

Spanish Institute of Energy

The Energetic Resources and their Financial Aspects

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Hispanic Chair, Universidad Complutense Madrid

Wednesday 24th September at The Spanish Energy Club

Finance at Imperial

MSc Metals & Energy Finance

A Joint programme between the Engineering Faculty (Department of Earth Science and Engineering) and the Imperial College Business School.



Professor Dennis Buchanan, Course Director,
Department of Earth Science & Engineering,
Engineering Faculty

Imperial at a glance

The University:

- world class scholarship, education and research in science, technology and medicine
- interdisciplinary collaborations
- communicate and share knowledge
- 13,964 students (30% Postgraduate)
- Students from 126 countries
- 242 taught courses

Established in 1907

Academic faculties:

- Engineering
- Natural Sciences
- Medicine
- Business School



Our standing



3rd in Europe and 10th in the world overall

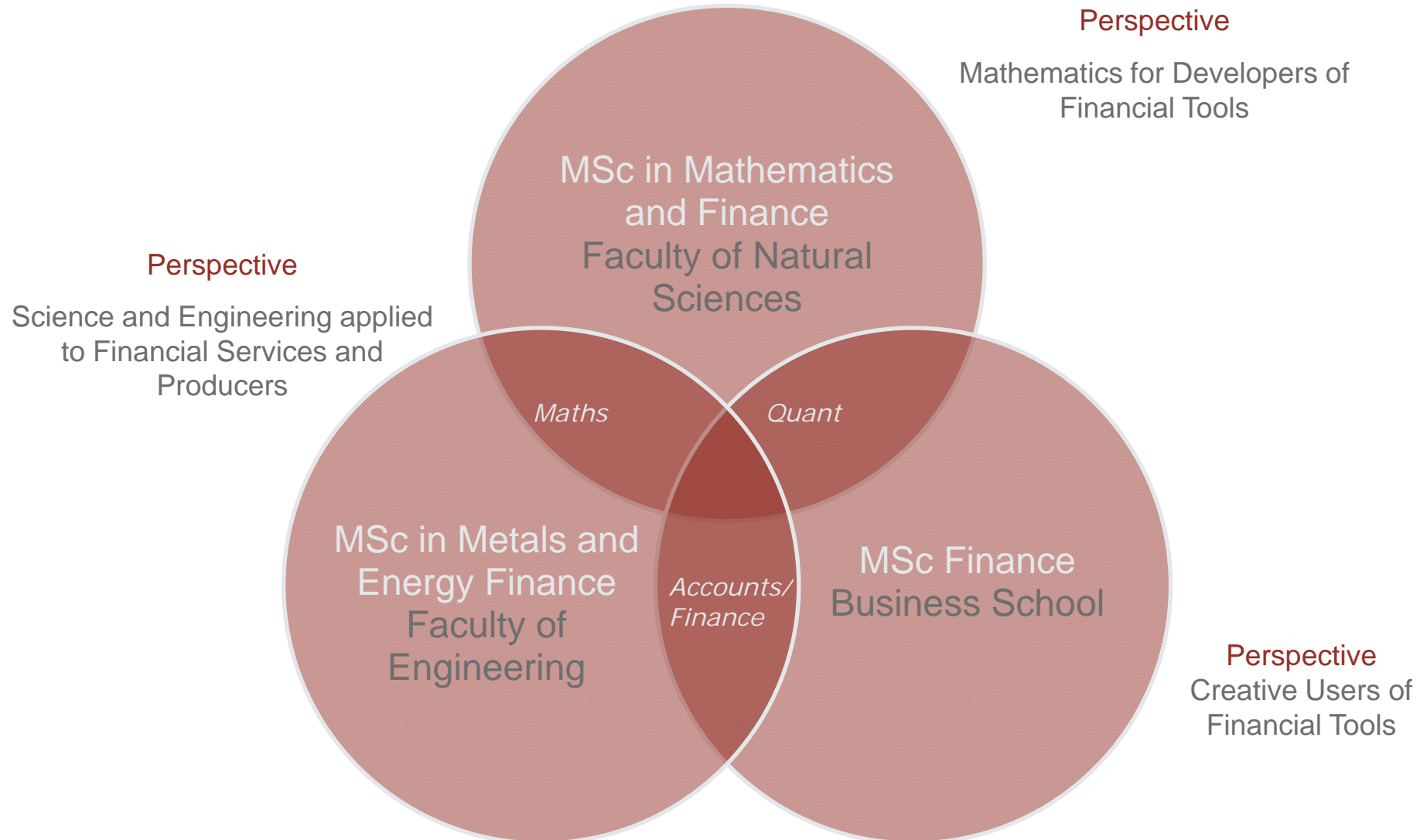
4th in Europe and 9th in the world for engineering and technology

3rd in Europe and 10th in the world for life sciences

4th in Europe and 13th in the world for physical sciences

3rd in Europe and 4th in the world for clinical, pre-clinical and health

Finance teaching at Imperial College



Application of Real Option Analysis to mining projects - Employ the Black & Scholes option pricing model.

:The Base Case value	(PV of FCFF during the operational period)
■ The strike price	(PV of the development costs)
■ Volatility	(of the PV of FCFF during the operational period)
■ Time to expiration	(time after which the Project is developed i.e. 3 years)
■ The risk-free rate	(the yield on 3-year sovereign debt)

The Black & Scholes equation for a Call Option:

$$V = N(d_1) A - N(d_2) X e^{-rT}$$

Can be interpreted as follows:

$N(d_1) A$	the expected value of A if $A > X$ at Expiration
$N(d_2)$	risk-neutral probability of $A > X$ at Expiration
$X e^{-rT}$	the Present Value of the development costs

Where:

- V current value of Call Option
- A PV of the FCFF during the operational period
- X Costs of development
- r risk-free rate of return
- T time to expiration
- σ volatility of the PV of the FCFF during the operational period
- $N(d_1)$ & $N(d_2)$ are the value of the normal distribution at d_1 and d_2
- d_1 $[\ln(A/X) + (r + 0.5 \sigma^2) T] / \sigma T^{0.5}$
- d_2 $d_1 - \sigma T^{0.5}$

