Techniques for Energy Project Evaluation

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The current instability in energy markets presents a dilemma to those planning energy projects – how to account for future changes in income and cost streams. If the future were known with certainty, then some simple arithmetic would suffice to turn in a proper evaluation of most projects. However, inflation, changes in relative costs and prices, shifts in demand, and government policies all make uncertain the likelihood of success for many projects.

To reduce the ranges of uncertainty surrounding projects, economists have developed techniques for project evaluation that can be profitably applied to a wide variety of projects. These techniques do not supply decisions but they help us make more informed choices by summarizing the relevant information into simple categories of benefits, costs, sensivities, etc.

Currently, the "normal" method used to evaluate investments is to calculate the simple payback period – the amount of time required for project revenues to exceed initial capital costs.[1] In contrast with this method are such alternatives as present worth analysis (PW) and Discounted Cash Flow Rate of Return analysis (DCFROR). The latter techniques, I shall argue, provide clearer, more direct information about the problem. In addition, they force the planner to seriously consider such factors as financing costs, salvage values, major maintenance costs, etc. not included in payback calculations.

Finally, in conformity with the strictures of some international lenders, including the World Bank, the PW and DCFROR techniques can be adjusted for errors in costs or prices arising from the peculiarities of a particular country. That is, an alternate system of prices, often referred to as "shadow" prices, can be used if the planner believes that market prices fail to reflect social costs.[2]

SOME BASICS: THE CASH FLOW DIAGRAM

The cash flow diagram is simply a means for organizing the relevant cost and revenue streams in an easily comprehensible manner. Such a diagram aids in shifting from one method of analysis to another. By convention, the cash flow diagram consists of a horizontal line in time. Above the line are the positive cash flows, and below the line are the negative cash flows.

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1. A method of calculating payback period using discounted revenues is available, but is cumbersome relative to the ease of doing the undiscounted payback calculation. In spite of the extra computations, the essential nature of the payback measure, as one of risk not return, remains.

2. Squire and van der Tak (1975) for a discussion of the World Bank's shadow pricing techniques. The Bank often requires two sets of calculations – one based on existing prices and the other based on shadow prices. Calculation of shadow prices involves revaluing goods or services whose prices are distorted by taxes, subsidies, currency overvaluation and the like. The shadow prices then give the real resource costs of the items in question.

e.g. a hydroelectric project has initial costs of US$1,000,000 and requires 3 years to build. The initial costs come in equal instalments of US$333,333.33 each. In year 4, partial production of electricity yields net revenues of US$50,000. The next year, revenues rise to US$100,000. By year 6, the lake fills and full power production commences with net revenues of US$500,000 until the termination of the project (siltation of the lake) in year 20.

For such a project, we get the cash flow diagram of Fig. 1.

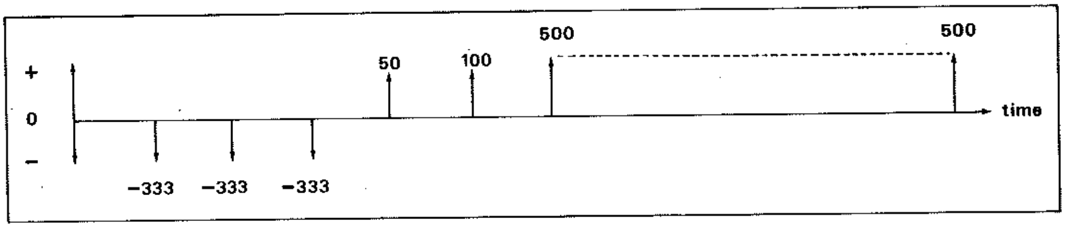

Fig. 1 Cash flow diagram for hydroelectric project (in thousands of dollars)

A cash flow diagram summarizes the relevant information about positive or negative cash flows by period. According to the conventions adopted, time flows from left to right, positive cash flows are above the axis and negative flows are below it.

