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100 YEARS

SPE Introduction to E&P

Petroleum Economics & Commercial

November 28th, 2019

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Table of Content

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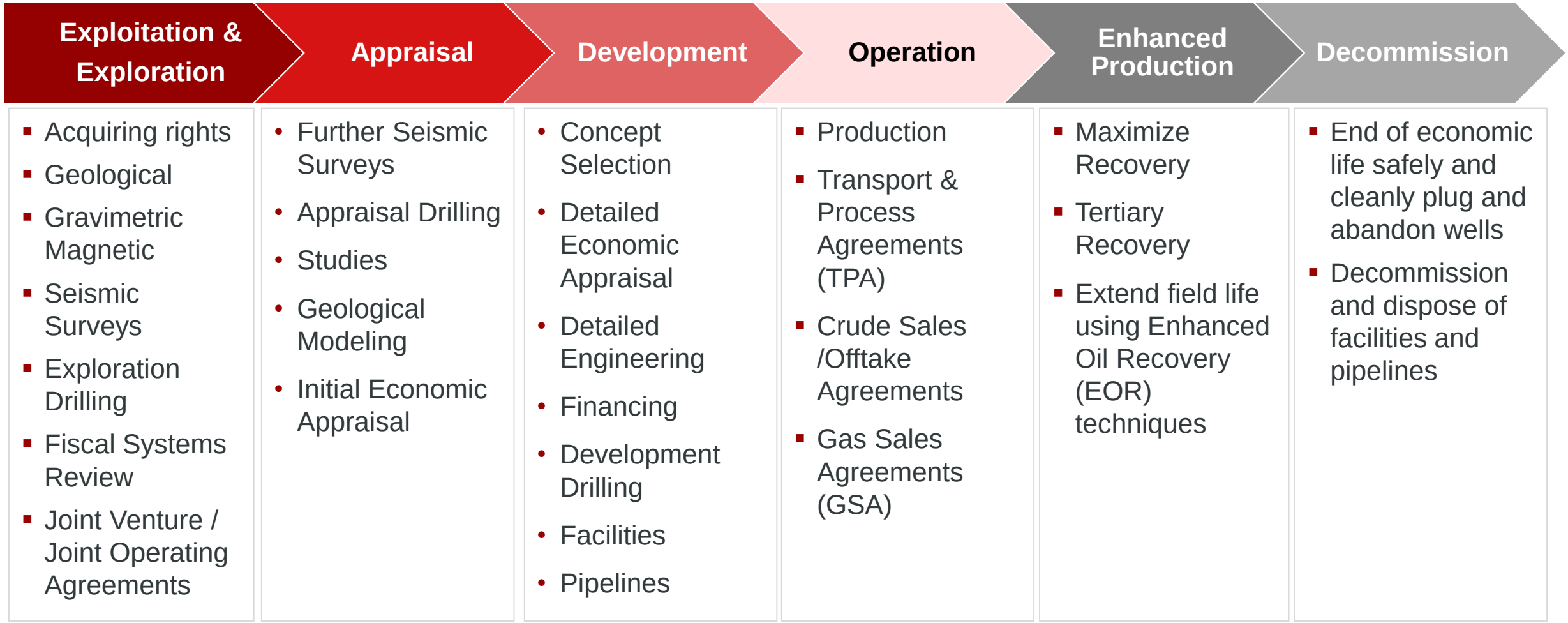
Introduction

Overview of the E&P Life Cycle

- The activities within the E&P lifecycle all require analysis and decision making utilizing Petroleum Economics & Commercial analysis tools



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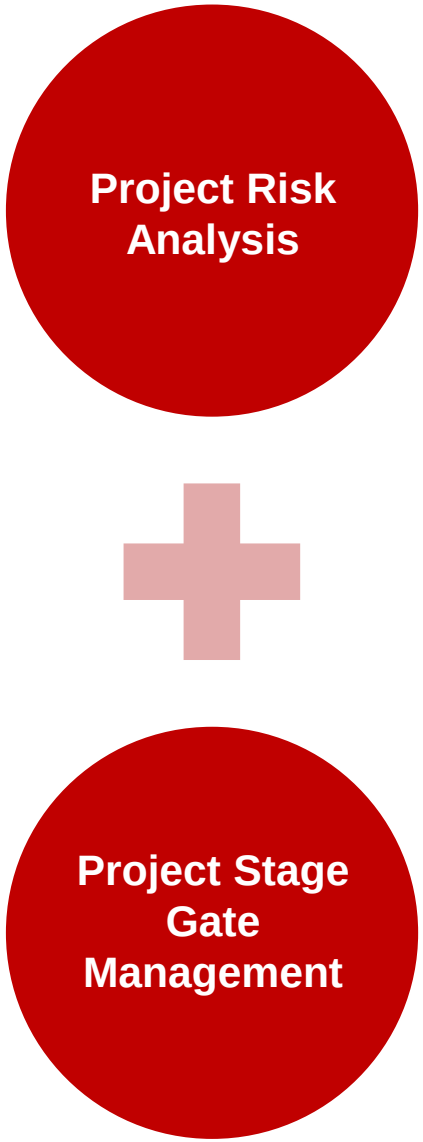
Why Petroleum Economics is Necessary



- Field Development Plans (FDPs) : To assess the inherent E&P project and decision risks
- Final Investment Decisions (FIDs) : To make informed decisions on how to efficiently allocate scarce resources
- M&A activities : To evaluate investment returns
- Statutory & Regulatory Requirements : To make submissions to SEC and facilitate IPO listing
- License Round Participation : To grow E&P portfolio organically

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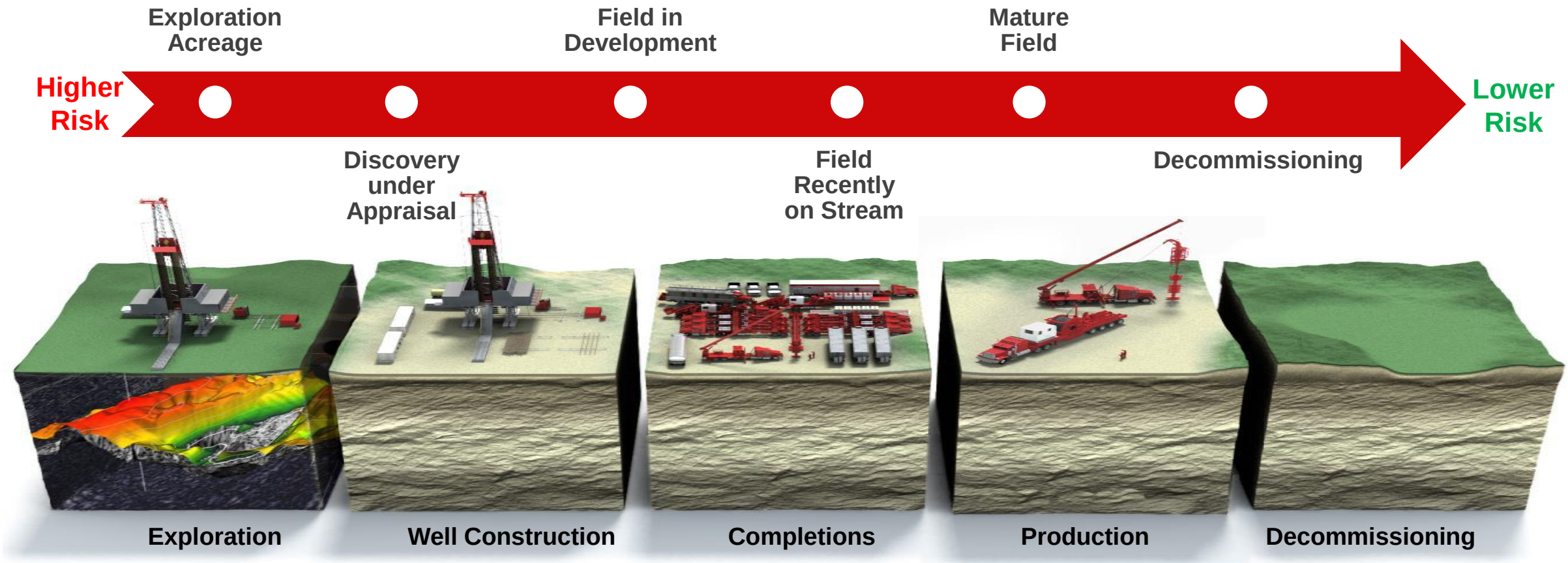
E&P Project Risk Lifecycle



