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INTERNATIONAL DEVELOPMENT ASSOCIATION

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July 25, 1974

ISSUES IN RURAL ELECTRIFICATION

Attached is the revised version of the paper on "Issues in Rural Electrification," prepared by the Public Utilities Department. The paper was discussed at a staff level meeting on July 8 and has since been revised in the light of comments. It is distributed for information only; no meeting of the Policy Review Committee is planned.

Frank Vibert
Secretary
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ISSUES IN RURAL ELECTRIFICATION

Public Utilities Department
July 24, 1974

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SUMMARY AND CONCLUSIONS

The following summary and conclusions provide a self-contained outline of the report.

I. Introduction

i. After an introductory review of rural electrification in developing countries, the report discusses three main topics:

(1) The prospects for successful investment in rural electrification;

(2) Approaches towards investment, as regards:

- economic justification;
- identification and preparation;
- finance;
- technical problems; and
- institutional problems.

(3) Implications for Bank policy and procedures.

The report indicates that there is plenty of scope for successful investments in rural electrification, provided they are properly selected and prepared; and it outlines an approach for undertaking them. Future Bank initiatives for providing funds and technical assistance in this field would require no serious revisions of policy and procedures. The report is an outcome of a research study in El Salvador, field trips to four countries, and correspondence with over twenty countries in Africa, Asia, EMENA and Latin America.

II. Rural Electrification in Developing Countries

ii. Levels of investment (paragraphs 2.2 to 2.5). Developing countries are putting increasing resources into rural electrification, and the resources countries allocate to it increase with their per capita incomes. Cumulative investment by countries within the Bank's area of operations was about \$10 billion by 1971, or 10% of total investment in electric power. In the next ten years over \$10 to \$15 billion will probably be invested, and about one quarter of the village-rural population, or 300 million people, will then be receiving service (as compared to about three quarters in urban areas at the present time).

iii. Aims (paragraphs 2.20 to 2.23). The aims of the investments are both social and economic. On the economic side, most countries state that the results are disappointing unless the programs have a productive context; for social reasons, however, countries often extend service to areas of low income and productivity even if the service is not financially self-sufficient for several years.

iv. Response (paragraphs 2.15 to 2.19). There are many rural areas which have very little use for electricity; the level and growth of consumption is low and there are few productive uses. However, some areas show a surprisingly good and all-round response to rural electrification projects, reflected in high, sustained growth rates of demand from households, rural commerce, farms and agro-industries (though initial demands are often low). Typically, the annual rate of growth of demand in rural areas is 10 to 20% (c.f. 10% per year in urban areas); over 50% of consumption may be for productive uses (as in urban areas); and average levels of consumption per consumer 1,000 kWh per year (5,000 kWh/year in urban areas). The main productive uses of electricity in rural areas are for motive power and refrigeration on farms, agro-industries and village commerce. Over 20 kinds of non-domestic consumers may sometimes be found in villages, in addition to the farm and agro-industrial consumers outside them.

v. The phases of rural electrification (paragraphs 2.11 to 2.14). Most countries have some degree of rural electrification, but are in different phases of developing it, depending on the level of demand for electricity. Before public electricity supplies from the main grid are introduced into an area it is very common to find businesses and communities, in all countries, supplying their own electricity from small diesel or hydro-powered generators (autogenerators). The costs of such sources of electricity are high (typically 9 to 21 cents per kWh as compared with 3 cents in urban areas); nevertheless, such enterprises are often profitable. As the demand develops, and as load factors improve, public supplies from the grid (which are more capital, but less fuel intensive, and are very expensive for small demands) become cheaper. It is then economical to replace autogeneration in the main demand centers by extending public networks to them. Once the main demand centers are connected, the final phase of electrification can begin; many of the smaller demand centers - which may be the smaller villages or the farm and agro-industrial consumers outside them - are now close to the networks and can be connected at low marginal cost. Broadly speaking, African countries are in the early phases using autogeneration and bringing some public supplies to the larger demand centers; Asian and EMENA countries are in the midst of bringing public supplies to the main demand centers; while Latin American countries are concluding this phase and beginning the final one of marginal extensions to the smaller centers.

vi. Overall costs of public supplies (paragraphs 2.8 to 2.10; 2.22). As compared to urban areas, the costs of serving rural areas are quite high. Typically, on a good project:

	Urban	Rural
Average costs, cents/kWh	3	6 to 8 initially; 4 after 10 years
Load factors (% utilization)	50%	20% initially; 40% in later years
Average price, cents/kWh	3	4

Costs are very sensitive to the level and growth of demand, the level of utilization, the distances between demand centers, and the difficulty of terrain. Subtransmission line costs work out at $3,000 to $5,000 per km, depending on the terrain; over a wide range they do not vary with demand, so that average capital costs decline as the level of demand increases. Load factor improvements also mean that increases in kWh demand can be met with proportionately less investment in capacity; this too reduces average costs. The initial investments in public supplies may cost about $50,000 per demand center, rising to $200,000 or more for larger demands in remote areas; but marginal extensions to neighboring demand centers may cost as little as only one-tenth of such levels (again reflecting the very large economies of scale in the early phases of electrification). For villages, initial capital costs work out at about $800 per consumer, but drop to about half of this as the number of consumers and demand levels rise; this works out at $40 to $80 per inhabitant initially, dropping to $20 to $40 or less as demand rises. On an annual basis, capital costs amount to roughly two-thirds of all costs, the other third being fuel, billing, maintenance and administration.

vii. <u>Financial returns</u> (paragraphs 2.20 to 2.27). Experience indicates that revenues are low in the early years, even when response is good. There are high, initial fixed costs in constructing the networks and setting up a billing and administration system; and the demand and load factors have to develop from low levels. Prices are kept lower than average costs in the early years in the interests of (a) promoting efficient use of electricity and (b) social aims. Although prices are normally sufficient both to cover the costs of operation and maintenance, and to contribute usefully to investment costs, it takes several years for average costs to decline to the level of average prices charged, unless the rate of growth of demand is very high. (It should be added that the majority of the projects in most countries are less than 10 years old, and have not yet reached this stage.)

viii. <u>The outlook</u> (paragraphs 2.24 to 2.27). Where there is a good response to the investment, reflected in an all-round and quick growth of demand, the indication is that the investment is generating a number of useful social and economic benefits, even if financial performance is poor in the early years. One of the first problems of investment analysis in rural electrification is to investigate the nature of these benefits to determine if the investment is justified (see Part III).

ix. Oil prices and rural electrification (paragraph 2.28). The rise in oil prices has had particularly large effects on the costs of:-

- electricity from diesel powered autogenerators (increases of roughly 50 to 100% depending on use);

- kerosene for lighting;

- motive power from diesel engines used in irrigation and agro-industries (increases of 30 to 60%, depending on use).

Areas already electrified are largely insulated from these increases, as will be areas to be electrified, depending on the mix of hydro, coal and oil plant in the system. Generally the effects should be to increase the number of households and businesses using electricity (though, of course, the costs of energy will have risen for those who would otherwise have preferred substitutes). The consumer-response data provided in this report relate to periods before the oil price increases; 1972 cost and price data are also used.

III. Project Justification

x. Least-cost investments (paragraphs 3.37 to 3.41 and Part VI). As with other projects, the search for a least-cost solution is an important aspect of appraisal. Public supplies from the grid should be shown to cost less than (a) autogeneration and (b) alternative network layouts and expansion plans.

xi. Economic benefits (paragraph 3.3 to 3.13). These are all related to the uses to which electricity is put, and increase commensurately with the level and growth of use (or demand). Broadly speaking:

- for productive uses, electricity is often a cheaper or superior form of energy for motive power, refrigeration and, for some purposes, heat; this enables the producer to increase profits by cutting costs and expanding output;

- for domestic uses the economic benefits are the households' valuations of a superior quality of lighting and ironing, or of new products like fans, refrigeration and television.

The importance of village electrification as a means of encouraging people to live in villages rather than cities is also often cited as an economic benefit. Although there is evidence that village populations increase, and that people often migrate out of rural areas to villages, there is no evidence to show that electrification plays an important role in this. For example, countries with the largest rural electrification programs generally are the most urbanized. Nevertheless, the growth of village and rural economies continues to provide increasing uses of electricity in these areas.

xii. Revenues and benefit measurement (paragraphs 2.14 to 3.16). In many areas of investment the revenues, which are a minimum measure of people's monetary valuation of economic benefits, are sufficient to justify projects. This is not often true of rural electrification, though good pricing policies may raise revenues significantly. In economic justification, it is necessary to look beyond the revenues to determine what additional or "surplus" benefits consumers obtain. This can be done straightforwardly for productive uses by costing out the alternative sources of energy and power available. But for domestic uses, estimation of surplus benefits is too difficult on account of large random differences between consumers and the more complicated nature of household decision making. In practice, therefore, cost-benefit analysis of rural electrification projects has to concentrate on the monetary benefits revealed in the revenues plus the surplus benefits in productive uses. If necessary, some consideration can be given to other benefits when discussing unquantifiables during project justification.

xiii. Economic rate-of-return (IER) (paragraphs 3.17 to 3.46). The economic rate of return calculation can begin with a forecast of demand and revenues, an estimate of costs, and then make adjustments for shadow prices and surplus benefits in productive uses.

xiv. Criterion for accepting projects (paragraphs 3.47 to 3.59). Calculations of the IER concentrate only on economic factors and only on what can be quantified. The resulting estimate of the IER may be sufficient to justify the project. This is particularly true if a strong demand develops from:

- a number of villages, not too widely scattered;

- farms, agro-industries and rural commerce;

and if attention is paid to keeping costs down and to pricing policy. This occurs if projects are properly identified and prepared, and relate to the development priorities of the areas they are to serve (as discussed in IV). Also, a rural development program may stimulate the demand and thus raise the IER by providing, for example, additional uses of electricity on farms and agro-industries. Often, however, the IER may not be sufficient to justify the project, and it is then necessary to examine social aims and unquantifiables; this may or may not lead to a recommendation of accepting a project with an IER lower than the opportunity cost of capital. If the IER is somewhat lower than but close to the cost of capital, the following factors might argue for justification: economic benefits that could not be quantified; special concessions for low-income households and small businesses; and an allowance for the social consequences of urban-rural imbalance. But a low IER may also signal that demand is still insufficient for the project, poor pricing policies, wrong priorities or simply that the least-cost project has not been chosen. A judgement will thus be required in such cases on what is an acceptable IER; it will depend inter alia on the strength of the social arguments and the importance of the unquantified economic benefits.

In general, however, it can be said that the allowances for social arguments and unquantifiables are likely to be smaller than for alternative investments: (a) electricity is not a basic necessity, and water and health projects, for example, deserve a greater social weight; (b) alternative sources of light and energy, though generally inferior, are available even in the poorest regions; and (c) water, education, health and transport projects, for example, arguably have larger unquantifiable benefits.

xv. Pricing policy (paragraphs 3.60 to 3.68; 4.23). This requires compromises between economic, social and financial aims. Economic aims require a forward-looking view with prices related to the marginal costs of expanding investment and output, ignoring the large initial sunk costs; the need to encourage people to use electricity also requires a forward-looking view, with a promotional element in tariffs in the early years; and social aims require provisions for small consumers. On the other hand, to provide the resources for an expanding program, and to limit pressures on the public revenue, financial analysis may suggest higher prices for the larger and better off consumers, and above the prices suggested by economic analysis of marginal costs. In practical terms, these various considerations should result in:

- prices that are higher in rural than in urban areas;
- prices below average costs in the early years on account of the high initial fixed costs, and also of the need to encourage people to use the service;
- low prices only for small consumers;
- generally, prices which substantially exceed operation and maintenance costs; and
- recovery of investment costs in later years, to an extent depending on the financial goals (see paragraph xx).

In practice many of these requirements are not being met. Low prices, for example, are often charged for large consumers who are able to pay more; while cost recovery is often undermined by prices which decline unduly with the volume of consumption. Hence thorough attention to pricing policy is an essential part of project preparation and justification.

IV. Project Identification and Preparation

xvi. Project definition (paragraphs 4.3 to 4.8). The size of the project needs to be defined in terms of electrifying the main demand nodes of a region as a whole. This is because (a) administration, billing and maintenance responsibilities need to be planned on a regional basis; (b) many network components serve not one, but several demand nodes; (c) the region, rather than, say, the village, is a more appropriate unit for economic analysis and (d) there are too many villages and other demand nodes to be analyzed comprehensively on an individual basis.

xvii. Identification (paragraphs 4.9 to 4.12). Projects selected need to yield satisfactory economic returns according to the criteria discussed above. This occurs where the level and expected growth of the uses to which electricity is put are reasonably high. This depends in turn on the quality of complementary infrastructure; growing productive uses on farms, agro-industries and village commerce; the presence of some large villages or of several villages not too widely scattered; and on the level and growth of wages and living standards.

xviii. Electrification plan (paragraphs 4.9 to 4.12). This begins with a strategy of electrifying the larger demand centers, followed by marginal extensions to smaller centers or consumers close to the networks. Several plans need to be considered which examine various rates of network expansion, alternative policies regarding which demand centers to connect, and alternative network designs (so as to determine a least-cost policy). In new areas, the plan needs to begin with a pilot project.

xix. Rural development and rural electrification plans (paragraphs 4.18 and 4.19). The effect of rural development plans, insofar as they succeed in raising productivity and incomes in a region and improving rural infrastructure, generally increase the expected economic returns to rural electrification because they increase the uses to which electricity is put. A high IER to the rural electrification element also signals that it forms a very useful and productive part of the rural development plan.

V. Means of Finance

xx. Financial goals (paragraphs 5.1 and 5.2). The financial characteristics of new or expanding programs are such that the initial investment should be financed by some combination of debt, grants, equity or internal funds of the utility which results in a relatively "soft" blend for the capital structure of the program. The reasons for this are: (a) the long gestation period before demand and revenues build up to reasonable levels, and (b) the various economic, promotional and social constraints acting on pricing policy. Often, these factors are made more difficult, and the financial returns worse than they need to be, by ill-structured prices. But even with suitable reforms to pricing policy, funding on soft terms, and especially with long grace periods, is necessary. In practice, the kind of financial goals that might be achieved would evolve with the level and growth of demand:

- initially (say, during the first 3 or 4 years) revenues could generally be expected to cover operating and maintenance costs quite comfortably;

- in the next phase (say, up to 10 years) revenues could additionally be expected to service debt (assuming the soft blend as suggested above);

- in subsequent years, revenues may generally be sufficient to make an increasing contribution towards the costs of expansion (sufficient in magnitude, on some projects, to meet a good proportion of the capital required, and to give a good internal financial rate of return to the project).

But such achievements, as noted earlier, would depend on the level and growth of demand; reforms to pricing policy; well-prepared and well-run projects; and also on a systematic follow-up on projects to insure that financial targets are raised as soon as circumstances warrant. As a matter of principle, then, it should not be assumed that costs cannot be recovered over the life of the investment; but whether or not they are will be determined by the pricing policies of the agencies involved. The appropriate targets need to be reviewed in each case, bearing in mind: (a) the financial needs of the program, (b) the effect of the program on the utility's overall financial performance, (c) the fiscal strength of the country, and (d) the economic and social objectives of the program.

xxi. Sources of finance (paragraphs 5.3 to 5.16). In most cases, a portion of the capital requirements will have to be provided by the government or the central electricity utility. The profits of the utility can be a substantial source, and using them has the added advantages of giving the utility some autonomy in expanding and running the program, and reducing the strain on the public revenue - which might be better used on projects such as water, education and health where funding problems are more severe. Also, there may be some scope for using general price increases on electricity to raise the funds for rural electrification, while tax increases may be unacceptable. On the other hand, government funding can be used to help the more backward regions, as a lever on the less innovative utilities (if there are several in the country), and to promote standardization and regional cooperation. The choice between using government funds or a public utility's profits (which are equivalent from an economic viewpoint) will depend on these institutional factors, the fiscal strength of the country and on the political acceptability of one arrangement or the other.

VI. Technical Problems

xxii. Public supplies from the grid consist of high voltage substations with transformers and medium voltage outlets; medium voltage subtransmission to the main demand centers in the rural areas; transformation to low voltages in the main demand centers; and local distribution at low voltages for service. Although this technology is standard, there is plenty of scope for cutting costs through examination of various design alternatives and expansion plans. The reasons are that, as noted in paragraphs (v) and (vi), costs vary enormously with the density and location of demand, economies of scale are strong, and there is a wide range of technical options. Among the most important options to examine are:

(a) Autogeneration and public supplies. Relative costs, and thus the choice, are very sensitive to demand, location, terrain and utilization, as remarked in (v) and (vi). Autogeneration costs may range from 9 to 20 cents per kWh or more (1972 oil prices, depending on load factor. The costs of public supplies for the same load are lower at 4 to 18 cents for villages close together, but may be two or three times these levels for widely scattered villages. (See Table 2.5, for example.)

(b) Standardization of equipment, construction and contract procedures;

(c) Lowered design standards; lowered quality of supply;

(d) Alternative network layouts, expansion plans and equipment designs.

Some countries have reported substantial cost reductions by thorough attention to these options.

VII. Institutional Problems

xxiii. The establishment of good institutions is of course central to the success of the program. Experience in many countries underlines both the importance and difficulties of training personnel, of promoting the service, and of building up administrative units capable of taking on many of the responsibilities of running the program in rural areas. Failures in local administration in particular - for example in billing or in reporting on and dealing with breakdowns in service -- may discredit programs in rural areas, and is a problem experienced by many countries. Local administrative units generally need strong support and assistance from the main electric utilities, particularly for training and for financial and technical assistance. But the extent of the support is partly a matter of policy. Countries have adopted (or are experimenting with) differing levels of delegated responsibility, with local administration placing:

- heavy reliance on the utility, and being responsible only for local billing and reporting on consumer complaints or requests for service; or

- medium reliance on the utility, and taking on additional responsibilities such as promoting service, identifying new areas to be served, and working out schemes with local people to extend service to them; or

- low reliance on the utility (as with the cooperative arrangement), and taking on many more of the financial, technical and administrative responsibilities.

Which of these arrangements is appropriate depends on the country, the available skills, the size and population of its rural areas, and the local culture. While, for example, cooperatives are reported to be working well in some countries, they are not suited to others. Also, different types of organization may work equally well; so in practice it is necessary to be flexible about their form.

VIII. Implications for the Bank

xxiv. The case for Bank assistance (paragraphs 8.1 to 8.10). This rests on three points: (1) The need expressed by developing countries for financial and technical assistance in this field. (2) The Bank's long experience with institution building and operations in the electric power sector. The programs to electrify rural areas are, in an important number of countries, being undertaken by institutions with which the Bank has had highly successful associations for many years. Rural electrification, which has so far formed a small but increasing fraction of their past investments, is a new dimension with new challenges and is likely to form an increasing portion of future programs. In many countries, there is a strong commitment to rural electrification and a desire to make it successful. (3) The good prospects for projects which are related to rural development priorities and can be justified. This last point rests, to repeat, on proper care and attention in project selection and preparation, and matching the project design to local needs.

xxv. The pattern of lending operations (paragraphs 8.9 and 8.10). Projects can be part of (a) rural development projects, or (b) projects for the electric power sector. Both have advantages and are worth pursuing:

(a) Rural development projects appeal because they promote coordination between sectors and generate large external economies. On the cost side, for example, improved roads reduce the costs of construction, maintenance and administration of the electrification program. On the benefit side, there are several inter-relationships: Rural development programs raise the level of output in agriculture and agro-industries, and through this the level of rural incomes. On account of increased incomes and improved infrastructure, commercial activity increases. Together, the growth of incomes and the growth of agriculture, agro-industries and commerce, create increasing demands for power and energy. These demands can be met by public supplies from the grid, local autogeneration or substitute sources of power and energy; which of these alternatives is best will be revealed by cost-benefit calculations.

(b) Electric power sector operations appeal because of the many financial, technical and administrative responsibilities delegated to the electric power sector, as is apparent from Section VII. Also, the sector still needs loans to finance its investments in generation and transmission capacity and in urban distribution networks.

In some countries, as in India and Iran, for example, rural electrification projects may be large enough to justify an operation specifically for this purpose. But in most countries this would not be the case. (See also the discussion on the lending program in (xxviii) below.)

xxvi. Lending conditions (paragraphs 8.11 to 8.15). Most loans would have to be made through the government (if it is a rural development loan) or the utility (if it is a power loan). The reasons for this are that local rural electrification agencies generally require a lot of financial support from the government or the utility so as to establish, expand and run the electrification programs. Even when local agencies are financially and technically strong, there is still a case for channelling aid through the government or the utility in order to promote regional and sectoral balance in the programs and cooperation between regions. Bank or IDA terms would of course apply according to the country; Bank terms might have to be passed on in part as equity, or blended with cheaper money, since the rural project could probably not generate funds to service a conventional Bank loan (though the utility often can). Local cost financing would be required since much of the materials and equipment would be provided domestically. Most loans would also have to make provisions for technical assistance.

xxvii. Which countries? (paragraphs 8.17 to 8.21; also see 2.11 to 2.14). There is scope for some degree of rural electrification in most countries though of course the type and extent of electrification depends on the level of development. As explained in paragraph (v), countries are in varying phases of the rural electrification process. Also, even when areas are already electrified, there is always a continual need for further investment to extend and reinforce networks within these areas (as in cities) to meet growing demands. Our estimates are that the following proportions of the village/rural populations may be served in 10 years time:

Africa and some Arab countries	-	less than one tenth
Asia and some EMENA countries	-	about one quarter
Latin American countries	-	about one third

Which countries would receive assistance would depend on the country's overall rural development effort, the claims for Bank help, and willingness to accept Bank conditions and procedures.

xxviii. The revised lending program FY74-78 (paragraphs 8.22 and 8.23). (a) Power loans. Roughly $250 million of the revised lending program for electric power ($3,100 million, in 1974 prices, for 90 loans) is allocated to rural electrification. Nearly half of this, however, is absorbed by three projects, two in India ($40 million each in FY75 and 76) and one in Iran (about $20 million in FY75, but tentative). These are specifically for rural electrification. The remaining proposals, which are relatively small, are components of larger loans to the power sector in 10 other countries (Thailand, Nepal and Pakistan, Panama, Honduras, Mexico, Bolivia and Brazil; Liberia, Tunisia). These lending programs were drawn up without any particular focus on rural electrification needs in the member countries, nor did the Bank have suitably developed operational procedures and guidelines for lending for rural electrification. Following the approach outlined in this paper, identification and preparation might be expanded upon during FYs 75 and 76, leading to an increased rural electrification element in the second half of the program.

(b) Rural development loans. Roughly 50% of the loans for Agriculture in FYs 74 and 75 might be classified as rural development loans. The rural electrification element in the projects financed by these loans varies considerably between countries. Rough indications are that rural electrification may average about 10% of the project costs in Latin American countries, about 5 to 10% in Asia and EMENA and very little in Africa. In all, between $150 and $300 million of the projected $6,500 million for Agriculture and Rural Development loans might be associated with rural electrification, under present projections. Again, however, with intensification of initiatives to identify and prepare projects for rural development and rural electrification, these figures might be revised upwards during the second half of the revised lending program.

xxix. Operational procedures (paragraphs 8.24 to 8.31). Most of these would be unchanged, except in degree, in that more work would be required in identification, preparation and appraisal, and uncertainties would be greater. Apart from this, sector survey work (of the electric power or the rural sectors), identification, preparation and appraisal would require only a widening of scope. The proposal is to begin work in rural electrification with thorough surveys, identification and preparation - the ultimate success of operations rests on this.

xxx. Monitoring, evaluation, research (paragraphs 8.32 to 8.34). Because of the uncertainties and the widespread lack of information about rural electrification (and, indeed, about rural development) it would be desirable (a) to begin with pilot projects in areas without service, but where there are good grounds for introducing it, and (b) to incorporate monitoring and evaluation techniques into both regular and pilot projects. This should provide information for planning further expansion and also a basis for improvements in subsequent operations. Problems requiring separate research include: (i) the scope for cutting costs; (ii) the factors affecting consumer response; and (iii) the linkages between economic growth in rural areas and the demands stemming from farms, agro-industries and rural commerce.

xxxi. Requirements of Bank staff (paragraphs 8.35 to 8.37). The new institutional and technological dimensions of the work would of course impose further demands on staff. While many of the new skills can be acquired with experience, consideration should be given to recruitment of people with experience in the field, short training courses, and further cooperation (perhaps sharing resources) between Regional Projects Departments.

I. INTRODUCTION

1.1 The possibilities for Bank financing of village electrification projects were first outlined in the Sector Working Paper on Electric Power. Since then, a number of initiatives have been taken to improve our knowledge in this field. Inquiries were made to over 20 countries regarding the extent of their programs and future plans; a major research study has been undertaken in El Salvador, and is nearing completion; there have been brief field trips by staff members to three other Central American countries, and also to India, specifically to look at village electrification programs; pilot village electrification projects were financed in Ecuador on the condition that the socio-economic impact of these projects was monitored over time; and finally, connections have been established between the Bank and other institutions undertaking research in Turkey, Tunisia, Costa Rica, Colombia and the Philippines.

1.2 A number of countries have also formally approached the Bank for development assistance in this field, including Iran, Oman, India and Thailand.

1.3 The time now seems appropriate to report on our findings to date on rural electrification. A number of diverse questions have been raised since previous reports (listed in Annex 1) were issued. For example: What is the extent of rural electrification in developing countries? and what are the prospects for successful investment? Is the economic-rate-of-return calculation a suitable basis for project appraisal in low income areas? and if so, how do we estimate economic costs and benefits? How do we identify good projects? Which institutional and financial arrangements work best? What are the technical problems? Finally, what should the Bank do?

1.4 This report is written in response to such questions. It begins with an introductory discussion on:-

II. Rural electrification in developing countries
- the extent, costs and uses of rural electrification, the aims, and the outlook for investment,

then presents our current thinking on approaches towards investment, as regards:-

III. Economic justification procedures;

IV. Project identification;

V. Means of finance,

VI. Technical problems;

VII. Institutional problems;

and concludes with a discussion of:-

VIII. Implications for Bank Policy and Procedures.

1.5 We now stand at the end of elementary inquiries to various countries and institutions, and at the end of limited field experience in India, Ecuador and Central America (including the research study in El Salvador, which is now being written up). Our evaluation of this material, which forms the basis of the present report, shows good grounds for the belief that useful and productive investments can be made; and we have proposed methods of undertaking them. So we also stand, if these proposals are accepted, at the beginning of project identification and appraisal work backed up by further research and evaluation.

II. RURAL ELECTRIFICATION IN DEVELOPING COUNTRIES

2.1 Rural electrification in developing countries is intended to serve both economic and social aims. To understand these aims and how they might best be achieved, it is first useful to know something about the extent and growth of village electrification in developing countries, the costs and the uses to which electricity is put; these matters are first discussed below.

Extent and Growth of Rural Electrification

2.2 Countries are putting increasing resources into rural electrification. As one might expect, the resources countries allocate to it increase with their per capita incomes, with the result that rural electrification is more extensive in Latin America than in Asia, and more extensive in Asia than in Africa:-

Table 2.1

	Population in 1971 /1 millions			Village/Rural Population /2 /3 Served 1971	
Region	Total	Village/2	Rural /2	Millions	%
Latin America	282	140	(50%)	32	23%
Selected EMENA Countries /4	143	87	(61%)	45	15%
Asia	934	700	(75%)	105	15%
Africa	182	165	(90%)	7	4%
	1789	1300	73%	187	14%

Source: Electrification data are compiled from miscellaneous documents and correspondence with the countries and are not official statistics. Population data are from UN documents.

/1 Population figures refer to the whole region, except EMENA (see 4).
/2 The definitions of "village" and "rural" vary between countries. Generally, villages are conglomerations of 5,000 to 10,000 people or less; rural refers to low density populations outside the villages, often living in clusters close to large farms.
/3 Electrification data not available for each country and the percentages should be taken as typical levels for countries in the region, about which there may be considerable variance.
/4 Cyprus, Egypt, Iran, Saudi Arabia, Tunisia, Algeria, Morocco, Turkey.

2.3 Total cumulative investment in rural electrification by developing countries within the Bank's area of operations was about $10 billion by 1971, or about 10% of total investment in the electric power sector. This figure includes generation, transmission and distribution which in the early stages of a project breakdown roughly as follows:

Investment in Generation and Transmission Capacity	30%
Investment in Sub-Transmission and Distribution Networks	70%

(Costs are discussed in more detail in paragraphs 2.6 et. seq.).

2.4 Future investment is likely to be much larger than in the past. We have formally questioned over 20 countries about their planned programs and have received information on several others. According to this information the rate of investment is generally likely to be higher than in the past and to form an increasing proportion of total investment. Some countries, including Iran, Egypt, Turkey and Thailand have announced major new initiatives, while others, in particular India and most of Latin America, are to continue and often expand on theirs.

2.5 The information is not good enough for a precise forecast of the level of investment, nor of the population likely to be affected. But it does seem that total new investment is likely to exceed $10-$15 billion in the next ten years (which is over 10% of total new investment), bringing supplies within the reach of 300 million more people; up to about half of these people, comprising 15% of the village/rural population, may be able to afford service. Thus a total of, say, one quarter of the village/rural population would be served in ten years time (as compared to about three quarters at the present time in urban areas).

Technology and Costs

2.6 Electricity is introduced into rural areas in three ways, through:

(1) Autogenerators serving single consumers;
(2) Autogenerators serving several consumers on a local network;
(3) Public supplies from the main grid system.

The term autogeneration refers to isolated generators powered by diesel engines, small steam turbines, or micro-hydro turbines. They range in size from about 5 kW, sufficient to meet minor needs of, for example, refrigeration and lighting on a farm, to over 1500 kW, sufficient to meet the motive power needs of a large sugar processing plant. Public supplies from the main grid consist of medium voltage (about 40 KV) subtransmission links to transmit electricity from the grid to the larger demand centers of an area, plus low voltage distribution within the demand centers.

2.7 Investment in rural electrification is mostly in public supplies from the main grid; at a guess, over 80% of rural electrification is supplied in this way. For small loads in remote localities, however, utilities often find that it is cheaper to meet electricity needs by installing small autogenerators. In the absence of public supplies, shops, farms and agro-industries will often install their own autogenerators to meet their own particular needs in lighting, refrigeration, heating and motive power; often, they also supply a few local consumers and provide public lighting if such demands occur when their equipment would otherwise be unused. Autogeneration, serving single or several consumers, is very common in rural areas.

2.8 Evidently, the utility must often make a decision whether to provide electricity from the grid or from local autogenerators. This decision depends on a number of factors, including the expected level and growth of demand, the expected utilization of the investment, the distance from the main network and the difficulty of terrain (which can affect costs enormously). The following table displays some typical cost data at two levels of demand:

Table 2.2

Typical Costs of Public Supplies and Autogeneration (1972 data)

		Autogeneration		Supply from Grid /1	
Capacity of Project	kW	50	25	50	25
Consumers Served		140	70	140	70
Capital Costs	$	34,000	25,000	56,000	38,000
Fuel, Operation and Maintenance	¢/kWh	6	6	0.5	0.5
Billing, Admin. etc.	$/year	2,000	1,000	2,000	1,000

Source: See Annex 2.

/1 Average length of subtransmission line per village = 4 km in this case. Note the economies of scale in capital costs. The 50 kW and 25 kW projects could serve fully developed loads in villages of about 2,000 and 1,000 people respectively. Demands from farms and agro-industries outside the village may add anything from 20 kW to 1000 kW or more to total capacity demands. Capital costs, it can be seen, range from $400 to $550 per consumer in the above case of supplies from the grid (or $40 to $55 per capita in the village served). However, for large villages of five to ten thousand people, these costs may drop to $200 per consumer ($20 per capita) or less.

2.9 The capital costs of supplies from the grid are much higher than those of autogeneration, but the fuel, operation and maintenance costs are much less. When the utilization of the project is high, this strongly favors the more-capital, less-fuel intensive investment in supplies from the grid. Taking the 50 kW projects, the relative annual costs of the two projects at various levels of utilization are:

Table 2.3 /1

	Autogeneration			Supplies from Grid		
Load Factor	10%	25%	50%	10%	25%	50%
Annual Capital Costs	$4,500	4,500	4,500	5,600	5,600	5,000
Fuel, O & M.	$2,600	6,600	13,200	200	500	1,000
Billing & Admin.	$2,000	2,000	2,000	2,000	2,000	2,000
Total	$9,100	13,100	19,700	7,800	8,100	8,600
Average, ¢/KWh	21	12	9	18	7	4

/1 See Annex 2 for calculations.

2.10 The fuel bill heavily penalizes autogeneration. In general, it compares well with public supplies from the grid only at low levels of utilization - except when the demands are remote. This last point is important, since to extend a subtransmission link by 25 km to an isolated demand may cost around $100,000 ($10,000 per year at 10% annuity), with the following kinds of effect on the capital costs of public supplies:

Table 2.4

Capacity of Scheme	50 kW	50 kW
Distance from Grid,	4 km*	29 km
Generation and Transmission Costs, $	24,000	24,000
Subtransmission Costs, $	18,000	118,000
Local Distribution, $	14,000	14,000
Total, $	56,000	156,000
Annual Capital Costs, $	5,600	15,600

Source: See Annex 2. *The 4 km case corresponds to the data in Tables 2.2 and 2.3.

Such cost increases are sufficient to make autogeneration the better alternative for all but high load factor demands. To see this it is useful to consider the effect of distance on the cost comparisons previously presented in Table 2.3.

Table 2.5

Average Costs of Different Schemes (cents/KWh)

Load Factor	Supplies From Grid: 4 km	Supplies From Grid: 29 km	Autogeneration
10%	18	40	21
25%	7	17	12
50%	4	8	9

(Note that average costs in urban areas are about 3 cents per KWh). Obviously, it is extravagant to extend networks to meet small demands in areas remote from the grid. However, the same subtransmission networks can be used to meet much larger demands, so that if a good demand develops from farms, agro-industries and several villages, average costs decline very quickly to about 4 to 8 cents per kWh.

2.11 It is now possible to explain how electrification schemes evolve in rural areas. It is a fascinating process which has three or four phases. In the initial phase, only a few scattered, isolated businesses may need and can afford electricity. They obtain it by installing their own generators and it is common to find them used for such purposes as refrigerating milk on farms, providing light and heat to egg and chicken farms, for refrigeration and light in shops, for refrigeration on a large scale in slaughter-houses, or for the motive power needs of large agro-industries such as sugar processing. During this phase, the motive power needs of small farms and businesses are generally met directly by animals or by small diesel engines. In the second phase, a small collective demand for electricity may develop from several households and businesses to meet needs like public lighting, private lighting, and further demands from large and small businesses and farms. During this phase, small local networks ("micro-grids") are often extended from local autogenerators installed through public or private initiative. If the collective demand becomes large enough, and offers good utilization of equipment, the second phase may be by-passed or lead to the third phase - fully-fledged electrification from the grid system. The "micro-grids" are taken over and extended; subtransmission links replace the old autogenerators, which are scrapped or used elsewhere; and small and large businesses begin to turn to electricity as a source of motive power in preference to animals or diesel engines (often creating a useful second-hand market in the latter), and may even introduce some new processes as a result.

2.12 During this third phase, a number of major demand centers can be identified in a region, stemming from the larger villages and the farms and agro-industries which lie outside them. A network design plan has to be worked out, to route the network so as to economize on the heavy costs of subtransmission and distribution lines. Once the networks have been established, a fourth and final phase follows quite obviously. Centers of low demand are now close to the networks and can be connected up at very low marginal cost. Whereas the initial thrust into a region may cost \$50,000 to \$200,000 per demand center, secondary thrusts into areas of low demand may now cost only \$5,000 to \$20,000. (Many areas of low demand remain remote from the main networks, and for this reason it is never worth electrifying them from the main grid; even in N. America and Europe, where rural electrification programs were substantially completed 20 years ago, many areas continue to be served by local autogenerators.)