PAYBACK PERIOD: A POOR GUIDE FOR PLANNERS

Many of us have had the experience of presenting a proposal full of charts and figures only to hear the question, "What's the payback?". Quite literally, the payback period is the amount of time required for project revenues to sum to the initial capital investment. In the above example, the total costs of US$1,000,000 are exceeded by revenues only in the 8th month of project year 7: i.e. payback period = 6.67 years.

What are we to conclude about this hydro project? Certainly 6.67 years is a long time to wait to recoup one's money. Under what conditions would such a wait be worthwhile? What effects will the cost of money have on the investment, and what about possible delays during construction?

Unfortunately, the payback period criterion gives little help to the planner faced with such questions. Quite simply, the technique is ill-suited to evaluation of large projects. Rather, it has seen use as a handy measure of the riskiness of small or incremental investments where the return is expected to run 2 or 3 years at most.

PRESENT WORTH ANALYSIS: ACCOUNTING FOR THE TIME VALUE OF MONEY

Most projects show a series of unequal cash flows, some negative and others positive. PW analysis summarizes those two streams into present value figures for costs and for benefits. By explicitly introducing a discount factor, it is possible to use various discount rates to test the soundness of the project under a variety of circumstances. Selection of discount rates can be a difficult business, as the level of that rate may indicate a strong bias in one direction or another.

Some lenders use "real" discount rates of 3-5%, whilst others rely on GNP deflators or high grade bond yields. Generally, the discount rate chosen will vary with the source of funds.

To determine the present worth of a project one needs simply to calculate the current values (PV) for costs and benefits as follows:

$$\text{PV (Cost)} = \sum_{n=1}^{m} \text{Cost}_n \ (1+i)^{-n} \tag{1}$$

$$\text{PV (Benefits)} = \sum_{n=1}^{m} \text{Benefits}_n \ (1+i)^{-n}, \tag{2}$$

where i is the discount rate, m is the lifetime of the project and n is the current year.

$$\text{Present worth (PW)} = \text{PV (Benefits)} - \text{PV (costs)} \tag{3}$$

$$\text{Benefit Cost Ratio (B/C)} = \frac{\text{PV (Benefits)}}{\text{PV (Costs)}}$$

A project is considered feasible if its present worth is positive. This is equivalent to saying PV (Benefits) exceed PV (Costs).

Using the data from the hydropower example and inserting into equations (1) and (2) with an interest rate of 0.075 per year, the following results emerge (in thousands of dollars):

$$\text{PV (Costs)} = \sum_{n=1}^{3} 333\ (1.075)^{-n}$$

$$= 333\ (1.075^{-1} + 1.075^{-2} + 1.075^{-3})$$

$$= 309.77 + 288.16 + 268.06$$

$$= 865.97$$

$$\text{PV (Benefits)} = \sum_{n=4}^{20} \text{Revenue}_n\ (1.075)^{-n}$$

$$= 37.4 + 69.7 + 3075.34$$

$$= 3182.44$$

These cost and benefit figures yield a present worth of the project (also known as net present value) as:

$$\text{PW} = 3{,}182{,}440 - 865{,}970 = 2{,}316{,}470$$

$$\text{B/C} = \frac{3{,}182{,}440}{865{,}970} = 3.68$$

Conclusion: the project is economically feasible and should be undertaken if funds are available.

The present worth technique has some drawbacks, however. First, it gives little information about the pattern of cash flows. Second, the technique does not yield enough information to select alternative projects using a limited budget. That is, it gives no assistance on determining how and in what order funds should be made available.

Specifically, what is lacking from present worth analysis is the rate of return yielded by alternative investments. Using the rate of return an investor can determine whether a given project is preferable to alternative investments.

ACCOUNTING FOR INFLATION AND PRICE CHANGES

One method of project analysis would have the planner remove the effects of inflation whenever possible – from interest rates, costs, revenues. Unfortunately, the project itself must be paid out in money of the day. Particularly for financial analysis, this means expressly including inflation.