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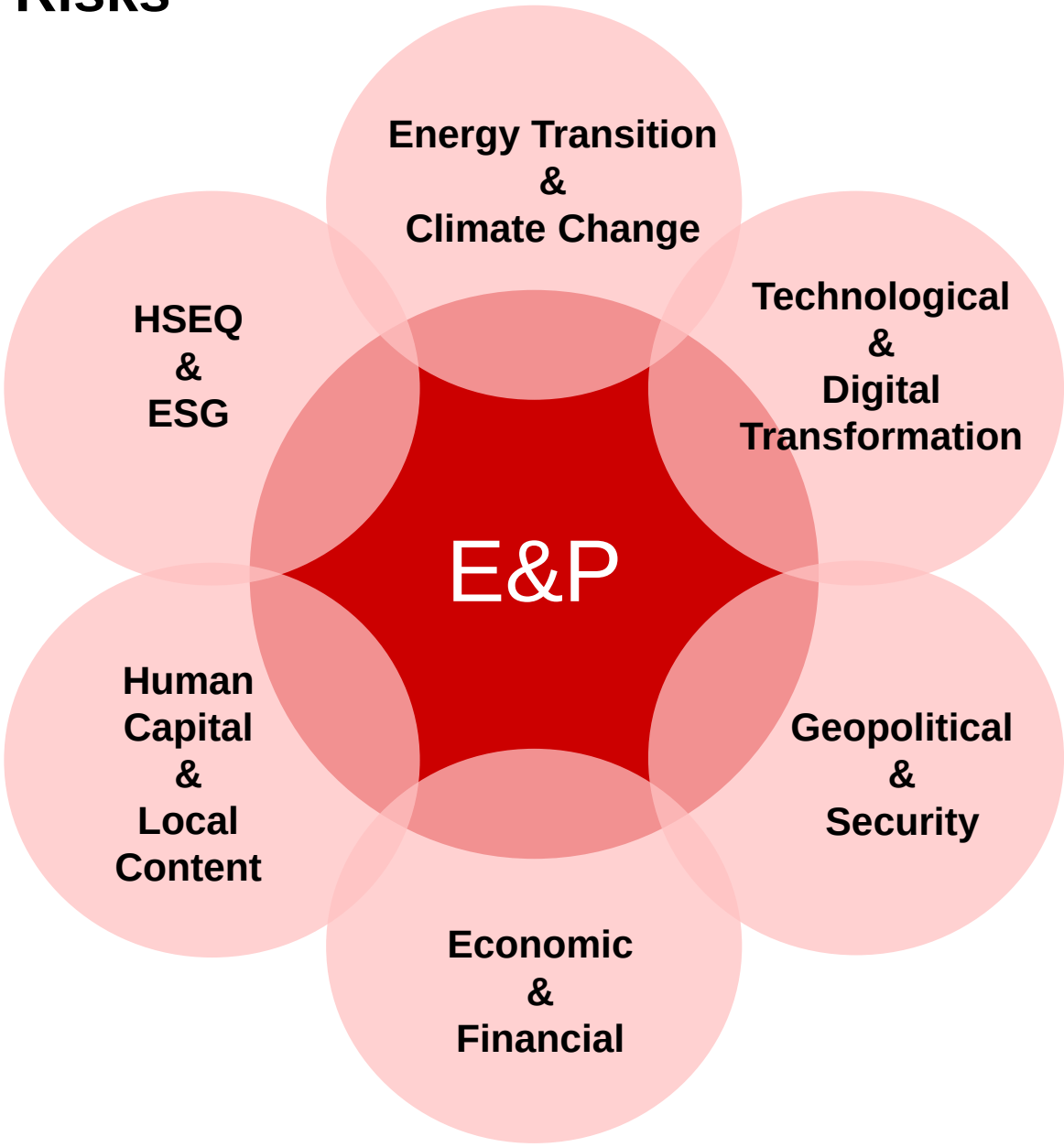
E&P Above Ground Risks



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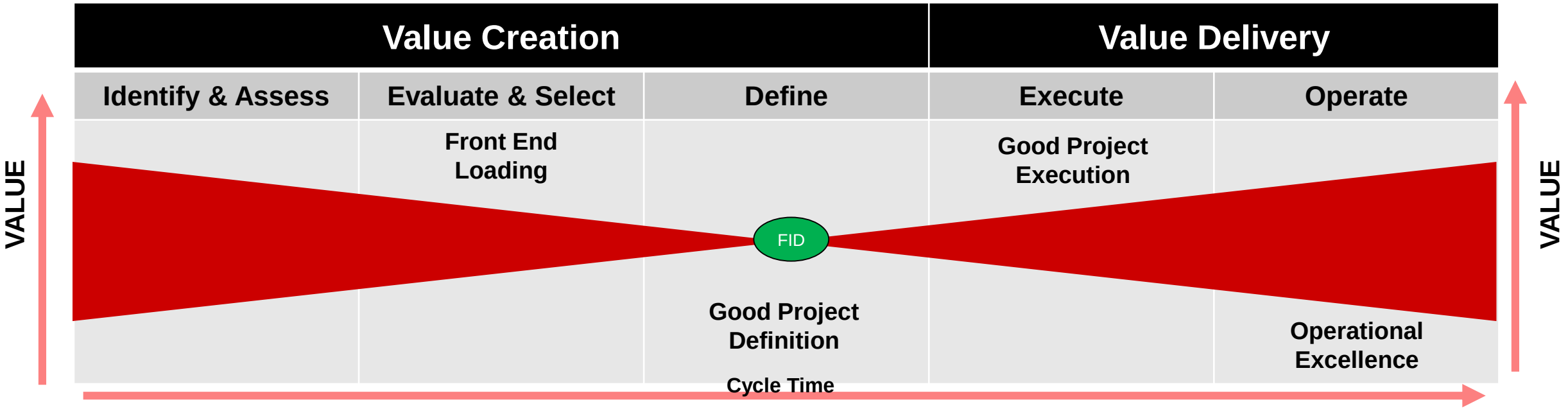
Project Stage Gate Process



Identify and Asses opportunity

Check fit with business strategy

Verify potential viability

Create Project Charter

Plan for Evaluate & Select phase

Most important phase

Identify, Evaluate & Rank multiple alternatives

Verify technical, commercial, economical viability

Verify alignment with business strategy

Select single “best” alternative

Plan for Define phase

Optimise selected alternative & plan execution

Basis for Design

Project Specification

Develop risk mitigation plan

Define KPIs

Develop project execution plan (PEP)

Detail Design and Execute project

Procure, construct, commission.

Track Project Performance

Verify readiness for Operations & pre-Start-up

Operate

Project close out

Project review (lessons learned)

Verify operating performance

Verify value realization

Maintain & optimize the system to maximise value

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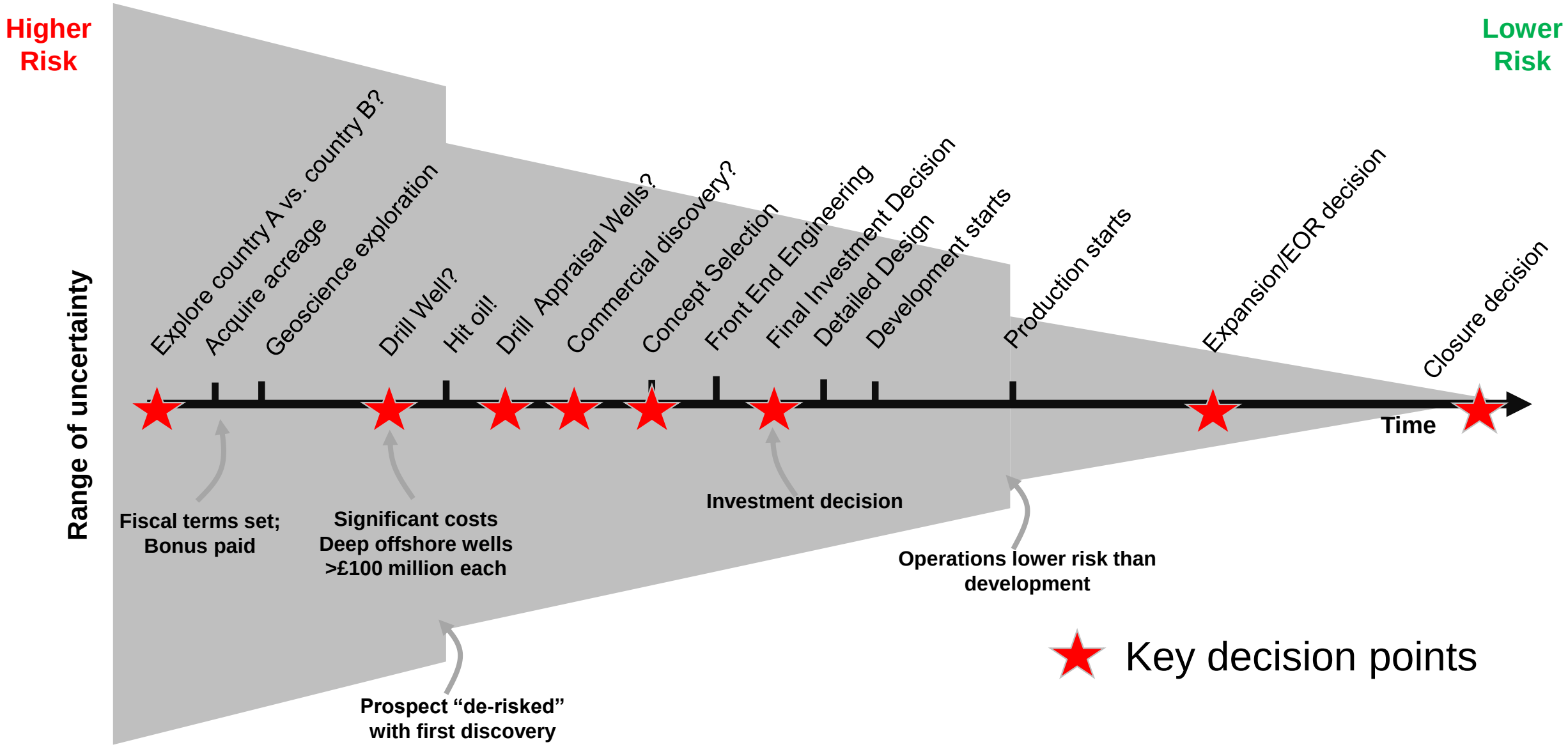
E&P Key Financial Decision Making Points



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Key Concepts in Petroleum Economics

