Two Day – Technical Workshop
Solar Water Heater deployment

SESSION 2.3

FINANCIAL ANALYSIS OF SOLAR WATER HEATING SYSTEMS

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Contents

- Introduction to input parameters
- Investment decision making tool
- Investors perspective for financial analysis
- Lenders perspective for financial analysis
- Input parameters and financial analysis
- Addressing risks & its sensitivity

Important aspects

- Comparatively high cost; capital intensive project
- Long term investment
- Critical analysis of long term risks and return
- Technical design needs to be checked for financial optimization
- Financial analysis of cash flow and project profitability

Input parameters

- System size – depends on the hot water demand, roof space availability, solar resources
- Capital cost – type of system and system size
- Hot water production capacity
- Auxiliary fuel usage
- Heat requirement – from solar and auxiliary
- Temperature difference
- Seasonal usage

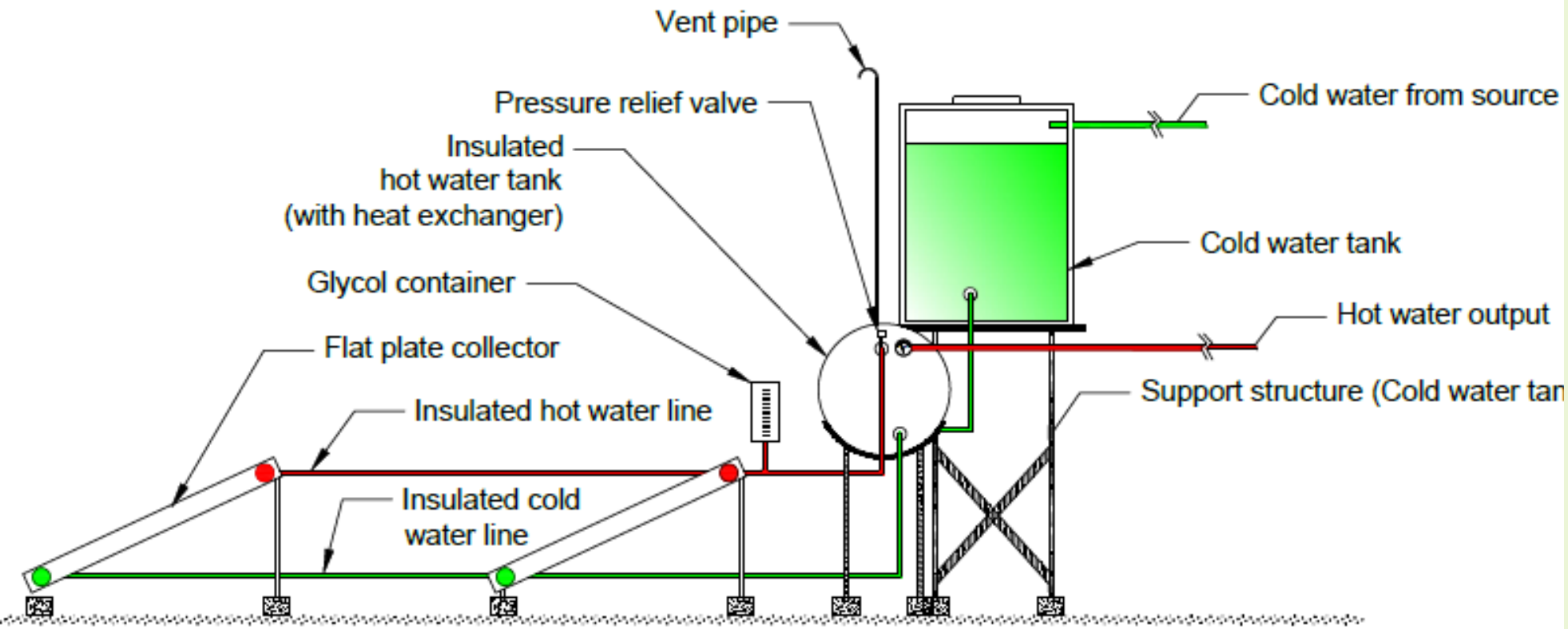
Project cost of the system

- Project cost includes the following:
  - Solar panels
  - Storage tanks
  - Piping including insulation
  - Support structure
  - Auxiliary source
  - Installation and commissioning
  - Transport cost
  - Taxes etc

Component wise SWH cost – 1000 Lit system (Nu.)