Our only means of accounting for inflation lies in making explicit projections about the future. For example, if costs for large earthmoving and construction projects have been rising at an average rate of 10% per year, then a prudent modification of the *construction cost* estimates from the hydro example would be:

$$\text{Cost}_1 = 333 \times 1.1 = 366.3, \quad \text{Cost}_2 = 366.3 \times 1.1 = 402.9, \quad \text{Cost}_3 = 402.9 \times 1.1 = 443.2$$

This gives:

$$\begin{aligned} \text{PV (Costs)} &= 366.3 \times 1.075^{-1} + 402.9 \times 1.075^{-2} + 443.2 \times 1.075^{-3} \\ &= 340.7 + 348.6 + 356.8 \\ &= 1046.1, \text{ as compared with a previous figure of } 865.97\text{, an increase of } 21\% \end{aligned}$$

Suppose, now, we thought that revenues would rise at a slower pace due to lack of effective demand for electricity at ever-increasing rates. Let the expected rate of price escalation be 5% annually. Modifying the positive cash flow appropriately gives the new PV (Benefits) as:

$$\text{PV (Benefits)} = \sum_{n=4}^{20} (B_n\ 1.05)(1.075)^{-n}$$

$$= 50 \times (1.05)^4\,(1.075)^{-4} + 100 \times (1.05)^5\,(1.075)^{-5} + \ldots + 500\,(1.05)^{20}\,(1.075)^{-20}$$

$$= \text{US\$}5558.04\text{, as compared with a previous figure of } 3182.44\text{, an increase of } 75\%$$

$$\text{PW} = 5{,}558{,}040 - 1{,}046{,}100 = 4{,}511{,}940$$

Overall, net benefits increase from US$2,316,470 to US$4,511,940, an increase of 95%. Given the magnitude of the change in results, the planner must ensure that his inflation projections are as accurate as possible.

During recent years, many alternative energy projects were undertaken with assumed inflation rates of 10% and *real* (above inflation) increases in oil prices of 1-3% annually. Given the current fall in oil prices and slowdown in inflation, these projects may not prove feasible. For example, solar energy projects with assumed 1990 oil prices of US$100/bbl. may become cash sinks with (nominal) 1990 oil prices of just US$50-75/bbl.

Detailed estimates are available for inflation rates in most of the cost areas relevant to alternative energy. Projections on prices are far less comprehensive. Moreover, the planner must decide the period over which the inflationary effects are to be calculated. The job crucially affects results but, alas, is still far more in the realm of art than science.

DISCOUNTED CASH FLOW RATE OF RETURN (DCFROR): NOT PERFECT, BUT BETTER.[3]

Often, during the course of a project, negative cash flows may occur due to needed remedial investment or weak markets. Such cash flows must be covered by borrowing short term. At the same time, positive cash flows may be reinvested in other projects. In general, the long-term reinvestment rate exceeds the short-term borrowing rate.[4] Unlike its antecedent, Internal Rate of Return analysis, the DCFROR can handle any pattern of cash flows.

$$\text{DCFROR}, \% = [(\text{T/D})^{1/n} - 1]\ 100 \tag{4}$$

where T is the modified terminal value,
D is the modified initial investment, and
n is the lifetime of the project

THE TECHNIQUE

In the DCFROR method the intermediate cash flows, positive or negative, are discounted according to external rates. For example, the company or agency building a dam-cum-hydro project will have to pay interest on the loans taken out during the construction phase. The rate on these loans is called the *short-term rate*. Alternatively, the positive cash flows of the later periods can be reinvested at some higher rate of return (called the *long-term rate).*

All of the negative cash flows are discounted back to period zero or to a positive value starting with the negative period furthest out. This process yields the modified initial investment shown below under phase 1.