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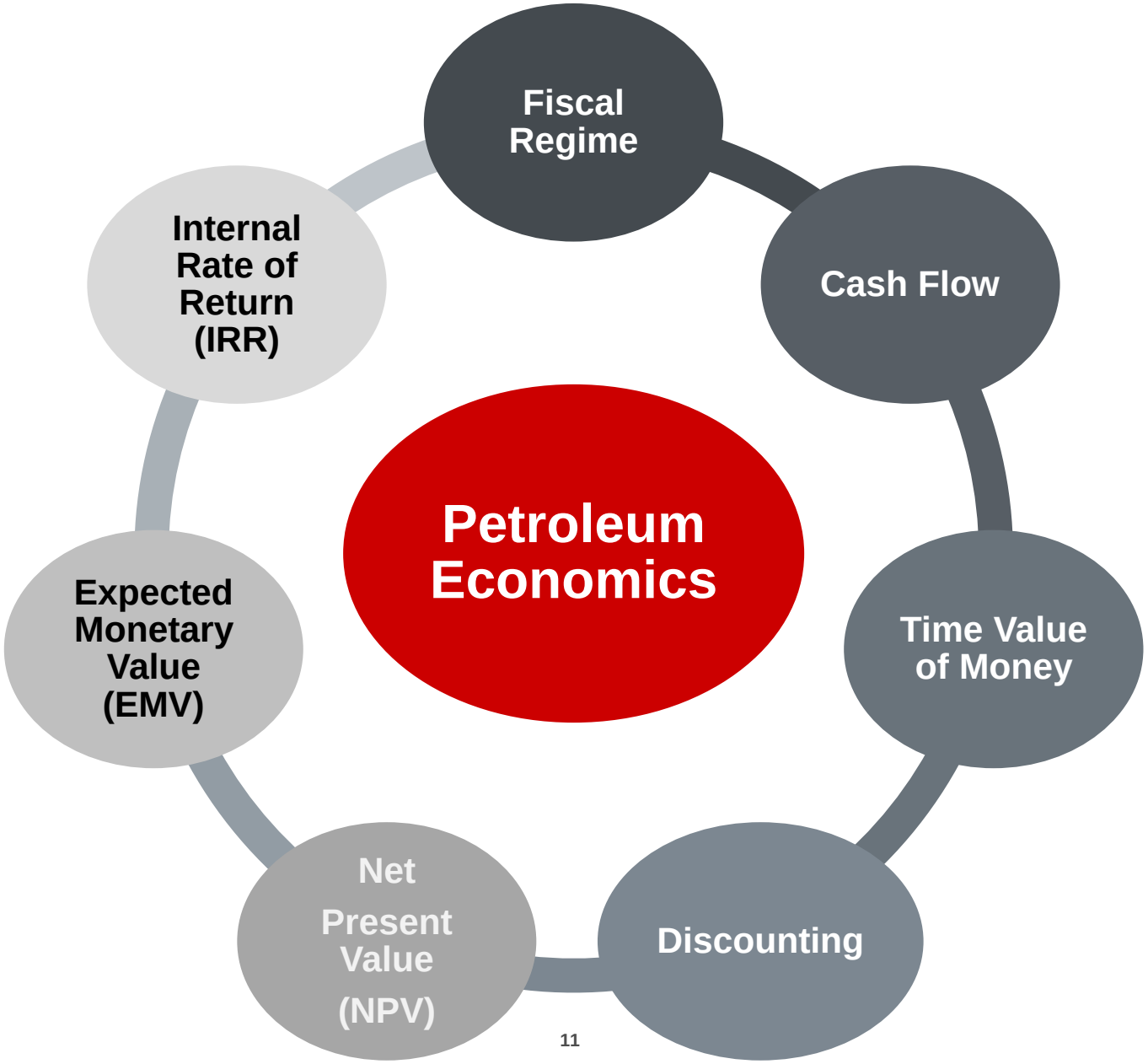
Key Petroleum Economics Concepts



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Fiscal Regime/Systems: Government Take

- Government take is the revenue that the sovereign state earns from an oil and gas asset.
- There are three main types of oil & gas fiscal systems/regimes around the world.

	Tax/Royalty Agreements (Concessions)	Production Sharing Agreements (PSA) / Production Sharing Contracts (PSC)	Service Agreements / Service Contracts (RSC, TSA, PEC)
Royalty	✓	✓	As per Heads of Terms Agreement.
Tax	✓	✓	
Corporate Tax	✓	✓	
Special Petroleum Taxes (PRRT, PPT, PRT etc.)	✓	✓	
Fees & Signature Bonuses		✓	
Profit / Production Share		✓	
Other		✓	

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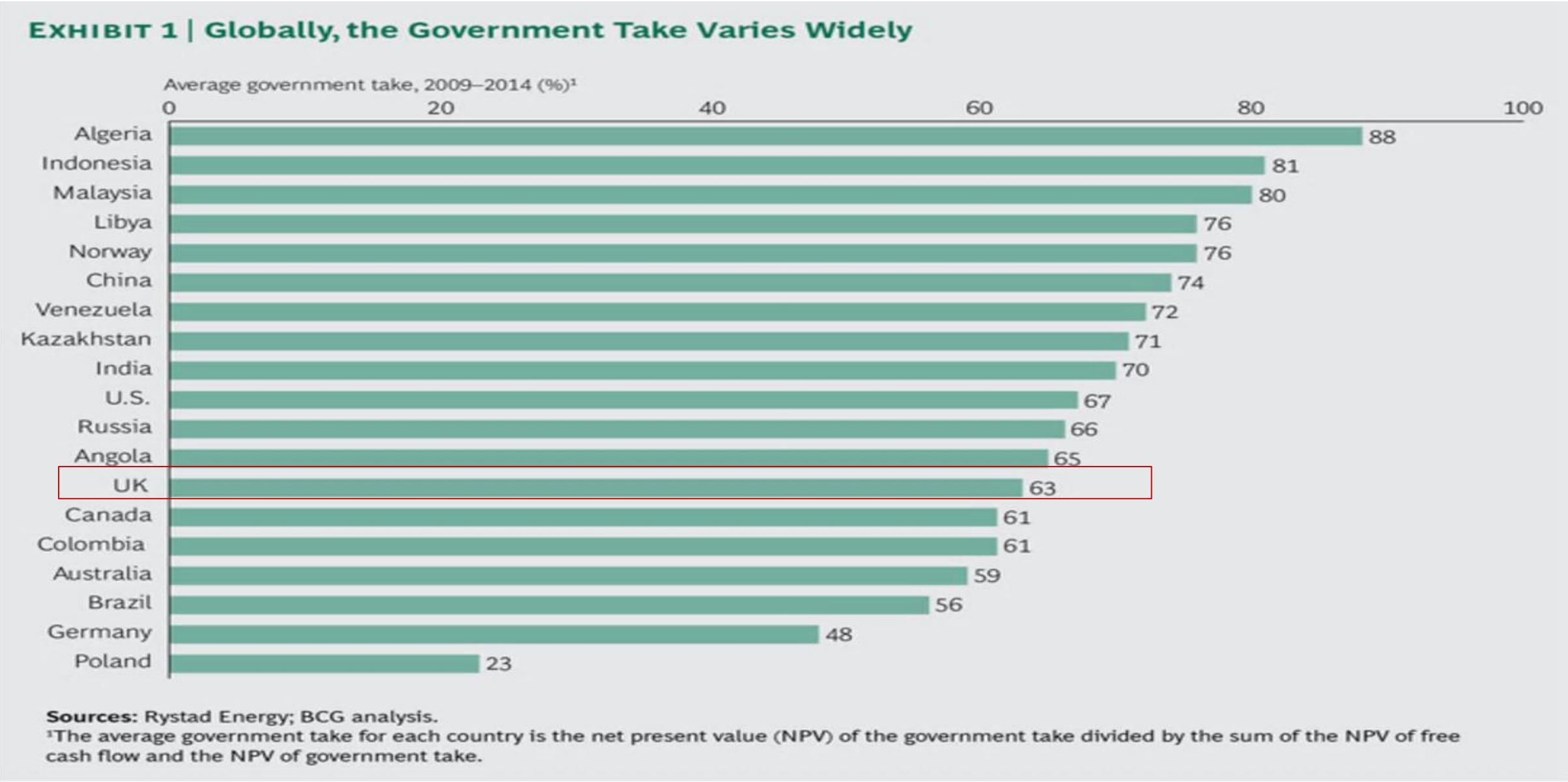
Government Take Examples



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Fiscal Regime/Systems: Resource Entitlement & Recognition

Contract Type	Ownership	Payment	Reserves Recognition
Concession	Contractor/Oil Company	In Kind	Yes
Joint Venture	Contractor/Oil Company	In Kind	Yes
Production Sharing	Contractor/Oil Company	In Kind	Yes
Revenue Sharing	State/Government	Share of Revenue	Yes
Risked Service	State/Government	Fee-Based	Likely*
Pure Service	State/Government	Fee-Based	No
Purchase	State/Government	Product Cost	No
Loan	State/Government	Interest	No

* If the contractor is exposed to capital risk and or market risk

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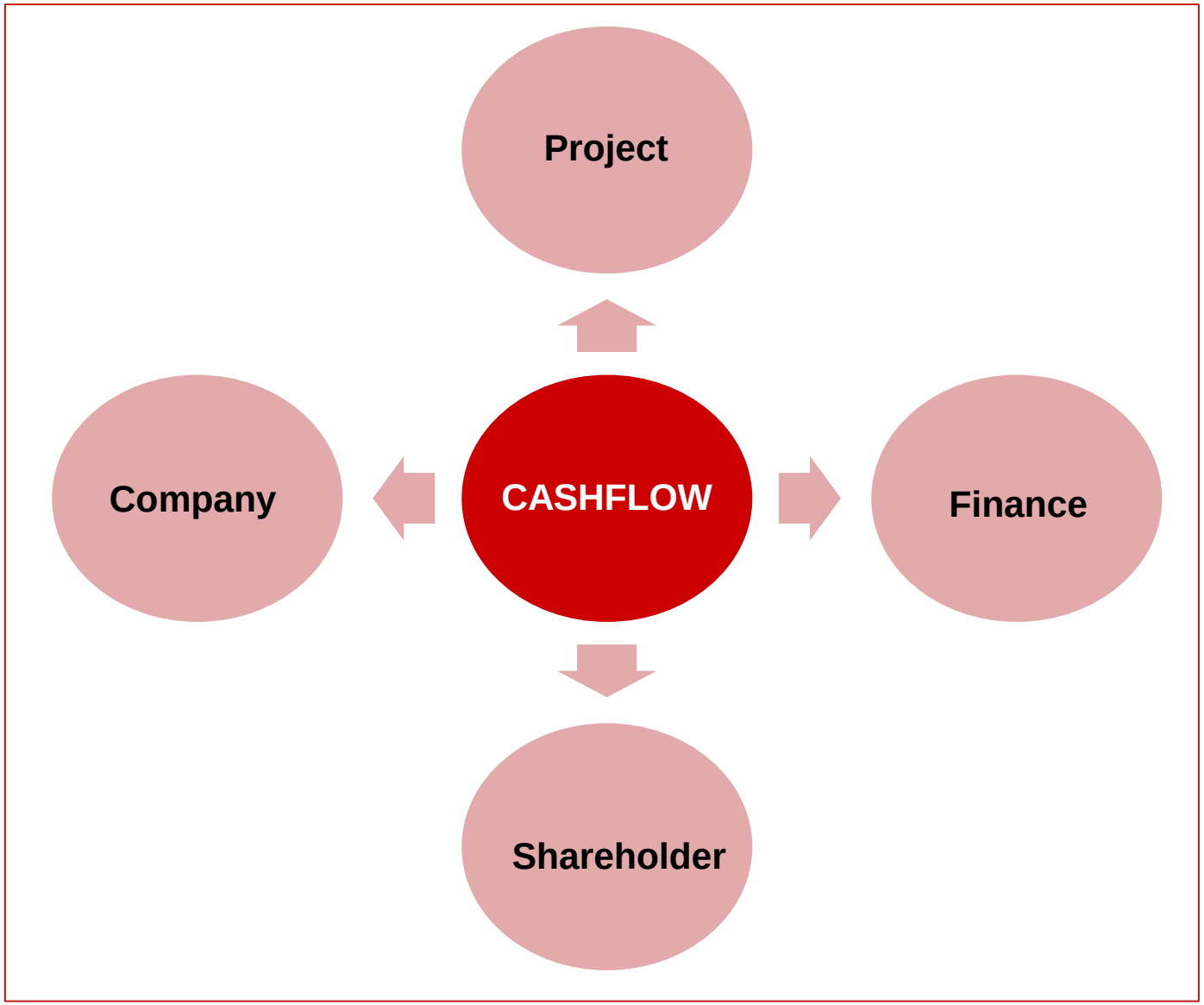
Cashflow

