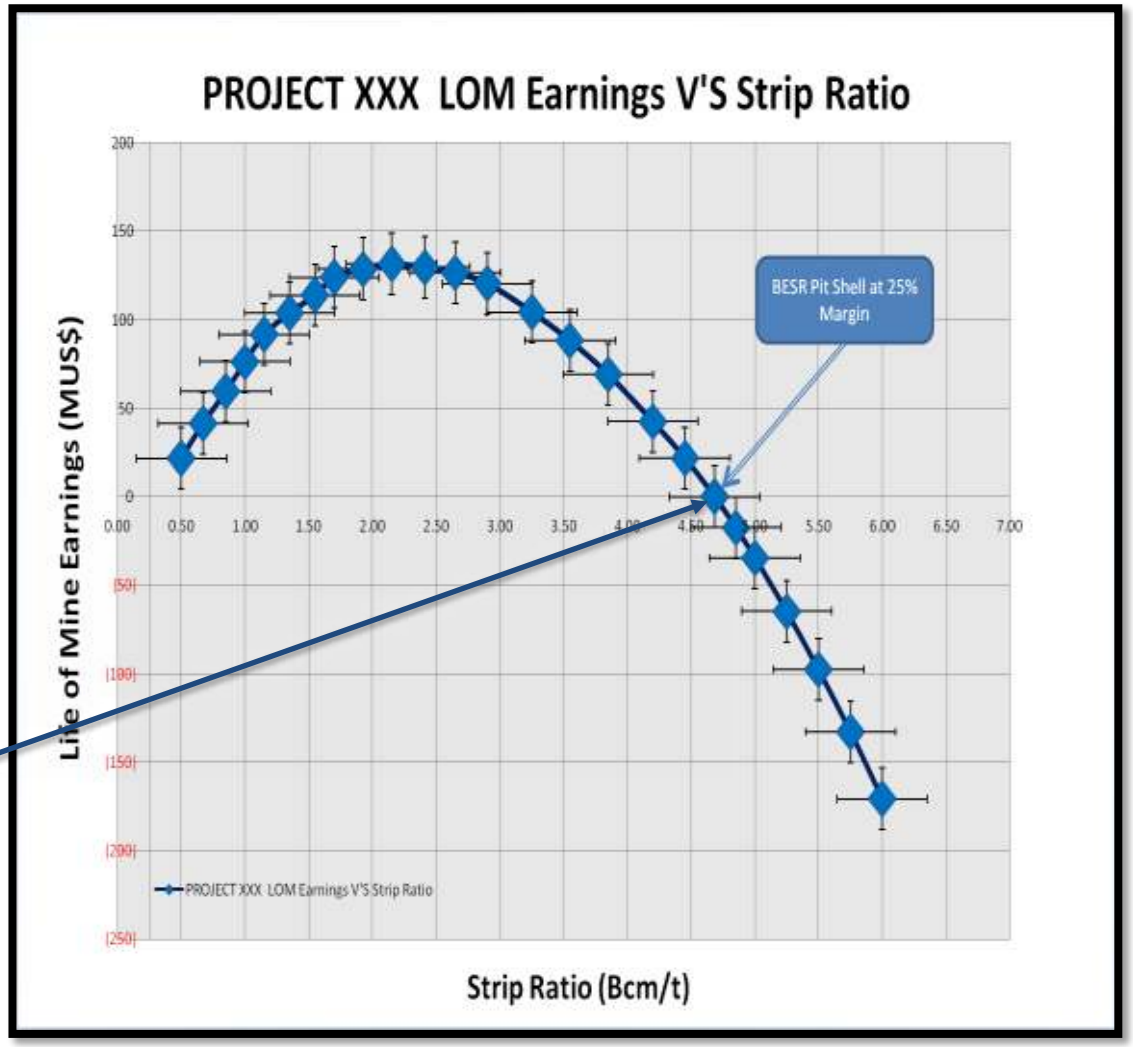
Case Study 2 : Mine Mouth Power Plant Project (MMPP) Scheme

Operating Cost for Reserves Estimation

Cost Structure	Unit	Quantity	Unit Cost (US$)	Total Cost (US$)
Direct Operating Cost				
O/B removal	bcm	1.93	2.41	4.64
Overburden Hauling	bcm	1.00	1.74	1.74
Coal Mining	t	1.00	1.70	1.70
Coal Hauling to Processing Location	t	1.00	0.28	0.28
Total Direct Operating Costs	**US$/t**			8.36
Indirect Operating Cost				
Coal Processing (Handling at ROM & Crushed Stockpile Management)	t	1.00	1.98	1.98
Amortization, Land Compensation, and Depreciation	t	1.00	6.88	6.88
Total Indirect Operating Costs	**US$/t**			8.86
General & Administration Cost				
Environmental, Reclamation, Rehabilitation	t	1.00	0.55	0.55
Occupational, Safety, and Health				
CSR				
Overhead expenses	t	1.00	2.07	2.07
Fixed Retribution	t	1.00	0.11	0.11
Government Production Retribution / Royalty	t	20.30%	26.60	4.05
Margin Target	t	25.00%	32.00	6.00
Total Overhead Costs	**US$/t**			12.78
Total Costs	**US$/t**			**30**
Estimated Coal Sale Price	**US$/t**			**30**

