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COST OF CAPITAL IN THE CHOICE BETWEEN HYDRO AND THERMAL POWER

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INTRODUCTION

1. Hydro power installations are regarded in many quarters as one of the primary symbols of economic development. There are, of course, real economic advantages in hydro, the most general of which are distinctly lower operating costs including depreciation. Hydro power may also eliminate fuel imports and thus ease the pressure on the balance of payments. In some cases, there are extensive multipurpose benefits with hydro. In some special cases, there may be significant advantage in the use of hydro for peaking purposes or for stand-by reserve in an integrated electric system.

2. On the other hand, the advantages of thermal power are not negligible. The most important are the feasibility of expanding power output in relatively small stages, and in locations which minimize transmission requirements, greater ability to maintain reasonable average total unit costs if the level of demand falls below expectations, shorter construction period, and lower and more easily determined capital requirements. These factors are particularly favorable to a developing economy where power requirements frequently do not justify the immediate installation of large scale generating facilities, where load factors may be relatively low, where demand is difficult to forecast, and where capital is scarce.

I. STATEMENT OF THE ISSUE

3. The scarcity of capital is a particularly important factor in properly making the comparison of hydro and thermal projects because of the dominant role that the cost of capital usually plays in the cost of producing power, particularly in a hydro station. The cost of capital is the cost of obtaining money for investment purposes. This includes interest, and profits before income taxes. The cost of capital normally averages about 80 to 85% of the unit cost of power in a hydro station while in a steam plant only about 40% of the cost of generating power. The other factor of comparable importance in a thermal plant is fuel which is typically more than 40% of the total cost of power.

4. In considering whether a hydro plant is preferable from the economic point of view to an alternative thermal plant in most situations, the question to be answered is, in essence: Is it worth spending the additional capital needed to build a hydro plant in order to save the cost of fuel? The answer to this question depends to a large extent on how short capital is or how abundant other investment opportunities are in the country concerned.

5. The savings in fuel costs, or more precisely in operating costs, can be stated as a percentage of the difference in total investment between hydro and thermal with the resultant percentage considered as a return on the additional capital invested in hydro. The charges made for power, it should be noted, do not enter this calculation. In five of the Bank projects for which it was possible to make this calculation on the basis of readily available information the yields calculated in this manner range between 6.5% and 13.9% To judge the adequacy of the return requires a general assessment of alternative investment opportunities which amounts to the same as determining the "real" return or "real" cost of capital, admittedly an elusive concept but, nonetheless, a relevant one. While it is not possible in most cases to determine the real cost of capital very precisely, it should not be impossible to establish in a given country which rates of return are low, which are adequate, and within what range reasonable doubt exists. As experience is accumulated in looking at this problem in these terms the basis for judgment can undoubtedly be strengthened. It is clear that this kind of computation leads to conclusions which cannot be reached by using the nominal cost of capital, however adequate nominal costs may be in judging profitability of alternative investments to the particular enterprise.

II. DIFFERENCE BETWEEN NOMINAL AND REAL COST OF CAPITAL

6. A survey of the nominal cost of capital invested in several government owned hydro projects which have been considered for Bank financing shows the average to be around 4½% and the total financial return to be only slightly higher - around 6% (see Table 1). Such a nominal cost of capital is defined as the actual cost of borrowing and, in some cases, either an imputed or a required rate of return on the equity capital. The rates actually charged for electricity in the projects included in the survey ordinarily yield a net financial return as indicated in Table 1 which in most cases is slightly in excess of the nominal cost of capital as defined above. In the five cases where sufficient information is readily available to permit a detailed analysis of the costs of the alternative thermal plant, the nominal cost of capital used for both thermal and hydro in this comparison varied as shown in Table 3 from 3.8% to 6.2%. A similar survey of the nominal cost of capital invested in several privately owned hydro projects which have been considered for Bank financing shows the average to be around 9% and the total financial return to be only slightly higher - around 10% (see Table 2).

7. The method usually applied consists of comparing the unit cost of producing a kwh of power in hydro and thermal plants on the basis of the nominal cost of capital to the enterprise. This is equivalent in its effect to calculating the return to the additional

capital invested in hydro and selecting hydro when the return exceeds the nominal cost of capital. In the Bank's experience hydro has been rejected in favor of thermal when cost calculations, made on the basis of nominal money costs, show a lower cost per kwh for hydro only when it was virtually impossible for the public utility enterprise to obtain the additional funds required for hydro. This was the case in the Verbundgesellschaft loan (Austria) where the Bank urged a substitution of thermal power for part of the proposed hydro development. The object of this memorandum is to suggest that the principle applied in substituting thermal for hydro should be extended to cover cases where the additional capital for hydro can actually be obtained but only at the sacrifice of higher yielding investment opportunities elsewhere.

8. There is strong evidence that the nominal costs of capital usually employed in the analysis of governmentally owned hydro projects do not represent the real cost of capital in the countries concerned. This is sometimes the case also for privately owned enterprises.

A. Differences in the nominal cost of capital to power enterprises within countries and among countries are based on such factors as the corporate financial structure, incidence of taxes, government pricing policies with respect to power and other factors unrelated to the real return on capital in the countries concerned.

B. The nominal cost of capital, particularly to government owned public utility enterprises, is frequently below the cost of borrowing money generally in the countries concerned, and government interest rates are frequently not meaningful in view of the fact that the market for government bonds both internally and externally is exceedingly thin. In countries where capital is scarce government funds are often obtained at subsidized rates.

C. Most important, in a number of cases there is evidence that the real return on alternative public investments is at levels substantially higher than the nominal cost of capital to the government (whether subsidized or not). The evidence is even more compelling if comparisons are made with the private sector.

A. Factors Influencing Cost of Capital to Power Enterprises

9. As stated above the nominal cost of capital for several government owned hydro projects considered for Bank financing has averaged around $4\frac{1}{2}\%$. In several private projects considered for Bank financing, the average nominal cost is around 9%. Broadly speaking, this difference in nominal costs reflects the terms on which different types of enterprises can finance themselves according to whether they have access to government funds or not. These levels of nominal money cost may be compared with the practices of the utility industry in the U.S., where the cost of raising capital is about 12% for private companies and where the cost of capital used in the analysis of public power projects is $6\frac{1}{2}\%$ 1/; in Brazil where private power companies are currently paying more than 11%; in Italy where even some of the recent projects financed by the Bank pay from 10% to 12%; in the U.K. where government power projects are analyzed on the basis of a 5% cost of capital. It seems clear that the difference between Bank financed projects and these other cases, as well as the difference among these examples themselves, bears very little relationship to the real cost of capital in the countries concerned.