The Black & Scholes model (1970) - a Nobel Prize winning model



Myron Scholes (Stanford) receiving his Nobel Prize for Economics in Stockholm

Myron Scholes & Robert C Merton were awarded the Nobel Prize for Economics in 1997

- Fischer Black passed away before the announcement of the Nobel Prize award
- Robert Merton (Harvard) adjusted the Black & Scholes model to take into account dividends
- Merton's work meant that the Black & Scholes model could be adjusted to value equities and other dividend bearing securities

William Sharpe (Nobel laureate for his work on the Capital Asset Pricing Model), said of the Black & Scholes Formula "Corporate strategists use the theory to evaluate business decisions; bond analysts use it to value risky debt; regulators use it to value deposit insurance; wildcatters use it to value exploration leases"

Financial Crisis not an Economic Crisis



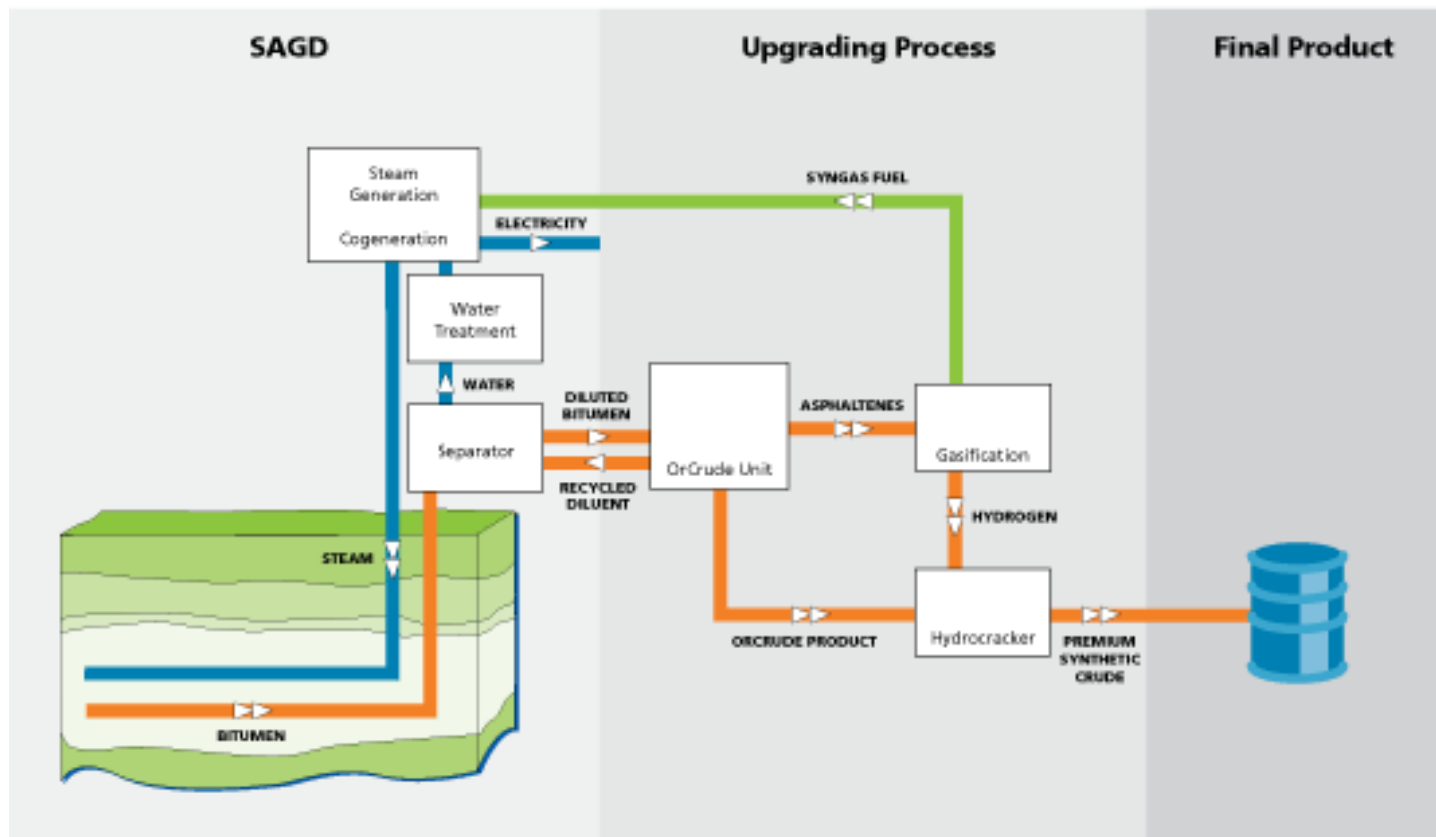
Lehman Brothers Office Canary Wharf – 15 September 2008