2.13 Practically every country has some degree of rural electrification, but different countries are in different phases. Broadly speaking, African countries are largely in the first phase of private generation, but are gradually beginning the second and third phases of meeting the larger collective demands from the grid or local autogenerators. Asian and EMENA countries are mostly in the midst of the third phase, of connecting the main demand centers to the grid. Most Latin American countries are in the fourth and final phase, of connecting low demand centers to networks already established in rural areas.

2.14 As remarked earlier, the term rural electrification is normally associated with electrification from the grid system, that is, with the third and fourth phases of electrification. The relative magnitudes of these phases may be gauged from Table 2.1 and also from the following statistics for Mexico, which show that over 50% of the rural population live in areas of low demand:

Table 2.6

Population Distribution of Villages in Mexico

Population of Village	No. of Villages	Population No.	Population %	Remarks
Less than 100	55,376	1,823,900	7%)	Low Demand Areas, 25% Electrified
100 - 499	28,494	6,944,500	26%)	
500 - 999	7,346	5,091,900	19%)	
1000 - 4999	5,207	9,681,800	37%)	Medium-to-High Demand Areas, 80% Electrified
5000 - 9999	416	2,894,300	11%)	
	96,839	26,436,400	100%	

Source: Supplied by Comision Federal de Electricidad.

Similar distributions in the size of village, and in the areas of high and low demand, can be observed in most countries. (In the Cameroons, much emphasis is placed on forming larger-sized villages before providing electricity and other infrastructure.)

Uses of Electricity

2.15 There is a surprisingly wide range of uses of electricity in rural areas, for both household and productive needs. Generally speaking, the total demand stemming from productive needs is higher than that stemming from households, as can be seen from the following table:

Table 2.7

Percentage Distribution of Electricity Demand in Urban and Rural Areas for Various Countries (1971 data)

	Rural Areas					Urban	
	Productive Demands				Domestic	Productive	Domestic
	Farms	Agro-Industry	Commercial-Community	Total	Total	Total	Total
Ethiopia	-	-	-	55%	45%	44%	56%
Tanzania	-	-	-	75%	25%	80%	20%
Chile	9	26	32	67%	33%	n.a.	n.a.
Costa Rica	-	-	-	70%	30%	43%	57%
Nicaragua	15	.....45.......		60%	40%	30%	70%
El Salvador	-	-	-	45%	55%	60%	40%
India	59	.....21.......		80%	20%	89%	11%
Pakistan	23	.....17.......		40%	60%	90%	10%
Taiwan	10	.....16.......		26%	74%	80%	20%

Sources: Rural data: Correspondence and miscellaneous documents provided by the countries.
Urban data: From similar sources and Bank Appraisal Reports.

These data, which refer to typical situations, understate the productive uses since many small business demands creep in under domestic and general tariffs.

2.16 The relative demands from households and producers change markedly from one area to another. Often, the demand in an area may be dominated by one large consumer, as with irrigation or cotton processing; and though some areas may use electricity for a wide range of productive purposes, others may use it for little more than domestic and public lighting.

2.17 In addition to the various agro-industrial demands which develop from the local agriculture, it is not uncommon to find demands developing from 20 or more commercial activities in a single village, such as for light and refrigeration in shops and services, and for light, heat and motive power in workshops (carpentry, welding and repairshops, for example). Community demands may include public lighting and demands from the local church, a water pump, a police station, school and health centers. Growth in local agriculture and wages, and improvements in complementary infrastructure, can thus generate all kinds of uses for electricity.

2.18 Consumption levels in rural areas are of course much less than in urban areas. But again it is surprising that there is often a strong response to rural electrification from consumers, reflected in high, sustained rates of growth of demand once an area is electrified:

Table 2.8

Level and Growth of Consumer Demand in Urban and Rural Areas. Estimates for Various Countries (1971) /1

	Demand per Consumer, kWh/year /2		Yearly Rate of Growth of Demand	
	Rural	Urban	Rural	Urban
India	1000	n.a.	15%	10%
Thailand	200	4000	12 - 20%	22%
Ethiopia	800	2000	40%	15%
Costa Rica	1900	6000	20%	10%
El Salvador	1000	4000	20%	10%

Sources: Rural data are estimates based on various documents and project reports provided by the countries. Urban data inferred from Sector Working Paper on Electric Power and Bank Appraisal Reports.

/1 Data purely illustrative, not average, for the country.
/2 Rural data for selected areas; Urban data for capital cities, except for Thailand, which is an average.

Demand per consumer varies between areas largely on account of variations in the type of productive uses, and also with the age of the project on account of the growth of demand per consumer. Irrigation pumpsets, for example, consume about 3000 kWh per year in India, while a large agro-industry may consume 100,000 kWh per year or more.

2.19 To sum up, there is often a surprisingly strong response to rural electrification projects. This is reflected in high rates of growth of demand, though they start from very low initial levels. This response stems from a wide range of uses of electricity.

The Aims of Rural Electrification, and the Conflicts Presented by Low Financial Returns

2.20 Having discussed the demand side and the supply side, it is now useful to put the two together and discuss the net returns - social, economic and financial - that are expected from the investments.

2.21 Most countries stress the social importance of their rural electrification programs, in particular the need to raise the standard of living in rural areas and to provide a counterweight to excessive urbanization. But many of the returns, as illustrated above, are of economic importance since they stem from the voluntary demands of communities, houses and businesses for a cheaper or superior form of energy. Indeed, many countries state that unless the programs are set in an economic context, the results are disappointing. For this reason, they stress the importance of both economic and social aims.

2.22 Where the economic content of rural electrification programs is large, it may seem reasonable to expect satisfactory financial returns - electricity increases energy use in the area, often reduces energy costs, and is far superior in quality to the alternatives. But there are three reasons why this is not the case, at least for a period of years:

a) the high initial investment costs associated with low density populations, often remote from the main networks;

b) low initial demand levels in relation to the capacity of the networks (which have large indivisibilities); it may take over 10 years for demand to develop fully in relation to capacity;

c) the arguments for keeping tariffs low in relation to costs to meet the social aims of cheap energy to low income households and small businesses.

The following figures illustrate these points:

Table 2.9

Comparative Data for Urban and Rural Areas

	Urban	Rural
Consumption: kWh/consumer/year	4,000	600*
Load Factor	50%	20%*
Investment in subtransmission and distribution per consumer (approx.)	$100	$300
Average costs, cents/kWh (approx.)	2.5	6 to 8*
Average price, cents/kWh (approx.)	2.8	4
Mean per capita incomes	$800	$125

Source: El Salvador Study.

* Figures refer to typical initial conditions.

The initial average costs are over two or three times those of urban areas, and though average prices are nearly 50% higher, this is not of course sufficient to make up the deficit. As both load factors and the level of demand rise, average costs decline very quickly; but the possible financial gains from this are often undermined by the system of declining block tariffs widely adopted in many countries throughout the world.

2.23 Financial assistance is generally considered to be necessary, therefore, at least in the early years. The assistance takes several forms, including low interest capital from internal or international sources, special depreciation provisions, preferential tariffs and contributions in kind from the rural areas, such as unpaid labor. (It is also interesting to note that when it was desired to promote rural electrification in the USA in the 1930's, it was considered necessary to finance it on concessionary terms in accordance with the Rural Electrification Act of 1936.)

The Outlook

2.24 So long as the investment programs are expanding, the fact is that continued financial assistance is required. Accepting this, however, three other facts are becoming clear:

a) In many electrified areas in all parts of the world the financial returns are improving markedly over time, though from very low initial levels. One reason is that there are substantial economies of scale as demand and consumer density increase.

b) Although existing projects are in the 'best' areas, extensions to 'worse' areas in the same region need not undermine overall financial or economic performance; the 'best' areas have absorbed the brunt of the high initial costs and, as explained earlier, subsequent extensions cost much less.

c) Financial performance can often be improved significantly by appropriate attention to pricing policy. Low prices often exist in places where they are unnecessary on account of ill-structured tariffs - the consumption of large farms and agro-industries is often subsidized, for example, even though they are able and willing to pay more for the service.

2.25 Taking a long perspective, therefore, and a constructive attitude towards tariff policy, it seems there are prospects both for continued expansion and improved financial performance.

2.26 Nevertheless, the prospects of low financial returns in the initial years, and the arguments for subsidizing small businesses and low income households, remove a simple criterion for project selection based on financial profitability. A broader basis for project selection is called for and is being sought by many countries and institutions.

2.27 Hence there are serious difficulties with project justification and identification, as there are, of course, serious difficulties with finance, institutional development and technical choice. None of these seem insurmountable however, as will be apparent from the following analysis of them.

Supplementary Note on the Effects of Oil Price Increases

2.28 The recent rise in oil prices has had particularly large effects on the costs of:-

- electricity from diesel powered autogenerators (increases of roughly 50 to 100% depending on use);
- kerosene lighting;
- motive power from diesel engines used in irrigation and agro-industries (increases of 30 to 60%, depending on use).

Areas already electrified are largely insulated from these increases, as will be areas to be electrified, depending on the mix of hydro, coal and oil plant in the system. Generally the effects should be to increase the number of households and businesses using electricity (though, of course, the costs of energy will have risen for those who would otherwise have preferred substitutes). The consumer-response data provided in this report relate to periods before the oil price increases; 1972 cost and price data are also used.

III. PROJECT JUSTIFICATION PROCEDURES

3.1 In the social and economic justification of rural electrification projects, it is useful to begin with a study of economic returns and then work social factors into the analysis. Confusion between social and economic aims is then avoided and trade-offs (to the extent that they occur) can be examined. This approach is followed below. The starting point is a discussion to clarify:

a) The nature of the (economic) benefits.

This is followed by a discussion of:

b) Practical aspects of benefit measurement;

c) forecasting demand and benefits;

d) cost analysis; and

e) cost-benefit (economic rate-of-return) calculations.

This covers the economic side. It will be seen that it is a traditional analysis of forecasting benefits and comparing them with the costs of the (least-cost) project in an economic rate-of-return calculation. The social side is then brought into the picture in the discussion of:

f) Criteria for project acceptability.

Finally, if the social and economic aims are to be met in practice, it is necessary to attend to the following, which are also discussed:

g) Pricing policy;

h) provisions for low income families and small businesses.

3.2 There are two main purposes, it should be noted, of the economic analysis of costs and benefits. One is the usual one of providing a consistent guideline for an efficient allocation of investments between the various sectors in urban and rural areas, and some indication, therefore, of economic priorities. The other is to provide some measure of the economic costs of investments when social aims are strong, economic returns low and conflicts arise. (Conflicts do not always arise, however, and some investments are socially and economically desirable.) Economic rate-of-return calculations can be very helpful for these purposes, and are adopted here. They only break down when social arguments are overwhelmingly strong -- as with water supply projects in drought areas. But this, in our experience, is not the case for rural electrification.

(a) The Nature of the Economic Benefits

3.3 There is a very close relationship between the level of use of electricity and the level of benefits derived from it, in the sense that when use is low, only a few people may be benefiting marginally from the service, and conversely when use is high. The benefits most frequently quoted, and which are all related to use, are that electricity:

(i) increases productivity and output in rural areas through reducing the costs of energy and thus increasing the profitability and output of farms, agro-industries and commerce;

(ii) adds to the standard of living in village homes and communities;

and, on account of (i) and (ii):

(iii) helps stem migration from rural areas to cities -- the problem of urban-rural balance.

(The third is related to use because to the extent that people and businesses are attracted to rural areas by electricity, they will use it.)

3.4 There is, in fact, little hard evidence as to the effect of electricity on migration. Our investigations have revealed, as one might expect, that older people migrate mainly in search of jobs, while the younger ones migrate in search of jobs and education or to begin families. Also, the countries with the largest rural electrification programs generally are the most urbanized (see Table 2.1 for example).

3.5 Nevertheless, despite migration to cities, and whatever its causes, the economic output of farms, agro-industries and rural commerce is increasing, large numbers of villages are increasing in population and are in a process of modernization. The result is that the demands for electricity, and the range of uses to which it is put, are also increasing. Hence there are positive benefits to look for, even if electricity by itself has little or no effect on stemming migration to cities.

3.6 In monetary terms, and ignoring complications about shadow prices and income distribution for the moment, the benefits of electricity to families and businesses are to be measured by the amount of the family or business income they are prepared to allocate to it. This is the monetary value placed by individuals on the service. Small businesses and low income families, in particular, make this allocation decision very carefully. The decision is made in the light of the many complex and varied circumstances of the family or business and of the alternative uses of this portion of family or business income.

3.7 The estimation of benefits, in monetary terms, can begin by adding up these monetary valuations over all family and business consumers. For practical purposes it is useful to divide the monetary benefits into two parts:

- actual revenues (the "direct consumer benefits")

- the surplus monetary benefits ("consumers' surplus benefits")

where the latter simply reflect the point that people generally do value service by more than the amount they may be asked to pay for it.

3.8 Revenue estimation presents no new problems apart from the difficulties of forecasting, but what is the nature of the surplus benefits? and how can they be estimated?

3.9 For farms, agro-industries and commerce, there is normally a substitute for publicly supplied electricity in the form of:

- Autogenerators for large agro-industries;

- diesel engines for many purposes, including irrigation, corn grinding, and motive power in small agro-industries;
- often, animal power;

- small autogenerators for refrigeration on farms;

- kerosene refrigerators, etc.

The surplus benefits are the net advantages of electricity over these alternatives. In many activities the same output can be produced by the substitute, so the net advantages are cost-savings. This is commonly the case, for example, with uses of electricity for motive power, as in irrigation pumping and corn grinding, where diesel engines can do the same job, though often at a higher cost. It is also the case for many large farms and agro-industries which can also produce the same output using diesel powered autogenerators, though again, often at a higher cost.

3.10 In other activities, however, electricity is far cheaper or of higher quality, and extra output also results; the net increase in the profits of the activity are the benefits. This is often the case, for example, for small businesses using electricity for motive power or refrigeration. The alternatives (including the associated capital and maintenance costs) are often too expensive or unreliable, and the business cannot make a profit with them. So new business activities can and do spring up if costs are cut sufficiently for them to become profitable. Refrigeration in shops and corn grinding are common examples in Central America.

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CONFIDENTIAL

INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT
INTERNATIONAL DEVELOPMENT ASSOCIATION

POLICY REVIEW COMMITTEE

PRC/s/M/74-9a

July 15, 1974

ISSUES IN RURAL ELECTRIFICATION

STAFF REVIEW - MINUTES

Attendance:
Messrs. van der Tak (Chairman), D. Anderson, Bailey, Beach, Bottelier, Churchill, Dosik, Fish, Gulhati, Howell, Karaosmanoglu, Leiserson, M. Miller, D. C. Rao, Reutlinger, Shields, Thalwitz, Wessels, Willoughby, Vibert (Secretary)

1. A staff review of the paper "Issues in Rural Electrification" was held on Monday, July 8, 1974.

2. The Chairman proposed that the discussion focus on three aspects:

- the description of the stages of rural electrification;
- the economic and financial analysis of rural electrification projects;
- the implications for the Bank Group's lending program, in particular whether rural electrification should be approached as one component of rural development projects, or rather through power sector loans.

3. In discussion there was general acceptance of the description of the rural electrification process. However, with respect to the economic and financial analysis it was suggested that the higher cost of fuels following recent petroleum price increases made rural programs (in common with most power programs) generally more expensive; and, in particular, made auto-generation less attractive relative to grid extension. Questions were also raised regarding allowances for unquantifiable benefits in the economic analysis, and the apparent acceptance in the paper of returns on project

investments below the opportunity cost of capital. It was explained that the paper recommended against rejecting investments with such low returns — provided, of course, the returns were reasonably near the opportunity cost — without first examining the nature of the benefits that had not been captured by the return calculation. As regards financial analysis, it was agreed that more should be said in the paper about financial targets.

4. There was considerable discussion of the intrinsic nature and purpose of the paper. The Public Utilities Department believes the paper accomplishes three purposes:

(i) it shows that successful investments can be made in rural electrification;
(ii) it reviews all the aspects of the process of doing so; and
(iii) it demonstrates that there are no policy or procedural issues which would impede Bank initiatives to lend for rural electrification.

5. Discussion of the Bank Group approach to rural electrification was inconclusive. Some participants favored lending through conventional power sector loans on the grounds that this facilitated evaluation of the country's overall rural electrification program and that the utility itself was likely to be a relatively strong institution, particularly where the Bank had a previous involvement. On the other hand, integration into rural development projects would help ensure the productive use of output and enhanced the likely economic rate of return.

cc: Those Attending
IBRD Department Directors
Program Coordinators
Mr. Qureshi (IFC)

3.11 By taking a representative sample of such activities, covering different types and sizes, it is possible to estimate a typical ratio of surplus benefits to actual amounts paid for electricity. From these ratios, and knowing the number of different types and sizes of business consumer, it is then possible to calculate total surplus benefits directly. 1/ Clearly the level of these benefits rises commensurately with the number and total demand of these consumers.

3.12 On the household side, the surplus benefits of some uses, such as for lighting and ironing, are also the net advantages over substitutes; while the benefits of others, such as refrigeration and television, are generally the household's valuation of a new product, practical substitutes not being readily available. As remarked earlier, the total monetary benefits would be the amount of income the households are prepared to allocate to such goods.

3.13 It is, however, exceptionally difficult to estimate the monetary value of surplus benefits to households, even with well-conceived sample surveys and elaborate econometric analysis. The problems of randomness, of specifying a correct algebraic model of household behavior, and of identifying the separate influences on household behavior, have so far precluded reliable estimation. What we do know, however, is that when service is benefiting many households, there will be a strong demand for it, reflected in quite good revenues (the direct benefits). So it is still revealing to look at the direct benefits even if the surplus benefits cannot be estimated -- though the point that such monetary benefits are omitted from the economic rate of return calculations means that tolerance is needed for projects with returns somewhat below the opportunity cost of capital (see paragraphs 3.47 et.seq.).

(b) Practical Aspects of Benefit Measurement

3.14 In practice, therefore, it will be necessary to confine cost-benefit analysis to what can be measured, and to supplement this as necessary by descriptive analysis. The benefits which can be measured will generally be:

- the direct benefits to households, reflected in the revenues;

- the direct benefits to farms, agro-industries and commerce, again reflected in the revenues;

1/ The forthcoming research study in El Salvador will provide illustrations of such calculations.

- the surplus benefits to farms, agro-industries, and commerce, reflected in the net effects on profits and output of electricity to these activities.

Descriptive analysis of households, and of household demand, can be couched in terms of indications of living standards, the number and percentage of the people demanding service and what they are likely to use it for. Analysis of the growth of the area, its history, whether people are likely to move into it and/or remain there are also important.

3.15 Where there is a strong demand for "productive uses" the above basis of benefit estimation will be more than sufficient to justify a good project. The revenues from farms and agro-industries should boost the project, unless tariffs are low. Counting in the surplus benefits to productive uses will boost justification further. If, for example, 80% of demand is from productive uses, and surplus benefits are (typically) 50%, then benefits are 120% of revenues not counting household demand, and 140% in total. This can make a large difference in rate-of-return calculations.

3.16 Where, on the other hand, there is a small demand for productive uses, coupled with low tariffs and a low level of demand from households, justification will be difficult -- as perhaps it should be in these situations.

(c) Forecasting Demand and Benefits

3.17 Demand forecasting in areas hitherto without service involves more uncertainty than in areas with service, on account of information shortages; it requires, therefore, a good deal of judgment and guesswork. This points to the importance of flexibility in project design and investment planning, as discussed in VI; and to the need to collate information from several sources and to experiment, as discussed below.

(i) Evidence from Other Projects

3.18 The most concrete basis for a forecast is provided by projects already functioning in other areas of the country. Most countries in Latin America, EMENA, and Asia, and several in Africa have had pilot projects and sometimes extensive programs for several years. The obvious thing to do is to examine how both domestic and non-domestic consumers have responded to these projects; things to look at are:

- The growth in the number consumers;

- the growth in consumption per consumer;

- the types of consumer, including a breakdown by large and small, irrigation, various agro-industries, various levels of household consumption, etc.;

- the changes in load factor; and, if possible,

- the kinds of uses to which electricity is put.

This information should not be difficult to obtain in a well-run program; if it is, serious questions should be raised about whether projects are being monitored properly and about the systematic keeping of records.

3.19 An elementary understanding of the areas in which these projects are located is also necessary in order to understand the factors which affect the projects' returns. Often, a look at the living conditions in an area, its infrastructure and the growth of local agriculture, agro-industries, commerce and wages may be sufficient for this purpose.

3.20 In building up forecasts from experience with other projects, it is of course desirable to take areas that are comparable with the area under consideration -- comparable population and income levels, and comparable with respect to local infrastructure, housing quality, and levels of activity in agriculture, agro-industries and commerce; or more generally, areas which are comparable in levels of development and size.

3.21 Such coincidences in levels of development and size do not always occur even within broad limits. However, to obtain an impression of how levels of development and size interact with the project, it is a good idea to look at how projects have functioned in larger and smaller areas, and in both more and less developed areas. This will provide a range to the forecasts.

(ii) Evidence from Neighboring Countries

3.22 If such evidence is scarce or is not available within the country, either because there are no pilot projects or because they are new and it is too early to form a judgment, the experience of neighboring countries is often highly relevant (indeed one can often go further afield than this). Again, the aim is to see how people and businesses have responded to projects in different situations.

(iii) The Use of Pilot Projects

3.23 Where there is absolutely no local precedent for the forecast, it is of course difficult to justify a full scale program. The case for pilot projects and the use of these as a base for forecasting, as well as experience in project design and management, is a strong one. It should be noted, too, that pilot projects can often be provided out of a very small fraction of a utility's budget. Typically about 5 villages can be electrified for $250,000 depending on their size and location.

(iv) Evidence from Low-Income Areas of Cities

3.24 As regards household demand, it is often the case that many households in villages are no poorer than many electrified households in low income areas of cities. Analysis of the latter may give some indication of likely response from households in villages (even though the costs of serving villages are higher).

(v) Economic and Social Analysis of the Area

3.25 Any evidence carried over from the experience in other localities and countries must, of course, be supplemented by local inquiries. On the non-domestic side, items to look at are:

- the type and growth of local agriculture;
- the development of local agro-industries;
- the extent of local commerce (strong correlations here with population of area);
- quality of local infrastructure such as roads, schools, water and health centers;
- any government plans on projects for the area.

Apart from its importance for forecasting, this information is important for determining priorities. For this reason, it is perhaps best provided by regional surveys of the rural sector.

3.26 On the domestic side, items to look at are:

- family income data (if available or ascertainable);
- quality of housing;
- history of the area;
- migration in the area.

There are some empirical points to be made about each of these items.

3.27 The main factor which determines household demand is household income. Electrical appliances and the costs of running them can be expensive for a low income family, even if large subsidies are offered on electricity costs. The following table illustrates these points.

Table 3.1

Relation Between Household Income and Expenditure on Electricity /1

Appliance	COSTS: US$ Connection /2	Appliances	Electricity	Annual Total /3	Family Income /4	Per Capita Family Income /4	Annual Cost ÷ Family Income
Lights (L)	13	2	6	9	430	72/6	2%
L+Iron (I)	18	15	8	15	550	90	3%
L+I+Refrig. (R)	18	270	22	81	850	140	10% /5
L+I+TV	18	240	10	62	1,000	170	6%
L+I+R+TV	18	600	40	160	2,300	380	7% /5

/1 Source: El Salvador Study.
/2 Includes housewiring.
/3 Using 20% annuity on connections and appliances.
/4 Group means. Family size of 6 taken in computing per capita family incomes.
/5 Refrigerator sales often used to augment family income by unascertainable amounts; family income is probably underestimated.
/6 The actual threshold income, at which families began to consume, was about $50 per capita.

3.28 Family income and costs are not the sole determinants of course. A large proportion of families in rural areas often can afford electricity but nevertheless do not request it. One reason for this is that there is a high propensity for families to move between regions in search of jobs, the opportunities for which may vary seasonally in the case of agriculture and agro-industries. Illiteracy, fragmentation of the family unit, a lack of incentive to develop the home, are also important. Generally, though there are exceptions, it is those families which seek better housing who are also likely to seek electricity; some kind of solidity or permanence in house structure is an important indicator of the likelihood of demand.

3.29 Turning to the history of the area, this too can provide indications of the likelihood of demand. Many villages, for example, have long (if scantily recorded) histories, with long traditions in commerce and socialization; for this reason they can and do form points for growth.

3.30 Related to this is the possibility of people migrating into an area. Even in the presence of migration from rural areas to cities, rural populations often do not decline. Furthermore, there is evidence from several countries to show that villages are often able to attract people out of rural areas on a par with cities. (Nearly all the villages we have studied in El Salvador also showed a general increase in the number of homes.) Evidence of this kind is exceptionally important in indicating people's regard for the future of the village; and it also indicates whether demand can be expected to grow.

3.31 This list of items for economic analysis is not, of course, exhaustive. Nor is such information often available. But analysis of what is known about the development of the area will add substance to the forecasts decided upon.

(vi) Evidence on Energy Use

3.32 Further evidence on the potential demand for electricity can be obtained by a sample study of energy use by households and businesses in the area. Items to concentrate on are:

- types, costs, and extent of motive power (generally animal and diesel) for various purposes;
- sources and costs of refrigeration;
- sources and costs of light in businesses and homes;
- sources and costs of heating for various purposes.

This information is not only useful for forecasting, but also for benefit calculations. Although it is not often available, it is not too difficult or costly for the utility to obtain, and it is all part of good record-keeping and an institutional interest in the prorgram. When it is not available, no harm is done by suggesting that someone should look into it, even if it is on a sample basis.

(vii) Building up a Forecast

3.33 Attempts are being made to interpret such data econometrically or through other statistical models. This is of course to be encouraged.

3.34 But generally, forecasts have to be made in a rough and ready way. In practice, the most straightforward thing to do is to begin with concrete evidence from other electrified areas within the country and, if possible, from other countries. Next, an economic analysis of the area should indicate whether the demand data obtained from these areas should be revised up or down; such revisions will be further strengthened by the studies of energy use. If there are concrete plans for the area's development, the revisions can be made fairly precisely, otherwise they can only be based on judment, the bounds of which can be determined by studying areas of higher and lower levels of development from the one considered.

(viii) Demand for Community Purposes

3.35 These include street lighting and service to schools and health centers. They can be estimated directly from technical coefficients.

(ix) Forecasting Benefits

3.36 From the demand forecasts, the forecasts of revenues follow rather obviously to give the direct benefits. To get the consumers' surplus benefits it is first necessary to distinguish between the various types of consumer:

- various sizes and types of farms, agro-industries and commerce;

- demand for community purposes;

- various levels of household demand.

An idea of what they use electricity for and of the costs of the substitutes will then give a basis for estimating surplus benefits per unit of demand. As remarked earlier, it will only be practicable, in general, to estimate surplus benefits for consumption for "productive uses". But information about what households are expected to use electricity for will give some qualitative idea of the benefits; also, as will be apparent later, this information is particularly important (i) for shadow price adjustments and (ii) for analyzing income distribution issues in pricing policy.

(d) Cost-Analysis

3.37 Once the forecasts of demand and benefits have been obtained, the next steps are to determine:

- the least-cost means of meeting demand, and

- if costs can be further reduced by lowering design standards and accepting an increase of supply interruptions.

The second problem is discussed later (Part VI), except to note here that some countries report large economies by careful attention to design and by keeping standards to a bare minimum.

3.38 The main alternatives to be considered in the least-cost exercises are:

(i) public supplies from the main grid;

(ii) the same, but with different network layouts, equipment capacities and expansion plans; and

(iii) local autogenerators serving local micro-grids.

The third needs to be considered before the initial decisions are taken to bring electricity into an area; and also, of course, for obviously small demands in remote areas. In areas close to the grid, or close to existing subtransmission networks, the main alternatives to be considered are (i) and (ii), that is, alternative plans for public supply.

3.39 Both the least-cost studies and the comparisons of costs (of the least-cost proposal) with benefits require a dynamic analysis over a long time horizon. As illustrated in Section II, costs change enormously over time with the growth of demand and utilization of equipment (load factors); and since the electrical equipment in the networks lasts about 30 years, this is the sort of time horizon needed for the study of costs and benefits.

3.40 Although there are periodic needs to reinforce and extend networks as demand increases, the costs of service per consumer and per unit of power and energy demand decline (in real terms). This is the case for both auto-generation and public supplies, for the following reasons:

(1) There is a large initial fixed cost in setting up the local networks and installing local-autogeneration or, in the case of public supplies, of setting up the subtransmission links to the main grid. Also, equipment costs per unit capacity decline very quickly with size. The following data taken from a project in Ethiopia illustrate these points:

Table 3.2 /1

		1st Year	7th Year	14th Year
Peak Demand	kW	100	425	1,120
Capacity /2	kW	150	1,150	1,500
Total Investment	$	104,000	254,000	288,000
Investment per kW Demand	$/kW	1,040	598	257
Investment per kW Capacity	$/kW	690	220	192
Average Costs per Consumer	$	870	320	72

/1 Source: Supplied by Ethiopian Electric Power and Light Company (1971 data). Data relates to Ghimbi district, 450 km from Addis Ababa. Population about 10,000 but apparently increasing rapidly. Forecasts were based on experience with similar project in Shashemene district which was of "similar economic status".

/2 Local autogeneration of following capacities 1 x 150 kW in 1st year; 1 x 150 kW + 2 x 500 kW by 7th year; 3 x 500 kW by 14th year.

(2) Related to (1) is that costs decline as consumer density increases. For a rural center with 500 persons per square mile, the Kenya Light and Power Company reports initial investment costs of $1,700 per kW, as compared with $250 per kW for a center of three times this population density (1971 prices).

(3) There are also fixed costs of administration, billing and maintenance which also decline in relation to demand. Again, this is illustrated by data supplied by the Ethiopian Electric Power Company.

Table 3.3 /1

	1st Year	7th Year	14th Year
Peak Demand, kW	100	425	1,120
Energy Demand, kWh per year	120,000	629,000	3,307,000
Capacity Costs. $ per year /2	15,600	38,000	43,200
Fuel Costs, $ per year	5,400	28,200	148,400
Admin. Costs - Fixed, $ year /3	13,600	13,600	15,100
- Variable, $ year /4	5,000	11,000	28,000
Total Costs per year, $	39,600	90,800	234,700
Average costs, cents per kWh	33.0	14.4	7.1
Admin. Costs, cents per kWh	15.6	3.9	1.3

/1 Same project as for Table 3.2, all cost data refers to 1971 (including fuel) and are presented here for purposes of comparison.
/2 15% annuity applied to capital costs of Table 3.2.
/3 Mainly comprise the salaries of the branch manager, clerk, cashier, production foreman and 4 mechanics, 1 distribution foreman and 4 electricians, plus guards.
/4 Meter readers and miscellaneous.

The costs, it can be seen, are dominated in the initial stages by the fixed costs of capital and administration. Later it is the fuel costs which predominate. The factors underlying costs structure thus shift markedly over time.

(4) As the demand per consumer increases, load factors improve. This means that peak demands and thus the investments in

more capacity do not rise as quickly as energy demand. Typically, load factors may rise from 10-20% initially to 30-40% after 10 years, thus doubling the returns only at the cost of extra fuel.

3.41 The changes in demand, load factor and cost structure over time clearly have an important bearing on both the least-cost and the cost-benefit analysis. In most cases it will be necessary to estimate a time-stream of costs for the following items:

- Running costs, related to kWh sales. Fuel and variable costs of maintenance and administration, mainly.

- Capacity costs, related to kW peak demand. Generators, local distribution networks and, in the case of public supplies from the grid, transmission and subtransmission capacity.

- Fixed overheads. Administration, mainly.

(e) Cost-Benefit (IER) Calculations

3.42 As in other projects, the time-streams of costs and benefits need to be calculated on a present worth basis. Calculations of internal economic rates of return (IER) and cost-benefit ratios also follow customary practices.

3.43 Shadow price adjustments are, as usual, required to allow for distortions in the pricing system. We have found that the most important adjustments to make are for:

(i) Net tax revenues: - These are part of the Government's profit stemming from sales of electrical appliances and equipment, and also of electrical energy if the utility pays taxes on inputs or sales. These should be counted in on the benefit side (or deducted from the cost side); often they can be quite large if appliances are heavily taxed.

These revenues are offset to some extent by reduced tax revenues due to a reduced use of substitutes. Mainly, this is only significant for farms and agro-industrial demands which would otherwise use autogenerators, diesel engines and alternative sources of refrigeration.

(ii) Foreign exchange: - The usual shadow price adjustments need calculating when the balance of payments is in disequilibrium and/or if there is heavy protection. The penalty applies to electrical appliances and equipment as well as to the production of electricity.

The penalty is partly offset because substitute sources of energy and equipment are often imported. Again, the most significant cases are generally to be found in the demands of farms and agro-industries -- autogeneration, diesel engines, substitute sources of refrigeration.

(iii) Capital: - A specific adjustment may often be needed to allow for scarcity of credit. This affects, mainly, the sales of appliances and equipment and the costs of connection. Local inquiries may sometimes show effective rates of interest above the opportunity cost of capital. The profits made out of this do not, of course, accrue to the consumers but to the sellers; nevertheless, they are part of the monetary benefits.

(iv) Labor: - The main element here is to be found in construction of the networks, where unskilled labor costs may form about 25% of initial investment costs, depending on the difficulty of terrain. The excess of wages over the shadow wage of labor can be deducted from cost-streams. Since it is linked to investment rather than operations, the adjustment will be lumpy.

3.44 Evidently the calculation of shadow price adjustments requires good records and data about consumers. Items (i) and (ii), for example, require some knowledge of what consumers use electricity for, and item (iv) a study of credit. It is desirable to encourage utilities to record and take an interest in such data. It is useful not only for cost-benefit calculations and investment decisions, but also for efficiently running and promoting electrification programs.

3.45 The assumption of the analysis becomes clearer if each of the time-streams of benefits, costs and shadow price adjustments are listed separately, so that the cost-benefit tableau contains, for example:

Benefit Streams: -

- direct benefits to households (revenues);
- direct benefits to agro-industries, farms and commerce (revenues);
- surplus benefits to agro-industries, farms and commerce.

Cost Streams: -

- generation, capital costs;
- transmission and subtransmission, capital costs;

- local distribution networks, capital costs;
- generation, energy costs;
- administration and maintenance costs.

Shadow Price Adjustment Streams: -

- net tax revenues (deducted from costs, or added to benefits);
- net foreign exchange penalties;
- profits from credit rationing;
- shadow wage adjustments to labor costs.

The cost streams, of course, refer to the least-cost project.

3.46 Some demand statistics, on total demand, its division between productive and domestic uses, load factors and numbers of consumers might also be added to the tableau for explantory purposes.

(f) The Criteria for Project Acceptability

3.47 Most of the economic factors so far discussed act to increase the calculated returns to electrification. The economic picture is thus somewhat more optimistic than the financial one. Taking a long run view, for example, shows benefits rising faster than costs (this is not so apparent in the financial analysis which is heavily preoccupied with financing the initial investments, low short-run returns and high risks). Counting in the surplus benefits to farms, agro-industries and commerce will, if the demands for these "productive uses" are high, add quite significantly to the calculated returns. The shadow price adjustments will generally be favorable towards the project because tax revenues, and the shadow price adjustments for capital and labor are likely to be greater than the penalties on foreign exchange costs. (In the El Salvador study we have found that the net adjustment for shadow prices works out at about +30% of sales; the mark-up for surplus benefits to agro-industries, farms and commerce varies, but may average around 50% or more of sales to these consumers.)