10. These differences simply reflect for the most part the institutional arrangements under which capital is made available to different public utility enterprises. In many countries there is a great difference between the financial structure of private and government enterprise. In the U.S., for example, the government regulatory agencies look with disfavor upon a financial structure for private utilities which includes much over 50% debt, whereas, it is common practice among public power projects to rely almost exclusively on debt. Given the different rates of return which are necessary in order to attract equity capital and borrowed funds, this produces a substantial difference between the nominal capital cost at which public utility enterprises can obtain funds as compared to private. Another factor contributing to the difference in the

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1/ This $6\frac{1}{2}\%$ is calculated on the basis of the current borrowing costs and uses an allowance as recommended by the FPC for "taxes foregone". The differences between the nominal cost of capital in projects considered for Bank financing and these nominal costs shown for U.S. power projects is largely compensated in its effects on total costs by the more conservative method of calculating depreciation allowances employed by the Bank compared with the method used for the U.S. data surveyed. In all instances being compared, the same definition of cost of capital is used, that is one which includes both interest charges on debt and the imputed or required rate of return on the equity capital.

nominal cost of capital available to private and government owned utilities is the incidence of taxes on business profits. In the U.S. for example, the corporate profits tax adds about 5 percentage points to the capital costs of private utility enterprises. Finally, the fact that governments can frequently borrow on more favorable terms than private corporations, tends to reduce the cost of money to government owned utility enterprises.

11. The resulting differences in the nominal cost of capital to public and private utility enterprises is frequently justified on the grounds that government owned utility enterprises have as one of their major objectives the provision of electric power at a low price. In fact, even private utility enterprises are frequently given special access to low cost capital in pursuit of this same objective.

12. It is becoming increasingly recognized that the provision of capital on special terms, while consistent with the pricing policies adopted by many governments in the electric power field, distorts the allocation of investment resources. This is particularly evident in the choice between hydro and thermal power. In order to correct, at least partially for such distortions in the choice between hydro and thermal power in the U.S., the FPC recommends that in calculating the costs of capital to a government hydro project an allowance be made for "taxes foregone". Even after this correction is applied, the cost of capital to government projects in the U.S. is roughly half the cost of capital to private projects, as noted above. While it might be argued that no great harm is done in the U.S. by the resulting tendency to undertake perhaps too many capital intensive projects in the public sector, such arguments are hardly applicable to those countries where capital is scarce.

B. Relevance of Actual Borrowing Rates

13. Further evidence for the thesis that the nominal cost of capital to utility enterprises usually understates the real cost of capital, is found in the fact that in some cases it is clearly below the normal cost of borrowing money in the particular countries concerned. The following examples illustrate the fact that the scarcity of capital is not adequately reflected in the nominal costs of capital used in some of the Bank's hydro projects. In two Austrian hydro power projects surveyed the average cost of capital paid by the government owned public utility enterprises is 4.1% and 5.5% whereas interest in that country normally seems to be 9% to 9½%.

In one of the Italian hydro projects capital was obtained at a cost of 7.7% whereas the cost of obtaining funds in most utilities in that country as was noted above, is over 10%. In the two Finnish projects that are government owned, capital costs only 6% whereas the official borrowing rates in that country have been between 7% and 9%, and even at such rates only limited funds have been available. For several Colombian hydro projects a nominal cost of capital well below 6% was used despite the fact that normal yields on government bonds in recent years had ranged above 10%, and very seldom below 6%. In the Baygorria (Uruguay) project, comparative costs of hydro and thermal power have been made on the basis of a cost of capital of 6.2%. This rate is based on the present price of UTE and government bonds in the Montevideo "market" which consists largely of government pension funds. In the words of the most recent economic report on Uruguay, "the capacity of the 'market' to absorb government bonds is limited, ... the result has been that funds available for public works have been small." In most instances surveyed, it is clear that the cost of money to the government and in turn to the public utility enterprise is hardly an accurate measure of the real return on investment in the particular countries involved. The government bond markets in many of these countries are very thin and very little in fact, is borrowed at the interest rates which prevail.

C. Return on Alternative Investments

14. In several instances it is possible to estimate the "real" cost of capital by reference to the expected return on other public investment projects. Governments have heavy responsibilities for providing for investment in many different fields, and the real return must be the highest return among alternative uses. While yields are more difficult to calculate for much of the basic overhead investment for which governments assume responsibility, it is clear that the real return to the economy in such projects must be substantial. This has certainly been the case for a group of non-power projects financed by the Bank. It is estimated that the average return for several of them is at a minimum around 12% and more typically around 16%. Included are a port in Nicaragua which reports an estimated return of around 17%, another port in Syria with a return of 40%, and a Honduras highway project with a return of 12%.

15. Even where the return to the economy from undertaking additional public investment in a particular country is not high, one should still investigate the possibility of channelling into

the private sectors the resources which would be released if a thermal project were accepted. Representative returns in the private sector are not usually below 15%. In the manufacturing projects financed by the Bank, investment yields are expected to reach well beyond 20% and may average over 15%. Recent Italian industrial projects indicate possible returns of 15% to 30% on investment, and actual earnings in recent years above 20%. Recent Japanese industrial projects indicate a return on total investment of 10% to 20%. Average industrial yields of around 14% have been reported in the past in Colombia. The average rate of return to total capital in various industries in the U.S., during 1954 was about 17%. Included were such rates as 23% for electrical machinery industries, 20% for chemicals and 31% for motor vehicles and parts. While the yields cited above refer to the financial return in the individual enterprises and not to the economic return to the economy at large it is unlikely that they would understate or overstate by a wide margin the average economic return on investment. In considering the minimum economic return on investment in the industrial sector, the Staff Economic Committee concluded in "Economic Considerations Affecting Industrial Projects" that "with the scarcity of capital that exists in most underdeveloped countries, any project that does not have an economic yield of at least 10% should be regarded with suspicion. Twenty percent is probably a more reasonable minimum." These figures are clearly on the high side for the purpose of this memorandum, since the risk factor in industrial projects is in general greater than in the utility field. They are, however, given here as an indication of the order of magnitude of the yields that should be obtainable if new resources could be directed to, and absorbed by, industrial enterprises.

III. APPLICATION OF PROPOSED METHOD

16. Taking into account the scarcity of capital that exists in many countries borrowing from the Bank, and the fact that the nominal cost of capital available to public utility enterprises does not necessarily reflect the real cost of capital to the economy, a need clearly exists for a method of comparing hydro and thermal power costs which does not rely exclusively on the nominal cost of capital to the enterprise. The method proposed here calls for an explicit judgment as to the adequacy of the return on the additional capital to be invested in hydro.

17. As a starting point for the appraisal of the adequacy of the yield on the additional investment, the following guide posts might be

considered. In appraising a hydro power project, a return of below 6% on the additional investment in hydro should be considered inadequate in most cases. A return between 6% and 9% may be adequate in some cases; but this is still doubtful because in most countries higher returns seem feasible in certain alternative uses where the risks are not substantially different. In such cases, in order to justify the additional investment in hydro a serious consideration of the thermal alternative is necessary. Such consideration should include an examination of both the alternative investment opportunities for the funds released by the less capital intensive thermal power project as well as the preparation of more exact cost estimates for the thermal project itself. Where the return on the additional investment is found in the preliminary analysis to be 10% to 12% a less careful consideration of the thermal alternative is necessary and only a very cursory examination of the thermal alternative need be made when the yields are above 12%.