- Petroleum economic evaluation is based on the use of Cashflow analysis or Discounted Cash Flow analysis (DCF).
- Cashflow measures the movement (inflow and outflow) of money in discrete time periods.
- **But**, we need to be clear on whose Cashflow we measure – *The Project, The Company, The Lender, The Shareholder?*



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Time Value of Money

- A Dollar (or Rupiah or Pounds or any unit of currency) is worth more today than it is tomorrow. This is known as the **Time Value of Money.**

- While there are a number of methods and techniques employed in the economic analysis of opportunities, the **Discounted Cash Flow** (DCF) is by far the most common.

- Present Value (PV) = Future Value (FV) * **Discount Factor**
  - Discount Factor = $1/(1+r)^n$
    - Where:
      - r = Discount Rate
      - n = Time Period

- Discount rate adjusts time value of money ("risk-free" investments) and systematic risk

Discounting - Discount Factor

- Discounting is the opposite of interest.
  - Put $100 in a bank and it will appreciate over time. Thus, at 10% interest, $110 next year is worth $100 today.

- Discount Factor depends upon timing, i.e. Start of year or Mid-year or End of year.

- Time value is relative to discount start date, e.g.

The Discount Factor in the First Year of a Project			
Discount Rate	**Start Year**	**Mid Year**	**End Year**
10%	1.0	1/(1 + .10) ^ 0.5	1/(1 + .10)
15%	1.0	1/(1 + .15) ^ 0.5	1/(1 + .15)

Values for subsequent years are calculated by dividing the previous factors by 1/(1.10) and 1/(1.15) respectively

Discounting - Cost of Capital

- The discount rate used in evaluating an investment should be appropriate to the risk of the PROJECT, not the company.
- Discount rates should only account for market (or systematic) risk, not idiosyncratic (unsystematic or specific) risk.
- When is a risk "market" or "systematic", and when is it "specific" or “unsystematic”?
  - Exploration vs. Development vs. Production
  - Oil vs. Gas
  - Working interest vs. Revenue interest
  - Upstream vs. Midstream vs. Downstream
  - Country A vs. Country B vs. Country C
  - Leveraged vs. Equity

Industry Value Chain	Activity	Typical Discount Rates
Upstream	Exploration	15% - 20%
Upstream	Production	10% - 15%
Midstream	Power	8% - 12%
Midstream	Pipelines	8% - 12%
Midstream	Petrochemicals	12% - 18%
Refining & Marketing	Refining	12% - 18%

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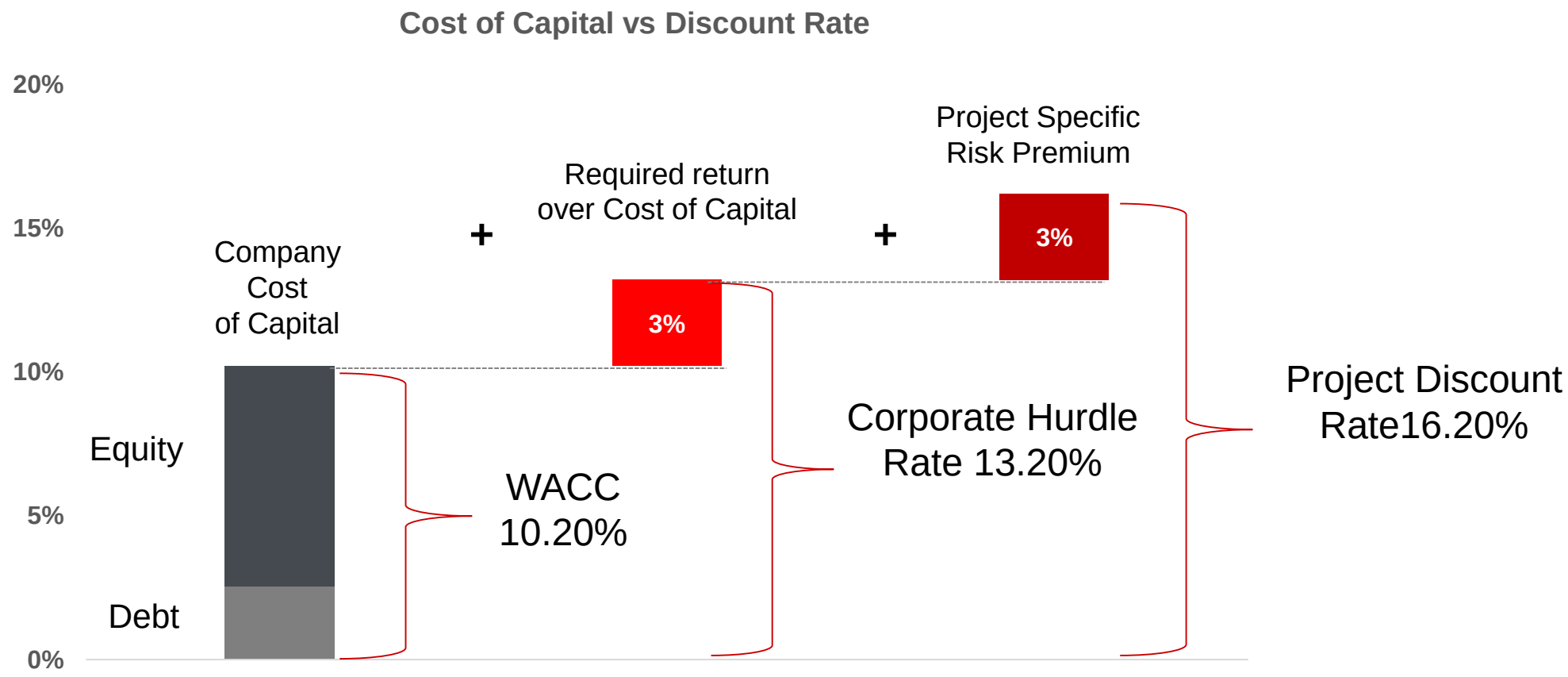
Cost of Capital vs Discount Rate

- Discount Rate is the Weighted Average (Company) Cost of Capital (WACC) and the Rate appropriate to project (Project Risk).



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Net Present Value (NPV)

- Net Present Value (NPV) is the sum of the individual discounted cash flows for a future cash flow stream.

- To properly express NPV, one must also show a discount rate and a point in time, e.g.:
  - The Net Present Value at 10% discount rate (NPV_{10} or PV_{10}) as of 1st January 2019 is $132.5M.

- **Note**:
  - NPVs of different cash flow streams as of the same date are additive, even if they have different discount rates.
  - NPVs as of different dates are NOT additive, even if they have the same discount rate.

- Net Present Value **Rule**:
  - A project with a positive NPV is worth investing in.
    - » Positive NPV = investment creates value,
    - » Negative NPV = investment destroys value,
    - » Companies should aim to maximize the NPV of its portfolio of projects and assets.

Net Present Value (NPV) Example

- NPV depends on the **Quantum** and **Timing** of cash flows.
- Higher undiscounted cash flows ≠ higher NPV.
- Example: Discount the following Cashflow at 10%

	Cashflows				**Present value**		Disc. Rate	10%
Year	A	B	C		Disc. factor	A	B	C
1	(100)	(100)	(200)		1.000	(100)	(100)	(200)
2	30	-	-		0.909	27	-	-
3	30	-	-		0.826	25	-	-
4	30	-	100		0.751	23	-	75
5	30	50	100		0.683	20	34	68
6	30	100	100		0.621	19	62	62
Net cashflow	50	50	100		NPV	14	(4)	6