Athabasca Oil Sands – Convergence between petroleum and mining



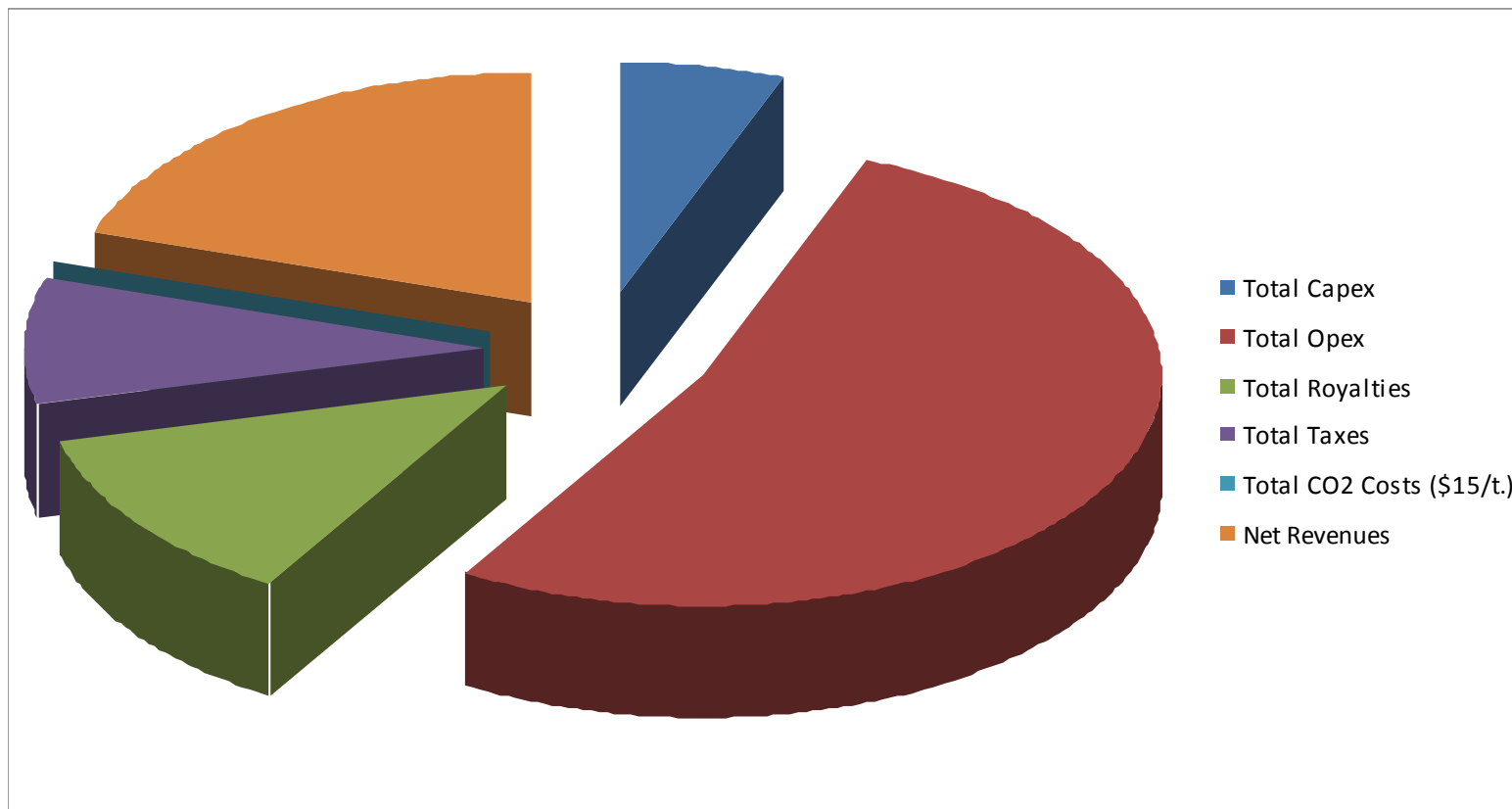
Base Case Oil Sands Financial Model Steam-Assisted Gravity Drainage



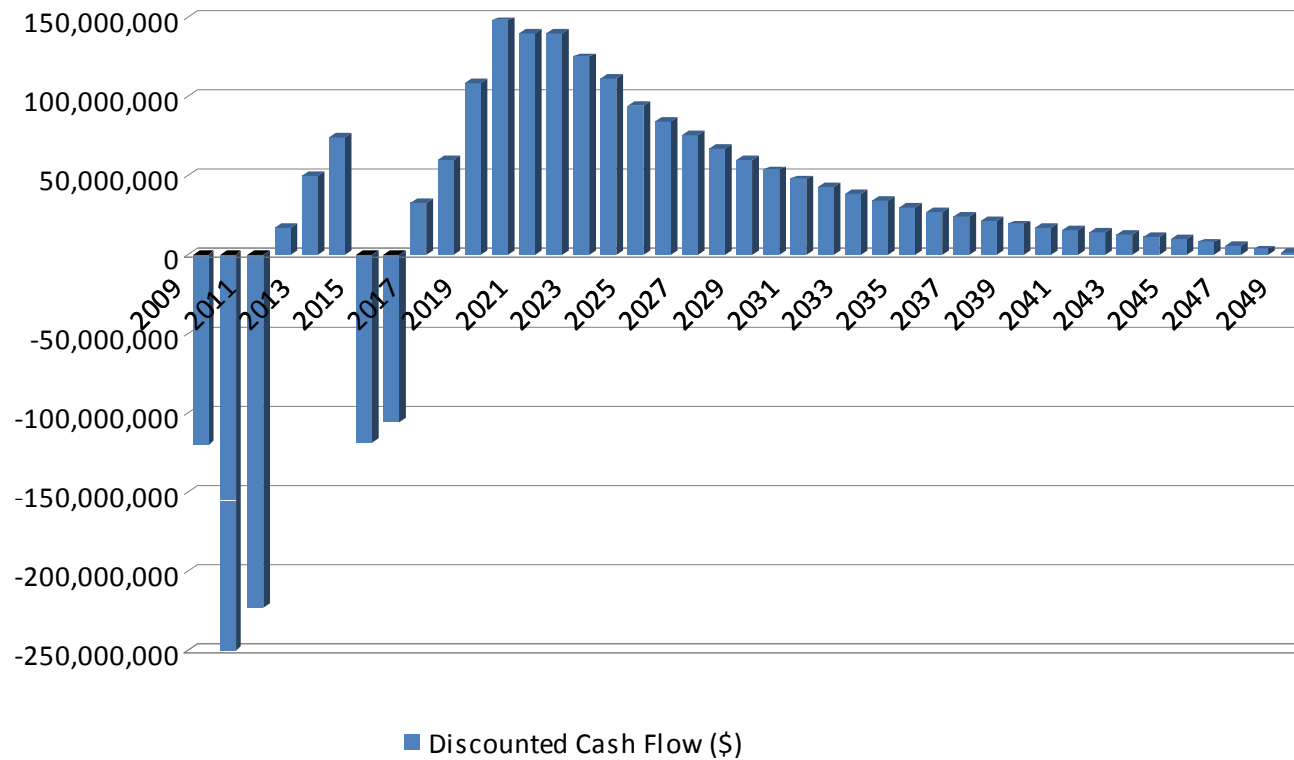
Base Case Oil Sands Financial Model Steam-Assisted Gravity Drainage