18. These guide posts to a judgment of the adequacy of the return on additional investment are admittedly arbitrary. The appraisal of alternative investment opportunities in terms which will yield a meaningful answer for the choice between hydro and thermal power in specific countries must be approached on a case to case basis. The proposed method is easiest to apply in the case where there are specific alternative projects in direct competition for the funds involved. The economic yield on the investment in these alternative projects can frequently be calculated and directly compared with the yield on the additional investment in hydro.

19. When the specific alternatives in competition for capital resources are not known in sufficient detail it is still possible to form a judgment of the adequacy of the yield on the additional capital invested in hydro even though such a judgment can hardly be precise. In many of these countries the Bank has a judgment on the burden which high priority public investment is imposing on available investment resources. These judgments, in each case, could be translated into a range of acceptable yields. In some of the countries the interest rates at which governments can borrow, plus an additional premium to cover the risks associated with specific projects, might be considered as indicative of alternative yields. This method is of limited usefulness, however, whenever the market for government bonds is very thin and is not at all applicable where the government is strictly rationing its limited investment funds.

20. Where the availability of capital to the public sector leaves a wide margin for exploiting investment opportunities it may be appropriate to evaluate the return on the additional investment in

hydro in terms of the yields which can be earned in the private sector since the possibility of channelling additional investment resources into the private sector should in such a case normally be considered. Yields in the private sector would, however, have to be discounted for the higher risks that may be associated with such investment and in countries with a history of inflation such yields may also reflect upward price movements.

21. Appraising the adequacy of the yield on the additional capital invested in hydro in terms of the yield on alternative investments poses some real problems when the yields on specific alternatives are not known. Unfortunately, it is exactly when the application of the proposed method encounters the greatest difficulty that the nominal cost of capital to the public utility enterprise is likely to be least representative of the real cost of capital. Thus, an explicit judgment as to the adequacy of the return on the additional investment, while admittedly more arbitrary than the use of nominal costs of capital, should be a sounder guide to the choice between hydro and thermal power.

IV. ILLUSTRATIVE CALCULATIONS

22. Using the information in Bank's reports there are five cases for which it is readily possible to calculate the return to the additional investment in hydro. They are listed in Table 3 and include Aswan, Litani, Yanhee, Baygorria and Kariba.

23. In each case, the computation made on the basis of the nominal cost of capital resulted in a cost per kwh which was lower than it would have been with a thermal alternative. For example, in the Litani with a nominal cost of capital of 5.3%, hydro power costs 9.7 mills per kwh compared to 11.5 mills for thermal. Similarly, in the Baygorria project at a nominal cost of capital of 6.2% hydro power costs 8.3 mills per kwh compared to a cost of 11.9 mills per kwh for thermal power. On the other hand, the additional capital required amounted to substantial investments: $22 million in the case of Litani, $30 million in the case of Baygorria, and $98 million in the case of Kariba. In all cases except Kariba where the additional investment yields 13.9%, the yields on the additional investment is in

the neighborhood of 6.5% to 8.8% 1/, that is within the range called "doubtful" in paragraph 17 above. It is suggested here that where similar calculations made at an early stage in the consideration of a hydro project reveal a return on the additional investment falling in the "doubtful" category, it is appropriate to investigate whether the amount of additional capital could not be invested elsewhere at a higher rate of return.

24. The implications of the proposed method can be illustrated by a series of hypothetical calculations applied to some representative cost situation as shown in Table No. 4. Assuming a fuel price of 50 cents per million BTU which is the typical cost to the economy of fuel used in power plants in most countries, (see Tables 5 and 6) a load factor of 70% and an investment of $175 per kw of installed capacity in the thermal alternative: (for comparative cost data see Tables 8 and 19). Hydro projects with capital investment requirements above $622 per kw of installed capacity including transmission costs, are out of the question in most cases as they yield less than 6% on the additional investment. Hydro projects with capital requirements between $475 and $622 are doubtful investments as they yield between 6% and 9% on the additional capital. Hydro projects with investment requirements of $425 to $466 yield 10% to 12% and are thus less doubtful but require careful consideration of the thermal alternative. Hydro projects with capital requirements of less than $425 yield more than 12% on the additional capital and are thus most likely sound investments and require only a cursory examination of the thermal alternative. The effect of different assumptions regarding fuel costs are brought out in Table No. 4. The effect of different load factors are indicated in Table 13 which shows that relatively high load factors are advantageous to hydro, whereas the low load factors which are common in

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1/ The calculation of the return on the investment in power in the case of the High Aswan Dam was based on what was inevitably an arbitrary division of costs between power and the other parts of the project; when other benefits are taken into account, the return on the total investment in the project is of course higher. Similarly, the calculations given in the text in the case of Litani and Yanhee do not take into consideration the possible benefits from multipurpose aspects of those projects, and, in the case of Kariba, the additional investment requirements for the production of domestic fuel which would be used if a thermal alternative were chosen.

underdeveloped countries are advantageous to thermal power.

V. OTHER ECONOMIC FACTORS IN THE COMPARISON OF HYDRO AND THERMAL

25. The return on the additional capital invested in hydro has been formulated above in terms of the savings in production costs. This assumes that the amount of power to be produced is equivalent and that the hydro project does not produce any benefits other than power. In fact, even though the return to the additional capital invested in hydro is low does not mean that projects cannot be justified on the basis of additional benefits which accrue from multipurpose programs. Where non-power benefits are significant, it is important to determine the return based on the full benefits resulting from the hydro project. This was done, for example, in the case of the High Aswan project.

26. The method of calculating the return on the additional capital is not substantially altered by the necessity of taking into consideration multipurpose benefits such as those which accrue from irrigation works. The calculation in this case would indicate the yield, or rather the sum of the savings in operating costs plus the net benefits from irrigation as a percent of the difference between the total investment in all phases of the multipurpose project and the investment required for a thermal alternative.

27. In evaluating the savings in production costs secured by the hydro alternative, it is important to evaluate fuel costs at their cost to the economy of the country and not their cost to the particular enterprise if these two are different. In some cases there are special taxes, tariffs and monopoly prices on fuel, the effects of which must be eliminated. Furthermore, in some instances fuel costs expected to prevail in the long run may differ substantially from present prices. When this is the case some assumption must be attempted as to what the long run price is likely to be. If fuel is to be supplied from local sources, as in the case of Kariba, which incidentally yields a relatively high return on the additional capital before any adjustments are made, and if the capacity for fuel production and distribution would have to be substantially increased if a thermal alternative were adopted, it may be very important to appraise the real cost of future fuel supplies.

