Asia-Pacific Economic Cooperation

Rooftop Solar PV System Designers and Installers

Training Curriculum

APEC Secretariat

March 2015


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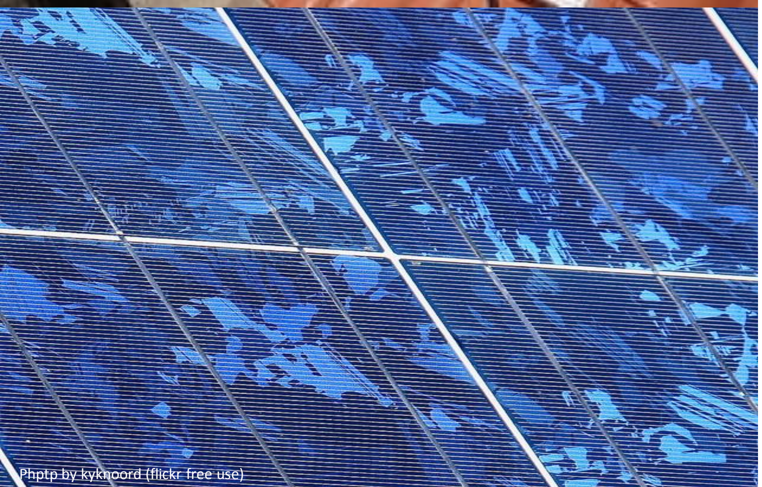
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FINANCIAL ANALYSIS

Training of PV Designer and Installer

APEC
Asia-Pacific Economic Cooperation

Cu International Copper Association
Copper Alliance

castlerock consulting

INTRODUCTION

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Financial Modeling Tools

- Used to analyze the input and assumptions
- Results in key metrics and indicators to gauge the possible financial outcome of the project/business given the assumptions
- Gives information to the client about the project's financial feasibility
- Provide an opportunity to see the financial feasibility of the project and what variables affect it

