

Lecture – 16A & 16B

# Energy Resources, Economics and Environment

## Financing Energy Projects

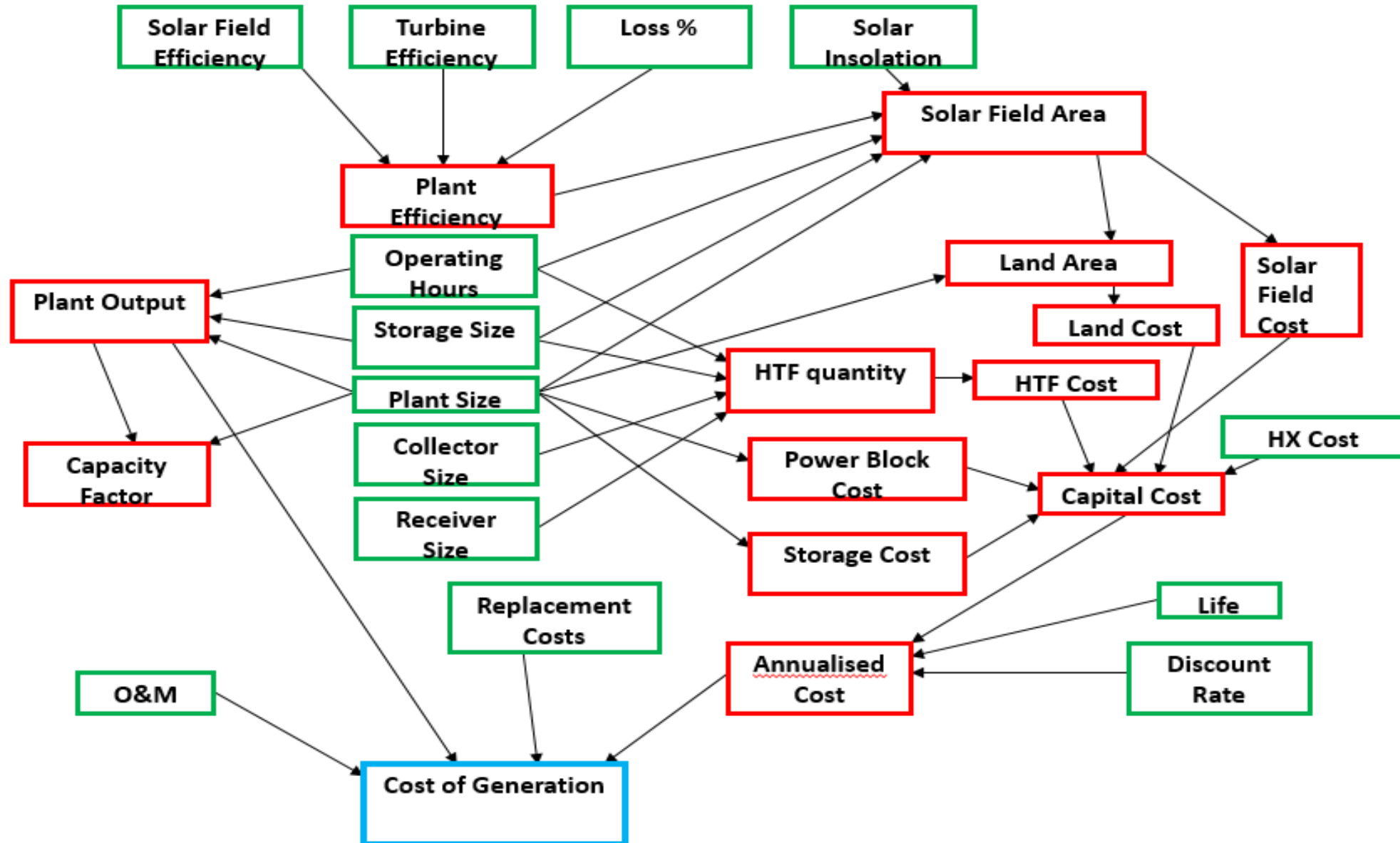
Rangan Banerjee

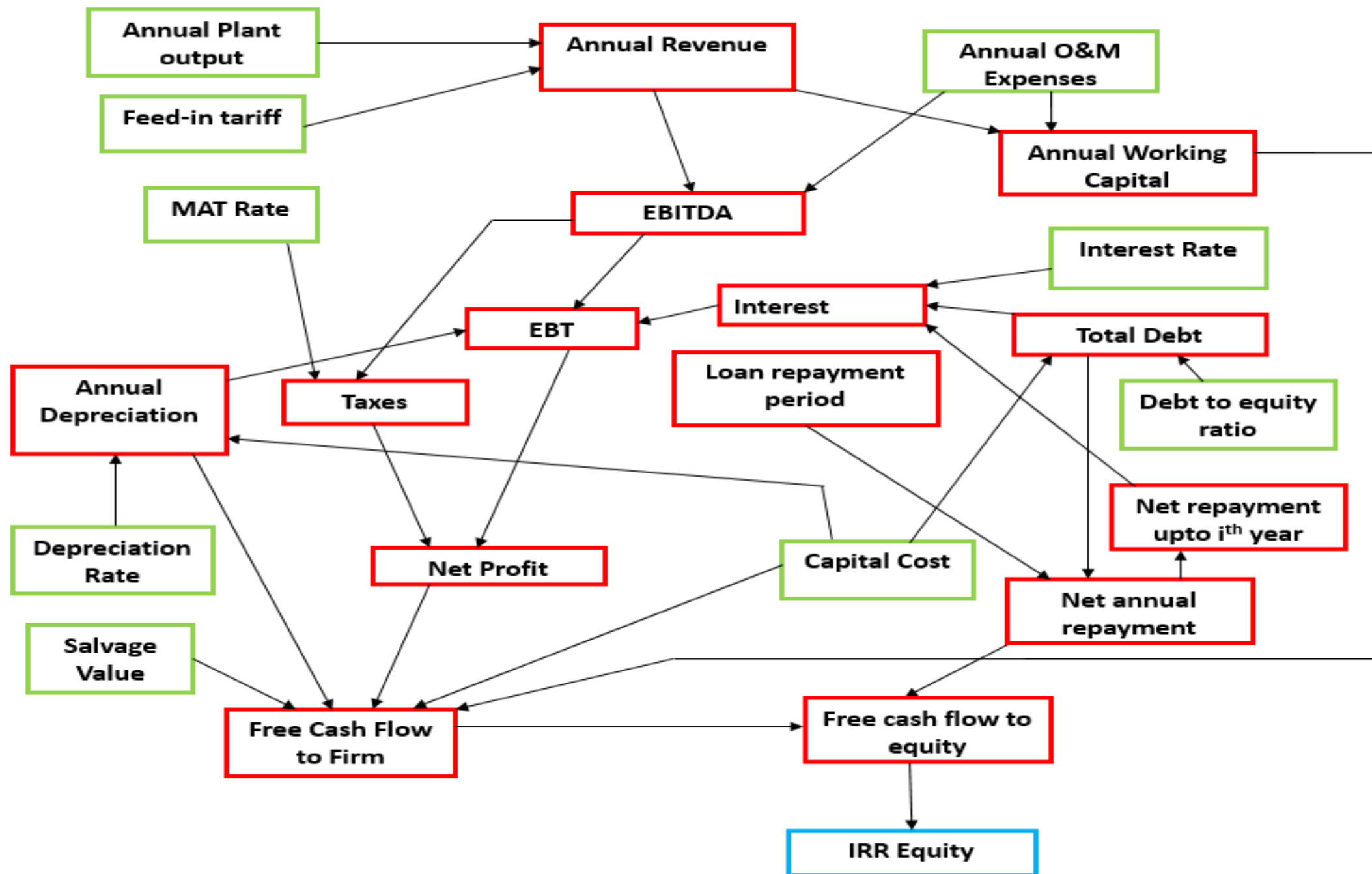
Department of Energy Science and Engineering



IIT Bombay

# Methodology - Cost Analysis





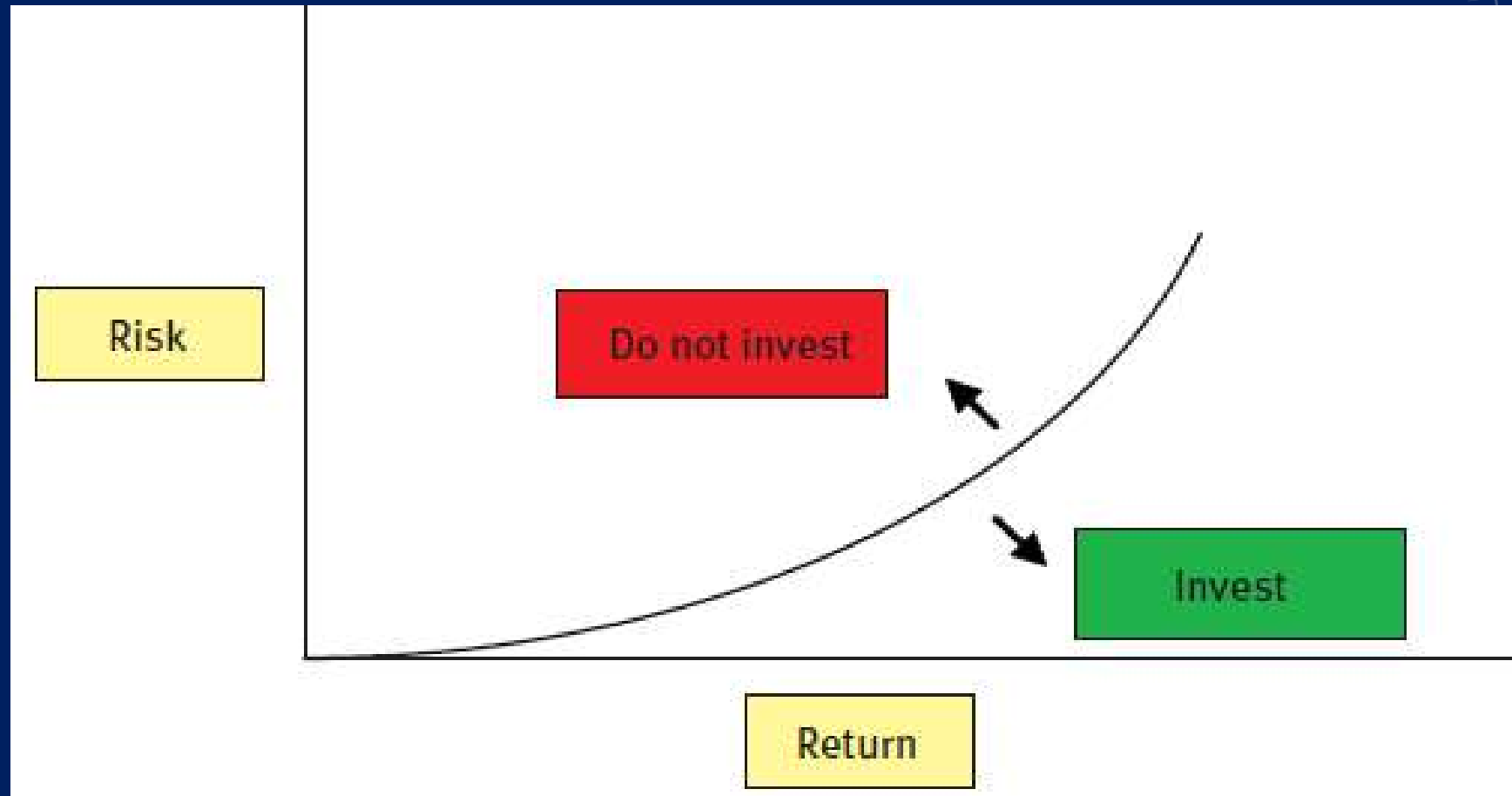
# Financing Basics: Risks and Returns



# Financing Sources

- Debt – acquisition of funds by borrowing
  - corporate or project loans, leasing arrangement
- Equity – selling shares for raising capital
- Grants and Guarantees

# Risk- Return Profile



# Risks

- Credit Risk – Creditworthiness
- Construction and Development Risk
- Operating/Commercial Risk
- Political Risk
- Financial Risk
- Regulatory/Legal Risk
- Environmental Risk
- Force Majeure

Dimension	Corporate finance	Project finance
Financing vehicle	Multi-purpose organization	Single-purpose entity
Type of capital	Permanent - an indefinite time horizon for equity	Finite - time horizon matches life of project
Dividend policy and reinvestment decisions	Corporate management makes decisions autonomous from investors and creditors	Fixed dividend policy - immediate payout; no reinvestment allowed
Capital investment decisions	Opaque to creditors	Highly transparent to creditors
Financial structures	Easily duplicated; common forms	Highly-tailored structures which cannot generally be re-used
Transaction costs for financing	Low costs due to competition from providers, routinized mechanisms and short turnaround time	Relatively higher costs due to documentation and longer gestation period
Size of financings	Flexible	Might require critical mass to cover high transaction costs
Basis for credit evaluation	Overall financial health of corporate entity; focus on balance sheet and cashflow	Technical and economic feasibility; focus on project's assets, cash flow and contractual arrangements
Cost of capital	Relatively lower	Relatively higher
Investor/lender base	Typically broader participation; deep secondary markets	Typically smaller group; limited secondary market

Source: Wharton teaching note 1996



# Financing Instruments

**Table 2.** Matrix of financing instruments

	Market-based loans	Soft loans	Grants	Equity investments	Guarantees	Technical assistance	Other
Multilateral development banks	X	X	Some	Some	X	X	
Bilateral aid	X	X	Some			X	
Funds/foundations	X	X	X	Some			
Green investment				X			X
National development funds	X	X			X	X	
Commercial loans and investment	X			X			