28. The importance of imported fuel to at least half of the thermal projects financed by the Bank, suggests that the foreign exchange savings due to hydro may be an important balance of payment

consideration. This can be taken into account in computing the investment yield by placing an assumed premium on foreign exchange savings. Assuming all fuel to be imported, the result of a series of calculations for a particular set of examples based on the same assumptions as in Table 4, indicated that with an average price for fuel of about 50 cents per million BTU which is typical for imported fuel oil, hydro investment of $375 per kw of installed capacity would yield the same return on the additional capital required, as an investment of $410 if a 10% premium is assumed on foreign currency savings. Similarly, if a 30% premium is assumed hydro could cost $425 and yield the same return and with a 60% premium, could cost $450 (see Table 15). In other words, a proper evaluation of the foreign exchange savings which result from hydro may well alter an original determination that thermal was more economical than hydro. This is of some importance since many of the important hydro projects considered by the Bank involve capital costs above $400 per kw.

29. This adjustment for foreign exchange savings does not, however, apply with equal force to all underdeveloped countries for the following reasons:

The above calculations were based on the assumption that the foreign currency share of hydro capital investment is 40% and of thermal 50%, which is similar to the Bank's average experience (see Tables 20 and 21). If the assumptions are changed slightly to be more nearly representative of the situation in many underdeveloped areas where the foreign currency share of power investment is higher, that is,for example, 65% for hydro and 70% for thermal then the effect of the foreign exchange premium is almost nil (see Table 16). This results from the fact that with a higher imported component in investment, the net effect of the foreign exchange savings on fuel is substantially offset. 1/ Even a 100% premium on foreign exchange savings would normally result in less than a one percentage point change in the return to the additional capital invested in hydro. In other words, a project with hydro costs of $500 per kw that was doubtful, would still be doubtful no matter what premium is attached to the foreign exchange savings. The foreign exchange benefits of

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1/ This assumes that the foreign exchange premium to be applied is no greater during the operating stage of the project than in the investment stage.

hydro may easily be exaggerated for many of the underdeveloped countries. 1/

30. All of the above illustrative calculations assume that power output is expanded at the same rate whether the choice be in favor of hydro or of thermal. This is not necessarily the most economically beneficial approach. The construction of thermal stations may be phased to more nearly coincide with the expected increase in power demand. If such is the case then not only is the investment more fully utilized at all times but a significant part of total investment is postponed to a time when the demands upon scarce capital resources may be less pressing in relation to their availability.

VI. RELATION TO ELECTRIC POWER RATES

31. As noted above the determination of the return to the additional investment in hydro is unrelated to the power rates charged to consumers. The savings in operating costs in a hydro project and the additional capital costs are the same, whatever the charges made for power. The issue of higher or lower rates, though obviously important, is not directly relevant to this particular argument, namely, whether it is better to build a hydro or a thermal plant. However, an incidental effect of the policy proposed in this paper might be somewhat higher rates for electricity unless offset by other factors such as a change in regulatory practices. This results from the fact that rates are usually based on nominal costs whereas it is recommended here that the choice between hydro and thermal be based on comparing real economic costs. As has been indicated above, thermal costs per kwh may be higher on a nominal cost basis but lower on a real cost basis. In other words, prices charged for electric power, to the extent they are influenced by the nominal cost calculation for a particular project, would be higher in such a case if the thermal project were accepted.

1/ The recent Suez crisis has once more brought home the strategic or defense value of domestic sources of energy. This is often adduced as an argument in favor of hydro rather than thermal power based on imported fuel. Quite legitimate in many cases, this argument is not an economic but a political one and should be recognized as such.

32. Another aspect of the problem of electric power rates may be noted. The Bank has become increasingly concerned with the problem of electric power rates and is attempting, in order to build up funds needed for reinvestment and to attract new funds, to secure in many instances rate adjustments which, if applied, would raise the expected financial return on the total investment considered for Bank financing. If as a matter of policy governments accept higher financial returns on investment in the power field as normal, capital may no longer be made available on such favorable terms to utility enterprises. In such a situation, the nominal cost of capital may be more nearly representative of the real cost of capital. This is, however, rarely the case at present.

STATISTICAL TABLES

Table No.

17. Levels of fuel costs to thermal plants adjusted for premiums on foreign exchange savings yielding various returns on additional investment in hydro installations.

18. Investment in hydroelectric projects considered for IBRD financing.

19. Investment in thermal projects considered for IBRD financing.

20. Investment in foreign currency in hydroelectric projects considered for IBRD financing.

21. Investment in foreign currency in thermal projects for IBRD financing.

Table 1

The return on total capital (profits before taxes plus interest) used in the financial analysis and the cost of capital 1/ used to calculate the unit cost of power in various government owned 2/ hydroelectric projects considered for IBRD financing.

Project	Cost of capital as a % of total investment	Estimated 3/ financial return as a % of total investment
Damodar (Maithon, Panchet Hill)	4.0	4.0
Lebrija, Colombia	2.3	2.3
Chidral, Colombia	1.0	8.3
La Insula, Colombia	6.0	6.4
Anchicaya, Colombia	1.3	1.3
Cunucyacu, Quito, Ecuador	3.0	3.0
Litani, Lebanon	5.3	7.8
Seyhan, Turkey	4.8	4.8
High Aswan, Egypt, 1st Stage	3.8	3.8
Tokke, Norway	2.6	4.4
Lunersee, Austria	4.1	4.1
Chainat, Thailand	5.0	5.0
Kariba, Rhodesia, 1st Stage	4.8	7.2
Pirttikoski, Finland	6.0	6.0
Junkoski, Finland	6.0	6.0
Ypps-Persenberg, Austria	5.5	6.8
Yanhee, Thailand, 1st Stage	5.0	8.9
Baygorria, Uruguay	6.2	11.0
Unweighted mean	4.3	5.5
Median	4.8	6.0

1/ This represents the cost of capital used in the project reports in calculating the cost per kwh. In some cases calculated for an enterprise's total operations rather than for a specific project because of the lack of information in reports consulted.

2/ Government ownership is defined as government equity interest of at least 51%.

3/ Financial analysis involved analysis of company data in some cases rather than project as such.

Table 2

The return on total capital (profits before taxes plus interest) used in the financial analysis and the cost of capital 1/ used to calculate the unit cost of power in various privately owned 2/ hydroelectric projects considered for IBRD financing.

Project	Cost of capital as a % of total investment	Estimated 3/ financial return as a % of total investment
Kaltimo, Finland	10.0	17.1
Coscile, Italy	9.6	9.8
Luzzi, Italy	7.1	7.7
Capodiponte, Italy	8.7	9.3
Castellano Ascoli, Italy	8.7	9.3
Unweighted mean	8.8	10.6
Median	8.7	9.3

1/ This represents the cost of capital used in the project reports in calculating the cost per kwh (in some cases) calculated for an enterprise's total operations rather than for a specific project because of the lack of information in reports consulted.

2/ Private ownership is defined as private equity interest of at least 51%.

3/ Financial analysis involved analysis of company data in some cases rather than project as such.

Table 3

The return to the additional capital invested in hydro as compared to thermal alternatives and the comparative cost of power per kwh in various projects considered for IBRD financing.

