Chapter 7
Costing and Financial Analysis

7.1 Costing of MMHP Schemes

As discussed in Chapter 4, some studies are carried out prior to deciding or approving a project proposal for installation of any kind, including the MMHP plants. In all such cases (e.g., prefeasibility or feasibility studies), cost estimates are included with a varying level of accuracy. Initially, e.g., during a prefeasibility study, rough estimates of cost are made, while, at a later stage, they should become more accurate. These cost estimates are also used to make economic/financial analyses to assess the viability of the plant, to compare and choose the best possible alternatives for different components, e.g., the head race and the allied civil works. The estimates are also used for comparing MHP with other alternatives such as photovoltaics, grid extension, or diesel-generator sets. Therefore, making such cost estimates is an important part and basis of decision-making and planning processes.

In some cases, it is also possible to redesign the same option in order to reduce the adverse environmental effects without severely affecting the other aspects, especially the costs. Similarly, some components may be changed/redesigned to create an optimum balance between the reliability aspects and the costs.

Financial analysis should also include accounting of the environmental, or even health, issues. It is usually not easy to put accurate monetary values on various environmental, social, or health aspects. For example, how to place a monetory value on better lighting from an electricity bulb compared to that from a kerosene lamp. Such difficulties would, no doubt, be encountered in almost all other cases. Therefore, an easier method would be to give quantified weightage to such a benefit or adverse effect separately from the financial analysis and make the decision, taking into account the results of the financial analysis as well as cumulative weightage of socio-environmental aspects. This procedure has been explained in Section 7.4. But, wherever possible, rigourous and accurate financial analysis should be undertaken so that 'apples are compared with apples'.

7.1.1: *Cost Approximation at Different Stages*

Cost estimation for a hydropower plant, in general, is described below for various stages of decision-making.

Stage 1: Prefeasibility Study

The cost estimate during this first stage is likely to be a crude one, accounting for major items such as civil works, electro-mechanical equipment, labour, transportation, and so on. The estimate would also reflect unusual construction problems, such as accessibility, climatic conditions, etc, affecting construction time or method; while altitude may affect the efficiency of equipment and manpower, availability of labour and supplies, equipment repair facilities, and location and quality of construction materials.

Stage 2: Feasibility Study

Detailed construction schedule and construction cost estimates should be made based on the main construction and equipment items and miscellaneous costs. The cost of the main civil works is based on computed volumes and unit prices adapted to the actual location. Miscellaneous costs cover all the costs not included in the main items. These will be defined as percentages of the main items.

The cost of the permanent equipment will be obtained, based on preliminary equipment descriptions and performance specifications, from approved manufacturers and suppliers.

Construction cost elements include general costs and infrastructure, civil works, equipment (manufacture, transport, and erection), taxes and import duties, engineering fees and supervision costs, administrative and legal costs, insurance, land acquisition, rights of way, resettlement, surveys and investigations, and interest during construction (for financial evaluation).

At this stage, construction schedules and procedures should also be prepared, and this might affect the costs and vice versa. For example, some equipment might be air-lifted rather than manually transported to save time; air lifting would increase the costs but saving time can reduce them in many ways.

Both construction schedules and cost estimates should be expanded to include all work and costs involved in the investigation, planning, design, purchasing (tendering), and construction.

Annual operation, maintenance, and replacement costs can be estimated from experience with similar projects in the area. Otherwise, a percentage figure of the construction cost is used, two to three per cent is an accepted figure.

An example of cost estimates for a hypothetical 60 kW scheme, itemising capital and running costs, is presented in Table 7.1.

7.2 : Methodology of Financial Analysis

7.2.1: Theoretical Concepts

An MMHP scheme is expensive and risky because all the investment is made in the beginning, without being sure about the performance and the extent of returns. Some kind of analyses/calculations are necessary to determine whether the scheme will yield financially viable results.