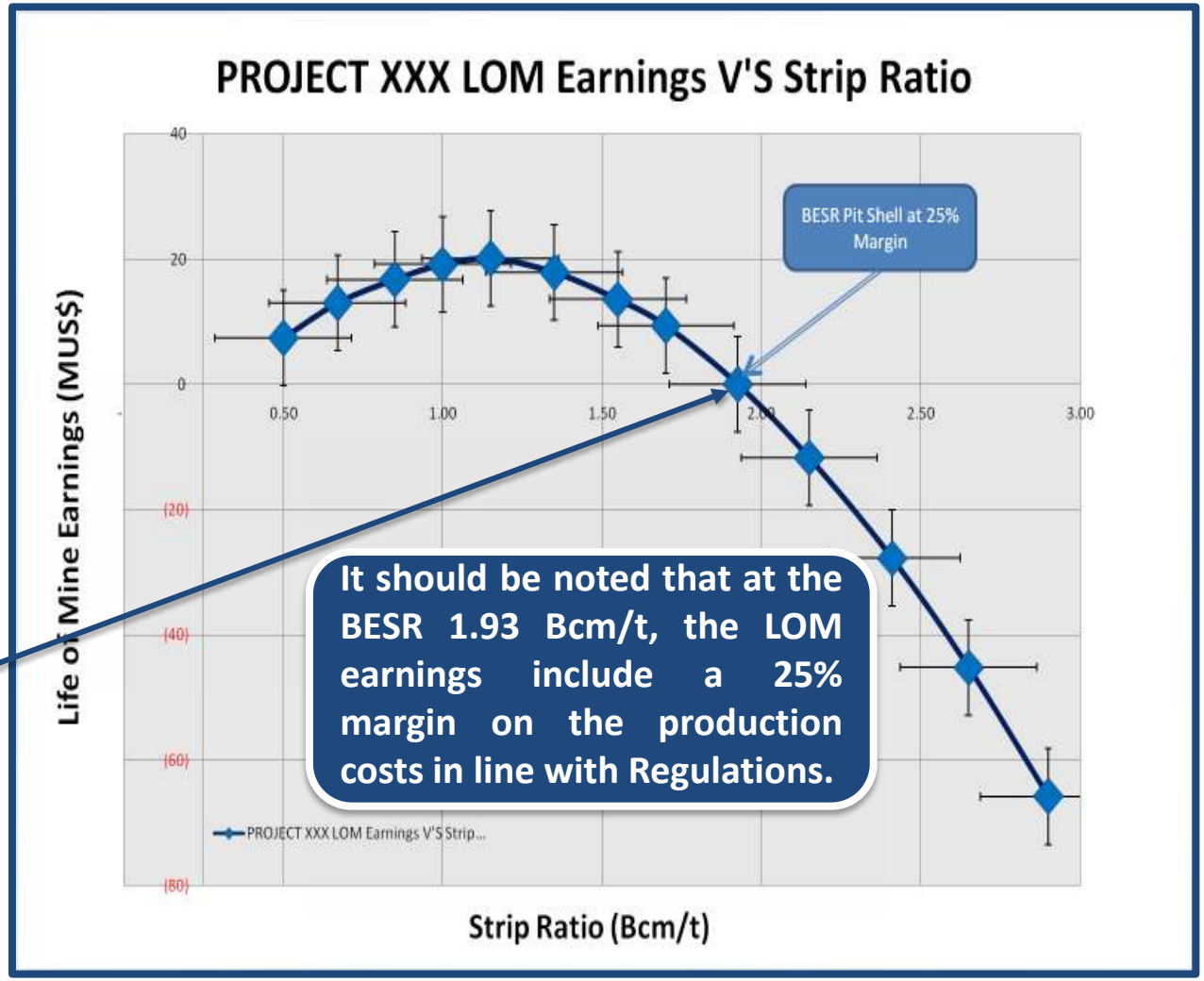
Case Study 2 : Mine Mouth Power Plant Project (MMPP) Scheme

Coal (Mt)	SR (Bcm/t)	LOM Earnings (MUS$)
25.00	0.50	21.73
50.00	0.67	41.69
75.00	0.85	59.73
100.00	1.00	76.53
125.00	1.15	91.76
150.00	1.35	103.89
175.00	1.55	113.93
200.00	1.70	123.98
225.00	1.93	128.94
250.00	2.15	131.61
275.00	2.41	129.92
300.00	2.65	126.78
325.00	2.90	120.47
350.00	3.25	104.29
375.00	3.55	88.38
400.00	3.85	69.34
425.00	4.20	42.78
450.00	4.45	21.94
475.00	4.68	0.00
500.00	4.85	(17.16)
525.00	5.00	(34.38)
550.00	5.25	(64.57)
575.00	5.50	(97.36)
600.00	5.75	(132.75)
625.00	6.00	(170.73)



Case Study 2 : Mine Mouth Power Plant Project (MMPP) Scheme

Coal (Mt)	SR (Bcm/t)	LOM Earnings (MUS$)
25.00	0.50	7.40
50.00	0.67	13.04
75.00	0.85	16.75
100.00	1.00	19.22
125.00	1.15	20.13
150.00	1.35	17.92
175.00	1.55	13.64
200.00	1.70	9.36
225.00	1.93	0.00
250.00	2.15	(11.66)
275.00	2.41	(27.68)
300.00	2.65	(45.15)
325.00	2.90	(65.79)



How to Estimate Coal Price for Resources Estimation ???

Background JORC 2012 Clause 20

Interpretation of the word **'eventual'** in this context may vary depending on the commodity or mineral involved. For example, for some **coal,** iron ore, bauxite and other bulk minerals or commodities, it may be reasonable to envisage **'eventual economic extraction'** as covering time periods in excess of **50 years**. However for the majority of smaller deposits, application of the concept would normally be restricted to perhaps 10 to 15 years, and frequently to much shorter periods of time. In all cases, the considered time frame should be disclosed and discussed by the Competent Person.

How to Estimate Coal Price for Resources Estimation ???

1. Ask a Professional Financial Analysis Company

2. Use Historical Coal Price from 5 or 10 years ago

3. Monte Carlo Simulation

Introduction to Monte Carlo Simulation

What is Monte Carlo Simulation ???

Introduction to Monte Carlo Simulation

Monte Carlo simulation is a technique that converts uncertainties in input variables of a model into probability distributions. **By generating thousands or millions of such simulations,** and taking the average of these results, ending with a **reasonable estimate of the future stock price**, provided the model holds.

http://www.investopedia.com/articles/07/monte_carlo_intro.asp

Monte Carlo simulation **performs risk analysis** by building models of possible results by substituting a range of values—a probability distribution—for any factor that has **inherent uncertainty**.

It then calculates results over and over, each time using a different set of random values from the probability functions.