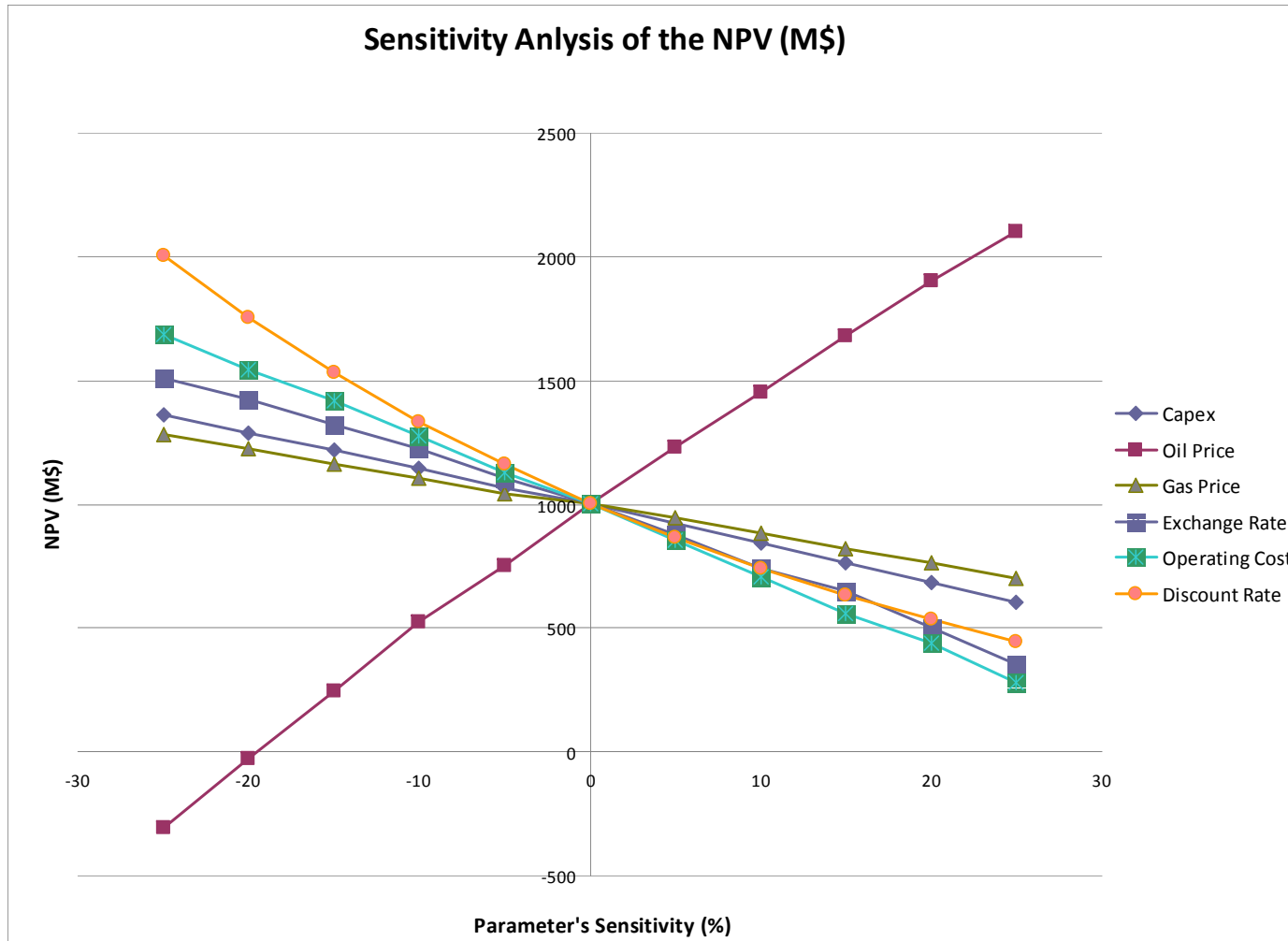
- To extract bitumen at a depth between 400 and 800 metres below the surface.
- Each barrel of extracted bitumen will be upgraded into a barrel of SCO (Synthetic Crude Oil) Start of Phase 1: construction period of 3 years from 2009 to 2011
- First oil production in 2012
- Phase 1 completed in 2014 with first peak oil production of 25,000bpd in 2015
- Start of Phase 2 in 2015
- Increase of production capacity from 2015 to 2022
- Phase 2 completed in 2019 with final peak oil production of 100,000bpd in 2022
- Plateau reached from 2022 to 2045
- Decline of production in 2046
- End of production in late 2049

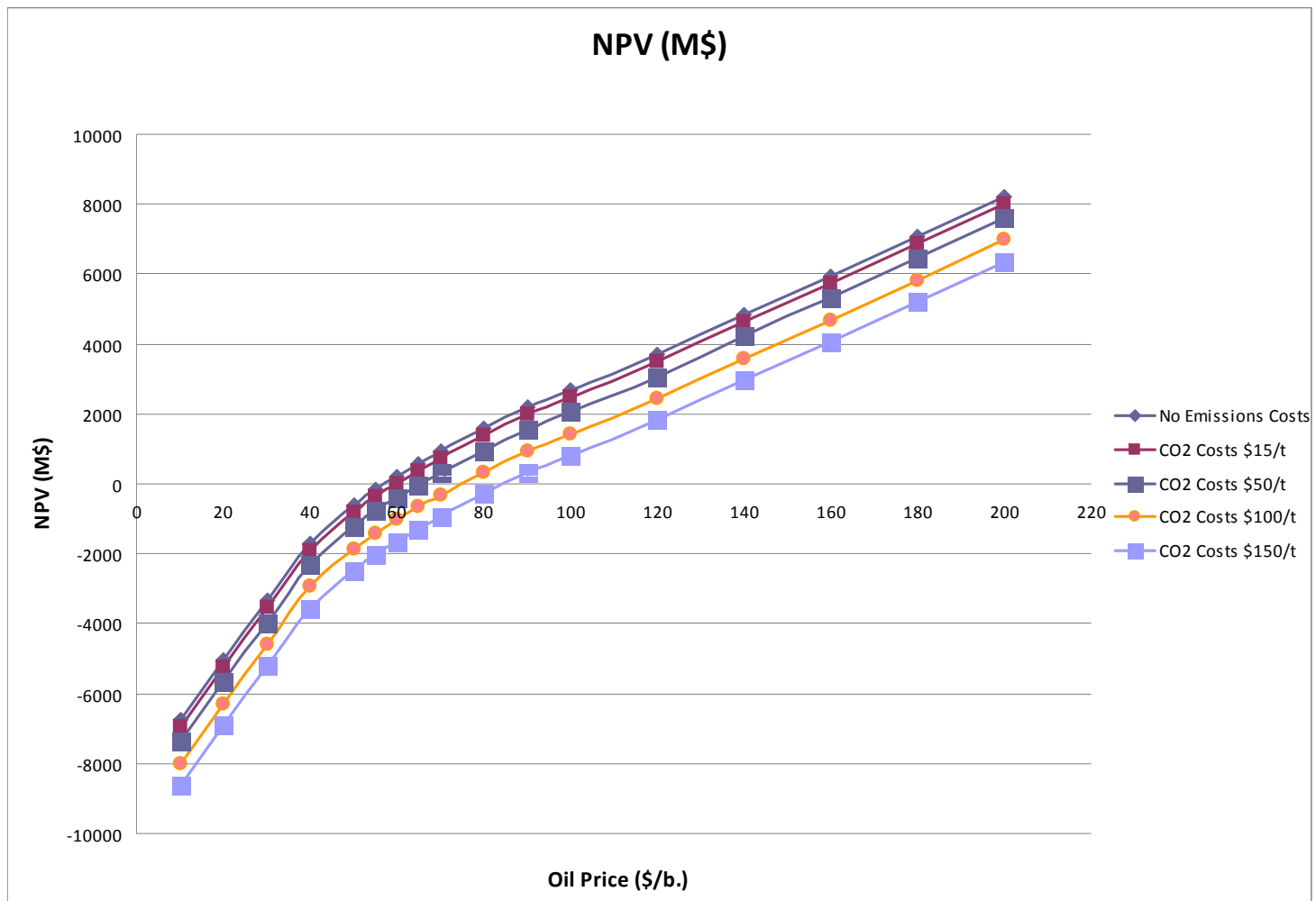
At a Discount Rate of 12%, a constant oil price of \$71 per barrel and a constant gas price of \$9.46 per Mcf), we get a total Net Present Value of \$1,005,000,000 and an Internal Rate of Return of 20%.



