

Chapter 24

Asset Decision Examples

Abstract The aim of this chapter is to present some examples of cases where asset decisions are required and to illustrate the financial and operational considerations involved. *Outcomes* After reading this chapter you will be aware of the application of discounted cash flow to repair or replace decisions and equipment acquisition decisions and the importance of taking operational factors into account in the overall decision-making process.

24.1 Repair/Replace Decision for Ore Loading Vehicles

The following example illustrates the use of discounted cash flow analysis to assist in analyzing a decision on whether to repair or replace an ore loading vehicle in an underground mine. As well as illustrating the use of discounted cash flow, the example illustrates the importance of using management judgment in regard to the operational factors involved in the analysis. In fact, the financial analysis is the simple part for any given set of facts. The hard part is deciding what factors should be taken into account and estimating the costs, revenues, and risks involved.

24.1.1 Situation

A mining company owns several vehicles of a type known as Load-Haul-Dump Trucks, usually referred to as “loaders”. The loaders are used underground to move rock containing copper, lead, and silver ores, which has been broken up by blasting. The environment is hot, rough, and abrasive and the maintenance costs are high. Figure 24.1 shows one of the loaders at work.

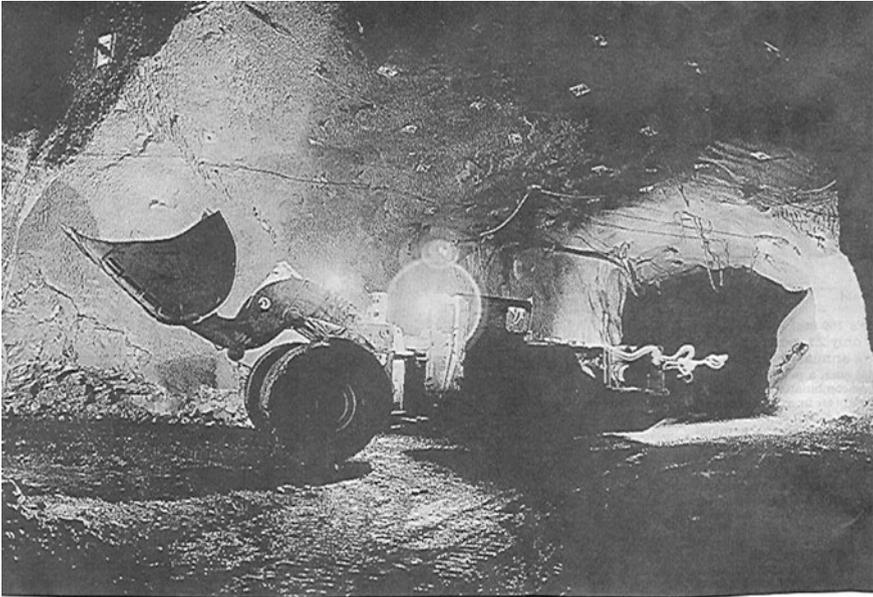


Fig. 24.1 Load-Haul-Dump truck at work

24.1.2 Required Decision

We have an existing 4-year-old loader and we need to decide whether to trade it in for a new one or to overhaul it and continue to use it for another 4 years. Thus, we are looking at two options:

- Replace Option—we replace the old loader, trading it in for a new one.
- Overhaul Option—we overhaul the old loader and keep it for four more years.

24.1.3 Factors Involved in the Replace or Overhaul Decision

Initially, we make a list of those factors that are relevant to our decision. Subsequently, we shall see how the story unfolds through several stages of analysis. The factors that we come up with are as follows:

- a. Cost of a new loader.
- b. Trade-in value of old loader.
- c. Overhaul cost of old loader (local rebuild).
- d. Maintenance costs of old loader over remaining life and new loader through life.
- e. Discounted cash flow of costs in each case, taking into account company tax.
- f. Reliability/availability of old versus new loader.

- g. Time taken to repair the old loader.
- h. Warranty on new loader.
- i. Possible operational improvements of new loader versus old.