The positive values are computed out to the end of the project using the long-term reinvestment rate. These sums are compounded to yield a modified terminal value. The modified terminal value accounts for the investment opportunities available to the firm as a result of the cash flows from the project. The process is shown in phase 2, below.

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3. The method of discounting cash flows has largely superseded the Internal Rate of Return (IRR) technique. This latter technique consisted of solving a geometric series to find a unique rate of return which would make both the costs and revenues sum to zero. Its two most serious drawbacks were the limitation on sign changes and the assumption that all revenues could be reinvested at the IRR. The first assumption does not permit negative cash flows for, say, maintenance, renovation, low sales, etc. The latter assumption artificially raises the apparent rate of return of the project. The IRR is calculated according to the formula: $\text{Costs}_0\ (1 + \text{IRR})^n = \text{Revenues}_n$. With costs and revenues given, we solve for IRR, which from this project = 25.9%.

4. This is, of course, necessary for the firm to stay in business.

Phase 1:
Computing the modified initial investment

Initial Cash Flow	Discount and Balance	Test	Final Cash Flow
$CF_3 = -333$, $CF_2 = -333$	$\frac{-333}{1.08} - 333 = -641.33$	< 0	$CF_2 = -641.33$
$CF_2 = -641.33$, $CF_1 = -333$	$\frac{-641.33}{1.08} - 333 = -926.83$	< 0	$CF_1 = -926.83$
$CF_1 = -926.83$, $CF_0 = 0$	$\frac{-926.83}{1.08} + 0 = -858.17$	Period Zero	$CF_0 = -858.17$

Phase 2:
Computing the modified terminal value

Cash Flow	Compound and Balance	Final Cash Flow
$CF_4 = 50$, $CF_5 = 100$	$50 \times 1.12 + 100 = 156.00$	$CF_4 = 0$, $CF_5 = 156.00$
$CF_5 = 156$, $CF_6 = 500$	$156 \times 1.12 + 500 = 674.72$	$CF_5 = 0$, $CF_6 = 674.72$
$CF_6 = 674.72$, $CF_7 = 500$	$674.72 \times 1.12 + 500 = 1255.69$	$CF_6 = 0$, $CF_7 = 1255.69$
....	....	....
....	....	....
$CF_{19} = 16958.69$ $CF_{20} = 500$	$16958.69 \times 1.12 + 500 = 19493.73$	$CF_{19} = 0$, $CF_{20} = 19493.73$

The results of the DCFROR calculations, equation (4), give a rate of return constrained by the cost of borrowing and the potential yields of future investments. It is thus not a pure internal rate of return but, rather, an internal *and* external rate of return.

In the first phase, negative cash flows are discounted at the short-term rate. These negative cash flows are then netted against prior cash flows until either a non-negative balance or period zero is reached. The procedure starts with the latest period.

From the hydro example, the latest period of negative cash flow is period 3. Let the short-term rate = 0.08 and the long-term reinvestment rate = 0.12. The procedure yields a modified cash flow value for the initial period usually called the *modified initial investment* (denoted D).

In the second phase, the positive cash flows are compounded using the long-term rate.[5] This procedure yields a modified terminal value (denoted T) of the positive cash flows starting with the earliest positive cash flow.

Once the modified terminal value is computed, the calculation of the DCFROR follows the simple formula given in equation (4).

For the hydroelectric project, we get

$$T = 19{,}493.73$$

$$D = 858.17$$

$$\therefore \text{ DCFROR} = \left[\left(\frac{19493.73}{858.17}\right)^{1/20} - 1\right] 100$$

$$= 16.90\%$$

This figure means that the hypothetical hydro project will yield a return of 16.90% over its lifetime given the assumptions about the short- and long-term rates. Using such a technique, it is relatively simple to construct investment criteria satisfying both social and financial constraints.

For example, suppose instead of 16.90%, the DCFROR figure was 7.5%. This would mean that the project would be incapable of covering its own short-term interest costs – i.e. worse than merely putting one's money in a savings account.

