Advancing the Global Energy Transition

Young Global Leaders Executive Education Module
Andlinger Center for Energy and the Environment
Princeton University
June 26 – 29, 2022

Mobilizing Energy Transition Capital

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PRINCETON UNIVERSITY

andlinger center for energy+the environment

Outline

1. Energy transition scenarios and ***capital discipline***

2. The capital allocation process and ***risk capital***

3. *Project **Valuation** methods*

4. Case study: ***Clean hydrogen hub investment***

A preliminary investment case for a **1 million tonne/year clean hydrogen hub** in your assigned country (one of U.S., Saudi Arabia, India, and Australia). Each country is considering :

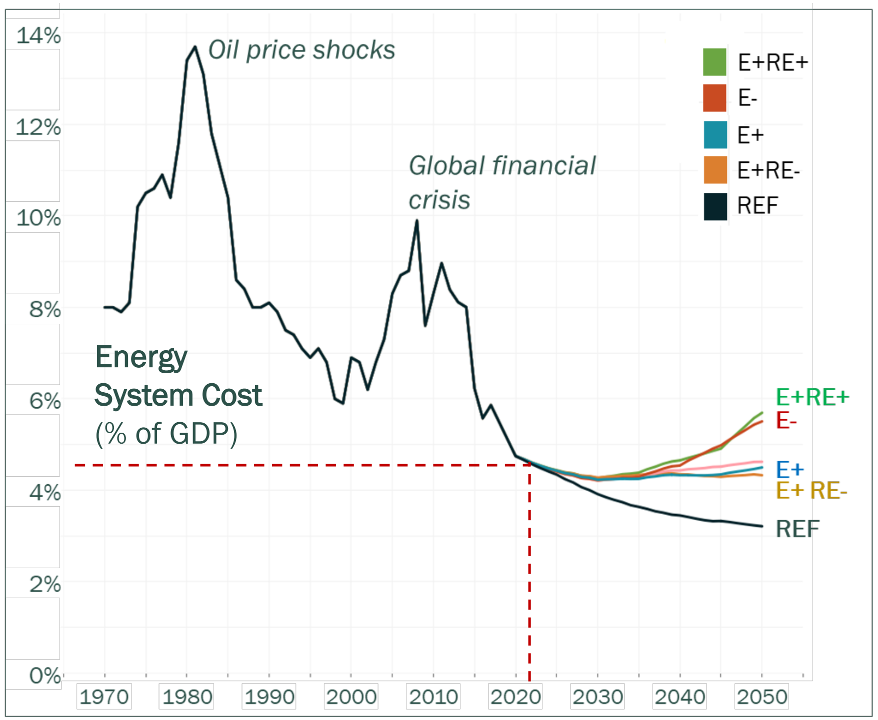
a) Large scale electrolyzers powered from the grid which is being decarbonized over time; and

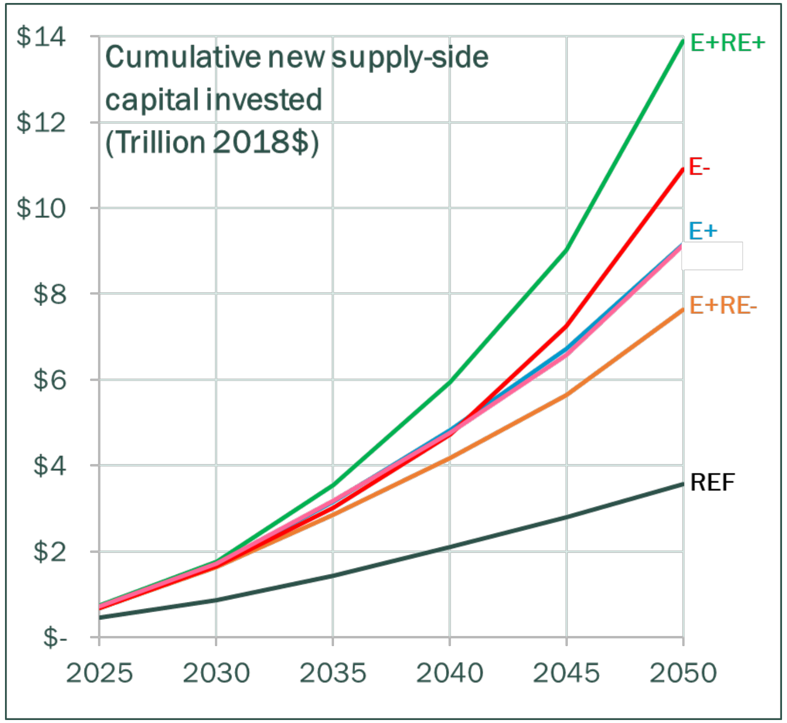
b) Large scale electrolyzers powered from a dedicated renewable energy hub comprising wind and solar PV capacity.

Context

Integrated assessment and other macro-scale energy systems models are indispensable tools for exploring alternate mitigation scenarios to could achieve net-zero by mid-century.

Often find that energy services can remain affordable throughout the transition.