*Source:* IEA PVPS, Sources of financing for PV-Based Rural Electrification in Developing Countries, 2004

# Project Finance History

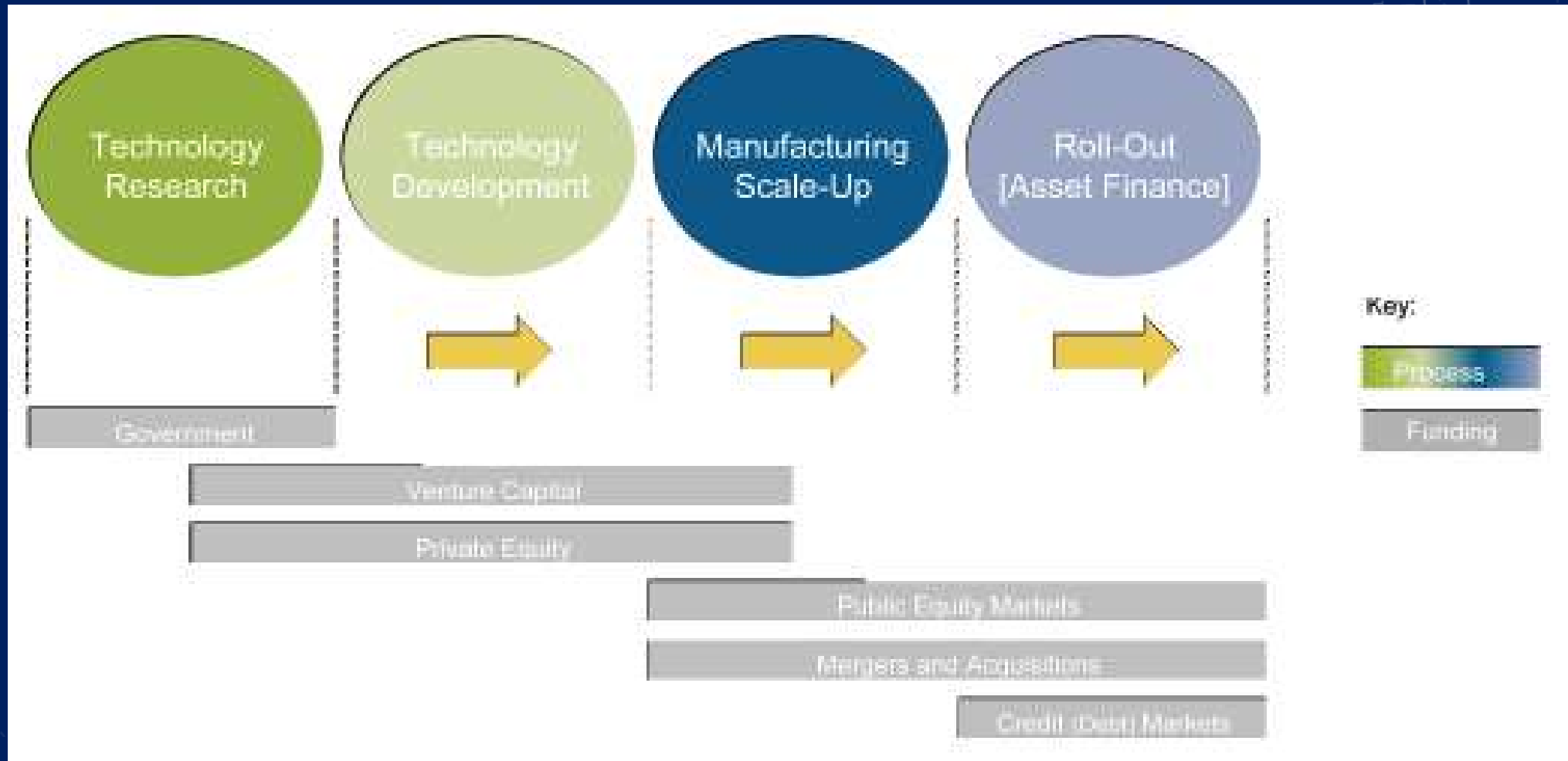
- 1299 English crown financed Devon silver mines Florentine bank Frescobaldi – one year lease and mining concession
- Financing sailing ship voyages 17<sup>th</sup> century – voyage by voyage basis, cargo and ships liquidated – proceeds split among investors
- North Sea Oil pipeline

# Project Finance

“a financing of a major independent capital investment that the sponsoring company has segregated from its assets and general purpose obligations “  
Wynant, Harvard Business Review, 1980

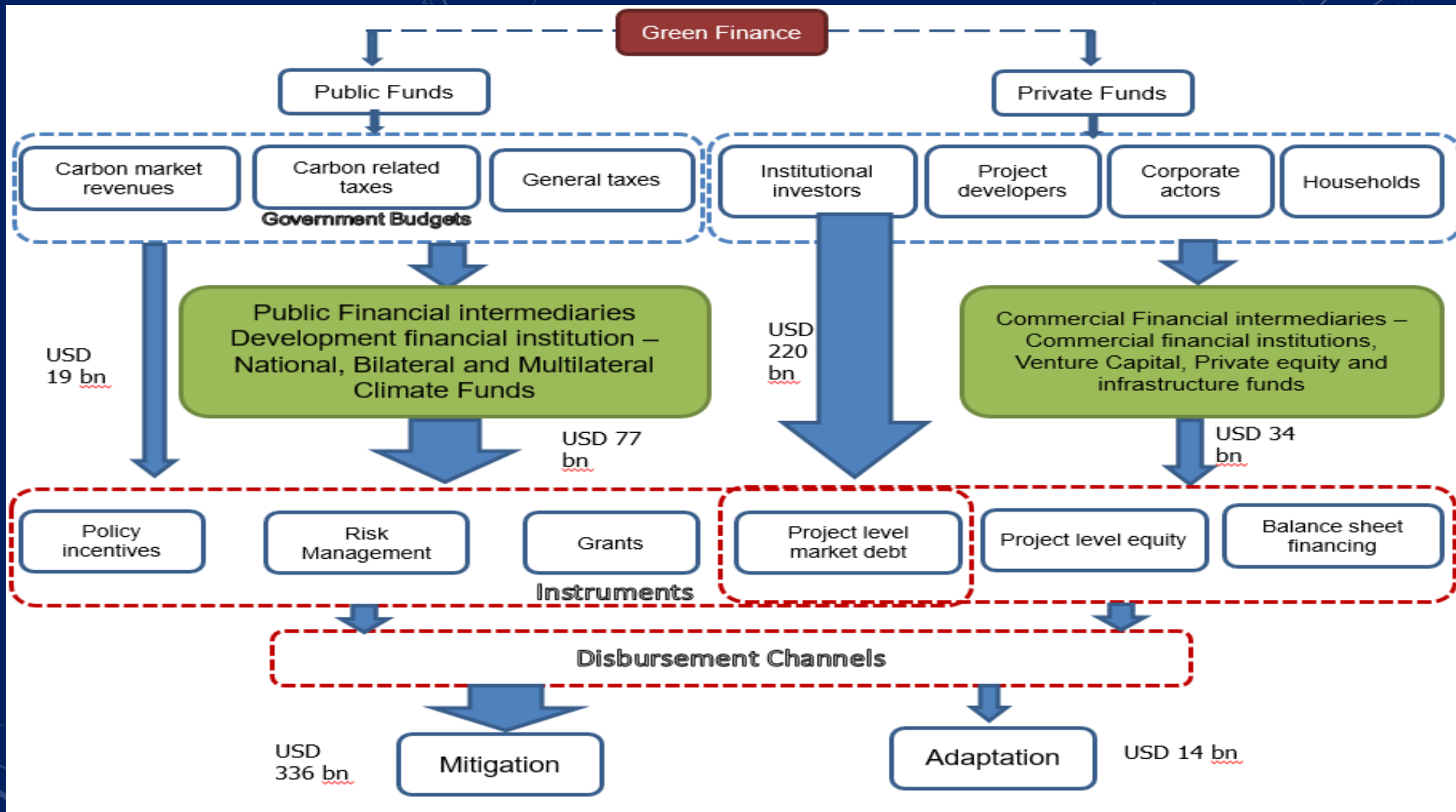
Source: Wharton teaching note 1996

# Funding Sources and Stages



## Some Definitions

- Financing with recourse- corporate financing, balance sheet financing -
- Non- Recourse Financing – Lenders only have recourse to cash flows of the project and the project assets in the event of project failure



Source: The Landscape of Climate Finance 2012, CPI Report

Figure 5: Global climate finance flows along their life cycle in 2015 and 2016. Values are average of two years' data, in USD billions

## LANDSCAPE OF CLIMATE FINANCE IN 2015/2016

Global climate finance flows along their life cycle in 2015 and 2016. Values are average of two years' data, in USD billions.

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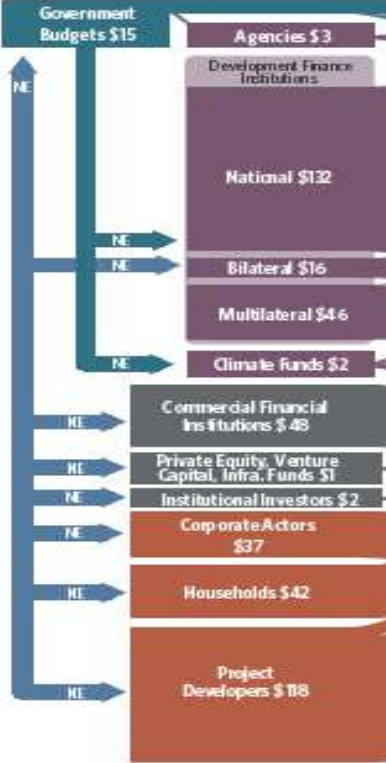
BN USD  
ANNUAL  
AVERAGE



CLIMATE  
POLICY  
INITIATIVE

### SOURCES AND INTERMEDIARIES

Which type of organizations are sources or intermediaries of capital for climate finance?



### INSTRUMENTS

What kind of financial instruments are used?



### RECIPIENTS

Does climate finance go through public or private channels?



### USES

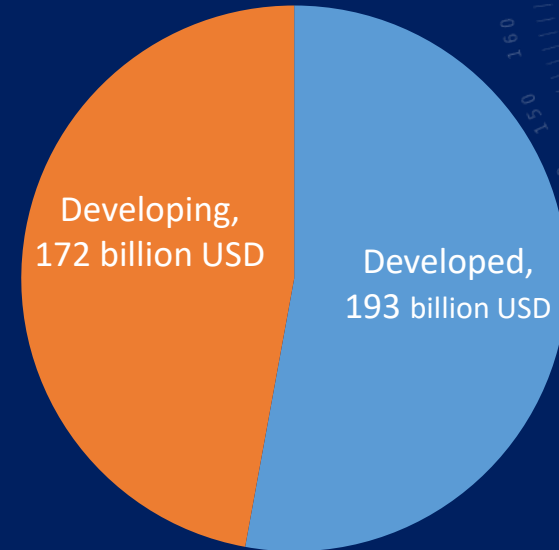
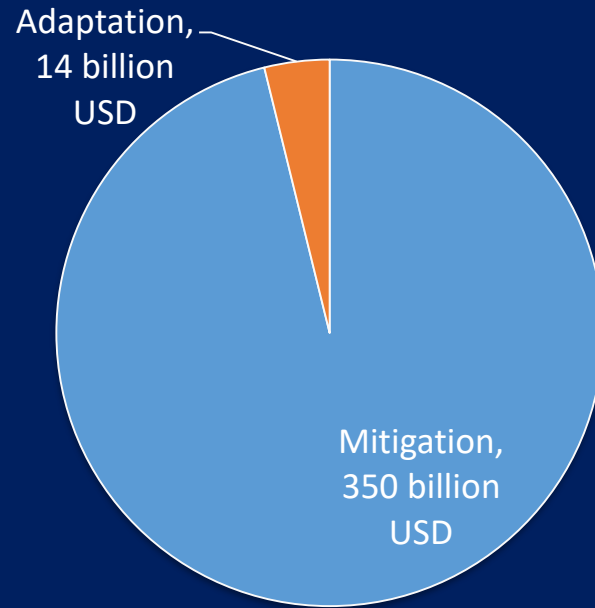
What types of activities are financed?