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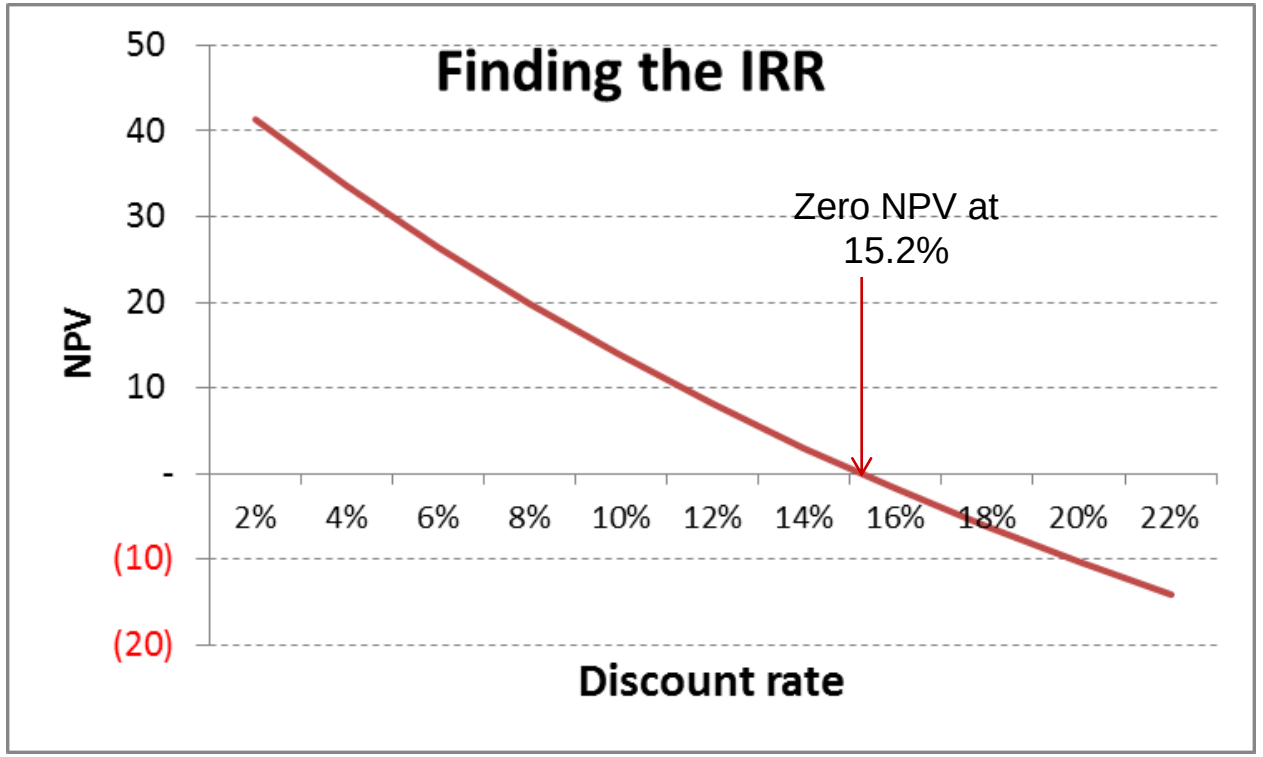
Internal Rate of Return (IRR) 1/2

- Discount rate at which the NPV of a cash flow stream = zero
- Also known as Rate Of Return (ROR, or DCFROR)
- Not the same as accounting Return on Assets (ROA), Return on Equity (ROE), etc.
- Rate of Return **Rule**
  - Projects where IRR exceeds the appropriate hurdle rate are worth investing in
  - “Hurdle rate” is usually WACC plus some margin and is company specific



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Internal Rate of Return (IRR) 2/2

- Watch out:
  - RORs are NOT additive, nor can they be averaged
    - One project with a 10% ROR and one with a 15% ROR do NOT = 25% ROR or average 12.5% ROR.
    - Aggregate the cash flows, not the IRR
  - High IRR can still mean low NPV
  - Multiple IRR if sign of cash flows changes multiple times in the Cashflow (investments)
  - The rate of return like NPV reflects the **TIMING** and **RELATIVE** size of cash flows and **NOT** the ABSOLUTE size
    - A small project can have a very high rate of return, but not necessarily be the best project to undertake.
    - When capital is limited, it is particularly important to understand the situation; it is the highest total NPV over the long term that matter, not the higher ROR projects

Net Present Value (NPV) vs. Internal Rate of Return (IRR)

Cashflows		
Year	A	B
1	(100)	(1,000)
2	50	300
3	50	300
4	50	300
5	50	300
6	50	300
Net cashflow	150	500
IRR	41.0%	15.2%

Present value		
Disc. factor	A	B
1.000	(100)	(1,000)
0.909	45	273
0.826	41	248
0.751	38	225
0.683	34	205
0.621	31	186
NPV	90	137

Project A has a higher IRR however a lower NPV.
Maximize NPV, Not IRR.

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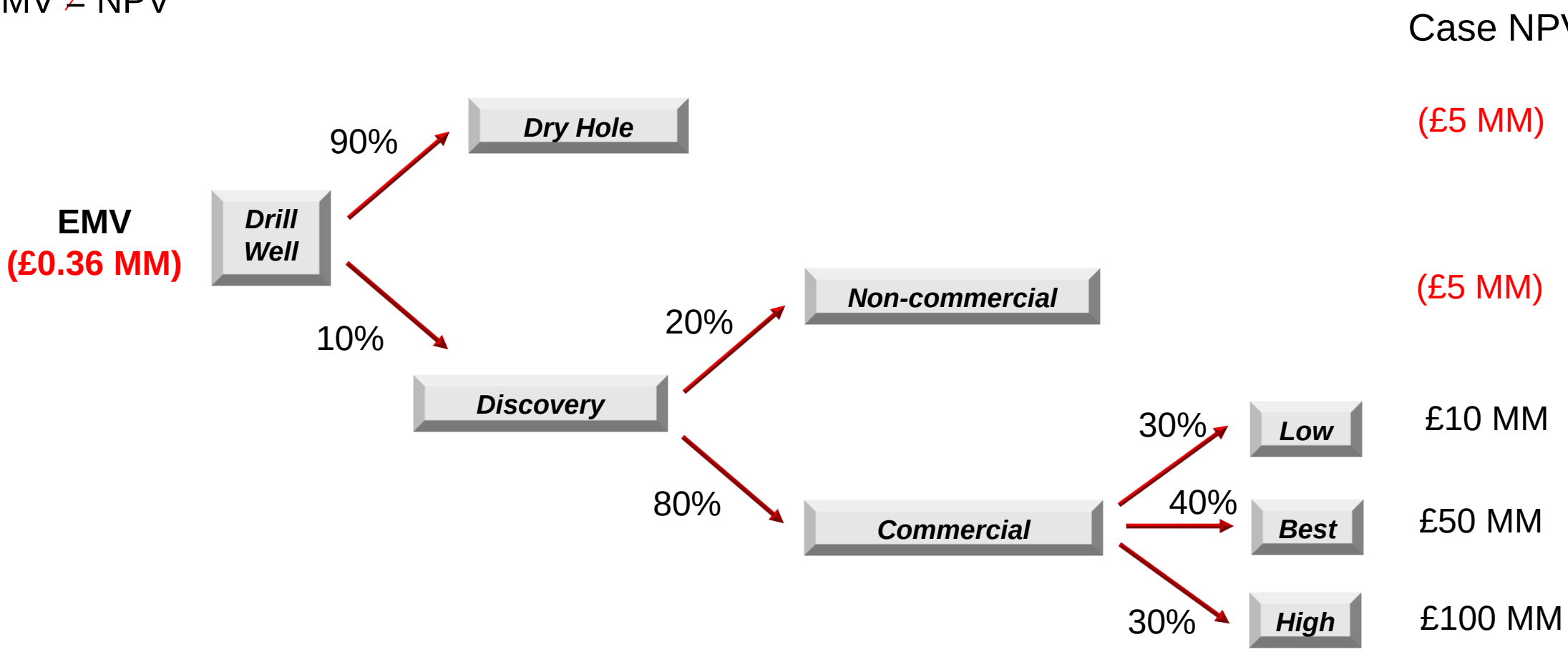
Expected Monetary Value (EMV)

- Ideal for Exploration & Appraisal Projects
- EMV ≠ NPV



Overall Probability of Commercial Discovery = 8%

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Recap

- Petroleum Economics is an Investment Decision Analysis tool
- It uses projected cash flows and takes into account:
  - The time value of money
  - The relative risk underlying the cash flows
- The most common approach is Discounted Cashflow Analysis (DCF)
- Collapses cash flows over the entire life of a project into a single metric - “Net Present Value” that can be used to compare alternative uses for the same funds
- NPV measures or evaluates whether a given project is worth doing; i.e. does the project create value relative to the cost of capital?
- IRR defines the economic return on investment

Applying Petroleum Economics Methodologies

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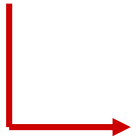
Discounted Cash Flow (DCF)

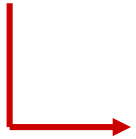
- Petroleum Economics is done using the discounted Cash flow analysis through:
  - Deterministic or Probabilistic method; and
  - In Real or Nominal terms
- DCF is done by combining all the **Technical, Economic & Commercial** inputs in a model