3.48 After all such adjustments have been made, what should be the criterion for project acceptability?

3.49 Strictly speaking, it should be somewhat lower than the opportunity cost of capital because some social and economic benefits generally cannot be quantified but are nevertheless considered to be important. Among these are:

- The surplus benefits to households;

- the value judgment that rural poverty is unacceptable and some degree of subsidy is desirable;

- institutional benefits in that it is a stimulus to public and private institutions, as well as to the area itself, to take a stronger interest in the area's development; this should feed back positively on the returns to the project but to an immeasurable extent (an example of Professor Hirschman's dictum that the benefits of unintended side effects on institutions are often more far-reaching than those of the intended effects of policy); 1/

- the expected returns may be lower than the optimistic returns: but an optimistic view of the project should be taken: the social consequences of neglect in rural areas far outweigh the risks of limited success.

(Related to the last point is the observation by many countries that demand is often higher than expected; and as regards institutional benefits, it is commonly reported that the initiative of one institution leads to initiatives by others.) Such matters are clearly of sufficient importance for tolerance to be exercised when the quantified economic returns are somewhat lower than the opportunity cost of capital. The degree of tolerance will depend on the country and in particular on its fiscal strength.

3.50 How much lower than the opportunity cost of capital the IER can be permitted to go is a matter of judgment; only experience and discussion can decide. But there are several related arguments for not permitting it to go too low.

3.51 Firstly, if rural electrification is to contribute towards the economic output and wages in rural areas, it must be couched in a productive context. Where it is, the demands from agriculture, agro-industries and commerce will be large, and the revenues and surplus benefits from these should provide a good economic return to the investment. In this respect, electricity is simply a factor input to agriculture and rural commerce, so the economic returns should be comparable to other investments in these sectors. Indeed, on a good project with strong demands from these consumers, the IER may often exceed the opportunity cost of capital and there will be no need to invoke the above arguments.

1/ "A Bias for Hope" - A. O. Hirschman, 1970.

3.52 On the other hand, where the IER is low it is a sign that demands for productive uses may be low and that its contribution towards raising productivity and incomes in the areas is limited.

3.53 Secondly, and closely related to this, is that it may signal that there is insufficient attention to the development of local infrastructure and agriculture: poor or no credit for example, or bad roads. Electricity is only one of many factor inputs needed for development. If the complementary inputs are neglected, the contribution of electricity to development is diminished.

3.54 Thirdly, low economic returns can also lead to disillusionment among both investors and, perhaps more important, consumers. One reason for this is that even subsidized electricity and the appliances to use it often cost far more than consumers anticipate; this can be an exceptionally unwelcome setback for low income households and a high rate of disconnection results. Another reason is that where development is expected but not realized there is cynicism (our study in El Salvador and an AID sponsored study in Costa Rica and Colombia have found solid evidence of this).

3.55 Fourthly, where there is a strong demand from households and businesses, a low IER probably indicates that tariffs are too low and wrongly structured. Many of the larger household consumers in villages are often above average per capita incomes, while many of the larger farm and business consumers make quite good profits. It is invariably the case, however, that subsidies continue, even though such consumers are able and willing to pay more. Tariffs can be restructured so as to help the lower income groups more while enabling the utility to earn a better financial return and extend service more widely.

3.56 Fifthly, the basic reason for a low IER is low levels of use on a high cost project. It is possible in such cases that a least-cost solution has not been found. Low demand stemming from simple uses like lighting, ironing and one or two refrigerators in village shops, can be met by small diesel or micro-hydro powered autogenerators at relatively low costs. When such alternatives are adopted, the economic rate of return is not only good but the schemes are often financially profitable.

3.57 Finally, there is the obvious point that a low IER signifies an inefficient investment and, perhaps, wrong priorities. For the $250,000 or more which it may cost to electrify about five villages, good water supplies may be provided; alternatively, respectable improvements to the access roads can be contemplated (this has the added advantage of cutting the costs of electrification significantly); or schools and health centers can be built -- villagers generally list these to be higher in their preferences.

3.58 In sum, the economic return calculation provides some useful messages. A high IER signifies a good investment. An IER somewhat below but approaching the opportunity cost of capital deserves tolerance since there are several benefits of importance which cannot be quantified. Low and very low IERs on the other hand may signal an ineffective project, wrong priorities and the possibility of disillusionment.

3.59 It should be added that postponement or rejection of electrification projects until priorities are sorted out need not lead to disaster -- as with rural water projects in drought areas for example. Farms, agro-industries and commerce can and do turn to useful substitutes in the form of diesel motors and autogenerators, and households are well adapted to using substitutes and doing without electricity.

(g) Pricing Policy

3.60 Pricing policy, like investment policy, has to take into account the social and economic aims of the program. In addition, financial obligations have to be designed and met for various reasons -- fairness to investors and other (non-rural) consumers; to reduce the burden, such as it exists, on the public revenue; and to enable the utility finance, and perhaps widen the scope of its investments. To reconcile these various requirements of pricing policy, the most appropriate approach is to proceed in four steps (as outlined in the references in Annex 1):

(i) Estimate the structure of marginal costs;

(ii) decide on the form of a metering and tariff policy which may practically reflect this structure in one or two respects; this will meet efficiency aims;

(iii) incorporate any fairness aims into the pricing structure; and finally;

(iv) place any further financial burden on those elements of tariff structure so as to minimize any adverse impact on fairness and efficiency.

A few remarks can be made on each of these steps.

3.61 The marginal costs of reinforcements and extensions to capacity, in order to meet increased demand, are well below (less than 50% of) average costs for the first 10-20 years of a project on account of the high initial fixed costs. Economies of scale and increasing consumer density also act to reduce the long-run marginal costs once an area is electrified (note again the cost estimates provided earlier in 3.37 et. seq.). For many years there is also excess capacity in the sub-transmission and distribution networks. In principle, efficient use of the services should not be held back by high sunk costs. Hence, there is an economic rationale for not demanding too high a financial return on assets, at least in the early years. (This is also desirable in the interests of promoting the project.)

3.62 As far as possible, there should be some steadiness in pricing policy. For this reason, it is best to take estimates of the long-run marginal costs (or average incremental costs) of future reinforcements and extensions and expansion -- of generation, transmission, sub-transmission and distribution -- as an initial basis for pricing policy calculations.

3.63 Metering and tariff policies have to be simple for most consumers. Complicated tariffs bewilder most people, and advanced metering is often too expensive. For most domestic consumers in rural areas, and for a good number of small business consumers, a flat rate tariff, accompanied as necessary by a fixed charge (which could serve revenue raising purposes or as an incentive to economize at times of peak demand) will do. Where metering and billing costs are very high, a device to reduce them is to eliminate meters and introduce a fixed charge, related to the setting on a simple load limiter, for very small consumers; however, this arrangement is only suitable if fuel costs are not high, for it encourages wasteage of energy. Seasonal variations in tariffs -- "wet" and "dry" seasons -- may be contemplated if there tends to be energy shortages in the dry season. For the larger farms and agro-industrial consumers more complicated metering (such as time-of-day for irrigation and other uses) may be considered.

3.64 The widely adopted system of declining-block tariffs to all consumers has several defects, and its application in rural areas should be questioned. Small household consumers don't understand it, it doesn't exploit willingness or ability to pay and so keeps financial returns down, and it has no obvious economic merit.

3.65 Fairness aims can be incorporated by providing concessions on one or more of the elements of the tariffs at low levels of consumption. Devices which can be used are a low first block followed by a higher flat rate in excess, say, of 50 kWh/month, a low connection cost to small consumers, and concessions on fixed charges.

3.66 If it is desired to raise financial returns further, while minimizing the impact of tariff increases on efficiency and fairness, increasing the fixed charges to large consumers and/or raising the flat rate at high levels of consumption are obvious devices.

3.67 Pricing policy clearly has an important bearing on the social and economic aims of the investments. It is nevertheless true that most pricing policies are a direct contradiction of these aims. Generally, the larger consumers get subsidized the most in tariff systems unrelated to economic aims and which also undermine financial performance. Pricing policy will, therefore, require thorough attention during appraisal, not only from the viewpoint of finance, but also from the viewpoints of fairness and efficiency.

(h) Provisions for Low Income and Small Business Consumers

3.68 Concessions to these consumers are of course helpful but the income distribution impact is small in relation to household or business income. The cost of electricity rarely exceeds 2 to 5% of the household or the business budget, even in rural areas (see Table 3.1 for example). There are two further points to bear in mind: (i) the larger businesses are often making good profits and there is no need for concessions; they are often willing and able to pay more and by being expected to do so will help financial performance; (ii) similarly, as remarked earlier, many household consumers in rural areas are also able and willing to pay more.

IV. PROJECT IDENTIFICATION AND PREPARATION

4.1 Perhaps the single most important factor which determines a program's success is care and thoroughness in identifying and preparing projects -- identifying the areas to be served, working out the investment plan, choosing equipment and designing networks so as to keep costs down and the continuity of service to satisfactory level, and attending to all the financial and institutional matters which will enable the program to be expanded and run efficiently. Project appraisal and justification, in a broad sense, is nothing more than establishing if the groundwork on these matters has been properly done.

4.2 This section discusses the economic side of identification and preparation, while later sections deal with finance, technology and institutions. The discussion begins with the problem of:

a. Defining Project Areas;

and then turns to:

b. Identifying Areas for Investment;

c. Working Out an Investment Plan;

d. The Relation Between Rural Electrification and Rural Development Plans;

e. Uncertainty and the Need for Experimentation and Evaluation; and

f. Pricing Policy.

(a) Defining Project Areas

4.3 One particular problem of identifying and appraising projects is posed by the very large number and interconnectedness of projects to be considered. It is particularly troublesome if the village is defined to be the unit for project evaluation. Even small countries have several thousand villages. Roughly speaking there are two to four thousand villages for each million of rural population, so that a country with a rural population of 30 million may have about 100,000 villages (as in Mexico for example). It is too much to expect (or to ask) that appraisal can be rigorous and comprehensive in each of these cases: it is also unnecessary.

4.4 Generally it is better to think in terms of the best way of introducing electricity into a region or zone, and then to calculate the overall costs and benefits of electrifying the region. One reason is that most of the non domestic consumption stems from outside the villages--irrigation is an obvious example, but it is also widely the case, for example, for the processing of rice, sugar, coffee and cotton. Villages are major demand nodes, of course, but so are demands outside the villages. Another reason is that the appropriate unit for economic analysis is the region rather than the village. It is an analysis of a region - of its demography, agriculture, wage levels, agro-industries, commerce and general infrastructure - which will give the main indications of the desirability of introducing rural electrification.

4.5 There are also technical and administrative reasons for thinking in terms of a region. Plans have to be made regarding the locations and capacity of substations and transformation points, the various voltage levels of subtransmission and distribution, the type of automatic protection equipment, and the routing and interconnection of the circuits between the various demand nodes. (Most lines and substations in any case serve not one, but several demand nodes.) Administration, maintenance and billing procedures also need to be worked out on a regional basis. Costs can be reduced considerably by coordinated planning rather than ad hoc piecemeal extensions in a region.

4.6 So generally it makes sense to enlarge the definition of the project and to relate it to the problem of electrifying a region or zone. In doing so, there are two sources of error to guard against. The first is that this procedure does not of course imply electrifying the whole region. There will be many demands not worth bothering with because they are to small and remote from the main demand nodes. Other demands can wait until the networks have been constructed to meet the more important demands; after this, extensions to neighboring demand nodes can be accomplished at low marginal cost.

4.7 The second source of error to guard against is that the sizes of the regions chosen for analysis should not be too large, otherwise control can be lost. The aggregate return can be held down heavily by a number of, for example, ill-chosen extension projects. One thing that is apparent is that some places are emphatically worth electrifying and others are emphatically not; but the latter are often electrified and this detracts not only from the merits of the former, but often from the whole program.

4.8 As in many other aspects of this work, the actual size of the region defined for study, and thus the 'size' of the project, is a matter of judgement. It is influenced by the availability of data, by the structure of economic and political institutions for regional administration as well as by project technicalities. Each of the following has to be considered:

- A similar problem occurs in arranging for local administration of the project. Within the region, local administration may be responsible for promoting the project and making arrangements to bring new consumers into the system, for billing, reporting faults, keeping records and perhaps undertaking some local engineering and maintenance work. They will, therefore, provide the information base for future extensions and supervision.

- Many countries are divided into a number of economic and political administrative districts, and it will often be useful to follow this division. Indeed the institutional framework (for local administration) is often best designed round such districts because it gives the districts a more direct involvement with the project and its success. Finally, the census and economic data are often classified according to such districts.

- Once the major demand centers have been identified, the network design will follow and it is often quite obvious on site how large the region should be from the viewpoints of expansion planning, administration, and thus of project identification and evaluation. Very often, these considerations may lead the utility to group several districts together.

(b) Identifying Areas for Investment

4.9 Having decided that it is best to evaluate projects on a regional or zonal basis, how is it decided which regions or zones to electrify and at what rate?

4.10 In answering this question, the obvious point to keep in mind is that the projects identified must eventually pass the appraisal test. From an economic viewpoint, then, the short answer is to choose regions which are likely to offer satisfactory economic rates of return to the investment, where the calculation and criteria are as discussed in Section III.

4.11 From this it follows that the projects should be in regions where reasonably strong and growing demands might be expected for the service, and where the resulting benefits can justify the costs. In general this will be the case for regions where:-

- the quality of infrastructure, particularly of roads, is reasonably good;

- there is evidence of growth of output from agriculture, and where, therefore:

- there is evidence of a growing number of productive uses in farms and agro-industries;

- there are a number of large villages, not too widely scattered;

- wages and living standards are improving.

- there are plans for developing the region;

- the region is reasonably close to the main grid (though if demand is particularly strong, remote regions may be considered too).

4.12 Such information about the region merely indicates the likelihood of useful investment. The first test will come where some rough estimates of demand and costs are made. From the demand estimates, the revenues and the consumers surplus benefits to non-domestic consumers can be estimated -- again, rather approximately. If the economic returns look reasonable, subject to all the allowances discussed earlier (in III) for social aims and for the economic benefits which cannot be quantified, a more thorough plan can be worked out and appraised rigorously.

(c) Working Out an Investment Plan

4.13 Generally, several alternative plans have to be considered in the interests of ensuring that (i) reasonable demands have not been excluded from the plan; (ii) unreasonably low demands have not been included when the costs of inclusion are high; (iii) the proposed expansion plan is not too fast or too slow; and (iv) that a least-cost plan has been determined.

4.14 In the case of regions which are to receive electricity from the grid for the first time, the first phase of an electrification plan consists of pilot projects -- unless there is good information about the use of auto-generators in the area indicating that demand is likely to be strong. This provides the necessary information and experience for future expansion, and for flexibility in decision making.

4.15 Both the pilot projects and the early phases of electrification concentrate on the main demand centers; subsequent phases extend the network to the smaller villages, and to new farm and agro-industrial consumers. Evidently, the early appraisals for electrifying the region need to make some allowance for the net benefits of subsequent extensions.

4.16 Following the pilot projects and the decisions to construct the main networks, decisions about subsequent reinforcements and extensions can be made on an incremental basis, as the demand develops, through a comparison of incremental returns with incremental costs (an exercise which can be left in the responsibility of the distribution engineers, say, rather than central management). This permits flexibility in decision making and enables the engineers to match investments and capacity more closely to the demand. The ground rules for decisions to extend the networks can often be stated quite simply: for example "the expected revenues, once the demand has developed, should be greater than (a) the annuitised capital costs of extension, plus (b) local running costs, plus (c) costs of bulk supply." Cost-coefficients for (b) and (c), per kWh of demand, and the appropriate annuity rate need to be specified.

4.17 Summing up, the investment plan generally begins with a pilot project followed by a more comprehensive network plan which is:

- the best of alternative proposals regarding which demand centers to connect up (in the early phase); and

- the least costly of alternative layouts and designs to connect up these centers.

Subsequent reinforcements and extensions can be decided on an incremental basis.

(d) Rural Electrification and Rural Development Plans

4.18 The returns to rural electrification increase with the level of development in rural areas. On the cost side, improved roads reduce the costs of construction, maintenance and administration of the electrification programs. On the benefit side, there are several inter-relationships, as follows. Rural development programs raise the level of output in agriculture and agro-industries, and through this the level of rural incomes. On account of increased incomes and improved infrastructure, commercial activity increases. Together, the growth of incomes and the growth of agriculture, agro-industries and commerce create increasing demands for power and energy. These demands can be met by public supplies from the grid, local autogeneration or substitute sources of power and energy. Which of these alternatives is best will be revealed directly by the calculations of the costs and benefits of public supply, the reason is that these calculations involve a comparison of public supplies with the alternatives.

4.19 Hence the economic rate-of-return calculation also provides a measure of the need for the project when there are plans for developing the area at public, private or local initiative; that is, it indicates if the electrification project fits into the rural development plans for the area. The main effects of such plans are, as just indicated, to raise the expected economic returns.

(e) Uncertainty and the Need for Experimentation and Evaluation

4.20 Uncertainty, and the related problems of information shortage and inexperience, can only be reduced through concrete experience and evaluation. This rather obvious point is the main reason for beginning with pilot projects. As a general rule:

- in countries without a rural electrification program, and where there are good grounds for embarking on one, experimentation is a necessary first step; this will generate information and experience for the subsequent program;

- in countries with programs, evaluation may be encouraged as a basis for improvements.

4.21 Part of the task of project preparation is to identify the need for and define the scope of such experiments and studies. One particular requirement is to keep their size within reasonable bounds and concentrate on what is relevant. A common occurrence, for example, is for the studies to become very large, costly and time consuming; often much can be accomplished by elementary investigations which concentrate on a few items such as:

- demand analysis;
- cost analysis;
- effectiveness of various management and promotional procedures;
- descriptive studies, for projects in selected areas, of the development of local agriculture, agro-industries and commerce; of the living standards of households and the community; and of how these relate to project performance.

If the utilities keep good records, all the project-related information should be available. If it is not, a start should be made to keep good records. (In many countries with rural electrification programs, records are not good, even on obvious things like demand and costs.)

(f) Pricing Policy

4.23 During project justification, it is necessary to show that pricing policy is satisfactory, as discussed earlier. During the preparatory stages, the main work will be in estimating the long-run marginal costs, selecting a simplified metering and tariff system, and then working promotional, social, and financial aims into the cost structure. In practical terms this results in:

- prices that are higher in rural than in urban areas;
- prices well below average costs in the early years, on account of the high initial fixed costs (and also to help promote the project);
- some degree of cost recovery in later years; and
- low tariffs only at low levels of consumption.

Decisions on the price levels and structure are generally less flexible than investment decisions, on account of the exceptional unpopularity and difficulty of effecting price changes. For this reason it is necessary to get the pricing policy into a satisfactory shape during the early stages of the program.

V. MEANS OF FINANCE

Financial Goals

5.1 The financial characteristics of new or expanding programs are such that the initial investment should be financed by some combination of debt, grants, equity or internal funds of the utility which results in a relatively "soft" blend for the capital structure of the program; long grace periods are also required. The reasons for this are: (a) the long gestation period before demand and revenues build up to reasonable levels, and (b) the various economic, promotional and social constraints also acting on pricing policy. Often, these factors are made more difficult, and the financial returns worse than they need to be, by ill-structured prices. But even with suitable reforms to pricing policy, funding on soft terms is necessary. In practice, the kind of financial goals that might be achieved would evolve with the level and growth of demand:

- initially (say, during the first 3 or 4 years) revenues could generally be expected to service debt (assuming the soft blend as suggested above);
- in subsequent years, revenues may generally be sufficient to make an increasing contribution towards the costs of expansion (sufficient in magnitude perhaps, on some projects, to meet a good proportion of the capital required, and to give a good internal financial rate of return to the project).

But such achievements would depend on the level and growth of demand; reforms to pricing policy; well-prepared and well-run projects; and also a systematic follow-up on projects to insure that financial targets are raised as soon as circumstances warrant.

5.2 As a matter of principle, then, it should not be assumed that costs cannot be recovered over the life of the investment; but whether or not they are will be determined by the pricing policies of the agencies involved. During project preparation and appraisal it is thus necessary to review the financial targets bearing in mind:

- the financial needs of the program;
- the effect of the program on the utility's overall financial performance,
- the fiscal strength of the country; and
- the economic and social objectives of the program.

Domestic Finance

5.3 In the early years of rural electrification projects, average costs are exceptionally high -- perhaps three or more times the average costs of urban electrification projects. Though average prices are generally higher than in urban areas, they have to be kept down as far as possible in the early years in the dual interests of promoting efficient use of the project and meeting social aims. The transition to the point where average costs fall below prices, and for cost-recovery to begin, may take 5 to 15 years on quite good projects - larger, of course, if the social aims are strong or prices are poorly structured. Furthermore, as the programs expand, the low financial returns on assets of new projects offset financial gains which may be appearing from the older projects.

5.4 The result is that continual financial assistance is required on new or expanding programs. On the domestic side, the main sources of financial assistance are:

(i) Funds from the government, either as cash grants or as loans at low interest rates;

(ii) Funds generated internally in the utility through general tariff increases to urban areas or to the country at large; or through cost reductions as the utility expands;

(iii) Raising and restructuring tariffs in rural areas;

(iv) Offering bulk supplies to the distributors at lowered prices;

(v) Local contributions in kind (e.g. "self-help" in the form of unpaid local labor).

Private sector finance is of course ruled out for some time on account of high risks. The last two items are only of indirect help, and mainly on expanding programs, since they reduce the financial burden rather than raise funds. Combinations of (i) to (v) are often used. What are their merits?

(i) Government Funding

5.5 Grants and low interest loans from the government have particular advantages in large countries where the supply and distribution of electricity may be undertaken by several independent regional utilities. It can be used to help the more backward regions, as a lever on the less innovative utilities, and to promote cooperation between regions. This system is used in India, under the administration of the Rural Electrification Corporation (REC). Apart from its success in deflecting capital to the more backward regions, it has also promoted some degree of coordination in policy, including equipment standardization, and a considerable interchange of ideas and experience.

5.6 The case for this source of financing is stronger the greater the fiscal strength of the country. When the public revenue is heavily burdened, however, it is practically necessary to turn to other sources. One of the more copious of these is internal cash generation.

(ii) Internal Cash Generation

5.7 Tariff increases to urban consumers, or to the country at large, can raise funds on an enormous scale. In many countries, tariff increases have been highly successful in providing capital to finance the very large investment programs of electric utilities; for many years the encouragement of this has been a cornerstone of Bank policy. There is no reason why a similar policy cannot successfully serve a similar purpose in financing rural electrification. Only a small increase in the average level of urban tariffs can provide funds for quite ambitious programs of rural electrification. Roughly speaking, when rural electrification takes 10% of total investment, a 5% increase in general tariffs will meet 50% of annuitised investment costs.

5.8 The same effect can be obtained as the system expands by keeping prices constant, apart from adjustments for inflation. The reason is that average costs in utilities generally decline (in real terms) with system expansion. The extra profits this leads to can be used to finance rural electrification.

5.9 The device of using internal cash generation is evidently worth pursuing if other sources are difficult to tap. An economic argument can be advanced in its favor in that it is consistent with the general aims of promoting urban-rural balance. Also, it can be adapted to a variety of institutional arrangements. Where electricity distribution is administered through several independent utilities, it can take the form of a trust fund to be redistributed through some central agency. Where electricity supply is the responsibility of one national organization, the transfer is internal. And where, for example, distribution is through cooperatives, soft loans or straight cash grants can be offered to them.

(iii) Increased and Restructured Rural Tariffs

5.10 Generating funds, or reducing the need for them, by increasing or restructuring tariffs may seem a contradiction - if this can be done, why the problem of finance in the first place? Mainly it is a question of degree: while the problem of finance is genuine, it appears that it is made far more difficult than it should be by badly structured tariffs that even conflict with the social aims of the programs. This is so even though tariffs in rural areas generally are higher than those of urban areas. The two most common defects of tariffs are:

- excessive use of declining block tariffs (which do not correspond to marginal cost structure);

- low tariffs are often offered to large consumers who are able and willing to pay more.

Flat rate or two-part tariffs, redesigned to pass on more of the financial burden to larger customers, can result in very useful improvements in financial returns. (It is necessary not to go too far in this regard, of course, since large consumers can and sometimes do opt for the alternative energy sources if the flat rates are set too high above the costs of supply.)

(iv) Low-Priced Bulk Supplies to Rural Areas

5.11 The device of selling electricity at low prices to the electricity distribution agencies in rural areas is also useful, and it can help them function on a normal profit and loss basis. (It is pointless to apply it, of course, if generation and distribution is undertaken by the same entity.) But the device has its limitations. The capital and running costs of generating and transmitting electricity - that is of providing supplies to distributors - are less than 40% of the total cost of providing supplies to rural areas. So if electrical energy were sold in bulk at half price to the distribution agencies, it would only cut their costs by 20%. This is helpful, but generally it is not sufficient.

5.12 One other limitation of this device is that it is not very helpful in raising the capital initially required for electrification: its effectiveness is after the investment, not before, so that its resource mobilization function is weak. Nevertheless it can help financial viability and reduces the funding requirements for the expansion programs of distributors.

(v) Local Contributions

5.13 Local contribution in the form of unpaid labor, materials and capital are also helpful, if limited in scope; they also engender more local interest in and appreciation for the area's development. As regards unpaid labor, however, the question should be raised if, through sensible financial policies, there is the means to pay for it; it is provided by the lowest income groups and the idea of not paying them should not be accepted lightly.

A Comparison of Domestic Sources of Finance

5.14 The main sources to consider will be the public revenue, general tariff increases and raising or restructuring tariffs in rural areas. The latter is worth considering in its own right if only to reconcile the three viewpoints of efficiency, fairness and finance, as discussed in Part III (paragraphs 3.60 et. seq.). But there is a distinct limit to this device, which in any case cannot be expected to raise funds in the early phases of the program.

5.15 Hence the public revenue or internal cash generation must be invoked. Internal cash generation has the advantage of giving the utility added autonomy in expanding and running the program. Apart from this, the choice is one of acceptability rather than economics, since the public sector could obtain its funds from a tax on electricity, and might even be doing so. Taxes may be unpopular, however, while price increases can be sneaked in during inflationary adjustments, or may even be acceptable if the intent of the increase is announced; internal cash generation through the occurrence of cost reductions as the system expands may, on the other hand, pass unnoticed. So the choice is a matter of politics, and will depend on the country's fiscal strength and the acceptability of one device or the other.

International Finance

5.16 Several countries have approached the Bank for finance of rural electrification. Also, on account of the low financial returns, and of the difficulty of raising funds, the suggestion has been made, sometimes explicitly, that the loans should be on soft terms as are AID and IDB loans. However, the justification of IDA credits reflects international inequalities in incomes, whereas the justification of soft loans for rural electrification reflects national inequalities. It has been shown that the latter problem can be met by appropriate tariff and financial policies within the country. Hence there seems to be no grounds for altering IDA policy except to note that when a country qualifies for IDA credits, well-conceived rural electrification projects would sometimes provide a good and productive use of them.

VI. TECHNICAL PROBLEMS

6.1 The distribution networks for rural electrification normally have five basic elements:

(1) High Voltage/Medium Voltage Substations (Typically 150/44 KV) comprising: high voltage connections to the main grid; transformation to intermediate voltage levels for medium voltage distribution over a wide area; switchgear and automatic protection devices to isolate the network or parts of it in case of faults or of maintenance needs, medium voltage outlets.

(2) Medium Voltage Sub-Transmission Networks.

(3) Medium Voltage/Low Voltage Substations (Typically 44/13 KV) comprising: transformation to low voltage levels for distribution over small areas; switchgear and automatic protection devices to isolate the network or parts of it in case of faults or of maintenance needs; low-voltage outlets.

(4) Low Voltage Distribution.

(5) Transformation to service voltage levels appropriate for use by households, commerce, agro-industries and farms at points close to these loads. The larger consumers may require their own transformers, but for households one transformer may serve e.g. one or more streets.

Occasionally, one of the transformation stages may be left out, depending on the area covered, the load density and the proximity of the main grid.

6.2 This technology is standard, though the design and layout of the networks and the choice of voltage levels, equipment capacities, protection devices, etc. require engineers of considerable experience and skill. (Most of the engineers within the Bank are versed more in generation and transmission planning, so that it would be desirable to increase staff experience in distribution network planning if the intention is to invest in this area, as discussed in VIII.)

6.3 Costs can be cut substantially by careful attention to design and standards of supply. When deciding if a particular arrangement is appropriate, it is useful to raise a number of questions of the following type:

a. Are small local auto generators cheaper than connection to the main grid? For small and/or remote demands, diesel powered generators or, if water is available, micro hydro units, are often better. (One particular problem to take into account with regard to diesels is the problem of maintenance; most countries report unfavorably on this problem which stems from the shortage of skilled operators.)

b. Are equipment and procedures sufficiently standardized? Many countries report substantial cost savings by standardizing on voltages, on equipment and on construction and contract procedures.

c. Are equipment standards too high? Lower design standards with regard to the construction of overhead lines and equipment are things to look for.

d. Closely related to (c), can more interruptions to supply be permitted? If so, design standards and the extent of standby capacity (in circuits and equipment) can be reduced. The reliability of very basic networks may often be quite high. Added protection and standby capacity might be justified for the larger loads, when the costs of interruptions are high (as in urban areas, but to a much lesser extent in rural areas).

e. Can the capacity of the networks and their equipment be matched more closely to the demand? Extending and reinforcing the networks and changing equipment as the demand develops, are obvious procedures. Though they are commonly practiced, it is not uncommon to find considerable excess capacity in the networks -- sometimes enough to meet 20 years growth in demand, for example.

f. Can costs be reduced by further attention to network layout? Often, careful routing in relation to the demand nodes, difficulty of terrain, quality of roads and other factors can further reduce costs. A further possibility is to increase substation sizes and reduce the number of substations or vice versa.

g. Is the strategy of network extensions sensible? In many instances costs are too high because the initial networks cover too wide an area; many of the fringe areas (including fringe areas of villages) would best be electrified later, once the demand has developed.

h. Can demand be met through one or two phases for a time, intead of three phases? This, too, cuts costs.

i. Is the choice of voltages and numbers of transformation stages correct?

j. Can mobile generators be used, at low demand levels, until demand levels justify permanent service? (these are then transferred to other areas).

Large cost reductions have been reported by thorough attention to these matters.

VII. INSTITUTIONAL PROBLEMS

7.1 The interdependence of the many elements of an investment program is such that the program's success can be undermined by a failure in any one of them. This is also the case for the institutional arrangements to run the program. At the local level of responsibility, for example, negligence in billing or a lack of trained personnel to repair faults, can discredit the program within the locality. At a more central level of responsibility, inappropriate directives as to which areas to electrify, for example, or bad pricing policies, may eventually discredit the program nationally, however well attended to the other aspects of the program may be.

7.2 Analysis of institutions therefore requires a careful look at each of their elements. In discussing this problem, it is convenient to classify the elements in terms of who is responsible for them -- that is, in terms of organization.

Tasks and Responsibilities of the Institutions

7.3 The diversity of tasks connected with rural electrification programs is such as to require special institutional arrangements at all levels of economic administration: namely, at the levels of:

(i) The Government;

(ii) The Electric Utility; and

(iii) Local Administration in the Rural Areas.

The division of responsibilities between these three levels depends partly on the situation and partly on the nature of the tasks. Table 7.1 lists the more important tasks and how they are sometimes allocated, though the allocation obviously changes from case to case.

Table 7.1

Typical Tasks and Division of Responsibilities in Rural Electrification Programs

TASK	MAIN RESPONSIBILITY OF: 1/ Public Sector	Electric Utility	Local Administration
1. Tariffs	*	*	
2. Finance	*	*	
3. Economic Analysis and Linkage with Development Aims	*	*	
4. Program Directives and Ground Rules	*	*	
5. Forecasting		*	
6. Identifying Markets		*	*
7. Engineering Planning		*	*
8. Equipment Procurement		*	*
9. Construction		*	*
10. Maintenance - identification			*
- repairs		*	
11. Standardization		*	
12. Promoting Regional Cooperation	*	*	
13. Training		*	
14. Supervision		*	*
15. Accounting		*	*
16. Record Keeping		*	*
17. Billing			*
18. Consumer Relations			*
19. Promotion		*	*
20. Provision of Credit (to consumers)		*	*

1/ An asterisk in two columns indicates that the task may be performed jointly, or by one of the two.

(i) The Government

7.4 Where the country has a singificant rural development program, there is clearly a need for the public sector to take an active interest in order to promote coordination between investment in related sectors, particularly in agriculture, agro-industries and other rural infrastructure projects such as roads, schools, water and health. In addition, where the country is large and electricity is generated and distributed by independent regional utilities, a central government agency (such as the REC in India) may be needed to promote standardization, cooperation between regions and a regional balance in the rural electrification program.

7.5 A further function for the public sector is to provide general directives and ground rules for tariff and financial policies, the allocation of funds, and the criteria to be used for project appraisal and selection. This is traditional, of course, except that the scope of the directives and ground rules needs widening to cover the special problems of rural electrification.

7.6 Much of the public sector's involvement need only be indirect if the ground rules and directives are well laid, and also if there is more reliance on pricing policy and less reliance on the public revenue as a means of finance.

(ii) The Electric Utility

7.7 Much of the public sector's policy of course needs to be worked out jointly with the utility, as is customary, particularly as regards tariffs, finance, the levels of investment and which programs are practicable.

7.8 Many other tasks can only be the exclusive responsibility of the utility (though some are occasionally delegated to local administration). These include forecasting, engineering design and construction, deciding on what quality of service is appropriate, maintenance, accounting, procurement and contracting, centralization of records, standardization, promoting interchanges of ideas and experience between areas, providing advice and supervision, and providing facilities for training the personnel of the local administrative units. In addition, the utility may assume the responsibility for promoting the service, provide credit, and undertake the job of connecting consumers to the networks.

(iii) Local Administration in the Rural Areas

7.9 In some countries the extent of local administration is minimal, its function being to look after billing, record consumer requests for connection and report on local problems such as electrical faults, maintenance needs and consumer complaints.

7.10 Other countries place far more emphasis on local administration. This is the case where co-operatives are established, as in Costa Rica, Colombia, Nicaragua and about ten other countries. It is also the case in Mexico, for example, where the Co-op system is not used, but large regional offices are established (one in each state) under the joint leadership of technically qualified personnel and local officials. The primary purpose of such arrangements is to enable a close contact between consumers and the supplier to be attained. The local administrations identify new areas to be served and work out an electrification plan with representatives of the villagers and businesses. They have the responsibility of promoting and extending service, and perhaps of supplying credit. In addition to this and to the routine work of billing, keeping records and looking after consumer complaints, they may also take on a good deal of the engineering construction and maintenance work, and look after accounts.

Which Institutional Arrangement is Best?

7.11 At the moment, there is no clear answer to this question. The main debate is about the extent to which the responsibilities just outlined should be delegated to local administration. It is sometimes said that the utility can provide this quite well with the added advantage that the more talented and motivated people can, in working at the center, spread their efforts more widely. On the other hand, close contact with consumers and care in identifying the needs of the area are clearly important, and local administration is in principle best suited for this. Also, delegated responsibility is reported to have provided a spur both to efficiency and to an interest in the project's success, in some of the countries visited by staff members. It is probable that a greater responsibility should be placed on local administration the larger and more populous the rural areas, even if it is only because central administration by the utility is too costly and difficult in these circumstances.

7.12 But there is in fact little evidence to show that one approach works better than another. A recent AID sponsored study in Costa Rica and Colombia found that consumers were indifferent between the co-ops and the utility serving them; all that mattered was good service. 1/ In this sense the merits of Co-ops and other forms of local administration, as compared to the merits of supply from the utility, rest on the incentives to good management rather than on the incentives to consumers (which is one of the benefits which Co-ops are thought to have).

7.13 In practice it is necessary to be flexible in deciding on the form of organization. On the one hand, several arrangements may work well; on the other, different arrangements suit different countries and cultures.

1/ It was found, however, that theft of electricity was lower in a Co-op arrangement because it was resented by consumers (who were of course members of the Co-op).