### KEY

- PUBLIC MONEY
- PRIVATE MONEY
- PUBLIC FINANCIAL INTERMEDIARIES
- PRIVATE FINANCIAL INTERMEDIARIES
- FINANCE FOR INVESTORS & LENDERS
- ME: NOT ESTIMATED

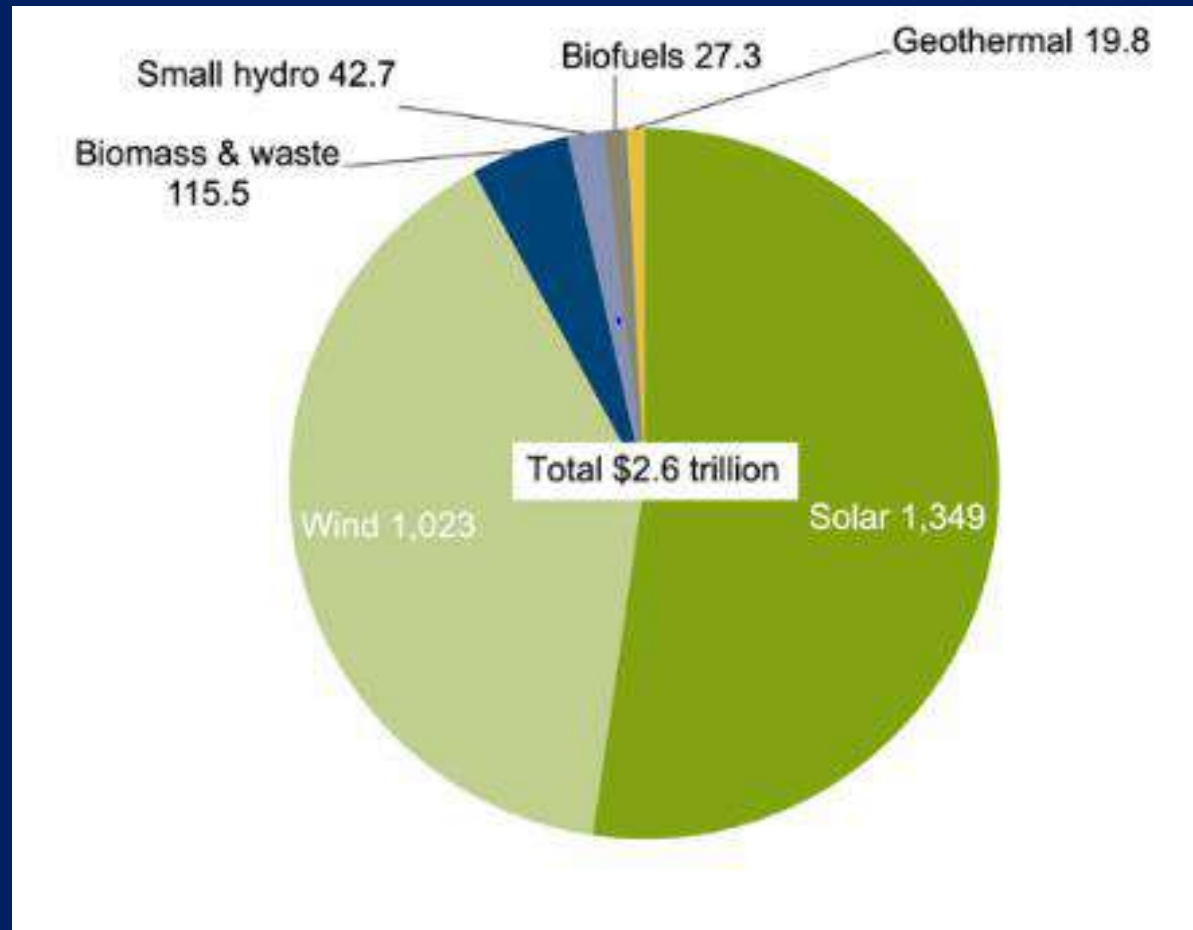
# Global climate finance landscape



- 171 billion USD (33% of total) to China, Brazil and India
- Out of ~ 85 billion USD from Government budgets and Development financial institutions ~ 30% in China and ~7% in India → ~6 billion USD