Component	Specifications	Total
Panel	12 panels - Double glazed , flat plate collector panels complying to IS 12933, EN 12975 or similar standards	264,000
Hot water tank with heat exchanger (1000 litres)	Insulated solar water tank of capacity 1000 litres with heat exchanger as per relevant Indian Standard and with TEMA Class C construction,	80,000
Cold water tank (2,000 litres)	PVC or HPDE, Cold water tank (similar BSR Civil – MT1668) of capacity 2000 Litres.	18,000
Pipes (GI), fittings and plumbing accessories	ISI marked, C Class, Galvanised iron pipes with necessary clamping , supports and fittings	12,000
Insulation and cladding	For all pipes except feed pipe - Rockwool or similar CFC free PUF insulation of 100mm thickness with density 28-32 kg/cu.m. and wrapped with material like material like chicken mesh etc., with Aluminium cladding, thickness 26 SWG	25,000
Structure	35 mmx 35 mmx 5mm L angle, Material - MS with anti-rust coating or paint	35,000
Mountings	Thermometer, water meter, strainer with spare mesh, glycol container and fittings, auxiliary heater (12kW) etc. as applicable	35,000
Miscelleneous	Civil material, Toolkit, fence and gate, glycol,, Fasteners, pumps, concrete, cement and other construction material, etc.	80,000
	Total	**549,000**

Components of SWHs affecting the cost



- Solar panels
- Storage tanks
- Piping including insulation
- Support structure
- Auxiliary source
- Installation and commissioning
- Transport cost
- Taxes etc.

Financial parameters

- **Debt:** An amount of funds borrowed by promoter from banks / FI's / any other lender with condition to pay back with interest. (70%)
- **Equity:** An amount of funds contributed by promoter in the project. (30%)
- **Interest rate on Term loan :** The charge for the privilege of borrowing money, typically expressed as an annual percentage rate. Calculated on outstanding debt principal amount.
- **Loan Repayment period :** It is the long term debt repayment period agreed by the project owner and the lender.
- **Moratorium Period :**A period in which, the promoter is allowed exemption to repay the loan principal amount. (up to 1 year)
- **O&M Cost :** Annual operation and maintenance cost of the project. This includes the cost of consumables, spares, parts, salaries of staff and workers, administrative charges etc.
- **O&M Cost Escalation :** Percentage increase in O&M cost annually.
- **Electricity charge:** Existing electricity charges and its escalation