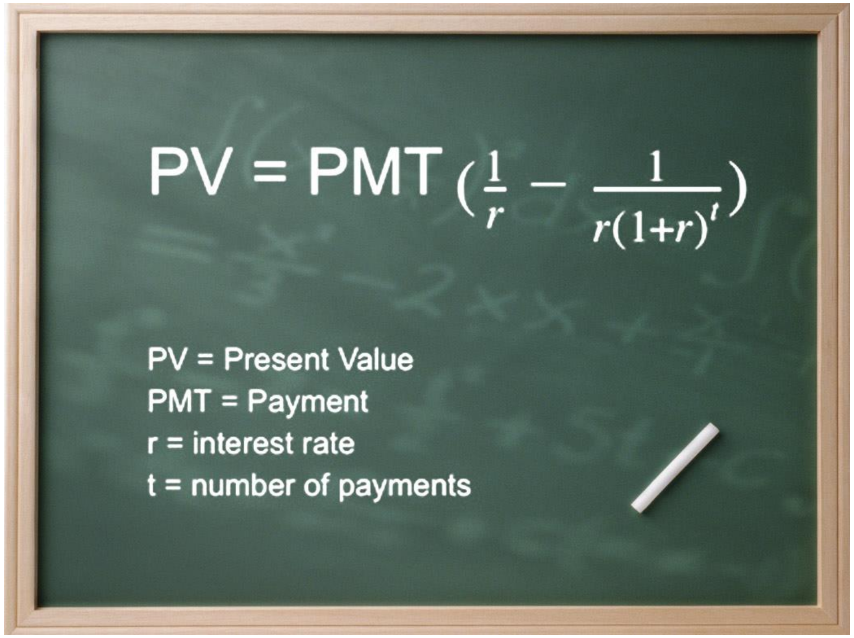
INTRODUCTION

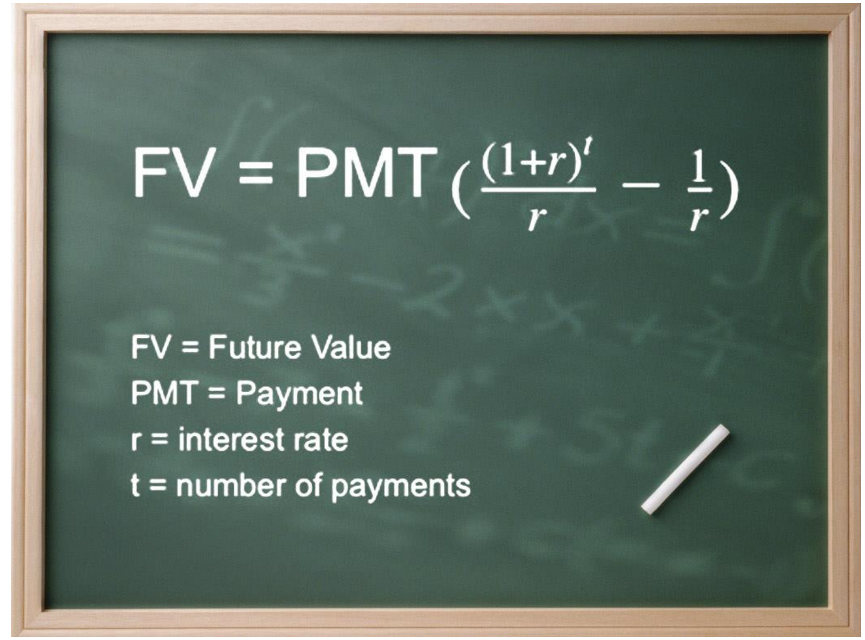
Financial Modeling Tools

- IRR (Present/Future Value)
- Return on Investment
- Payback Period
- Cashflow/expected savings
- Lifetime Cost per kWh

There are many other, more complex ways to analyse a solar PV project financial feasibility. But for most residential scale rooftop systems, the above is enough to gauge the benefits to the client

PRESENT/FUTURE VALUE





What it is: The present value equates the value of a series of payments in the future to a lump sum today by using the time value of money (inflation) -- a dollar today is worth more than a dollar tomorrow. **How to use it:** Receiving $100 today is more valuable than having $10 handed to you every year for the next 10 years, because you could invest the $100 today then earn interest on it over the decade.

What it is: The time value of money is also an important concept for the future value of an annuity, or the worth of your payoments down the line. **How to use it:** This equatin answers the question: Should you take $10 payments each year for 10 years, or a lump sum of $120 in 10 years?

PRESENT/FUTURE VALUE

	Annual Payment	Present Value	Annual Payment	Present Value
Start of year 1	$(500.00)		$(500.00)	
End of year 1	$ 100.00	$95.24	$ 115.49	$109.99
End of year 2	$ 100.00	$90.70	$ 115.49	$104.75
End of year 3	$ 100.00	$86.38	$ 115.49	$99.76
End of year 4	$ 100.00	$82.27	$ 115.49	$95.01
End of year 5	$ 100.00	$78.35	$ 115.49	$90.49
Total income	$ 500.00	$ 432.95	$ 577.44	$500.00

Price of goods are always increasing

An item costing $100 today may cost $105 at the end of the year

That same item may cost $150 after 5 years

Lending $500 in return of 5 x $100 annual payment yields $432.95 in present value

PRESENT/FUTURE VALUE

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	Annual Payment	Present Value	Annual Payment	Present Value
Start of year 1	$(500.00)		$(500.00)	
End of year 1	$ 100.00	$95.24	$ 115.49	$109.99
End of year 2	$ 100.00	$90.70	$ 115.49	$104.75
End of year 3	$ 100.00	$86.38	$ 115.49	$99.76
End of year 4	$ 100.00	$82.27	$ 115.49	$95.01
End of year 5	$ 100.00	$78.35	$ 115.49	$90.49
Total income	$ 500.00	$ 432.95	$ 577.44	$500.00
Rate	5%			
NPV	($63.86)		$0.00	
IRR	0%		5%	

Without charging interest, after 5 years the loan will lose $63.86 of the capital's value (assuming 5% annual increase of prices)

Charging 15.5% annual interest will keep up with the 5% annual increase of prices (the loan's capital value is still $500)

With an IRR of 5%, the Present value of the payments = $500 and NPV = $0.