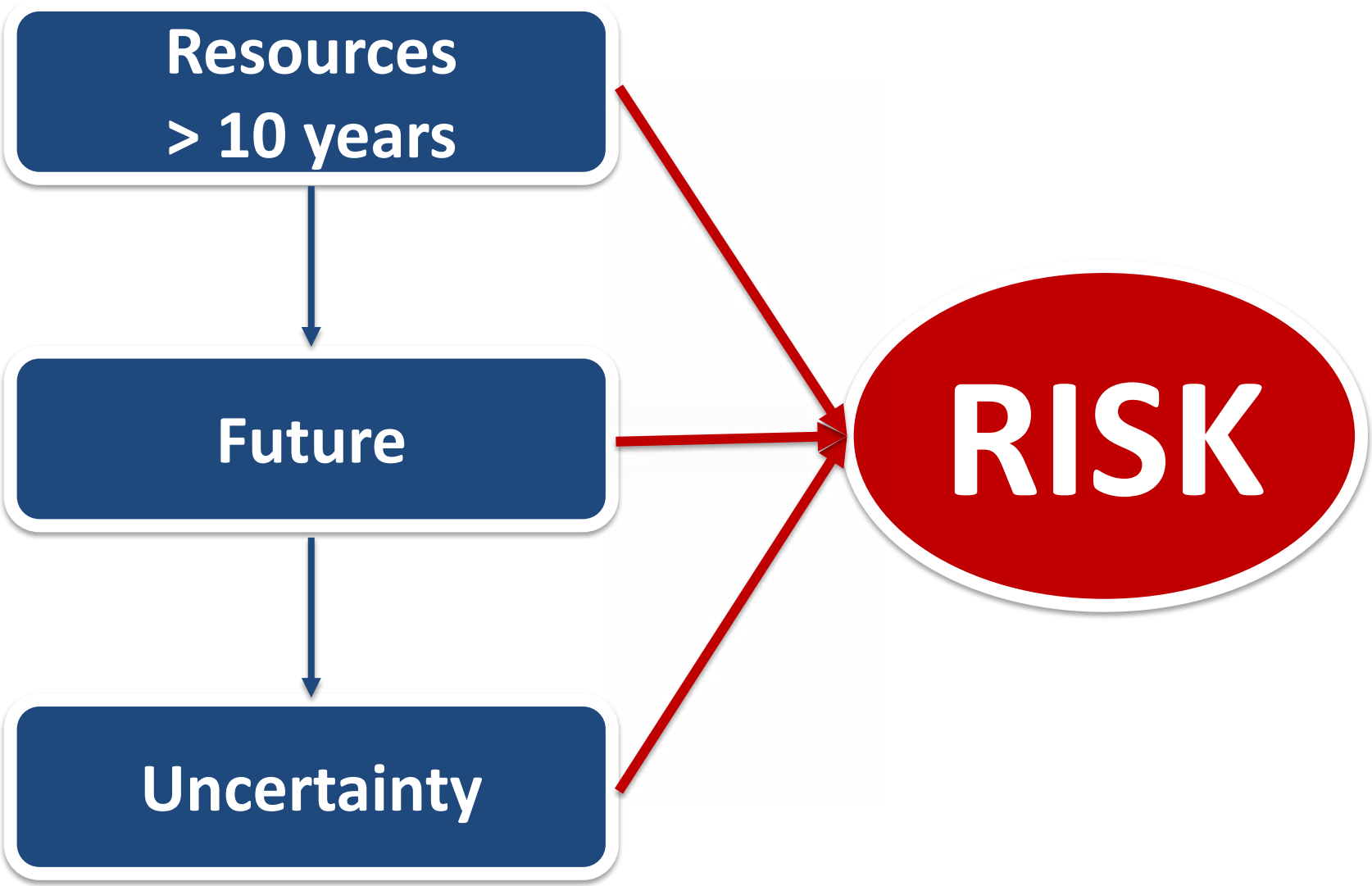
Monte Carlo simulation could involve thousands or tens of thousands of recalculations before it is complete, producing distributions of possible outcome values.

http://www.palisade.com/risk/monte_carlo_simulation.asp

Introduction to Monte Carlo Simulation

Why use Monte Carlo Simulation as a Solution to Estimate Coal Price ???

Introduction to Monte Carlo Simulation



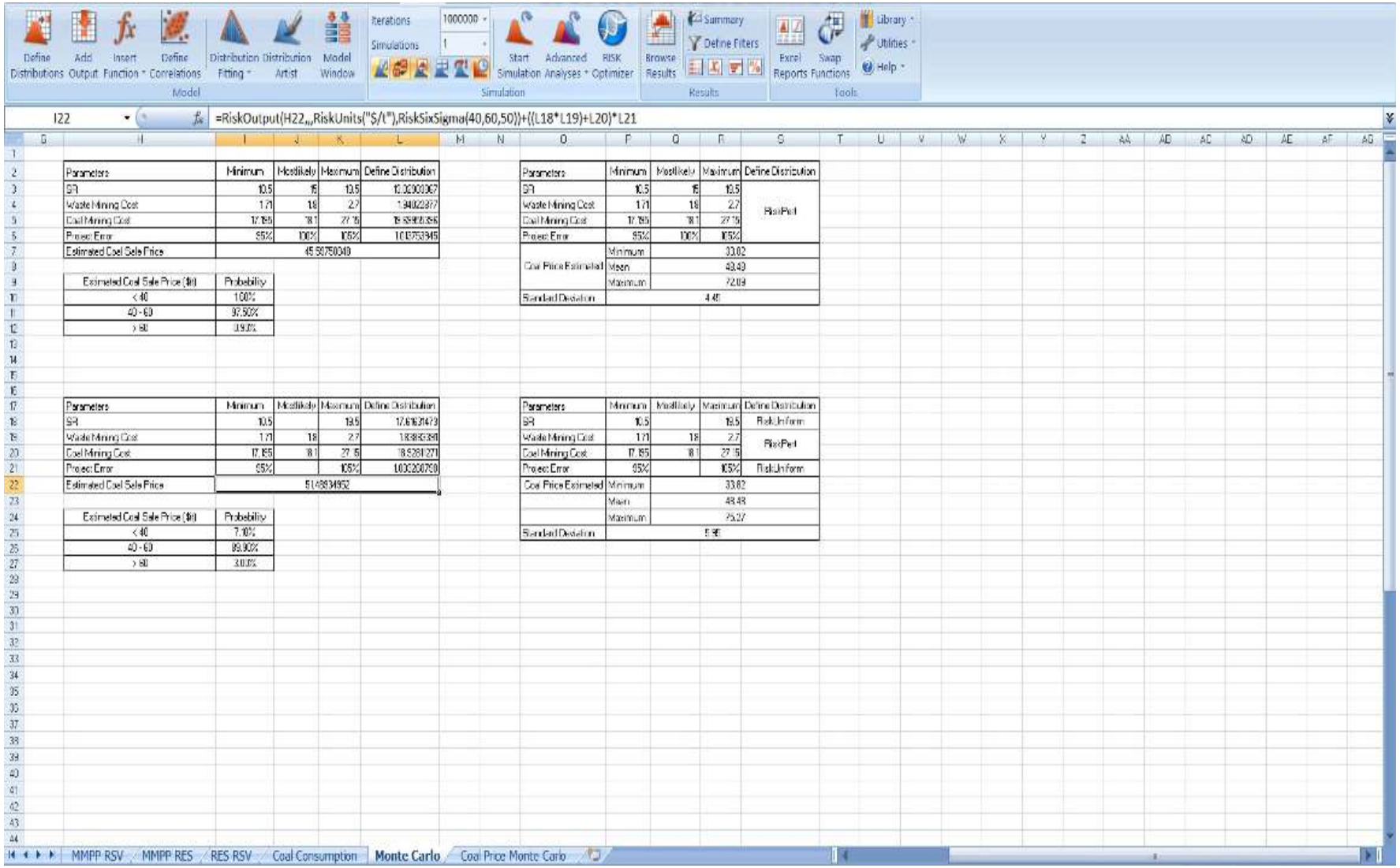
Case Study for Monte Carlo Simulation : Export Scheme