	High Aswan 1st stage 1/	Litani 2/	Kariba 3/ 1st stage	Yanhee 4/ 1st stage	Baygorria 5/ Uruguay
Installed capacity of hydro in thousand kw	720	84	500	140	103
Net generation in million kwh	1,625	336	1,167	409	451
Cost of hydro in $ per installed kw	310	418	442	550	455
Cost of thermal in $ per installed kw	154	220	245	290	187
Additional capital required for hydro in million $	112.0	22.3	98.0	47.9	29.6
Annual production expenses for thermal including depreciation in million $	16.8	2.9	16.1	4.4	3.8
Annual production expenses for hydro incl. depreciation in million $	8.1	1.1	2.5	1.3	1.2
Savings in annual production costs in million $	8.7	1.8	13.6	3.1	2.6
Return on additional capital invested in hydro	7.8%	8.2%	13.9%	6.5%	8.8%
Cost per kwh of hydro power in mills per kwh	10.2	9.7	4.3	12.5	8.3
Cost per kwh of thermal power in mills per kwh	13.2	11.5	6.9	16.8	11.9
Cost of capital used in project report	3.8%	5.3%	4.8%	5.0%	6.2%

1/ Calculations based on 1965 estimates from Tables 18-19, Project report TO 94b and allocation of investment to power as indicated in that report.
2/ Total cost of dam allocated to power. The cost of other works to be used exclusively for irrigation have been excluded as indicated in Annex 5, TO 87a.
3/ Calculations based on 1964-1965 estimates from Annex 5, Project report TO 116.
4/ Calculations based on USBR report, pp. 176, 162 - completion of initial development, 1961. Thermal alternative calculated on basis of footnote 1, Table 17, page 176, with 100,000 kw of installed capacity operating at 40% load factor.
5/ Calculated on basis of data presented in project report TO 120, with fuel costs adjusted to price of 60 cents per million BTU, rather than the Uruguay fuel monopoly price of about 90 cents per million BTU.

Table 4

Levels of capital investment for hydro installations yielding various returns on the additional investment over that required for thermal alternatives. (in $ per KW of installed capacity)*

Return on additional capital	Low price for fuel at 25 cents per million BTU	Medium price for fuel at 50 cents per million BTU	High price for fuel at 70 cents per million BTU
Below 6%	above $417	above $622	above $786
6% to 9%	$348 - $417	$475 - $622	$611 - $786
10% to 12%	$310 - $333	$425 - $466	$515 - $573
Above 12%	below $310	below $425	below $515

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* Assumptions:

Both thermal and hydro stations have installed capacity of 100,000 KW and operate at 70% load factor (annual net generation 614.0 million KWH). Fuel consumption for the thermal plant is 10,000 BTU per KWH, with capital investment at $175 per installed KW, and production expense excluding fuel and depreciation at 0.50 mills per KWH. Annual depreciation allowance based on a sinking fund method is 2.75% of total capital invested. The depreciation charge for the hydro station is 1.5% with production expenses excluding depreciation at 0.40 mills per KWH.

The above assumptions with respect to fuel consumption imply a thermal efficiency typical of new plants installed in the U.S. Such efficiency may involve operational pressures which are too high for some under-developed countries. On the other hand, such countries rarely achieve a 70% load factor. This means that on balance the assumptions adopted here generally are somewhat unfavorable to thermal.

TABLE 5

DELIVERED PRICE OF IMPORTED BOILER FUEL OIL, CIF PORT OF IMPORTATION, FOR VARIOUS PORTS OF THE WORLD AS OF AUGUST 1955.

Port	Price per barrel in U.S. $	Estimated cost per million BTU in U.S. cents*
New York	2.50	42
Los Angeles	1.80	30
Vancouver	2.97	50
Punta Arenas	3.03	51
Rotterdam	2.79	47
Rijeka	2.93	49
Piraeus	2.87	48
Rastanura	1.64	27
Capetown	2.82	47
Bombay	2.39	40
Yokohama	3.08	52
Wellington	3.38	57

* Based on assumption 18,000 BTU per lb. and 6.04 barrels per short ton.

Source: National Planning Association Confidential Study.

TABLE 6

COST OF COAL 1/ USED FOR POWER PRODUCTION IN VARIOUS REPRESENTATIVE COUNTRIES DURING 1955

Country	Cost in Cents Per Million BTU
United Kingdom	40
Austria	65
France	57
West Germany	50
Italy	55
Turkey	80
India	25
Japan	90
Union of South Africa	15
Brazil	100
Australia	40
Denmark	45
Greece	30
Netherlands	50
Yugoslavia	30

1/ Cost delivered to steam plants.

Source: Economic Aspects of Electric Power Production in Selected Countries, Harry I. Miller, F. Douglas Campbell, July 1955. (ICA) Appendix D.

TABLE 7

Construction costs and operating data for various privately constructed hydroelectric plants in the U.S. (Annual data for the year 1955).

	Connecticut Light & Power Co. (1)	Wisconsin River Power Co. (2)	Calif. Oregon Power Co. (3)	Pacific Gas & Elec.Co. (N.Fork Feather River) (4)	South Carolina Elec. & Gas Co. (5)	Minnesota Power & Light Co. (6)
Installed cap. in thou. KW	37,200	15,000	18,000	113,400	130,000	67,400
Date of construction of plant	1955	1951	1951	1950	1930	1930
Net generation mill. KWH	204.0*	80.3	104.6	355.2	103.1	343.9
Plant factor in %	63*	61	66	35	9	58
Peak demand in thou. KW	48,000	18,800	18,000	110,000	108,000	69,700
Original Cost of Plant ($ per installed KW)						
Land & land rights	60	183	-	18	43	10
Structures & improvements	21	83	21	20	8	12
Reservoirs, dams & waterways	285	246	157	278	101	58
Equipment costs	111	94	45	33	14	25
Roads, railroads & bridges	0	1	9	3	1	0
Total cost per KW of installed capacity	477	607	232	352	167	105
Total cost (in thou. $)	17,726	9,110	4,182	39,247	21,693	7,063
Production Expenses in mills per KWH						
Operation, labor, supervision, engineering	0.30	0.55	0.08	0.14	0.74	0.38
Supplies and expenses	0.03	0.31	0.03	0.01	0.12	0.03
Maintenance	0.06	0.30	0.31	0.03	0.27	0.09
Other expenses, e.g. rent	-	-	0.07	0.05	-	-
Total Production expense	0.39	1.16	0.49	0.23	1.13	0.50
Estimated overhead using Federal Power Commission Standards	11.06	13.80	4.86	13.50	25.60	2.51
Total costs in mills per KWH	11.45	14.96	5.35	13.73	26.73	3.01

* Annual rate as plant only in operation several months during 1955.

TABLE 8

Construction costs and operating data for various privately constructed steam power plants in the U.S. (Annual date for the year 1954).