The financial viability of a project is judged on the basis of the cost-benefit analysis. From the private entrepreneur's stand point, a project is regarded as viable if the benefits quantified as financial returns are higher than the costs.

It is also useful to distinguish between 'economic analysis/evaluation' and 'financial analysis/evaluation'. Financial analysis is usually based on cost-benefit analysis; accounting only for the monetary benefits against the investment costs based on market prices. An economic analysis also attempts to quantify social and other such intangible benefits and includes them in the cost-benefit analysis. Admittedly, this is not an easy or accurate task. However, some aspects and methodologies are discussed in the next section.

Table 7.1 Itemised Capital and Running Costs for a 60 kW scheme

Capital costs	Cost ($)	Proportion of total cost	Contribution to benefits
1. ***Planning/design*** Engineering, energy survey, hydrology study, site survey, pre-feasibility report, feasibility report, supervision fees, commissioning fees, training, manuals	4,000	3%	High
2. ***Management and finance*** Institution formation, funding procurement, legal & insurance, training for management	2,000	1%	High
3. ***Penstock***	37,000	27%	Medium
4. ***Other civil works*** Weir & intake, canal, powerhouse, site preparation/access roads, others	35,000	25%	Medium
5. ***Electro-mechanical*** Turbine, generator, switchgear, other	36,000	26%	Medium
6. ***Distribution of electricity*** Transmission lines, distribution lines, domestic connections	12,000	9%	High
7. ***Appliances***	3,000	2%	
8. ***Contingency***	10,000	7%	
Total capital costs	139,000	100%	
Running costs			
1. ***Fixed annual (O&M) costs*** Labour wages (O&M staff) Management committee (O&M) Specialist overhaul, maintenance, others	2,000/year	6%	High
2. ***Variable running costs*** O&M staff recruitment, initial O&M training, 5-yearly O&M training refresher, spare parts, tools, materials, specialist advice, replacement, equipment, others	Allow 1,000/year	3%	High
3. ***Contingency***	Allow 1,000/year	3%	
Estimated total yearly running costs (O&M)	4,000	12%	High
Capital cost expressed as an annual cost (C_{an}) [See equation (8)]	28,000/year	88%	
Total annual cost = C_{an} + (O&M) = 28000 + 4000	32,000	100%	
Plant factor	0.4		Very high

Unit energy cost $= \dfrac{C_{an} + (O + M)}{P_{ins} \times 8{,}760 \times PF} = \dfrac{28{,}000 + 4{,}000}{60 \times 8{,}760 \times 0.4} = 0.15\$.\text{kWh}$

Cost per kW installed $= \dfrac{139{,}000}{60} = 2{,}300\$ / \text{kW}$

Some indicators of financial analysis and viability of schemes and basic financial concepts are described below.

Discount Rate

The economic life of an MMHP is generally assumed to be in the range of 10 to 30 years. The costs as well as benefits incurred in different years of the MMHP plant's life need to be reduced to the price of a particular year so that these can be compared. For example, $ 100 spent in year-1 is not equal to $100 earned in year-2, since $100 earned in year-1 would have yielded ($ 100 + x) in year-2 because of the opportunity cost of capital, which explains the interest paid by the banks for the deposited capital. Therefore, $ 100 in year-2 is less than $ 100 in year-1. The value in $ 100 of year-2 in year-1 can be found by multiplying the earnings in year-2 by a factor known as the discount factor. Mathematically,

Value of $ 100 earned in
year-2 reduced to year-1 $(B^1{}_2)$ = Earnings of year – 2(B_2) x Discount factor (DF)

$$\text{or,} \quad B^1{}_2 = B_2 \times DF \quad --- (1)$$

in a non-inflationary economy, the discount factor is known as the real discount factor DF_r
In this case:

$$B^1{}_2 = B_2 \times DF_r$$

where, $$DF_r = \frac{1}{(1+r)}, --- (2)$$ and

r = real discount rate.