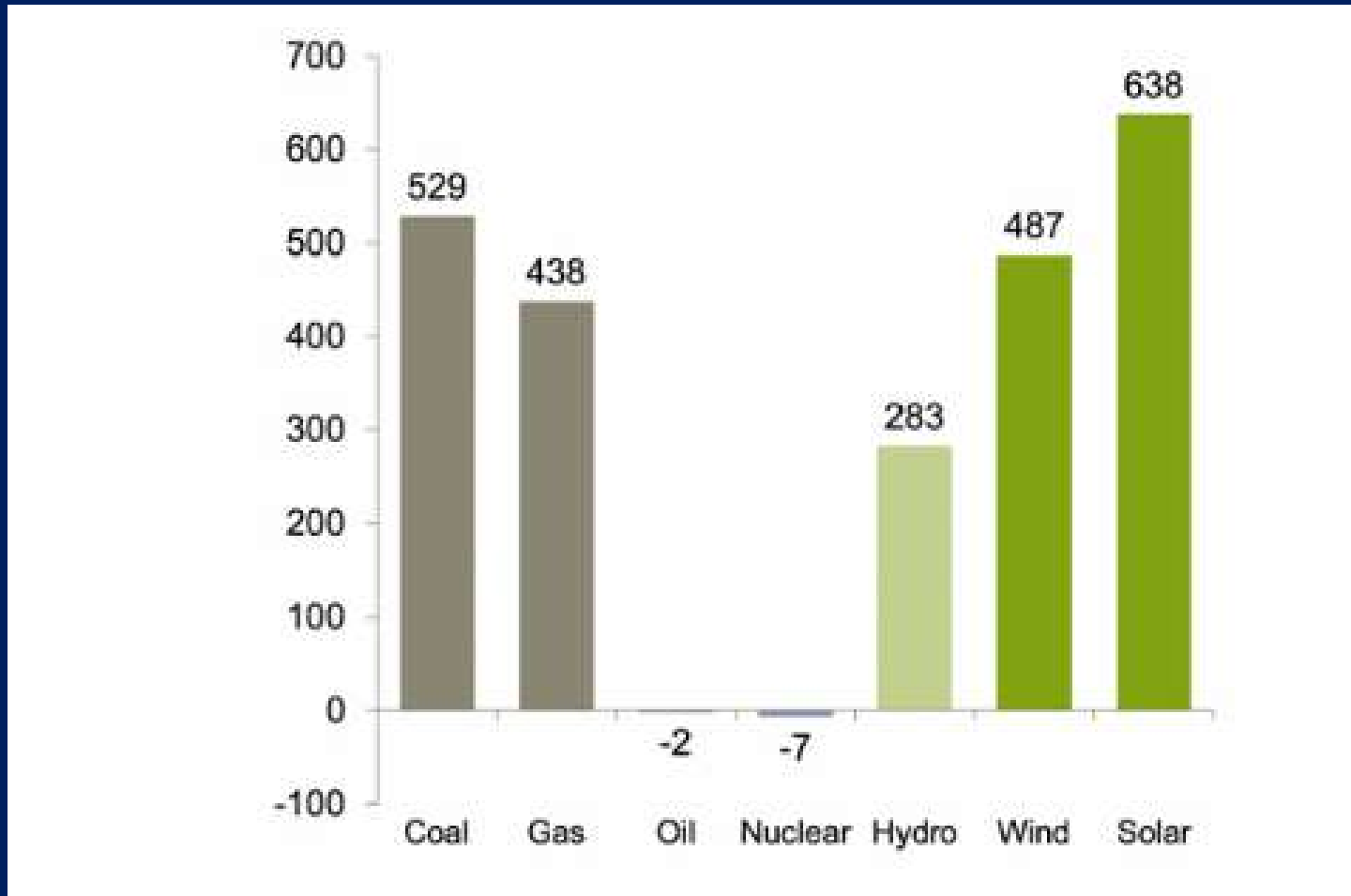


# Renewable Investment 2018

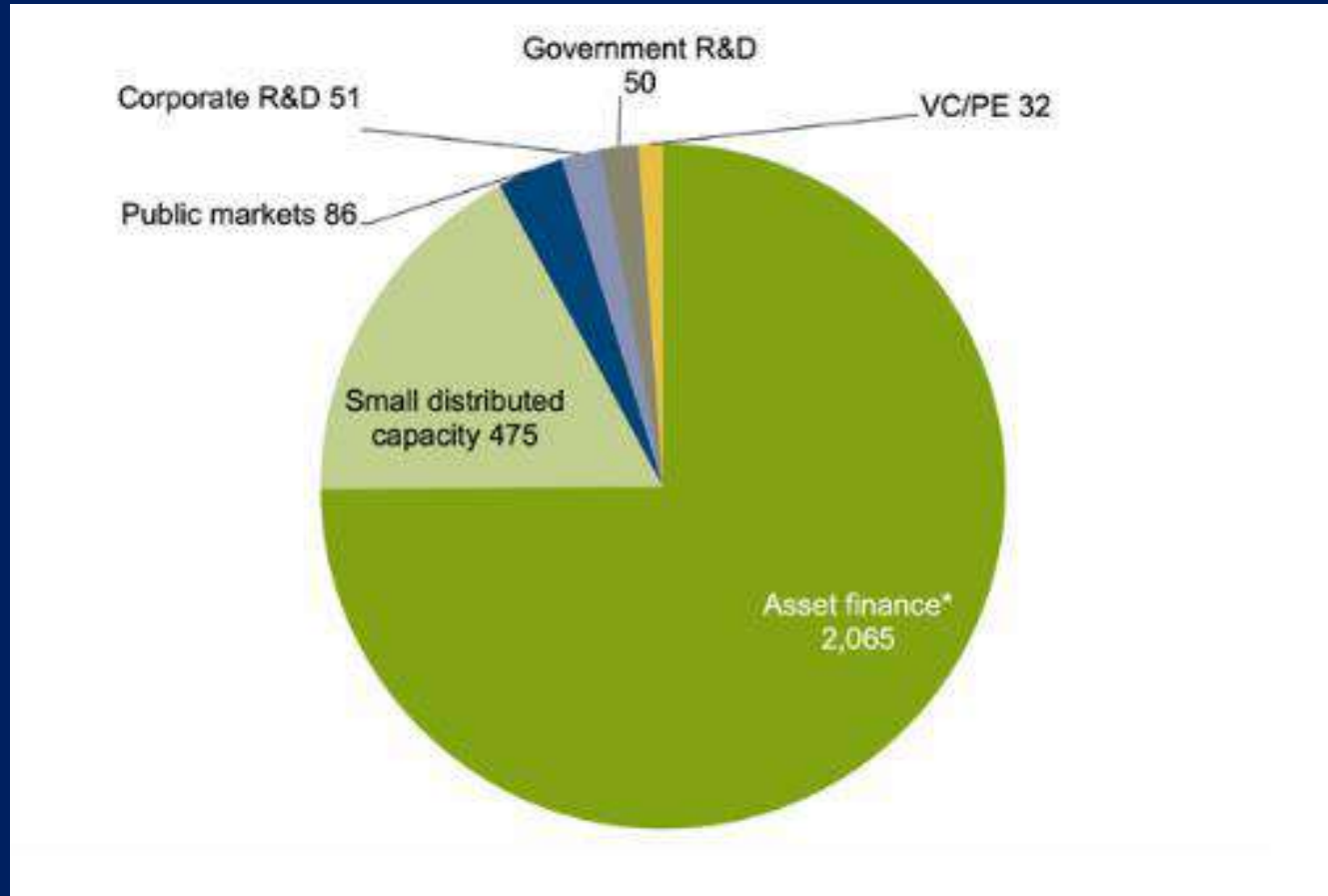


BNEF, 2019

# Net Capacity added during 2009-19



# Source of Renewable Energy financed over last decade

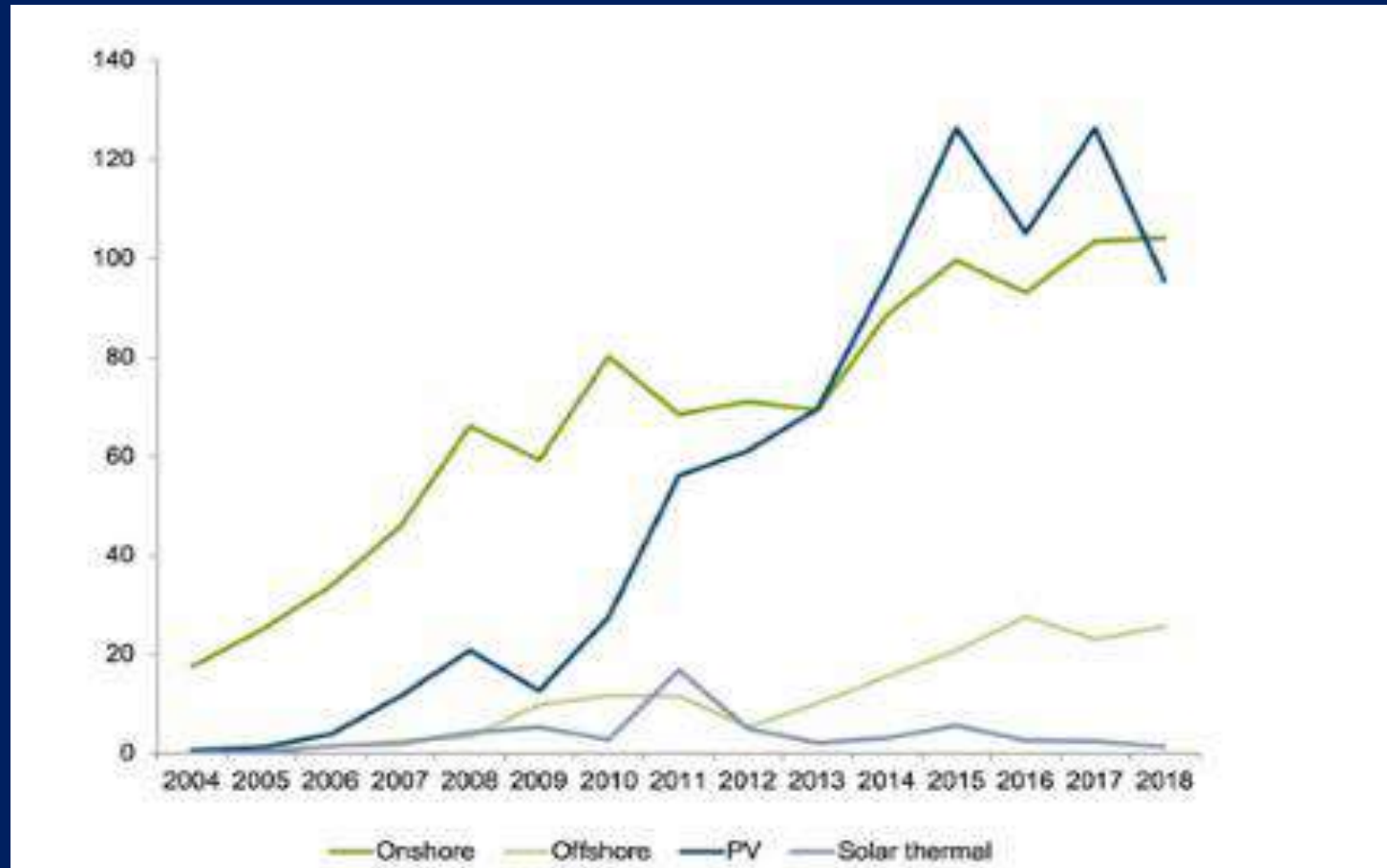


BNEF, 2019

	Investor type	Examples	Preferred asset classes	Investment horizon	Targeted returns <sup>(a)</sup>
← Low returns / low risk – High returns / high risk →	Venture capital	<ul style="list-style-type: none"> <li>• Accel Partners</li> <li>• Sequoia Capital</li> </ul>	<ul style="list-style-type: none"> <li>• Early-stage companies and platforms</li> </ul>	<ul style="list-style-type: none"> <li>• ~10 years (fund life)</li> <li>• ~3-5 years (exits for individual investments)</li> </ul>	<ul style="list-style-type: none"> <li>• &gt;30%</li> </ul>
	'Development' private equity	<ul style="list-style-type: none"> <li>• KKR</li> <li>• Starwood Energy</li> </ul>	<ul style="list-style-type: none"> <li>• Infrastructure projects</li> <li>• Portfolios of projects</li> </ul>	<ul style="list-style-type: none"> <li>• ~7-10 years (fund life)</li> </ul>	<ul style="list-style-type: none"> <li>• ~10-20%</li> </ul>
	Infrastructure debt funds	<ul style="list-style-type: none"> <li>• Hadrian's Wall</li> <li>• Macquarie Group</li> </ul>	<ul style="list-style-type: none"> <li>• Direct infrastructure loans</li> <li>• Infrastructure debt securities</li> </ul>	<ul style="list-style-type: none"> <li>• ~20 years</li> </ul>	<ul style="list-style-type: none"> <li>• ~8-11% (low risk/operational projects)</li> <li>• ~11-15% (low/medium risk primary deals)</li> </ul>
	Hedge funds	<ul style="list-style-type: none"> <li>• Bridgewater</li> <li>• Soros Fund Mgmt</li> </ul>	<ul style="list-style-type: none"> <li>• Liquid securities</li> </ul>	<ul style="list-style-type: none"> <li>• ~1 year</li> </ul>	<ul style="list-style-type: none"> <li>• ~7-10% for absolute return funds</li> <li>• Maximise returns (~20%+) for aggressive funds</li> </ul>
	Banks	<ul style="list-style-type: none"> <li>• JP Morgan</li> <li>• US Bank</li> </ul>	<ul style="list-style-type: none"> <li>• Currently: project finance (construction and term debt), tax equity</li> <li>• Future: construction finance, tax equity</li> </ul>	<ul style="list-style-type: none"> <li>• Debt: <ul style="list-style-type: none"> <li>– Historically: &gt;10 years</li> <li>– Currently: 5-10 year semi-perms</li> </ul> </li> <li>• Tax equity: 5-10 years</li> </ul>	<ul style="list-style-type: none"> <li>• &gt;7% (overall company earnings)</li> <li>• ~2.5-3% debt spreads over three month LIBOR<sup>(b)</sup></li> <li>• ~7-8% tax equity after-tax yield for utility-scale PV, ~9% for distributed portfolios (unlevered), 14-18% (levered)</li> <li>• &gt;14% for tax equity structures favouring IRR over NPV</li> </ul>
	Large corporations	<ul style="list-style-type: none"> <li>• Apple</li> <li>• Chevron</li> </ul>	<ul style="list-style-type: none"> <li>• Cash</li> <li>• Short-term commercial paper and notes</li> <li>• Liquid, low-risk tax credits</li> </ul>	<ul style="list-style-type: none"> <li>• &lt;1 year for &gt;50% of fixed income on balance sheet</li> <li>• ~1-5 years for most other fixed income holdings</li> <li>• Corporate minority equity holdings</li> </ul>	<ul style="list-style-type: none"> <li>• &gt;7% (overall company earnings)</li> <li>• &gt;LIBOR for fixed income holdings</li> <li>• &gt;8% for tax equity (eg, low-income housing)</li> </ul>
	Mutual funds / Retail investors	<ul style="list-style-type: none"> <li>• Fidelity</li> <li>• T Rowe Price</li> </ul>	<ul style="list-style-type: none"> <li>• Liquid securities</li> </ul>	<ul style="list-style-type: none"> <li>• Quarterly, for some</li> <li>• ~1-2 years, for others</li> <li>• ~10+ for retirement portfolios</li> </ul>	<ul style="list-style-type: none"> <li>• ~6-8%</li> </ul>

↓	Pension funds / Endowments	<ul style="list-style-type: none"> <li>National Pension Service of Korea</li> <li>New York State Teachers</li> <li>Yale Endowment</li> </ul>	<ul style="list-style-type: none"> <li>Various: willing to invest in managers (sometimes directly) across broad range of asset classes – eg, venture capital, equities, real estate</li> </ul>	<ul style="list-style-type: none"> <li>Annual (liability matching framework: ensure yearly liabilities are met)</li> <li>'Perpetuity' for overall fund lifetime</li> </ul>	<ul style="list-style-type: none"> <li>~7-8%</li> </ul>
	Utilities	<ul style="list-style-type: none"> <li>Constellation</li> <li>Tri-State G&amp;T Coop</li> </ul>	<ul style="list-style-type: none"> <li>Power plants</li> </ul>	<ul style="list-style-type: none"> <li>Quarterly (overall company earnings)</li> <li>&gt;20 years (asset lifetimes)</li> </ul>	<ul style="list-style-type: none"> <li>~11% required return on equity</li> <li>~5–6% WACC</li> <li>~4% dividend yield</li> </ul>
	Insurance companies	<ul style="list-style-type: none"> <li>AIG</li> <li>Prudential</li> </ul>	<ul style="list-style-type: none"> <li>Fixed income to cover claims</li> <li>Riskier assets to grow asset base</li> </ul>	<ul style="list-style-type: none"> <li>&gt;20 years (long-term assets)</li> </ul>	<ul style="list-style-type: none"> <li>~6% (long-term)</li> <li>Maximise return</li> </ul>
Other stakeholders	Vendors / EPC installers	<ul style="list-style-type: none"> <li>Bechtel</li> <li>Trina Solar</li> </ul>	<ul style="list-style-type: none"> <li>Pipelines / channels for their products</li> </ul>	<ul style="list-style-type: none"> <li>~3-5 years (companies looking to ensure future sales of their products)</li> </ul>	<ul style="list-style-type: none"> <li>~2.5-3% debt spreads over three-month LIBOR<sup>(b)</sup></li> </ul>
	Landowners / Real estate developers	<ul style="list-style-type: none"> <li>Ted Turner</li> <li>Vornado</li> </ul>	<ul style="list-style-type: none"> <li>Land, buildings</li> </ul>	<ul style="list-style-type: none"> <li>~10 years (fund lifetime)</li> <li>&gt;20 years (for individual holdings)</li> </ul>	<ul style="list-style-type: none"> <li>~20-25% (development)</li> <li>~5% REIT dividend yield</li> </ul>
	Government	<ul style="list-style-type: none"> <li>California PUC</li> <li>US Treasury</li> <li>US Army</li> </ul>	<ul style="list-style-type: none"> <li>Projects</li> </ul>	<ul style="list-style-type: none"> <li>Long term</li> </ul>	<ul style="list-style-type: none"> <li>n.a.</li> </ul>

# Renewable Investment Trend





# Renewable Energy Investors

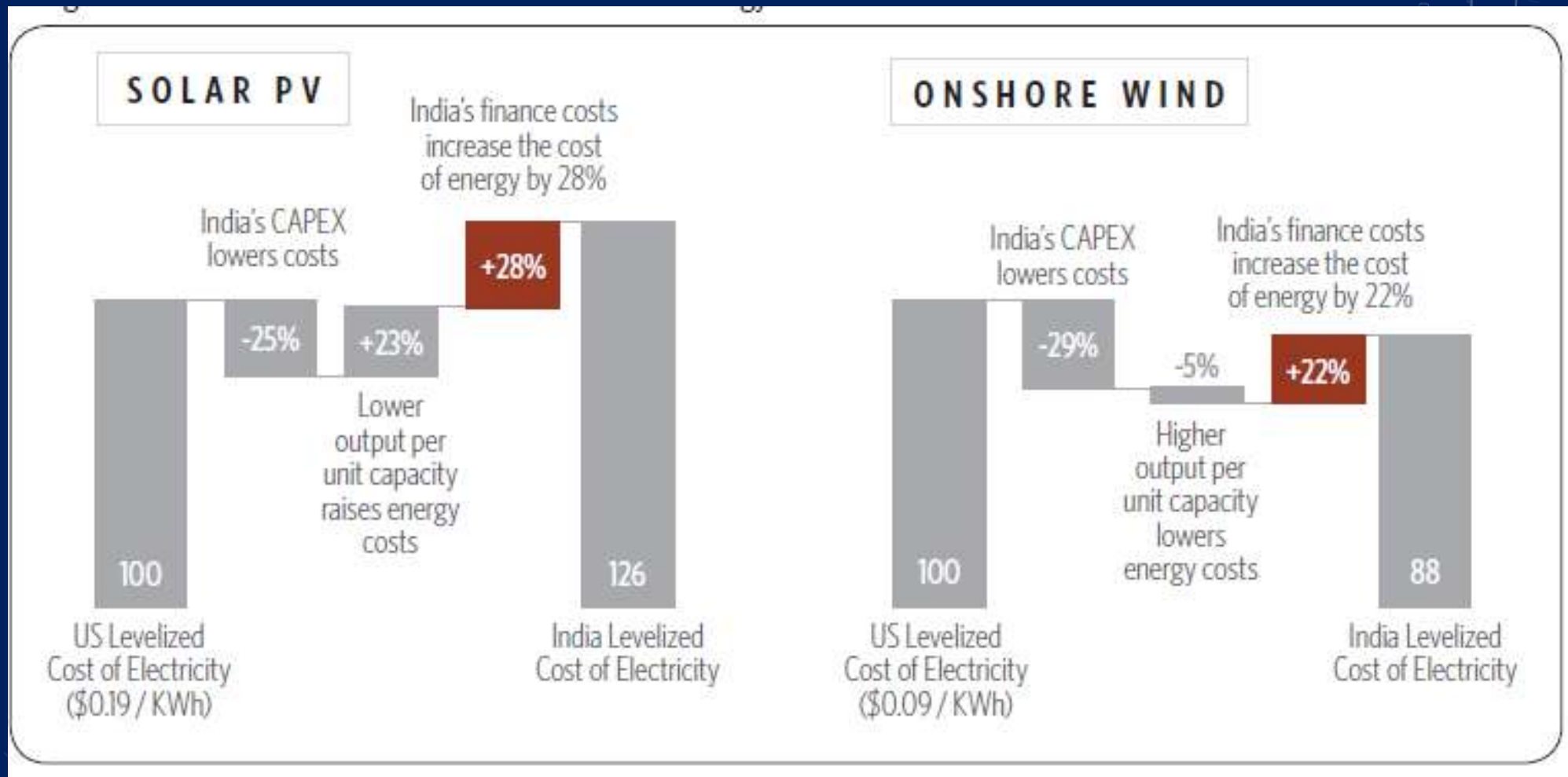
Table 2-1: Renewable energy investors (number of institutions)

TYPE OF INVESTOR	CATEGORY	TOTAL REGISTERED IN INDIA	ACTIVE IN RENEWABLE SECTOR
Commercial banks	Public sector banks	26	9
	Private sector banks	30	6
	Foreign banks	37	-
Equity investors	Private equity	51	16
	Venture capital	180	21
Institutional investors	Insurance funds	24	11
Development Banks	Development financial institutions*	3	3