Activity	Unit	Quantity	Unit Cost (US$)	Total Cost (US$)
O/B removal	bcm	???	1.80	1.80
Coal Mining and Hauling to ROM	t	1.00	1.00	1.00
Coal Haulage ROM to Port	t/km	10.00	0.15	1.50
Barge Loading and Port Stockpiling	t	1.00	1.00	1.00
Barging Cost	t	1.00	10.00	10.00
Floating Crane & Stevedoring	t	1.00	1.50	1.50
Overhead Cost	t	1.00	0.25	0.25
G & A Cost	t	1.00	0.50	0.50
Community Development	t	1.00	0.25	0.25
Reclamation	t	1.00	0.10	0.10
Government Royalty (5 %)	t	5%	40.00	???
VAT 10%	10%	0.10	33.55	???
Estimated Coal Sale Price	US$/t			???

Case Study for Monte Carlo Simulation : Export Scheme

Parameters	Minimum	Most-likely	Maximum
Strip Ratio	70%	100%	130%
Waste Mining Cost	95%	100%	150%
Coal Mining Cost	95%	100%	150%
Project Error	95%	100%	105%

Case Study for Monte Carlo Simulation : Export Scheme



Parameters	Minimum	Mostlikely	Maximum	Define Distribution
SR	10.5	16	19.5	12.30000367
Waste Mining Cost	1.71	1.8	2.7	1.94002877
Coal Mining Cost	17.165	18.1	27.15	19.58405356
Project Error	95%	100%	105%	1.013753845
Estimated Coal Sale Price				45.59750349

Estimated Coal Sale Price ($/t)	Probability
< 40	1.00%
40 - 60	97.50%
> 60	1.50%

Parameters	Minimum	Mostlikely	Maximum	Define Distribution
SR	10.5	16	19.5	RiskPert
Waste Mining Cost	1.71	1.8	2.7	
Coal Mining Cost	17.165	18.1	27.15	
Project Error	95%	100%	105%	
Coal Price Estimated	Minimum		33.02	
	Mean		49.49	
	Maximum		72.09	
Standard Deviation			4.48	

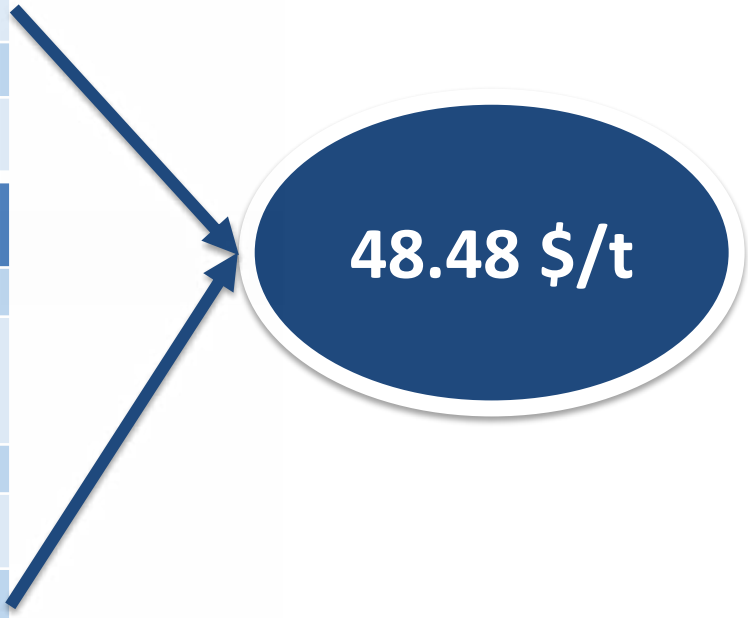
Parameters	Minimum	Mostlikely	Maximum	Define Distribution
SR	10.5		19.5	RiskUniform
Waste Mining Cost	1.71	1.8	2.7	RiskPert
Coal Mining Cost	17.165	18.1	27.15	
Project Error	95%		105%	RiskUniform
Coal Price Estimated	Minimum		33.02	
	Mean		48.48	
	Maximum		75.27	
Standard Deviation			5.96	