Equation (1) and (2) can be combined in the following general form:

$$PV = \frac{FV}{(1+r)^n} \quad ------- (3)$$

Where, PV → present value of an expected future return / value

FV → future value, and

n → number of years (between future and present value).

For example, if a $ 100 was earned in year-11 and the annual real discount rate was 0.12 per annum, then the value of this future earning reduced to year-1 may be determined as follows:

$$PV = \frac{FV}{(1+r)^{10}} = \frac{100}{(1+0.12)^{10}} = \$32.2.$$

In other words, if a $100 was expected to be earned during the 11th year, its value at present is only $ 32.3.

Inflation is another reason why the value of a particular sum of money decreases in future. The relationship between present and future values of a sum in an inflationary situation can be expressed by the following formula without accounting for the opportunity cost[8] of capital.

$$PV = \frac{FV}{(1+f)^n} \quad \text{--------(4)}$$

where, $f \rightarrow$ inflation rate for the relevant period (year, month, etc), and

$n \rightarrow$ number of periods separating the periods under consideration.

In real life both the opportunity costs of capital and inflation are to be taken care of while discounting. Such a discount rate is known as the market discount rate (m) or actual yearly rate of return, which may be equivalent to the prevalent market interest rate or actual yearly rate of return on an investment. The market discount rate is reflected in the lending interest rates of the banks.

The following relationship exists between the real and market discount rates.

$$r = \frac{1+m}{1+f} \quad \text{-----------(5)}$$

or, approximately $r = m - f$ ----------(5a).

Choosing an appropriate discount rate is very important for the financial analysis which reflects the real yearly return after deducting the inflation rate. A real discount rate of eight to 12 per cent is recommended for the developing countries.

The Annuity Equation

Equal income or expenditure over a long time (over a number of periods) is called annuity (A). The present value of annuity and vice versa may be found using the following annuity equation:

$$PV = A.\frac{(1+r)^n - 1}{r(1+r)^n} = A \times DF \quad \text{------(6)}$$

[8] The opportunity cost of capital is the earning it can make when invested. For example, if $100 invested in an enterprise yielded $20 in return after one year, the opportunity cost of capital ($100) is $20 provided there is no inflation. If there was inflation and $20 earned after one year equals $10 at the time of investment (assuming 10% inflation), then the opportunity cost of capital was $10. Real discount rate reflects the opportunity cost of capital.

Example: Cash flow analysis and calculation of financial indicators calculate NPV, IRR, B/C and discounted pay-back period for the scheme for which the yearwise revenues and expenditures are given below (in thousand $).