Revenue = Production X Price

Undiscounted Cash flow =
Revenue – Royalties – Costs – Taxes



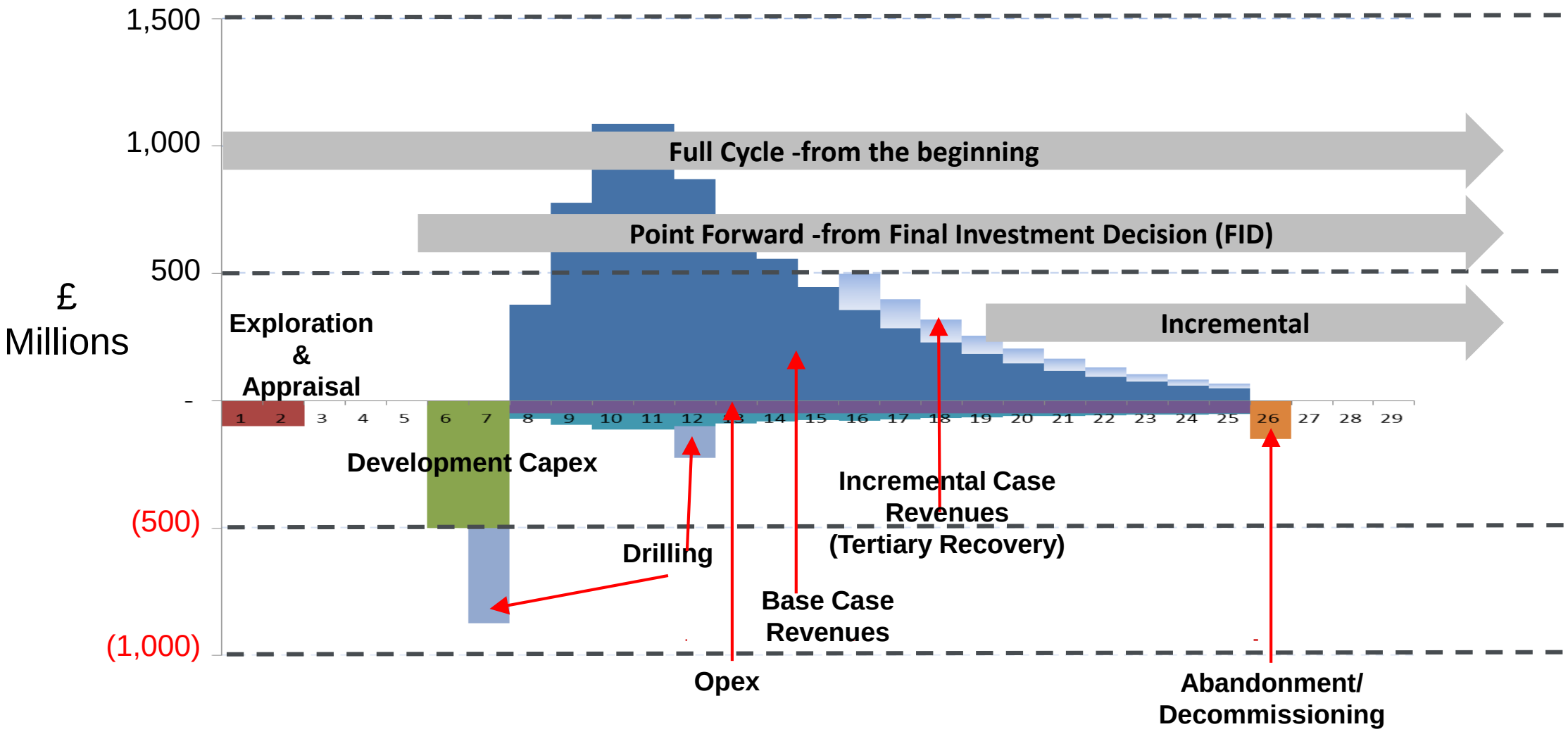
Discounted Cash flow =
Undiscounted Cash flow X Discounting Factor



Net Present Value =
Sum of Discounted Cash flow

Identifying Cash Flows for DCF Analysis

- Typically done either - Full Cycle or Point Forward or as an Incremental Analysis



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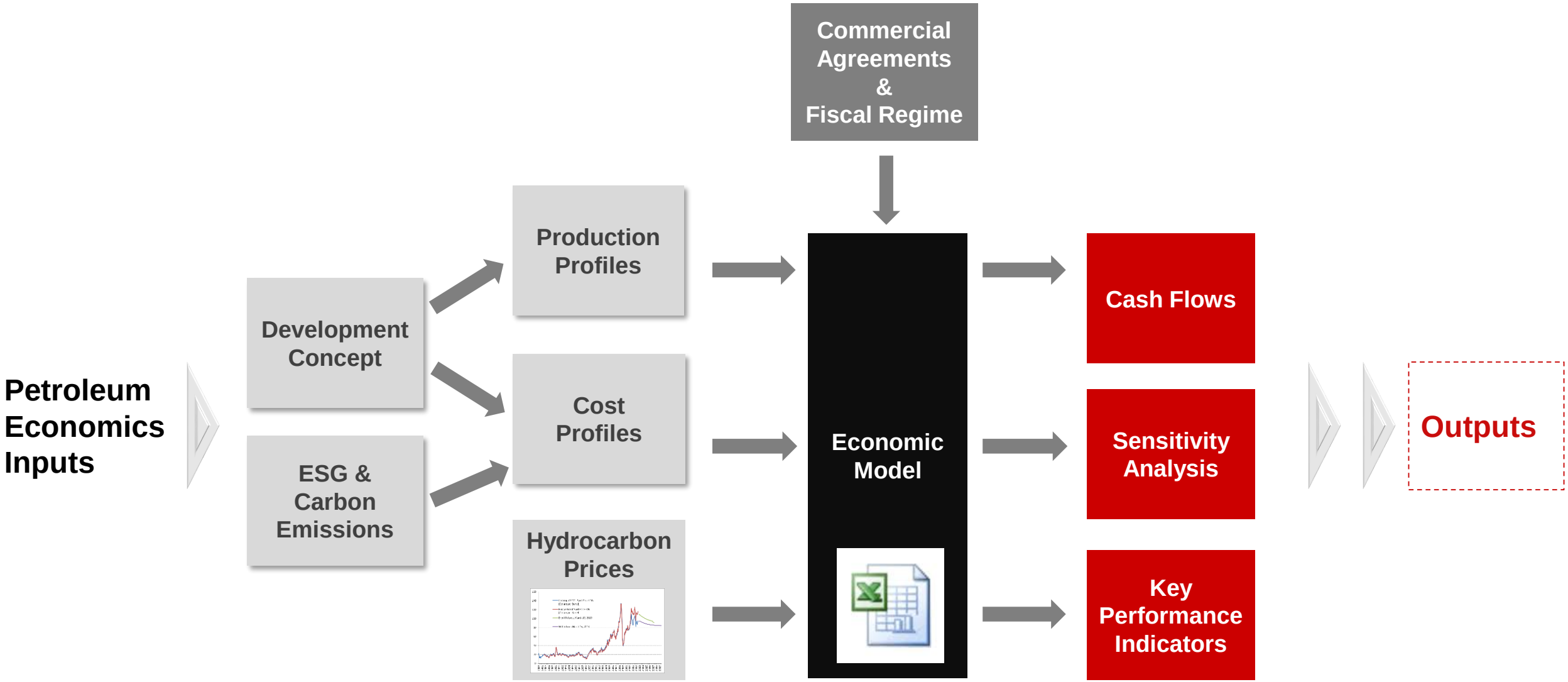
Economic Modelling Considerations



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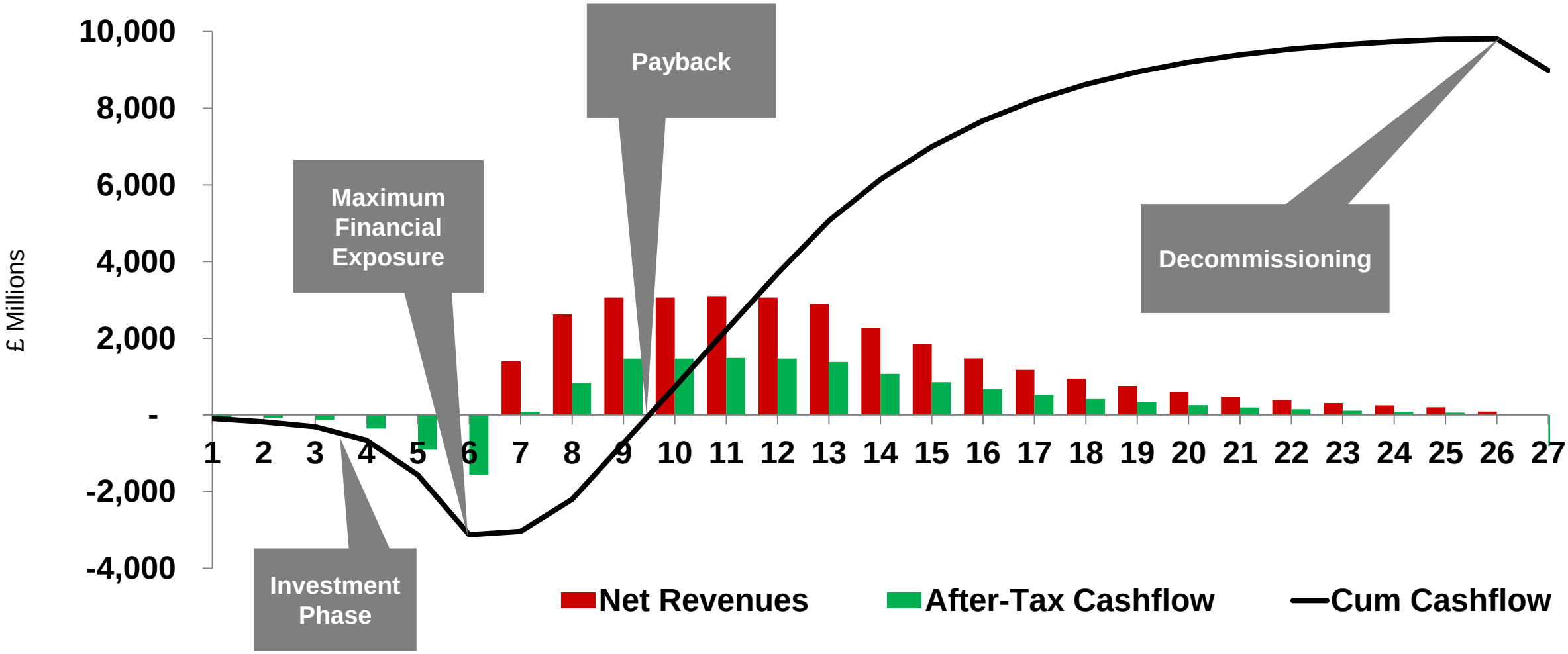
Key Outputs from PE Methodologies