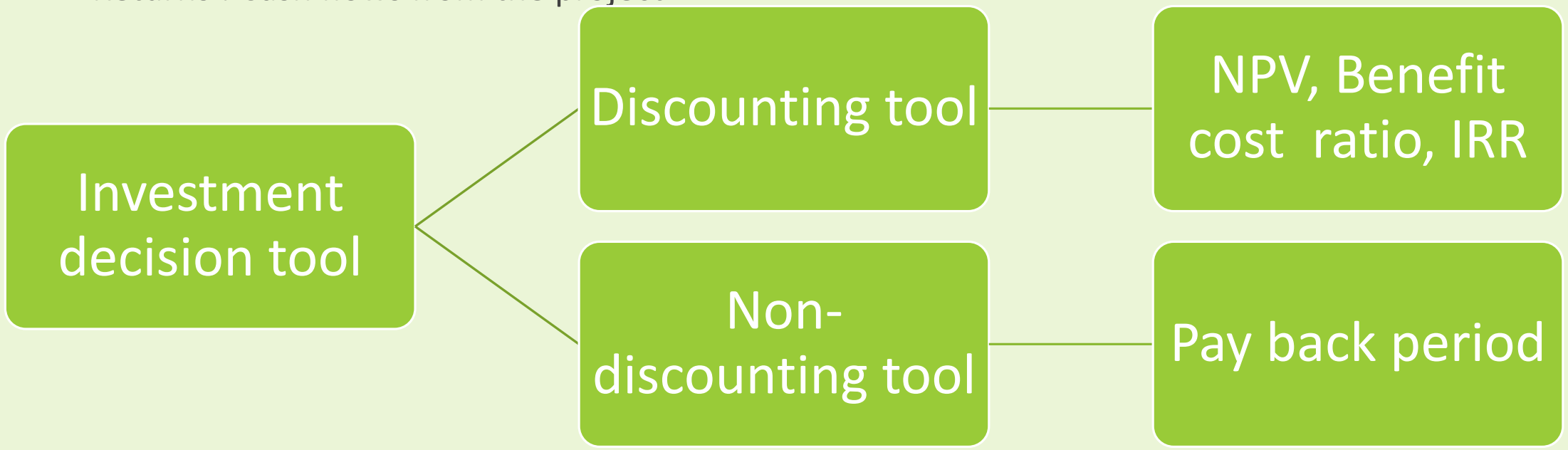
Savings potential of SWHs

- SWHs saves the electricity required for heating the water.
- Heat requirement is coming from solar.
- Electricity savings → energy required for hot water
- Energy requirement = Mass X Specific heat X temperature difference
- Mass: tank capacity
- Temperature difference: depends on requirement and seasonal

Decision making tools

Projects are assessed from different angles to factor in the risks while projecting the returns.

- Risks : Impact of Variation (e.g. technological risk, environmental risks, regulatory risk, political risks, market risks etc.)
- Returns : Cash flows from the project



- IRR and Pay back are the most preferred

Consumers / Investors

- Maximum returns
- Lower investments requirements (Equity)
- Early payback
- Lower risk (market risks, regulatory risks, cash flows risk (prompt payments and positive returns)

- What they are looking for?
- Pay back period
- IRR

Lenders

- Interested in fix and regular returns
- Balancing risk and returns
  - Risks (credibility of borrower, market risk, regulatory risk etc.)
  - Returns (income from interest charged)

  - What they are looking for ?
  - Assessment of project from various risks
  - Higher interest rate for higher risks
  - DSCR > 1.2
  - Securities and collateral guarantees of promoter

Pay back period

- It is the length of time required to recover the cost of an investment.
- Longer payback periods are typically not desirable for investment decisions.
- e.g.
- Project cost / initial investment = Rs. 10, 000/-
- Pay back period is 2 years

	Yr0	Yr 1	Yr2	Yr3	Yr 4	Yr5	Yr6
Cash Outflow	-10000						
Cash Inflow	0	5000	5000	3000	2000	0	-2000

Net present value

- NPV analysis considers the time value of money.
- This is the difference between the present value of cash inflows and the present value of cash outflows.
- e.g. Calculation of NPV with 10% discount rate (r)
- NPV = -10000+4545+4132+2253+1366+0-2257
- **NPV= 38** (NPV >0 i.e. + means returns are higher then discount rate / market rate , so accepted)

	Yr0	Yr 1	Yr2	Yr3	Yr 4	Yr5	Yr6
Cash flow	-10000	5000	5000	3000	2000	0	-2000
PV = $\frac{\text{(Cash flow)}}{(1+r)^t}$	$\frac{-10000}{(1.10)^0}$	$\frac{5000}{(1.10)^1}$	$\frac{5000}{(1.10)^2}$	$\frac{3000}{(1.10)^3}$	$\frac{2000}{(1.10)^4}$	$\frac{0}{(1.10)^5}$	$\frac{-2000}{(1.10)^6}$
PV	-10000	4545	4132	2253	1366	0	-2257

Internal rate of return (IRR)

- The discount rate often used in capital budgeting that makes the net present value of all cash flows from a particular project equal to zero.
- The IRR is a profitability measure which depends solely on the amount and timing of the projects forecasted profit.

	Yr0	Yr 1	Yr2	Yr3	Yr 4	Yr5	Yr6
Cash flow	-10000	5000	5000	3000	2000	0	-4000
PV	$-\frac{10000}{(1+r)^0}$	$\frac{5000}{(1+r)^1}$	$\frac{5000}{(1+r)^2}$	$\frac{3000}{(1+r)^3}$	$\frac{2000}{(1+r)^4}$	$\frac{0}{(1+r)^5}$	$\frac{-4000}{(1+r)^6}$
NPV = 0 =	$-\frac{10000}{(1+r)^0}$	$\frac{5000}{(1+r)^1}$	$\frac{5000}{(1+r)^2}$	$\frac{3000}{(1+r)^3}$	$\frac{2000}{(1+r)^4}$	$\frac{0}{(1+r)^5}$	$\frac{-4000}{(1+r)^6}$

- IRR = r = 10.38%
- Accept the project if IRR is greater then expected rate of return