1. Year, n	0	1	2	3	4	5	6	7	8	9	10	11	12	Total
2. Cost (expenditure)	100	15	5	5	5	5	5	7	7	7	37	7	7	
3. Benefit (revenue)	0	28	28	28	30	31	31	31	31	31	25	31	31	
4. Cash Flow	-100	13	23	23	25	26	26	24	24	24	-12	24	24	
5. Discount Factor (for r = 12%)	1	0.893	0.797	0.712	0.636	0.567	0.507	0.452	0.404	0.361	0.322	0.288	0.257	
5a. Discounted Costs	100	13.40	3.99	3.56	3.18	2.84	2.54	3.16	2.83	2.53	11.91	2.02	1.80	153.76
5b. Discounted Benefits	0	25.00	22.32	19.94	19.08	17.58	15.72	14.01	12.52	11.19	8.05	8.93	7.79	182.31
5c. Discounted Cash Flow	-100	11.6	18.38	16.38	15.90	14.74	13.18	10.85	9.69	8.66	-3.86	6.91	6.17	28.55
5d. Discounted Cumulative Cash Flow	-100	-88.4	-70.7	-53.69	-37.79	-23.04	-9.87	0.98	10.67	19.33	15.47	22.38	28.55	NPV=28.55 B/C = 1.19
6. Discount Factor (for r=15%)	1	0.870	0.756	0.658	0.572	0.497	0.432	0.376	0.327	0.284	0.247	0.215	0.187	
6a. Discounted Costs	100	13.05	3.78	3.29	2.86	2.49	2.16	2.63	2.29	1.99	9.14	1.51	1.31	146.5
6b. Discounted Benefits	0	24.36	21.17	18.42	17.16	15.41	13.39	11.66	10.14	8.80	6.18	6.67	5.80	159.16
6c. Discounted Cash Flow	-100	11.31	17.39	15.13	14.30	12.92	10.90	9.03	7.85	6.81	-2.96	5.16	4.49	
6d. Discounted Cumulative Cash Flow	-100	-88.69	-71.30	-56.17	-41.87	-28.95	-18.05	-9.02	-1.17	5.64	2.68	7.84	12.23	NPV =12.23 B/C = 1.09
7. Discount Factor (for r= 18%)	1	0.848	0.718	0.609	0.516	0.437	0.370	0.314	0.266	0.226	0.191	0.162	0.137	
7a. Discounted Costs	100	12.72	3.59	3.05	2.58	2.19	1.85	2.20	1.86	1.58	7.07	1.13	0.96	140.78
7b. Discounted Benefits	0	23.74	20.10	17.05	15.48	13.55	11.47	9.73	8.25	7.01	4.78	5.02	4.25	140.43
7c. Discounted Cash Flow	-100	11.02	16.51	14.00	12.90	11.36	9.62	7.53	6.39	5.43	-2.79	3.89	3.29	
7d. Discounted Cumulative Cash Flow	-100	-88.98	-72.47	-58.47	-45.57	-34.21	-24.59	-17.05	-10.67	-5.24	-7.53	-3.64	-0.35	NPV= -0.35 B/C = 0.998
8. Discount Factor (for r=17.9%)	1	0.848	0.719	0.610	0.518	0.439	0.372	0.316	0.268	0.227	0.193	0.163	0.139	
8a. Discounted Costs	100	12.72	3.60	3.05	2.59	2.20	1.86	2.21	1.88	1.59	7.14	1.14	0.97	140.95
8b. Discounted Benefits	0	23.74	20.13	17.08	15.54	13.61	11.53	9.80	8.31	7.04	4.83	5.05	4.31	140.97
8c. Discounted Cash Flow	-100	11.02	16.53	14.03	12.95	11.41	9.67	7.59	6.43	5.45	-2.31	3.91	3.34	
8d. Discounted Cumulative Cash Flow	-100	-88.98	-72.45	-58.42	-45.47	-34.06	-24.39	-16.80	-10.37	-4.92	-7.23	-3.32	0.02	NPV= 0.02 B/C = 1.00

where, $DF = \frac{(1+r)^n - 1}{r(1+r)^n}$ - - - - - (7).

DF is known as the discount factor based on the discount rate.

For example, if an investment of $ 100,000 was made for an MMHP plant in year-1, and it yielded a constant net income of $ 6,000 from year-2 to year-20, the viability of this MMHP could be established easily using the annuity equation as follows (assuming r= 0.10)

$$PV = 6,000 \times \frac{(1+0.1)^{19} - 1}{0.1(1+0.1)^{19}} = \frac{5.12 \times 6,000}{0.612} = 8.36 \times 6,000 = \$50,159$$

or, alternatively

$$A = \frac{PV.r(1+r)^n}{(1+r)^n - 1} \quad \text{- - - - - -(8)}$$

$$= \frac{100,000 \times 0.612}{5.12} = \$11,963$$

The above example shows the financial non-viability of this plant, because the present value of the expected returns over the lifetime of the project is less than the capital investment.

In the above example, the discount factor for conversion of annuity into the present value equals 8.36. Discount factors are calculated by using equation (7), or they can be found in the discount factor tables given in many books dealing with financial analysis. Equation (8) can also be used to calculate the annuitised Capital Cost C_{an} (C_{an} = A) over the lifetime of the plant representing the Capital Cost.