However:

- Net-zero transitions are **more capital intensive**
- **2.5 to 4 x** conventional energy systems (supply side)

Larson, Greig, Jenkins, et al., Net-zero America; Pathways, Infrastructure & Impacts , Princeton University (2021)

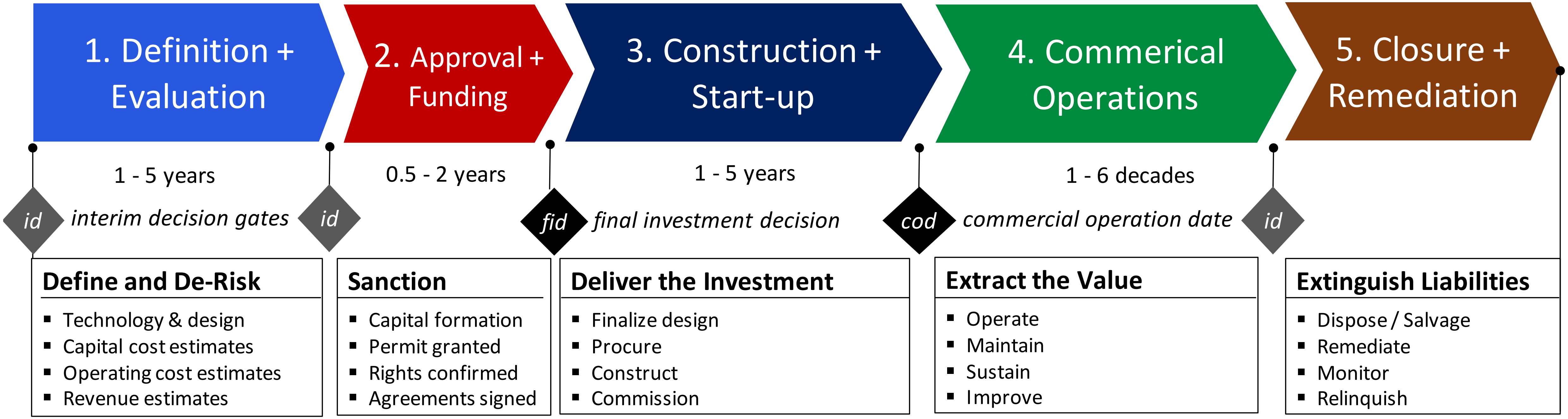
Large increase in capital intensity →

Capital formation and mobilization is a critical challenge

While the modelled investor has foresight & visibility across the energy value chain;

Real-world investors make decisions under uncertainty with limited visibility across the full value chain;

→ **Capital discipline** forces a cautious sequencing of investment decisions and capital allocation



The world is awash with capital to fund the transition

1. Definition + Evaluation	2. Approval + Funding	3. Construction + Start-up	4. Commerical Operations	5. Closure + Remediation
1 - 5 years	0.5 - 2 years	1 - 5 years	1 - 6 decades	

id — *interim decision gates* — id — fid — *final investment decision* — cod — *commercial operation date* — id

Define and De-Risk
- Technology & design
- Capital cost estimates
- Operating cost estimates
- Revenue estimates

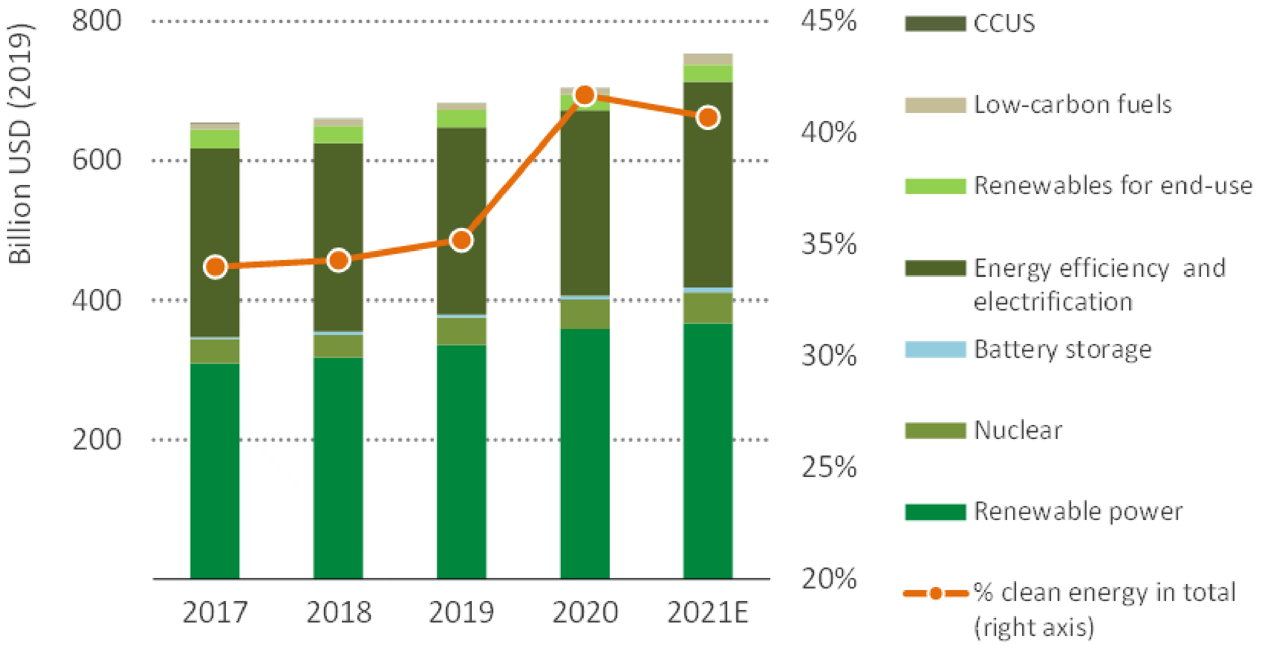
Sanction
- Capital formation
- Permit granted
- Rights confirmed
- Agreements signed