Analysis of Institutional Problems

7.14 To identify institutional problems it is probably a good idea to make a checklist of the kinds of tasks listed above in Table 7.1. The questions can then be asked: how well is each task being performed? and what steps can be taken to improve those that need improving? The answers to these questions may sometimes point to specific actions, such as "more funds should be provided for training personnel" (often cited as a bottleneck) or "records should be better kept on project performance" (another commonly neglected matter). Alternatively, the answers may point to the need for major organizational changes.

VIII. IMPLICATIONS FOR BANK POLICY AND PROCEDURES

The Need for Development Assistance from the Bank

8.1 The possibilities for development assistance from the Bank in rural electrification were first enunciated in the Sector Working Paper on electric power. Subsequent studies undertaken by the Bank in this and related fields have also pointed to a need for a widening of the Bank's aims in its investments in the electric power sector and to relate them to rural development policy. Finally, over 25 countries have formally or informally urged the Bank to provide assistance, both technical and financial.

8.2 Although development assistance is being provided in this field by AID and IDB, it is generally accepted that assistance needs expanding upon. By 1973, the financial aid provided by AID and IDB, who began efforts in 1964, amounted to $230 million in 14 countries. In contrast, countries in the Bank's sphere of operations are to invest perhaps over $10 billion in the next ten years, that is, about 10% of total investment in electric power.

8.3 It is also a field in which the Bank has a comparative advantage for development assistance. The programs to electrify rural areas (and also low income areas of cities) are for the most part being undertaken by institutions with which the Bank has had highly successful associations for many years. Rural electrification, which has so far formed a small but increasing fraction of their past investments, is a new dimension with new challenges and likely to form a larger and significant portion of future programs. Generally speaking there is a strong commitment to rural electrification and a desire to make it successful.

Prospects for Successful Projects

8.4 The main case for development assistance, however, must rest on the desirability of rural electrification. In this regard, it is apparent that in many rural areas, there are only a few elementary needs for electricity and the high costs of public supply from the grid cannot be justified; in such areas, these needs are best served by local auto generators or by substitute energy forms.

8.5 However, there are also areas where there is scope for successful investment. In areas where there are clear signs of rural development taking place, as a result of public and private investments in agriculture and agro-industries, and public investments in local infrastructure, electrification can often augment development. It can usefully add to the profitability and output of farms, agro-industries and commerce through providing a superior and cheaper means of motive power, lighting, refrigeration and, for some purposes, heating; and it can serve a number of uses in households, even at quite low levels of household income. The evidence for this is the often strong response of rural households and businesses to electrification projects, reflected in sustained high rates of growth of demand from all categories of consumers, though from low initial levels.

8.6 Furthermore, the growing emphasis on rural development in many countries will, as shown earlier, react positively on rural electrification projects. Finally, it is also probable that, as per capita incomes increase in developing countries, some of this increase will filter through to rural areas, partly due to increased urban and international demands for rural products and partly due to improved economic linkages between urban and rural areas; this process will also generate increasing rural demands for energy and thus for electricity.

8.7 Nevertheless, there are the familiar difficulties of investment in rural areas. Response, though often much better than expected, is very uncertain. Project justification and identification requires information from the utilities and about rural areas that is often hard to find. Costs are high, and a lot of care and ingenuity is needed to keep them down. Finance, as usual, is difficult to find, and requires, on the domestic side, hard compromises between pricing for efficiency, social and financial needs in rural areas, and at the national level, between utility pricing policies and the public revenue. Finally, institutional failures may discredit the programs in the rural areas and nationally. On the other hand, these kinds of difficulties are one reason for aid; the other reason, of course, is that if the difficulties are resolved, the investments can do some good.

8.8 To move from these conclusions to formulating a policy of Bank assistance, it is necessary to consider:

- The pattern of Lending Operations;
- Lending Conditions;
- Which Countries?
- The Lending Program;
- Operational Procedures;
- What is Required of Bank Staff;

These matters are now discussed in turn.

The Pattern of Lending Operations

8.9 Loans for rural electrification will generally have to be elements of loans to:

(a) packages of rural development projects; and/or

(b) the electric power utilities.

The former appeals because it promotes coordination between sectors, sorts out priorities and generates very large external economies -- that is, the economic gains from different investments augmenting each other. The latter appeals, if some degree of coordination already exists in the country, because of the many institutional, financial and technical responsibilities delegated to the utilities. But whichever approach is taken, the criteria for accepting the rural electrification component of rural development is the same: some coordination between sectors will be necessary and should have the effect of raising the expected economic returns to the investment; the projects must be well chosen in terms of meeting the social and economic aims of the program; and the projects will have to be carefully and thoroughly prepared institutionally, technically and financially. Provided these criteria are met, the approach to lending can be through (a) or (b).

8.10 Rural electrification loans specifically to the utilities will generally have to be elements of larger loans to them. There are three reasons for this. One is that, with the exception of large countries, rural electrification is not a suitable vehicle for lending on a large scale since it typically absorbs no more than 5 to 10% of total investment in electric power. Second, rural electrification is only an added dimension to the work of the electric power sector, and there is still the need to continue with the expansion of generation and transmission capacity (doubling every 5 to 7 years in most countries) and of service to urban areas. Third, many issues connected with rural electrification relate to the sector as a whole - tariffs and finance, for example, the promotion of regional balance and regional cooperation, and the provision of technical assistance, training and supervision.

The Content of Lending Operations

(a) The Borrowers

8.11 Lending for rural electrification would generally require involvement with institutions at all levels:

(i) The Government -- either rural development or rural electrification agencies, if such agencies are established;

(ii) The Central Electricity Utility;

(iii) Local Electricity Distribution Agencies (e.g. co-ops or State electricity boards).

In most cases, funds and other assistance would best be channelled through (i) or (ii), because local agencies generally require a lot of financial support and assistance from the government or the utility so as to establish, expand and run their rural electrification programs. Even when the local agencies are financially and technically strong (because, say, they may also be serving cities in the region) there is still a good case for channelling aid through (i) or (ii), as in India, in order to promote regional and sectoral balance in the programs, and cooperation between regions. Finally, funds and assistance would also be needed for the country's overall electrification program (if it is a power loan) or for the country's rural development program (if it is a rural development loan).

(b) Bank and IDA Conditions

8.12 Whether Bank or IDA conditions should apply to the loan depends, as discussed earlier (5.14), on the country. If Bank conditions apply, this inevitably means that lending must not only be through the government or the utility, but also that the funds would be channelled to the rural areas at concessionary rates. This is unavoidable unless tariffs are set undesirably high in the early years of rural electrification programs -- a decision which would act against promoting efficient use of the investments.

(c) Finance of Materials and Equipment

8.13 The kinds of materials and equipment involved in rural electrification, and their share in total costs when the projects are intitally constructed, are illustrated in Table 8.1.

Table 8.1

Cost Breakdown of a Rural Electrification Project /1

Item	Cost, $	%	Remarks
Substation	86,000	10	
Poles and Fixtures	280,000	33)	162 miles
Conductors and Protection	178,000	21)	
Line Transformers	61,000	7	
House Connection	19,000	2.5)	1,100 houses,
Meters	12,000	1.5)	initially /2
Street Lights	5,000	0.5	
Administration, Engineering	180,000	21.5	
Interest During Construction	11,000	1.5	
Other	10,000	1.5	
	842,000	100	

/1 San Carlos Co-operative, Costa Rica (1969 data). Project serves about fifteen villages. Data exclude a provision for the co-op's working capital.

/2 Capacity of scheme sufficient to serve over 5,000 consumers.

8.14 Much of the equipment, in particular poles, lines, small transformers, switchgear and substations, can often be manufactured in the country on very competitive terms with international suppliers. In general, therefore, support for rural electrification would involve support for local manufacturing and local cost financing, though the extent of this obviously depends on the country.

(d) Technical Assistance and Program Development

8.15 The shortage of skilled and trained workers to develop, maintain and run rural electrification programs is commonly cited. Most loans would thus have to make a provision for technical assistance.

8.16 A further area where technical assistance can be provided is in (a) establishing and monitoring pilot projects or (b) evaluation of existing projects. As discussed in previous sections (3.18, 3.23 and 4.20 et. seq.) this provides the information base and the experience for program development.

Which Countries?

8.17 In most countries, it seems, there is scope for some degree of rural electrification, involving the electrification of selected:

- villages (and, in Africa and the Arab countries, small towns);

- surrounding farms and agro-industries.

But the extent of the possibilities and the type of electrification varies with the country, as discussed in Part II. The situation is roughly as follows, though records are not good enough for a detailed account.

8.18 In Africa and some Arab countries the main programs are concerned with electrification of small towns, the larger villages and the larger businesses located in or near to them. Auto-generation is the main option, though public supplies can be contemplated in areas close to the main networks. However, in ten years time, these programs are unlikely to have extended service to more than one tenth of the village/rural population.

8.19 Several countries in Asia and EMENA are in the midst of a strong push towards electrifying the large and medium sized villages and the surrounding farms and agro-industries. In some cases, as in parts of India and Taiwan, the programs are also extended towards the smaller villages. Public supplies from the grid are the main option, auto-generation being an alternative for small or remote demands. About one quarter of the village/rural population might be receiving service in ten years time.

8.20 In Latin America, several countries are also in the midst of programs to electrify the larger villages and surrounding farms and agro-industries; other countries have completed this phase, and are moving out to the smaller villages and new farm and agro-industrial consumers. Again, the main option is public supplies to replace local auto-generation, which, apart from remote or low demand areas, is becoming extinct. About one third or more of the village/rural population might be receiving service in ten years time.

8.21 The main question about these programs is, of course, which programs in which countries are socially and economically desirable and require support? As in all aspects of Bank operations, the answer to this should evolve in the course of sector, pre-investment, project and other studies. At the present time it can be said that there are no grounds for dismissing the idea of some degree of rural electrification in any country. While it is possible to find, in any country, that some of the investments are of very little use, it is equally true that others are very useful and the high costs can be justified. Indeed, the first phases of rural electrification -- of private auto generators serving one consumer or several connected to micro-grids -- were historically carried out by private enterprise and were profitable. Growth of output in agriculture and agro-industries, improvements in rural infrastructure, migration to villages, and increases in rural wages, eventually act to increase the demand for electricity and the case for replacing auto generation by public supplies from the grid. The question is therefore reduced to one of timing: has the demand developed sufficiently to justify the investment? The answer to this, in any particular country, can be provided by survey, identification and appraisal work in the course of operations.

The Revised Lending Program FY 74-78

(a) Electric Power Loans

8.22 Roughly $250 million of the revised lending program for electric power ($3,100 million, in 1974 prices, for 90 loans) is allocated to rural electrification. However, $100 million of this is absorbed by three projects, two in India ($40 million each in FY75 and FY76) and one in Iran (about $20 million in FY75, but tentative. These are specifically for rural electrification. The remaining proposals, which are relatively small, are components of larger loans to the power sector in ten other countries (Thailand, Nepal, and Pakistan; Panama, Honduras, Mexico, Bolivia and Brazil; Liberia; Tunisia). However, initiatives to identify and prepare projects with significant rural electrification components might be expanded upon during FYs 75 and 76, leading to an increased rural electrification content in the second half of the program.

(b) Rural Development Loans

8.23 Roughly 50% of the loans for Agriculture in FYs 74 and 75 might be classified as rural development loans. The rural electrification element in projects financed by such loans varies considerably between projects and countries. Rough indications are that rural electrification may average about 10% of project costs in Latin America, may be 5 to 10% in Asia and EMENA, and very little for Africa. In all, about $150 to $300 million of the projected $6,500 million for Agriculture and Rural Development loans might be associated with rural electrification, under present projections. Again, however, intensification of initiatives to identify and prepare projects with rural electrification components might increase the rural electrification content of the second half of the program.

Operational Procedures

8.24 The kind of work to be done -- economic, institutional, financial and technical -- was outlined in Sections III to VII. The following discussion is about the implications of this work as regards:

(a) Sector Surveys -- of The Energy or Electricity Sector;

(b) Sector Surveys -- of The Rural Sector;

(c) Project Identification, Preparation and Appraisal;

(d) Supervision;

(e) Research.

The following discussion of these topics follows a very obvious and well-known pattern. The reason is that no serious revision of operational procedures is needed for dealing with rural electrification projects. The differences are mainly in degree, in that the uncertainties are larger than usual, problems can be tougher, and extra tolerance may be needed (as discussed in III) on projects with quantified economic returns which are lower than, but approaching, the cost of capital.

(a) Surveys of the Electricity (or Energy) Sector

8.25 Since rural electrification is only one aspect of the sector's investment program, it will probably be necessary to report on it separately but in parallel with the other aspects. As regards the rural electrification aspect, surveys need to discuss the origins of the program, the aims, and past and future developments; analysis is required, as is customary, of the institutions, finance, technology and economics of the program.

8.26 To proceed from this to the identification work of a sector survey, would, in many instances, be impractical. Problems, not projects, will often be identified. Records are often exceedingly poor and totally insufficient for investment analysis; institutional problems may be severe and may require a variety of reforms, technical assistance programs and other measures before successful investment can begin; while financial difficulties may arise from poor pricing policies, over-expansion or a technology that is too costly. Sector surveys may often have to concentrate on these problems for a time and to point to the types of studies or programs that might be commissioned to resolve them. The basic work of project identification can then begin.

8.27 When, on the other hand, the programs are well organized and planned, and records are properly kept, the basic work of project identification can probably be accomplished quite efficiently in the course of the sector survey.

(b) Surveys of the Rural Sector

8.28 As far as rural electrification is concerned, the important points about these surveys, which complement surveys of the electricity sector, are that:

- They may often lead to the identification of a rural electrification component as part of the rural development package;

- they should also identify the extent of and the need for coordination between investments in various sectors.

(Identifying useful and workable projects during the course of these surveys may present difficulties far greater than those discussed above for electric sector surveys. Important as these difficulties are, however, they are not an issue for this paper.)

(c) Project Identification, Preparation and Appraisal

8.29 The work of project identification, which may be done during or as a result of sector surveys (or specially commissioned studies), may generally be confined to a rough assessment of (i) the institutional, technical and financial capacities of the borrowers and (ii) regional analysis of the expected economic returns and the factors which bear on them. If the prospects for successful investments look reasonable, according to the criteria discussed in Part III, feasibility and preparatory studies can be initiated or commissioned, as is customary.

8.30 The terms of reference for project feasibility and preparation studies need to request:

- estimates of the expected economic returns;

- an investment plan which is:

    (a) the best of several alternatives as regards the rate of expansion and which demand centers are connected; and

    (b) the least-cost method of following this expansion path;

- technical design;

- an evaluation of sources of equipment;

- institutional plans;

- the financial plan, and tariff studies;
- provisions for monitoring the project and record keeping.

This provides the material for appraisal. On some occasions, the terms of reference may need to request the preparation of pilot projects as a first conditional step in the investment program, or the evaluation of existing projects as an information base for the proposed plan.

(d) Supervision

8.31 The main problem with supervision is likely to be poor records. The only way round this is to set up a good monitoring and record keeping system during the preparatory stages of the project. Items which need to be recorded include, for example, demand statistics, revenues, costs, faults and maintenance problems.

(e) Research

8.32 The work of supervision might be expanded occasionally to examine more widely the project's impact on the area's development. In addition to project related data, the following kind of information can also be recorded and backed up by small scale survey work:

- developments in local agriculture and agro-industries;
- socio-economic developments in the village communities;
- demographic changes;
- changes in household incomes;
- changes in local infrastructure.

This information can often be obtained and analyzed by local consultants.

8.33 Similar kinds of supporting research can be very useful in the preparatory stages of the program, either: (a) to monitor pilot projects, as with the Bank financed project in Ecuador, or (b) to evaluate *ex post* the impact of specific programs, as with the research project in El Salvador. The research need not, of course, be confined to sociology and economics, but might also usefully look at institutional problems, for example.

8.34 Apart from research into overall project performance as part of project preparation, evaluation and supervision in particular countries, there are a number of specific problems to research into, such as:

(a) Consumer response. How does this differ between countries? and what factors affect response? We are particularly short of insights into this in African and Asian conditions.

(b) Costs. What is the precise scope for cost reductions? Can costs really be cut substantially by standardization and by keeping design standards to a bare minimum, as is often suggested? The indications are that this is possible and has been done, but engineering design studies are needed to investigate this matter.

(c) Forecasting, in particular, the movements of the exogenous variables which explain the strong growth of demand often observed from farms, agro-industries and village commerce.

Items (a) and (c) are often best carried out by local researchers.

Requirements of Bank Staff

8.35 Where there are good institutions to work with, identification, preparation and appraisal might proceed in the usual way, but as a component of a power or a rural development loan. The main work would be in preparation: in setting up the terms of reference and providing supervision and assistance regarding:

- economic and social analysis of alternative plans;
- engineering standards and design;
- financial arrangements;
- institutional arrangements;
- tariffs.

8.36 Where the institutional difficulties and the problem of information shortages are more serious, it would of course take longer to build up successful operations. This is, of course, a familiar problem with new operations. The main work consists of seeing that the various difficulties are attended to in order that identification, preparation and appraisal can begin.

8.37 While the problems and the procedures for attacking them are familiar (and there is no reason to suppose, as remarked above, that present operational procedures need revision before dealing with rural electrification), some new skills and experience will probably be needed in the Bank. Much of these might best be acquired in the course of actual operations. But consideration should also be given to (a) sending staff on short training courses, e.g. in distribution network planning and running distribution systems; (b) recruitment of some people with experience in the field, particularly distribution engineers; (c) cooperation between the Regional Departments. As regards (a) and (b) it might be noted that investments in urban and rural distribution networks take over 50% of total investment in electric power.

REFERENCES

Previous material written in or prepared for the Bank on this subject are:

(1) "The Appraisal of Village Electrification Projects," Public Utilities Department, Note No. 6, August 1, 1973.

(2) "Back to Office and Full Report on the El Salvador Village Electrification Study," D. Anderson, May 1973.

(3) Various documents cited in (1) and (2).

(4) "UN Inter-Regional Seminar on Rural Electrification," New Delhi, December 1971. Full Report by T.B. Russell, February 1972.

(5) "Electrificacion Rural," February 1974. Report prepared by Universidad Centroamericana Jose Simeon Canas, San Salvador, El Salvador.

(6) On Pricing Policy:

Public Utility Reports Nos. RES 1 and RES 3, on "Economic Analysis of Electricity Pricing Policies: An Introduction" (Jan. 9, 1974) and "Framework for Electricity Tariff Studies" (March 18, 1974) by Messrs. Anderson and Turvey.

(7) World Bank Sector Working Paper or Electric Power, 1972.

COSTS COMPARISONS OF AUTOGENERATION AND PUBLIC SUPPLIES FROM THE GRID

A2.1 The costs of supplies through electrical networks connected to the main grid system vary with load density and the terrain. The following are typical data for villages in El Salvador, in a region where the average length of subtransmission lines is 4 km per village:

Annex Table 2.1 - Public Supply Costs

		Network Capacity	
		50 kW	25 kW
Consumers Served		140	70
Village Size		2,000	1,000
Capital Costs:			
Generation and Transmission		$24,000	$12,000
Subtransmission		$18,000	$18,000
Local Distribution		$14,000	$ 8,000
Total		$56,000	$38,000
Running Costs:			
Generation	cents/kWh	0.5	0.5
Operating and Maintenance	$/year	2,000	1,000

Source: El Salvador Study (1972 price data).

A2.2 This data does not include the demand and costs of serving local agro-industries, which may add anything from 10 kW to over 1000 kW to local demand.

A2.3 Subtransmission costs change with load density since the average length of line per load center changes. The above figures are based on a subtransmission cost of $4,500 per km (which is higher than many countries report). If, then, the average length of line per village rises by, say 25 km, in a sparsely populated, or remote area, the subtransmission costs rise by $112,500.

A2.4 For diesel, most of the above costs change, except those for local distribution. Typical data for motor-generator sets are as follows:

Annex Table 2.2

kW Capacity	Price (f.o.b.)
30 - 35	$ 6,500
50 - 60	$ 8,000
80 - 90	$ 9,500
90 - 110	$11,000
115 - 140	$12,500

Source: "Detroit Diesel" motor-generator sets (1974 data). 1972 data are about 30% lower, at a guess.

To add to these costs, are the costs of transport, installation and accessories which together amount to about 50% of capital costs. Also, it is fairly common practice to have one spare motor-generator unit on account of the problems of breakdown and maintenance. So the above prices should be multiplied by 1.5 x 2.0 = 3.0 in order to make comparisons with public supplies from the grid (or a factor of 2 to convert to 1972 prices).

A2.5 Other cost items are:

Control Board and Substation (50 kVA)	$5,000
Fuel	6 cents/kWh

These data are based on observation of various projects. The fuel costs would be about 5 cents per kWh in 1972 prices, depending on the efficiency of the motor, to which a nominal amount of 1 cent per kWh has been added for generator maintenance (which is expensive).

A2.6 In sum, the cost data for providing electricity from auto-generation on the same scale as in Annex Table 2.1 would be roughly as follows:

Annex Table 2.3 - Autogeneration Costs

		Network Capacity 50 kW	25 kW
Consumers Served		140	70
Village Size		2,000	1,000
Capital Costs:			
Generators /1		$15,000	$12,000
Substation		$ 5,000	$ 5,000
Local Distribution		$14,000	$ 8,000
Total		$34,000	$25,000
Running Costs:			
Fuel	cents/kWh	6	6
Operating and Maintenance	$/year	2,000	1,000

/1 Taking a unit price of $7,500 for the 50 kW set and $6,000 for the 25 kW set, by interpolating the data in Table A2.2.

These figures are only rough, and may change enormously according to the country and the date. Inflation and changes in oil prices in particular, make precise estimates very difficult.

A2.7 In view of the different levels of capital and running costs, the total costs of the schemes vary according to how much they are used. Also, while the capital costs of autogeneration appear to be much cheaper, this equipment only lasts for about 10 years, as compared with about 25 - 30 years for the electrical equipment.

A2.8 To allow for these points, the following table compares the cost of the alternatives for three levels of utilization (load factors of 10%, 25% and 50% respectively) and puts all costs on an annual basis taking a 17% annuity for the motor-generators and a 10% annuity for the remaining electrical equipment (corresponding to 10 and 30 years respectively at 10% interest).

Annex Table 2.4 - Annual Cost Comparisons

Network Capacity	25 kW			50 kW		
Load Factor	10%	25%	50%	10%	25%	50%
Autogeneration Costs - $						
Capital	3,300	3,300	3,300	4,500	4,500	4,500
Running*	2,300	4,300	7,600	4,600	8,600	15,200
Total	5,600	7,600	10,900	9,100	13,100	19,700
Total/kWh (cents)	25	14	10	21	12	9
Public Supply Costs - $						
Capital	3,800	3,800	3,800	5,600	5,600	5,600
Running*	1,100	1,250	1,500	2,200	2,500	3,000
Total	4,900	5,050	5,300	7,800	8,100	8,600
Total/kWh (cents)	22	9	5	18	7	4

* kWh of output per kW capacity = 876 kWh at 10% load factor
= 2,190 kWh at 25% load factor
= 4,380 kWh at 50% load factor

A2.9 In this case public supplies are cheaper for all loads except those of very low load factors of about 10%. On the other hand, if the average length of subtransmission line per village were 25 km, instead of 4 km assumed above, annual capital costs would rise by over $10,000, with the following effects on the average costs of public supplies.

Annex Table 2.5 - Annual Costs of Public Supplies (25 km)

Network Capacity		25 kW			50 kW		
Load Factor		10%	25%	50%	10%	25%	50%
Annual Costs	$	14,900	15,000	15,300	17,800	18,100	18,600
Annual Costs/kWh	(cents)	70	27	14	40	17	8

A2.10 From this data it is apparent that (a) load density is enormously important in reducing average costs, and (b) so are the size of load and load factor.

A2.11 One major element in reducing average costs is the presence of agro-industrial demand, which may improve load factors and also increase the level of consumption by factors of two to ten or more -- though extra sub-transmission networks are generally needed to reach them.

A2.12 The above analysis is also rather static. A full analysis of course requires a study of the growth of demand and of costs over time.

Mr. Willoughby

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POLICY REVIEW COMMITTEE

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July 22, 1974

PRICING AND COST RECOVERY OF PUBLIC SECTOR PROJECTS

STAFF REVIEW

A staff level meeting will be held on Wednesday, July 31, 1974, at 3:30 p.m. in Conference Room D-556 to discuss the paper "Pricing and Cost Recovery of Public Sector Projects" prepared by the Projects Advisory Staff.

Frank Vibert
Secretary
Policy Review Committee

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PRICING AND COST RECOVERY POLICIES
FOR PUBLIC SECTOR PROJECTS

Anandarup Ray
Projects Advisory Staff
July 1974

PRICING AND COST RECOVERY POLICIES

FOR PUBLIC SECTOR PROJECTS

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PRICING AND COST RECOVERY POLICIES FOR PUBLIC SECTOR PROJECTS

I. INTRODUCTION

1.1 A major consideration in project analysis concerns the project's impact on the financial resources available to the government to carry out its development program, and on the finances of the project entity. This consideration has a general bearing on nearly all aspects of a project. It bears on its choice, on its scope, size and timing, on its design and service standards, and, in particular on the determination of the prices, charges and taxes that the project beneficiaries should pay. This paper focuses on this last aspect, which concerns the level and means of recovery of the costs of a project from its beneficiaries. This aspect is not, of course, a clearly separable one in the overall analysis of a project. The limited focus of this paper is warranted not only because of the complexity of the subject matter but also because the paper on the "Economic Analysis of Projects," recently prepared,[1/] covers in detail the various interdependent decisions involved in project analysis.

1.2 This paper does not aim to establish specific sectoral guidelines and policies for cost recovery, but rather to elucidate the

1/ See van der Tak and Squire (23).

general principles relevant to the development of such guidelines -- it refers to specific sectors and types of projects only by way of illustrative examples. Each sector and indeed each type of project has its own special characteristics which need to be reviewed in depth before more specific guidelines can be provided. But the diversity of issues that arise in this context, ranging from the determination of financial rates of return for revenue earning publice enterprises to the analysis of government budgets in projects such as in education and family planning, points to the need for a statement of the general principles involved. This is the aim of this paper, although its scope is further limited in that it refers only to public sector projects, not private sector ones.

1.3 Cost recovery issues are important not only because of the scarcity of resources for development purposes that most government face but also because prices and taxes bear directly, and sometimes very heavily, on the benefits of a project to the country. Clearly it is of great importance to get the prices "right," as these influence the amount of use that people make of the products and services provided, and their decisions in this matter determine the project's value to the country. As long as the country does not want to waste its resources and opportunities it will want the people to make the right decisions on the amount of use they make of the facilities and services being provided, so that on balance the benefits, net of

2/ For example, see Duane (11) for guidelines on cost recovery for irrigation projects.

costs, derived from a project are as large as possible. In a sense this is a prior concern, because it will remain relevant even in the unlikely situation where a government has plenty of resources at its command and is, consequently, not particularly concerned whether a project produces a deficit or a surplus.

1.4 It is of some importance therefore to be clear about how the right product prices can be determined even if no revenue scarcity existed, or "efficiency" prices as these are referred to in this paper. When prices are higher than these efficiency prices, project benefits are sacrificed in order to realize more revenue, and this is a factor that needs to be taken into account in decisions on product prices. The next section, Section II, is devoted entirely to the various aspects that enter into the determination of these important efficiency prices.

1.5 Section III considers cost recovery policies, and to that end pulls together the discussion of efficiency prices with considerations related to revenue scarcity, economic inequality and equity. It stresses the point of view of the public sector, rather than that of project entities within it, although the relations of a particular entity with the rest of the public sector are also discussed. It reviews some cost recovery norms, such as the principle that "beneficiaries should pay total costs," although it refrains from recommending the norms that may be suitable in specific sectors.

1.6 Finally, this paper is not intended to provide guidance on the analysis of general fiscal, monetary or trade policies of the government. It is oriented towards individual projects, and this project orientation is maintained throughout, although some of its observations may have more general applicability. "Macro-economics" is linked with the discussion in this paper through the general judgments, not specific to any one individual project, on the scarcity of developmental resources at the disposal of the public sector, which are of critical importance to cost recovery matters.

II. PRICING AND EFFICIENCY

2.1 The benefits and costs of a project depend on the levels of outputs and services that are actually provided, and these levels depend on the prices charged. The prices at which the outputs and services are sold will, therefore, materially affect the net benefits from a project. The best prices are those that will maximize the net benefits from the investment.[1/]

2.2 The determination of these output prices is intimately linked with the precise way in which the benefits and costs are defined. This Section is concerned only with pricing in relation to economic benefits and costs in the conventional sense, setting aside considerations related to income distribution. This discussion of product pricing with the sole objective of maximizing net economic benefits, or "efficiency" pricing for short, also leaves aside the revenue generation aspects and the considerations related to inadequacy of total savings in the economy. These aspects will be discussed in the next Section. This separation of issues facilitates the exposition and the analysis of trade-offs; it also has some pragmatic relevance as it may not always be desirable or feasible to orient output pricing towards revenue and savings generation and income distribution.

1/ This project orientation, i.e., the use of the project net benefit maximization objective, for discussing pricing policy has considerable expositional advantage in the context of this paper. It also has been frequently used in the literature, see, e.g., Acharya (1), Feldstein (12), and especially Turvey (20).

2.3 This discussion of pricing policy is purposely put in the context of the analysis of project investments so as to relate it easily to the cost recovery issues. Given this context, it may be noted that the objective of ensuring maximum project benefits is not special to the design of a pricing policy, but bears equally on the interrelated issues such as the determination of the size, design and timing of the project, as well as various other considerations relevant to efficient project operations. The familiar practice of making sure that the accepted project has a least cost design is an example of the application of this objective, which simply reflects the idea of not wasting resources, or in other words, getting as much out of an investment as possible.2/

2.4 The principal considerations in the determination of efficiency prices are taken up sequentially, beginning with the traditional or basic rule. The outline of this section is as follows:

(i) the basic rule,

(ii) complexity and variability of efficiency prices, and the costs of implementing and administering such prices,

(iii) the relationship with investment policy,

2/ It may be useful to note that a sufficiently high internal economic return for a project merely assures that the project is expected to produce at least as much economic benefits as it costs. It is, by itself, no proof that even higher net benefits cannot be earned by following say, a different pricing policy.

(iv) the effect of prices on future demand, and on consumer expectations,

(v) the implications of possible differences between economic and financial costs, and between privately and socially perceived benefits,

(vi) the implications for meeting foreign demand,

(vii) inflation.

Finally there is a brief summary.

(i) The Basic Rule

2.5 The traditional rule for product pricing so as to realize the highest net economic benefits can be stated as follows: the product price should be equal to the current economic cost of producing the last unit of the product sold. If, however, demand is not fully satisfied at such a price, the price should be raised so as to clear the market.[5/]

2.6 This rule implies that current production should be expanded as long as the cost of an additional unit is less than the benefits generated by that unit, i.e., as long as the net benefits can be increased by increasing production. If there is a strict production

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5/ The rule is that during each period (product price) = (current production cost of the last unit sold) + (mark-up to clear the current market when necessary). Note that period-wise independence of costs and benefits are being assumed, so that maximizing net benefits in each period will lead to the maximization of benefits over the relevant future period. The implications of relaxing this assumption will be considered subsequently.

constraint so that an extra unit cannot be currently supplied then the price should be raised so as to ration demand. Increasing the price in that case will distribute the consumption of a fixed supply between consumers in such a way that those who are prepared to pay more get more.

2.7 This type of pricing is intended to provide inducement to purchasers to make correct decisions regarding the extent of their use of the product, and leads them to make appropriate choices in terms of the impact of their decision on the economy as a whole. When the cost of producing additional output is very low, as in the presence of excess capacity, the price will be correspondingly low, thus inducing greater use of the product by the customers. When the product is in short supply, the price will be high to allocate the product to its most productive uses, or to those customers who have the least access to product substitutes. A few simplified examples are needed to illustrate what this pricing rule will mean if applied in practice.

2.8 In a project supplying potable water to an urban area, the price of water per thousand gallon charged to a consumer will equal the cost of supplying him with the additional water. When the system capacity is not fully utilized, this cost will simply be the cost of treating and distributing the additional water. If the distribution costs differ by consumer groups, the prices charged will accordingly differ. Charging less than this will encourage the consumer to put the water in uses where the benefits are less than the costs, and "waste" water in this sense. Not charging anything at all will, of course, encourage him to let the water run to waste literally. Charging more than the additional cost will mean that he will not put the water to some uses where benefits are greater than costs. This will also be wasteful, in the sense that some opportunities for increasing benefits to the public will be needlessly foregone.

2.9 Similarly, the price to be charged for connecting and metering a consumer will equal the cost of providing the additional cost of so doing, viz mainly the cost of the additional equipment and labor. The actual use of water by the consumer after connection will, of course, not be affected by the connection charge, although this charge will determine the number of consumers who will seek metered connections.

2.10 The price of water should, of course, be high when the system capacity becomes a bottleneck, as it will when the demand growth catches up with the capacity provided, or during periods of "peak" demand, such as summer months. Different prices for "peak" and "off peak" periods should be charged, as in the case of electric power. Prices will be low when electricity can be produced cheaply, as in the presence of excess system capacity, and high when demand would otherwise violate the security constraints.4/

4/ See Anderson and Turvey (2), (3), for more detailed discussions of electricity pricing, and Turvey and Warford (21) for urban water pricing.

2.11 Similar considerations apply in most other cases. The actual use of inter-urban and rural roads is very cheap -- the cost of an additional vehicle trip is simply the wear and tear of the road cuased by that trip. The price charged for using such roads should thus reflect only the wear and tear cost, differentiated by vehicle types as different vehicle types cause different amounts of wear and tear. Use of congested urban road space, however, is very expensive -- the additional congestion cost imposed on others by a vehicle trip, and the cost of additional pollution and noise. Use of vehicles in "heavy" traffic zones should be deterred by high prices.[5/]

2.12 The use of irrigation water will similarly be very cheap in periods of excess system capacity, and expensive in "heavy" demand periods. Farmers thus will be charged for the actual use of water, and at rates which differ by periods. This will provide incentives to farmers to economize on water, and allocate it to the acres where it is most productively used. The prices for seeds, farm equipment fertilizers, etc., will reflect the additional cost to the economy of producing or importing them.

2.13 As these examples suggest, one would expect to find a "structure" of prices, corresponding to the "structure" of additional economic costs of meeting the demand of different consumer groups and regions, and in different periods of time. The uniformity in pricing that is often found in practice is generally contrary to the

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5/ See Churchill (7) and Walters (25) for detailed discussions of road user charges.

efficiency pricing rule. The mere existence of the structure of prices that will follow the application of the rule does not, however, necessarily indicate cross-subsidization between consumer groups and regions. Indeed, uniform tariffs often result in cross-subsidization. If a low-cost consumer and a high cost consumer pay the same rate, then the low-cost consumer will be subsidizing the high-cost consumer.

2.14 These examples also bring out that the efficiency pricing rule is designed to induce the right level of current use of a product. Past costs are completely irrelevant for calculating the additional economic costs of current production. The level of current use of a facility will tend to affect the costs of future use, however, through wear and tear. Use-related maintenance costs are, therefore, part of the cost computation for efficiency pricing. Similarly, stock depletion needs to be taken into account, e.g., liberal use of irrigation water during the off-peak season may lower the reservoir water availability during the dry season.

2.15 If the efficiency pricing policy is not followed, then the magnitude of the loss of economic benefits will depend on the difference between the actual price and the efficiency price, and on the responsiveness of demand to the price difference. There will be no loss involved only in the case where demand does not change at all in response to price. The product supply conditions, and the repercussions on other markets may also, of course, be relevant.

The following highly simplified example is designed to illustrate quantitatively some of the considerations involved.