Characteristics of the tools

Pay Back

- Do not consider time value of money
- Usually seen in case of small cap projects

NPV

- Determination of discount rate is a critical
- Represents the net benefit over and above the compensation for time and risk
- The absolute value doesn't represent the exact returns; NPV is calculated by assuming discount rate

IRR

- Gives exact discount rate
- IRR can be compared to the expected inflation/current borrowing rate/cost of capital etc
- Closely related to NPV & easy to understand and interpret

A sample calculation

Assumptions					
Type of user		Commercial / institutional establishment			
Capacity of the system	1000	Litre / day	**Inlet water (Ambient)**	15	° C
Hot water requirement per year	365	days	**Outlet water**	60	° C
Solar			**Electric**		
System Capacity	1,000	Litres	Equivalent heater requirement	14.4	kW
Hot water from solar	300	days	Capital cost	28,800	Nu.
SWH System capital cost	600,000	Nu	Efficiency	80%	
Yearly O&M cost (0.1% of capital)	600	Nu	Yearly O&M cost (1% of capital)	288	Nu.
Escalation in O&M Cost	3%	%	Energy cost	3	Nu/ kWh
Subsidy	30%	%	Energy cost escalation	5%	%

Yearly costs and savings

	Solar Water Heating System			Electric Water Heating System			Savings
Year	O&M Cost	energy cost (backup)	Total cost	O&M Cost	energy cost	Total cost	Annual
	Nu.	Nu.	Nu.	Nu.	Nu.	Nu.	Nu.
Net present Value			454,988			489,271	
Year 0 (Capital)			420,000			28,800	
Year 1	600	9183	9783	288	64,427	64,715	54932
Year 2	618	9642	10260	297	67,648	67,945	57685
Year 3	637	10124	10761	306	71,031	71,336	60575
Year 4	656	10631	11286	315	74,582	74,897	63611
Year 5	675	11162	11837	324	78,311	78,636	66798
Year 6	696	11720	12416	334	82,227	82,561	70145
Year 7	716	12306	13023	344	86,338	86,682	73660
Year 8	738	12922	13660	354	90,655	91,010	77350
Year 9	760	13568	14328	365	95,188	95,553	81225
Year 10	783	14246	15029	376	99,948	100,323	85294

Payback period = over 6 years

Sensitivity w.r.t. subsidy

% Subsidy	Subsidized Cost of Solar	Life Cycle Cost of Solar (NPV)	Life Cycle Cost of Electric (NPV)	Difference (solar – electric)	Payback period
0	600,000	620126	489271	130855	9 years
10	540,000	565080	489271	75809	Over 8 years
20	480,000	510034	489271	20763	Over 7 years
30	420,000	454988	489271	(34283)	Over 6 years
35	390,000	427465	489271	(61805)	6 Years