24.2 Replace Option

24.2.1 New Ore Loader Costs

As a first step in our analysis we calculate the net present value of the life cycle costs of acquiring a new loader and maintaining it for 4 years. For this purpose we need data on the costs relating to the acquisition of a new loader, the maintenance costs, and the disposal cost. The data shown in Fig. 24.2 have been estimated for the acquisition, maintenance, and disposal of a new loader over 4 years. The existing 4-year-old loader can be traded-in for \$150,000.

A cash flow diagram for these costs is shown in Fig. 24.3. These data are the same as that used in Chap. 5 to illustrate the calculation of the life cycle Net Present Value and Equivalent Annual Cost using the Excel functions NPV and PMT.

Fig. 24.2 New ore loader costs

New vehicle cost = \$780,000
 Trade-in allowance for existing loader = \$150,000
 Net acquisition cost = \$630,000

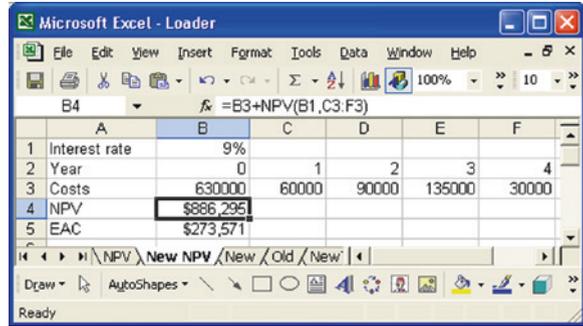
Year	Maintenance Costs, \$
1	60,000
2	90,000
3	135,000
4	180,000

Resale value at age 4 = \$150,000

Fig. 24.3 Cash flow diagram for new loader costs, \$k



Fig. 24.4 Replace option—NPV and EAC of life cycle cost of new loader



24.3 New Loader Life Cycle NPV and EAC

The Net Present Value and the Equivalent Annual Cost of the life cycle costs of the loader can be calculated using the Excel NPV and PMT functions. The spreadsheet is shown at Fig. 24.4. The background to this is outlined in Chap. 5. The NPV for the life cycle cost of \$886,295 with the interest rate specified as 9 %, and the Equivalent Annual Cost is \$273,571 per year. Note that, although the spreadsheet gives the answer to an impressive degree of precision, the accuracy of the result depends on the accuracy of the various cost estimates, and we should therefore allow for a significant degree of variability in practice.

24.4 Overhaul Option

24.4.1 Old Ore Loader Costs

The next step toward our replace or overhaul decision is to estimate the costs of overhauling and maintaining the old loader over the 4-year period. These costs are shown in Table 24.1, where the costs are taken as occurring at the end of the years shown. The initial overhaul cost is \$240,000. The maintenance cost in year 1 is \$90,000. In year 2 the maintenance cost is \$135,000 and a second overhaul is required at the end of year 2/beginning of year 3 at a cost of \$240,000. The resale value of the loader at the end of year 4 is \$0.

Table 24.1 Old loader overhaul and maintenance costs

Year	Overhaul costs	Maintenance costs
0	240,000	
1		90,000
2	240,000	135,000
3		105,000
4		150,000

Fig. 24.5 Overhaul option—old loader cash flow

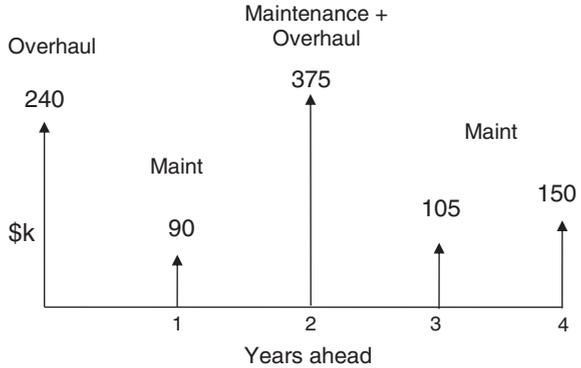
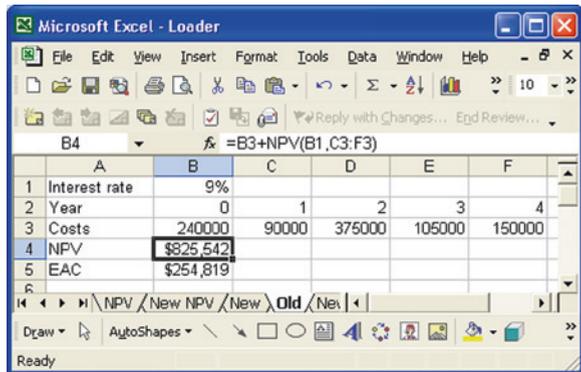


Fig. 24.6 Calculation of NPV and EAC for old loader option



The cash flow diagram for the option of overhauling the old loader is shown in Fig. 24.5.