	Conn. Light & Power Co. "Devon" Conn. (1)	Long Is. Lighting Co. "Far Rockaway" (2)	Minn. Power & Light Co. "Aurora" Minn. (3)	American Gas & Elec. Co. "Kanawha" River (4)	Public Service Co. of New Hampshire "Schiller" (5)	Gulf States Utilities Co. "Station No.2" (6)	South Western Public Service Co. "East" (7)	Salt River Project, "Saguaro" Ariz. (8)	TVA "Kingston" Tenn. (9)
Installed cap. in thou. KW	272,000	90,000	88,000	351,500	80,000	140,000	65,000	100,000	405,000
Date of construction of plant	1953	1953	1953	1953	1950	1951	1949*	1953-4	1954
Net generation mill. KWH	1,388.4	704.6	353.9	3,027.7	479.2	861.1	430.4	575.0**	3,380.0**
Plant factor in %	58%	89%	46%	98%	68%	70%	76%	66%**	95%**
Peak demand in thou. KW	271,200	115,000	84,700	460,000	97,700	161,000	80,500	102,000	422,000
Original cost of plant (in $ per installed KW)									
Land & Land rights	1	6	0	2	1	0	1	1	3
Structures & improvements	33	62	23	29	65	11	17	11	34
Equipment	92	156	123	120	182	104	100	112	122
Total Cost per KW	126	224	146	151	248	115	118	124	159
Total Cost in thou. $	34,323	20,167	12,852	52,923	19,822	16,115	7,657	12,381	64,363
Production Expenses (in mills. per KWH)									
Operation, labor, supervision etc.	0.37	0.28	0.38	0.09	0.46	0.23	0.38	0.32	0.44
Supplies & Exp.	0.03	0.06	0.03	0.03	0.07	0.05	0.25	0.17	0.12
Maintenance	0.53	0.15	0.23	0.16	0.95	0.16	0.26	0.11	0.27
Other expenses	-	-	-	0.01	-	0.03	-	0.01	-
Fuel	4.27	3.57	4.14	1.75	3.59	1.12	1.09	2.37	1.94
Total production expenses	5.30	4.06	4.78	2.04	5.07	1.59	1.98	2.98	2.77
Estimated overhead using FPC standards	3.24	3.75	4.75	2.57	5.46	2.42	2.32	1.83	1.57
Total costs in mills per KWH	8.54	7.81	9.53	4.61	10.53	4.01	4.30	4.81	4.34
Major Fuel Used:									
Av. BTU per KWH	11,953	9,894	11,511	9,113	9,666	12,200	15,314	10,854	9,877
Type	Coal	Coal	Coal	Coal	Oil	Gas	Gas	Gas	Coal
Cost delivered plant $ per short ton $ per barrel or ¢ per MCF	9.40	9.49	8.37	4.30	2.17	10.00	6.39	24.00	4.85
Cost per mill. BTU, ¢	35.76	36.04	34.49	19.18	34.39	9.19	7.10	21.83	19.59

* Completely modernized

** Annual rate since first operation June 1954.

TABLE 9

INVESTMENT AND OPERATING COST DATA FOR VARIOUS GOVERNMENT CONSTRUCTED HYDROELECTRIC PROJECTS IN THE U.S. (ANNUAL DATA FOR THE YEAR 1955)

	Bureau of Reclamation Anderson Dam, Boise River, Idaho (1)	Bureau of Reclamation Davis Dam Colorado River, Arizona (2)	City of Los Angeles Bishop Dam California (3)
Installed capacity in thousand KW	27,000	225,000	37,500
Date of construction of plant	1951	1951	1952
Net Generation, million KWH	129.8	1,185.1	136.9
Plant factor in %	55	60	42
Peak demand in thousand KW	38,000	272,000	39,000
Investment in plant ($ per installed KW)			
Land and land rights	-	-	-
Structures and improvements	59	47	53
Reservoirs, dams and waterways	58	186	232
Equipment costs	64	45	50
Roads, railroads and bridges	-	-	6
Total cost per KW of installed capacity	181	278	341
Total investment in thousand $	4,878	62,681	12,784
Production costs in mills per KWH			
Operation, labour, supervision, engineering	0.28	0.09	0.21
Supplies and expenses	0.01	0.06	0.02
Maintenance	0.12	0.07	0.15
Total production expenses	0.41	0.22	0.38
Estimated overhead using Federal Power Commission standards.	2.68	3.78	6.65
Total costs in mills per KWH	3.09	4.00	7.03

TABLE 10

THE RETURN TO CAPITAL IN VARIOUS NON-POWER PROJECTS FINANCED BY IBRD (AS A % OF TOTAL INVESTMENT)

Project	Capital invested in project (in thousand dollars)	Annual increase in net profit attributable to investment (in thousand dollars)	Rate of return to capital invested (in %)
Port of Corinto, Nicaragua	4,740	800**	16.9
Port of Latakia, Syria	14,750	1,400	39.2
Honduras Highway Maintenance	8,200	1,000	12.2
Kawasaki Steel, Japan	52,300	5,560	10.6
Karnaphuli Paper, Pakistan	20,000	1,980	9.9***
Pacasmayo Cement, Peru	5,000	630	12.6
Mitsubishi Shipbuilding, Japan	2,000	220	11.1*
Toyota Motor Co., Japan	9,640	1,390	14.4
Yawata Steel, Japan	13,900	2,920	21.0
Nippon Steel Tube, Japan	11,300	1,260	11.1
Japan Seamless Tube	2,200	470	21.5
Total	$144,030	$17,630	12.3%
Unweighted mean rate of return			16.4%

*** Foreign exchange savings 22%

** Annual savings estimated for the year 1955.

* Annual savings on engine production alone.

TABLE 11

REPRESENTATIVE RATES OF RETURN* AS A % OF TOTAL CAPITAL INVESTMENT IN VARIOUS UNITED STATES MANUFACTURING INDUSTRIES DURING 1954.

Industry	Rate of return before taxes	Rate of return after taxes
Apparel & Finished Textiles	9.0%	4.1%
Paper & Allied Products	18.0%	8.9%
Chemicals & Allied Products	19.8%	10.7%
Rubber Products	17.0%	8.7%
Leather Products	12.4%	5.2%
Primary non-ferrous metals	15.3%	8.9%
Primary Iron & Steel	14.4%	7.3%
Products of Petroleum & Coal	13.9%	11.4%
Machinery	16.3%	7.8%
Electrical Machinery	22.8%	11.4%
Motor Vehicles & Parts	30.8%	14.6%
Unweighted Mean	16.7%	9.0%

* Net of interest payments. However, debt averages only 8.8% of total capital in above industries.

TABLE 12

Illustration of the calculation of the return to the additional capital required for hydroelectric stations as compared to thermal power alternatives for various cost assumptions for hypothetical projects.