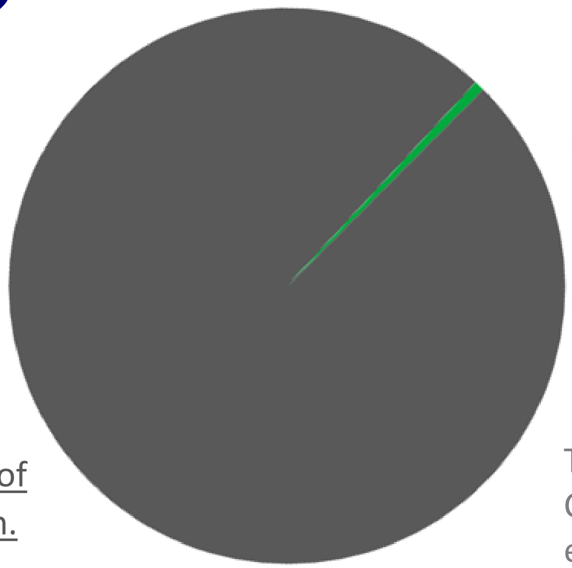
Deliver the Investment
- Finalize design
- Procure
- Construct
- Commission

Extract the Value
- Operate
- Maintain
- Sustain
- Improve

Extinguish Liabilities
- Dispose / Salvage
- Remediate
- Monitor
- Relinquish

Could this mobilization challenge explain the slow pace of clean-energy investment?





Global investment in clean energy assets in 2021 estimated at $754 billion. (9)

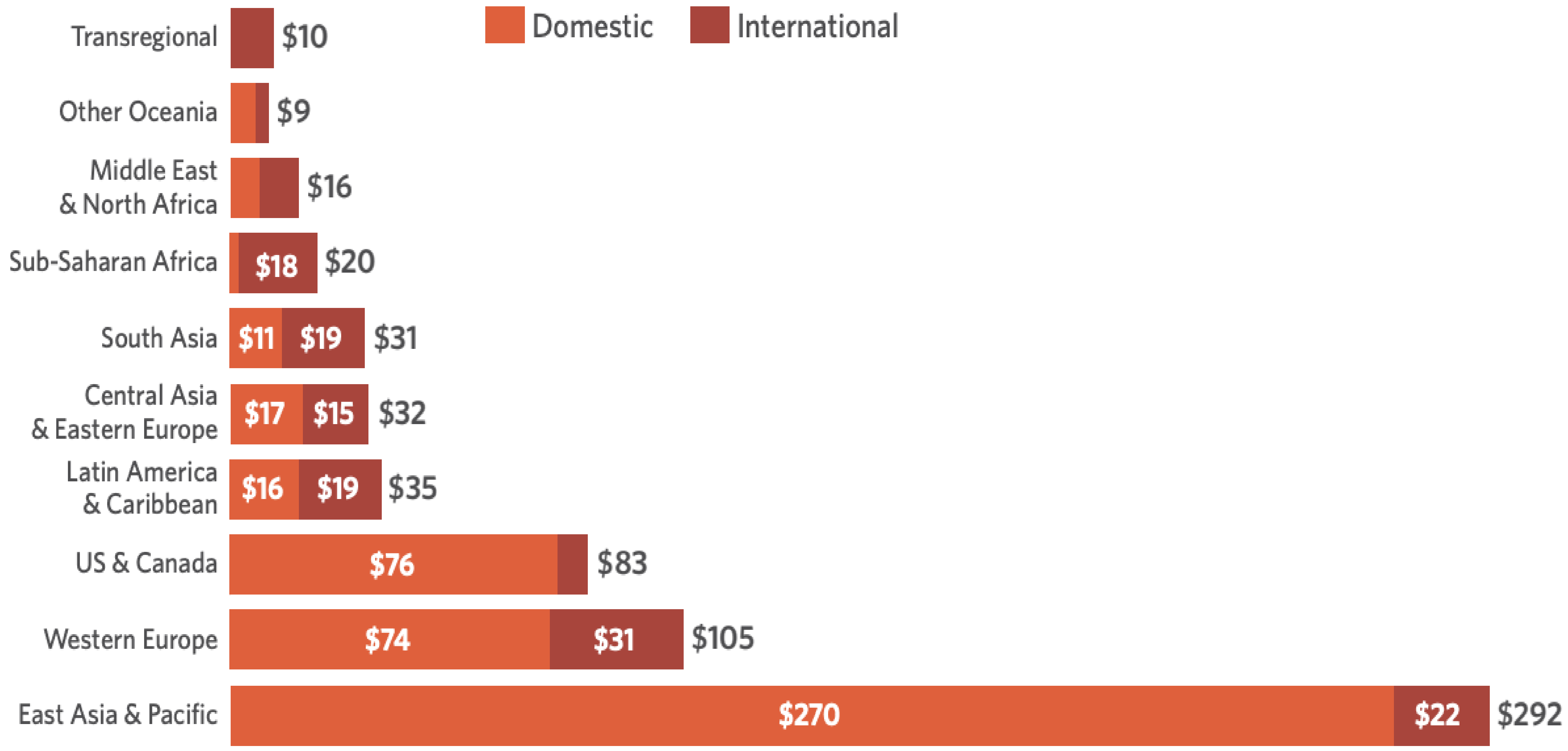
This is just 0.6% of the total capital announced as “committed” to a net-zero economy. (11)