Estimated Coal Sale Price ($/t)	Probability
< 40	7.10%
40 - 60	89.90%
> 60	3.00%

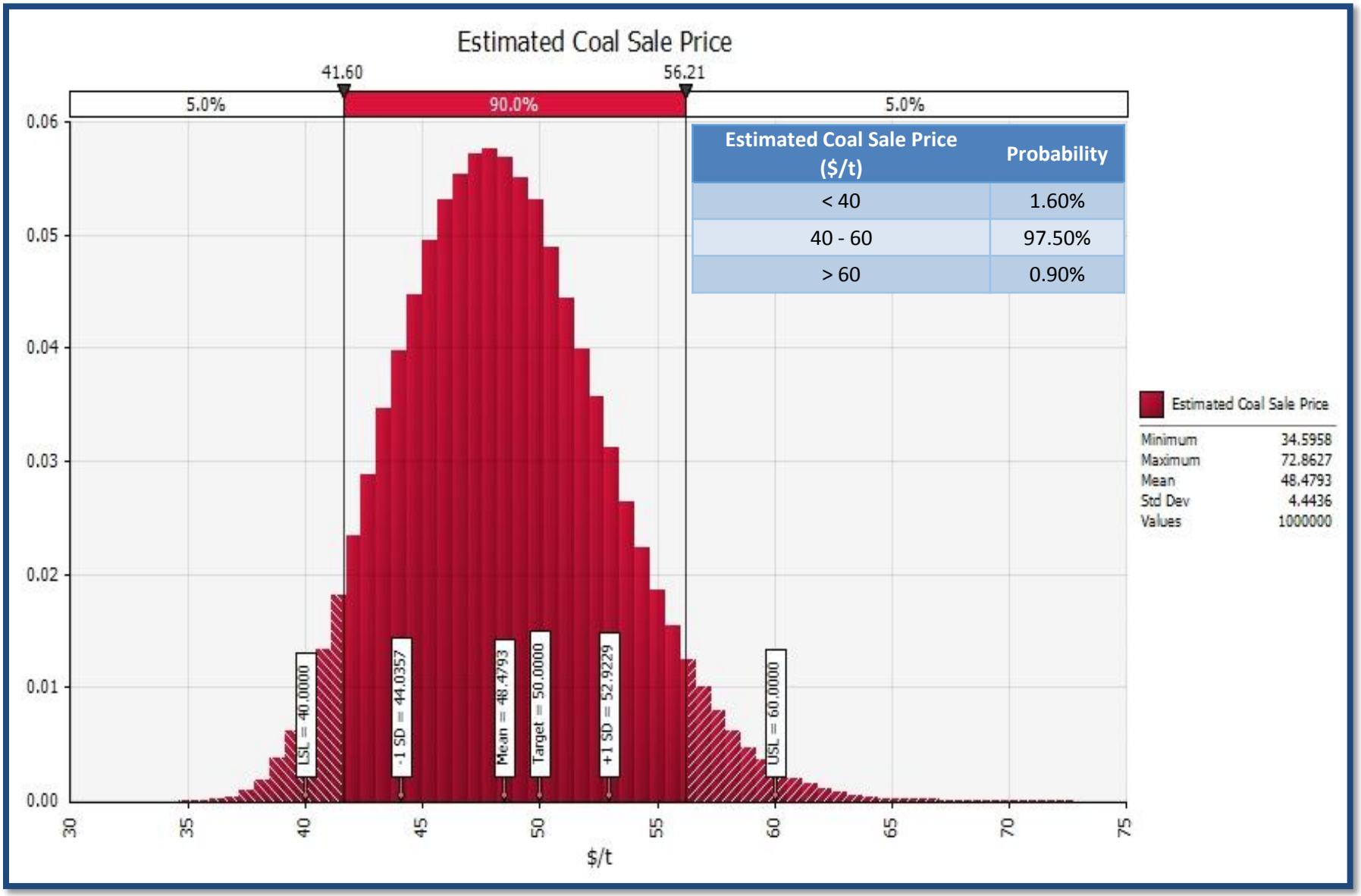
Case Study for Monte Carlo Simulation : Export Scheme

Parameters	Minimum	Most-likely	Maximum	Distribution Definition
Strip Ratio (Bcm/t)	10.5	15	19.5	RiskPert
Waste Mining Cost ($/Bcm)	1.71	1.8	2.7	
Coal Mining Cost ($/t)	17.195	18.1	27.15	
Project Error	95%	100%	105%	
Estimated Coal Sale Price ($/t)	**Minimum**	**34.59**		
	Mean	**48.48**		
	Maximum	**72.04**		
Standard Deviation ($/t)	**4.44**			

Parameters	Minimum	Most-likely	Maximum	Distribution Definition
Strip Ratio (Bcm/t)	10.5	-	19.5	RiskUniform
Waste Mining Cost ($/Bcm)	1.71	1.8	2.7	RiskPert
Coal Mining Cost ($/t)	17.195	18.1	27.15	
Project Error	95%	-	105%	RiskUniform
Estimated Coal Sale Price ($/t)	**Minimum**	**33.73**		
	Mean	**48.48**		
	Maximum	**74.96**		
Standard Deviation ($/t)	**5.96**			