\*DFIs include national level institutions IREDA, IFCI, SIDBI

Source: Nelson et al, 2012

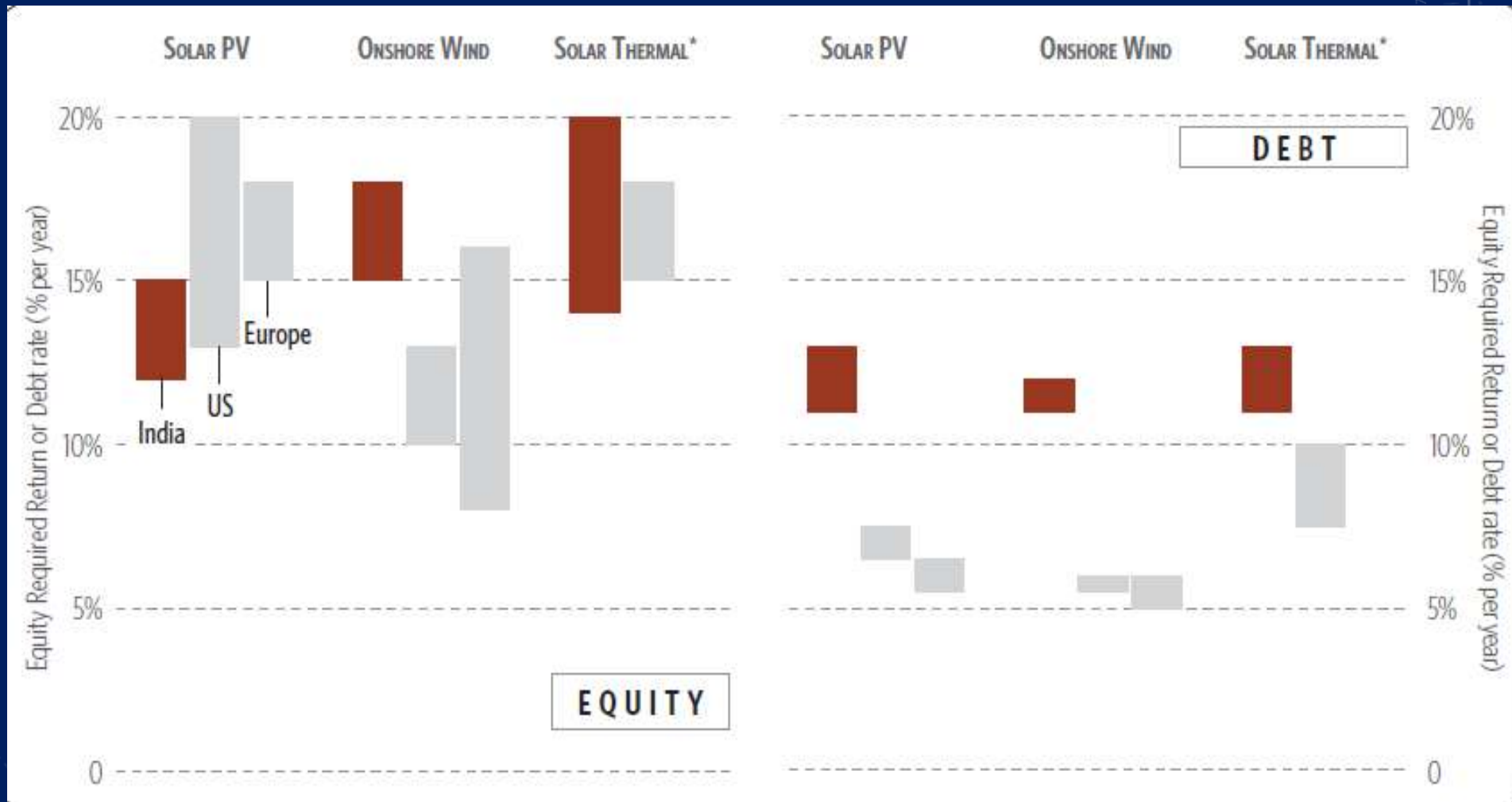
# Cost Of Finance – India and US



Source: Nelson et al, 2012

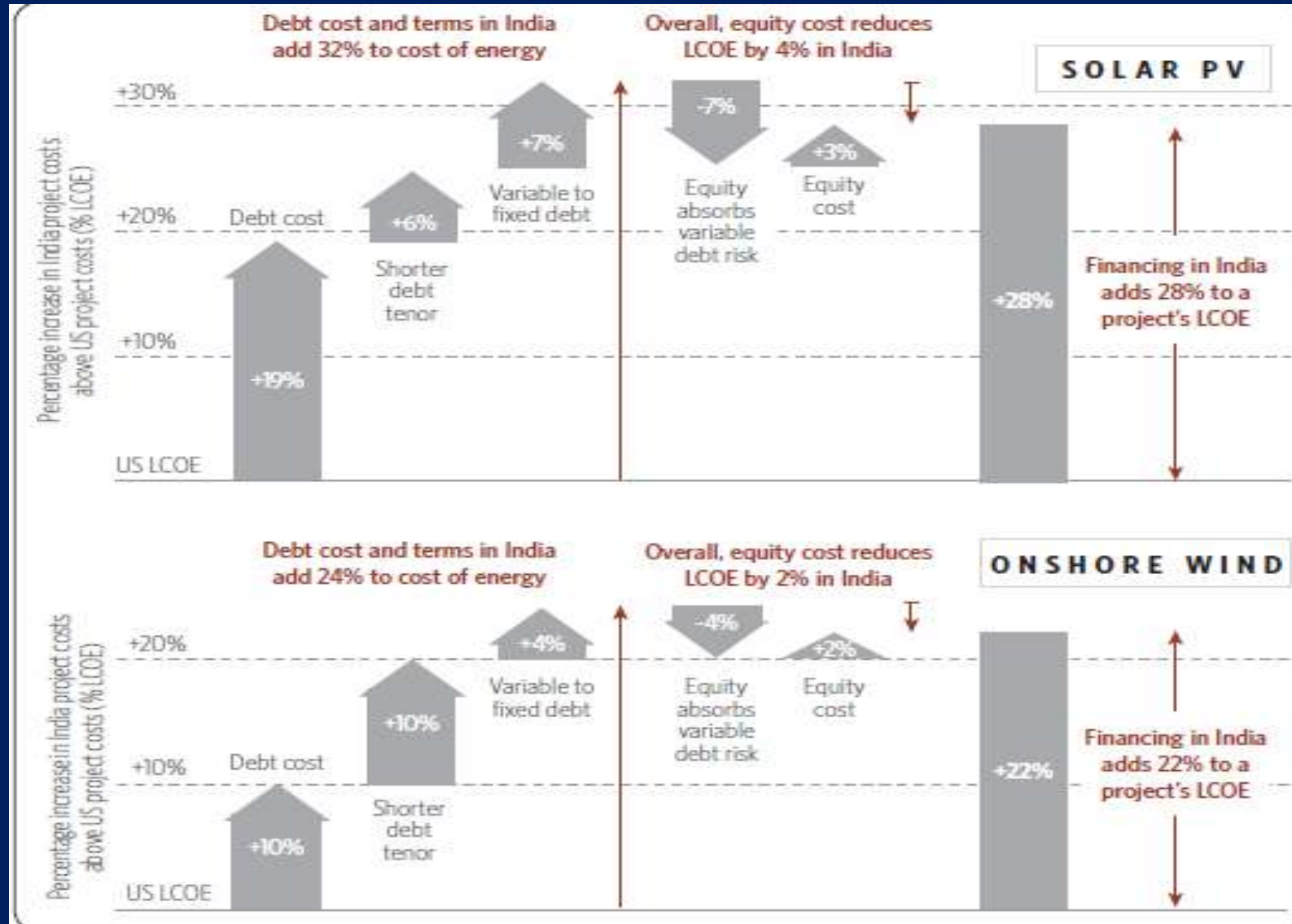


# Returns on Debt and Equity

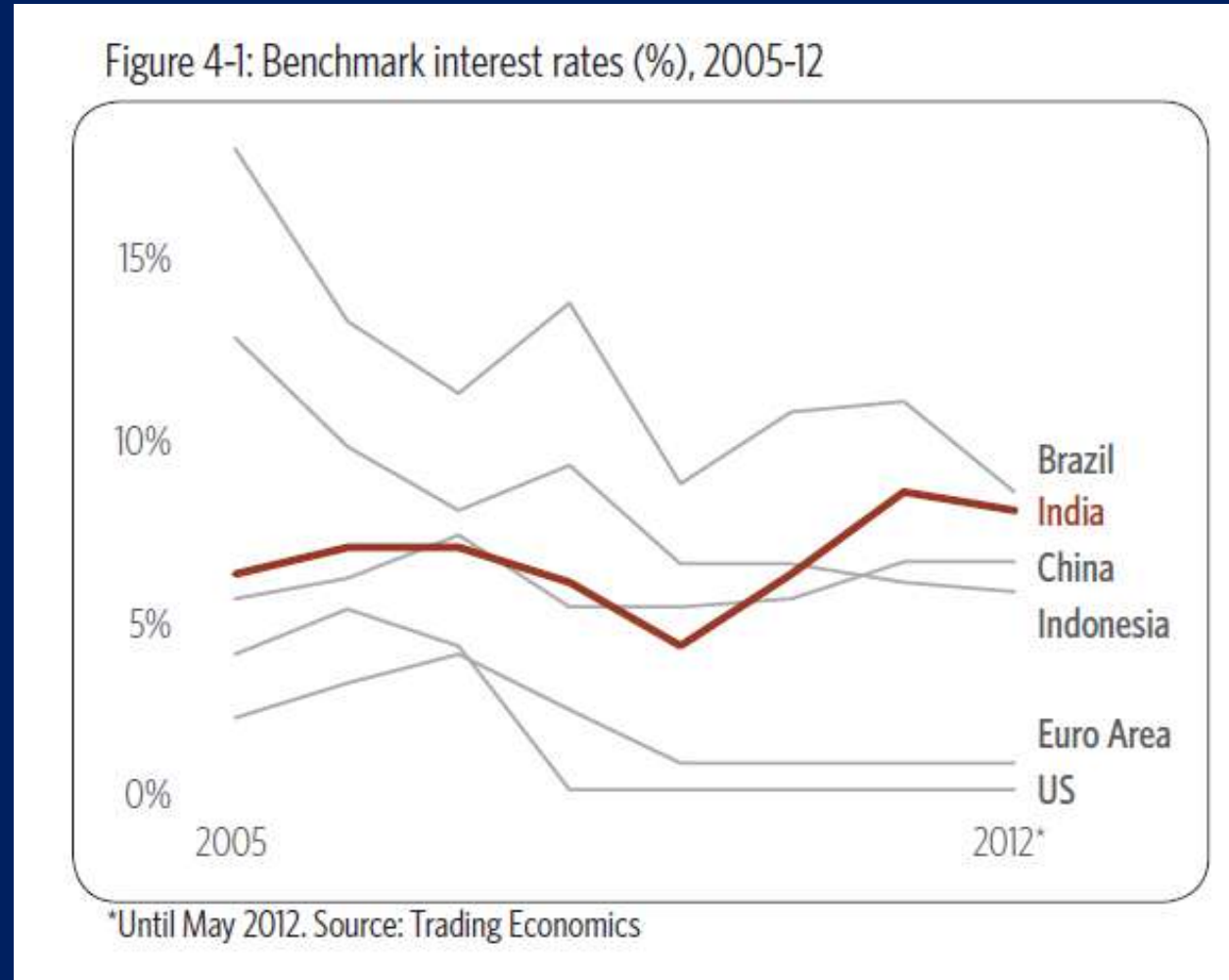


Source: Nelson et al, 2012

# Impact of Debt and Equity

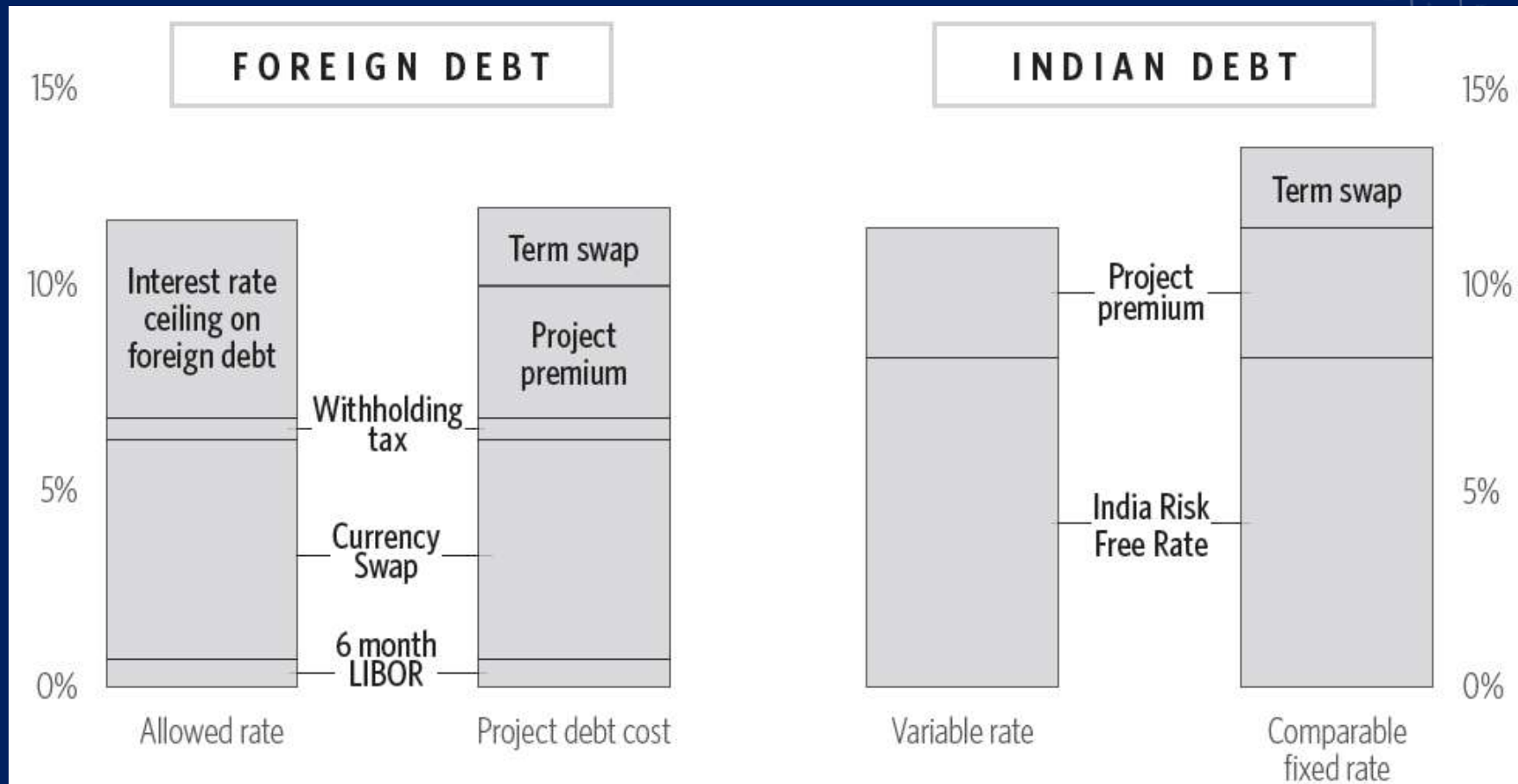


# Comparison of Benchmark Interest Rates



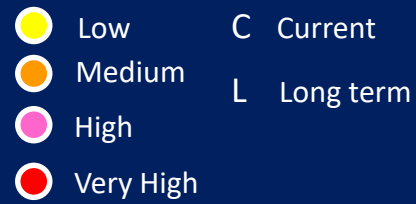
Source: Nelson et al, 2012

# Comparison of debt rates



Source: Nelson et al, 2012

## Debt : Summary



Financial Market	Renewable Specific	Foreign Investment	Tech. Specific	State. Specific
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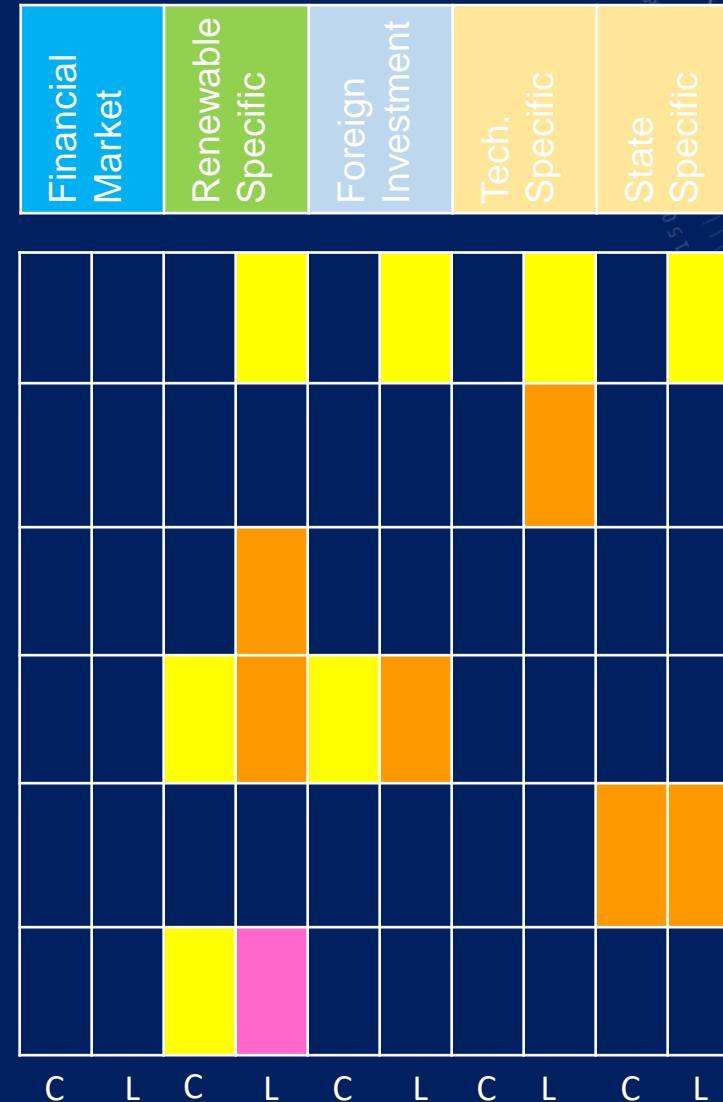
COST AND TERMS	High general Indian interest rate environment	Very High	Very High																
	Longer tenor debt is generally unavailable	Medium	High																
	Fixed interest rate debt is difficult to find	Low	High																
	Debt is usually offered on a relationship basis	Medium	Medium																
	Shortage of debt			Low	Medium														
AVAILABILITY	Bank place limits			Low	High														
	Renewable energy debt is often included within power or energy sector limits			Medium	High														
	Some banks are not lending to renewable energy			Medium	High														
	Limits on foreign debt	Low	High			Low	High												
	Technology risk							Medium	Medium										
	State-level policy									Medium	High								
