ENGR290: Renewable Energy

Homework 2: Time Value of Money

Assigned: May 22, 2014
Due: May 29, 2014

Notes:

Time Value of Money

In order to correctly compare the value of various alternatives, we must have a method to convert the monetary value of present and future costs into a common value that can be directly compared. For example, $1000 today does not have the same value as $1000 in 10 years due to interest rates. If you are building a renewable energy system and expect investors to invest money into it, you must prove that it will give them a good return on their investment. This is what time value of money calculations address.

Time value of money can be a very complex field of study, but for our purposes a simple approach is often sufficient. The Present Value Analysis procedure is a way to convert all the expenses or incomes of a project into their *Present Day* value.

A very useful tool for this analysis is the Cash Flow Diagram. It is simply a timeline that shows positive (income) and negative (expenses) cash flow on the year in which that cash flow occurs. For example, Figure 1 shows a cash flow diagram for a car loan. The bank pays you $20,000 at present day and you pay $6000 each year for 5 years. Another example is in Figure 2 where you buy a solar system today for $10,000 and it offsets $1200 per year of your electric bill, but you have to replace the inverter for $2,000 after 5 years.

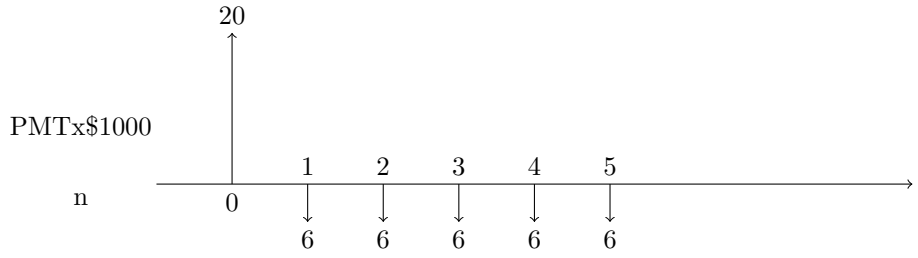

Figure 1: Cash flow for a loan

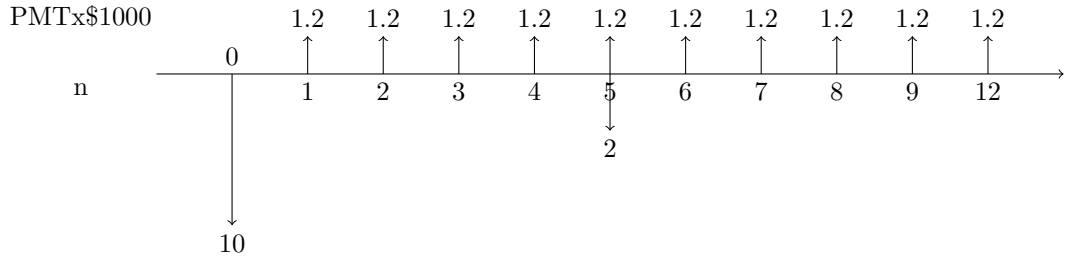

Figure 2: Cash flow for a simple PV system

So the question that a time value of money calculation answers is: What is the present day value of a cash flow? It can be done in several simple steps:

1. Identify the interest rate to be used in the calculations. If none is given, assume 8%.
2. Convert all annual payment series (the same value every year) to a present day value
   (a) Look up P/A factor based on the interest rate and number of payments in the "Annual to Present " chart (handout)
   (b) Multiply the annual payment amount by the P/A factor. This is the present value of that annual series so write this value at time 0 on the cash flow.

3. Convert all future payments into present day values
   (a) Look up P/F factor based on the interest rate and number of years in the "Future to Present" chart (handout)
   (b) Multiply the future value amount by the P/F factor. This is the present value of that future payment so write this value at time 0 on the cash flow.
4. Add up all of the cash flow at time 0. This is the Present day value of all of the cash flow. (If it is a good investment it should be positive!)

- For example, in the cash flow in figure 1:
  1. You have \$20k at time 0. This is already in the present so leave it alone.
  2. The series of \$6k per year for 5 years is an annual series so look up the P/A factor in the table for 8% and 5 years and you find 3.9927. So multiply $-\$6000 * 3.9927 = -\$23,952$.
  3. Now add (or subtract) all the values at time 0 : $\$20000 - \$23952 = -\$3952$.

  So the present day value of this loan for you is -\$3952 which, of course, means the bank is making money off of the loan.
- From figure 2 we can do a similar analysis.
  1. Convert the annual income of \$1200 over 10 years by finding the P/A factor in the table under 8% and 10 years = 6.7101. So the Present value of the series is $\$1200 * 6.7101 = \$8053$.
  2. Now consider the present value of the cost to replace the inverter. It is a Future value of \$2000 in 5 years, so look up the P/F factor in the F to P table = 0.6806. So multiply $-\$2000 * 0.6806 = -\$1361$.
  3. Now you have all values in the present, so sum them up: $-\$10000 + \$8053 - \$1361 = -\$3308$.

  So, as an investment, this would lose \$3308 and is therefore not a good investment from a purely financial perspective.

A final note: If you get confused whether you should multiply or divide by the factor in the table, remember that money *ALWAYS* grows with time if the interest rate is positive. So if you move a Future value to the present it must get smaller. The Present value of an Annual series must always be less than the sum of the payments.

Homework

I am thinking about buying a new car and can't decide if I should get the new Corvette ZR1, the new Prius Hybrid or a Volkswagon Diesel. For the following questions, assume an 8% interest rate and a gas price of $3.40 per gallon and diesel costs $4.10 per gallon.

Problem 1

The Corvette costs $70,000 and uses an estimated 50 gallons of fuel each month for my commute to work.

1. How much money per year will I spend on gas?

2. Draw a cash flow diagram for the purchase of the Corvette (if I pay in cash) and the fuel cost.

3. What is the total Net Present Value of the car and gas.

Problem 2

The Prius costs $30,000 and uses an estimated 10 gallons of fuel each month for my commute to work.

1. How much money per year will I spend on gas?

2. Draw a cash flow diagram for the purchase of the Prius (if I pay in cash) and the fuel cost.

3. What is the total Net Present Value of the car and gas.

Problem 3

The Volkswagen Rabbit Diesel costs $20,000 and uses an estimated 12 gallons of diesel each month for my commute to work.

1. How much money per year will I spend on fuel?

2. Draw a cash flow diagram for the purchase of the Rabbit (if I pay in cash) and the fuel cost.

3. What is the total Net Present Value of the car and Fuel.

Problem 4

Which car should I buy (and why)?