Net Present Value = sum of the payments' present value – initial capital loan

RETURN ON INVESTMENT

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ROI (%) = (Net Profit/Investment) * 100%

Simple to Understand

BUT there are many variables that can be included or omitted to make the ROI look better:

- Length of period
- is overhead included?
- What part of the income is used
- What part of cost/expenses are included

NEED to define exactly how the ROI is derived, what variables and definition of terms were used

PAYBACK PERIOD

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Simply a calculation of how long it would take for the initial investment to be paid back by its financial benefits. Not all benefits can be calculated directly

An example would be a small business who can advertise that it is using solar PV for its energy. The increased sales because the clients selected them specifically for having installed the solar PV system will have to be tracked separately

Payback period is simple to calculate but has many complex variables such as expected future energy prices, future value, what are the variables included in total ownership costs, etc

PAYBACK PERIOD

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Payback period = (Initial cost + annual cost) – (annual savings + annual benefits)

Note: The above graphic is also a cashflow graph that shows the payback period at around 5.5 years

CASHFLOW

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Annualized cashflow is determined from a table that shows the costs and income/savings/benefits for each year. For each year, the total cashflow is calculated by subtracting the cost for that year from the income + savings + benefits for that year

Future cashflow analysis use the same method, but future costs and income/savings/benefits are predicted values

Cumulative annual cashflow graph will also show the payback period of an investment

CASHFLOW

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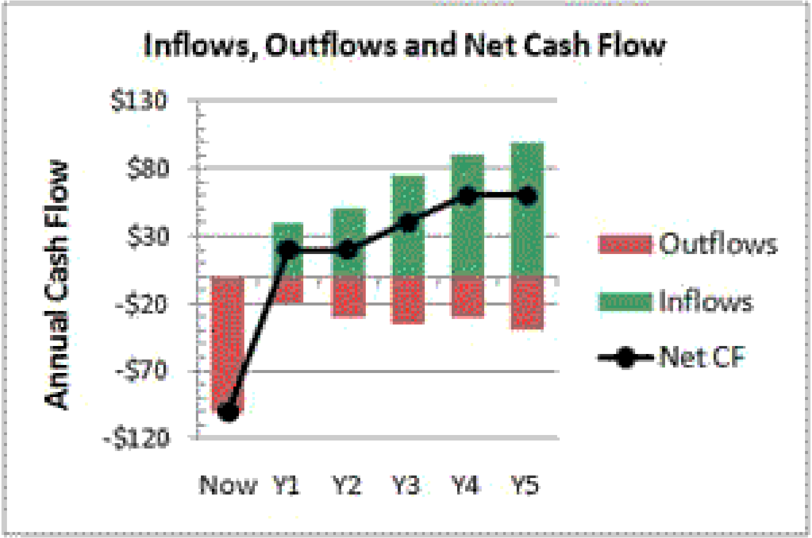


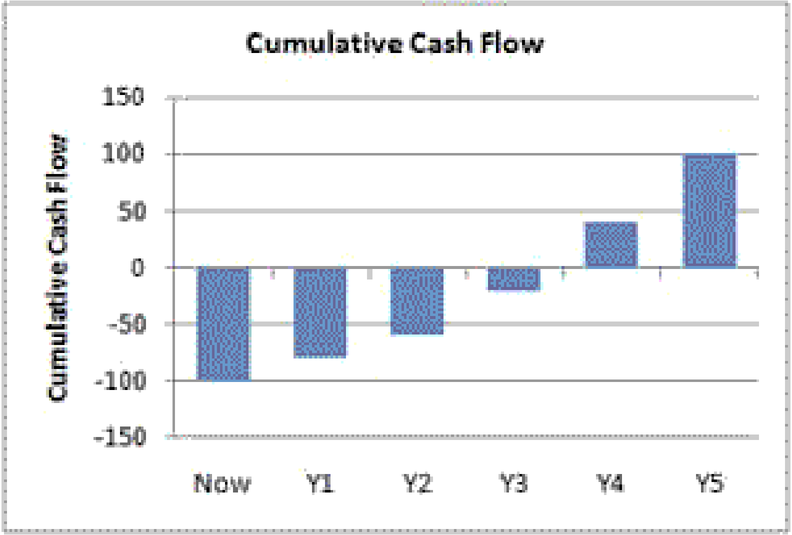
This table shows each year's outflow of cash, inflow of cash and the net cashflow (inflow – outflow)