Such information can serve well, particularly when foreign currency will be required. Any project returning less than the cost of the foreign loan (say, the World Bank rate of interest) will lead to a net increase in indebtedness. Projects with DCFROR exceeding the cost of money reduce overall debt.

Suppose, however, that a project gives a rate of return more than the short-term rate but less than the long-term rate. Such a project would be feasible but clearly unattractive given other opportunities. That is, it would yield less than what the investor expects from alternative investments.

In the current example, a fall in the terminal value to US$8,278.16 occasioned by, say, a gradual reduction in power output, lowers the DCFROR to 12%. Conversely, a cost increase resulting in a modified initial investment of US$2,020.85 would accomplish the same goal.

SENSITIVITY ANALYSIS

At a minimum, the planner must determine those critical values which cause the project to become undesirable or infeasible. A sensitivity analysis should be performed on the following elements of costs and revenues:

1) interest, discount, and reinvestment rates
2) patterns of cash flows – i.e. effects of moving costs or revenues in time
3) actual costs and revenues – e.g. capital and operating costs, product prices.

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5. A minimum long-term investment quantity may be given but is not used in this example.

4) unexpected, but possible, changes in patterns of costs and revenues – e.g. repairs, changes in demand, upgrading of output, etc.

Overall, the planner needs to know how confident he can be in the results emerging from a baseline set of assumptions. If, as in the hypothetical example used, the revenues or costs could vary over a wide range without destroying the basic feasibility of the project, then the results may be described as "robust". Alternatively, if the project were to become infeasible with only small changes in costs or revenues, then the planner would have to be all the more confident of his projections about cash flows. Tying the apparent robustness of the project evaluation to the degree of confidence in the actual data and subsequent projections gives the planner greater knowledge of how reality might surprise (pleasantly or not) the project sponsors.

INVESTMENT CRITERIA

The basic test of project feasibility remains the present worth criterion. By analyzing the sensitivity of the results to changes in cash flows and discount rates, the planner can determine the likelihood of maintaining feasibility over a variety of situations. Modifying the cash flow values in line with "shadow price" calculations yields a social measure of present worth. Often, a great divergence between social and financial feasibility indicates the need to modify certain tax or subsidy policies in order to make the project acceptable regardless of its putative social benefits.[6] In such cases, it is crucial for the planner to know the likely magnitude of tax changes or required subsidies.

A degree of precision is added to the selection of projects by submitting those which pass the present worth screen to discounted cash flow analysis. For example, if controls on electricity prices or taxes on equipment reduce the DCFROR below the borrowing rate, it is but a simple matter to determine either the required subsidies from other funds or such price changes as are necessary to make a project financially feasible or acceptable.

Concluding, then, a project may be called economically feasible if its present worth at "shadow" costs and prices exceeds zero. Financial feasibility requires that the project pass the same test based solely on market prices. Whether the project achieves an acceptable return can be determined from DCF analysis. An acceptable project gives a rate of return in excess of that offered by other investments. If the financial rate of return cannot assure a proper return, then the project must yield the acceptable rate with adjusted or shadow prices and costs. A project which fails the rate of return test on both financial and real resources will prove a net drain on both financial and real resources.

So far, financial analysis has failed to come up with a unique single number for ranking projects. Rather, we have a two stage procedure with two different tests of feasibility. The crucial inputs to both techniques are good data – without that, the exercise degenerates into mere number crunching. However, given good data, the results can be expressed as succinctly as with the payback period with the advantage of improved confidence in the validity of the results.

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6. Suppose, for example, government control of electricity prices reduced the maximum revenue to US$-200,000/year. The recalculated PW figure would be US$852,900, a drop of 63%, the B/C ratio would fall to just under 2. The modified terminal value in the DCFROR calculation would fall to US$8,933,190 This implies a DCFROR of 12.4%, significantly lower than the previous rate and only marginally better than other opportunities. In this case, the planner might well value the electricity produced at its full value in the social analysis while considering the financial implications of controlled electricity prices.