7.2.2: Unit Energy Costs and Returns

The unit energy cost of MMHP can be calculated by using the following formula:

$$\frac{\text{Unit energy cost}}{\text{(say \$ / kWh)}} = \frac{\text{Total annual cost}}{\text{energy usefully consumed per year}}$$

$$= \frac{C_{an} + (O+M)_{an}}{P_{ins} \times 8,760 \times PF} \quad \text{- - - - - -(9)}$$

where,

C_{an} (or A) → annual repayments for invested capital in \$ they can be calculated usin g the annuity equation,

$(O \& M)_{an}$ → annual operation and maint enance cos t, which is assumed to be cons tan t at this stage,

P_{ins} → installed capacity in kW and plant factor.

PF — PF is defined as the ratio of total actual energy produced by a plant in a year to its max imum energy production capacity

Mathematically,

$$PF = \frac{\text{Annual Energy Output}}{8{,}760 \times P_{ins}}$$

7.2.2: Unit Energy Costs and Returns

The unit energy cost of MMHP can be calculated by using the following formula:

An example of a unit energy cost calculation is presented below.

Example

Plant Capacity	=	20 kW
Plant Cost (c)	=	\$40,000
Annual O & M Cost	=	3% of the capital cost
Expected Life	=	10 years,
Real Discount Rate, r	=	10% / annum
Plant Factor	=	25% or 0.25

Annuitised Capital Cost (C_{an}) (or Annuity (A)

$$= PV\frac{r(1+r)^n}{(1+r)^n - 1}$$

$$= \frac{C \times r(1+r)^n}{(1+r)^n - 1}$$

$$= \frac{40{,}000 \times 0.1(1+0.1)^{10}}{(1+0.1)^{10} - 1}$$

$$= \$6{,}510$$

Total Amount Cost

$$= C_{an} + \text{Annual O\&M Cost}$$

$$= C_{an} + 0.03 \times 40{,}000 \text{ (3\% of capital cost)}$$

$$= 6{,}510 + 1{,}200$$

$$= \$7{,}710$$

Unit Cost

$$= \frac{\text{Total Annual Cost}}{\text{Installed Capacity} \times 8{,}760 \times PF}$$

$$= \frac{7{,}710}{20 \times 8{,}740 \times 0.25} = \$0.176 / kWh$$

Net Present Value

The Net Present Value (NPV) is the sum of the discounted net benefits (revenues) throughout the project period. A project is regarded as financially viable if the NPV is greater than 0.

Mathematically,

$$NPV = \sum_{i=o}^{n} \frac{B_i - C_i}{(1+r)^i} \text{ ---------(10)}$$

where,

B_i, C_i → benefit and cost of year i

i → time interval under consideration, and

n → life of the project in terms of the intervals (say years)

In the above formula, the project begins with a 0 interval, which is the construction period of the project. This convention is adapted to start the life of the project from the first interval.

Alternatively, and more simply, the NPV at a given real discount rate (r) can be calculated from the following equation:

$$NPV_{(r=---\%)} = PV - C \text{ ----------(11)}$$

where,

C is capital cost and the PV can be calculated from equation (6).

The following example illustrates the use of NPV as an indicator of the financial viability of a project.

Capital cost, \$120,000; expected life, 15 years; expected yearly net income, \$12,000; real discount rate, 12 per cent.

$$PV = A\frac{(1+r)^n - 1}{r(1+)^n} = \$12{,}000\ \frac{(1+.12)^{15} - 1}{0.12\ (1+.12)^{15}} = \$81{,}600$$

$$\therefore\ NPV_{(r=12\%)} = PV - C = \$81{,}600 - \$\ 120{,}000 = -\ \$38{,}400$$

The -ve sign shows that the present value of all the future net incomes is less than the present investment. Therefore, the project is not viable at the given discount rate and the expected life.

Internal Rate of Return

The Internal Rate of Return (IRR) is the discount rate at which the project's NPV is zero. The determination of IRR is an iterative process and hence time consuming for manual calculations. The procedure for calculating IRR is demonstrated in cash flow analysis, given in the Example on p86.