The Excel calculation of the Net Present Value and Equivalent Annual Cost are shown in Fig. 24.6. Use is made of the Excel NPV and PMT functions. We see that the Net Present Value of costs for the old loader option is \$825,542, and the Equivalent Annual Cost is \$254,819 per year.

24.5 Cost Summary

The Equivalent Annual Cost for the old loader option and the corresponding result for the new loader option are summarized in Table 24.2.

Table 24.2 indicates that the old loader overhaul option is \$18,752 per year cheaper than the new loader, or replace, option. In the application on which this example is based, a decision was made initially to overhaul the old loader, but later, when the full implications of the choice were realized, it became clear that this decision was incorrect. The reasons for this will become apparent as we analyze the problem further.

Table 24.2 Cost comparison

New loader EAC	\$273,571 per year
Old loader EAC	\$254,819 per year
Saving	\$18,752 per year

24.6 Ore Loader Cost Analysis with Tax

The decision of whether to buy a new loader or to overhaul the old one was also influenced by the question of tax. If the work that we have referred to as an “overhaul” was classified as operating expense it would be immediately tax deductible. This would improve the cash flow of the overhaul option, compared to the replace option. Since the overhaul option has already been found to be cheaper before tax, this would further increase the advantage of the overhaul option after tax.

This question of OPEX or CAPEX expenditure can be something of a gray area. Repairs or overhauls carried out as part of the normal life cycle of an equipment are generally regarded as operating costs. But a major overhaul aimed at rejuvenating an equipment and hence, increasing its capital value beyond that which is normal for an item of the given age, is regarded as a capital expense. The book value should be revised upwards and the depreciation regime should be adjusted.

We now consider how the after tax costs will work out if the overhaul is regarded as a maintenance cost, which is tax deductible in the current year.

24.6.1 “Replace” Option with Tax

We illustrate the application of tax credits by continuing the replace or overhaul analysis relating to the ore loader. The adjusted cash flows are based on tax credits in the manner indicated in Fig. 23.9. The cost analysis for the Replace Option is shown in Fig. 24.7.

The effective life of the loader has been given as 5 years for depreciation purposes. Straight line depreciation is used. The annual depreciation is shown in row 6 of the spreadsheet. The depreciation tax credits are shown in row 7 and the maintenance tax credits in row 9. To determine the tax on resale, the book value, or Written Down Value (WDV) is calculated and is shown at B10 for the original old vehicle and at F10 for the acquired vehicle. The tax on resale is shown at B11 and F11.

The costs year by year are then calculated as shown in row 12 and the Net Present Value of the costs, and the Equivalent Annual Cost are shown at B13 and B14, respectively. We see that the NPV for the Replace option allowing for tax credits is \$622,833 and the EAC is \$192,249 per year.