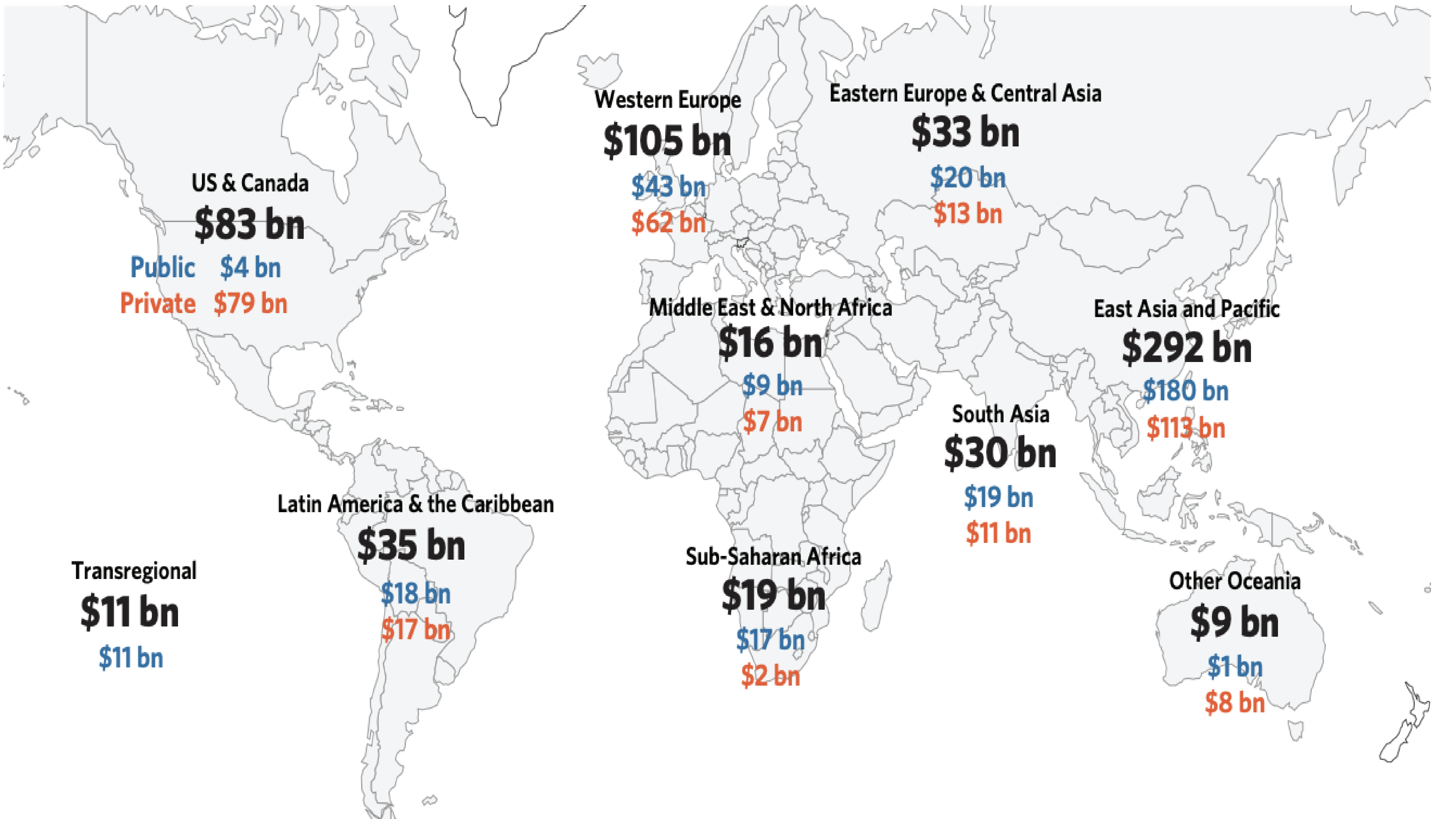
International Energy Agency, (IEA), “World Energy Investment 2021” (2021); https://www.iea.org/reports/world-energy-investment-2021.

Glasgow Financial Alliance for Net Zero, Press Release 3 November 2021, Amount of finance committed to achieving 1.5°C now at scale needed to deliver the transition. https://www.gfanzero.com/ accessed 2 March 2022.