		Project A	Project B	Project C
1.	Installed capacity in KW	100,000	100,000	100,000
2.	Net generation in million KWH	614.0	614.0	614.0
3.	Plant load factor in % =(2) ÷ (1) x 8760 hrs	70	70	70
4.	Cost of hydro plant in $ per installed KW	500	500	250
5.	Cost of thermal plant in $ per installed KW	175	125	125
6.	Capital investment in hydro plant in thousand $	50,000	50,000	25,000
7.	Capital investment in thermal plant in thous. $	17,500	12,500	12,500
8.	Additional capital required for hydro = (6) - (7)	32,500	37,500	12,500
9.	Operation and Maintenance of thermal plant in mills per KWH	0.50	0.50	0.50
10.	Fuel costs	4.50	3.50	3.50
11.	Depreciation cost of thermal plant in mills per KWH	0.80	0.55	0.55
12.	Unit production cost of thermal in mills per KWH = (9) + (10) + (11)	5.80	4.55	4.55
13.	Annual production cost of thermal in thousand $	3,550	2,795	2,795
14.	Operation & Maintenance of hydro in mills per KWH	0.45	0.45	0.30
15.	Depreciation cost of hydro in mills per KWH	1.22	1.22	0.60
16.	Unit production cost of hydro in mills per KWH = (14) + (15)	1.67	1.67	0.90
17.	Annual production cost of hydro in thousand $	1,025	1,025	560
18.	Annual savings in production costs with hydro = (13) - (17)	2,525	1,770	2,235
19.	Annual return to additional capital required for hydro (18) as a per cent of (8)	7.8	4.7	17.9
	Fuel assumptions: Consumption in BTU per KWH	10,000	11,000	11,000
	Cost in cents per million BTU	45.0	31.8	31.8
	Ave. BTU per lb of coal	12,500	12,500	12,500
	Cost of coal per short ton in $	11.25	7.95	7.95

Depreciation assumptions: 2.75% for thermal and 1.5% for hydro on sinking fund basis.

TABLE 13

Illustration of the calculation of the return to the additional capital required for hydroelectric stations as compared to thermal power alternatives for various assumptions as to load factor for hypothetical projects.

	Project D	Project E	Project F
1. Installed capacity in KW	100,000	100,000	100,000
2. Net generation in million KWH	614.0	438.0	263.0
3. Plant load factor in % = (2) ÷ (1) x 8760 hrs	70	50	30
4. Cost of hydro plant in $ per installed KW	300	300	300
5. Cost of thermal plant in $ per installed KW	150	150	150
6. Capital investment in hydro plant in thousand $	30,000	30,000	30,000
7. Capital investment in thermal plant in thous. $	15,000	15,000	15,000
8. Additional capital required for hydro = (6) - (7)	15,000	15,000	15,000
9. Operation & Maintenance of thermal plant in mills per KWH	0.50	0.55	0.60
10. Fuel costs	3.75	3.80	4.00
11. Depreciation cost of thermal plant in mills per KWH	0.70	0.95	1.55
12. Unit production cost of thermal in mills per KWH = (9) + (10) + (11)	4.95	5.30	6.15
13. Annual production cost of thermal in thousand $	3,020	2,320	1,620
14. Operation & Maintenance of hydro in mills per KWH	0.34	0.45	0.80
15. Depreciation cost of hydro in mills per KWH	0.73	1.05	1.70
16. Unit production cost of hydro in mills per KWH = (14) + (15)	1.07	1.50	2.50
17. Annual production cost of hydro in thousand $	665	657	655
18. Annual savings in production costs with hydro = (13) - (17)	2,355	1,663	965
19. Annual return to additional capital required for hydro (18) as a per cent of (8)	15.7	11.1	6.4
Fuel assumptions: Consumption in BTU per KWH	10,500	10,650	11,250
Cost in cents per million BTU	35.7	35.7	35.7
Ave. BTU per lb of coal	12,500	12,500	12,500
Cost of coal per short ton in $	8.95	8.95	8.95

Depreciation assumptions: 2.75% for thermal and 1.5% for hydro on sinking fund basis.

TABLE 14

LEVELS OF CAPITAL INVESTMENT FOR HYDRO INSTALLATIONS YIELDING VARIOUS RETURNS ON THE ADDITIONAL INVESTMENT OVER THAT REQUIRED FOR THERMAL ALTERNATIVES*

Investment in hydro in dollars per installed KW	Return based on fuel at 15¢ per million BTU	Return based on fuel at 25¢ per million BTU	Return based on fuel at 35¢ per million BTU	Return based on fuel at 50¢ per million BTU	Return based on fuel at 60¢ per million BTU	Return based on fuel at 70¢ per million BTU
800	0.4	2.2	2.4	3.9	4.9	6.0
700	0.8	2.9	3.1	4.9	6.1	7.4
600	1.3	3.9	4.2	6.4	7.9	9.4
500	2.2	4.1	6.0	8.8	10.7	12.9
400	3.8	8.7	9.3	13.4	16.2	19.3
300	8.1	16.9	17.9	25.3	30.3	36.1
200	41.6	90.0	95.6	132.5	157.5	186.0

* Basic Assumptions:

Both thermal and hydro stations have installed capacity of 100,000 KW and operate at 70% load factor (annual net generation 614.0 million KWH). Fuel consumption for the thermal plant is 10,000 BTU per KWH, with capital investment at $175 per installed KW, and production expense excluding fuel and depreciation at 0.50 mills per KWH. Annual depreciation allowance based on a sinking fund method is 2.75% of total capital invested. The depreciation charge for the hydro station is 1.5% with production expenses excluding depreciation at 0.40 mills per KWH.

TABLE 15

LEVELS OF CAPITAL INVESTMENT FOR HYDRO INSTALLATIONS YIELDING VARIOUS RETURNS ON THE ADDITIONAL INVESTMENT OVER THAT REQUIRED FOR THERMAL ALTERNATIVES AFTER PREMIUMS FOR FOREIGN EXCHANGE SAVINGS.*

Capital cost of hydro in dollars per installed KW	Return based on no foreign currency premium	Return based on foreign currency premium of 10%	Return based on foreign currency premium of 30%	Return based on foreign currency premium of 60%	Return based on foreign currency premium of 100%
800	3.9	4.1	4.5	5.1	5.7
700	4.9	5.2	5.7	6.4	7.1
600	6.4	6.7	7.4	8.2	9.1
500	8.8	9.3	10.2	11.3	12.6
400	13.4	14.1	15.5	17.2	19.2
300	25.3	25.8	29.5	33.2	37.6
200	132.5	148.5	181.0	239.0	351.0

* Basic Assumptions:

Fuel cost assumed to be 50 cents per million BTU. The foreign currency share of hydro investment and depreciation is 40%; of thermal investment and depreciation 50%; of thermal production expenses 80%. Hydro production expenses excluding depreciation are assumed to be all local. Same foreign exchange premium applied to the investment stage as the operating stage. All other assumptions the same as in Table 14.