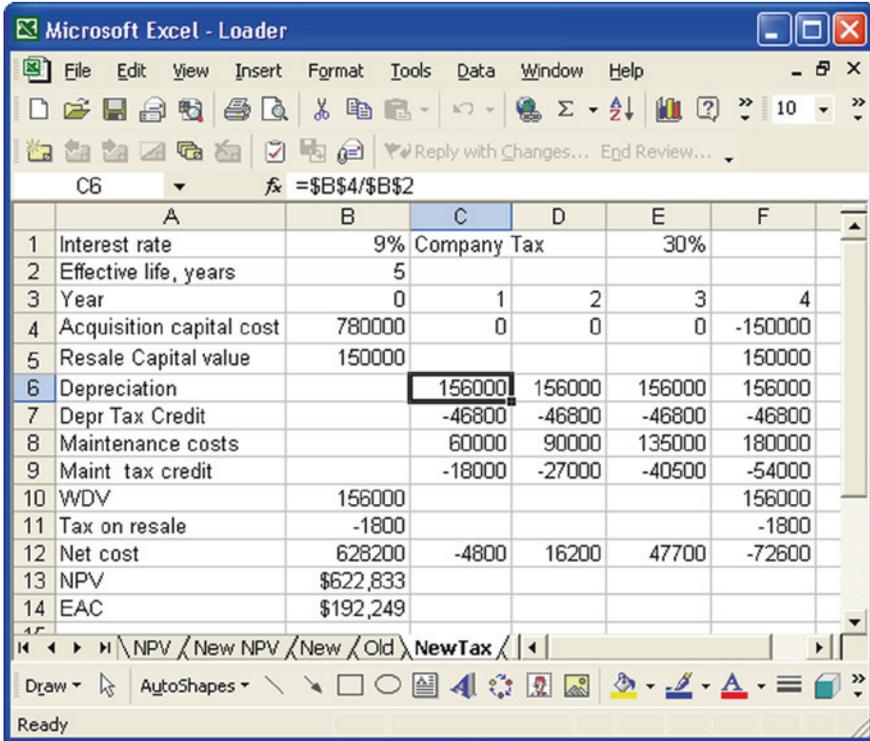


Fig. 24.7 New loader option—cost analysis with tax credits

24.6.2 “Overhaul” Option with Tax

For the option of overhauling the old loader the cost analysis with tax credits is shown in Fig. 24.8.

The maintenance tax credits appear in row 4. There is 1 year of depreciation remaining as the loader is 4-years old at the start and this is shown in cell C6. The net present value of costs over the 4-year period is \$534,944, cell B8, and the equivalent annual cost is \$165,120, cell B9. The value of the saving, as an equivalent annual cost, is given by the difference between the EACs shown in cell B14 of Fig. 24.7 and cell B9 of Fig. 24.8. The saving is shown at cell B10 of Fig. 24.8 and is \$27,129 per year. This result is also summarized in Fig. 24.9.

24.6.3 Loader Initial Policy Decision

The initial decision taken by the mining company in the replace versus overhaul issue was to overhaul the old loader. This was based on the cost comparisons indicated in Fig. 24.8.

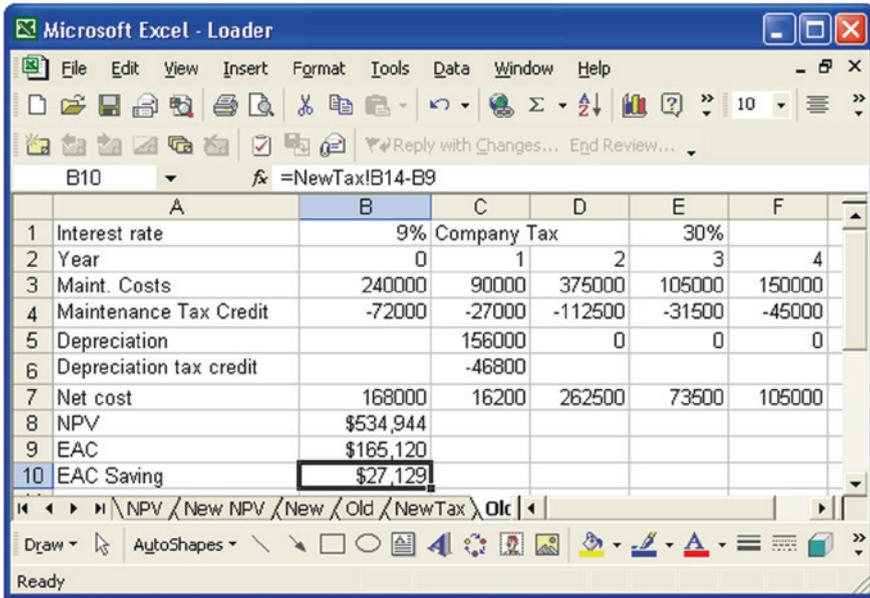


Fig. 24.8 Old loader option—cost analysis with tax credits

Fig. 24.9 Old loader savings after tax

New Loader EAC	\$192,249/yr
Old Loader EAC	\$165,120/yr
Saving	\$27,129/yr

24.7 Availability and Reliability

Although the costings indicated in favor of overhauling the old loader, the assumptions on which this was based turned out to be overoptimistic.