Taken from an article under review by Chris Greig with two financial sector executives

Figure 22: Domestic and international climate finance flows by region of destination (USD billion, 2019/2020 annual average)




US & Canada
$83 bn
Public $4 bn
Private $79 bn
Western Europe
$105 bn
$43 bn
$62 bn
Eastern Europe & Central Asia
$33 bn
$20 bn
$13 bn
Middle East & North Africa
$16 bn
$9 bn
$7 bn
East Asia and Pacific
$292 bn
$180 bn
$113 bn
South Asia
$30 bn
$19 bn
$11 bn
Latin America & the Caribbean
$35 bn
$18 bn
$17 bn
Sub-Saharan Africa
$19 bn
$17 bn
$2 bn
Transregional
$11 bn
$11 bn
Other Oceania
$9 bn
$1 bn
$8 bn

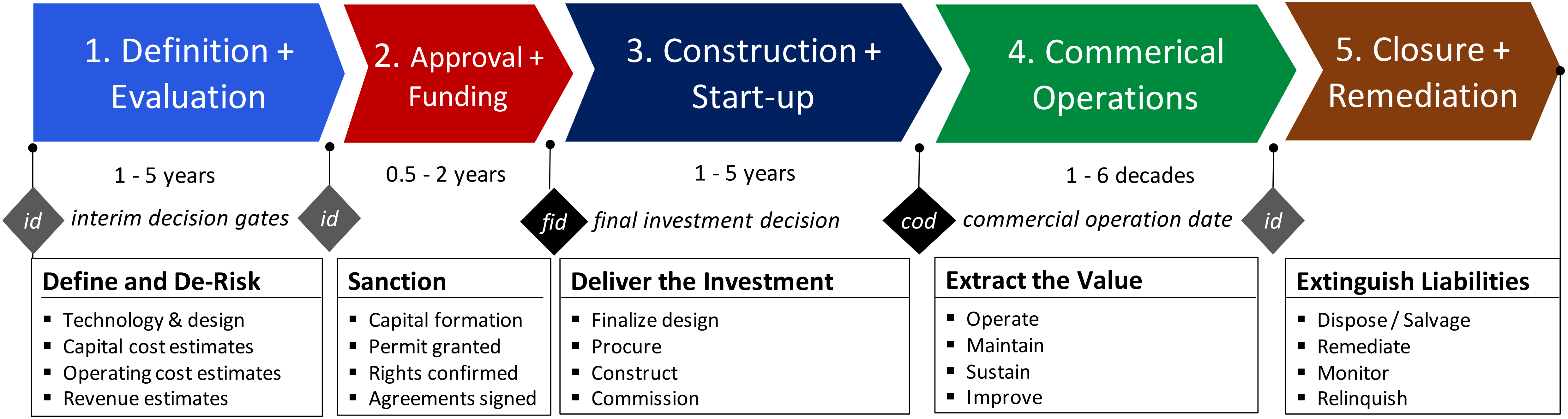
Large increase in capital intensity →

Capital formation and mobilization is a critical challenge

While the modelled investor has foresight & visibility across the energy value chain;

Real-world investors make decisions under uncertainty with limited visibility across the full value chain;

→ **Capital discipline** forces a cautious sequencing of investment decisions and capital allocation



Final investment decision (FID) is taken only after the developers (equity providers) and lenders are satisfied that the **rewards outweigh the risks**

- Technology
- Location
- Markets & Customers
- Sales Prices
- Costs (capital & operating)
- Competition
- Supply Chains
- Access to infrastructure

- Human Resources
- Health & Safety
- Environment Impacts
- Community support
- Environmental & social justice
- Legal & Regulatory
- Management & Operations capability
- Robustness of Execution Plan

Each topic is considered at each stage with a view to revealing risks that could affect the **value of the investment**

Approach to valuation

All approaches should be based on **incremental future cashflows**

DEFINITION:

- Incremental future cashflows are all cashflows that are expected to occur in the future **with the project** *minus* all those that would occur in the future **without the project**

Important CONCEPT from economics: the ‘counterfactual’ ≠ ‘the current situation’…

Incremental Future Cashflows

- Incremental future cashflows include:
  - Cash **inflows** of the project
    (e.g., sales revenue, royalties, salvage value of project assets at end of project life)
  - Cash **outflows avoided or reduced** due to the project (e.g., operating costs saved)*
  - Cash **outflows** which occur due to the project (e.g., capital expenditure, acquisition costs, additional operating costs, tax expenses, closure/rehabilitation costs at end of project life)
  - Cash **inflows prevented/reduced** by the project
    (e.g., an asset which could otherwise be sold is retained)*
- Incremental future cashflows **DO NOT** include:
  - **Past cashflows** (financial analysis needs to be 'foreword looking')
  - **Accounting creations** which are not a cashflow (e.g., depreciation)

* Note: these may appear in the 'without project' counterfactual (count, but don't double-count them!)

Methods of Analysis

Two common methods of financial analysis:

- **Simple payback period** (SPP) analysis
- **Discounted cashflow** (DCF) analysis:
  - Net present value (NPV)
  - Internal rate of return (IRR)

Case Study: (hypothetical) C*lean hydrogen hub investment*

Gather into your 8 teams of 5.