2.16 Suppose, for example, a municipality runs a bus transit system, providing 1 million rides a year at 15 cents a ride.6/ If in order to raise more revenue it raises the fare to 20 cents, i.e., by 33%, ridership falls by 10% to 900,000 rides. The persons who continue to use the system now will pay $45,000 extra (5 cents x 900,000). However, 10% of the ridership has been diverted to other alternatives, which the riders consider inferior to the bus system at 15 cents a ride and preferable at 20 cents. The persons affected are worse off by amounts ranging from 0 to 5 cents per ride, or on average by 2.5 cents. The total loss of benefits on account of diverted rides is thus $2,500 (2.5 cents x 100,000). The total loss of benefits suffered by the customers is consequently $47,500.

2.17 As against this loss, the municipality makes an extra $30,000 (20 cents x 900,000 - 15 cents x 1,000,000) from fare collection. If its operating costs remain unchanged, the net loss will be $47,500 - $30,000, or $17,500. This is the loss which is not compensated by extra revenue, and is thus a dead loss to the economy. That is, for every $1.00 of extra revenue, the economy loses $1.58 (47,500/30,000). The "deadweight" loss is 58 cents per every dollar.7/

2.18 The operating cost will, however, fall in all likelihood. If the initial 15 cent fare represented only operating costs which

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7/ This example is taken from Vickrey (24).

are now avoided, and if the unit operating costs are constant, the municipality's profit will further increase by $15,000 (15 cents x 100,000), and the deadweight loss will now become 6 cents per every dollar of extra profit.[8/] The saving in operating costs will be less than $15,000 if the unit operating costs fall, and/or if the initial fare partly represented capital charges and fixed maintenance costs which remain unchanged. Thus, the deadweight loss will vary between 6 cents and 58 cents for every dollar depending on how unit operating costs behave, and how the initial fare was set. If, for example, the cost saving is $7,500, the deadweight loss will be about 26 cents to the dollar.

2.19 It can easily be seen in terms of the above example that the deadweight loss will be greater, the greater the demand responsiveness. Thus, if ridership fell by 20% in response to the 33% fare increase, the extra revenue will be only $10,000 (20 cents x 800,000 - 15 cents x 1,000,000), assuming no change in operating costs, but the loss suffered by customers will now be $45,000. The deadweight loss will now be $3.50 for every dollar of extra revenue.[9/] If operating costs fall by as much as $30,000 (15 cents x 200,000), the deadweight loss will be 12 cents. The loss will thus vary between 12 cents to $3.50 for every dollar, depending on cost saving assumptions.[10/]

8/ As 0.06 = (47,500/45,000) - 1.

9/ As 3.50 = (45,000/10,000) - 1.

10/ As to the repercussions on other markets, if the traffic is diverted to private autos then there may be an additional loss due to increased traffic congestion. For a more extended analysis of consumer and producer surpluses, including the necessary qualifications, see Currie et al (8), and van der Tak and Ray (22).

2.20 Even a loss of 6 cents to the dollar is not negligible, and this was obtained by assuming a fairly low demand responsiveness and that the initial fare reflected only variable operating costs. A 10% reduction in demand due to a 33% increase in price implies an elasticity of demand of only about -0.3. Thus, in general, one would expect the gains from correct pricing to be quite significant, and this also makes the analysis of trade-offs between the generation of greater revenue and the generation of greater economic benefits more meaningful.

(ii) Administration and Transaction Costs

2.21 The efficiency pricing rule tend to suggest that prices should be finely differentiated to reflect the differences in the costs of meeting the demand of different consumer groups, and at different time periods. Indeed the pricing rule may be interpreted to mean that each bus driver, in terms of the previous example, be given the option of choosing the routes himself, and be continually appraised of the costs of taking each route option, and be allowed to clear the market at each stop by negotiating the fare, i.e., operate in a manner not unlike unregulated taxi cabs. This would, of course, be absurd because the service provided by the bus system is scheduled service, apart from other reasons such as administration costs.

2.22 More generally, the administration of a price system is not costless, and the more differentiated the price system, and the more its variability over time, the greater the administration costs. Similarly, it is costly for the customers to receive and respond correctly to a large number of price signals. In any complex system, it takes time to compute the optimum response, and optimum transactions will either not take place, or will take place after considerable delay. Simplicity in the price structure, as well as its stability, are often economical policies.

2.23 Thus in the case of electric power, for instance, one would differentiate prices only to reflect major cost differences, such as between peak and off-peak periods, and by regions; one would not want the price to respond continually to random fluctuations in demand; temporary excess supplies and demands are thus inevitable. As it may not be desirable to make very frequent price changes price setting will have to be somewhat "forward looking" in nature. Similar considerations apply to other sectors.

2.24 A related aspect is the cost of the mere act of charging for the amount used. For example, product pricing in water supply requires metering devices as well as meter reading and bill processing. In some circumstances, it may not be desirable to incur the expenditures for metering, as the benefits therefrom may be less than the costs. Public standpipes, for example, are hard to meter. In such cases resort to flow limitation devices may be preferable.

2.25 The problem is even more typical of road transport. In the absence of toll gates, which are usually neither desirable nor feasible, there is presently no way of monitoring the use of individual road segments and charging for their actual use. Indirect means, such as registration fees, gasoline taxes, parking fees, etc., need to be used, which at best only broadly distinguish between "heavy" and "light" traffic zones and different vehicle types.11/

(iii) Relationship with Investment Policy

2.26 As noted previously the pricing rule implies that prices should be raised to clear the market in periods when current production from existing capacity cannot be expanded to meet demand, i.e., there should be no quantity rationing. In such periods, however, the government or the public enterprise concerned may consider installing new capacity to meet demand, if the high demand is expected to continue. More specifically, there will be an upper limit to the price beyond which it will be desirable to install new capacity. This is sometimes considered to be an advantage of the pricing rule over quantity rationing, as the market clearing price will provide a "signal" for new capacity creation -- an equally simple signal is not provided by the length of the queues, or the magnitude of waiting time, or the magnitude of bakshish that quantity rationing tends to involve.

2.27 The calculation of this upper limit is first illustrated with a simple example, before considering some difficulties related to its use. Suppose that in a particular case capacity can be

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11/ See Churchill (7) and Walters (25).

expanded by acquiring some machines, and the problem is to find the price per hourly service from the existing machines at which it becomes desirable to acquire an extra machine. As in conventional cost benefit analysis, it will be desirable to acquire an extra machine if the benefits therefrom exceed its costs. If the machine is expected to provide say, 5,000 hours of service each year of its life, then the present value of the costs of providing that service can be calculated and added to the purchase price of the machine to compute the total cost of investing and running the machine. Dividing this cost by the total hours of service to be provided (5,000 times the number of years of service) will give the cost per unit of service, and clearly if the expected demand is such that the machine's services can be sold at a price exceeding this unit cost, it will be preferable to acquire the extra machine, as the present value of gross revenues will then exceed the present value of the cost of investment and operating the machine. The upper limit to the market clearing price of the hourly services provided by the existing machines will thus be the unit cost of expanding the service by acquiring an extra machine so calculated. This limit price is sometimes referred to as "long run marginal cost" price or "incremental" cost price.[12/]

12/ More strictly, this is one version of the concepts. It should be noted that a marginal capacity increment is involved in the example: for large increments the averaging device will be wrong. For a more rigorous version in terms of the dual (shadow price) to the capacity constraint see Anderson and Turvey (4), Chapter 8.

2.28 There are two difficulties. First, in the above example the acquisition of a new machine is supposed to take no time at all. This may be so in some cases, but generally capacity expansions in public enterprises take a number of years. Consequently, public enterprises should not wait till the price actually shoots up to the upper limit, but anticipate it to make timely investments. In fact, in situations where demand growth is very fast, and a public enterprise frequently has to add to capacity to meet it, it might just as well set the "peak period" price equal to the unit cost of capacity increments without incurring significant losses in terms of economic benefits.[13/]

2.29 The key difficulty with this limit price calculation is that it relates to small additions to capacity. This sort of calculation is meaningfully made for electric power or urban water and telecommunications only when relatively small increments to system capacity are involved so that the incremental capacity can be expected to be fully utilized during peak periods shortly after installation. Since Bank projects often involve large additions in relation to the expected growth in demand this difficulty needs to be specially noted.

13/ The merit of this policy may in fact be a bit stronger than this. In such cases the risk of running short on supply may be too great, calling for a relatively high price for some "safety." For example, in electric power, "black-outs" and "load shedding" are very costly in terms of industrial disruption, etc.

2.30 In the case of large additions to capacity, such as a new road, a new irrigation dam, provision of water supply or electric power to new towns, etc., the incremental revenue earned is a very poor measure of incremental benefits generated. The product price only reflects the marginal benefit from the last unit sold, and thus the incremental revenue generated will not reflect fully the total benefits from the intra-marginal units. This point is best seen by taking the extreme example of a zero price (no revenue) due, say, to the infeasibility of product pricing. The benefit will, of course, not be zero simply because revenue is zero.

2.31 The larger the output increment provided the greater will tend to be the divergence between incremental benefits generated and incremental revenue, although even for relatively small changes this divergence may be important. The limit price calculation in the manner illustrated in para. 2.27 loses its value as a guide to good investment policy whenever the incremental revenue earned is likely to seriously underestimate the incremental benefits generated. This is inevitably the case whenever capacity can only be provided in large "chunkc," i.e., whenever significant indivisibilities are present.

2.32 In any case, it should be noted that what is at issue here is not the operation of a pricing rule as such, but how it can be (and whether it can be) combined with a suitably specified investment rule. Except in the case of small capacity increments the appropriate investment rule may not impinge on the pricing rule, and even when it does the investment rule merely defines an upper limit to the price that should optimally be charged. The upshot of all this is to confirm the validity of the efficiency pricing rule even in the "dynamic" context when investments are being considered.[14/] The "dynamic" elements on the demand side are considered next.

(iv) Consumer Adaptation

2.33 A frequently important consideration is the effect of prices on the future development of demand. In many cases, it is necessary to charge very low prices initially, or not to charge at all, to create a market. The need for promotional pricing is seen most clearly in the case of projects geared to new unsophisticated markets. There may be no or very little demand for safe potable water in a small town or village with adequate access to other sources, albeit contaminated sources, unless the consumers can learn to associate health benefits to the direct consumption of water. This type of cases arises routinely in general agriculture projects which aim to introduce new methods and techniques of farming. One would not, however, expect such promotional pricing to continue indefinitely. That promotional elements are sometimes relevant in other cases as well, such as for example tourism related airport

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14/ For an interesting discussion of pricing policy in a dynamic optimization context, see Turvey (20), Chapter 7 on "Optimal Pricing Through Time," esp. p. 74 for a summary statement confirming the textual statement. See also Walters (25) for an extensive discussion of the optimal investment rule in the case of highway investments.

pricing, need no elaboration. As is usual one needs to form a judgment about the extent of promotion or advertisement desired, its length of time, and least cost ways of so doing, including other non-price alternatives.

2.34 A more difficult issue arises regarding the impact on consumer expectations, as formed by the prices they have experienced in the past and the current price. Industries make investments in equipment of varying durability, select products, and choose locations on the basis of their long term expectations of the prices at which they expect to get electric power, coal, steel, and other intermediate products, many of which may be provided by the public sector. Similarly, consumers also choose residential locations, equipment of varying durability such as refrigerators and autos, and generally adapt their behaviour and mode of living to expected prices. If the industrial and consumer expectations prove to be quite wrong, there will undoubtedly be a substantial waste of resources involved.

2.35 This is one reason why stable prices may be desirable (para. 2.22). This consideration may also imply that prices be set higher than they otherwise should be, if the optimal time path of prices is an increasing one. However, one needs to review such conclusions carefully. One can easily imagine that a proper analysis of this aspect of pricing will involve complex dynamic optimization models. Such models will clearly require a theory of how specific expectations are formed, how they affect private investment behaviour, and also of the various means, other than price, that can be used to influence expectations.

(v) Economic and Financial Costs/Benefits

2.36 The discussion has thus far run in terms of economic costs and benefits, but project entities generally observe only financial data, not necessarily economic data. Thus, one may distinguish between: (a) efficiency prices based on "shadow" prices, with due allowance for "distortions" in related markets,[15/] and (b) efficiency prices that can be fairly easily estimated by project entities on the basis of data they directly observe. The latter may differ from the former for various reasons.

2.37 From the pragmatic point of view, it should suffice to identify only the major reasons for the discrepancy, if significant to begin with, between the two sets of prices (a) and (b) above. Reasons which are minor, or very transitory, or highly speculative in nature should be ignored. The extent to which one would be concerned with such discrepancies may also depend on the role of the relevant project entity within the government's decision making framework. A few examples are given below to illustrate these observations.

2.38 First, it should generally be possible to measure production costs by using shadow prices, at least for major cost items. One would first identify the major cost items which affect the derivation

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15/ See van der Tak and Squire (23) for a full exposition of "shadow" prices.

of efficiency prices significantly (labor in some cases, imported inputs in others, etc.) and revalue them using shadow prices.[16/] It should be noted that in estimating efficiency prices, one would normally subtract taxes paid, or add subsidies received, on purchases of inputs from other public sector enterprises.[17/]

2.39 Secondly, there may be taxes or subsidies on goods which are related to the use of the product, either in production or in consumption. A tax on gas will call for a higher price of electric power, as gas is a substitute for power. Similarly, a tax on refrigerators will call for a subsidy on power sold to residential users as they are complements. The use of such "corrections" to the efficiency prices are, however, more complex than this suggests. The actual "correction" will be a weighted average of the effects on other goods, some complementary and some substitutes. Moreover, it is not easy to decide which indirect taxes and subsidies are to be regarded as distortionary.[18/]

2.40 With respect to these complications, there is a commonly held view that no individual project entity should be given the responsibility, or assumed to have the capability, for taking actions designed to correct distortions elsewhere in the economy, e.g., it should not be the responsibility of a railway department to subsidize the transport of cotton in order to nullify the effects a

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16/ See van der Tak and Squire (23) for shadow price evaluation methodology.
17/ See Little/Mirrless (13) for a fuller discussion.
18/ See Little/Mirrless (13), pp. 223-227, and also Turvey (21), Chapter 2, for a discussion of second best pricing.

"wrong" tax on cotton imposed by the Finance Ministry. Similarly, no port authority should be concerned with whether the government imposes the optimal trade taxes or not. There is clearly a great deal of merit in this view. The extent to which the project entity should gear its pricing policy to corrective actions will have to be a matter of judgment in specific cases, depending on the type and severity of policy constraints faced by particular governments, and the permanency of the distortions in the related markets.

2.41 Thirdly, there are other types of effects which may be pertinent to consider. Increases in pollution due to increased production of the product, or due to its use by other industries, is one example. However, better antipollution measures may be available. On the consumption side, one may consider the case of potable water supply. Increased consumption of potable water supply may produce increased health benefits, which consumers underestimate because they act as private individuals, and because they themselves may not be aware of the benefits. Health benefits, of course, will not increase after the minimum requirements are satisfied, and thus after that point be irrelevant for efficiency pricing. The important point here is that not all external effects are relevant for product pricing, but only those which directly vary with the amount of output at the margin.

2.42 To summarize, whereas in principle all "externalities" related to the volume of output at the margin should be taken into account, in practice one has to be very selective and sure about charging prices which are different from a more straightforward calculation of the efficiency prices.

(vi) Foreign Demand

2.43 The efficiency pricing rule discussed so far does not apply with respect to foreign sales, whether exports of goods abroad or sales to foreign tourists. In such cases the country should exploit whatever monopoly power it may have, with due consideration to "good will" and promotional value of pricing, and long-term demand implications. Price discriminations vis-a-vis foreign and domestic tourists will be warranted.

2.44 One special point with respect to airport pricing is important to note. Even if an airport authority has considerable monopoly power in setting airport charges on foreigners and foreign aircraft (due to say, lack of competition from other airports) it should not exercise this power if in so doing it would reduce the total volume of tourist expenditures in the country. The reason is that tourism is an industry in which a large number of activities participate, and the objective is to maximize net profits in social terms from all these activities considered jointly.

(vii) Inflation

2.45 Finally, the discussion so far has assumed implicitly that costs and benefits are measured in real terms. In theory, inflation is defined as a uniform rate of increase in all prices in the economy;

in practice, however, inflation not only is accompanied by, but also gives rise to, relative price changes, i.e., differential rates of changes in prices. A project entity seeking to implement efficiency prices need not, however, be directly concerned with attempts to distinguish between relative and absolute price changes. On the cost side, the entity need only be concerned with the cost increases as it sees or expects them, whether stemming from inflationary changes or not. Similarly, on the demand side the entity need only be concerned with the demand growth it experiences, or expects. Indexing its price to the general inflation rate may be far better than the extreme "stickiness" often observed in practice, but it will not be a good policy if the changes in the efficiency prices for its products differ markedly from the growth of the general price index. The best policy in an unstable environment may be one of flexibility, or fairly short lags in price changes, as otherwise its price will tend to be unrealistically high after a period of rapid inflation has subsided, or too low after a period of stable prices is followed by rapid inflation.

(viii) Summary

2.46 This Section has discussed the pricing policy that would be appropriate if income redistributional, revenue and savings generation considerations are set aside. Such a pricing policy, here called the "efficiency" pricing policy, is derived from the objective of maximizing the net economic benefits, in present value terms, under the assumptions mentioned. This discussion was necessary in order to highlight the efficiency considerations without which no meaningful judgments on cost recovery issues can be made in most cases. It is not implied that such a pricing policy will necessarily continue to be appropriate when the other important considerations are discussed in the following Section. It should be noted that the efficiency pricing rule is a rule for product pricing, and as such it does not apply in cases where product pricing itself is not feasible, e.g., flood control or flood irrigation schemes.

2.47 Efficiency pricing involves a large number of aspects, and should not be summed up simply in terms of a rule. But if a rule is needed as a starting point it should be as stated in para. 2.5. Each public sector undertaking has its own particular conditions relevant to the derivation of efficiency prices, and consequently it will take too much space to indicate the specific characters that efficiency pricing policies may take in practice beyond what has been done.[19/] It needs to be stressed, however, that significant departures from efficiency prices for revenue or other purposes should only be made after due consideration of the losses that may accrue to the economy as a consequence.

19/ There is a considerable volume of Bank literature on the subject which may be consulted for more detailed guidance. See Bibliography for the principal sources.

conflict between efficiency pricing and revenue generation has traditionally been the center of the discussion on public sector enterprises' pricing policies, especially in connection with the railways and electric power. This conflict is usually discussed in terms of "decreasing costs" and "economies of scale," and the main points may be illustrated in terms of such a stylization.

3.3 First, one may envisage a large indivisible investment, which provides a lot of excess capacity initially, before demand "catches up." The fixed cost of the basic initial installations or equivalent annual capital charges, will be spread over more and more output as demand grows. If the operating costs are a small fraction of total costs, or if the operating costs do not increase fast enough with increase in output, the total unit costs may decrease over a wide range of output, even near full capacity utilization. Total costs will not be covered then until production can no longer be expanded, and then only after the demand grows sufficiently to raise the market clearing price to the level of total unit costs. And additional investment in basic capacity may possibly become desirable well before that happens.

3.4 A highway investment fits into this category. Even if a toll gate is provided so that a price can be charged per trip on the highway created, all annual costs, i.e., fixed maintenance costs, use-related maintenance costs, toll operating costs and capital charges, will not be covered on the basis of charging for use-related road maintenance costs and toll gate operating costs. Until significant traffic congestion starts so that a congestion surcharge becomes justified, total cost recovery is not likely to occur. A widening of the highway, or an alternate highway investment, may become desirable prior to that actually happens. In this case, even the conventional operation and maintenance costs will not be covered as the maintenance costs which are independent of actual use will not be charged for.

3.5 Secondly, even if such infrastructural indivisibilities are relatively small, the capacity installation costs per unit capacity provided may decrease with plant size, or as increments to capacity are made. Greater size, for example, may involve technologically more efficient options. Superior technology, both its progress and its adaptation, may be biased towards large size.1/ These descriptions are, of course, stylizations. In many cases "capacity" is a multi-dimensional concept, and a large investment is usually associated with a multitude of sub-activities, each with its own "capacity," and involving many types of products and services.

3.6 While these problems may arise, in many cases the cost structure is such that the efficiency prices recover all costs of project investments. However, a distinction need to be made between

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1/ See Westphal (27) for illustrations of economies of scale.

historic or sunk costs, and presently avoidable costs, as these processes take place over time. For example, efficiency pricing of electric power may well cover the incremental capacity costs relevant at a point in time, without doing much for historic costs which were incurred years ago when the system was set up but which may still be important in financial accounting. When indivisibilities are relatively unimportant, and/or operating costa are a significant portion of total costs and rise rapidly with output, and/or demand growth is very rapid, the revenue generated from efficiency pricing should cover at least all new investment costs. To the extent that efficiency prices are lower than they otherwise would be because of special factors (e.g., promotional pricing, para. 2.33), the revenue generation implications become, of course, worse, and conversely if such prices are "corrected" upwards (e.g., if an important input is very important in production costs and foreign exchange is scarce).

3.7 One should not prejudge the implications of efficiency prices from the revenue generation point of view. Efficiency pricing may generate large surpluses, as well as deficits. Paradoxically, the serious problems in practice often tend to arise not because efficiency prices are being charged, but because the prices set are below their efficiency levels. The tendency to underprice is quite commong in utilities, and is, of course, chronic in the case of urban private automobile use, among other areas.

(ii) Cost Recovery and the Public Sector

3.8 This subsection discusses cost recovery issues from the point of view of the public sector defined comprehensively to include its project entities. A measure of the fiscal impact of a project is first introduced, followed by discussions of revenue generation policies in the project context and of cost recovery norms.

(a) Fiscal Impact

3.9 The impact of a project on the financial resources available to the public sector is a natural concern given that in many countries the size of the public sector investment program is constrained by the government's inability to raise sufficient revenue. This concern appears in project analysis directly when the project entity is a government department, e.g., an irrigation or a highway department, which does not collect revenues itself but relies on transfers from the government to finance its expenditures. Analysis of the project's impact on the government's budget is a routine part of rural development projects, for example. This concern also arises indirectly in the case of specific financial accounts, such as that of a state-owned power company. One of the purposes of financial autonomy is to safeguard drains on the Treasury by encouraging or requiring self-financing for revenue generating entities, when feasible. Similarly, the prescription that at least the annual operating and maintenance costs be covered is intended to minimize the adverse effects of the project on the public sector budget on a recurrent basis.

3.10 When public funds are scarce and less than socially desirable the fiscal impact of the project becomes a material consideration in both project choice and financing decisions. In such cases there will be a scarcity "premium" on a dollar of revenue at the disposal of the public sector, and this premium may be used to evaluate the deficits or surpluses generated by the project.2/ Decisions on the pricing of products and on beneficiary taxation will be affected by judgments on this premium.

3.11 From the point of view of the public sector, the relevant measure of a project's budgetary impact is the present discounted value of the annual deficits and surpluses due to the project, the discount rate being the relevant shadow interest rate.3/ The annual deficits or surpluses are measured as follows (in real terms):

(a) the total incremental public sector expenditures due to the project,

(b) <u>minus</u> the total incremental revenues that accrue to the public sector due to the project.

2/ If a project yields a deficit of $1.00 in a particular year, and the public sector has to reduce some other expenditure to finance it, the "shadow price" of the dollar will be the present discounted social value of the use sacrificed, and the excess of this price over unity is the premium. See Marglin (16) for a full discussion.

3/ For a discussion of shadow interest rates see van der Tak and Squire (23).

A corresponding fiscal cost recovery rate may be defined as the present discounted value of (b) divided by the present discounted value of (a).

3.12 This measure relates to the account of the public sector, and involves all public sector cash flows directly or indirectly related to the project. Private sector expenditures and receipts in connection with the project are excluded, although the changes in public revenue and income that these induce are counted. For example, the private investments made by farmers in an agricultural project will not be a part of this measure, except for the revenues that the public sector receives from the taxes on inputs that the farmers purchase from elsewhere. Similarly, the income that the farmers receive from selling their outputs is not included, although any changes in the proceeds of taxes on these outputs will be included, as will any change in the profits that the public sector might make if it undertakes marketing and processing of the outputs. The public sector revenue or income changes from the additional consumption expenditures of the farmers will also be included in the measure. Indeed, all changes induced in public income in or outside of the project boundaries are relevant.

3.13 It is clear that the fiscal cost recovery rate as defined above is very difficult to measure, since it requires an estimate of <u>all</u> net incremental revenues accruing to the public sector as a result of the project. Some of the major revenue items that are relatively easy to measure are (i) revenues from sales of the products and services provided by the public sector component of the project, (ii) revenues from taxes, tariffs and subsidies on private sector inputs and outputs of the project, and (iii) revenues from direct taxes on beneficiaries because of the income or capital gains they receive.

3.14 To see this more clearly, it is convenient to categorize the major components of the cash inflows (item (b) para. 3.11) separately. The following breakdown of the fiscal effects is an illustration only, as the appropriate decomposition will depend on project type and pragmatic convenience.[4/] Noting that the fiscal impact is to be measured in terms of present discounted values, and in real terms, the measure is:

(a) incremental public sector expenditures on the project at market prices;

(b) minus the tax/tariff/subsidy components in (a) above; these payments are merely transfers within the public sector;

(c) minus the tax/tariff/subsidy component in incremental private project expenditures, i.e., other than the public expenditures (a) above;

4/ The classification here is least convenient for credit operations. For such operations, item (a) below will simply be the public sector outflow on credit disbursements and administrative costs etc. The item (d) below will then consist of the repayment stream, the "product price" being the real interest rate.

(d) minus the incremental revenues earned, gross of sales taxes and net of sales subsidies, from the sales of the products and services provided by the public sector. These revenues stem from the prices charged for these products and services. In some cases, these products and services are also considered to be the project's output, e.g., public utilities projects.

(e) minus the incremental revenues earned from taxes on outputs and services of the private sector resulting from the project (in the case of a subsidy, it is to be regarded as cost). In some projects, as in agriculture, these products and services provided by the private sector are considered to be the project's outputs. In an irrigation project, e.g., the incremental revenues from sales taxes on the agricultural commodities produced will be included in this category.

(f) minus the incremental revenues earned from direct taxes on users and beneficiaries. Typical examples are land taxes, betterment levies, income and property taxes. This may be further divided into:

(1) direct taxes which are general,

(2) direct taxes which are specially designed to bear on users and beneficiaries only,

i.e., "discriminatory" direct taxes, e.g., a differential property tax on a neighborhood benefitting from a project, a betterment levy paid only by benefitting farmers, etc.

(g) minus the incremental net revenues earned from all other effects not counted above. This is the residual "catch-all" term, which is very difficult to measure and which can be either negative or positive.

3.15 It should be noted that the various terms in the measure of the fiscal impact of the project (para. 3.14) are not necessarily mutually independent. For example, the prices set for the public sector products will affect the costs (item (a), para. 3.14) by changing the amounts purchased, and the other inflows as well.

3.16 Discriminatory taxes and charges on project beneficiaries deserve special emphasis for two reasons. First the possibility of raising additional revenue from such taxes is obviously relevant from the point of view of equity and income distribution. Secondly, even apart from equity and income inequality aspects, raising additional revenue from such taxes, related as they are to the incremental project benefits, may be one of the easiest options available to the public sector, whose ability to raise additional revenue through other means may be quite limited. Consequently, this option, along with the pricing of products provided by the public sector, should be considered a basic revenue generating policy parameter in the context of a project.

(b) Revenue Policy

3.17 The revenue generating policy in the context of a project consists of the decisions on pricing of the products and services provided by the public sector, and on the discriminatory benefit taxes to be levied on project beneficiaries. The objective in raising a given amount of revenue through these two instruments will be to do so at least sacrifice of net economic benefits. And the higher the scarcity premium of public funds, the greater the sacrifice that can be tolerated, i.e., the greater the additional revenue that should be raised. The method of raising additional revenue and the amount of revenue to be raised may both, of course, be conditioned by the income levels of the beneficiaries in the context of existing economic inequalities and by equity.

3.18 It may be helpful to consider these issues in terms of two steps:

(a) the determination of the efficiency prices for the products and services provided by the public sector (discussed in Section II), so as to obtain the maximum net benefits from the project, and any discriminatory benefit taxes that might be levied with negligible adverse effects on the total net benefits of the project,

(b) the determination of the desired level of revenue generation from the project in excess of the revenues that will be generated from step (a).

3.19 If the first step (a) involves a deficit, then the second step (b) raises the issue of the best way of financing it. Any additional revenue generated from the project will reduce its total net economic benefits, and this sacrifice needs to be compared with the net benefits which would otherwise be sacrificed elsewhere in financing the deficit, either from reductions in other expenditures or from raising additional revenue through other means. If the first step involves a surplus, then the second step raises the issue of whether a larger surplus would be desirable. That is, is it worth sacrificing some of the project benefits in order to avoid having to raise additional revenue by other means to finance other expenditures?

3.20 In both cases, the issue is essentially the same one, i.e., what is the social opportunity cost, or the social value, of public funds, given that it is scarce and less than socially desirable, and how does it compare with the cost of raising additional revenue from the project. The two instruments, product pricing and benefit taxation, are discussed separately below from this point of view.

everything usually taxed to some extent.

Pricing Policy

3.21 To start with, the amounts of products and services to be provided by the public sector, and the corresponding efficiency prices, may be estimated, assuming that all taxes, tariffs, and subsidies are given and that no discriminatory benefit taxes are feasible. At issue then is whether departures from efficiency prices are justified, given the scarcity premiun on public revenue. The fiscal impact, corresponding to these efficiency prices may be a deficit or a surplus -- in either case the premium is applicable.

3.22 The usual approach to this issue is as exemplified in Section II (para. 2.16). If a dollar of public revenue obtained from the private sector is worth, in social terms, one dollar and fifty cents, then a mark-up on the efficiency price can be tolerated as long as the resultant loss in economic benefits ("deadweight" loss) is less than fifty cents. The more inelastic the demand for the products with respect to price changes, the higher the mark-up that can be tolerated for any given premium on public funds. Since the valuation of the losses in economic benefits will depend on the income level of the persons suffering the losses, the mark-ups will be lower, possibly zero or even negative, the poorer the consumers of the products.[5/] When price discrimination is possible the mark-ups will be higher for those consumers whose demand is relatively inelastic, or those who are affluent. These are familiar conclusions. Two qualifications need to be noted, however.

5/ The premium will then have to be defined relative to a norm level of consumption or income.

3.23 First, this approach assumes that not only all other taxes, tariffs and subsidies are given, but also all other prices. The losses of economic benefits sacrificed cannot be fully measured by this approach if other prices also change as a result of the mark-up. A mark-up or a tax on, say, the fertilizer price will also be partly passed on to consumers of the agricultural products through higher prices. When all such repercussions are taken into account it turns out that in many cases the ideal policy for the government would be to tax only final consumption goods for raising revenue and either not to tax production at all, or to tax it in a manner so as not to impinge on production decisions. In particular, in pricing the products of public sector undertakings it would be preferable to avoid "mark-up"s or "mark-downs" on efficiency prices of the products which enter into other production processes (as is often the case with Bank financed projects). The reason is that if the prices of such intermediate goods do not reflect social costs, the production methods adopted by industries and farmers will not be minimum social cost methods for given levels of output. If, for example, prices of coal, transport, etc., do not reflect social costs the resultant industrial location patterns may not be least (social) cost. Similarly, mark-ups on fertilizers will also mean that whatever the volume of agriculture production may be, it will not be produced at least cost socially, as the socially correct combination of fertilizers with other inputs will not be used. Such "ideal" policies are of course not followed in practice, and hence the possible need to adjust efficiency pricing to reflect the "distortions" due to prevailing taxes, tariffs, etc., as discussed in 2.36-2.42. These adjustments, however, will be efficiency oriented, not revenue oriented, possibly exacerbating the revenue generation problem rather than ameliorating it. Thus unless the demand elasticities are very low, one needs to be cautious in recommending mark-ups on efficiency prices for revenue generation, especially for intermediate goods, as the losses of economic benefits may easily be underestimated.[6/]

3.24 Secondly, judgments on demand elasticities are very difficult in practice. This is an additional reason for minimizing mark-ups on efficiency prices. The premise that demand is very inelastic, as commonly used in practice, is highly plausible for some commodities in the short-term but long-term effects should not be ignored. It is not generally plausible that long-term elasticities are also very low.

3.25 Similar considerations apply also to the issue of product subsidies. Just as a mark-up on the efficiency price can be justified only if it is the best way of raising revenues, a product

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6/ Little and Mirrless (13) strongly recommend that the efficiency pricing policy should be followed for all intermediate goods. See Dasgupta and Stiglitz (9), however, for a taxonomy of cases where this advice will not be strictly correct. For a discussion of the classical "elasticity" and "proportionality" rules, see Baumol and Bradford (5), and Dixit (10).

subsidy, or mark-down on the efficiency price, can be justified only if this is the best way of transferring income. The more conventional reason that individual users and purchasers may underestimate the social value of their consumption has already been incorporated in the definition of efficiency prices (Section II). Purely from the point of view of transferring income, a product subsidy is just one of many alternative instruments that may be available and its merit should be assessed in that context. In practice product subsidies often tend to be somewhat haphazard in nature, and this may be quite costly if the revenues lost thereby could have been better used through well planned poverty redressal programs. Given that the resources available for poverty redressal are limited, the issue is the most effective form in which subsidies can be given.[7/]

3.26 Subsidy costs are usually minimized by appropriate choices of products and service standards for the poor. Some quantity rationing may also be necessary to "reserve" the products for the poor, as is the case with urban sites and services, for example. In allocating such products the prime consideration may be to reach a target income group through controlled selection, the price playing an allocative role only within the target group, even so perhaps a limited one. In such cases the issues is how poor the chosen target group can be, consistent with minimum service standards, and the scarcity of public funds.

7/ For a discussion of alternative forms of consumption subsidies from the efficiency point of view, see Pauly (17).

3.27 Finally, the product pricing option may not always exist. It may not be feasible in some cases (e.g., flood control), while in others it may not be desirable if the cost of implementation and administration of a pricing system outweigh the benefits (Section II (ii)). However, the option of instituting product pricing should not be dismissed without serious consideration, both for efficiency and revenue reasons (e.g., irrigation water).

Benefit Taxes

3.28 There are various types of discriminatory taxes, charges and levies that may be imposed on project beneficiaries to capture a part of the benefits generated. When feasible, this option should be examined first, prior to any decisions on departures from efficiency prices. However, since most devices tend to impinge on production or consumption decisions, at least to some extent, benefit taxes generally also have efficiency effects and cannot be neatly divorced from the pricing considerations disbussed above. Any distinction between product pricing and benefit taxes has to be a matter of practical convenience, based on differences in degree rather than on matters of principle.

3.29 For example, the fee for a private connection to a water supply system is usually regarded as a "price," the "product" being private access to the system. As such, it will have an efficiency level which will optimize the number of private connections to the system. But if the responsiveness of demand for private connections to mark-ups on the efficient connection fee is low, the mark-up may also be regarded as a fairly good discriminatory benefit charge. Similarly, a tax on each household with access to a community water tap may be a good benefit charge, although it may make some households worse off. A betterment levy on project farmers after an irrigation project may be a good tax, although again it may make some farmers worse off. On the other hand, a sales tax on the crops produced by the project farmers will not only hurt all other farmers producing the crops, but may also involve significant efficiency losses. Thus, such a sales tax is not likely to be a good discriminatory benefit tax.

3.30 Generally, the scope for suitable benefit taxes will depend on whether or not it is possible to restrict the incidence of such taxes to the project beneficiaries with very little efficiency losses, and relate them to the net benefits received by the different beneficiaries so that the tax burden imposed on a beneficiary does not exceed the net benefits he receives. In practice differential land and property taxes may be the best of the available options. However, in many cases the scope for suitable discriminatory benefit taxes may be very limited, e.g., in most transportation and industrial projects, and in poverty redressal programs and projects such taxes may defeat the purpose.