In most situations, it is generally asked what would be an acceptable rate of return estimated before implementation for commercial MMHP projects. As a very simplistic 'rule of thumb', an IRR of 12 per cent or higher would justify the investment on a project, and eight per cent or less would not; the values in between are a grey area.

Benefit-Cost Ratio

Benefit-Cost Ratio (B/C) is the ratio of discounted total benefit (income) to the discounted total cost. A project is financially viable if B/C is greater than one.

Mathematically,

$$B/C = \frac{\sum_{i=o}^{n} B_i}{\sum_{i=o}^{n} C_i} \text{ ----------(12)}$$

B/C has also been calculated in the following example (p90). Its value is 1.19 at a discount rate of 12 per cent. Thus the project is viable.

Pay-back Period

The time period (usually in years) within which the simple or discounted capital investment is completely recovered is called the pay-back period. It is an important indicator for private investors because they will be interested not only in a high IRR but also in a short pay-back period.

'Simple pay-back period' does not take into account the time value of money; i.e., the money is not discounted and can be calculated by using equation 13. It is usually not used for long-term projects such as MHP. The 'discounted pay-back period' takes into account the change of money value with time.

$$\text{Simple payback period (yrs)} = \frac{\text{Total capital cost}}{\text{Annual revenue} - \text{Annual expenditure}} \text{ --------(13).}$$

Discounted pay-back period 'n' can be calculated from the following equation, when capital cost, annuity and discount rate are known. Various values of 'n' can be assumed until the two sides are numerically equal. Alternatively, it can be calculated through cash flow analysis, as demonstrated in the following example. This is the only method in which the net incomes are not constant over the years. When the investment is paid back, the sign of discounted cumulative cash flow changes from '-' to '+'. Thus, the discounted pay-back period is seven years in the example for r = 12 per cent.

$$C/A = \frac{(1+r)^n - 1}{r(1r)^n} \text{ ----------(14).}$$

'n' in the above equation is the pay-back period.

Steps for Iterative Cash Flow Analysis

Step 1. Calculate the B/C and NPV at a real discount rate considered to be suitable; say 12 per cent in this case. The B/C ratio of over one and NPV greater than zero indicate the viability of the scheme at a given value of 'r' (Lines 5-5d).

Step 2: IRR is the discount rate at which the NPV is zero. At r = 12 per cent, the NPV is greater than zero. Therefore, the IRR is greater than 12 per cent. The B/C ratio of 1.19 indicates that the IRR is not near to 12 per cent. Assume r = 15 per cent as a second guess; but that the NPV is still positive. Therefore, a higher r needs to be tried. Note that when r was raised by 3 per cent the B/C ratio dropped by 0.10. The B/C ratio needs to be further reduced by 0.09, therefore r may be raised by a further 3 per cent.

Step 3: Assume r = 18 per cent as a third guess. Here, the NPV is nearly zero but -ve. Thus, for practical purposes the IRR may be taken as 18 per cent. However, for a better understanding of the iterative process more steps may be introduced in this example.

Step 4: At r = 18 per cent the NPV is negative. Therefore the IRR is somewhat lower than 18 per cent, but quite close to 18 per cent as the B/C ratio of 0.998 indicates. Make a fourth guess of r=17.9 per cent. The NPV in this case is 0.02, which is close to zero and +ve. Therefore, the IRR is very slightly above 17.9 per cent but less than 18 per cent.

Results: The NPV is -ve at r=18 per cent and +ve at r=17.9 per cent. Therefore, the value of the IRR can be taken as 17.9 per cent.

Also, B/C = 1.0 at r=17.9 per cent

The pay-back period at r=12 per cent is about 7 years (when discounted the cumulative cash flow becomes +ve)

at r=15 per cent, it is about 9 years

at r=18 per cent, it is more than 12 years.