Each team will develop a preliminary investment case for a standalone 1 million tonne/year clean hydrogen hub in your assigned country (one of U.S., Saudi Arabia, India, and Australia).

There are two configurations under consideration:

- Large scale electrolyzers powered from the grid which is being decarbonized over time; and
- Large scale electrolyzers powered from a dedicated renewable energy hub comprising wind and solar PV capacity.

Each country has different has a different combination of resource quality, capital costs, feedstock/operating costs, price on emissions (see Excel data sheet).

Each country also has a set a different offtake price for early mover clean hydrogen production and a different weighted average cost of capital (WACC).

You have been provided with a discounted cashflow (Excel) model which will allow you to make the decisions regarding value proposition:

[Clean Hydrogen Hub - Data and DCF]

Task questions

1. **Is the project likely to proceed at the proposed clean hydrogen off-take price**?
2. **What alternative price would be required for the project to be viable** meet your required WACC?
3. In order for you to proceed with the investment, **which of the following government concessions would be preferable**?
   a) Government Capital Grant of 1/3 of total investment
   b) Loan Guarantee which reduces the WACC by 2%
   c) Increase in the offtake price by $2/kg
4. <u>Optional challenge if time</u>: Several countries have set a target of <$2/kg of green hydrogen by 2030, which is when your facility will come online. **What combination of capital cost reductions, electricity prices and/or efficiency improvements would be needed to hit that target**?

Each team should elect a representative to report out on findings, starting at 5 PM.

Send a summary report on a single PowerPoint slide to **cgreig@princeton.edu**

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Slides on Discounted Cashflow Analysis

for anyone wanting a tutorial on approach

Discounted Cashflow Analysis

- Discounted cashflow (DCF) analysis includes two major metrics: **net present value** (NPV) and **internal rate of return** (IRR)
- DCF analysis assesses all future cashflows of a project but we "discount" the value of later cashflows in comparison to earlier cashflows
- Based on the premise that **money received now is more valuable than the same amount received in the future** ('time value' of money)
  - Money received now can be reinvested (at the very least, in a bank with an interest rate)
  - Money received later involves greater risk
  - The same dollar value in the future will have less spending power due to inflation

DCF Analysis – Net Present Value (NPV)

- Future cashflows are discounted using a "**discount rate**" to a **present value** (or discounted cashflow)
- The **SUM** of the discounted cashflows over the project life is the NPV
- The discount rate may be the "**hurdle rate**" set by the investor, which considers:
  - The level of risk of the project
  - The investor's cost of capital
  - Investor preferences (relative time preference)
  - Returns available on alternative projects (**opportunity cost**)
- The discount rate may also be the "**weighted average cost of capital**" (WACC)
- The **higher the discount rate**, the **lower the value** attributed to **future cashflows**

DCF Analysis – Net Present Value (NPV)

Element	Year 0 (Present)	Year 1	Year 2	Year 3	Year 4	Year 5
Investment/Residual Value	(1000)	-	-	-	-	200
Sales	-	300	320	350	380	380
Expenses	-	(100)	(105)	(105)	(110)	(110)
Net Cashflows	(1000)	200	215	245	270	470
Discount Factor (r = **5%**)						
Discounted values (reciprocal)						
Discounted Cashflows						
Net Present Value (NPV)						

Net Cashflows = Sum of Revenues & Costs

Discount Factor = $(1 + r)^n$

Reciprocal = $1/(1 + r)^n$

Discounted Cashflows = Net Cashflow / Discount Factor

NPV = Sum of Discounted Cashflows

Or use the NPV() function in Excel

r = discount rate = **5%**

n = year

DCF Analysis – Net Present Value (NPV)

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Investment/Residual Value	(1000)	-	-	-	-	200
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Expenses	-	(100)	(105)	(105)	(110)	(110)
Net Cashflows	(1000)	200	215	245	270	470
Discount Factor (*r* = **5%**)	1.00	1.050	1.103	1.158	1.216	1.276
Discounted values (reciprocal)	1.00	0.952	0.907	0.864	0.823	0.784
Discounted Cashflows	(1000)	190.5	195.0	211.6	222.1	368.3
Net Present Value (NPV)	**187.5**					

Net Cashflows = Sum of Revenues & Costs

Discount Factor = $(1 + r)^n$

Reciprocal = $1/(1 + r)^n$

Discounted Cashflows = Net Cashflow / Discount Factor

NPV = Sum of Discounted Cashflows

r = discount rate = **5%**

n = year

Or use the NPV() function in Excel

DCF Analysis – NPV With Tax unleveraged

Element	Year 0 (Present)	Year 1	Year 2	Year 3	Year 4	Year 5
Investment/Residual Value	(1000)	-	-	-	-	200
Sales	-	150	700	800	900	900
Expenses	-	(100)	(110)	(120)	(130)	(130)
Operating Margin		50	590	680	770	970
Depreciation	-	(200)	(200)	(200)	(200)	(200)
Carried Forward Loss	-	-	(150)	-	-	-
Taxable Income		(150)	240	480	570	770
Tax Expense (30% Tax Rate)	-	0	(72)	(144)	(171)	(231)
Net Cashflows	(1000)	50	518	536	599	739
Discount Factor (*d* = **5%**)	1.00	1.050	1.103	1.158	1.216	1.276
Discounted values (reciprocal)	1.00	0.952	0.907	0.864	0.823	0.784
Discounted Cashflows	(1000)	47.6	469.6	462.9	492.6	579.2
Net Present Value (NPV)	**1051.9**					