3.31 The limit to benefit taxes is set by the incremental project benefits received by a beneficiary, <u>net</u> of (i) the incremental payments he makes on his purchases from the public sector, (ii) incremental production expenditures that he incurs, if any, to realize the benefits, and (iii) his incremental payments of direct general taxes, if any, due to the benefits he receives. Within this limit, the level of new discriminatory tax payments imposed on a beneficiary should depend on the valuation of his personal income, as it would be after the project, in relation to those of others in the country. The lower is his relative post-project income, the lower should be the level of the additional taxes imposed on him. The efficiency losses due to such taxes (sometimes referred to as incentive effects in this context), if any, will also tend to be less the lower the new taxes. On the other hand, the lower the new taxes the less revenues the government will have for financing other expenditures, including expenditures for more deserving persons. The resolution of these opposing factors determines the level of incremental tax payments from new or higher taxes that should be imposed on each project beneficiary and thus on the beneficiaries as a group.

3.32 It may be noted that the systematic incorporation of the objective of income redistribution requires a redefinition of the concepts of economic benefits and costs, and correspondingly requires some basic modifications in the conventional project analysis. The conventional analysis implicitly assumes that the social value of a dollar's increment in consumption is the same regardless of the income of the person it accrues to. The necessary modifications stem from the replacement of this implicit "regressivity" with suitably progressive schemes for the relative valuation of benefits accruing to, or cost incurred by, different income groups.[8/] If such a progressive scheme is specified, then the income distributional considerations can be consistently brought to bear in pricing and taxation decisions in all projects in the country concerned.

3.33 In addition to these considerations of efficiency, scarcity of public funds and economic inequality, the notion of "fairness" (or "equity" as it is sometimes construed) may be noted. It has two interpretations in this context. First, it is sometimes used in the sense that project beneficiaries should receive equal treatment. That is, each should pay benefit taxes or charges in proportion to the benefits he receives. As such this notion conflicts with both efficiency and the concern with economic equality. As discussed earlier uniform prices often result in cross-subsidization from low-cost consumers to high-cost consumers (para. 2.13). And charging benefit taxes in proportion to benefits received (as also equal taxes per beneficiary regardless of the distribution of benefits) ignores the initial economic inequality between the beneficiaries. Two beneficiaries with very different income levels receiving the same benefits would then be required to pay the same taxes. From the point of view of redressing economic inequality, it is

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8/ See van der Tak and Squire (23) for methodological details, and Chenery (6) for a discussion on income redistributional policy options and analysis thereof.

preferable to relate benefit taxes to the with-project distribution of income, i.e., to the initial distribution of income as modified by the distribution of benefits from the project.

3.34 The second interpretation of "fairness" would be as follows: (i) equal-cost consumers of equal income should face the same product price. That is, prices will differ between consumers only to reflect differences in the cost of supplying different consumers and/or to reflect differences in income (or more appropriately "welfare") levels between the consumers. Price discrimination between consumers of different income levels is not, however, always possible, and even if it is possible, it should only be practiced when mark-ups on efficiency prices are unavoidable for raising additional revenues; (ii) beneficiaries with equal with-project income (or "welfare") should be charged the same benefit taxes.

3.35 "Fairness" in this sense is entirely consistent with, and indeed, should result from, the systematic application of the efficiency and economic inequality considerations. The concept of "fairness" is a separate consideration only in the first sense (para. 3.33). Two difficulties in the application of the "fairness" notion or of the concern with economic inequality to pricing and discriminatory benefit taxes need to be noted. First, with respect to both price discrimination and benefit taxation, the appropriate concept is "welfare." Annual with-project personal monetary income will be a poor index when family sizes differ, cost-of-living differs, expected lifetime incomes differ etc., and moreover, "income" may sometimes be in non-monetary form, especially in rural areas. For this reason it might be preferable to apply the economic inequality considerations to pricing and taxation only when large differences exist. Secondly, it is rarely possible to treat all beneficiaries equally, because there are different types of beneficiaries, not all of them the direct purchasers of the products and services being provided. For example, the consumers of the crops produced by an irrigation project may gain substantially from the project, but yet it will not normally be feasible to levy discriminatory benefit taxes on them. This is a limitation of the "fairness" notion.

(c) Cost Recovery Norms

3.36 The fiscal benefit or surplus associated with a project, as defined in para. 3.11, is important in project evaluation as the social value of each dollar of public revenue will be greater than unity when the funds available to the public sector are scarce and less than socially desirable. It is important to note, however, that unless the project deficit or surplus is large in comparison with the total resources available to the public sector, one's judgment on the scarcity of public funds (i.e., the scarcity premium) should not be altered by the project. Consequently, from the point of view of pricing and taxation decisions, the actual size of the deficit or surplus will be immaterial as long as the initial judgment on the scarcity of public funds is unaffected by the project. If benefit taxes and mark-ups on efficiency prices are considered desirable because a deficit would otherwise result, these should be equally desirable if efficiency prices would have generated a surplus. In the unlikely event, however, that the deficit or surplus is so large as to affect the basic judgment on the scarcity of public funds, it becomes important to measure the actual size of the deficit or surplus comprehensively.

3.37 There is, however, no natural reference value for the fiscal cost recovery rate defined in para. 3.11. Even if public sector outputs are distributed free of charge and there are no benefit taxes, the fiscal cost recovery rate need not be zero, while it can easily exceed 100%, even if only efficient product prices are charged. However, if the pricing and taxation decisions made with reference to the considerations discussed earlier are judged to be optimal, the fiscal ratio will have a corresponding optimal value.

3.38 The fiscal cost recovery rate may be partitioned in order to focus on the two revenue generating policy instruments, viz product pricing and benefit taxes. It may be rewritten, using the breakdown given in para. 3.14, as follows (noting that all terms should be in discounted present value terms, and in real terms):

The fiscal cost recovery ratio = $R = R_1 + R_2$, where

R_1 is the ratio of the term (d) (i.e. incremental revenues earned from product sales, gross of sales taxes and net of sales subsidies) <u>plus</u> the term f (2) (i.e., incremental revenue from discriminatory benefit taxes), to the term (a) (i.e., the total public sector project expenditures). In other words, R_1 reflects the policy variables determining the fiscal cost recovery rate; and

R_2 reflects the other "passive" fiscal effects of the project.9/

3.39 The partitioned cost recovery ratio, R_1, also does not have a natural quantitative reference value of general validity. Its minimum value is uniquely defined to be zero, while, like the complete cost recovery rate, it can easily exceed 100% on the basis of efficiency prices for the products, if the undertaking is a profitable one at such prices. In general its optimum value will tend to be higher, _ceteris paribus_, the higher the scarcity of public funds; in this sense it is country specific. It will also tend to be higher, _ceteris paribus_, the higher the level of efficiency prices and/or the higher the relative income class of the project beneficiaries; in this sense it is sector and project specific.

3.40 The optimum value of R_1 may be zero in some cases. For example, it may be zero for some programs and projects geared to extreme poverty groups. It may also be zero for family planning projects

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9/ In the notation of para. 3.14,

$$R_1 = \frac{d + f(2)}{a} \quad \text{and}$$

$$R_2 = \frac{b + c + e + f(1) + g}{a}$$

as the efficiency price for such services may be zero because of the benefits external to the individual beneficiaries and because discriminatory benefit taxes are also unlikely to be desirable in such cases. In general, it will be zero regardless of the income level of the beneficiaries whenever suitable discriminatory taxes and product pricing are either not feasible or not desirable.

3.41 The optimum value of the partitioned cost recovery rate, R_1, or of the complete fiscal cost recovery rate, will be 100% only by chance. In this sense there is no intrinsic merit in full cost recovery, i.e., in the principle that "beneficiaries should pay total costs," from this point of view.

3.42 If the principle that "beneficiaries should pay total costs," is regarded as a value judgment independent of the judgments on the scarcity of public funds, economic inequality and efficiency, then <u>all</u> incremental payments made by the beneficiaries to the public sector in order to become beneficiaries should preferably be counted, regardless of the means or mechanisms of payment employed. In particular the payments on direct general taxes which the beneficiaries could have avoided by not choosing to earn additional income by using the services provided by the project should be counted. It should, in fact, be preferable to use a measure similar to the complete fiscal cost recovery measure (except for the "residual" term (g) in para. 3.14) from this point of view, making allowance for project-induced incremental payments to the public sector made by non-beneficiaries, if any.

3.43 Unless such a value judgment is made, quantitative reference norms can be devised only in the context of specific sectors or types of projects. For example, in circumstances in which there is a chronic tendency to underprice products and services, or reluctance to levy desired discriminatory benefit taxes, a suitably high quantitative norm may be very useful in counteracting such biases. A general quantitative standard is not feasible. At any rate it should be clear that the general considerations underlying pricing and taxation decisions are the same, regardless of the specific sectoral norms that may be devised, viz

(a) the losses of the project's net benefits likely to be incurred by departing from the efficiency prices for the products and services of the public sector (when product pricing is relevant),

(b) the losses of project's net economic benefits likely to be incurred from the imposition of discriminatory benefit taxes (when such taxes are relevant),

(c) the scarcity of resources available to the public sector. If the project's deficit or surplus is a material consideration in this judgment, then the comprehensive fiscal measure, in para. 3.11, should be used; all incremental revenue inflows to the public sector are relevant, whether from new or existing taxes on income and wealth, or from new or existing taxes on the various project inputs and outputs, or from other sources,

(d) the post-project income and wealth of the individual beneficiaries as compared to those of others in the society, and the relative social valuation of their income and wealth.

3.44 Pricing and taxation policies may also be geared towards increasing the total amount of private savings and re-investment, e.g., by discriminating in favor of those consumers who save more, i.e., with higher marginal savings rates, and in favor of those industries which plough back a greater share of their profits. This is of little more than academic interest in most cases as the information requirements are very high. The incorporation of this element will make the pricing and taxation policies more regressive than otherwise, as the savings rate tends to increase with income. However, the impact on private savings might be considered when meaningful judgments are possible, and in such cases this consideration should be added to the list above.

(iii) Cost Recovery and the Public Sector Project Entity

3.45 The discussion in the preceding sub-section (ii) covers well the project entities which may be regarded as simply project implementation agencies of the government, with no discretionary powers on pricing and taxation decisions, e.g., the various governmental departments. Numerous problems may of course arise in practice, related to such issues as decentralization of decision making, allocation of funds between the different levels of the government and between sectors and projects, but the broad perspective of the country's economic and social objectives can in principle be directly brought to bear on pricing and taxation decisions, and the relevant revenue generation objectives are those of the government itself, not of the entities.

3.46 Cost recovery issues mainly arise at the level of the project entity when the entities concerned earn revenues directly from the public and are required to maintain satisfactory and viable financial positions. The typical examples of such project entities are the public sector enterprises in the public utilities, railways, air and sea ports, major industrial branches, etc. The cost recovery rate relevant for the public sector, discussed earlier, will differ from the cost recovery rates relevant to such public enterprises as the public sector's cash flows and the public enterprises' cash flows are generally quite different. Since public sector enterprises normally do not have the option of levying discriminatory benefit taxes, the cost recovery instrument available to such enterprises is usually only the pricing of its products and services.

3.47 The key consideration in treating a public enterprise from the cost recovery point of view concerns the valuation of the financial resources at its disposal relative to the valuation of the financial resources at the disposal of the government. With this in mind one may distinguish between two types of cases:

(a) "independent" enterprises. An enterprise should be classified in this category if its financial resources should be valued differently from the resources at the disposal of the government, and

(b) "semi-independent" enterprises. An enterprise should be classified in this category if the value of its financial resources should be regarded as equal to the value of the financial resources of the government.

These two categories are briefly discussed below. Matters such as administrative, managerial and general operating efficiency, various sector and project specific financial issues, etc., are not considered.

(a) <u>"Independent" Public Enterprises</u>

3.48 This category is likely to be relevant for the fully autonomous public enterprises, with independent financial objectives, which are generally required to follow the commercial rules and practices of the private sector. They may also in some cases borrow directly, or accept equity participation, from the private sector. Such enterprises are usually required to do without special privileges from the government which are not also available to the private sector, e.g., subsidized interest rates, exemptions from dividend payments, lower taxes, etc.

3.49 The desired cost recovery rate for such a public enterprise depends on its financial objectives and targets. It will seek to be profitable, and earn enough to cover all its financial costs and obligations, based on market prices, including a reasonable return on its invested capital. Complementary to this is the need for prudent financial planning in a dynamic context, which may require it to generate internally surplus cash for future investment purposes. Its desired cost recovery rate may be expressed by suitable financial indices, such as a minimum required rate of return on its net fixed assets on an annual basis.[10/]

3.50 The pricing policy of its products and services, as also its investment policy, will be geared to profitability considerations. Although the dominant objective for such an enterprise is to attain its internal financial targets, it may be able to charge efficiency prices when such prices are consistent with its financial requirements. When it has to charge more than efficiency prices it may be able to take into consideration economic inequality between its customers. The financial stringency faced by such an enterprise may be much more or much less severe than the financial stringency faced by the government, and accordingly the mark-ups on efficiency prices that such enterprises will charge may be much more or much

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10/ The project's internal financial rate of return may be analytically preferable, but it cannot be conveniently covenanted. See Solomon (18) for a discussion of some of the different rates of return concepts and their interrelationships.

less than the mark-ups that would be desirable from the point of view of the general government.

(b) "Semi-independent" Public Enterprises

3.51 As revenue earning financial institutions the public enterprises in this category will also have their financial targets and objectives, like the enterprises in the previous category. As such a "semi-independent" public enterprise will also have its own cost recovery rate, as discussed in para. 3.49.

3.52 However, in this case the public enterprises are to be treated as integral parts of the public sector, and their pricing and investment policies must coincide with those that would be appropriate from the broader perspective of the public sector. The pricing policy appropriate to such an enterprise may thus be derived directly from the considerations discussed in the previous subsection (ii) and in Section II.

3.53 In each case it is possible to estimate both (i) net revenue requirements necessary to satisfy the individual public enterprise's own desired financial cost recovery rate, and (ii) the net revenue generation that would result if the pricing policy is determined from the point of view of the public sector, with reference to the fiscal cost recovery rate. It should be noted that the accounts of the enterprises in this category should be regarded as a part of the public sector account in estimating the fiscal impact of the projects concerned. The products and services provided by the

the enterprise are to be regarded as public sector products and services, and the total incremental sales revenue therefrom are to be regarded as accruing to the public sector, although this revenue may be shared between the government and the entity if there is a sales tax.

3.54 In the event that the comparison of the estimates (i) and (ii) in the previous paragraph reveals material differences, the preferable procedure would be to adjust the financial targets of the public enterprise. If this is undesirable in a particular case, then alternative (but essentially equivalent) means may be employed, such as reimbursing the public enterprise for providing services at prices which are not adequate to cover the financial costs of the services. For example, a municipality may reimburse a water supply enterprise for providing water to a neighborhood free of charge through public standpipes, by levying additional taxes on the households in the neighborhood.

3.55 Such problems tend to arise whenever the optimum product prices are too low to permit satisfactory financial performance, i.e., whenever project entities are charged with the mixed responsibility for managing both financially viable and non-viable operations. But optimum product prices may also be higher than those derived by an entity from its financial targets. As a general rule, therefore, it is preferable to compare the fiscal cost recovery considerations with the entity's own cost recovery considerations, and if these two different perspectives produce material differences to the pricing and investment decisions, these should be reconciled through appropriate re-arrangements of the financial relationship between the entity and the government. Such re-arrangements would have the desired effect of equating the scarcity "premium" on the resources at the disposal of a public enterprise with the scarcity "premium" on the resources at the disposal of the government.

IV. SUMMARY

4.1 This paper has discussed the general principles relevant to the decisions on recovery of the costs of a project from its beneficiaries. From this point of view, the discussion has centered on the two revenue generating instruments specific to a project, viz. the pricing of its products and services, and discriminatory taxation of its beneficiaries. When both these options are available, greater reliance should be placed on taxation than on pricing. The prices of the products and services provided by the public sector should be set at their efficiency levels (discussed in Section II), unless the sacrifice of the net project benefits involved in charging more than such prices is fully compensated by the value in alternative uses of the additional revenue raised. The risk of underestimating the sacrifice of the net project benefits is particularly high when the products and services concerned enter into other production processes.

4.2 More generally, the principal considerations that should determine the optimum pricing and beneficiary taxation decisions are the following:

(a) The losses of the project's net benefits that are likely to be incurred by departing from the efficiency prices for the products and services of the public sector (when product pricing is relevant).

(b) The losses of the project's net economic benefits that are likely to result from the imposition of discriminatory benefit taxes (when such taxes are relevant).

(c) The scarcity of resources available to the public sector when this aspect is relevant, the project's deficit or surplus should be determined by a comprehensive fiscal measure, defined in para 3.11, which includes all incremental revenue inflows to the public sector, whether from new or existing taxes on income and wealth, or from new or existing taxes on the various project inputs and outputs, or from other sources.

(d) The post-project income and wealth of the individual beneficiaries as compared to those of others in the society, and the relative valuation of their income and wealth.

4.3 If these considerations are applied to determine the optimum pricing and taxation policies, then a corresponding optimum fiscal deficit or surplus will be defined, yielding an optimum fiscal cost recovery ratio. A corresponding optimum partitioned cost recovery ratio may also be defined with only the policy variables, viz. product pricing and discriminatory taxes in the numerator, as in the ratio R_1 defined in para. 3.38. It should be noted that the generation of additional private savings may also be a relevant additional consideration in some cases.

4.4 There is, however, no a priori reason why the optimum value of such a ratio should be at any particular level. The optimum value can be zero or over 100%. It will be 100% only by chance, and consequently the conventional full cost recovery rule has no intrinsic validity. Furthermore it is usually defined in partial terms. If a value judgment is made that the "beneficiaries should pay total costs" then all incremental payments made by the beneficiaries to the public sector in order to realize their benefits should preferably count, regardless of the particular mode of payment. Meaningful quantitative cost recovery norms can only be derived for specific sectors and types of projects, and then only if the general considerations listed in para 4.2 bear with sufficient uniformity.

4.5 These considerations remain material when revenue earning project entities are considered, as long as the financial resources at the disposal of such entities are not valued differently from the resources at the disposal of the general government. In the event that correct pricing decisions are not consistent with the financial targets of an individual project entity, the preferred procedure will be to adjust the financial targets, or alternatively the entity should be reimbursed directly in exchange for a commitment to charge lower prices than its financial targets require. Situations in which neither adjustments to the financial targets nor compensating payments are desirable, are situations in which it is considered appropriate to evaluate the financial resources of the entity and of the government differently. In such cases the mark-ups on efficiency prices will be determined entirely by the independent financial objectives of the entity, and the third factor (c) listed in para 4.2 above will need to be changed accordingly.

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PRELIMINARY

BACKGROUND PAPER II

For

"PROSPECTS FOR THE DEVELOPING COUNTRIES"

ENERGY SUPPLY DEMAND OUTLOOK 1980-1985

IBRD
Report # 477
July 18, 1974

ENERGY SUPPLY/DEMAND OUTLOOK 1980-1985

1. This paper provides the general background for Section II C: "Future Demand and Supply of Energy," of the Bank's July 8, 1974 report on "Prospects for the Developing Countries". It is divided into four parts: A. Historical Background; B. Alternative non-OPEC Energy/Supply Developments; C. Demand Changes; and D. Energy Balance--Projected Requirements of OPEC Oil.

A. Historical Background

2. Modern society is characterized by high and continually increasing levels of energy consumption. "Technological Man" (U.S. 1970) is using about one million BTU of energy per capita per day. 1/ His consumption is three times that of "Industrial Man" (Western Europe, 1870's); ten times that of "Renaissance Man" (Europe, 16th century); and 100 times of that used by "Primitive Man" (100,000 BC) whose prime concern was getting the 10,000 BTUs needed to feed himself. Today's energy consumption per capita in different societies varies almost as broadly as the historic range. 2/

3. Until 1800 the main fuel in use was wood. With the industrial revolution the coal age arrived; up to 50 years ago it provided 85% or more of world energy requirements. With the advent of the internal combustion engine and its suitability for transportation, the petroleum industry developed very rapidly, first in the U.S. and after 1950 in the Middle East and Africa. The present age of hydrocarbons--oil and natural gas--had begun.

1/ 1 BTU = 0.25 Kcal.

2/ World average is about 1/5 of U.S., Europe 1/2, India 1/10, Rural Africa 1/100.

4. Table 1 summarizes past developments in the world energy mix since 1925. It shows the changing roles of the various primary energy sources, it also gives the growth of total energy consumption, and the proportion of it which goes through the secondary form of electricity.

Table 1

World Consumption of Primary Energy: 1925-1970/1

	Actual		
	1925	1950	1970
Total Primary Energy, 10^{13} kcal (MToe)	1200	1800	5100
	% Distribution		
Coal	81.7	60.4	33.6
Oil	13.1	24.6	39.6
Natural Gas	3.1	10.4	19.9
Hydro	2.1	4.6	6.5
Nuclear	-	-	0.4
	100.0	100.0	100.0
Electricity % of Total	7	14	25
Nuclear % of Electricity	-	-	2

/1 Including centrally planned countries. Energy is expressed in millions of tons of oil equivalent (Mtoe) or 10^{13} kcal which is its approximate heat content. Other conversion factors are shown in Annex 1.

Source: International Atomic Energy Agency Bulletin, Vol. 15, No. 5, 1973.

Table 1 shows the increasingly rapid shift of primary energy consumption from coal to oil and gas as well as the growth of the electric sector as a final form of energy use.

5. More recent (1960-1973) evolution of world consumption of energy by type of resource and by main groups of countries is illustrated in Table 2.

Table 2

World Consumption of Energy 1/

(in MToe)

(1960-1973)

	N.A.	W. Europe	Japan	Others	Total	%
1960						
Coal	253	363	41	97	754	36
Oil	516	205	30	169	920	45
Gas	332	11	1	20	364	17
Primary Electricity 2/	21	19	5	6	51	2
Total	1,122	598	77	292	2,089	100
(% of World)	53.7	28.6	3.7	14.0	100.0	100
1973						
Coal	335	260	55	130	780	19
Oil	896	736	236	432	2,300	57
Gas	653	135	4	70	862	21
Primary Electricity	50	35	8	20	113	3
Total	1,934	1,166	303	652	4,055	100
(% of World)	47.7	28.7	7.5	16.1	100.0	100

Growth 1960-1973 (% per year)	N.A.	W. Europe	Japan	Others	Total
Coal	2.18	-2.53	2.29	2.28	0.26
Oil	4.34	10.33	17.19	7.49	7.30
Gas	5.34	21.27	11.25	10.12	6.86
P.Electricity	6.90	4.81	3.68	9.70	6.31
Total	4.28	5.27	11.11	6.37	5.23

1/ Excluding centrally planned economies.

2/ Primary electricity is of hydro, geothermal and nuclear origin. Total electric production includes secondary electricity generated in coal, oil and gas burning plants.

Source: P.E.L. Consultants, May 1974

The substitution of petroleum for coal was particularly strong in the period 1960-1973. The growth rate per year was only 0.26% for coal while for oil and gas it was about 7%. In W. Europe and Japan oil and gas were growing at percentages between 10 and 20% while coal was actually declining in Europe, and increasing only slowly in Japan.

6. The changes in the composition of the world energy mix are a reflection of the high degree of substitution which is feasible in the energy sector. Broadly speaking primary energy resources are used in modern societies about equally for (1) transportation, (2) industry, (3) commercial and residential heating, and (4) electricity production. 1/ Electricity is finally consumed in the other three groups but principally in the second and third.

7. The transport sector accounts for about 15-25% of total energy consumption. For technical and/or economic reasons it has become a virtually exclusive province of petroleum. Automobiles and airplanes are a "captive" market with present engine technologies. Railroads and shipping have been converted from coal to petroleum as a result of overall system economics: lower capital and operating costs, flexibility of operation, customer preferences (e.g., cleanliness) all have been factors which made oil more attractive in spite of its higher cost vs. coal as measured by heating value alone. 2/

1/ For instance in the EEC in 1971, primary energy usage was distributed: (i) industry 33%, (ii) transportation 16%, (iii) residential/commercial 24%, (iv) electricity 23%, and (v) other 4%.

2/ In 1925 more than 90% of locomotives and 50% of ships used coal. Today these percentages are negligible.

8. Residential and commercial use accounts for about 20% of primary energy consumption in industrialized countries and about 10% in the developing world. Lighting and the electric motors in air-conditioners, refrigerators, and other household appliances represent a "captive" market for electricity. Domestic and industrial space heating, which together represent up to 40% of all energy consumption in industrialized countries, present ample opportunity for competition and substitution among energy sources. Heating is presently dominated by gas, having in the past relied in succession on wood, coal and oil. Availability, price, installed cost of appliances, and convenience (cleanliness, automation) are the main factors usually considered in making a choice between fuels. Electricity has also been used for space heating, mainly in the U.S. in connection with commercial buildings where saving in duct space is an important cost factor. In the past this practice has been criticized as wasteful of energy, 1/ but it need not be. The more prevalent use of the heat-pump 2/ and other heating devices, together with significantly improved insulation, will encourage more efficient electric heating, which under appropriate circumstances will be both economically attractive and conservative of primary fuel. This will be especially significant as power systems begin to rely on nuclear plants for most of their off-peak generating needs.

1/ Power plants convert only one-third to two-fifths of the heat in fuel they burn to electricity, and so direct reconversion of electric power into heat in space heating applications cannot be more than 33%-40% efficient in terms of original fuel.

2/ A reverse refrigeration-type machine, electrically-driven, which delivers heat from the environment (e.g., the air) to the space to be heated. An efficient installation will deliver two times the heat value of the electricity to run it.

9. Industry and electric utilities account for another 20-30% each of the primary energy market (with the latter growing at nearly twice the rate of the other users). Coal, oil, gas and nuclear power will compete for these markets primarily on the basis of their respective costs per unit of heat delivered at the plant. 1/ The outcome of this competition depends very much on local conditions, especially proximity to coal mines. In the case of the utility industry, coal transport costs can be minimized as power plants can be built near the mines and the electricity transported. For these reasons coal, at least in many regions of the U.S., the U.K. and Western Europe, has maintained a very significant share of the utility market. In the U.S. where coal is relatively cheap, its choice as a boiler fuel is dictated by purely economic considerations. In the U.K., Western Europe, and Japan, however, it continues to be used largely because government policies have protected it against the inroads of (then) cheaper imported oil. In the long run, nuclear energy seems destined to become the dominant utility source.

10. The sharp increases in petroleum prices which took place in late 1973 and early 1974 roughly quadrupled f.o.b. crude oil prices. In the period 1955-1970 Persian Gulf f.o.b. crude oil prices had decreased from about $1.90 to $1.30, a drop in real terms of about 60%. The new high prices of crude oil thus drastically change the comparative advantage between oil and alternative sources of energy, domestic or imported. In addition higher energy costs influence choice of machinery and appliances in favor of more

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1/ Plants burning coal usually have slightly higher capital costs than those burning oil or gas. This can be offset by a fairly small fuel cost differential. Nuclear plants, on the other hand, have much higher capital costs, and become attractive only where substantial differentials exist between nuclear and fossil fuel costs.

efficient, less energy-consuming equipment and processes. Over and above the results of multiple, decentralized market decisions based on the new cost relationships created by the higher oil prices, the Governments of oil importing countries, pressed hard by the very significant effects of these costs on their balances of payments, are likely to adopt accessory policies (in taxation, prices, regulatory codes, etc.) directed to energy conservation, demand compression, and rapid development of cheaper energy supplies--often with a preference for domestic sources.

11. In what follows we discuss the effects which these actions--and the changed world economic outlook--are likely to have on the energy supply/demand prospects as compared with what had been expected under the conditions prior to the events of October-December 1973.

B. Alternative Non-OPEC Energy/Supply Developments

12. In global terms 1/ and for the period up to 1985 major non-OPEC energy developments will be concentrated in the traditional sources of primary energy: coal, crude oil and natural gas. Coal production which has been growing at about 2% in most areas and actually decreasing by 2.5% per year in W. Europe (see Table 2, p. 3) is now expected to increase at about 4.5% per year, particularly in the U.S. and Australia. Its share of total energy which almost halved in the period 1960-1973 from 36% to 19% is expected now to stabilize at about 20%. Non-OPEC oil and gas production which was expected to grow slowly, by about 25% in the 13-year period 1972-1985, is now projected to grow by as much as 55% (Table 6, para. 65). The

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1/ Global figures in this report will generally include market economies only, and exclude centrally planned countries.

most important non-traditional new form of energy to be added in this period will be nuclear power, which is expected to represent the equivalent of about 750 Mtoe 1/ by 1985 or about 30% of the total energy supply additions to be made in the period 1974-1985. During this period it is also expected that a significant technological and financial effort will be made to develop commercial production of oil-like fuels from tar sands (Canada), shales (USA) and coal (USA); maximum feasible volumes of production are estimated at about 200 Mtoe by 1985 from all these sources combined, but this could only be achieved with considerable support from Government. Actual expected production figures by 1985 are estimated to be considerably less, about 50 Mtoe per year. Other sources, conventional such as hydro or less conventional, such as geothermal, solar heating and wastes, are also expected to make some contribution to total energy supplies; but in global terms they are considerably less important (altogether they may be about 5% for hydro and 1-3% for all the rest). A more detailed discussion of the various non-OPEC sources mentioned above follows. Estimates of possible production volumes and costs are given.

Crude Oil and Natural Gas

13. At the new oil prices it has become economic to accelerate exploration and production of oil and gas in all geologically promising areas. Initial efforts would probably be concentrated in North America and the North Sea. The comprehensive US National Petroleum Council study of 1972 considered that US domestic production of oil could be increased from about

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1/ Mtoe = million tons of oil equivalent = 10^{13} kcal = 1.4 million tons standard coal. 1 million barrels per day (mbd) = 50 Mtoe/year.

520 Mto to about 665 Mto by 1980 and 775 Mto by 1985 if a policy of maximum development of domestic resources were undertaken. Without such a policy, domestic production would stagnate at the 500 Mto level. A similar situation exists in natural gas. An intensive development policy would mean an increase from present levels of US production of about 500 Mtoe to 650 Mtoe in 1980 and 775 Mtoe in 1985. Without such a program, natural gas production would be expected to decrease by about 25%. In the light of present conditions some of the assumptions underlying NPC's above quoted forecasts, particularly those regarding price evolution in the period 1973-1985, have in fact been over fulfilled. 1/ The supply estimates used in this report are about 5 to 10% lower than the figures quoted above. The capital requirements needed for the intensive development of US domestic oil and gas as indicated above were estimated at about $250 billion, of which about $170 billion would be used in exploration and production. 2/ This is about double the investment required to maintain the current output level.

14. Developments in the North Sea might increase indigenous supplies of oil in OECD-Europe from current levels of 25 Mto to about 220 Mto in 1980 and 285 Mto in 1985. Oil consumption by these dates is projected at about 870 Mto and 1100 Mto. Thus, requirements from outside sources will remain high. Western Europe's natural gas production is expected to increase from about 110 Mtoe to about 230 Mtoe in 1980 and 290 Mtoe in 1985, while total

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1/ E.g., the "required" prices for intensive development were about $5 per barrel of oil in 1975 and $7.50 in 1980 (in 1974 US$).

2/ Measured in 1970 US$. In current dollars these amounts could be 40-50% higher, depending on the timing of these expenditures.

consumption is projected at 290 and 385 Mtoe by the same dates. In this way W. Europe dependency on petroleum imports might be reduced from about 85% of petroleum consumption in 1972 to about 60% in 1985.

Oil Prospects in Non-OPEC LDCs

15. There is considerable scope for oil and gas exploration and production in non-OPEC LDCs. The development of this resource base may be important for the economic well-being of many present oil importing LDCs; however, it is unlikely that major production additions will materialize before 1985.

16. Presently known oil fields can only sustain world oil requirements for the next 2-3 decades and are heavily concentrated in 8 OPEC members plus the US and the USSR. Undiscovered oil, however, may be 1.7 to 5 times the above amount; and about half of it probably lies in developing countries of Latin America, Africa, and Asia which are not already playing a major productive role. Undiscovered oil is assumed to exist in areas with geologically favorable characteristics--geosynclines and cratonic formations. 1/ Without exploratory drilling it would be very difficult to ascertain which basins in these petroleum "prospective" areas would contain petroleum in commercially recoverable form.

17. Estimates of "ultimate" recoverable reserves from all these prospective areas would add about 1,700 to 5,000 billion bb to the 1,000 billion bb quoted as existing in known fields. It is estimated that Latin America may hold about 500 to 1,200 billion bb; Africa and Madagascar about 470 to

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1/ Geosyncline: a great downward flexure of the earth crust filled with folded and faulted sediments. Cratonic: relatively stable segment of earth crust overlain by not too deformed sedimentary deposits.

1,200 billion bb; and South and South East Asia about 130 to 325 billion bb. That is, Latin America and Africa may each hold as much ultimate oil reserves as those of the Middle East. Among most promising new oil countries not in OPEC are: Mexico, Colombia, Brazil, Peru, Argentina in Latin America; Mali, Niger, Egypt, Mauritania, Chad, Tanzania, Somalia and Mozambique in Africa; India, Pakistan, Burma, Bangladesh, S. Vietnam and Thailand in South Asia.

18. The above estimates are based on correlations with average geologic conditions; some further allowances might be made for the eventual occurrence of abnormal clusters of giant accumulations such as those of the Middle East, which may not be unique. Candidate regions for such clusters are the north slopes of Canada and the USSR, Gulf of Mexico, Argentine continental shelf, the offshore areas between Mozambique and Madagascar and between Australia and New Guinea.

19. As suggested above most of the undiscovered oil potentially lies in regions (on and off-shore) belonging to non-OPEC LDCs. To explore and develop these resources a major reorientation of past drilling efforts would be required. It is a remarkable fact that the US, with only 5% of the world's oil prospective area, has concentrated two-thirds of all past world drilling. The density of drilling per square mile of "prospective" area is in the US 8 times that of the USSR and 20 to 300 times that of other promising regions (see Table 3).

Table 3

Past Drilling Efforts

	Wells drilled per 1,000 sq. mile of prospective area	Prospective area (100,000 sq. miles)
US	1,117	79.0
USSR	150	34.8
Argentina, Mexico, Venezuela	50)	48.9
Latin America (rest of)	10)	
South and S.E. Asia (including Indonesia)	10	30.0
Africa and Madagascar	3	47.2
Middle East	10	12.0

The drilling in the US may have been excessive (this was particularly the case in the past). A reasonable drilling density would be of the order of 500 wells per 1,000 sq. mile for average conditions. 1/ This would mean to increase ten-fold the effort in Latin America and about 100 times that in Asia and Africa.

20. Many well known and obvious factors explain past concentration of efforts in such areas as the US, the USSR, Middle East and Africa. In the first two cases an increasing domestic demand accompanied by a large domestic resource potential; in the others the accessibility provided by direct or indirect political control by the West. In this second group of countries we now witness a process of recuperation of control and ownership by the host governments through the establishment of national oil companies. The major international companies and the many private entrepreneurs which were responsible for the discovery and development of the great oil fields in

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1/ The Middle East is an abnormal region characterized by very large clusters where considerably less exploratory drilling is required to ascertain reserves.

OPEC countries are not likely to try again in other LDCs on the basis of past arrangements. Nor are non-OPEC LDCs likely to accept them. Developing countries and agencies should become aware of the great potential value of "undiscovered" oil and begin to work out appropriate policies for its rational and beneficial exploitation. Developing countries with petroleum prospects need to train immediately a minimum number of top level petroleum-related scientists, technologists, engineers and executives, first to deal effectively with foreign counterparts in arranging for technical and financial cooperation, and secondly, to do an increasing part of the work themselves. Foreign companies should realize that they are unlikely to maintain stable associations with LDCs in petroleum development unless mutually satisfactory arrangements can be worked out. These are likely to be service contracts, joint ventures, or other balanced type agreements, rather than the concession contracts which are now generally collapsing.