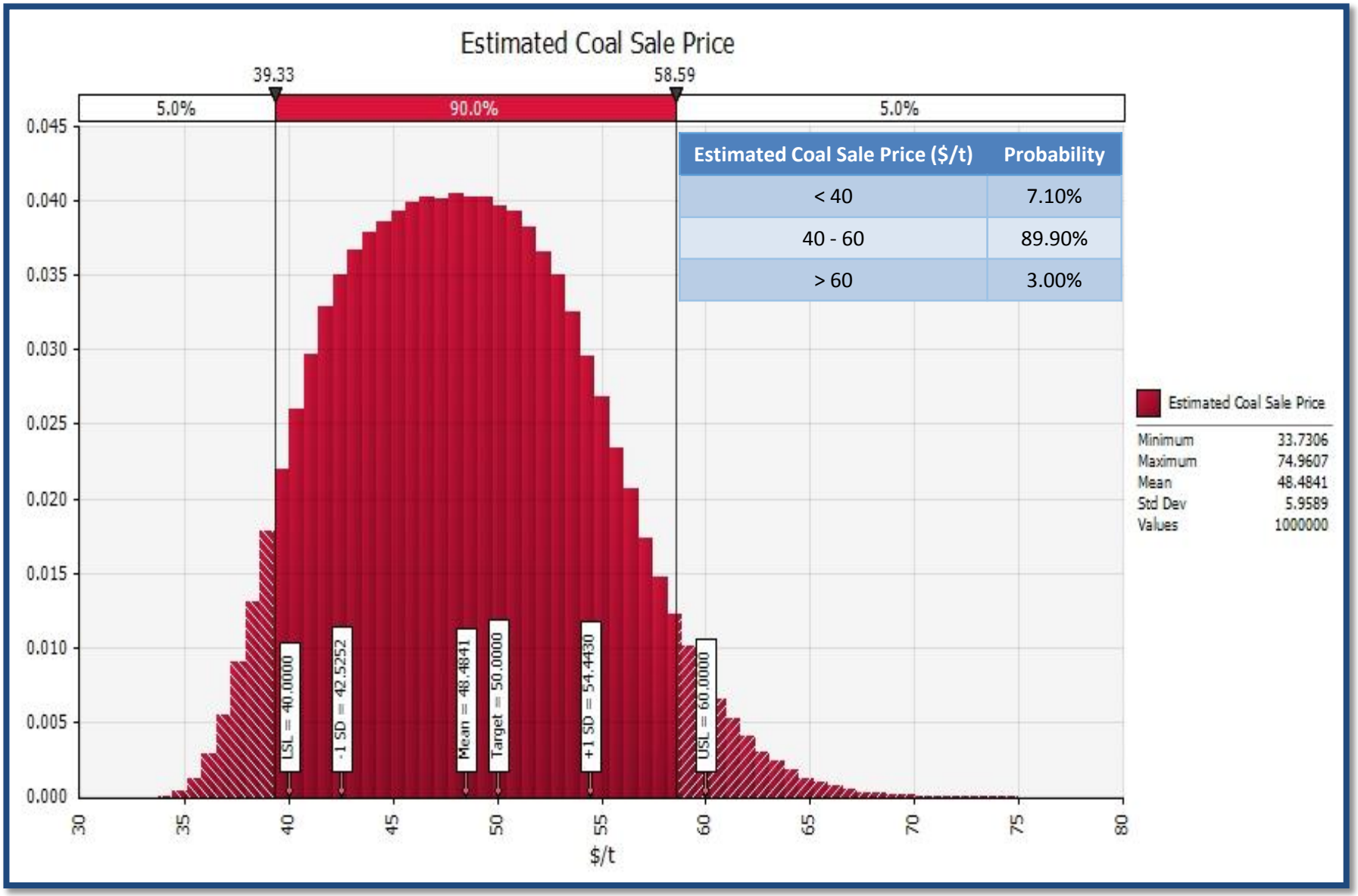


Monte Carlo Graphic & Probability Result



Estimated Coal Sale Price ($/t)	Probability
< 40	1.60%
40 - 60	97.50%
> 60	0.90%

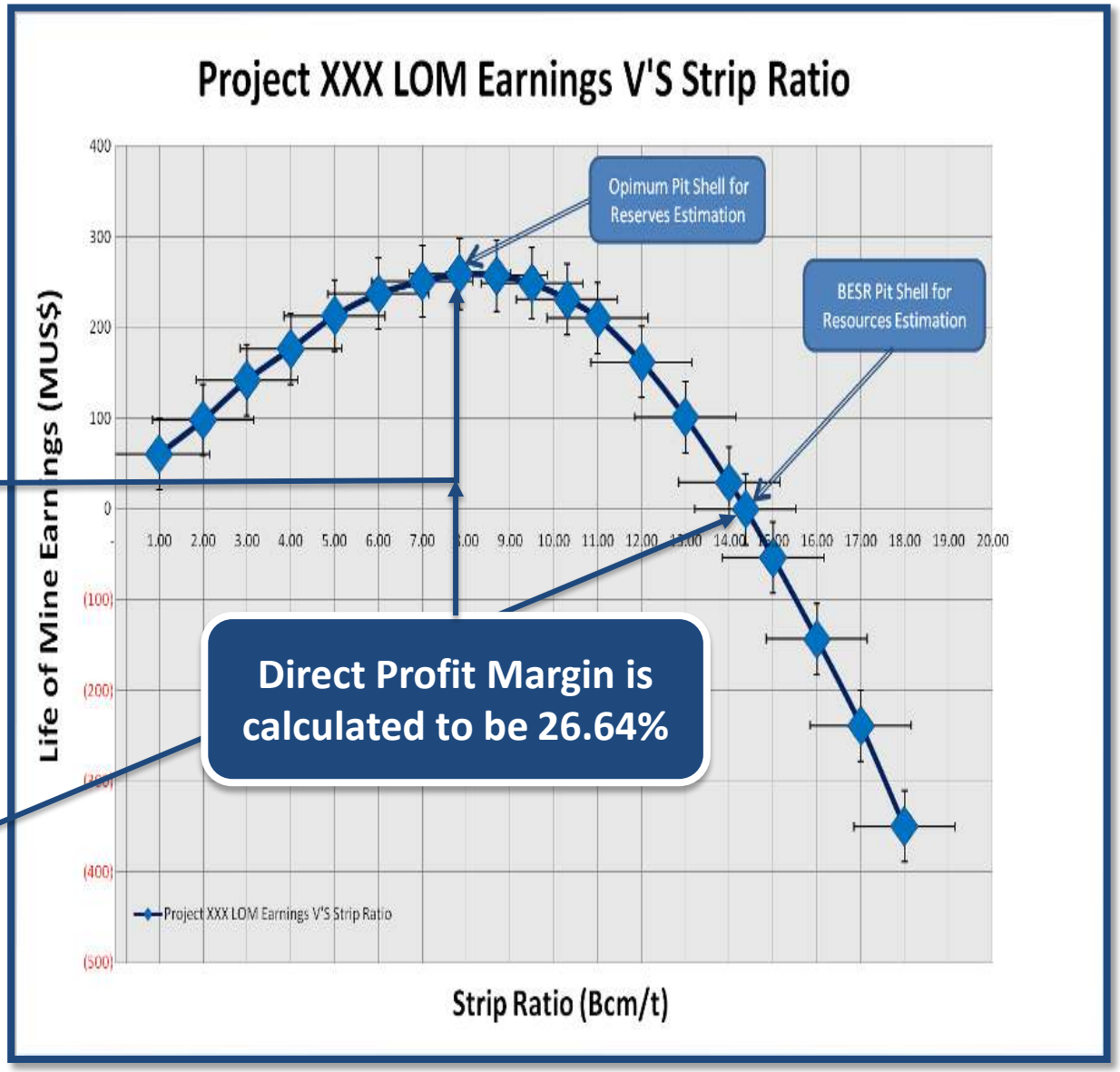
Monte Carlo Graphic & Probability Result



Estimated Coal Sale Price ($/t)	Probability
< 40	7.10%
40 - 60	89.90%
> 60	3.00%

BESR Using Simulated Coal Price

Coal (Mt)	SR (Bcm/t)	LOM Earnings (MUS$)
40.00	1.00	60.69
70.00	2.00	98.27
110.00	3.00	141.94
150.00	4.00	176.53
200.00	5.00	212.68
250.00	6.00	237.49
300.00	7.00	250.94
350.00	7.85	259.01
400.00	8.70	257.43
450.00	9.50	248.76
500.00	10.30	230.84
550.00	11.00	210.43
600.00	12.00	161.47
650.00	13.00	101.17
700.00	14.00	29.53
725.00	14.37	0.00
750.00	15.00	(53.47)
775.00	16.00	(143.19)
800.00	17.00	(238.59)
850.00	18.00	(349.95)