		C	L	C	L	C	L	C	L	C	L								

Source: Nelson et al, 2012

## Equity : Summary

- Low
- Medium
- High
- Very High
- C Current
- L Long term

COST AND TERMS	Equity returns appear reasonable for good projects
	Technology maturity and strategic positioning affects required project returns
AVAILABILITY	Equity is generally available
	Equity from foreign investors is also available
	Equity availability is heavily skewed towards a few states
	Lack of debt may reduce available equity in the medium term



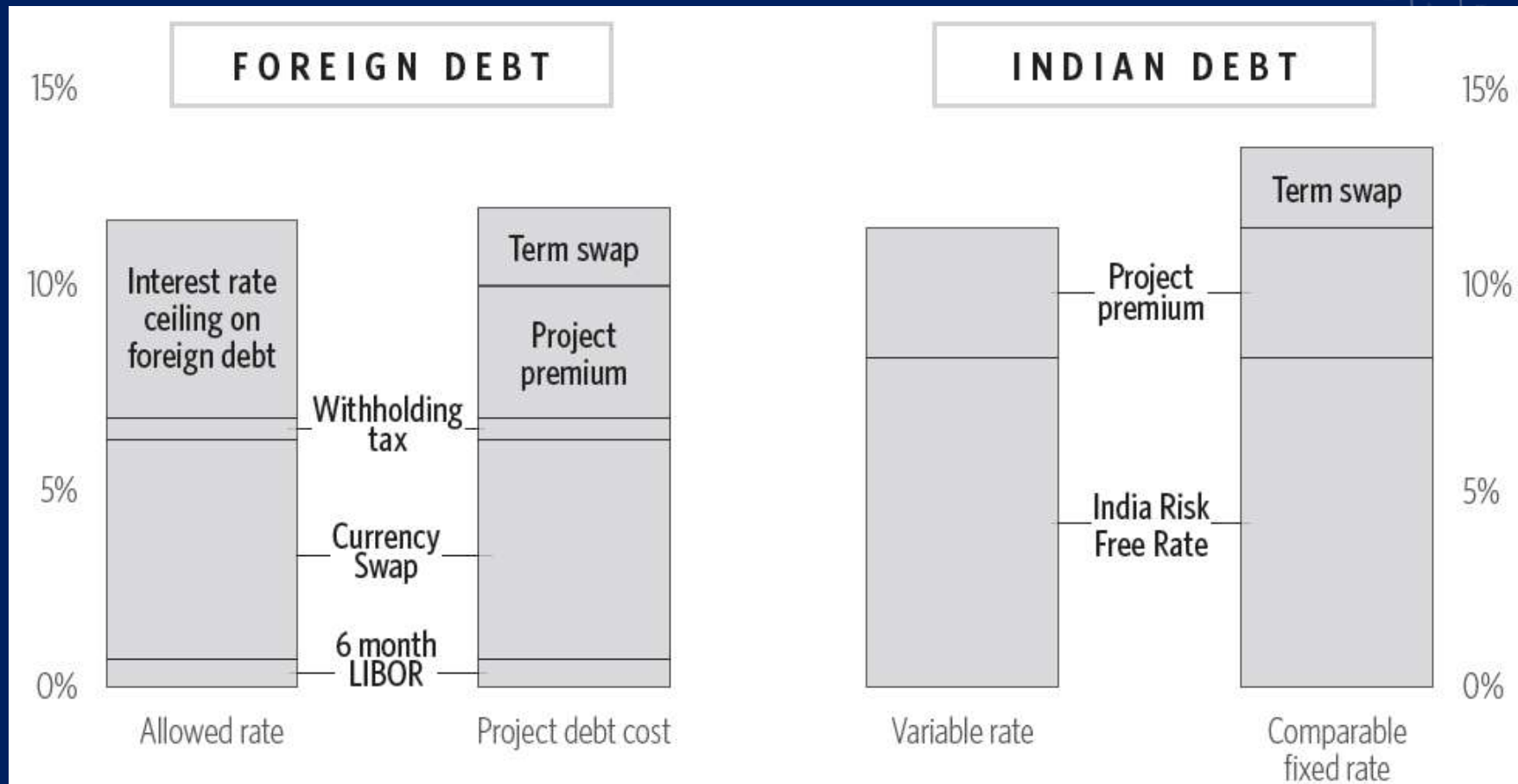
Source: Nelson et al, 2012

# Comparison of Renewable Projects

TECHNOLOGY	CAPITAL EXPENSES (RS. '10 MILLION/MW)	OPERATING EXPENSES (RS / KWH)	TARIFF (RS./ KWH)	TYPICAL INITIAL DEBT LEVELS (% OF TOTAL CAPITAL)	EQUITY INTERNAL RATE OF RETURN (%)	COST OF DOMESTIC DEBT (%)	DEBT-EQUITY SPREAD (%)
Solar PV	7-10	0.60	7.5-12.5	70-75%	12-15%	12-14%	0-3%
Solar CSP	12	0.90	11-15	70-75%	14-20%	12-14%	2-8%
Biomass Power	5.5	1.00 (excl. biomass cost)	5	60-70%	20-25%	13-14%	7-12%
Wind	6	0.45	3.7-5	70-75%	15-18%	11-12%	4-7%
Small Hydro	5.5	0.60	2.2-2.6	70-75%	17-20%	11-12%	6-9%

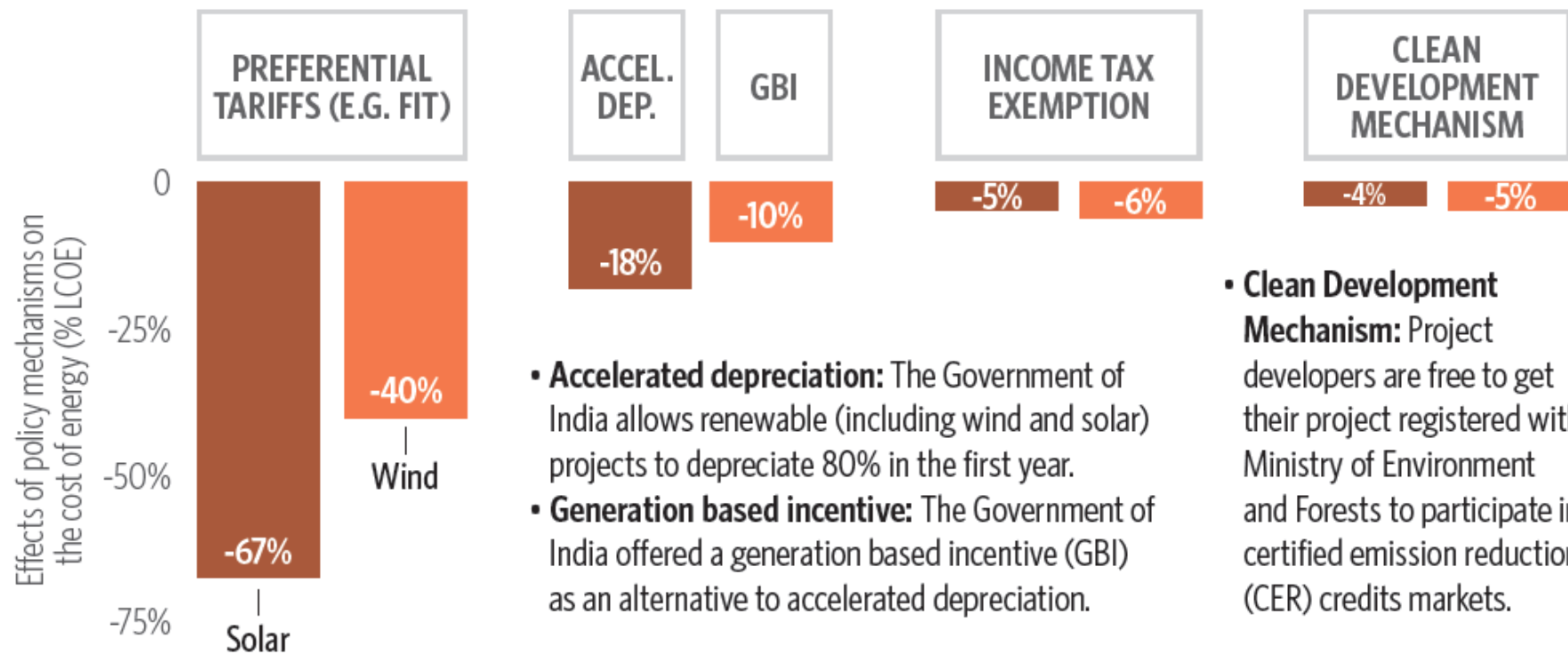
Source: Nelson et al, 2012

# Comparison of debt rates



Source: Nelson et al, 2012





- **Feed-in (or preferential) tariffs (FIT):** FITs are determined in a cost plus manner; and involve long contracts (20-25 years), priority purchase, and priority access to the grid. With the exception of JNNSM, FITs are declared by State Electricity Regulatory Commissions (SERCs).