A Typical Cash Flow Curve



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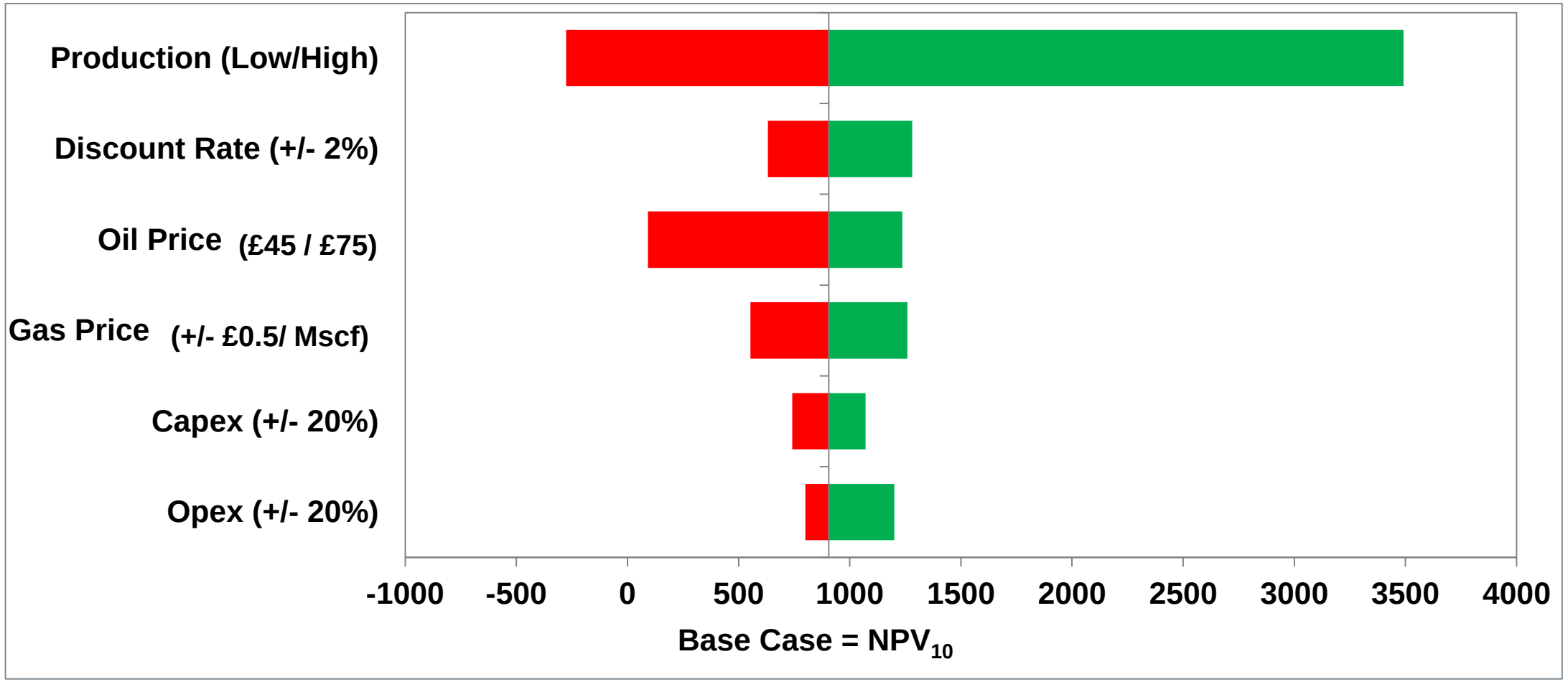
Sensitivity Analysis

Example Tornado Chart



All Parameters & Variables should always be stress tested

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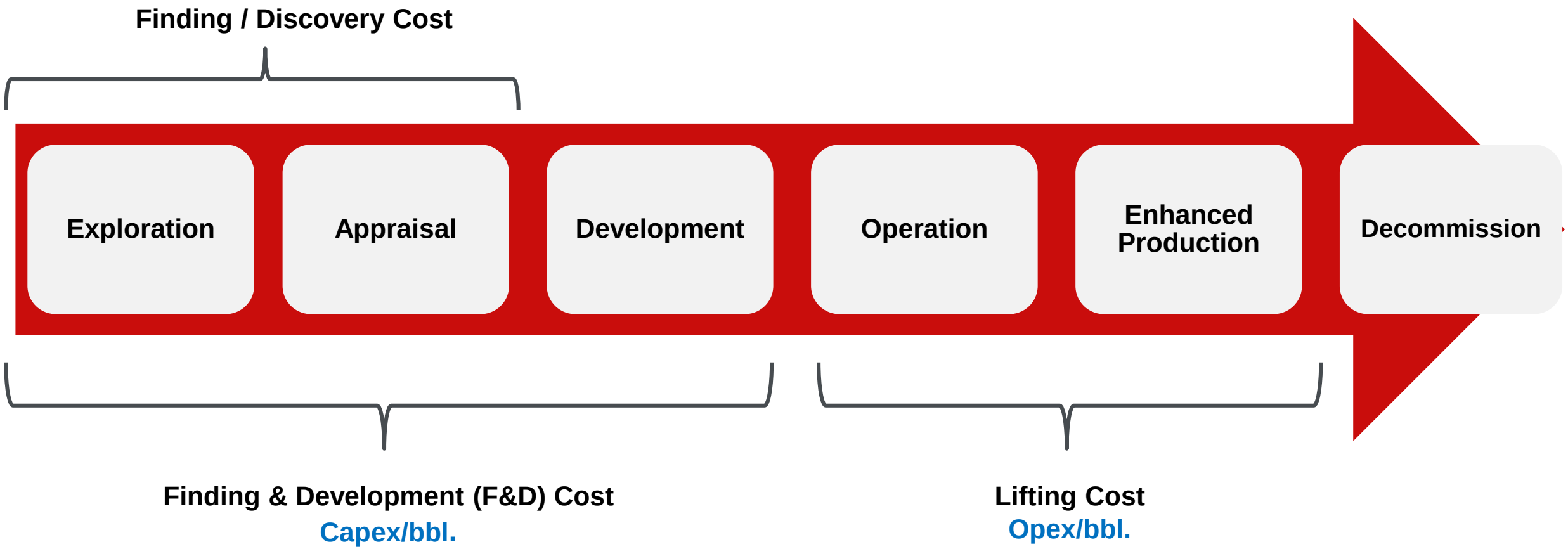
Unit Cost Analysis

- Cost Categories and Unit cost show efficiency in £/bbl.



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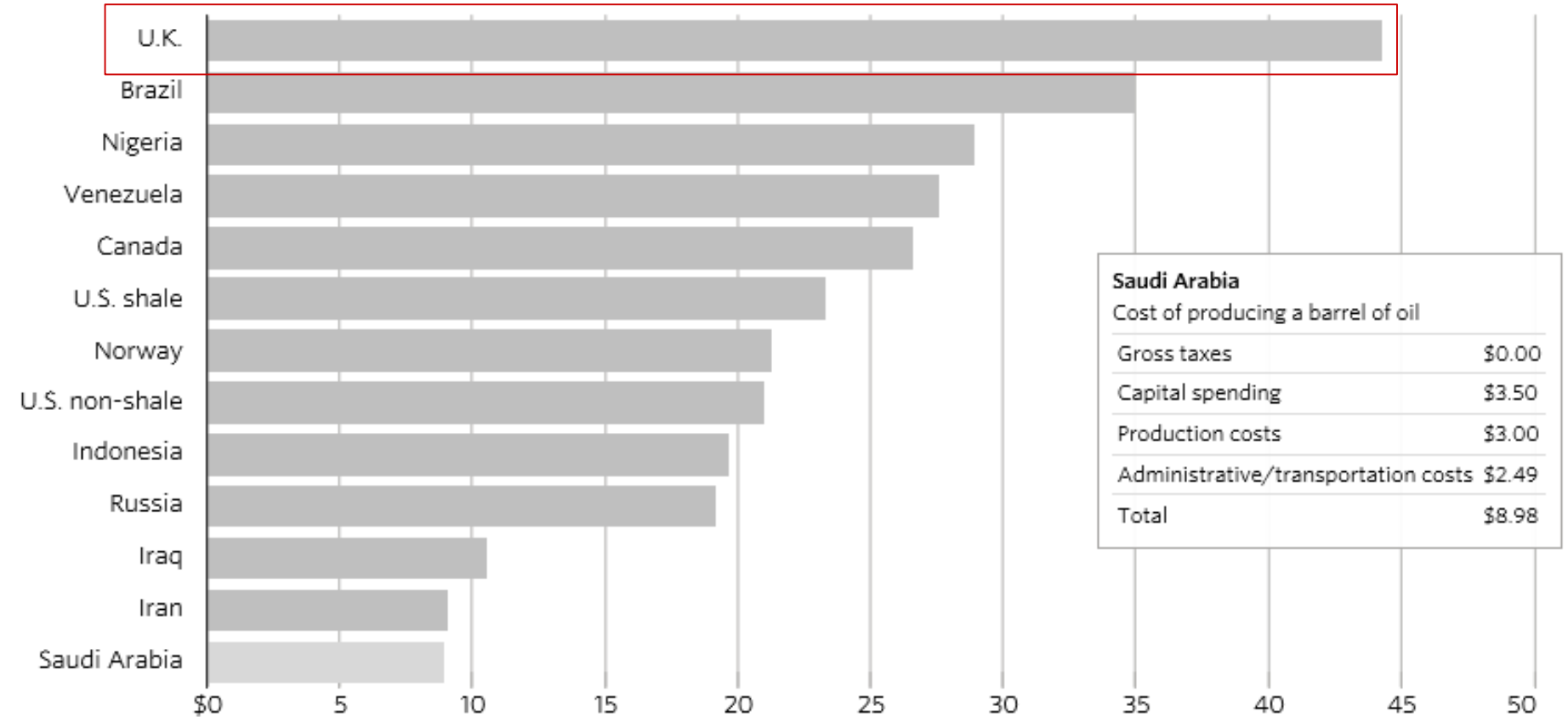
Unit Costs per Barrel Example

Cost of producing a barrel of oil and gas

Average cash cost to produce a barrel of oil or gas equivalent in 2016, based on data from March 2016.



Note: Brent crude price as of Invalid date BST.