Synthetic Oil and Gas Fuels

21. Oil can be produced also from shale oil, tar sands and coal.

Oil Shale

22. Major known reserves of oil shale have been identified in the US and Brazil; significant reserves are also reported in Sweden and Thailand. The regional breakdown of world reserves presented below is taken from a 1965 report of Duncan and Swanson; Column 1 is known reserves very likely to be recoverable with current state of technology (adequate content of oil per ton of shale and at reasonable depth). They are about equal to the presently proven reserves of crude oil, i.e., about 600 billion barrels.

Column 2 is a best guess as to the magnitude of total oil shale formations with a minimum of 10 gallons per ton of rock; these are indeed very large, about a hundred times present estimated ultimate reserves of crude oil; but what fraction of these deposits may be commercially developed is not known.

Estimates of Oil Shale Resources
(billions of barrels)

Region	(1)	(2)
Africa	100	84,000
Asia	90	115,000
Australia/New Zealand	-	21,000
Europe	70	27,000
North America	600	53,000
South America	50	42,000
Total	910	342,000

23. Some oil from shale is being produced in the US, Brazil and Scotland and other areas on a small scale (a few thousand barrels a day). Massive production of shale oil will involve difficult environmental problems if current technology (above ground as against underground in situ retorting of oil shale) is used. Degradation of the landscape (volume of crushed rock is greater than the original hole), contamination of the water table, and water requirements, which according to some studies may be the most critical limiting factor, are the main difficulties. The best available estimates of the capital cost of plants producing 100,000 barrels per day range from \$600 to \$900 million (in 1974 US\$). The construction time for such plants is estimated to be about 4 years. A recent report to the US Senate 1/ estimates that

1/ "Energy Research and Development - Problems and Prospects." 93rd Congress, 1st Session. Serial No. 93-21 (92-56). US Government Printing Office, 1973.

3 to 4 plants could be built per year starting operations in the late 1970's under a crash government supported program. At this rate, about 3 million barrels per day of production could be available by 1985 or about 150 Mtoe. Oil from shale may under these conditions be competitive in the US market with f.o.b. Persian Gulf crudes at $5 to $7 per barrel (1974 US$).

Tar Sands

24. Major deposits of tar sands containing hundreds of billions of barrels of oil have been reported in Canada, Venezuela and Colombia. In general, the inventory of these deposits is very incomplete; relatively small deposits may also exist in the US, USSR, Trinidad, Albania and Romania. Oil from tar sands is produced commercially in Athabasca (Alberta, Canada) in a plant with a capacity of 50,000 barrels per day. Intensive development of new facilities could bring Canadian production up to a level of about 1 million barrels per day (mbd) by the mid 80's. Oil from Canadian tar sands would be competitive in the North American market with f.o.b. Persian Gulf oils at about $6 per barrel (1974 US$). Similar facilities could be initiated in the Venezuela and Colombian tar areas, though further exploratory work would undoubtedly be required. Production before 1985 is therefore unlikely.

Oil from Coal

25. Two processes for extracting oil products from coal were successfully developed in Germany during the 1930's. 1/ Other plants were also operating in the UK, Italy, Korea and the USSR during the last war. Since 1955 a modernized plant consuming 4 million tons of coal per year has been

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1/ Over 5 million tons of gasoline were produced by these plants during World War II.

operating in South Africa. In all these cases strategic factors have overriden economic considerations. Past efforts also were directed primarily to the production of gasoline, whereas future efforts are more likely to emphasize the production of substitute heating and fuel oils as well. Future commercial plants would be designed for a 100,000 barrel per day capacity and are estimated to cost about $600 to $900 million. 1/ Overall coal liquefaction costs would be competitive with Persian Gulf f.o.b. crude oil prices of about $7 to $9 per barrel (1974 US$), using low cost US coals. The environmental problems will be the same as those associated with coal mining in general and somewhat less than those of oil-shale mining. However, some of the technological problems associated with coal liquefaction processes themselves are complex and it is unlikely that major plants would be built without considerable testing of the processes in pilot operations. Consequently, oil production from coal before 1980 is unlikely; however, if the technology proves out, production may expand more rapidly than that of shale oil. A production level of about 100 Mtoe for 1985 might be feasible.

Gas from Coal

26. Coal gasification, particularly the production of high BTU gas equivalent to natural gas--is one of the most promising and significant developments in the energy field. Several processes have been tested in the pilot stage and one of them (the Lurgi process originally developed over 30 years ago) has been used on a commercial scale. At least 3 processes are far advanced for the production of low BTU gases suitable for power and industrial uses. Over 8 processes have been proposed for production of SNG (natural

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1/ US Senate report quoted para. 23.

gas substitute) which is more suitable for domestic and established users. Estimated costs of coal based synthetic natural gas are about $1.00 to $1.60 per thousand cubic feet. US well head natural gas prices in inter-state commerce (regulated by the Government) are about $0.42, but intrastate prices range up to $1.00; and imported LNG may cost anything between $1.30 to $2.00 when it is delivered in quantity in the late 1970's.

27. 176 potential coal gasification sites have been identified in the US. The main requirements are: (1) an adequate adjacent coal reserve base (i.e., about 200-500 million tons) for operating a commercial size gasification plant (250-750 million cubic feet per day) for 30 years; and (2) abundant water supplies to provide the steam required by the hydrogeneration process. In addition, it is essential that coal be available at reasonable costs; open cast mines and moderate depth underground mines are the most suitable. It seems reasonable to suppose that suitable sites also would exist in the UK, Germany, and other coal mining countries; however, no important programs of this type outside the US have been announced.

28. It is estimated that thirty plants might be put in operation in the US by 1980 and about 70 by 1985. Each plant would produce 250-750 million cubic feet (MCF) per day. The capital cost would be about $1 million per MCF per day of capacity, equivalent to about $600 million for 100,000 barrels per day production of oil. Total energy from this gas would represent about 50 Mtoe in 1980 and about 150 Mtoe in 1985.

Coal

29. For the last decade coal consumption has been increasing at a very low rate of 0.26% per year, while oil and gas increased at about 7% and overall energy by an average of 5.2% (Table 2, page 3). Furthermore, one of the major coal markets--the electric utilities--recently began to turn towards nuclear power. 1/ All previous forecasts regarding the future of coal had, therefore, assumed a continual decrease in importance, so that for the year 2000 only about 10% of primary energy was foreseen as originating in solid fuels in spite of the fact that coal reserves are about 15 times those of oil or gas.

30. Average coal prices in major markets were in 1973 equivalent to anything between 30¢ and 90¢ per MBTU 2/--the lowest prices prevailing in the US, Canada, Australia and South Africa, and the highest in the U.K., W. Europe and Japan. In these latter regions, oil was a very competitive alternative at its 1973 price of about 50¢ to 60¢ per MBTU. With current and foreseen oil prices of about \$1.30-\$1.50 per MBTU, there is an economic incentive for substitution back to coal, even allowing for additional environmental and pollution control costs.

31. The most promising areas for increasing coal production are the US, Australia and some parts of Africa, where open cast mining is possible and production facilities can be expanded in a few years. The UK and Germany, which also have a large coal base, as well as Japan, may find it difficult to activate more mines, mainly because of labor recruiting problems for underground mining.

1/ World coal consumption of about 2,300 million tons per year is shared by Utilities 900, Iron and Steel 470, Industry 700 and Domestic 230; these figures include centrally planned countries.

2/ About \$8 - \$25 per ton of standard coal.

32. In the US the investments needed, in terms of dollars per ton of additional annual production, are about \$18-\$22 for underground mining and \$10-\$13 for strip mining. Expansion is expected to be shared about equally by each type of mine, so that a good average figure is \$16/ton/year of capacity. Therefore, total investment requirements up to 1985 to produce an additional 700 million tons of coal per year (including replacing about 200 million tons of existing capacity) would total about \$11 billion. To this one should add about \$3 billion for investment in coal transportation facilities. In Europe and Japan, the investments required to maintain present levels of production are estimated at about \$4 billion through 1985 on the basis that about 100 million ton/year of new production would be required in order to replace pits closing during the period; and that investment per ton per year of additional capacity is about \$36 in these regions, due to the less favorable characteristics of the mines.

33. Major new extraction facilities for coal may require a lead time of about 1-2 years for strip or open-cast mining (depth 0-100 ft); 3-4 years for adit and drift mines (depth up to 200 ft); and 4-8 years for deep underground mines (up to 2000 ft depth).

34. An intensive coal production drive in the US would mean that coal production may grow from the current 500 MTon/year to about 1,000 MTon/year by 1985. Part of the new increase would be used for the production of synthetic gas and oil mentioned previously. The main problems are the environmental requirements of land reclamation in open cast mine areas and air pollution from combustion gases. Both these problems can be solved by existing and foreseeable technologies but at a rather significant cost--estimated at about \$0.35 per MBTU.

35. A net increase in coal production can also be expected from Australia mainly for export to Japan. The latter are currently about 20 MTon/year and are expected to double by 1980. Europe, on the other hand, was expected to experience a decline in output from present levels of 360 MTon/year to 260 MTon/year in 1985. Major efforts are now likely to at least maintain the present output levels. In order for this production to increase it would be necessary that new underground mining technologies be adopted more widely. The same considerations apply to Japan.

36. The developing countries have generally not exploited their coal resources very extensively, a notable exception being India. Under present conditions these countries may be expected to look again into their coal potential both for domestic as well as for possible export. Coal and lignite may play an important domestic role in a few LDCs (Yugoslavia, Turkey, India, Brazil, Argentina, Chile, Korea, Taiwan, Indonesia). Very few--e.g., Colombia, Botswana, Swaziland--may develop it as an export product.

Nuclear Power

37. Prior to the current energy crisis, nuclear power was already being developed at a very high rate, although the share of nuclear energy in total supplies remained very small. World installed capacity by the end of 1973 was about 50,000 MWe, with over a half in the US. By 1980 this figure could be about five times higher and by 1985 about ten times or approximately 500,000 MWe. In terms of percentage of total installed electrical plant, these figures would represent about 20% by 1980 and 25% by 1985. In terms of energy generated, because nuclear plants are used as base load, the percentages would be higher--about 28% and 35%. It seems very difficult to

increase pre-crisis nuclear programs very substantially before 1980 due to the long lead time--up to 10 years--required for licensing and construction of these facilities, and the difficulties involved in expanding ancillary engineering and manufacturing capacities. A 10% to 20% increase over previous plans may be feasible by 1985.

38. Until recently the economies of nuclear power vis-a-vis oil plants looked marginal at unit sizes below 600 MW. They would now be theoretically competitive at sizes well below that--even 200 MW--and, therefore, they could be located in a larger number of developing countries. However, it is very unlikely that they would be available as the manufacturers with experience in this field are geared to produce the larger units and will be overstrained to meet the increased demand of the industrial countries.

39. Rapid expansion of nuclear power capacity can only take place if a number of present constraints can be overcome. Safety is a major consideration in operating such plants, and opinions still vary widely as to the degree this problem is under reasonable control. Other factors which are of importance are the identification of proper sites (which combines to some extent with the need to dispose properly of nuclear and heat wastes) and the potential of countries acquiring nuclear capacity to use this for military purposes. Nevertheless, a major further expansion can be foreseen, combined with a wider spread in terms of the number of countries relying on this technology.

40. In terms of investment nuclear power requires about twice as much capital per unit of power generated as fossil fuel plants (about $400 per KW of capacity vs $200 for a typical 600 MW unit). However, overall energy costs, are lower because fuel costs in nuclear plants are equivalent to about 20¢/MBTU compared with January 1973 oil costs of 35-50¢/MBTU and current prices of the order of 100-150¢/MBTU.

Hydroelectricity

41. At the present time a large portion of the developing world's electric energy requirements are being met from hydroelectric sources: 44% of all electric production is hydraulic, as compared to 24% in the developed world. Total production of electricity in the developed world is presently some 9 times that in the developing world, but the developing world has a much greater untapped potential of hydroelectric power, particularly in some parts of Africa, most of Latin America and in south central Asia. In some of these areas, it is the energy resource which can be developed most easily.

42. Some of the countries with major hydroelectric resources which have not yet been developed include: in Africa Cameroon, CAR, Congo, Zaire, Gabon, Mozambique, and Malagasy; in the Western Hemisphere Chile, Venezuela, Peru, Brazil and Colombia; in Asia India, Pakistan and Thailand; and in Europe Turkey, Greece and Iceland. In some countries, a substantial part of the total undeveloped resources is located far from the present market for electricity; these sites may nevertheless be attractive for development at the new level of prices of fossil fuels.

Other Sources

43. Geothermal resources are being explored in about 20 countries, most of them LDCs. Geothermal energy is used already in minor amounts in about 8 countries for electricity production and space heating. Until new technology is developed to extract heat from deep rock the only economic sources are rarely occurring brine and steam deposits located at depths between 500 to 2,500 m. Their energy potential is too limited to make a meaningful contribution to world needs but they may be significant for specific locations (e.g, Salvador, Iceland, North of Chile, South Luzon, etc.).

44. Solar energy can be used for residential/commercial space heating and in some industrial processes. We may expect an increase in its use for these purposes, particularly in new construction. Solar heating in temperate countries may reduce residential energy requirements by as much as 50%. It is used extensively in Israel and had begun to be used in California and Florida in the US, till cheaper fuels discouraged further growth. Solar electricity can be produced (and is used in space applications) in solar cells. At current costs it is about 100 to 1,000 times more expensive than conventional power generation. Only major research and development efforts might produce the breakthroughs that are needed to bring these costs down; none are foreseen within the next 10-15 years.

45. Other energy sources frequently mentioned are: wastes, wind, tides, etc. Though instances in which each of them can be of limited help do exist, globally speaking they have been evaluated as potentially small (wastes, tides) or costly except under special circumstances (wind in isolated rural areas).

C. Demand Changes

46. Many studies have been made in the industrial countries in order to forecast accurately the growth of energy demand. Most of these studies project energy consumption, locally and by sector (transportation, industrial, commercial, residential, and electricity); they consider the relations of energy use to total GNP as well as to its sectoral composition; they include appropriate assumptions on population trends, modes of life, environmental policies and technological changes. In exceptional cases (e.g., the 1972 NPC US Energy Outlook Study) assumptions on price trends have also been explicitly incorporated.

47. In the years 1955-1972, energy use has grown at rates fairly close to GNP growth. The elasticity of energy consumption to GNP 1/ in the developed countries generally ranges around unity but appears to be lower with higher levels of development. Thus in the US and Canada energy use increased slightly less per year than real production; in Western Europe the rates were about the same on average, but in Japan and the centrally planned countries energy consumption growth exceeded the rate of growth of GNP. In the developing countries, energy consumption growth has tended to exceed production growth even more, reflecting the modernization of their economies towards more energy intensive production activities.

1/ This elasticity coefficient, also called "income" elasticity, measures the percentage change in energy demand caused by a 1% change in GNP.

48. Most experts 1/ have favored an empirical-historical approach when forecasting demand for LDCs. They have noted that the fairly constant GNP/energy relations observed in most industrial societies do not hold for long in LDCs as these evolve from agrarian to industrial production modes.

49. In estimating the likely impact on demand for energy of the recent oil price increases and the changed world economic outlook, major modifications of pre-crisis estimates should include:

(i) A first impact due to price elasticity of demand 2/ and, to a lesser extent, Government fiat enforcing energy conservation practices.

(ii) A second impact due to changes in the previously expected rate of GNP growth.

Price Elasticity of Demand

50. Extrapolation of energy and particularly oil consumption trends for the next decade based solely on energy/GNP ratios measured during the last 15-20 years would be grossly inadequate under present conditions, particularly if one takes into account the fact that energy prices and specially petroleum prices had been falling in real terms and now have suddenly increased by a large step.

1/ E.g., A. Aoki (Japan), F. Felix (USA).

2/ Price elasticity is the percentage change in demand caused by a 1% change in price. A "cross-elasticity" of demand measures the percentage change in quantity demanded of a fuel with respect to a 1% change in the price of another (substitute) fuel.

51. There is considerable literature on energy demand elasticities (as a function of income and price). Some of it relates to specific fuels or uses (e.g. natural gas, fuel oil, residential electricity); most of it refers to the U.S. and Europe. The application of past studies to the present conditions can only be made with a high degree of caution, particularly because, for short-term substitution effects, not only the rigidities of user's equipment but also the limitations of available supply alternatives may act as very important constraints. 1/ For longer term projections (beyond 1985) these constraints should not be so limiting. Caution is also needed before extrapolating linearly for price changes which are much higher and sudden than any previous ones.

52. For these reasons it appears advisable to project lower elasticities than historical over measured and to prefer aggregate sectoral energy elasticities (e.g. change in total residential demand with average energy cost to the sector) rather than cross-elasticities among energy substitutes (e.g. heating oils vs. gas). Typical long-term (above 5 years) price elasticities of demand in the various sectors which have been used in recent studies range between -0.2 and -0.4 (see table below).

1/ In the period 1950-1972 coal was being replaced by oil and natural gas which were not only cheaper and more convenient to handle but also were made available in large amounts as demand increased. Availability of coal and nuclear energy is much more constrained by technical, financial and environmental factors. Therefore cross-elasticities for substitution among fuels are not likely to behave symmetrically (e.g., oil to coal vs. coal to oil).

53. Long-Term Price Elasticities of Demand for Energy by Sector

Sector	U.S.A.	W. Europe	Japan
Residential/Commercial	-0.2 to -0.3	-0.4 -0.4	-0.3
Industrial	-0.4	-0.3	-0.2 to -0.3
Transportation (Gasoline)	-0.3 to -0.5	-0.3 to -0.4	-0.4
Transportation (Other fuels)	-0.20 to -0.40	-0.2 to -0.30	-0.40

Sources: N.P.C. - U.S. and OECD reports

Other studies which have used cross-elasticities rather than average total sector elasticity coefficients quote figures such as: -0.24 to -0.82 for gasoline; -1.0 for residential electricity; -0.76 to -2.0 for various heating oils. 1/

54. For short-term elasticities the values observed are considerably lower. The U.S. Federal Energy Administration for instance is projecting 1974 unconstrained quarterly demands using elasticities of about -0.07 for kerosene; -0.15 to -0.21 for gasoline; and -0.12 to -0.16 for petrochemical feedstocks. They use higher values for longer periods.

55. In the Energy Balance Tables, which are presented in Part D of this paper we have generally used for total energy demand an income elasticity (energy/GNP) of about 1.0 and an average long-term price elasticity of about -0.2. This latter value may be somewhat conservative; its adoption is based on the considerations given in paras. 50-53 above. Out projections thus forecast a higher energy demand than others based on coefficients bigger than -0.2, and accordingly larger OPEC sales and revenues.

1/ Houthakker & Kennedy used these demand price elasticities, and oil supply price elasticities - 0.25 to - 0.67 in a recent World Oil Market Model. The result is to project US consumption in 1980 at the level of 1973 and a return to a US oil surplus position.

56. Price elasticities are naturally applied at the consumer price level. Therefore it has been necessary to make assumptions regarding the effects of crude oil f.o.b. price changes on final costs to the consumer, and not only for petroleum products but also for other fuels and electricity. For petroleum products we have assumed that absolute pre-crisis differentials with crude oil prices will be maintained. To the extent that Governments apply absolute rather than percentage type taxes this may be reasonable; for the time being this appears to be the case in most countries.

57. For gas and coal the assumption made is that their prices would increase up to a level of competitive equilibrium with oil based substitutes in those markets and localities where possibility of substitution exists (e.g. coal and fuel oil in thermal plants compete if prices at plant site are about 25% less per heat unit for coal than for fuel oil). On the whole the above assumptions mean that an increase in Persian Gulf f.o.b. crude oil prices of a 100% would have the effect of raising average retail energy costs by about 15% in the U.S., 20% in W. Europe, 50% in Japan and something like 30-40% in most oil importing LDCs. The differences between percentages result from higher or lesser availability of competing domestic fuels and different national tax levels. On the average for the whole of OECD the energy price increase at the consumer level is about one-fifth of the percentage increase in f.o.b. Persian Gulf crude oil prices.

Energy Conservation

58. In addition to the price mechanism, it is likely that Governments by administrative or legislative fiat, will further constrain the growth of energy use. Examples of these measures would be: new building codes requir-

ing better heating/cooling insulation; minimum efficiency ratings for equipment, vehicles and appliances; higher energy-related taxes and possibly (tail-end) power and gas domestic tariffs; restriction on the use of certain fuels for power generation; rationing of fuels for residential/commercial heating, etc. In 1972 the U.S. Government conducted a study 1/ of the possible short, medium and longer term measures that would be needed to reduce the consumption of energy without impairing GNP growth or most people's freedom of choice and mode of life. The study concluded that conservation policies (many of them relying on higher prices to induce market decisions towards energy conservation) could diminish by about one-third the projected growth of energy consumption up to 1990 (and one-half that of oil). In brief, overall growth in energy consumption could be slowed from a rate of about 3.8% per year to about 2.5% without detectable effects on projected GNP growth rates. It is unlikely that similar reductions can be obtained in other societies, where intermediate energy uses (forming part of the process) are a much higher proportion of total uses than in the US; such reductions could be achieved only through considerable adjustments in the industrial and transportation sectors. Some analysis of these possibilities have begun in Japan and other countries, exploring non-energy intensive domestic patterns of industrial growth which happen to be coincidental with other, mainly environmental, objectives.

59. There are considerable differences in the composition of energy consumption by end-uses at different levels of development. Power and transport are the major elements in most developing countries but industrial uses

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1/ The Potential for Energy Conservation, Office of Emergency Preparedness, October 1972 (about 150 pages).

take an increasing share at higher levels of development; in the industrial countries household use is a rapidly growing component. Consequently, conservation of energy use as a means to reduce the cost of and dependence on imported oil is clearly more difficult in countries at lower development levels, as it is hardly possible to save energy without at the same time reducing output and income growth. In industrial countries, where household use is important, reduction can be brought about without production losses. But past experience does not provide any basis for estimating demand elasticities of energy use; this makes it hard to estimate the degree to which consumption can be reduced through the use of the price mechanism.

60. A recent study by OECD 1/ assessed the possibilities of reducing the use of energy in its member countries and found that, on the average, a reduction of demand by 7-8% might be feasible without reducing economic growth. This percentage varied from country to country, being highest for the US (8.5%) and lowest for Japan (6%).

Substitution and Technical Constraints

61. The shifts which are likely to take place in the composition of the energy "mix" in the period 1973-1985 under the supply/demand assumptions discussed in this paper are comparatively minor compared with those of the preceding 10-15 years in W. Europe and Japan. Table 4 illustrates the expected shifts in the primary energy composition up to 1985 in the OECD group of countries, which may be compared with the larger changes shown in Table 2 for the period 1960-1973. Background Paper V discusses in more detail the sector shifts which are likely to occur, particularly in electricity production and some energy intensive industries.

1/ OECD: "Economic Outlook," No. 14, dated December, 1973.

Table 4

Changes in the Energy Mix in OECD Countries
(In %)

	1971 Actual	1980 Estimated	1985 Estimated
Coal			
Indigenous	20	17	19
Imported	1	1	1
Total	21	18	20
Oil			
Indigenous	21	22	21
Imported	32	27	24
Total	53	49	45
Natural Gas			
Indigenous	21	21	20
Imported	-	2	1
Total	21	23	21
Primary Electricity	3.5	10	15
(of which Nuclear)	-	(7.5)	(12)
Total Primary Energy			
Indigenous	66	70	75
Imported	34	30	25
Total	100	100	100

Table 5 shows the expected shifts in use of sources of energy by the various user sectors: residential/commercial, transportation and industrial; it also shows the important changes expected in the energy sources required to generate electricity.

Table 5

Shifts in Energy Use in OECD Countries by Sector

			Coal	Oil	Gas	Electricity (Secondary)	Total
Industry:	1972	(MTOE	208.3	290.0	326.1	150.9	975.3
		(%	21	30	34	15	100
	1985	(MTOE	224.4	418.4	534.0	331.3	1508.1
		(%	15	27	36	22	100
Transportation:	1972	(MTOE	2.9	721.0	.1	4.2	728.2
		(%	1	98	-	1	100
	1985	(MTOE	-	1195.7	-	9.1	1204.8
		(%	-	99	-	1	100
Residential/ Commercial:	1972	(MTOE	56.3	402.5	251.3	141.6	851.7
		(%	6	48	29	17	100
	1985	(MTOE	20.4	420.5	516.5	345.6	1303.1
		(%	1	33	40	26	100

			Coal	Oil	Gas	Nuclear	Other	Total
Electricity Production:	1972	(MTOE	329.1	219.4	130.6	34.8	250.1	974.0
		(%	34	33	13	4	26	100
	1985	(MTOE	603.0	224.5	196.6	790.9	390.3	2205.3
		(%	27	10	9	36	18	100

The main sectoral shifts observed are an increasing role of gas and electricity in residential/commercial use - mainly at the expense of oil. Shifts in transportation are nil (it continues to be a captive petroleum market); and shifts in industry are minor, a continuing decline of coal and increase in electricity, while oil and gas have only small variations; in the generation of electricity the most remarkable, but not unexpected, change is towards nuclear power at the expense of all other primary fuels.

D. Energy Balance - Projected Requirements of OPEC Oil

62. In parts B and C of this paper we have discussed the general basis for the following supply and demand estimates. In the case of supply we assume that the new level of oil prices will stimulate a more rapid development of indigenous resources, oil and non-oil -- in all non-OPEC countries. Supply estimates are based on best available data regarding what is feasible to achieve within the period in question and at costs competitive with imports. Constraints of a financial, technological, and social nature at the producer and utilization ends are also taken into account (e.g. coal production could be expanded in the US at a much higher rate than society will allow, due mainly to environmental constraints). In the case of demand, our estimates vary according to the assumptions regarding GNP growth and future prices of crude oil.

63. As explained in the main report, for the purposes of this study a detailed energy balance analysis has been made only for the OECD group of countries. This group represents 81% of world oil consumption and 86% of oil imports (excluding centrally planned countries which have and are expected to continue to have small energy exchanges with the rest of the world). Our estimates, particularly on supply are based on preliminary results of a recent study made by the Long Term Energy Assessment Group of OECD, which had the benefit of inputs and comments from member governments and their specialized agencies.

64. Depending on which assumptions are made on GNP growth and oil prices, many cases could be developed. In Table 6 we have shown 3 such cases for 1980 and 1985 differing mainly in the price assumptions. These are intended to

TABLE 6 1/

Consumption and Imports of Primary Energy in OECD Countries - 1972, 1980, 1985
(High GNP variant - 3 oil price alternatives)

		1972 Actual	1980 (a)	1980 (b)	1980 (c)	1985 (a)	1985 (b)	1985 (c)
			Persian Gulf Prices f.o.b. 1974 US$					
		2.60	4.12	8.25	12.35	4.12	8.25	12.35
			Average GNP Growth Rates					
			5.0	4.7	4.7	5.0	5.0	5.0
Primary Energy			(millions tons of oil equivalent)					
Coal	Indigenous	640	770	870	880	940	1080	1090
	Imported	20	10	-	(40)	10	(40)	(90)
	Total	660	780	870	840	950	1040	1000
Oil	Indigenous	680	900	970	1090	940	1090	1380
	Imported	1230	2000	1460	1030	2640	1720	1090
	Total	1910	2900	2430	2120	3580	2810	2470
Gas	Indigenous	760	770	870	960	850	1020	1100
	Imported	(10)	170	120	120	280	190	160
	Total	750	940	990	1080	1130	1210	1260
Primary Electricity								
	Nuclear	30	330	350	350	660	760	760
	Hydro/Geothermal	100	120	130	130	140	160	160
	Total	130	450	480	480	800	920	920
Total								
	Primary Energy	3450	5070	4770	4520	6460	5980	5650
	Indigenous	2210	2890	3190	3410	3530	4110	4490
	Imported	1240	2180	1580	1110	2930	1870	1160
	Dependency (% imported)	(36)	(43)	(33)	(24)	(45)	(31)	(20)

1/ This Table provides data for Fig. 2, page 18 of the main report.

Source: IBRD staff estimates based on OECD preliminary results.

provide a broad framework for additional interpolations. Case (a) corresponds to the scenario foreseen prior to the crisis of October 1973. GNP is assumed to grow at about 5% and prices to be $4.12 or about equal to October 1, 1973 (pre-crisis) levels. Case (b) assumes a slightly reduced rate of GNP growth in 1980 (the High variant of Table II.3 of the main report) and a doubling of the pre-crisis price. This price is somewhat less than the average price for 1974 of about $9.60. Finally Case (c) assumes the same GNP growth as (b) but a further price increase to three times October 1, 1973 levels, or $12.35. Table II.5 of the main paper includes two cases which are not far from Case (b) of the Table; they assume prices of $8.65 and $7.00 and are expected to give a reasonable and narrower range for what are currently believed to represent likely scenarios.

65. Cases (a) and (b) of Table 6 give a good indication of the approximate impact of the "energy crisis" on projected amounts of energy consumption and oil imports under pre- and post-crisis conditions. Total primary energy consumption in 1980 would be compressed by about 6-7% of which about 1/3 would be due to income elasticity and 2/3 to price elasticity of demand. At the same time the supply of indigenous sources would increase by about 10%. The net effect is a very significant drop in oil imports: from 2,000 tons (40 mbd) to about 1,460 (29 mbd) or about 30%. 1/ Another interesting point to note in Table 6 is the fact that pre-crisis projections assumed an increased OECD energy dependency from exports of about 45% by 1980-1985.

1/ A reduction of the GNP growth rate for OECD countries from 4.7% to 3.5% (High and Low cases in Table II.3 of main report), together with a price of about $8 per barrel, would lead to even lower projected oil imports, similar to those of 1972 (about 25 mbd).

Under presently foreseen conditions in Case (b) this dependency goes down to about 30%; and in the case of the U.S. (not shown separately) to about 15-10%.

66. Adding to OECDs the oil import requirements of other countries (mainly oil importing LDCs) Tables II.6, II.7 and II.8 of the main report were developed. They are given as Annex 2 in order to make this paper self-contained. 1/

67. In conclusion the above tables show that future world energy growth is likely to slow down from past levels of about 5% to levels of about 4%, and oil consumption in particular from levels of about 7% to about 4.5%. As for oil imports from OPEC countries, the forecasts range over a wide margin. OPEC oil sales will depend on the actual magnitude of the gap between total demand and indigenous supplies of non-OPEC energy; small changes in either will have a large effect on OPEC exports. For Cases I and II of the tables above OPEC sales are projected to be about 30% below those of pre-crisis forecasts. At these reduced volumes of exports, market sharing agreements among OPEC countries would be needed; this has not been necessary before.

The Transition Period 1974-1980

68. In the interim period 1974-1980 supply and demand are likely to evolve as follows. Energy demand will respond first to Government programs and short term (small) price elasticity effects. It may stabilize in 1974 at near 1973 levels and then slowly grow at the new reduced rate of about 4% instead of 5% per year (for oil these percentages are 4.5% and 7.5% respectively). Non-OPEC supplies are not expected to increase significantly before

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1/ Some OECD member countries appear in these tables as other developed (New Zealand, Australia) or as developing (Turkey, Greece). Note that Table 6, on the other hand, included all OECD as one Group.

1977-78 when the initial impacts of Alaska, North Sea and some US offshore supplies will reach the market. World supplies are expected to remain as much or even more dependent on OPEC at least till then; only after 1977-78 will the impact of longer term (larger) ~~since~~ price elasticities and important new supplies begin to become evident.

2 Attachments (Annexes 1 and 2)

E. Friedmann
July 18, 1974

ANNEX 1

Energy Conversion Factors

Source	Unit	Tons of Oil Equivalent (10^7 Kcal)
Crude Oil	Ton	1.034
Coal	Ton	0.7
Natural Gas	M^3	0.9 (USA) - 0.84)
Gasoline	Ton	1.128
Jet Fuel	Ton	1.133
Gas Oil	Ton	1.095
Fuel Oil	Ton	1.055
Electricity (Nuclear)	1000 Kwh	0.2436 (33% efficiency)
Electricity (Hydro)	1000 Kwh	0.1064 (80% efficiency)

July, 1974

TABLE II.6 WORLD OIL CONSUMPTION
(millions of metric tons)

	1970	1972	1973 Provisional	1980 Forecast a/ Case I	1980 Forecast a/ Case II	1985 Forecast a/ Case I	1985 Forecast a/ Case II
United States	695	776	815	958	1110	977	1130
Canada	73	79	84	110	115	130	140
Western-Europe	626	701	748	880	994	1110	1245
Japan	199	234	267	415	430	495	525
Total b/	1593	1790	1914	2363	2649	2712	3040
Other Developed Countries	52	61	64	103	110	146	160
Developing: Non-OPEC	250	288	306	450	470	633	638
OPEC	40	45	48	96	96	157	157
Increase in Stocks	78	34	71	95	100	105	105
Total	2013	2218	2403	3107	3425	3715	4100

a/ See Note to Table II.5
b/ Net of oil consumption and production in centrally planned economies, these appear as net oil exports in Table II.8.

Source: IBRD staff estimate based on OECD preliminary results.

Table II.7 WORLD OIL PRODUCTION
(million of metric tons)

	1970	1972	1973 Provisional	1980 Forecast a/ Case I	1980 Forecast a/ Case II	1985 Forecast a/ Case I	1985 Forecast a/ Case II
United States	538	532	517	680	680	792	740
Canada	72	89	102	115	115	150	145
Western Europe	23	22	23	220	220	285	275
Japan	...	...	1	1	1	5	5
Total	633	643	643	1016	1016	1232	1165
Other Developed Countries	9	15	18	25	25	28	25
Centrally Planned Economies (net exports)	52	49	44	...	...	...	...
Developing: Non-OPEC	161	175	188	300	300	455	480
OPEC	1158	1336	1510	1766	2084	2000	2430
Total	2013	2218	2403	3107	3425	3715	4100

a/ See Note to Table II.5 and footnote b/ to Table II.6.

Source: IBRD staff estimates.

TABLE II. 8 NET OIL EXPORTS AND IMPORTS BY AREA
(millions of metric tons)

	1970	1972	1973 Provisional	1980 Forecast a/		1985 Forecast a/	
				Case I	Case II	Case I	Case II
Net Oil Imports							
North America b/	158	234	280	273	430	165	385
Western Europe	603	679	725	660	774	825	970
Japan	199	234	266	414	429	480	520
Total	960	1147	1271	1347	1633	1470	1875
Other Developed Countries	43	46	46	78	85	118	135
Non-OPEC Developing Countries c/	89	113	118	150	170	140	162
Increases in Stocks	78	34	71	95	100	105	105
Total	1170	1340	1506	1670	1988	1843	2277
Net Oil Exports							
OPEC Countries	1118	1291	1462	1670	1988	1843	2277
Centrally Planned Economies	52	49	44	...	...	...	...
Total	1170	1340	1506	1670	1988	1843	2277

a/ See Note to Table II.5 and footnote 2 in Table II.6.
b/ Canada is a net oil exporter.
c/ Includes developing countries which are non-OPEC net oil exporters.

Source: Bank staff estimates.

PRELIMINARY

SECTORAL ADJUSTMENT TO HIGHER ENERGY COSTS

Background Paper V

for

"PROSPECTS FOR THE DEVELOPING COUNTRIES"

IBRD
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SECTORAL ADJUSTMENT TO HIGHER ENERGY COSTS

I. Introduction

1.01 This paper reviews the general problems of adjustment to the recent sharp increases in petroleum prices in five sectors, viz. power, industry, transportation, agriculture and tourism. The discussion mainly focuses on the probable changes in the costs of production in these sectors, on the scope for saving energy through changes in the production processes, and on the broad implications for sectoral investment choices.