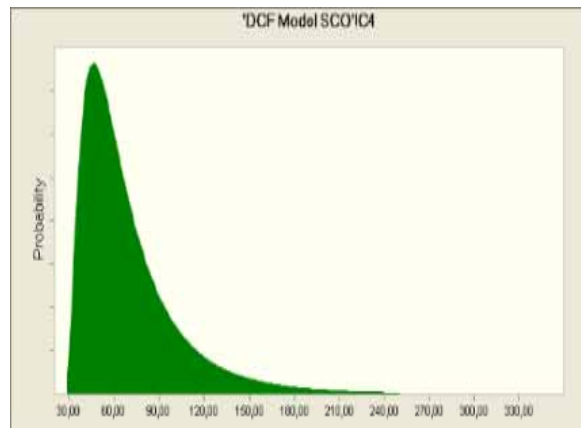
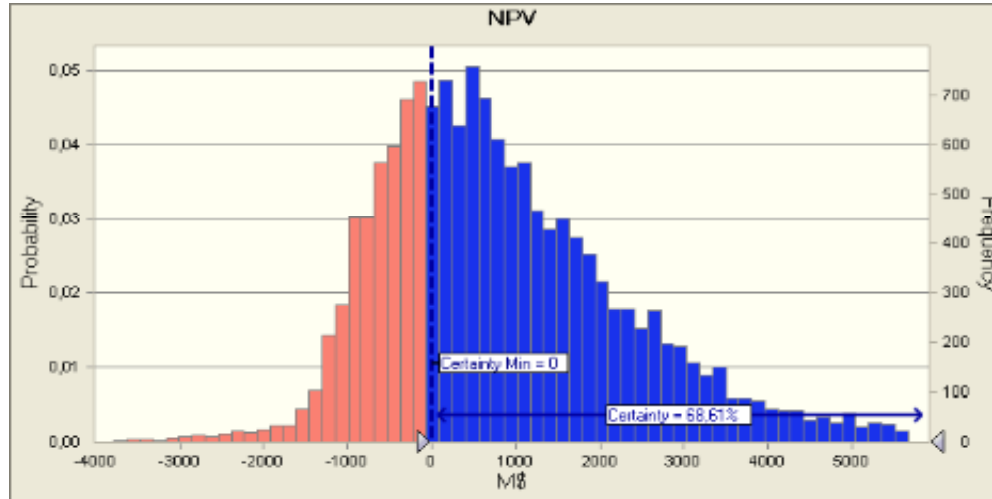
Discounted Cash Flow (\$)







Real Option Valuation



Lognormal distribution of oil price
Mean of \$71, SD of 37.7

Time Delay (y)	Real Option Value (M\$)	NPV (M\$)
0	1,005	1,005
2	1,147	898
3	1,203	716
5	1,096	570

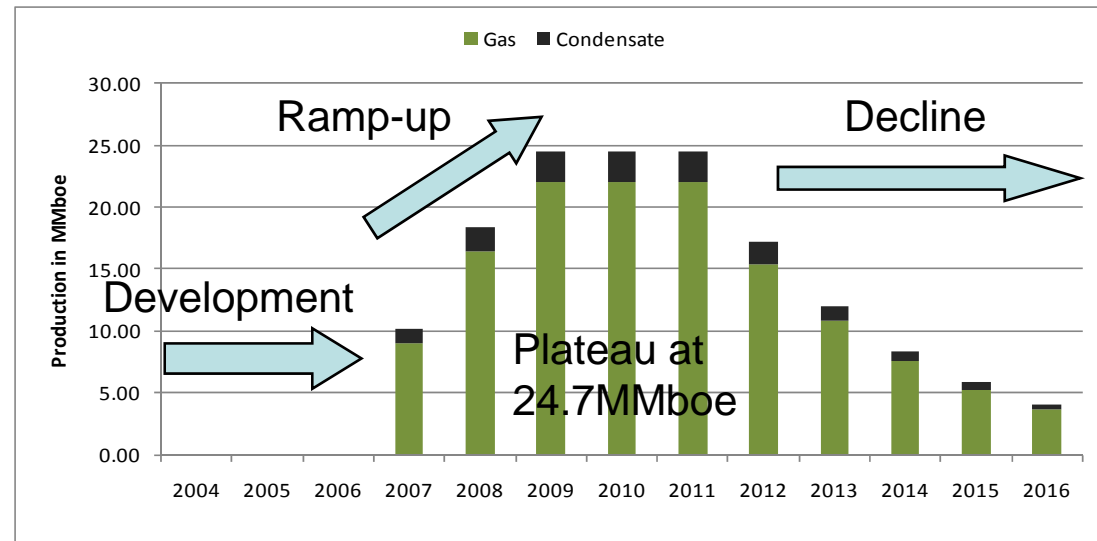
Relevance ?