With rate of return analysis, projects can be straightforwardly ranked in order of rates. With present worth analysis, some allowances must be made for the limitations of project budgets. One possible criterion is the PW divided by the agency's or firm's *equity contribution.* That is, given two projects with a PW = 1000 the one requiring less equity from the agency or firm should be preferred. If this equity is denoted as E then this suggested criterion implies PW/E should be as high as possible with projects then ranked in descending order.

For example, given five proposed projects, suppose the PW and rates of return were as follows:

Project	A	B	C	D	E
PW (US$'000)	2500	2000	600	3000	1200
DCFROR (%)	14.5	13.0	17.5	15.0	15.5
E	600	400	50	700	600

According to the DCFROR criterion, the project rankings should be:

$$C > E > D > A > B$$

Suppose, however, that the firm's equity contributions to each project were as given in the third row. This yields a project ranking as follows:

Project	A	B	C	D	E
PW/E	4.17	5	12	4.5	2
Rank	4	2	1	3	5

i.e. $C > B > D > A > E$ – a far different mix than before.

How can the ranking inconsistency be resolved? One way is to set an arbitrary minimum rate (often given by the reinvestment rate of DCFROR analysis) for the rate of return. Such a hurdle rate might eliminate, say, both A and B. Alternatively, a minimum investment requirement could eliminate small projects such as C.

Public agencies might have different goals from private firms. Firms might feel more inclined to rely on rates of return to achieve the highest possible rate of growth, while public agencies might be more inclined to go for the greatest present worth available from a limited budget.

There is no magic number, but we are far more able than we were previously to decide what constitutes a worthwhile project.

REFERENCES

HIRSHLEIFER, J. (1970), *Investment, Interest, and Capital,* Prentice-Hall.

SQUIRE, L. & H. VAN DER TAK (1975), *Economic Analysis of Projects,* Johns Hopkins.

In addition, there are numerous textbooks on financial management or financial analysis that the reader may refer to.

TECHNICAL ABSTRACT

Energy Policy and Renewable Energy Resources in Taiwan, R.O.C.*

by Tony T.L. Liao, Taiwan Power Company, Republic of China, 1983

STATISTICAL DATA

The gross national product in Taiwan increased from US$7.2 billion in 1961 to US$47.0 billion in 1982, with an annual growth rate of 9.2%. Per capita income increased from US$584 in 1961 to US$2,334 in 1982, representing an annual growth rate in per capita income of 6.7%.

Regarding energy consumption, the increase was from 4.3 million kilolitres of oil equivalent (K.L.O.E.) in 1961 to 28.0 million K.L.O.E. in 1982, or an annual growth rate of 9.3%. In 1982, industry accounted for 15.1 million K.L.O.E., or 54% of the total energy consumption; residential, commercial and other sectors accounted for 5.6 million K.L.O.E., or 20% of the total energy consumption; transportation accounted for 3.6 million K.L.O.E., or 13% of the total energy consumption; raw materials accounted for 2.8 million K.L.O.E., or 10% of the total energy consumption; and agriculture accounted for 0.9 million K.L.O.E., or 3% of the total energy consumption.

Concerning the structure of energy supply in 1982, out of a total of 31.7 million K.L.O.E., 20.0 million K.L. (20.0 million kilolitres) was provided by oil, i.e. 63% of the total. Coal, with a total of 5.7 million K.L.O.E. (8.3 million tons) provided a further 18% of the total; nuclear power provided 3.1 million K.L.O.E. (12.5 TWh), representing 10% of the total; natural gas provided 1.6 million K.L.O.E. (0.6 billion cubic metres), which was 5% of the total; and the remaining 1.3 million K.L.O.E. (4.8 TWh), 4% of the total, was provided by hydropower.