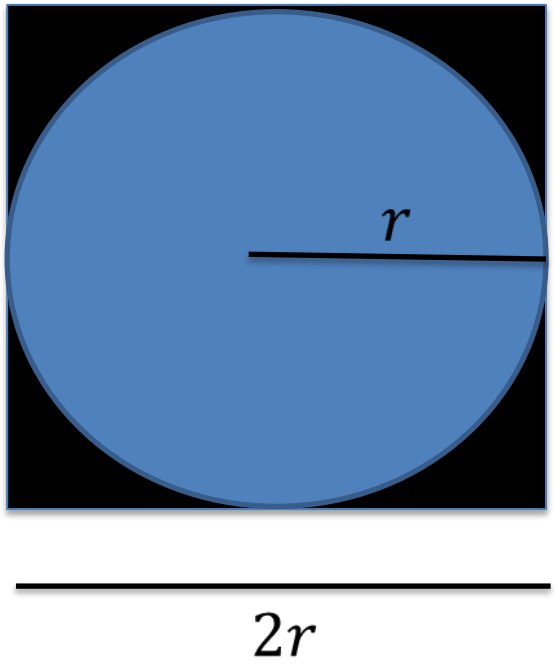


The Application of Monte Carlo Simulation

A very simple example is an value of Pi (π), by randomly plotting points in a unit square and measuring how many of them fit inside a unit circle.

Using many random points, and good counting, will get a very good estimate for Pi(π).

The Application of Monte Carlo Simulation



$$A(Circle) = \pi r^2$$

$$A(Square) = (2r)^2$$

Ratio of the area of the circle to the area of the square will be :

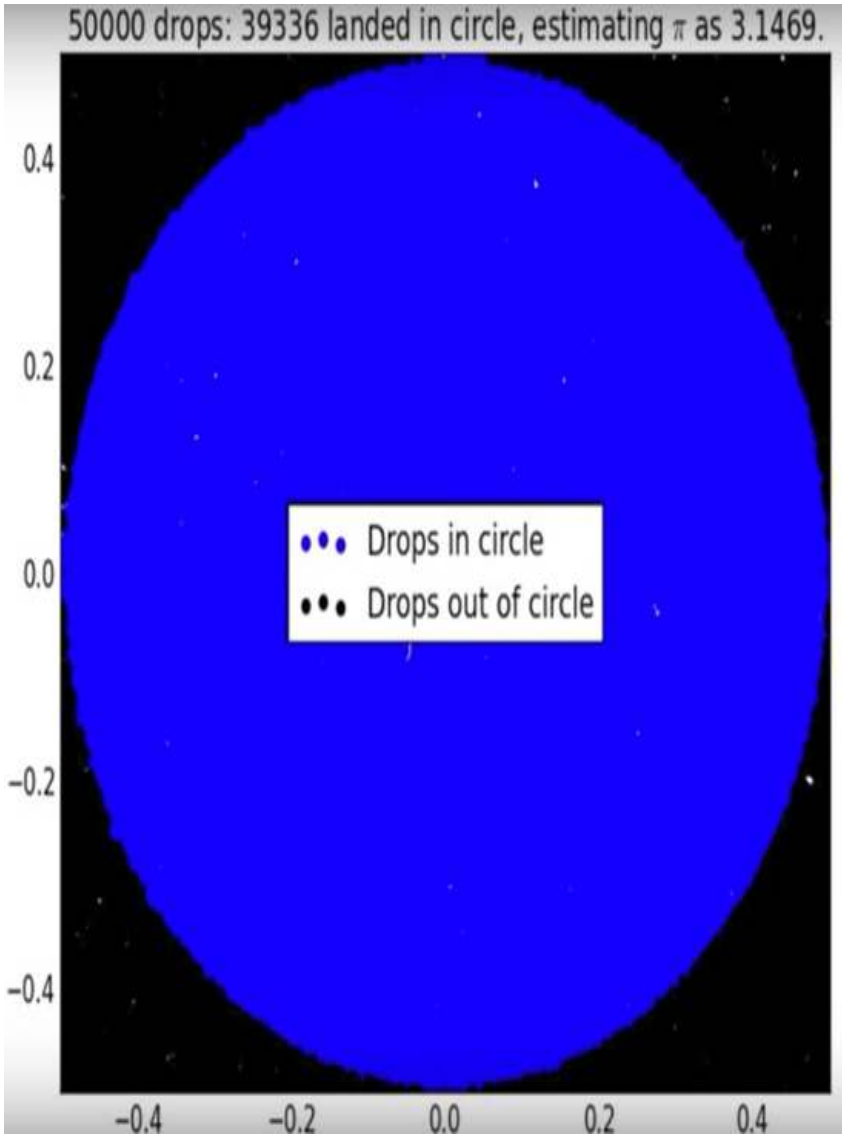
$$\frac{\pi r^2}{(2r)^2} = \frac{\pi}{4} = \frac{M}{N}$$