Paper delivered in 2010 to a Conference of Petroleum Engineers in Canary Wharf to universal incomprehension – but requests to learn more when geographical location of Lehman Brothers offices and links explained. Role of quantitative finance in society.

Assumptions of the PSC (II)

Profile of Production
Phases I & II
(estimated at the wellhead)

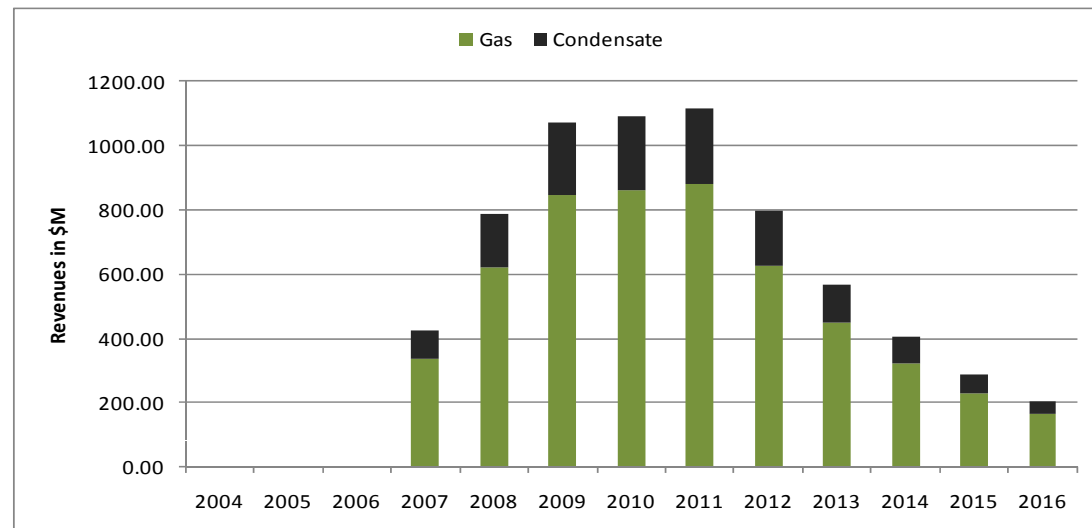
10% from condensate
90% from gas



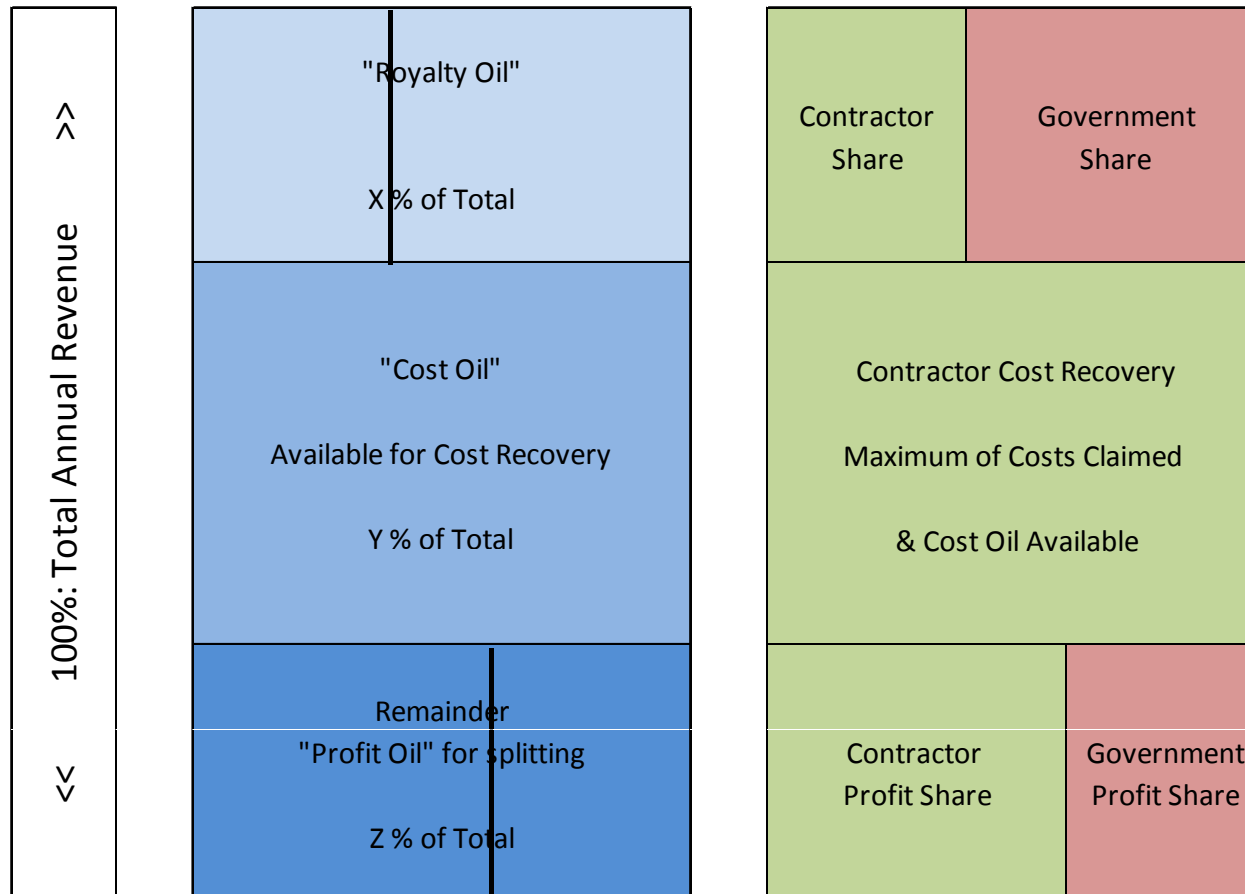
Inflated Gross Revenues
(after 2% of inflation)