Simply shows that for each year, the inflow of cash exceeds the outflow of cash. Does not show the accumulated cash

Note that there is significant investment in the beginning

This Cumulative Cash Flow show the total cashflow for the above project. While there is positive income for years 1 through 5, it is only in year 4 that there is positive net cashflow

Cumulative cash flow also show a payback period between years 3 and 4 of operation



LIFETIME COST PER KWH

A simplified calculation of the lifetime cost of a solar PV system (including maintenance, etc) compared to the amount of electricity it produces

This value can then be compared to the cost of energy from other sources (such as the utility company). In many areas around the world, even developing countries, the cost of a solar PV system is already the same as or cheaper than the utility company's current rates

A more complex calculation of this value is called Levelized Cost of Energy (LCOE)

LIFETIME COST PER KWH

$$lcoe = \frac{Capex + \sum_{i=1}^{N} \frac{Opex_i}{(1+r)^i}}{\sum_{i=1}^{N} \frac{e_i}{(1+r)^i}}, \quad \begin{cases} r & \text{Discount rate} \\ e_i & \text{Specific energy yield [kWh/kWp]} \\ N & \text{Lifetime [years]} \end{cases}$$

LCOE calculations are complex and for most residential projects are unnecessary

A much simpler way, but adequate to gauge the financial feasibility of the project is to calculate the total cost of ownership divided by the kWh the system is likely to produce

The complexity of this method is in choosing the variable to calculate the cost of ownership and deciding an accurate method to predict the total kWh produced over the lifetime

Many variables will affect this calculation but with experience, the appropriate variables for the local conditions can be determined

System size	5kWp
System type	Roof top grid tie
System cost	$15,000.00
Local Peak Sun Hours	4.5 PSH
System losses	20%
Expected net daily production	5kWp * 4.5 PSH * (100%-20%)
	18.0 kWh
Expected net annual production	6,570 kWh
Expected system lifetime	20 years
Expected net lifetime production	131,400 kWh
Amortized cost of electricity	$15,000 / 131,400kWh
	$0.11 /kWh

LIFETIME COST PER KWH

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- High reliability required (solar PV with batteries)
  - At factories where product startup cost is high
  - High avoided costs related to blackouts
- High cost of electricity per kWh
  - High utility cost
  - High equipment maintenance cost (ie. Generators)
  - High fuel cost

Even when the cost of solar PV exceeds current utility cost, there are other qualitative reasons why solar PV systems can still make sense.

LCOE

Even when the cost of solar PV exceeds current utility cost, there are other qualitative reasons why solar PV systems can still make sense. Just because the solar PV system has a higher LCOE cost than the current system, it doesn't immediately rule out solar PV as a solution.

The avoided cost calculation over the lifetime of the system also need to be considered. Factors such as increasing cost of fuel or electricity, high cost of blackouts, production losses, and many others can contribute to a high avoided cost if a solar PV system was installed. This means that a solar PV system has a value higher than just the cost savings through its Levelized Cost of Energy

WHAT'S IMPORTANT

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- Should the customer invest in a solar PV system?
- What's the cost of not doing anything?
- Helping the customer make the right decision
- How do we find out?
  - Today's investment cost vs future savings of electricity cost
  - Positive Net Present Value over the lifetime of the project
  - Positive Internal Rate of Return over the lifetime of the project
  - Cost of electricity with solar PV is less than utility

WHAT'S IMPORTANT

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- A financial model does not need to be overly complicated
- Just need to be honest and captures the majority of costs and revenue/savings
- When done properly, it is a powerful tool to help the solar PV designer assist the client in making a financial decision to invest in a solar PV system
- Many customers are investment oriented, if the project is financially viable, it will be attractive to them
- Most decision makers will want to see a financial model of a project

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Produced By

Andre Susanto
Chitra Priambodo
Castlerock Consulting - http://www.castlerockasia.com/

For
Asia Pacific Economic Cooperation Secretariat
35 Heng Mui Keng Terrace
Singapore 119616
Tel: (65) 68919 600
Fax: (65) 68919 690
Email: info@apec.org
Website: www.apec.org

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