TABLE 16

LEVELS OF CAPITAL INVESTMENT FOR HYDRO INSTALLATIONS YIELDING VARIOUS RETURNS ON THE ADDITIONAL INVESTMENT OVER THAT REQUIRED FOR THERMAL ALTERNATIVES AFTER PREMIUMS FOR FOREIGN EXCHANGE SAVINGS ADJUSTED TO INVESTMENT CONDITIONS TYPICAL IN THE MORE UNDEVELOPED COUNTRIES.*

Capital cost of hydro in dollars per installed KW	Return based on no foreign currency premium	Return based on foreign currency premium of 10%	Return based on foreign currency premium of 30%	Return based on foreign currency premium of 60%	Return based on foreign currency premium of 100%
800	3.9	4.0	4.2	4.4	4.6
700	4.9	5.0	5.2	5.5	5.7
600	6.4	6.5	6.8	7.1	7.5
500	8.8	9.0	9.4	9.8	10.3
400	13.4	13.7	14.3	15.0	15.6
300	25.3	26.1	26.9	28.2	29.5
200	132.5	140.0	153.5	167.0	189.0

*Basic assumptions:

Fuel cost assumed to be 50 cents per million BTU. The foreign currency share of hydro investment and depreciation is 65%; of thermal investment and depreciation 70%; of thermal production expenses 80%. Hydro production expenses excluding depreciation are assumed to be all local. <u>Same foreign exchange premiums applied to the investment stage as the operating stage</u>. All other assumptions the same as in Table 14.

TABLE 17

LEVELS OF FUEL COSTS TO THERMAL PLANTS ADJUSTED FOR PREMIUMS ON FOREIGN EXCHANGE SAVINGS YIELDING VARIOUS RETURNS ON THE ADDITIONAL INVESTMENT IN HYDRO INSTALLATIONS OVER THAT REQUIRED FOR THERMAL ALTERNATIVES. *

Fuel costs in cents per million BTU	Return based on no foreign currency premium	Return based on 10% foreign currency premium	Return based on 30% foreign currency premium	Return based on 60% foreign currency premium
15	2.2	2.4	2.7	3.1
25	4.1	4.5	4.9	5.6
35	6.0	6.6	7.2	8.1
50	8.8	9.6	10.5	11.8
60	10.7	11.7	12.8	14.3
70	12.6	13.8	15.0	16.7

* Basic assumptions:

The Hydro station has capital investment of $500 per installed KW. The foreign currency share of hydro investment and depreciation is 45%; of thermal investment and depreciation 60%; and of thermal production expenses 80%. Hydro production expenses excluding depreciation are assumed to be all local. Same foreign exchange premiums applied to the investment stage as the operating stage. All other assumptions the same as in Table 14.

TABLE 18*

CAPITAL INVESTMENT IN VARIOUS HYDROELECTRIC PROJECTS CONSIDERED FOR IBRD FINANCING

Project	Amount of capital invested in power plant and transmission facilities per KW in U.S. $
Reisseck-Krewzeck (102 - AUA)	302
Lunersee (118 - AUA)	202
Salto Grande (93 - BR)	458
Itutinga (76 - BR) 2/	625
Cunucyacu (37 - EC)	440
Damodar (72 - IN)	340
Litani (129 - LE) 3/	466
Tokke (138 - NO)	175
Kariba (145 - RN)	442
Cassa (117 - IT)	238
High Aswan 1/	220
Ypps-Persenberg 1/	474
Baygorria	512
Anchicaya (113 - CO) 1/ 4/	120
Pirttikoski (142 - FI)	307
Junkoski (142 - FI)	274
Kaltimo (142 - FI)	348
Djendjen (131 - AL) 1/	313
Unweighted Average investment per KW	$ 348

1/ Without the cost of transmission facilities.

2/ The initial stage of a project to be enlarged to twice its present capacity.

3/ Power is charged with the cost of part of the development beneficial to irrigation and water conservation.

4/ An addition to an existing station.

* Source: Technical Operations Department.

TABLE 19*

CAPITAL INVESTMENT IN VARIOUS THERMAL PROJECTS CONSIDERED FOR IBRD FINANCING

Project	Amount of capital invested in powerhouse and transmission facilities per KW in U.S. $
Piratininga (95 - BR)	222
Trombay (106 - IN)	224
Kansai (89 - JA)	205
Kyushu (90 -JA)	224
Chubu (91 - JA)	210
Managua diesel (82 - NI)	150
Nicaragua (121 - NI)	265
Karachi (120 - PAK)	265
South Africa (78 - SA) 1/	135
Montevideo (132 - UR) 1/	126
Anchicaya (113 - CO)	267
Helsinki (142 - FI) 2/	130
Pargas (142 - FI) 2/	140
Unweighted average investment per KW	$ 197

1/ Additions to existing power stations

2/ Costs do not cover land, fuel handling facilities or all of the required transformers and switchgear.

* Source: Technical Operations Department

TABLE 20

TOTAL INVESTMENT IN FOREIGN CURRENCY EXPENDITURES IN VARIOUS HYDROELECTRIC PROJECTS CONSIDERED FOR IBRD FINANCING.

Project	Total capital investment in million $	Total Foreign currency expenditures in million $	Foreign currency expenditures as a % of total investment.
Damodar (Maithon, Panchet Hill)	$103.0	$ 26.0	25.2%
Lebrija, Colombia	7.3	3.1	42.5
Chidral, Colombia	6.8	4.5	66.1
La Insula, Colombia	9.4	2.9	30.8
Anchicaya, Colombia	12.2	4.9	40.1
Cunucyacu, Quito, Eduador	5.7	2.2	38.6
Litani, Lebanon	40.8	27.0	66.2
Seyhan, Turkey	66.0	27.6	41.8
Lunersee, Austria	38.6	7.2	18.7
Chainat, Thailand	7.6	4.6	60.5
Kariba, 1st stage	226.0	130.0	57.5
Pirttikoski, Finland	33.8	4.3	12.8
Juukoski, Finland	30.2	4.4	14.6
Kaltimo, Finland	8.7	1.7	19.6
	$ 596.1	$ 250.8	

Weighted average foreign currency expenditures as a % of total investment 42.1%

TABLE 21

TOTAL INVESTMENT IN FOREIGN CURRENCY EXPENDITURES IN VARIOUS THERMAL POWER PROJECTS CONSIDERED FOR IBRD FINANCING.

Project	Total capital investment in million $	Total foreign currency cost in million $	Foreign currency costs as % of total investment.
Bokaro-Damodar, India	$ 52.8	$ 25.9	49.1%
Trombay, India	27.5	16.2	58.9
Uruguay Thermal	6.3	5.5	87.3
Nicaragua Thermal	10.8	7.5	69.3
Karachi, Pakistan	21.1	13.8	65.4
Litani Alternative	18.4	12.6	68.5
Chidral, Colombia	6.8	4.5	66.1
Pargas, Finland	4.3	1.2	27.9
Helsinki, Finland	9.6	2.6	27.1
Total	$ 157.6	$ 89.8	

Weighted average foreign currency expenditures as a % of total investment 57.0%