Link to the model

Inputs parameters and sensitivity

Sensitivity - High

Capital Cost | **Subsidy** | **Heat Generation**

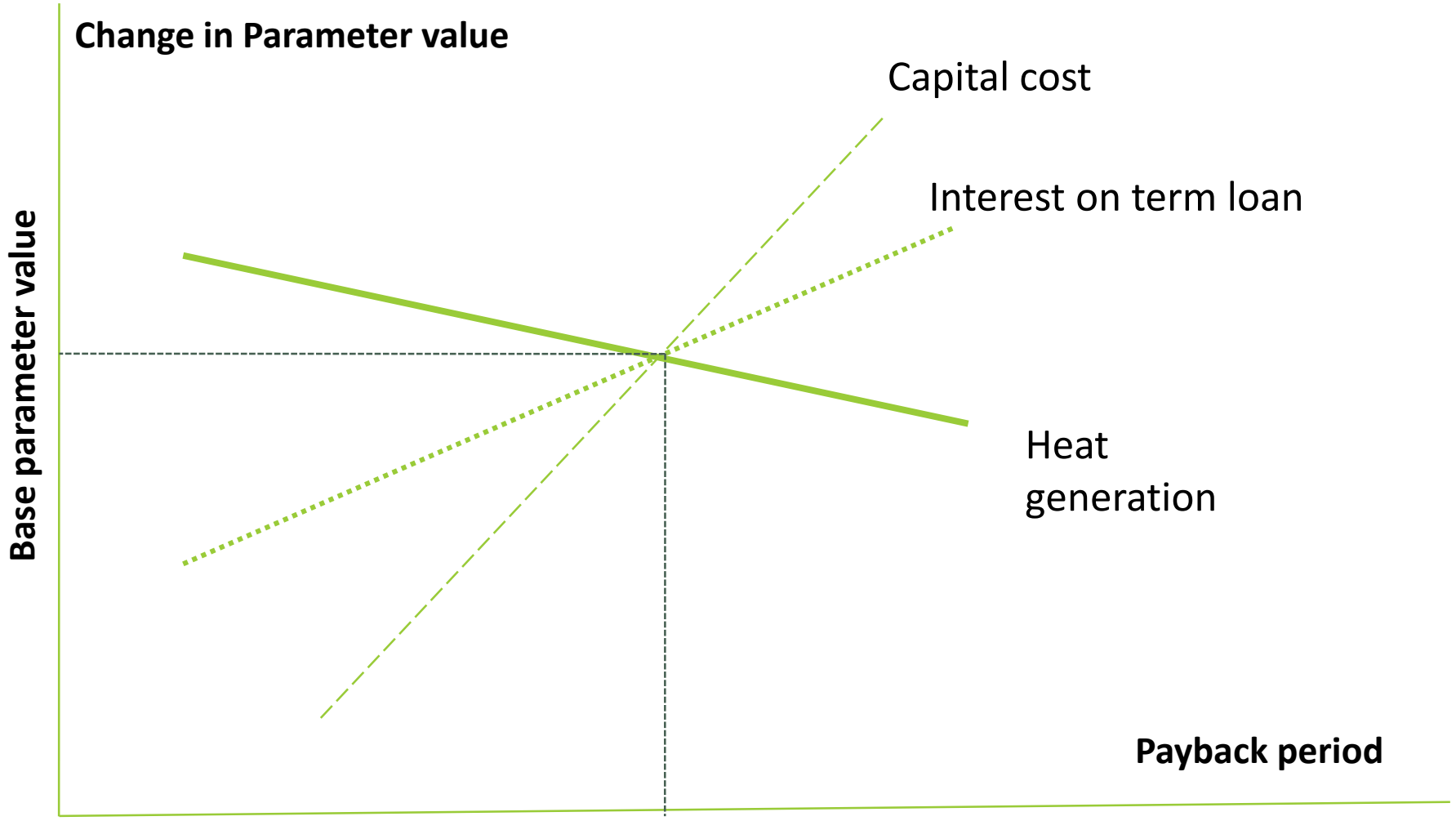
Sensitivity – Moderate

Interest Rate | **O&M**

Sensitivity - low

Interest on working capital | **O&M Escalation factor**

Sensitivity analysis



Key consideration for sensitivity

- Identified risks can be built in financial model by changing the input parameters and the sensitivity of the same can be analyzed.
- Selection of input parameter, range of parameter variation is completely subjective which is based on technical, commercial, market, regulatory, policy analysis and requires multidimensional expertise.
- Three scenarios can be built in (Best cased, base case and worst case scenario)
- Again subjective decision making based on the results of three scenarios.

Addressing the risk and its impact

Resource Risk : Errors in resource measurements will lead to lower production

RISK LEVEL : Moderate

Resource estimation and actual radiation measurements

Proper estimation of heat production for the identified site

Sensitivity : Heat production / hot water amount Sensitivity

Technology Risk : Loss of production due to technical design / manufacturing defects / increase in losses etc.

RISK LEVEL : Low

Well designed system with review

Strict standard with Third part inspection / testing in labs

Inspection before despatch from Factory / witnessing the factory testing etc.

Sensitivity : Deration in production and affects project financials

Addressing the risk and its impact

Construction Risk : Risks associated with construction labour, theft of material , Local risks, Input prices

RISK LEVEL: MODERATE

Analysis of local labour availability, delay due to seasons and festivals etc.

Addressing the risks through insurances.

Sensitivity : increased capital cost sensitivity as well as increase in loan interest payment.

Policy/Regulatory Risk : Change in cash flow due to policy changes

RISK LEVEL : Moderate

Proper analysis of existing national policies and guidelines

Subsidy disbursement mechanism

Sensitivity : Payback period sensitivity

Thank You

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- Policy research and advocacy
- Energy Regulations and Tariff
- Energy Efficiency
- Renewables - Solar, Wind, Biomass
- Climate change and Sustainability
- Training and Capacity Building