Based on US\$80/boe
and US\$6/MMbtu of gas,
US\$6.75 of gross revenues

21% from condensate
79% from gas



Production Sharing Contracts – Fiscal Modelling





Energy Projects

Coal is a low value (\$80/tonne) commodity so any project has to be large-scale to stand any chance of commercial viability. Total SA Coal Exports – 61MT (worth \$4.9B). Same principle for industrial minerals (iron ore)

Coal NYMEX Price
82.85 USD/mt
5 Aug '11



Kleinkopje loading
facility – role of
infrastructure key
to successful coal
projects (and iron
ore)



Surface mining has a potentially
large environmental impact –
Footprint of actual mining
relatively small when integrated
with rehabilitation

Visits and Contribution

Planning – September 2013

Teaching – April 2014

Follow-up – September 2014

Discussions aimed at examining the merits of integrating the traditional teaching of mineral and petroleum geoscience in the Faculty of Geology with the skills that are available through the Department of Economics at Madrid. The purpose was to consider the merits of launching a new postgraduate degree in **Extractive Industry Finance** which would cover basic concepts central to the field of natural resources and finance.

Financial Crisis not an Economic Crisis

*Major changes in the international mining and petroleum industries over the last decade have significantly increased the demand for professionals with skills that blend **technical and financial engineering** with a business perspective. Post the 2008 international financial crisis and the more recent euro financial crisis, there is also a universal perception among young graduates that complex financial products have real relevance to society. It was the failure of investment banks themselves to understand the risk inherent in the quantitative tools they had developed which is now also creating career opportunities for graduates with sound mathematical skills.*

Technical and Financial Engineering

The Institute of Material, Minerals & Mining (IoM3) who act for the UK Engineering Council so that graduates qualify for CEng (Chartered Engineer). The panel were in the Department in March and will be recommending that the Engineering Council be approached to have the MSc in Metals & Energy Finance be accredited. Future graduates will therefore meet a key academic requirement needed to be registered as Chartered Engineers. Reciprocation allows registration as a European Engineer (EUR ING).

Course Weighting: MSc Metals and Energy Finance

Examinations (43%)	Management & Business Examination Module
	Accounting paper (2 hours)
	Management of Projects, Markets & Supplies, Strategic Management paper (3 hours)
	Petroleum & Mineral Geoscience Examination Module
	Mineral Deposits (2 hours)
	Petroleum Geology and Engineering papers(2 hours)
	Project Evaluation Examination Module
	Metals & Energy Project Appraisal and Finance, Resource Evaluation paper (2 hours)
	Mining Engineering. Extractive Metallurgy paper (2 hours)
	Quantitative Finance Examination Module
	Asset Pricing and Derivatives paper (3 hours).
	Investment and Portfolio Management 2 paper (3 hours)
	Mathematical Techniques in Finance paper (3 hours)

Delivery is undertaken within a formal academic structure which requires careful reconciliation with the Bologna Process and the European Credit Transfer System(ECTS) in which the degree generates a minimum of 90 points needed for a European MSc.

Language and Excursions (26%)	Language Module
	Choice of Spanish, French or Italian. Assessment through a Viva voce, coursework and test
	Excursion to Wessex and South Africa Course Work Module
	Field exposure to petroleum systems and active energy and metal operations. Write-up presented in two extended reports
Dissertation Module (31%)	Independent research undertaken over 10 weeks during the summer

Magister in Extractive Industry Finance

“Magister” degree which permits a Faculty to deliver a postgraduate vocational qualification which does not entitle the graduate to proceed to a PhD. The Master of Business Administration qualification awarded by the Faculty of Economics falls into this category. The Magister degree has two significant advantages over the Masters degree. The approval process is faster and the Faculty delivering the programme is not restricted to charging a fee of Euro 4,000, but whatever the market will bear. Furthermore, provided the syllabus justifies assigning 90 ECTS points, this would be the equivalent of an MSc at, say, Imperial College. There would be no restriction of graduates being able to proceed to a PhD if they so wished.

MSc Metals & Energy Finance 2014/2015 Fees : £30,000 (overseas) and £18,000 (Home EU) = Euro 38,100 and 22,875 respectively.

Magister in Extractive Industry Finance - Academic Resources and Programme Design

The Faculty of Economics has formidable resources through the 400 members of the academic staff. Their division of Applied Economics would be able to deliver all the financial courses needed for a credible degree in extractive industry finance. If the proposed Magister in Extractive Industry Finance were a combined Faculty of Geology and Faculty of Economics programme, this would offer wide appeal. Graduates from the programme with first degrees in science and engineering are likely to give emphasis in a CV on the role of the Faculty of Economics, while those with a first degree in economics will take the contrary view. For promotion as a joint degree to have credibility the Faculty of Economics would need to deliver at least 25% of the total teaching contact hours.

Magister in Extractive Industry Finance - Academic Resources and Programme Design

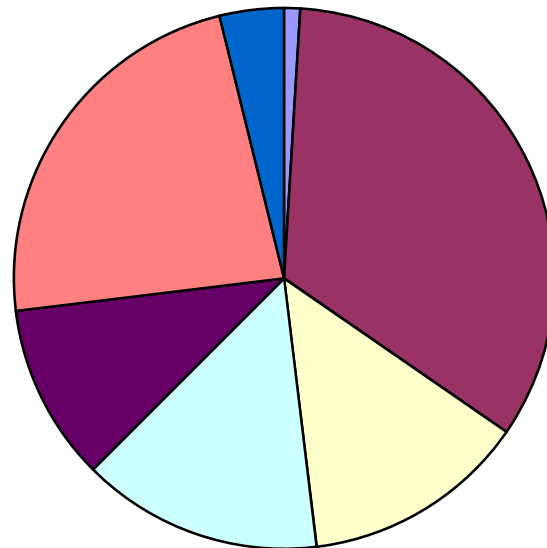
Entry qualifications for students on the course would need to include basic mathematical literacy. A sound science background at least up to final school leaving is necessary but admission policy should consider accepting graduates with finance or economics degrees provided they have good mathematics. This of course implies that basic concepts in earth science will need to be covered.