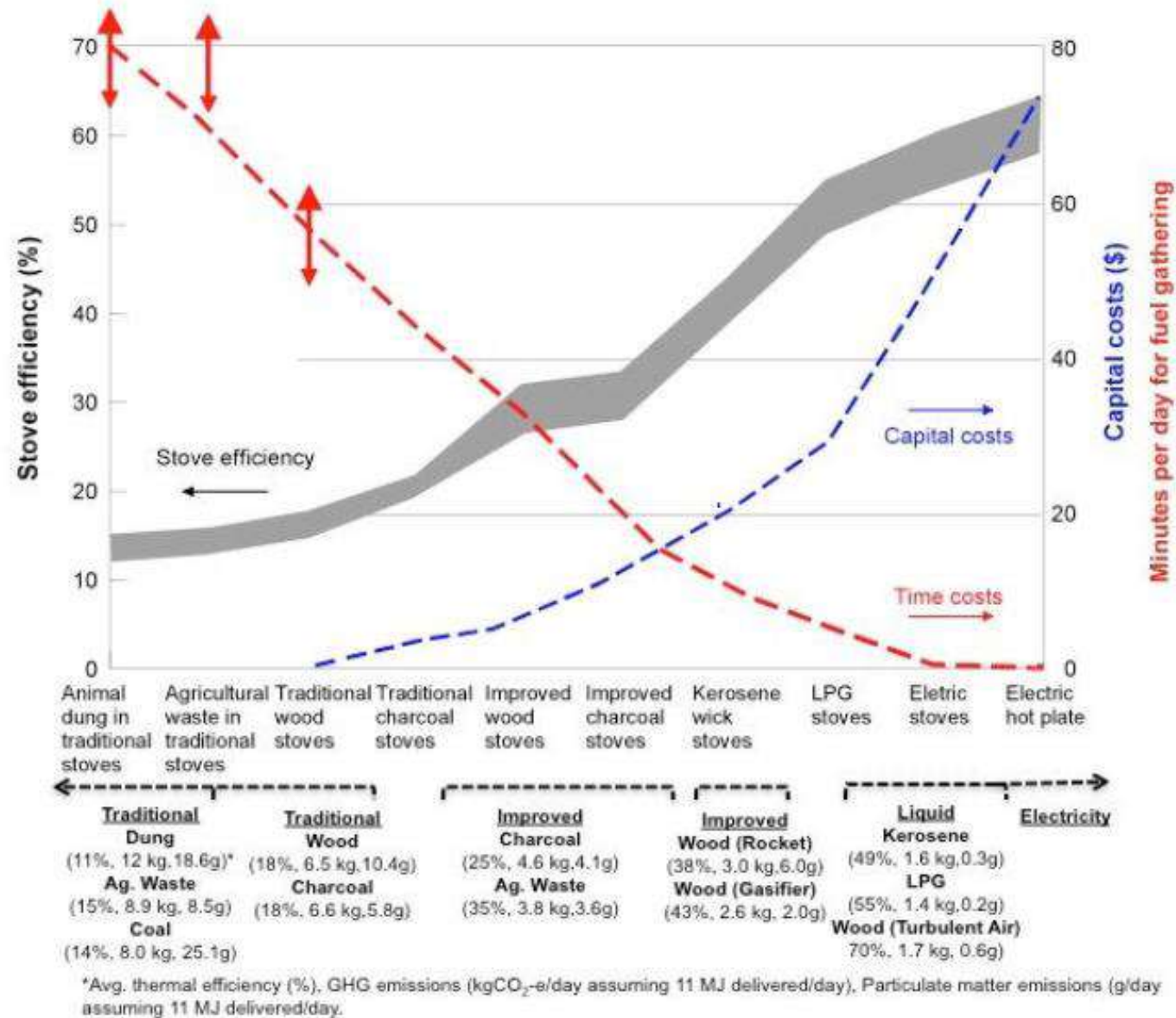
- **Accelerated depreciation:** The Government of India allows renewable (including wind and solar) projects to depreciate 80% in the first year.
- **Generation based incentive:** The Government of India offered a generation based incentive (GBI) as an alternative to accelerated depreciation.

- **Income tax exemption:** The Government of India allows a 100% tax waiver on profits for any single 10-year period during the first 15 years of the operational life of a power generation project.

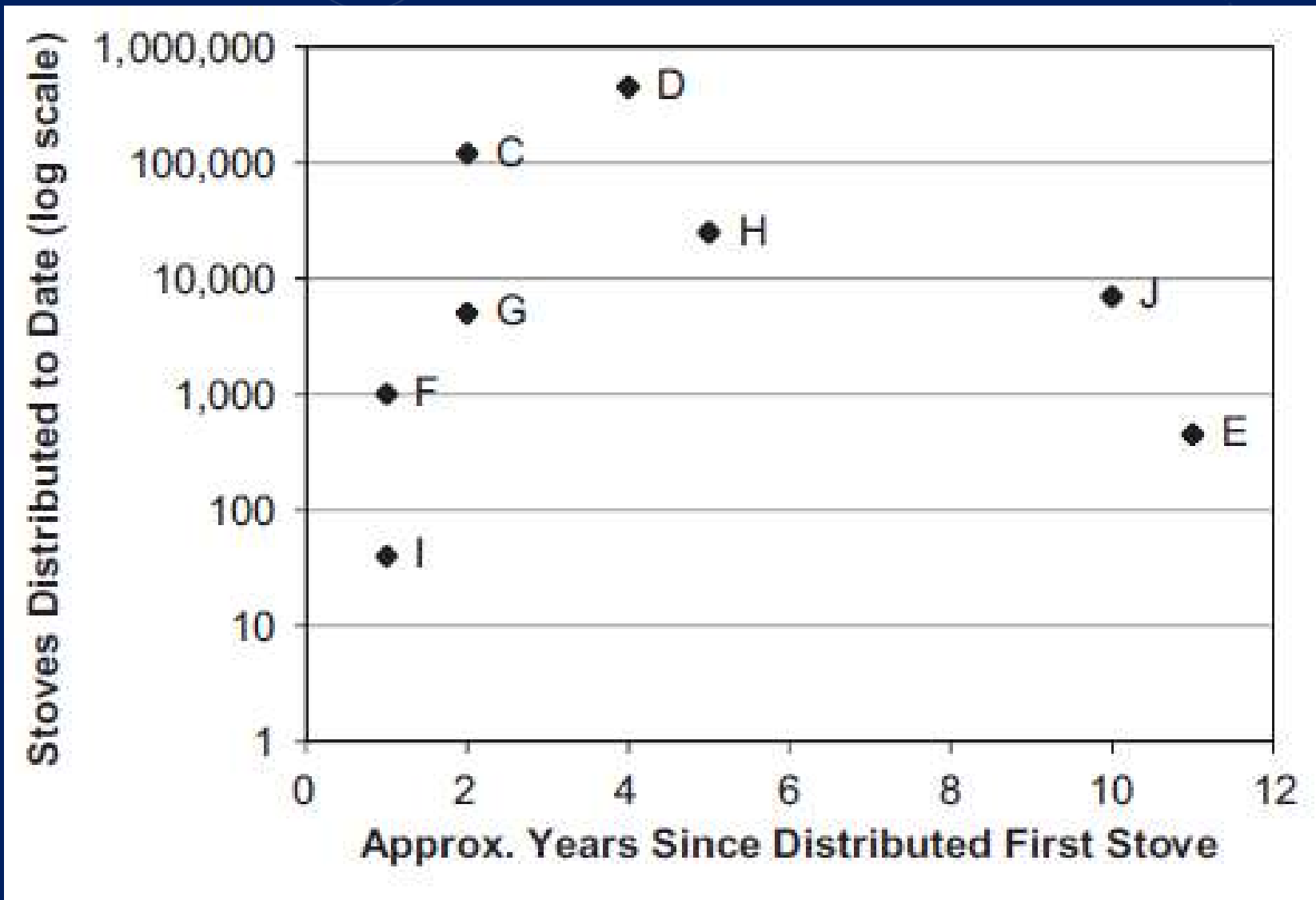
- **Clean Development Mechanism:** Project developers are free to get their project registered with Ministry of Environment and Forests to participate in certified emission reduction (CER) credits markets.

Source: Nelson et al, 2012

Organization	Years in stoves business	Approx. # of direct employees in stoves	Est. total # of stoves sold in India (as of June 2010)	General information (Organizations are for-profit unless otherwise noted)
A	1	3	0	Received first VC funding in late 2010
B	40	300	0 (sold 150,000 in Africa)	Previously funded by Foundation Y, but never managed to develop commercial operations in India; now active in Africa
C	2	60	120,000	Partnered with a US university, parent NGO, and Foundation Y; ramping sales
D	4	21	450,000	Part of Multinational X 2006–2009; currently focused on fuel supply chain
E	11	2	450	Family-run business; initial customers were schools, now expanding to restaurants
F	1	Unknown	1000	Part of large consumer appliances multinational; moving cautiously and has just started operations
G	2	5	5000	Not-for-profit “social enterprise” selling stoves in India, Haiti, Africa
H	5	10	25,000	Private company that grew out of an NGO; seeking funding to grow further
I	1	5	40	Small for-profit company (same founder as Company J); starting to sell to street vendors
J	10	20–50	7000	Non-profit organization; declining sales and concerns about funding stability



[https://www.who.int/airpollution/guidelines/household-fuel-combustion/Review\\_11.pdf?ua=1](https://www.who.int/airpollution/guidelines/household-fuel-combustion/Review_11.pdf?ua=1)



Source: G Shrimali, et al, 2011

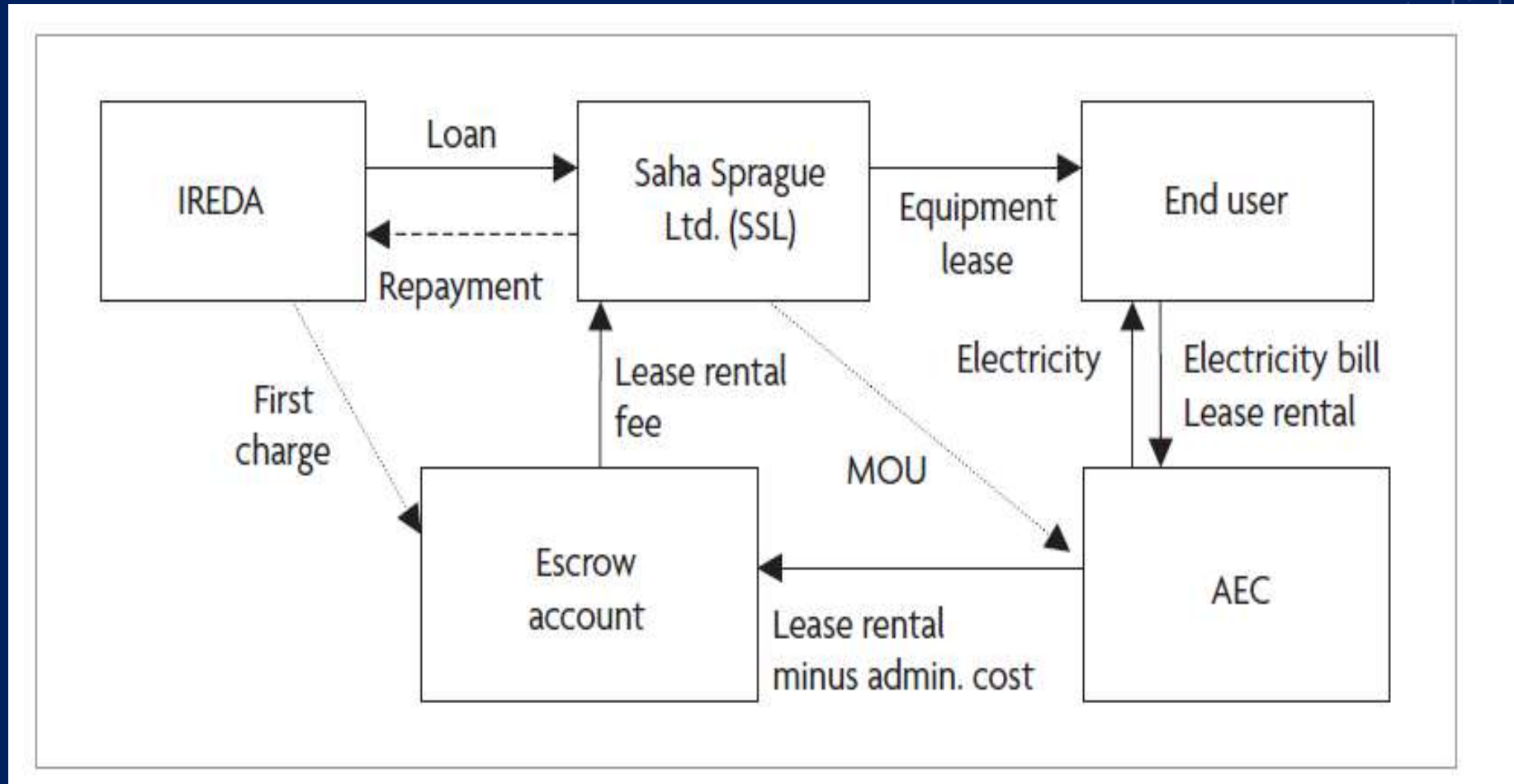


Summary of some key business model attributes and results.