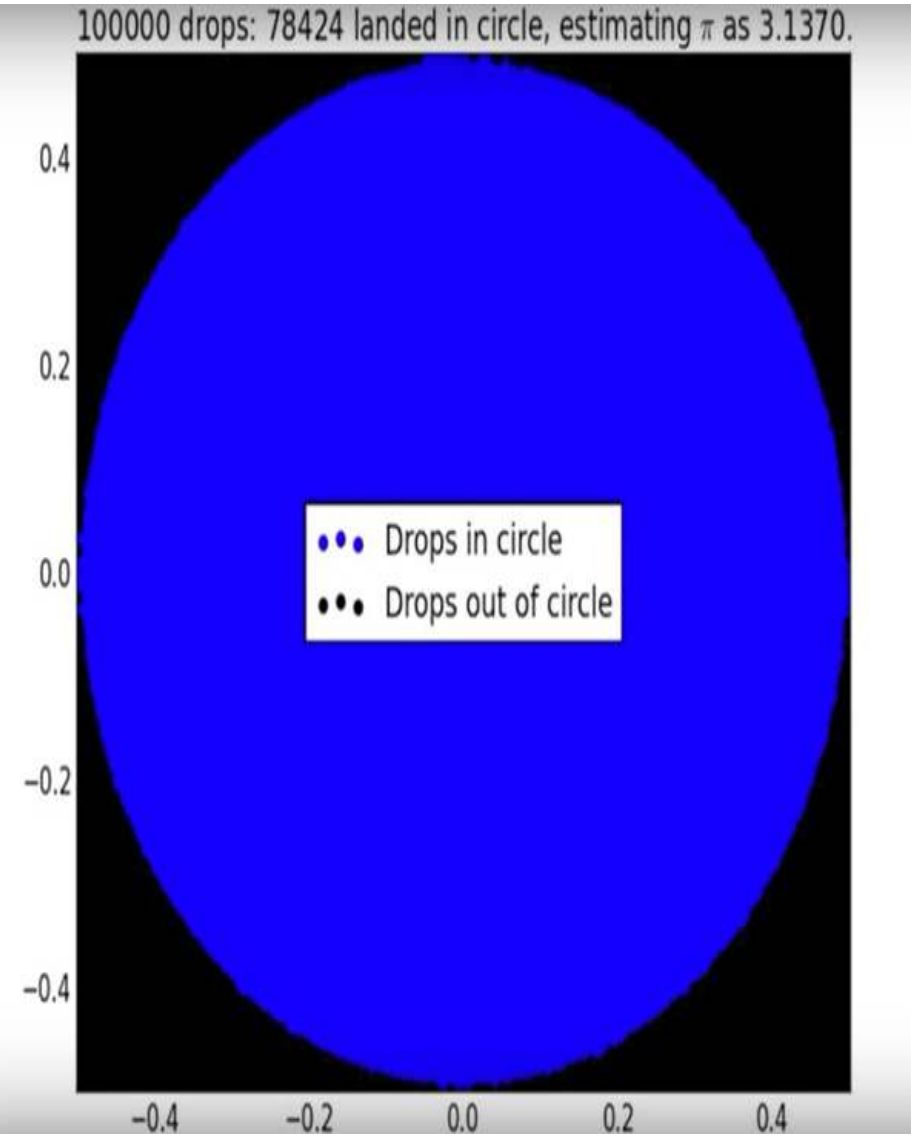
This program picks points at random inside the square. It then checks to see if the point is inside the circle.

The program keeps track of how many points it's picked so far (N) and how many of those points fell inside the circle (M).

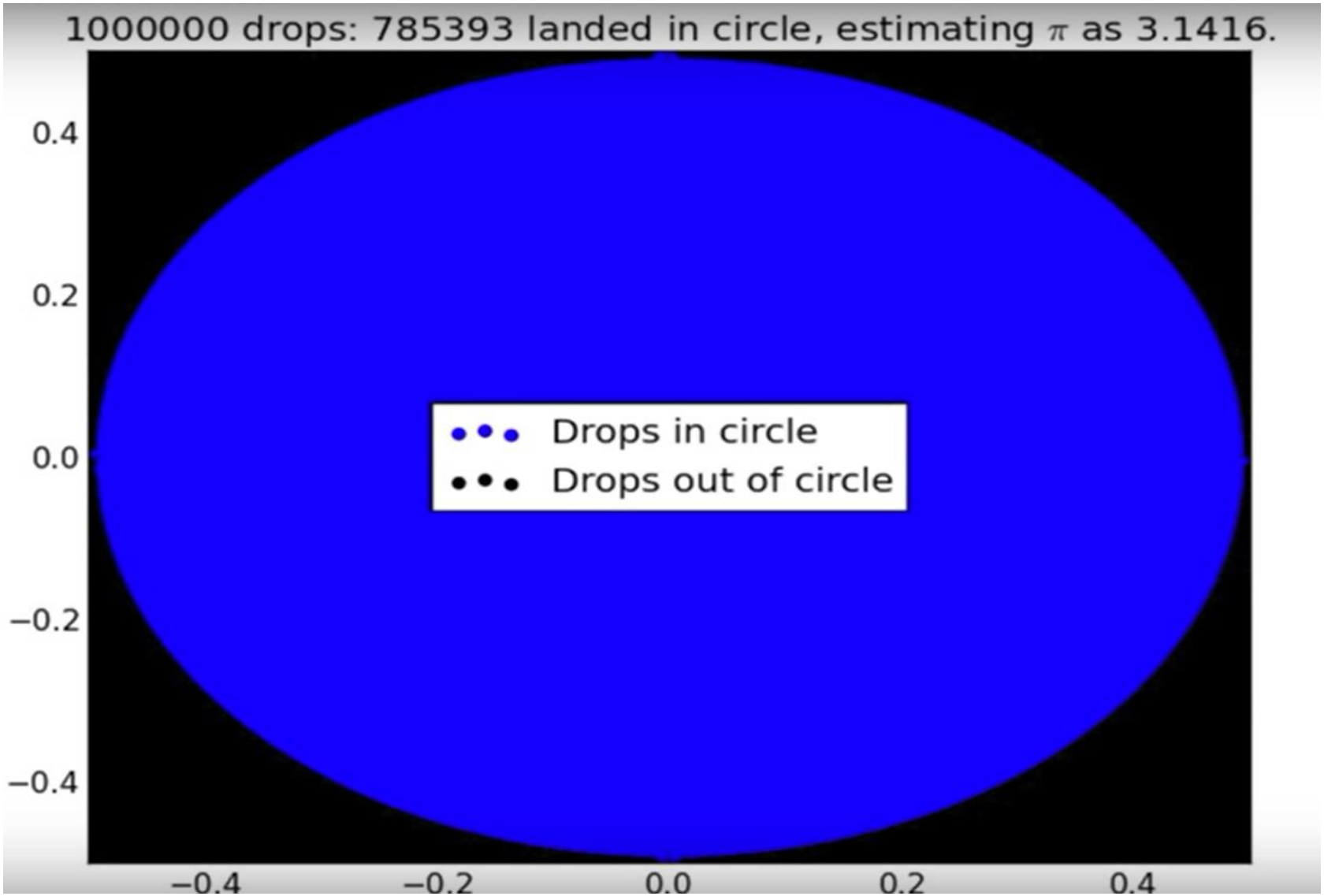
$$\pi = \frac{4M}{N}$$

The Application of Monte Carlo Simulation





The Application of Monte Carlo Simulation



Conclusions

- JORC 2012 Requires that Mineral Resource should have a economic viability and **implies an assessment by the Competent Person.**

- For Resource Estimation, Pit Optimisation or BESR must be undertaken to prove that there is **a reasonable prospect for eventual economic extraction**.

- Monte Carlo simulation is a solution to **estimating future uncertainty**, as it takes into **account risk** therefore giving a **defendable estimate** of the future coal price.

TERIMA KASIH
THANK YOU
DANKJEWEL
DANKE
GRAZIE
谢谢
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