DCF Analysis – NPV With Tax unleveraged

Element	Year 0 (Present)	Year 1	Year 2	Year 3	Year 4	Year 5
Investment/Residual Value	(1000)	-	-	-	-	200
Sales	-	150	700	800	900	900
Expenses	-	(100)	(110)	(120)	(130)	(130)
Operating Margin		50	590	680	770	970
Depreciation	-	(200)	(200)	(200)	(200)	(200)
Carried Forward Loss	-	-	(150)	-	-	-
Taxable Income		(150)	240	480	570	770
Tax Expense (30% Tax Rate)	-	0	(72)	(144)	(171)	(231)
Net Cashflows	(1000)	50	518	536	599	739

What is the NPV using a discount rate of 5%?

DCF Analysis – Net Present Value (NPV) as a Decision Metric

- **Positive NPV** means that the discounted value of the net cash inflows is greater than the cost of investment: value is being created
  - Project **should proceed** considering the discount rate set by the investor
- **Negative NPV** indicates that the return requirement of the investor has not been met
  - Project **should not proceed** considering the discount rate set by the investor

DCF Analysis – Internal Rate of Return (IRR)

The internal rate of return (IRR) is the **discount rate** at which the **net present value** (NPV) of all cashflows is **equal to zero**

Tells us what rate of return we will get on our investment

- Calculated by iterating the discount rate until NPV equals zero
- In theory, a project should be undertaken if the IRR is **equal to or exceeds** the investor’s **hurdle rate**
- Strategies to solve the IRR include:
  - Manual iterative trial and error: varying the discount rate until NPV equals 0
  - Excel “Goal Seek” (Data > What-If Analysis > Goal Seek)
  - Excel IRR function (Formulas > Insert Function > IRR)

DCF Analysis – Internal Rate of Return (IRR)

Element	Year 0 (Present)	Year 1	Year 2	Year 3	Year 4	Year 5
Investment/Residual Value	(1000)	-	-	-	-	200
Sales	-	300	320	350	380	380
Expenses	-	(100)	(105)	(105)	(110)	(110)
Net Cashflows	(1000)	200	215	245	270	470

Calculate the IRR.

Should the project proceed, assuming your hurdle rate is 5%?

DCF Analysis – Internal Rate of Return (IRR)

Element	Year 0 (Present)	Year 1	Year 2	Year 3	Year 4	Year 5
Investment/Residual Value	(1000)	-	-	-	-	200
Sales	-	300	320	350	380	380
Expenses	-	(100)	(105)	(105)	(110)	(110)
Net Cashflows	(1000)	200	215	245	270	470
Discount Factor (*d* = **10.67%**)	1.00	1.107	1.126	1.355	1.500	1.660
Discounted Cashflows	(1000)	180.7	175.5	180.7	180.0	283.1
Net Present Value (NPV)	**0**					

- The **IRR** (discount rate) **is 10.67%** where **NPV is zero**
- Given this **exceeds** the investor's **hurdle rate of 5%** (used in the previous slide), we should **proceed**

DCF Analysis – NPV Versus IRR

- NPV and IRR methods are directly linked and will give consistent “go” and “no go” decisions
- **However**, they may not give the same conclusion when a choice is to be made between competing “go” projects
- Generally, NPV is a superior method except where capital is limited, but
  - In this case, rationing capital to the higher IRR projects may be optimal
- If a project makes economic sense, there should be an entity able to raise the capital
- The aim should be to **maximize the NPV** of the whole organization
- WARNING: there are some mathematical and practical quirks with IRR related to
  - The sequence of positive and negative cash flows
  - Multiple solutions
  - Some cash flows patterns have no real IRR solution

DCF Analysis – NPV Versus IRR

Cashflows	Initial Investment	Year 1	Year 2	IRR	NPV^{10}
Project A	(10)	10	10		
Project B	(1000)	800	800		

- Calculate the IRR and NPV_{10} of each project
- Which project is a better investment?
- Which do you prefer?

DCF Analysis – NPV Versus IRR

Cashflows	Initial Investment	Year 1	Year 2	IRR	NPV^{10}
Project A	(10)	10	10	62%	7.36
Project B	(1000)	800	800	38%	388.43

- Calculate the IRR and NPV_{10} of each project
- Which project is a better investment?

  Project A has a **higher IRR** and returns more for the investment made

  Project B has a **higher NPV** and would return far more absolute value
- Which do you prefer?