Explanatory Notes for Cash Flow Analysis

1. *The capital cost of the project is $100,000. All investment is supposed to be made in year-0, which is the construction year. The life of the project is assumed to be 12 years. It is critical to properly assess the plant life.*
2. *The analysis has been made at constant prices, that is without consideration of price escalation. When all cost and benefit components are subject to the same inflation rate, inflation need not be considered. Operation and maintenance costs that spread throughout the project life are variable. The costs at year-1 are high because of training and initial management costs. These costs have been assumed to increase from year-9, due to wear and tear of equipment. The high costs in year- 10 are due to refurbishment of some capital equipment.*
3. *Benefits (revenues) shown in row 3 are income from energy sales. The energy sales have been assumed constant in the first three years, then they rise slightly and stabilise from year-5. The low revenue in year 10 is due to plant refurbishment works.*
4. *Cash Flow = Benefits - Costs.*
5. *Discount Factor* $= \frac{1}{(1+r)^n}$
6. *Discounted Costs = Discount Factor x Cost (for each year separately)*
7. *Discounted Benefits = Discount Factor x Benefits*
8. *Discounted Cash Flow = Discount Factor x Cash Flow.*
9. *(Discounted Cumulative Cash Flow)*$_{12}$ = *(Discounted Cumulative Cash Flow)*$_{12-1}$ + *(Discounted Cash Flow)*$_{12}$.
10. *Positive NPV, IRR higher than discount rate and B/C ratio greater than one indicate the financial viability of the MHP. The pay-back period of seven years is a little high.*
11. *If subsidies are available, the costs used for calculations should be exclusive of these.*
12. *One might attempt more calcuations, e.g., for r=17.91 per cent. However, for practical purposes this is not necessary.*

7.3: Selection of Analysis Method

MMHP plants are long-life projects with varying revenues and expenditures (benefits and costs) each year. These variations are mainly associated with time taken for load growth, heavy expenditure during the construction period, and replacement of equipment. It is important to note that the treatment of benefits and costs of MMHP as constant annuities could become a risky over-simplification. A feasibility study for MMHP requires a fully-fledged cash flow analysis, which essentially is an effort to consider actual benefits and costs on an annual basis.

More accurate expenditure in and revenue from an MMHP can be predicted using the following guidelines.

a. Depending upon the size of the MMHP and the socioeconomic conditions of the locality, it could take three years or more for full use of the plant's capacity. Judgement of load growth should be made by comparing the locality under consideration with other similar localities where MMHPs have been installed earlier. The feasibility of the MMHP is greatly influenced by this load growth. Therefore, it is advisable to be conservative in estimating the load growth.

b. MMHP technology is relatively new. There is still no well-established MMHP expenditure pattern, especially for repairs and parts' replacement. Expenditure seems to be influenced by the type and make of the equipment, management capability of the owner, and remoteness of the site. Therefore, it is advisable that expenditure patterns of similar MMHPs be studied in order to estimate expenditure for the MMHP under consideration.

At the prefeasibility study stage, whenever possible, it is desirable to use cash flow analysis. This is especially true if the purpose of these studies is to check the financial viability of a particular project and not the ranking of a number of candidate projects. This is what a private entrepreneur normally does.

When the assessment of yearwise benefits and costs is yet to be made, the annuity method may be used for financial analysis. The annuity method assumes the annual benefit and costs to be constant. Therefore, judgement of the financial strength of the project can be carried out simply by assessing the financial performance for one year. The indicator very often used for this purpose is the unit cost of energy produced. The unit cost gives a general impression about the financial standing of the project as well as helping to rank the candidate projects.

7.4: Accounting for Social and Environmental Factors

Financial analysis is designed to make judgements about the viability of an MMHP purely from the market stand point, commonly called financial viability. A private investor might be interested in the financial analysis only but not the public investor or the society; because financial analysis might not take social costs and benefits fully into account. For example, the market price of many commodities might not reflect the real price due to government subsidies and taxes. The wages also may not reflect the real wages due to these price distortions. When the financial analysis is conducted, by using not the distorted market prices but the real values to the society, the analysis is called economic analysis. Government or public agencies are expected to make judgements on the projects on the basis of economic analysis.