The reserve indigenous energy resources of Taiwan consist of 1.5 kilolitres of oil, 200 million tons of coal, and 23 billion cubic metres of natural gas. Production of indigenous energy supplies in 1982 consisted of 0.1 million kilolitres of oil, 2.4 million tons of coal, and 1.4 billion cubic metres of natural gas. Hydropower resources are estimated at 5,300 MW, of which 1,387 MW have already been developed.

ENERGY POLICY

For reducing the impact of energy problems in Taiwan, an "Energy Policy for the Taiwan Area" has been approved and promulgated by the government. Highlights of the contents are as follows:

1. Efforts should be strengthened to explore and develop indigenous energy, and emphasis should be laid on the diversification of imported energy forms and supply sources, while incentives should be offered to encourage investments in overseas energy development.

2. The price structure of various forms of energy should be correlated to each other and reasonable enough to reflect their real costs.

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*Adapted, with permission, from notes given in a workshop on Energy Development Policies for the Asian Countries, Asian Institute of Technology, 9 August 1983.

3. Vigorous and intensified efforts should be made to plan and develop the import energy handling harbors and the corresponding inland transportation system and storage facilities.

4. For energy utilization and conservation, priority should be given to the industrial use of coal, and certain restrictions should be imposed on the use of local natural gas as industrial fuel, while energy-related equipment and appliances should be upgraded to improve energy efficiency.

5. Efforts should be made in the research and development of non-conventional energy sources which have potential for future use.

ASSESSMENT OF RESEARCH AND DEVELOPMENT OF RENEWABLE ENERGY

Since Taiwan has meagre indigenous energy resources, research and development of domestic renewable energy resources is a major approach to reduce the dependence on imported energy. With due consideration to the physical environment and social conditions of Taiwan, a long-range development plan covering the period from 1983 through 2000 has been primarily proposed for six types of renewable energy, namely: solar energy, biomass energy, wind energy, geothermal energy, ocean thermal energy conversion, and small hydropower.

The research and development of six types of renewable energy are described as follows:

1. Solar Energy

Since Taiwan is located in the subtropics with an annual average insolation of 1,236 x 10^6 kcal/m^2, it is very conducive to the development of solar energy. Research items include: 1) solar water heating systems; 2) solar cooling systems; and 3) photovoltaic systems.

2. Biomass Energy

The main biomass energy resources applicable in Taiwan are: agricultural wastes and by-products, and wood or charcoal and hog waste. R&D items cover: 1) direct combustion; 2) synfuel from biomass; 3) methane from biomass; and 4) alcohol from biomass.

3. Wind Energy

According to the meteorological data there is a high potential for generating wind power along the coasts, in mountainous areas and on the off-shore islands of Taiwan. R&D of wind power generating technology in such areas will be the future objectives for electric power generation, cultivation of stocks and irrigation.

4. Geothermal Energy

According to the exploration data in the last 15 years, geothermal potential for generating electrical power in Taiwan has been estimated to be 970 MW. R&D of electric power generation and multiple-purpose usage of geothermal energy in very high potential areas will be strengthened.

5. Ocean Thermal Energy Conversion (OTEC)

The average temperature of the surface ocean water near the eastern coast of Taiwan is about 27°C, but the lower temperature of 7°C prevails at a depth of 700 m. The temperature difference is approximately 20°C, which is suitable for generating electrical power. According to the preliminary estimate, the potential in a square kilometre will be 45.6 GWh per year. Collection of basic data is under way. The research in the future will emphasize the investigation of the characteristics of the ocean. When foreign technology in this field has been developed to its fullest extent, this technology may be transferred to others in due course.

6. Small Hydropower

Small hydropower potential in Taiwan is estimated to be 300 MW. Private investment in development of hydropower plants with an installed capacity of less than 20 MW is highly encouraged by the government. A full-scale islandwide investigation of all the streams and canals will be conducted in the near future. Some of the favorable locations will be first developed, especially where power is urgently needed.