Source: Rystad Energy UCube

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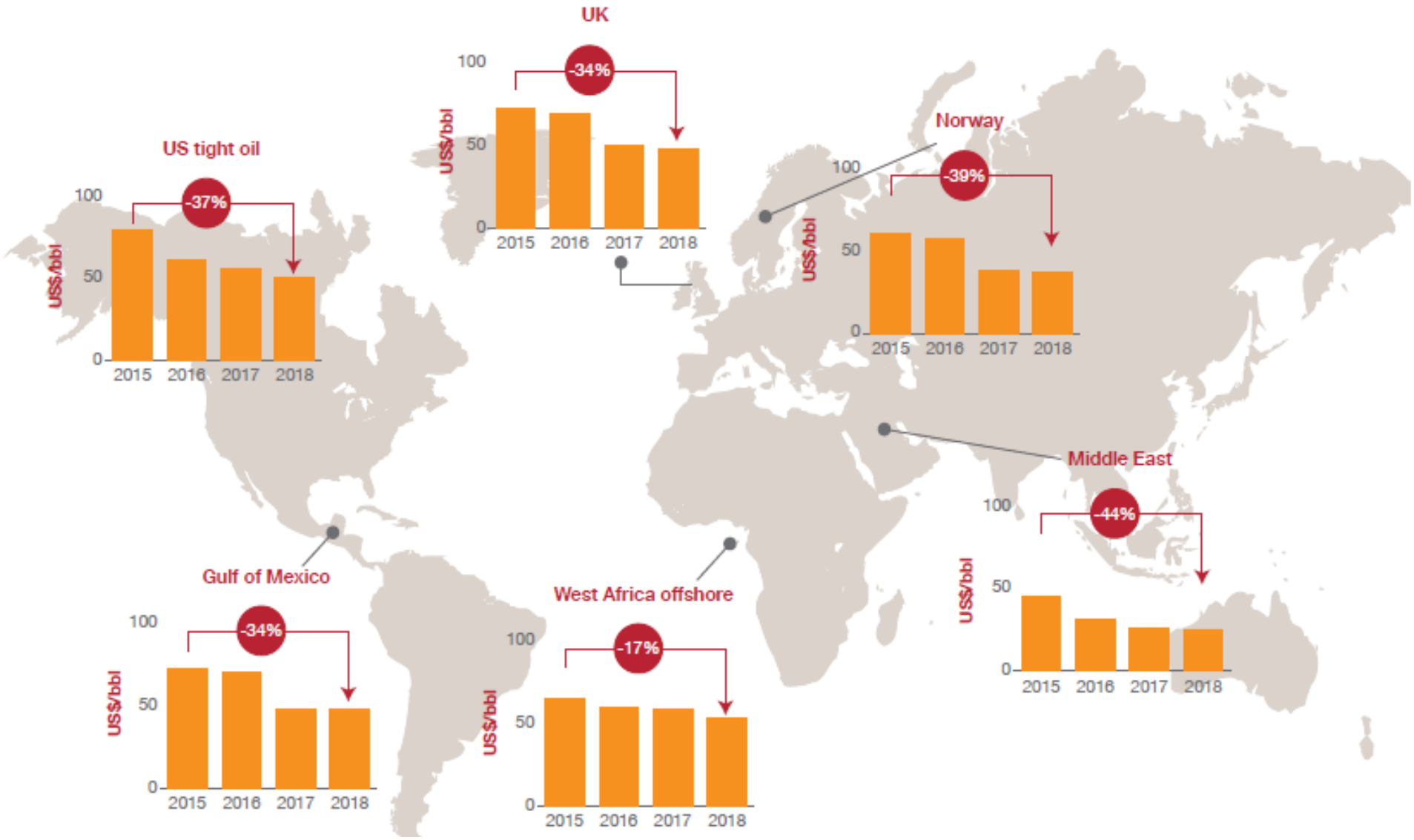
Example of Break Even Prices 2015 - 2018



Source: PWC Report - *Current developments and a look into the future November 2018*

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Petroleum Economics Output - Key Performance Indicators

- **Reserves**
  - Reserve Life Index (years)
  - Reserves Replacement Ratio (%)
  - Reserves Replacement Cost (£/boe)
- **Technical Competence**
  - Discovery Cost (£/boe)
  - Finding and Development Cost (£/boe)
  - Lifting Cost (£/boe)
  - Technical Cost £/boe)
- **Successful Efforts**
  - Commercial Success Ratio (%)
  - Technical Success Ratio (%)

- **Economic**
  - NPV / EMV
  - IRR
  - PV-Ratio (Profit Investment Ratio)
  - Pay Back
  - Maximum Financial Ratio
  - Breakeven
- **Financial**
  - Earning Before Interest and Taxes (EBIT)
  - Return on Average Equity
  - Return On Capital Employed (%)
  - Weighted Average Cost of Capital (%)
  - Revenue per boe (£/boe)
  - Profit per boe (£/boe)
  - Cash Flow per boe (£/boe)

The E&P Team

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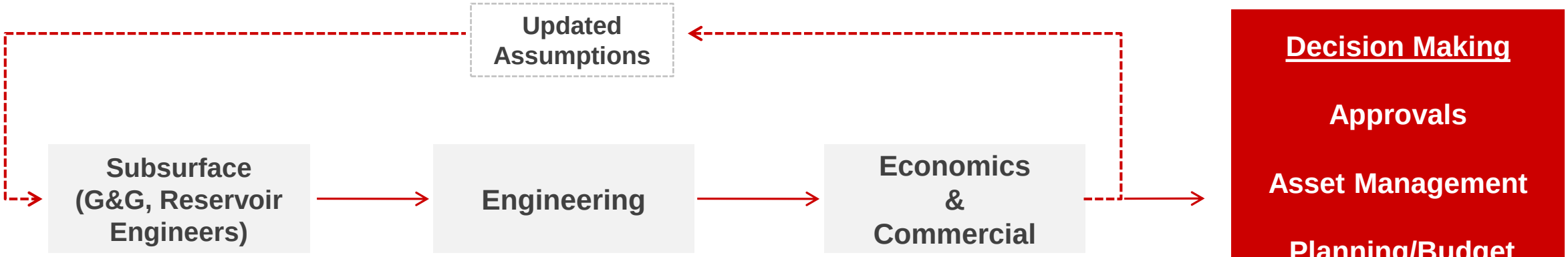
The People, The Process

An integrated workflow & team is highly recommended



STOIIP/GIIP/ Production Profiles

- Calculate MCFS (min com/eco field size) based on current economic & technological assessment.
- Production Profiles above MCFS (P10, P50 & P90)
- # Wells (E, A & P)
- Hydrocarbon mix
- Product data (shrink, yield etc.)
- Peak rates

Development Options & Cost Estimates

- Wells (Number & Location)
- Facilities (topside & subsea)
- Pipelines
- Product-2-market solutions
- CAPEX Schedule etc.

Discounted Cash Flow Analysis

- NPV & EMV
- IRR, PIR, MFE, Payback
- Sensitivity Analysis
- Graphing
- Economic Cashflow
- Economic Limit Test
- Tariffs Expense (Transport, extraction and production)
- Tariff income
- Other income, etc.

Peer Reviews are Essential

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Conclusion

Useful Checklist

FISCAL & COMMERCIAL

Fiscal Regime/Special Taxes

- Tax/royalty
- Production Sharing Contract
- Risk Service Contract
- Technical Service Contract
- Bonuses
- Petroleum Profit Tax, etc.
- Education Tax/VAT/Import Tax
- Other local taxes

Commercial

- Transportation Agreements (If any)
- Crude Oil Handling (if any)
- Gas Sales Agreements
- Gas Processing (if any)
- Loan Agreement (if any)
- Any special agreement/contracts
- Tariff receipts or payments
- Overriding royalties
- Abandonment Security Agreement

Expiry dates

- License
- Infrastructure lifespan
- FPSO lease

TECHNICAL

Production Profile

- Sales Volume
- Units – Metric/imperial
- Day rates/Annual Volumes

Associated Costs - Real/Nominal & Units

- Exploration and appraisal
  - Geological and geophysical costs Exploration drilling
  - Studies
- Development Capital costs “Capex”
  - Drilling costs:
  - Facilities costs
  - Pipelines
  - Sustaining (replacement) capital costs
- Operating costs: “Opex”
  - Lifting costs
  - Treatment
  - Injection / fuel
  - Transportation
  - General and admin: G&A
- Abandonment/Decommissioning cost

ECONOMIC & OTHER

Appropriate Price Scenario

- Forecast/Constant
- Discount or Premium to reference crude

Real vs. Nominal

- Inflation/Escalation

Discounting/Evaluation Date

- Discount Date
- Discount Rate

Exchange Rate (where applicable)

Depreciation

- Straight Line
- Unit of Payments

Tax Position (at start of evaluation period)

- Capital Allowances (historic Capex)
- Tax Losses (from previous tax years)
- Unrecovered Cost Pool in case of PSCs
- Accumulated Net Cash Flow Balances (in case of PSCs)
- Ring-fences
- Sunk cost

ESG & Carbon Emissions

In Summary

- **The What?**
  - » Petroleum Economics Concepts
  - » Fiscal Systems
- **The Why?**
  - » Project Ranking, Concept Selection
  - » At every stage of the project or asset life cycle.
  - » Regulatory Requirements, Financing, Monitoring
- **The How?**
  - » Economic Modelling
  - » Using Discounted cash flow analysis
  - » Project economics can be done on the following basis:
    - ✓ Deterministic or Probabilistic
    - ✓ Full Cycle or Point Forward
    - ✓ Incremental or Standalone
    - ✓ In real or nominal terms

- **Inputs Required**
  - » Project economics require the following input data:
    - ✓ Technical
    - ✓ Economic
    - ✓ Fiscal
  - » Other commercial terms
- **Main Outputs:**
  - » Cashflow analysis
  - » KPIs like NPV, EMV, IRR, MFE, Payback,
  - » Sensitivity analysis
  - » Unit cost per barrel

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2005 Commercial & Economics Analyst — Sterling Energy PLC

2007 Head of Economics UKCS — E.ON Ruhrgas

2009 Corporate Finance Program — London Business School

2011 Manager Economics Americas — Gaffney, Cline & Associates; Baker Hughes

2013 MBA — Imperial College Business School

2015 Founder & Co-Founder — ScanTECH Industrial Pipe Solutions Worldwide; Alaric & Associates

2017 Snr Region Manager, Treasury Credit & Collections Europe, Eurasia & Sub-Saharan Africa — Halliburton 100 Years

2019 Women's Leadership Development Program — University of Oxford Said Business School

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