  If many instances of Project A can be undertaken, Project A may be preferred
  Otherwise, Project B would be preferred

Choosing A Discount Rate: value and the basis

- Discount rates are critical to DCF methods (NPV and IRR)
- There are two ways to calculate a discount rate:

1. **Hurdle Rates**:
   - Specified by the investor
   - May reflect the investor's cost of capital, risk appetite, competing opportunities etc.
   - May not necessarily have a clear basis
2. **Weighted Average Cost of Capital** (WACC):
   - A calculated cost of capital based on market parameters and research
   - A theoretical cost of capital for the industry and for the risk profile of the project
   - A firm's actual cost of capital, based on their borrowing costs and market return on equity
   - WACC may change based on country due to risk adjustment
     (e.g. more risky to operate in Zambia than in US)

Weighted Average Cost of Capital (WACC)

WACC Parameter		
Nominal Risk Free Rate (Australia)	Rf	4%
Market Risk Premium	MRP	6%
Base Equity Beta	βe	0.90
Nominal After-Tax Cost of Equity	Ke	9.4%
Equity Proportion	E/V	70%
Debt Proportion	D/V	30%
Debt Margin	-	3%
Pre-Tax Cost of Debt	Kd	7%
Effective Average Tax Rate (Before Imputation)	T	30%
Imputation Credit Utilisation Rate	γ	100%
“Traditional” Imputation Adjustment	1-T/(1-T(1-γ))	70%
Costs of Capital		
Post-Tax Cost of Equity	Ke *(1-T)/(1-T(1-γ))	6.58%
Post-Tax Cost of Debt	Kd * (1-T)	4.9%
Post-Tax Nominal WACC	Ke * (1-T)/(1-T * (1-γ)) * E/V + Kd * (1-T) * D/V	6.08%
Assumed Rate of Inflation	-	2.25%
Post-Tax Real WACC	(1+NomWACC)/(1+Inflation) - 1	3.74%

- Analysts publish WACCs for various organisations and industry sectors
- Complex calculation and based on a great number of variables
- WACCs can change based on country, which may affect projects operating across jurisdictions
- The table shows example calculations using typical inputs for illustration

Choosing a Discount Rate: type

- Discount rates can be “**real**” or “**nominal**”
- The **Nominal** discount rate = the **real** rate + impact of **inflation**
  - A nominal discount rate must only be applied to inflated (dollars of the day) cashflows
  - e.g. your model assumes the prices of products will increase over time and you have adjusted both the revenues and expenses accordingly
  - Real WACC = (1+NomWACC)/(1+Inflation) - 1
- **Real** rates must be applied to cashflows expressed in today’s dollars
  - Express all values as their monetary value today
NOT taking into account the effect of inflation on revenue or expenses

Guidelines for DCF analysis - a reasonable approach

A good guideline to remember:

- Use **real** values and a real discount rate for an **economic analysis**
- Use **nominal** values and a nominal discount rate for **financial analysis**

Advice: **start with an economic analysis using real values**.

- Real analysis is simpler, more stable and requires fewer assumptions
- Most people can relate more easily to values expressed in today's dollars (real values)
- If it doesn't make economic sense, it will only make financial sense if:
  - there are financial **subsidies** available from somewhere and/or there are **tax** quirks
  - reliance on subsidies or a tax loss business is more about securing transfers than creating value
- You can add complexity as the project analysis proceeds

Advice: **conclude with a financial analysis using nominal values**.

- We borrow and repay loans in nominal dollars
  so once debt financing is included your analysis should use nominal values

REMEMBER: real and nominal cashflows *for the same item* or 'row' should discount back to the same 'present values'

Rookie Errors (1)

- Incorrect identification of incremental cashflows (revenues and expenses)
  - Including sunk costs (analysis must be ‘forward looking’ and exclude these)
  - Excluding opportunity costs (e.g. asset sale foregone)
  - Excluding impacts on other business activities
  - Ignoring the terminal value and closure or rehabilitation costs
- Mismatch of the discount rate and the cashflows
  - Applying a nominal discount rate to real cashflows
  - Applying a real discount rate to nominal cashflows
- Ignoring cost escalation and considering this a proxy for “real” cashflows
  - “Not escalated” does not mean real values: *costs can escalate more than general inflation*
  - Some items have a fixed nominal value (e.g. the tax benefit of depreciation)
    The real value of such items declines over time

Rookie Errors (2)

- Using the Excel function (NPV/IRR) where the cashflows are not evenly spaced in time
  - The function XNPV/XIRR allows dates to be assigned to each cashflow for an accurate calculation
- Discounting the first cashflow, where this occurs on Day 0
  - You should exclude this cashflow from the formula, and deduct the full value
- Including a tax loss in the cashflows (as a benefit)
  - Valid only where the loss can be grouped with other entities, otherwise, loss should carry forward until there are profits
- Failing to assess reasonable sensitivities and scenarios
- Sensitivity analysis does not reflect consequential changes
  (e.g. substantial reduction in sales without reduction in operating costs/overheads)
- Overly complicating models, making them less usable and increasing the risk of error
- Failing to obtain expert assistance in preparing/reviewing models

Recap

- **Energy transitions are capital intensive**
- Many, large, long-lived individual investment decisions
- Investors aim to **maximize 'value'**
- An understanding of project economics & valuation is necessary to assess value.
- The most important things for project economic and financial analysis are to:
  - capital discipline drives **project investment decision making** process - from concept to closure.
  - develop a deep intuitive understanding of the concept of **opportunity cost:**
  - develop a solid appreciation of the **time value of money:**
- As your analysis becomes more complex, don't lose sight of the core:
  Check back to the essence of where and how and when the project **creates value**

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