After experiencing one overhaul, the policy was changed for future loaders, and the loaders were subsequently replaced at age 4 years. The main reason for the change was the loss of availability while the old loaders were being overhauled. Initially it was assumed that the overhaul could be completed during the 2-week annual shutdown, but in fact further delays occurred resulting in an extra week of production losses which could not be made up. Also, the overhauled vehicles had no warranty cover, they were less reliable than new ones, and did not offer various design improvements that the manufacturer had built into later models. These factors more than offset the savings from overhauling the old vehicles. The saving in Fig. 24.8 of \$27,129 per year is less than the sales value of the metal moved in one working day by a loader.

24.7.1 Replace/Overhaul Ore Loader Conclusion

The conclusion of the Overhaul/Replace decision analysis for the loaders was that the loaders should be replaced rather than overhauled. The initial cost analysis did not make sufficient allowance for the time required to complete the overhaul or for the poorer reliability, availability, and reduced performance of the overhauled loaders when compared with the latest models. This highlighted the need to combine financial analysis with an overall view of the operational requirements.

24.8 Exercises

24.8.1 Standby Generator Exercise

A company is to install a standby generator in a certain location, at which it is required for 5 years. The initial capital cost is \$75,000 and the annual routine maintenance cost is \$2,500. The annual unscheduled maintenance cost has been estimated at an average value of \$3,500 per year. The value of the generator at the end of 5 years is estimated at \$40,000.

The company wishes to ascertain an equivalent annual cost as a basis for charging out the generator. Running expenses are additional and are not included at this point. The cost of capital advised by the finance department for this application is 9 %.

Calculate:

- (a) the equivalent annual cost of providing the generator,
- (b) the NPV of this cost.
- (c) If the company rents the generator out at \$30,000 per year, how much profit will it make in total?

Answers: (a) \$18,598 per year. (b) \$72,341. (c) \$44,350 (npv).

24.8.2 Solar or Diesel Power Exercise

Two options are being considered for providing electric power to a remote site. Estimate the life cycle cost of each option. Use discounted cash flow at 7 %. Which system would benefit if interest rates rose/fell? Which system is the cheapest at zero interest rate? The government wishes to encourage the installation of solar systems. How much upfront subsidy will it need to provide in order to make the solar system cost competitive over a long-term future?

Option 1: Solar Power

- (a) Acquisition and installation cost of all items excluding batteries. \$90,000
Life of Items (a) 15 years
- (b) Acquisition and installation cost of batteries (deep cycle). \$60,000
Life of Items (b) 7 years
- (c) Operating and maintenance cost per year for solar power system. \$3,000

Option 2: Diesel Power

- (a) Acquisition and installation cost. \$50,000
- (b) Overhaul cost after 10 years. \$20,000
- (c) Life of diesel system. 20 years
- (d) Operating and maintenance cost per year for diesel system. \$12,000

The solution to this exercise has been given using the discount factors and annuity factors directly, rather than through Excel.

The following discounted cash flow factors are given for an interest rate of 7 %:

Years	Discount factor	Annuity factor
7	0.6227	5.3893
10	0.5083	7.0236
15	0.3878	9.1079
20	0.2765	10.5940

24.9 Exercise Solutions**24.9.1 Standby Generator Exercise Solution**

The solution is obtained using Excel to carry out the calculation. Figure 24.10 shows the spreadsheet. Notes on the additional Excel features used in this exercise are given at the end of the solution.

For question (a) we need to calculate equivalent annual cost for the various cost components.