Organization	Selected independent variables					Dependent variables		
	Technology and design	Target customers	External enterprise funding	Channel involvement	Management experience (operations and marketing)	Scale	Sustainability (if current trends continue)	Rationale for assessment of financial sustainability
A	Incremental	Household	Private	Unknown	Limited	TBD	Unknown	Too early to assess
C	Incremental	Household (> \$7/day)	Donor	Significant	Significant	High	Likely	Self-reported possibility of positive cash flow in 2011 and profit in 2012
D <sup>h</sup>	Radical	Household (\$2–8/day)	Private	Significant	Significant	High	Unlikely	Household use has plummeted due to required fuel price increases
D <sup>hc</sup>	Radical	Household (\$2–8/day); commercial	Private	Significant	Significant	High	Likely	Commercial customers starting to help stabilize cash flow
E	Radical	Commercial	Limited	Limited	Limited	Low	Proven	Has demonstrated profits in sales to commercial segment
F	Unknown	Household (\$3–7/day)	Private	Unknown	Limited	TBD	Unknown	Too early to assess
G	Incremental	Household; commercial	Limited	Limited	Limited	Moderate	Possible	Self-reported expectations for profitability in 2010
H	Incremental	Household (> \$3/day)	Limited	Limited	Limited	Moderate	Possible	Selling moderate numbers of stoves but funding stream uncertain
I	Incremental	Commercial	Limited	Unknown	Limited	TBD	Unknown	Starting to sell to street vendors
J	Incremental	Household	Donor	Limited	Limited	Moderate	Unlikely	Declining sales; concerns on funding stability

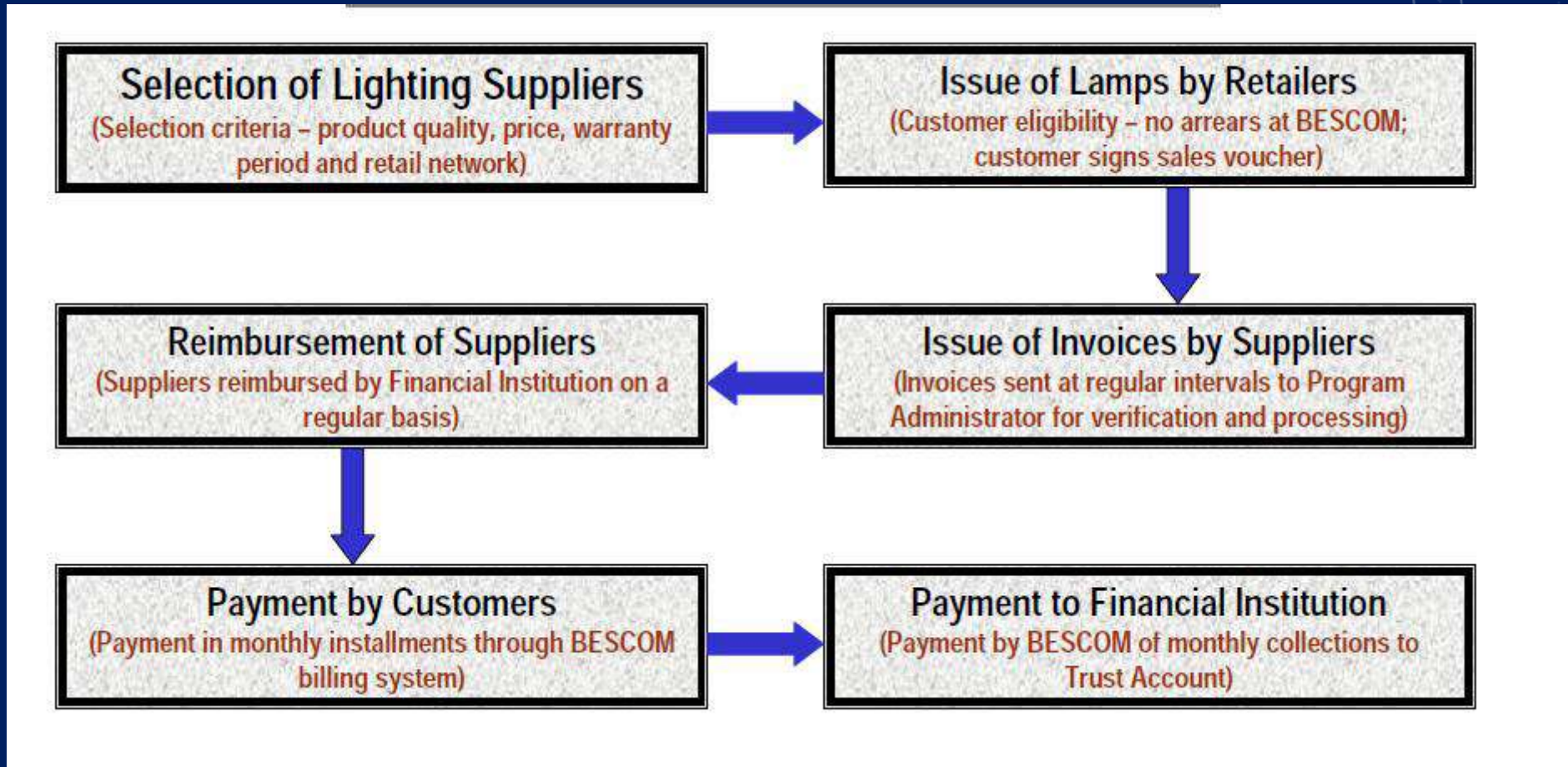
Notes:

# Case Study : Capacitor Leasing



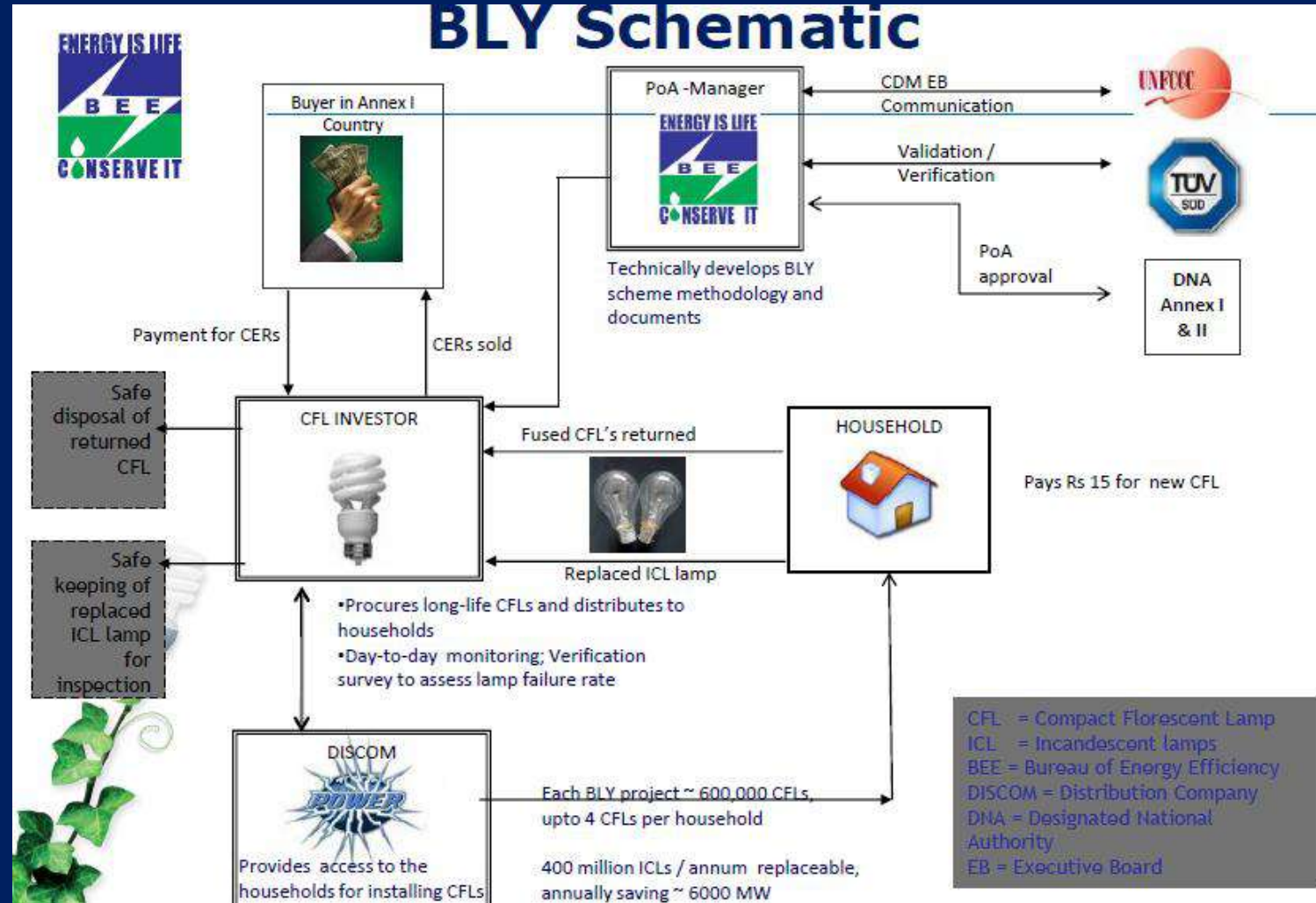
Source: Taylor et, al, 2008

# DSM: Financing through Utility Bill





# Bachat Lamp Yojana



Source: BEE web site



# Bachat lamp yojana

- Dependence on the carbon market (\$12/ tonne initial CER price – reduced to 5\$/ tonne)
- Payments to CFL manufacturers and/or utilities take 3-4 years
- Kerala, Andhra Pradesh, Karnataka, Punjab and Delhi
- Target 400 million bulbs
- Actual about 25 million bulbs
- Lack of investors

	Decentralized Renewable Energy: Biomass and Small Hydro	Solar Home Systems	Solar Lanterns	Energy-Efficient Cookstoves
Potential Market /yr	Rs 94.06 billion	Rs 1.26 billion	Rs 855 million	Rs 1.11 billion
Avg Price	IRs 8 to 13 /kWh (B) INR 2 to 2.5 /kWh (H)	Rs 7,000 - 20,000	Rs500 -1,600	Rs 150 -1,100
Competitive Advantage	operational reliability , low upfront cost.	Customised solution.	Kerosene replacement	Reduced fuel costs; health benefits
Business Model	B: Company-owned minigrids; electricity priced to existing fuel expenditure levels. H:using existing grid infrastructure; paid at government- tariffs.	Sold on credit, in partnership with local banks. Users typically pay 10 to 25 percent upfront and the rest in installments.	Bulk sales to corporate, NGO, and (MFI) partners; sold directly to consumers through local retailers.	Sold through multiproducts rural distributors and retailers; partnerships with MFIs and NGOs.

Source: IFMR- WRI, 2010

# Selco Case study

- For profit company – Solar Home systems – started 1996 – sold about 100,000 SHS
- 90% of products – credit schemes
- Partnership with 9 banks – interest rates between 12-17%
- Financing Institutions pay 85% of the amount- monthly payments of Rs 300- 400 over a period of 5 years
- Financing/ repayment options – tailormade to end users – paddy farmers – repayment schedule based on crop cycle, street vendors – daily payments – Rs 10
- Funding from REEP – meet margin amount for poor customers, reduce interest rate



Source: SELCO, 2011

# DESI Power

- Biomass based power solutions – Bihar- 25 kW to 100 kW
- Local distributors – decide pricing
- Registered under CDM and sold CERs to Swiss buyer
- MNRE funds, Promoters Equity, ICICI Loan
- Monthly rate based on no of bulbs / loads, Circuit breaker to limit consumption
- Irrigation pump users Rs 50/ hour, Household Rs 120- 150 per month
- Underground trunk wiring-distribution
- Enabling micro-enterprises –battery charging station, flour mill, workshop etc
- Tie up with Telecom towers – increasing capacity factor

# Husk Power

- Initial funding – prize money
- 30-100 kW – biomass gasifiers- based on rice husk
- Energy audit of households
- Focus on household demand for lighting
- Lower production, operating costs – use of bamboo, asbestos
- Overhead pole wiring
- Directly reach end user

# Tutorial

1. An infrastructure company is planning to invest in a Wind farm of rating 56 MW – capital cost Rs 340 crores. The preferential tariff for wind based electricity is Rs 4.50 /kWh. The annual O&M cost is Rs 0.45/kWh (based on the annual generation).

Assuming a life of 25 years and a capacity factor of 30%, calculate the internal rate of return. If debt is available at 11% interest and a tenor of 10 years, calculate the internal rate of return IRR on equity for a debt: equity ratio of 50: 50 and 70:30. How should the company finance the plant?

# Tutorial

2. An independent power plant (IPP) is proposing a 250 MW gas based combined cycle power plant in Maharashtra. The direct capital cost is Rs 880 crores (including interest during construction and escalation). The net heat rate for the plant is 2000 kcal/kg. The average calorific value of natural gas used is 8500 kcal/sm<sup>3</sup> and the price of NGas is Rs 8/sm<sup>3</sup>. The fixed operating and maintenance (O&M) cost is Rs 2 crores and the variable O& M cost is Rs 0.05/kWh. Assuming a life of 25 years for a PLF of 70%, for a Power Purchase agreement at Rs 3.50 /kWh, calculate the Internal rate of return. If debt is available at 12% interest and a tenor of 10 years, calculate the IRR on equity for a debt: equity ratio of 50: 50 and 70:30. How should the IPP finance the plant?



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