Virtually all the environmental problems being faced by developed countries are also found in the developing countries; although the scale and extent of damage might be different. If industrial pollution is more pervasive in the industrialised countries, soil erosion and deforestation are more acute problems in the developing countries. Therefore, it is necessary that both, the developed as well as the developing countries, make efforts to address these difficult problems and collaborate with each other.

Thus, the environmental consequences of various energy supply and usage options must also be appraised and accounted for while selecting one for a given area or application. The same is also true for the social consequences (benefits as well as damage).

MMHP can have intangible social and environmental benefits such as stimulation of the rural economy, substitution of fuelwood, etc. Likewise, it can result in environmental damage, such as erosion, along the canal and tailrace. Monetary evaluation of benefits and costs in such cases is not easy. But there are cases for which these could be accounted for. For example, the damage caused by seepage along the canal can be abated through engineering solutions, for which costs could be estimated. It is important that the negative consequences of MMHP, if any, should be identified and the abatement costs related to them should be accounted for as far as practicable. Obviously, the negative effects of fuel systems, such as petroleum products, are far more serious than those of the MHP on the environment and sometimes even on health. Therefore, the potential costs of such effects have to be taken into consideration also.

7.5: Selection of an Appropriate Option

At present, in Nepal, private utility MHP is being promoted not as one of the competing sources of electrical energy but as the sole source. Therefore, the MHP being appraised is, generally, not compared with other sources. Likewise, a particular MHP is not compared with other MHPs that can be built elsewhere as investment alternatives, because the MHP is still a completely local enterprise with local entrepreneurship designed to provide electricity to a particular locality. Therefore, so far, the project selection implies the assessment of financial viability of a particular MHP rather than the selection of a best MHP project for investment within a large area/region/district.

7.5.1: Appraisal of a Single Option

While appraising a single option project, any of the financial indicators can be used to judge the viability of the option. However, the IRR has some advantage over others, because of its being easily understood by investors, and because it directly shows the per unit (period) yield from capital. In addition, the IRR of a project helps to facilitate a decision about the feasibility of the project through direct comparison with the prevailing interest rates.

Power projects being long-life projects, it is important not only to know the ultimate profit from the project but also the pay-back period. Therefore, it is recommended that the IRR and discounted pay-back periods be used as tools for measuring the financial viability of single option projects.

7.5.2: Comparative Evaluation of Options

Comparative evaluation of options is carried out to find a project or a set of projects yielding the best financial rewards. When the available projects are ranked as per the benefit-cost ratio, net present value, and internal rate of return, the preferences shown by these parameters might differ. Furthermore, the ranking for a particular financial indicator might differ for different interest/discount rates. Therefore, the choice of a particular indicator for project selection should be made only after considering the context of selection. The following guidelines for project selection could be used.

(a) Select an appropriate real discount rate. The real discount rate should be based on the real interest rate applicable for the projects being considered.

(b) Consider meeting the following criteria for ranking projects:

B/C > 1, NPV > 0, IRR > Discount Rate.

(c) If there is no resource constraint to project funding, or, in other words, if the available funds are sufficient to fund any of the alternatives, then the alternative yielding the largest NPV should be selected.

(d) When the availability of capital is relatively small, compared to the availability of projects, it is most desirable to develop those projects that have the highest benefit-cost ratio first.

(e) The net present value indicator is to be preferred to the internal rate of return for ranking mutually exclusive projects.

(f) In the case of independent projects, selecting projects in order of their benefit-cost ratio, until the available funds are exhausted, should be preferred to selecting projects on the basis of their net present values. However, when a large amount of money remains unused while adapting this method, the combination of projects yielding the maximum NPV should be chosen.