1. Convert the initial capital cost of \$75,000 into an EAC over the 5-year period by using the PMT function. The result is shown at cell C4 and is \$19,282 per year.
2. Convert the terminal value into an EAC by using the PMT function with the option of the cost being at the end of the time period. The result is shown at cell C5 and is $-\$6,683$ per year. (Note: this use of the PMT function is illustrated separately at the end of this exercise.)
3. The maintenance costs are already annual costs, and their total is:

$$\$2,500 + \$3,500 = \$6,000 \text{ per year.}$$

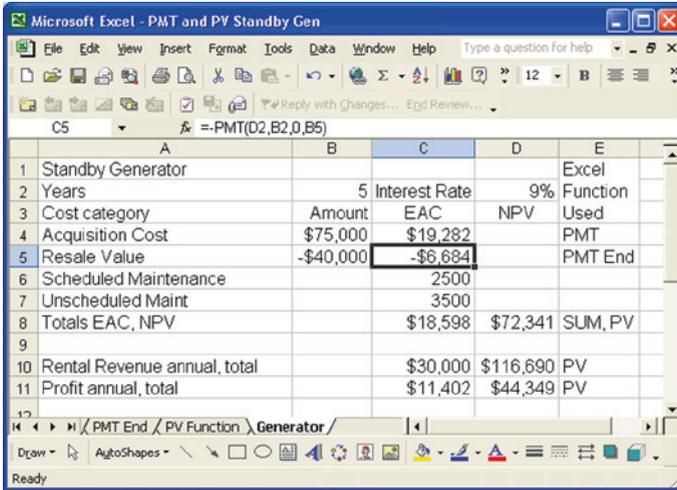


Fig. 24.10 Standby generator Excel solution

Add the amounts from steps 1, 2, and 3 to get the total cost (the terminal value is negative):

$$\begin{array}{r}
 \text{Initial capital EAC} = 19,282 \text{ \$ per year} \\
 \text{Terminalvalue EAC} = -6,683 \text{ \$ per year} \\
 \text{Maintenance EAC} = 6,000 \text{ \$ per year} \\
 \hline
 \text{Total EAC} = 18,599 \text{ \$ per year}
 \end{array}$$

This result of \$18,599 per year is shown at cell C8.

For question (b) we need to convert the EAC of \$18,599 per year into an NPV. This can be done using the Excel function PV, with the result shown at cell D8, that is, \$72,341.

For question (c), if rent is \$30,000 p.a. the net revenue is $30,000 - 18,599 = 11,401$ p.a.

The total NPV of net revenue is calculated using the PV fuction at cell D11 and is \$44,346.

24.9.1.1 The Excel Function PV

The Excel function PV calculates the net present value of a uniform series of annual payments. Figure 24.11 shows an example of the use of the Excel PV function. In a certain application there is an annual scheduled maintenance cost of \$2,500 incurred each year for 5 years. We wish to calculate the net present value of this maintenance cost at an interest rate of 9 %. The annual cost is at B6, the

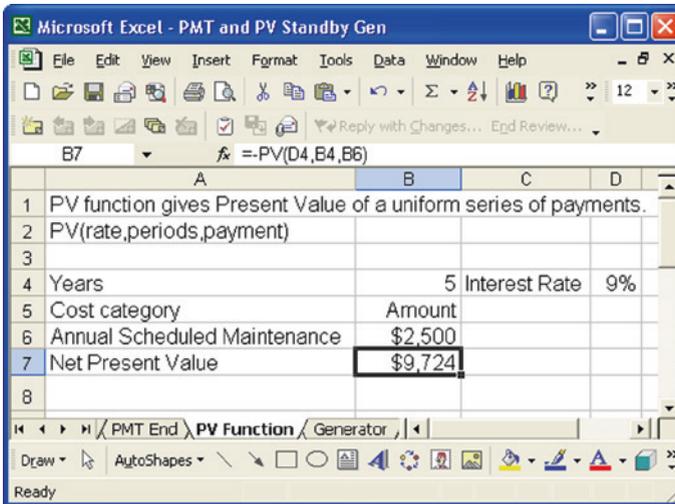


Fig. 24.11 The Excel function PV

number of years at B4, and the interest rate at D4. The function PV is used in cell B7 to calculate the net present value of these maintenance costs. The function field shows the use of the Excel function PV. The minus sign in front of the function gives the PV the same sign as the maintenance cost.