Magister in Extractive Industry Finance - Academic Resources and Programme Design

The Faculty of Geology would need to deliver core courses in mineral deposits studies and petroleum geoscience and this capability already exists. Fundamental to any qualification in the field of extractive industry finance is the recognition that the primary asset is a natural resource. Innovative conventional and financial engineering will not create a mineral or petroleum resource that has not originated through natural processes.

Placements in January 2014 of MSc M&E Finance Graduates

Employment & Recruitment by Sector as at Jan 2014 Analysis of 73 Organisations



- International Development
- Financial Services
- Mining, Metals & Quarry Industry
- Petroleum Industry
- Energy and Utilities
- Consultants & Accountants
- University MSc, PhD, Post doc & Faculty

MSc M&E Finance Graduate First Placements –Financial Services (Jan 2014)

- Altus Capital Ltd – Energy Policy Analyst (London)
- Appian Capital – Investment Associate (London)
- Barclays Capital – Commodities Trading (London)
- BMO Capital Markets – Analyst (London)
- BNP Paribas – Business Analyst and Structured Debt (Paris, Brussels and London)
- BTG Pactual – Risk Analysis (London)
- Central Bank of Niger - Analyst
- CIM Investment – Analyst (London)
- Citibank – Management Associate (Algeria and London)
- Commerzbank – Structured Interest Rates (London)
- Deutsche Bank – Financial Analyst (UAE)
- Elara Capital – Analyst (India)
- Grant Thornton – Corporate Finance (UAE)
- GMP Securities Europe LLP – Investment banking and Analyst (London)
- HSBC – Relationships (China)

MSc M&E Finance Graduate First Placements –Financial Services (Jan 2014)

- JP Morgan – Associate (London)
- Macquarie Group – Associate (London)
- Polygon Investment – Analyst (Paris) (Nicosia)
- Renaissance Capital – Financial Analyst
- Resource Capital Funds – Analyst (Denver Rabobank Group – Sales (London)
- Rabobank Group – Sales (London)
- Societe General – Interest Rates Structure (London) Global Head Mining Finance (Hong Kong)
- Sumitomo Mitsui Banking – Manager, Metals & Mining Project Finance (London)
- Tudor, Pickering, Hold & Co – Equity Research (London)
- UniTrust Finance & Leasing – Credit Analyst (China)
- WestLB – Director and Head of Credit (Sydney)

MSc M&E Finance Graduate First Placements – Mining, Metals & Quarry (Jan 2014)

- Alecto Minerals – Technical Manager (London)
- Allana Potash – Senior Geologist (Umea, Sweden)
- Anglo America – Market Analyst, iron ore (Luxembourg) Business Development (London)
- Asian Metal – Raw Materials Analyst (London)
- Barrick Gold Corporation – Exploration Geologist (Zambia)
- BHP Billiton – Junior Engineer (Johannesburg)
- Cluff Natural Resources – CFO (London)
- De Beers – Corporate Finance and Strategy Analyst (London)
- Glencore – Junior Engineer (Quebec)
- Rio Tinto – New Business Development (London)
- Rotherham Sand and Gravel – Manager (UK)
- Southern Peaks Mining – VP Business Development (Peru)

MSc M&E Finance Graduate First Placements – Petroleum Industry (Jan 2014)

- Antero Resources – Finance Director (Denver)
- BG Group – Commercial Advisor (Mumbai)
- BP – Finance Analyst (Azerbaijan)
- Exxon Mobil - Product Master Coordinator (Turkey)
- Shell – Senior Well Engineer (London)
- Sinopec – Research Analyst (China)
- Total – Strategy Engineer (Paris) Junior Reservoir Engineer (Qatar)
Drilling Engineer (Indonesia) Market Analyst (London) E&P Economist (UAE)
Economist (London) Risk Analyst (London)

MSc M&E Finance Graduate First Placements - Energy & Utilities (Jan 2014)

- Anthony Veder - Assistant
- Calash – Upstream Oil and Gas Analyst (London)
- Clean World Capital – Associated (London)
- Drax – Quantitative Commodity Analyst (UK)
- EDF – Risk Analyst (Paris) Risk Analyst Trading (London) Power Analyst (Paris)
- ESB International – Mechanical Engineer (London)
- GDF SUEZ Key Account Sales (France)
- Moroccan Agency for Solar Energy – Technical and Financial Advisor (Morocco)

MSc M&E Finance Graduate First Placements – Consultants, Advisors and Accountants (Jan 2014)

- AWR Lloyd Capital – Investment Analyst Mining (London)
- Bayphase – Senior Consultant (London)
- Booz & Co – Consultant (UAE)
- CGGVeritas – Party Manager (France)
- CRU – Research Analyst Nickel & Ferrochromium (London) 2x Research Analysts (London)
- Equinox Consulting – Consultant (Paris)
- EY – Junior Consultant (Paris) Junior Transaction Advisor (Paris)
- Independent Project Analysis – Analyst (UK)
- Insight Consulting – Analyst (London) Business Consultant (Surrey)
- Mazars – Transaction Support and Corporate Advisory (London)
- NAPIMS – Petroleum Economist (Nigeria)
- Schlumberger – Field Engineer (Italy) General Completions Engineer (Indonesia) Business Analyst (London)

MSc M&E Finance Graduate First Placements – Consultants, Advisors and Accountants (Jan 2014)

- SML Group – Financial Analyst (London)
- Strand Partners – Intern (London)
- Wood Mackenzie - Energy Markets Analyst (Houston, Texas) Metals Research Analyst (London) Copper Analyst (London)
- Xodus – Commercial Consultant (London)

Launch Strategy

Once the programme structure and content have been defined it is likely to be advantageous to seek endorsement by potential employers of the graduates. If the intention is to provide career opportunities in the investment banking sector, new business development of the petroleum and mining companies and consulting firms, then obvious targets would be the Santander Group (the largest bank in the Eurozone) and BBVA (a multinational Spanish banking group) REPSOL and CEPSA (Spanish multinational oil companies), BP, Schlumberger (an oil field services company) and Lundin Mining that operate the Aguablanca nickel/copper mine north of Seville.

Questions?



Newman Shaft LONMIN Platinum