24.9.1.2 Payment or Cost at End

The PMT function has an option for calculating the equivalent annual cost of a payment made at the end of the last period, rather than at the beginning of the first period. This is useful if we require the EAC of a terminal or resale value. An example in which a resale value of \$40,000 received in 5 years time is converted to an equivalent annual cost at 9 % is shown in Fig. 24.12 at cell C5 and in Fig. 24.12 at cell C7.

24.9.2 Solar or Diesel Power Exercise Solution

This exercise illustrates the use of the Equivalent Annual Cost (EAC) in comparing costs for items with different life cycle durations. For example, the solar cells have a life of 15 years but the batteries have a life of 7 years. Expressing both costs as EACs provides a basis for comparisons.

In this solution, the discount factors and annuity factors have been used directly, rather than through Excel, so as to show the principles involved.

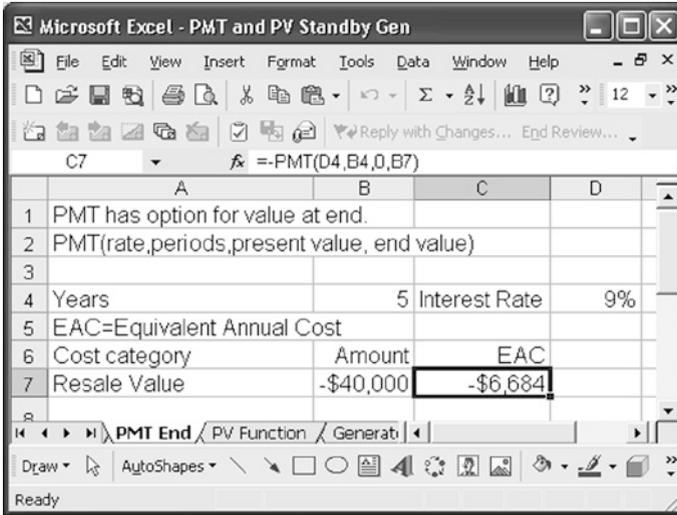


Fig. 24.12 PMT function with payment at end

Option 1: *Solar Power*

- (a) Acquisition \$90,000, 15 years $EAC = 90,000/9.1079 = 9,882$
- (b) Batteries \$60,000, 7 years $EAC = 60,000/5.3893 = 11,133$
- (c) O & M Cost = 3,000
- Total \$/year = 24,015

Option 2: *Diesel Power*

- (a) Calculate NPV over 20 year life cycle :
 - (b) $NPV = \text{Acquisition} + 10 \text{ year discount factor} \times \text{overhaul cost}$
 $= 50,000 + 0.5083 \times 20,000 = \$60,166$
 - (c) $EAC = NPV/AN \text{ for 20 years}$
 $= 60,166/10.5940 = \$5,679 \text{ per year}$
 - (d) O & M Cost = 12,000
 - Total \$/year = 17,679

Solar NPV to infinity at 7 % = $EAC/r = 24,015/0.07 = \$343,071$
 Diesel NPV to infinity at 7 % = $EAC/r = 17,679/0.07 = \$252,557$

Increasing the interest rate would favor diesel because it has fewer upfront costs. Lowering the interest rate would favor solar power, but diesel is still cheaper at zero interest.

Solution at Zero Interest

Option 1: *Solar Power*

$$\begin{aligned}
 \text{(a) Acquisition } \$90,000, 15 \text{ years EAC} &= 90,000/15 = 6,000 \\
 \text{(b) Batteries } \$60,000, 7 \text{ years EAC} &= 60,000/7 = 8,571 \\
 \text{(c) O\&M Cost} &= \underline{3,000} \\
 \text{Total } \$/\text{year} &= 17,751
 \end{aligned}$$

Option 2: *Diesel Power*

$$\begin{aligned}
 \text{(a) EAC} &= \text{NPV}/20 \\
 &= 70,000/20 = 3,500 \\
 \text{(b) O \& M Cost} &= \underline{12,000} \\
 \text{Total } \$/\text{year} &= 15,500
 \end{aligned}$$

In this case diesel power is cheaper at all interest values. In some applications the optimum policy may vary with the interest rate.

Diesel power also is not dependent on the sun shining, so it is more reliable in a remote location with no alternative supply.