1.02 The paper neither prescribes nor predicts the particular courses of action that individual countries might follow. Needless to say, the actual developments in all these sectors will critically depend on the various changes in government policies that may occur in response to problems arising from the changing energy situation. For example, the levels of tariffs, taxes and subsidies are generally important elements of the costs of production in these sectors and of final fuel prices in particular, and changes in them may very easily accentuate or counteract the changes in relative prices that would otherwise tend to occur because of higher energy costs.

1.03 The sector reviews suggest that significant reductions in the use of petroleum products, per unit of output, are likely to occur only through the incorporation of energy saving technology in new sectoral investments. Such changes are unlikely to be effective prior to 1980, and will also involve considerable additional capital and foreign exchange expenditures. In view of this, the changes in sectoral investment plans need to be formulated expeditiously but in full awareness of the fact that shifts towards energy saving production technology may involve substantially higher costs.

1.04 The unit production costs in the various activities within these sectors are generally not very sensitive to changes in energy costs. Nevertheless, the large increases in energy costs recently experienced will naturally have serious adverse effects on some of the more energy-sensitive activities. This should provide strong incentives to greater economy in energy use, but the scope for saving energy through better conservation measures is of very limited significance in the overall picture.

1.05 The scope of adjustment is greatest in power production, except in those countries currently using sources of energy other than oil. Due to the large increases in the cost of using oil for power production, countries with large oil-based systems will find it relatively much more attractive to switch to the alternatives of using hydropower, coal, lignite, gothermal energy and nuclear energy. However, the feasibility and desirability of greater use of these alternatives vary greatly by system size and the domestic availability of the alternative sources of energy, and depend also on the planning horizon. Even where the system size is not a limiting factor, the development of power capacity from scratch using non-oil resources typically involves much longer lead times (extensive feasibility studies for hydro sites, mining development, regulations for nuclear safety, etc.), longer construction periods and greater potential manpower and equipment supply problems. Consequently, the immediate abandonment of all (pending) oil-based projects designed to meet the growth of demand during the next 5-7 years is unlikely to be feasible or desirable. Even in the longer run, new oil-based capacity should not be entirely ruled out, as the cost of installing alternative plants is roughly twice as high as oil-based plants for the same capacity, and in many cases the economies in operating costs to be realized from hydro, coal or nuclear power may not offset the higher capital costs.

1.06 Substitution possibilities in the major industrial branches are more rigidly constrained by technology than in power, and the progress of technological adaptation is more difficult to foresee. Apart from the use of energy saving measures and some changes in techniques such as the possible attenuation of the trend towards the direct reduction possible in steel making in favor of the traditional blast furnace/BOF process, 1/ there is little direct substitution in production methods that can be expected. Indirect substitutions through changes in the pattern of industrial demand and output and changes in the regional and international location pattern of industry will perhaps be more important responses to the energy crisis.

1.07 Transportation depends almost exclusively on petroleum products to provide the primary source of motive power. There is little scope for energy substitutions or savings within each mode, except for the switch-over to small autos, which principally concerns only the U.S.A., and the electrification of railways in cases where traffic volumes are sufficiently heavy to bear the much higher capital expenditures needed. However, electric power is scarce, and is expected to remain so in the near term, in the few countries where this latter option is promising. The railways are a relatively efficient user of diesel oil, and the efficient solution would tend to be greater use of electric power in industry and commercial and residential heating and lighting, rather than electrification of railways. 2/ ?

1/ Another example is the possibility that coal gasification in connection with petroleum derivatives from coal will become more economical in the production of ammonia/urea fertilizer in some countries. Gas and oil will continue to be the prevalent feedstock in the foreseeable future, however.

2/ Diesel fuel prices would have to increase by about 15 times before stream locomotives would become attractive economic alternatives.

1.08 Regarding inter-modal switches in transportation, the evidence suggests that the relative cost differences between modes, such as highways and railways, remain virtually unaffected over any conceivable range of crude oil prices. Urban transport options are no exceptions in this respect. Considerations such as the spatial distribution of the city and population densities are far more important factors affecting the choice of public versus private transportation than fuel prices.

1.09 The higher cost of energy will mainly affect the more modern sector in agriculture which is dependent on diesel pumps for irrigation, chemical fertilizers and pesticides, and mechanized traction. However, due to some possibilities for substitution in production at the margin, for example compost and green manure for chemical fertilizers, electric instead of diesel pumps, and animal power instead of mechanized traction, the increases in the cost of production due to higher energy costs per se may not be large, perhaps less than 10% for most crops. Changes in the commodity prices and the effects of the prevailing shortage of fertilizers are likely to dominate the developments in this sector in the near term. The increased fuel costs make rural electrification more attractive in cases when the small town and rural area networks can be integrated and consolidated to enable the use of non-oil based power. Similarly, higher feedstock costs accentuate the need for better capacity utilization and new capacity creation in chemical fertilizer production in developing countries, which would, of course, be desirable anyway to help meet the present worldwide shortage.

1.10 Although the tourism market, being strongly correlated with the real income growth rates in the advanced western countries and Japan, may suffer severely during the next few years from the oil crisis and its aftermath, its rate of growth during 1974-80 is not likely to be significantly lower than in the favorable years between 1958-72. The price impact of higher fuel costs will mainly be on long distance tour packages associated with air charters. Unlike scheduled airlines, charter airlines operate with high capacity utilization and relatively low overhead costs, and consequently have little margin to absorb increased fuel costs. Short haul charters will be relatively less affected. In terms of areas, the Mediterranean and the Caribbean regions are likely to gain relatively to more long-haul destinations.

II. POWER

A. Introduction

2.01 This Section reviews the impact of recent increases in oil prices on power systems in developing countries. It discusses the likely effects on generation costs and on demand growth, and draws broad implications for investment choices with references to individual groups of countries.

2.02 The main points developed below are as follows:

(i) The increased oil prices by themselves are not likely to affect the growth in the demand for electric power significantly; the costs to the consumer would rarely increase by more than 40% (small diesel and gas turbine systems) and in most other cases will be less than 20%.

(ii) Relative to gas and oil-fired plants, the economics of hydroelectric, nuclear and thermal power plants using local coal or lignite have been improved; also, longer transmission lines and, in some cases, interconnection have become more attractive.

(iii) Hydro, nuclear, coal and lignite plants (including mining development in the latter two cases) are all significantly more capital intensive (50-100% higher) than oil-fired plants; foreign exchange requirements will increase in parallel.

(iv) All involve longer lead times, including preparatory steps (feasibility studies for hydro sites and mining development; regulatory provisions for nuclear power safety, etc.); potential manpower (nuclear power and mining engineers) and manufacturing or supply bottlenecks; and all involve longer construction periods.

(v) The lead time involved in any power system planning is such that in most systems no significant changes can be effected in power projects already prepared or underway to meet requirements of the next five to six years.

(vi) The impact of higher oil prices on power systems will vary significantly from one country to another according to the availability of indigenous alternative energy sources and size of systems. Five categories of countries are identified. About 30 countries presently operating small power systems and deprived of domestic fuels will be the hardest hit. Another group of about 10 countries, operating medium and larger systems and heavily dependent at present on imported oil, though hard hit, will be able to adjust within a decade or so by a shift to nuclear, hydro and/or coal-based generation. For the rest of the LDCs including some of the largest and most populated (India, Brazil, Pakistan, Bangladesh) the impact on the sector will be small or minimal due to availability of domestic alternatives. In general, adjustment will require more exploration of domestic resources and improved power system planning.

B. Impact on Generating Costs

2.03 The effect of oil price increases on power costs to the consumer is highly dependent on the nature of the power supply system. In many LDCs power supply is based very largely on hydro power (e.g. Colombia, Brazil, Chile, Zaire). In a few others (e.g. India), hydro and coal take most of the load. Some, such as the Philippines, Korea and Taiwan, are largely based on oil. but are now turning to other sources, particularly nuclear.

2.04 Small systems (very common in rural areas and provincial towns of LDCs) using diesel plants will be the most strongly hurt by oil price increases. In medium and large systems, generation is supplied by a mix of hydro and steam plants (the latter burning oil, gas, coal or lignite, and more r ntly uranium). Cost changes, will, therefore, be quite variable depending on the primary energy base of these power systems.

2.05 The likely effects of the recent changes in oil prices is reviewed below for power generation by diesel, gas turbines and steam plants. Impact on individual countries which use these various modes in different proportion are reviewed in para. 2.22 below.

Diesel

2.06 Tables 1-3 in Annex I show diesel generating costs for a range of sizes (500 to 10,000 KW); plant factors (30 and 50%); gas oil (fast diesels) and fuel oil (slow diesels); and for two fuel prices approximately equivalent to those prevalent in January 1973 and January 1974. On the whole, generating costs increase by about 30-90% depending on several parameters but mainly on the type of fuel used, e.g. less for fuel oil than for gas oil. Diesel plants are characteristic of small isolated systems (less than 50 MW demand). In these, costs to the consumers will not rise as much as generating costs, as the costs of distribution, which are about as much as those of generation, will not change. The impact of higher generating costs on final consumers may also be diminished by changes in tax policies on fuels (in many countries these taxes are quite high).

Gas Turbines

2.07 Tables 4-6 in Annex I illustrate the effect of higher fuel prices on gas turbines (Gts) generating costs for a range of sizes (10-45 MW); load factors (10 and 30%); and for the estimated fuel prices prevalent in January

1973 and January 1974. The change in the oil price during that period on GTs would tend to increase the GTs generating costs by 50-100%. Few systems use exclusively or mostly GTs and they are located in petroleum producing areas; for these the actual price increases to the consumers will depend on domestic pricing policies rather than on actual increases in fuel prices in the international market. GTs are also used extensively in many oil importing countries to provide the peak-load requirements of their medium and large size systems but the energy generated by GTs in these systems is generally a very small fraction of total (about 5%), so that even with the high relative increases in GT generating costs, the impact on total systems costs is small.

Steam Plants

2.08 Tables 7-9 in Annex I illustrate the effect of oil price changes (between January 1973 and January 1974) for a range of steam plant sizes (50-600 MW) and plant factors (50 and 80%). Steam plants are generally used in medium and large systems. In most but not all cases they provide electric power in combination with some hydro installations. In a system using only oil burning steam plants the increase in generating costs is about 50-60%. To the consumer, the average impact is about one-half of that (as the costs of transmission and distribution remain unchanged).

C. Impact on Demand

2.09 Generally speaking, demand growth for power is not expected to change significantly as a result of the increase in oil prices. In effect, one of the major consequences of the rise in fossil fuel prices is expected to be an acceleration in the rate at which primary energy is going to be used passing through its conversion to electricity, as this provides a flexible vehicle for the substitution of costly and/or imported fuels for cheaper and/or local energy resources.

2.10 The proportion of primary energy which is finally used in electrical form varies from country to country; for the world as a whole, past as well as future trends point towards increasing the electricification factor (percentage of electricity in total energy). This factor has gone up from 7% in 1925 to 25% in 1970 and is expected to reach about 35% by 1980 and over 50% by the year 2000. However, for this to happen it will be required that power be used not only for mechanical purposes (electric motors) and light where it has enjoyed a considerable economic and convenience advantage over alternatives, but to an increasing degree for heating, residential as well as industrial.

2.11 In most LDC's the major consumer of power is the industrial sector where (with a few notable exceptions which need special analysis: the energy-intensive electrochemical and electrometallurgical sectors), the cost of production has only a 2-4% electric cost component. For this reason, even in those few countries where the major form of generation is based on oil-fired plants (e.g. Korea, China, Malaysia, the Philippines, Uruguay) the increased cost of power should not, by itself, deter industrial growth or slow demand.

2.12 The cost impact on residential and commercial consumers is even less, as their tariffs, reflecting a higher cost of distribution, buffer the impact of increased genration costs even more; these tariffs are not likely to change by more than 20%. Most studies done on residential electricity use (e.g. Anderson 1973; Houtakker et al 1950 UK, 1970 USA; Adams and Griffin 1972) have shown significantly high long term price elasticities, of the order of -1. This is almost certainly due to the importance of the domestic heating component in the countries studied and the ready and cheap availability of substitutes, particularly gas. These conditions do not apply today e.g. the OECD Study of Supply and Demand for 1980 and 1985 shows substantial reductions in demand for the aggregate of energy but practically none for power.

2.13 Opposition to electric heating has been due mainly to the belief that it imposes a heavier burden on primary energy requirements and not because of any higher cost to the consumer (which is influenced by many other factors, such as off-peak tariffs). In what follows it is shown that this need not be the case even when the same fuel is used for generating power and for direct heating in the users's home. The problem has been thoroughly studied by Electricite de France and many others. The Table below has been calculated on the basis of Table 10 in Annex I and compares primary energy requirements of electric heating (with resistance heaters and with heat pumps) and direct heating (furnaces).

Table II-1

Comparative Usage of Primary Energy

(to deliver same energy from space heating device)

Primary Fuel	Electricity from -	Ratio of fuel requirements of electric heating vs direct (furnace) heating: Resistance Heaters	Heat Pumps
Oil	Oil	2.40	1.04
Gas	Gas	2.65	1.15
Coal	Coal	1.71	0.74
Coal	Gas via combined cycle plant	1.52	0.66
Coal	Gas	2.67	1.16

The table assumes that in all cases the same heat will be delivered to the building. However, resistant heating systems are considerably (about half) less costly than the others. If these cost savings are invested in improved building insulation the energy needed to keep the building adequately heated may be cut by as much as 40-50%, reducing the energy requirements to a level similar to those of the other systems.

D. Implications for Investment Choices

2.14 It should be noted that fears of increasing oil prices, concern for its availability over the life of new thermal generating plant (25-30 years), and in some cases balance of payments consideration, have influenced system planning in many industrial as well as in some developing countries since the mid 50's and particularly after the Teheran Agreements of

Feabuary 1971. To some extent, therefore, the latest energy crisis had been anticipated or "discounted" by many power authorities, not so much as to the exact date of occurrence, but sufficiently as to have influenced many of the pre-crisis decisions (e.g. lignite in Turkey, nuclear in Korea and Taiwan, etc.) in the correct post-crisis direction (see paras. 2.22-23 below). The result of the latest increase in oil prices has been to reinforce recent trends regarding: (i) greater utilization of domestic resources such as hydro, coal, lignite and geothermal; and (ii) replacing imported oil for nuclear energy. In the first case the main constraint has been the availability of domestic resources; in the second case the size of the system: nuclear units were not available (nor competitive) at sizes less than about 500 MW.

2.15 The new oil prices are likely to have their major impact in the choice of plant in the following cases:

(i) Base load facilities for large systems (over 3,000 MW installed capacity by 1980). Systems like these exist in about 15-20 LDCs. Here the trend will be to use hydro or domestic coal where available; otherwise the choice will most probably be nuclear.

(ii) Supply of small towns and rural areas. The economics of diesel plants has generally been attractive in the past. Integration and consolidation into larger regional and medium sized systems using hydro or coal plants would now be much more attractive.

(iii) Medium sized systems using oil might be interconnected (sometimes across international borders; e.g. Honduras, Nicaragua; Uruguay, Argentina) to employ cheaper hydro or nuclear generation.

(iv) Generating plant for peaking purposes include gas turbines, relatively old oil or coal burning steam plants, hydro generating or pumped storage facilities. The higher oil prices have made the utilization of the non-oil alternatives more attractive, in particular pumped storage if associated with low cost pumping power (such as nuclear, lignite or run-of-the-river hydro).

2.16 The comparative advantage of hydro power in the current situation does not increase much for the large projects (500 MW and above) which in effect have or will be competing with nuclear rather than with oil burning plants. Medium and especially small (micro) hydro plants which may replace oil burning steam or diesel plants are the ones which have become economic at very much higher costs than before. An interesting effect of the new overall economics of power systems is that hydroelectric resources when available are more likely to be developed with relatively less firm capacity and more non-firm energy and peak generation characteristics as this would minimize systems requirements of thermal energy. A study of this type is currently underway in Brazil and will probably result in the addition of more units to existing hydro plants as well as in raising the levels of some reservoirs in order to achieve the effects described.

2.17 The improved competitive position of nuclear vis-a-vis fossil fuel plants for the supply of base load requirement is shown in Table II-2 below.

Table II-2

Prices of Fossil Fuels at which Generation Costs Equal Costs of Nuclear Power

Nuclear Unit Size MW	Breakdeven Fuel Prices /a Coal /b "Base" Nuclear /d (US$/ton of coal)	Coal /b 125% "Base" /d (US$/ton of coal)	Oil /c "Base" Nuclear /e (US$/bbl of oil)	Oil /c 125% "Base" /e (US$/bbl of oil)
100	42.00	60.00	10.20	13.90
200	27.00	39.00	6.70	9.30
300	21.00	31.00	5.20	7.35
400	18.00	28.00	4.75	6.75
600	16.00	24.00	4.00	5.70
800	14.00	21.00	3.55	5.15
1,000	11.00	18.00	3.10	4.50

/a At plant utilization of 72%.

/b "Standard" coal, 7,000 kcal per kg.

/c Heavy fuel oil.

/d Capital costs from Annex I. Best present estimates.

/e Nuclear capital costs and fuel costs increased 25%.

As shown in Table II-2 nuclear plants as small as 200 MW would be competitive with oil at current prices. These size plants are not yet commercially manufactured (most orders are for plants in the 600-1,200 MW range) but it can be expected that given the large potential market for nuclear plants of this size they will be offered by suppliers in a few years, as industry expands its manufacturing capacity. Medium and large nuclear plants also compete favorably with installations using imported coal: imported coal prices vary but are not expected to be much below \$30/Ton in the future. Some countries using small steam plants may shift from oil to imported coal (Cyprus, Malta) on economic as well as security of supply grounds. Domestic coal prices at sites near the mines may be very low; typical values quoted for 1972 were of the order of \$5/Ton (Mexico), \$8-\$14 (Bangladesh, Korea); US prices are about \$8-\$15/Ton. These cases suggest (see Table II-2) that domestic coal when available may be the most economic of all thermal generating alternatives. Annex I presents a series of tables (Tables 11-17) comparing investments costs of nuclear, hydro and fossil plants and breakeven fuel costs for several sizes and plant factors.

Transmission

2.18 As shown above, small and medium sized systems are likely to pay a heavier penalty than larger systems as a result of the increase in oil prices. The economies to be achieved by aggregating small isolated diesel systems into larger - hydro, coal, or nuclear based - systems are very important. In rural electrification the competitive advantage of larger systems integrated by fairly long sub-transmission lines has also improved vis-a-vis independent, small systems, usually based on diesel generation. In the same way the interconnection of medium sized oil based thermal system, nationally or across borders, (e.g. Uruguay with Argentina; Singapore and Malaysia) will now be much more economic.

Financial Implications

2.19 The comparative economics of oil burning plants vis-a-vis most other alternatives such as hydro and nuclear is based on lower capital costs compensating for higher operating (fuel) costs. Investments in oil-fired facilities are about one-half of what nuclear plants of the same capacity will require (see Annex I, Table 12). Even if domestic coal were to be used, this alternative would generally imply a much larger investment in plant, transportation and probably mining developments. In short, for those countries which will need to shift from oil to other sources of power, the financial requirements for an equivalent power expansion are likely to be 50-100% higher. Foreign exchange needs would rise in about the same proportion.

Lead Times

2.20 Oil power projects normally require short lead times to engineer (1-2 years) and build (3-4 years); plants are fairly standard, siting conditions not very restrictive, and civil engineering and erection problems routine. Hydro and nuclear projects require considerably longer preparation (3-5 years) and construction times (5-7 years). Coal plants are somewhere in between. Nuclear plants, in addition, involve considerable preparatory steps at the regulatory and training levels. For these reasons no immediate abandonment of oil projects designed to supply electricity in the next 5-7 years might be possible without accepting a penalty in terms of reduced reserve capacity in the sytems, lowered reliability, peak-shaving and/or load shedding. These measures and risks might be justified in very specific circumstances. To the extent that it would be possible and foreseeable in some cases, oil projects should include provisions for burning coal as well, in order to broaden the scope of future fuel supplies. In any case, it is now more necessary than in the past that countries attend very early to the preparation of feasibility studies of the new types of generating and transmission facilities that have become important substitutes for oil burning plants.

Project Costs - Bottlenecks

2.21 A general world shift away from oil burning plants towards nuclear hydro and coal is likely to produce during a few years considerable bottlenecks in the supply and contracting industry. These will show up in the form of higher bid prices and longer delivery times.

E. Country Implications

2.22 Power systems differ so much as to their size and resource base that it is not possible to offer any but the most general type of ideas for their analysis. In practice each situation will require an in-depth study before new system expansion programs can be devised. The main new trends, however, can be foreseen through preliminary reappraisals of each situation. The following main categories of countries can be identified from the point of view of the impact of the crisis on their power development:

(i) About 30 countries, many of them in Africa, with one or many isolated power systems use diesel, gas turbines and small size steam plants; they depend on imported oil for 30-100% of their needs and will be the hardest hit. Their inclination will be to integrate their small systems (if not too distant): to develop further their domestic resources (hydro, coal, geothermal); to import coal or electricity. These countries are listed below with their likely alternative options:

ELECTRICITY (imported): Kenya, Niger, Somalia, Upper Volta, Yemen A.R. and Yemen P.D.R.;

COAL (imported): Cyprus, Jordan, Malta, Mauritius;

GEOTHERMAL: El Salvador;

GEOTHERMAL and HYDRO: Guatemala, Iceland;

HYDRO: Fiji, Nepal, Guyana, Honduras, Panama, C.A.R., Chad, Equatorial Guinea, Ethiopia, Gambia, Guinea, Ivory Coast, Liberia, Madagascar, Mali, Mauritania, Senegal, Sierra Leone, Sudan, and Tanzania.

(ii) About 11 countries with medium or large size power systems are heavily dependent on imported oil but can adjust to the new situation by the use of nuclear power or domestic resources which were previously comparatively expensive. These countries will also be hard hit and will only be able to alleviate slowly the effects of the increases in oil prices by the use of power generation alternatives requiring about twice the capital investment (and foreign exchange) of previous oil-based expansions. They are: Korea, Taiwan, Philippines, Singapore, Thailand, Turkey, Greece, Jamaica, Ireland, Morocco and Uruguay.

In most of these countries, impact on the sector as well as on the economy is likely to be major.

(iii) In a few cases international cooperation will help to alleviate the impact. For example: Nicaragua could import power from Honduras, Uruguay could use hydropower jointly (e.g., Salto Grande) with Argentina; Kenya could import electricity from Tanzania and Uganda; Liberia could use hydro jointly with Sierra Leone or Ivory Coast; Upper Volta could import power from Ghana.

(iv) Many countries including some of the bigger and more populated of the LDCs (e.g., India), and heavily dependent on oil imports for other sectors such as transport, are, however, independent of oil for their power generation These form part of a group which relies mainly on domestic hydro, coal, lignite and even uranium (Argentina) for their present and future power needs; the impact of the crisis on their power systems will be small or minimal: India, Sri Lanka, Cambodia, Laos, Brazil, Peru, Chile, Argentina, Colombia, Paraguay, Yugoslavia, Zambia, Zaire, Uganda, Malawi, Swaziland, Burundi, Rwanda, Botswana, Lesotho, Cameroon, Ghana, Dahomey and Togo.

(v) Finally, there is a balance of countries, not necessarily important as oil exporters but with sufficient domestic resources of oil and natural gas to be able to adapt in a very flexible way to the crisis. Other than OPEC members they include Malaysia, Bangladesh, Pakistan, Burma, Afghanistan, Bolivia, Oman, Syria, and Congo. Two OPEC countries with fairly large power systems (Iran and Venezuela) are also exploring the possibility of using nuclear power instead of oil and gas; the economics of these projects need careful study in view of the difficulties of exporting some of the heavy residues likely to be produced in their planned new refinery activities, and/or calibrating gas production precisely to LNG exports.

2.23 Other conclusions from the country reviews are:

(i) With regard to changes in investment choices, the immediate impact of the recent events is not large. Lead times for the engineering and construction of new plant do not allow important changes for expansions due to be on service before 1980. 3/ And for those needed after 1980, most pre-crisis plans had assumed much higher future oil prices since the Teheran Agreements of early 1971. The crisis has confirmed the need for changes already partly foreseen and given support to some decisions which may have been marginal when originally taken

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3/ A specific instance of a shift made immediately is Kenya where an oil steam plant was cancelled and a hydro project was substituted. This could be made because this project was already prepared.

(e.g., the 1973 lignite burning Elbistan Power Plant Project in Turkey; the 600 MW nuclear projects of Taiwan, Korea, Mexico, Argentina, Brazil and others).

(ii) In medium and large size LDCs which are net oil importing countries the general trend is to develop local resources such as hydro or coal to the maximum degree economically justified; if these options are not available or insufficient, to complement them with nuclear power base load or with oil (generally GTs) for peaking. As a result overall shifts in primary energy use can be quite remarkable. For a group of countries in this category (Korea, Malaysia, Pakistan, Philippines, Singapore, Malaysia, Taiwan and Thailand) a preliminary study gives the following interesting results:

Table II-3

Source of Power Generation
(in % of total)

	1974 %	1990 %
Oil	63	18
Coal	15	10
Nuclear	1	60
Hydro	21	12
Geothermal	-	1
Pumped Storage	0	(1)
Total %	100	100
Total GW	74,294	406,379

A similar study for Afghanistan, Algeria, Cyprus, Greece, Iceland, Iran, Ireland, Jordan, Malta, Morocco, Oman, Syria, Tunisia, Turkey and Yugoslavia, shows the following expected shifts in primary energy use for power:

Table II-4

	1971 %	1985 %
Coal	35	34
Oil	24	9
Natural Gas	5	7
Nuclear	-	22
Hydro	36	28
Total %	100	100
Total GWh	31,135	71,261

These percentage shifts are not dissimilar to the developments expected to take place in some of the industrial countries. They include a very large increase in the role of nuclear power, a dramatic decrease in the role of oil (imported) and lesser changes depending on availability) of such local resources as coal and hydro.

(ii) Nuclear power is expected to play an increasingly important role in about 15 developing countries: Korea, Philippines, Taiwan, Thailand, Mexico, Brazil, India, Pakistan, Yugoslavia, Spain, Argentina, Egypt, Greece, Romania and Israel. Over a hundred reactors above 500-600 MW would be economically justified for installation before 1990. Another hundred in the 200-400 MW range could be added to those as well as other countries (Peru, Chile, Uruguay, Jamaica, Bangladesh) as they become available from manufacturers.

(iv) In a few countries that have coal and lignite there is a clear trend to explore and develop new production facilities. The major and in some cases the only use of these resources will be the power sector. Among these countries are India, Mexico, Greece, Turkey, Yugoslavia, Colombia, Ireland and Swaziland.

(v) Hydroelectricity currently represents about 40% of power generation in LDCs (20% in OECD). Hydro expansion will continue to play an important role for the next 10-15 years. In percentage terms, however, hydro will decrease in importance. In some countries new hydro plants will continue to play a major role (e.g., Afghanistan, Brazil, Iceland, Vietnam, Sri Lanka, Burma, Laos, Papua and New Guinea, Honduras, Nicaragua, Chile, Peru, Ecuador, Colombia, Zambia, Zaire, Uganda, Tanzania, Malagasy, Rwanda, Burundi) or at least a significant one (Greece, Syria, Yugoslavia, Ireland, Korea, Pakistan, Philippines, India, Bangladesh, Panama, Guyana, Argentina, Venezuela).

(vi) Finally, the preliminary reviews indicate that there is a great need in many countries for better data on their energy resource base, and for a much more sophisticated approach to planning of the power sector.

III. INDUSTRY

A. Introduction

3.01 The effects of energy price increases on production costs, and product and process substitutions were investigated for a group of industries most likely to be important in country development plans and for Bank lending. The sample consisted of representative major products in the following industries: iron and steel, pulp and paper, fertilizers several chemicals and plastics, cement, machinery (tractors, commercial vehicles) and metal fabrication (castings and forgings).

B. Effects on Production Costs and Product Substitution

3.02 The direct effect on production costs vary between industries, depending on the extent of capital intensity and the relative importance of energy inputs compared to other inputs. Energy costs, however, are generally a small fraction of total costs, and consequently a quadrupling of petroleum prices leads to an increase of about 37% in cement, 30% in the costs of some chemical products, up to 20% in newsprint, but less than 13% in steel products and as low as 4% in Kraft paper and liner board (see Table III-1).

Table III-1: IMPACT ON PRODUCTION COSTS[a/]

Industries and Products	Cost Increases (%)
1. Steel	
a. Slabs	8.7
b. Heavy plate	13.0
c. Cold-rolled sheet	13.1
d. Rebars	11.9
2. Fertilizers	
a. Nitrogen (ammonia/urea)	48.0
b. Phosphates; potash	Negligible
3. Pulp and Paper	
a. Liner board	4.0
b. Bleached pulp	4.0
c. Newsprint	Up to 20.0
4. Cement	
5. Chemicals	
a. PVC	32.0
b. Polyethylene	72.0
c. Polypropylene	27.0
d. Nylon	30.0
e. Polyester	40.0
6. Machinery and Metal Products	
a. Trucks and tractors	1.0
b. Grey iron castings	1.0
c. Steel forgings	15.0

a/ Incorporates only the recent increases in petroleum prices as well as the prices of other energy sources such as coal.

3.03 Due to the general world inflation, it is difficult to determine the extent to which the cost changes will reflect relative price changes. In any event, the demand substitutions are likely to be indirectly effected through changes in the pattern of output of goods using these products as intermediates, rather than through direct substitution as this possibility is very limited. Some substitution may be foreseen occur in packaging (shift to plastics from paper), fiber mixes (between nylon, polyesters and cotton) and in steel products (plastics or aluminum for tin plate).

C. Energy Substitution and Process Changes

3.04 The scope for process changes in existing plants is very limited, although some changes are possible such as less reliance on blast furnace oil injection. No significant changes in energy requirements are likely on the basis of conservation measures.

3.05 In the longer run, a number of process changes are probable. In steel, the traditional blast furnace/BOF process will become more attractive than the direct reduction method, as the former requires 25% less fuel input. Similarly, continuous casting is more thermally efficient than ingot casting, with a net saving of 10 to 20 therms per ton of steel cast. Lesser use of oil injection into blast furnaces will, however, be mitigated by the fact that it allows greater output to be achieved from existing equipment than coking coal.

3.06 In fertilizer, a shift away from naphtha as an ammonia feedstock is likely to occur, although the existing naphtha based plants should be able to remain profitable given the forecast ammonia/urea prices. The use of coal can only grow slowly, however, even where it is relatively inexpensive. Gas and oil will continue to be the prevalent feedstock in the foreseeable future, although the technology of coal gasification in connection with petroleum derivatives may become economical.

3.07 In machinery and metal fabrication, there are a number of changes in foundry and forging processes that might be undertaken to save fuel, as well as to modernize the basic technology. For forgings, the changes involve adoption of more efficient induction heating for billets, and adoption of continuous heat treat furnaces replacing batch-type furnaces. For castings the changes include adoption of modern ladle preheating and heat treat furnace burners, acid melting instead of basic melting practices and elimination of oil sand cores and substitution with CO_2 cores, shell cores or chemically air setting cores.

3.08 In chemicals, PVC ethylene can be produced with coal as the starting material. An alternative vinyl chloride process is the vapor phase reaction of acetylene and hydrogen chloride. Acetylene may be produced from carbide, which is made from lime and coal on electric furnace. Commercial development of such alternatives will, however, take time, as will substitution for polypropylene. As old plants are phased out, they will be replaced by more efficient slurry or gas phase processes. The derivation of monomer feedstock benzene and ammonia from coal are also possible.

3.09 Finally, process changes such as increased use of the dry process (with preheater kiln), shifts to bigger size single units to replace many smaller units working in parallel, greater use of grate coolers, etc., may occur in the cement industry. Such changes will require both higher capital costs as well as considerable time for development.

IV. TRANSPORTATION

A. Introduction

4.01 Most methods of transportation of passengers and goods are dependent, almost exclusively, on petroleum products to provide the primary source of motive power. The use of substitute fuels is limited and this substitution can only take place after considerable capital investment, e.g. the electrification of railways.

4.02 The energy demands of transportation vary between 16 and 26% of the total energy demand of developed countries. There are no reliable figures for the developing countries but rough calculations suggest similar orders of magnitude. The percentage of the petroleum requirements of a country devoted to meeting the transportation demand varies considerably and is largely dependent on the availability of alternative fuels for electric power generation. In the US, 53% of the petroleum consumed is used in transportation (1972). The average for Europe is 29%.

4.03 In the analysis below the final price to the consumer of the various fuels is related to crude oil prices f.o.b. Persian Gulf. The basic assumption is that only crude oil prices and ocean transport costs change and that marketing margins, taxes, and local distribution costs remain the same in absolute amounts. Thus, the relationship between crude prices and consumer prices should be considered as indicating orders of magnitude rather than precise estimates.

4.04 The general conclusion reached is that the cost of fuel alone is not a large enough element in the cost of transport either to alter the relative attractiveness of the different mode or to change significantly the pattern of investments and operations within modes. The effect of fuel price increases on transportation tend to be swamped by the world-wide upward movement of prices. The tripling of crude oil prices, for example, increases truck operating costs by less than 5%. Many countries are experiencing general pipe increases well above this percentage.

4.05 Data used in this paper are drawn largely from U.S. sources and should be used with caution when applied elsewhere. They indicate only broad orders of magnitude and should not be used, for example, to make a precise estimate of truck operating costs in a particular country. Although the composition or structure of transportation costs may vary from country to country, the total costs for each mode are not likely to be very different. Lower labor costs, for example, tend to be offset by higher capital costs. Thus, the conclusions reached on the relative attractiveness of the different modes should hold for most situations.

4.06 This Section does not attempt to provide policy prescriptions. This can only be done on a country by country basis. It should be noted, however, that there is much scope for adjustments. Prices of petroleum products are often controlled, and contain a large element of taxation in their final price. Thus, governments are in a position to decide how much, of the price increases in crude oil is to be passed on to the final consumer.

B. Energy Characteristics of Transport Modes and Modal Choice

4.07 The energy demands of the various modes of transport vary considerably. The following are average US figures but since the technology is roughly similar worldwide, they should be reasonably representative for all countries.

Table IV - 1

Mode	Load Factor	Energy Intensiveness (BTU per ton-mile)
Inland Waterway	85%	500
Rail	94%	750
Pipeline	-	1,850
Truck	59%	2,400
Air Cargo	65%	63,000
		(Btu per pass-mile) /a
Small Car	2.2	2,582
Standard Car	2.2	4,323
Urban Bus	30%	2,803
Air	50%	6,300

/a The energy characteristics of passenger carriage are highly variable and averages have little meaning. Utilization rates or loan factors have the major impact on enerby intensiveness; these are very different between modes, countries, and even times of day.

4.08 Although the fuel requirements of the various transport modes are different, this difference is not sufficiently important in the overall structure of costs and service characteristics of each mode to allow fuel prices to play an important role in model choice. The relative cost differences between modes is large enough that even substantial shifts in fuel prices will not, with a few exceptions, alter the relative attractions of different modes.

4.09 The following summary figures show the impact of a movement of crude oil prices from $2.00/bbl (f.o.b. Persian Gulf) to $7.00/bbl on the structure of average US prices for transport, assuming that tax and distribution margins remain unchanged (for more details see Annex II).

Table IV-2

	Fuel Cost/ Total Cost	Average Cost/ ton/pass-mile	Fuel Cost/ Total Cost	Average Cost/ ton/pass-mile
	$2.00/bbl		$7.00/bbl	
Pipeline	53.1	0.32	68.6	0.51
Waterways /a	3.7	0.27	16.1	0.31
Ocean Shipping	7.7	0.0248	22.4	0.0295
Rail	4.6	1.51	8.9	1.58
Truck	3.5	9.63	5.7	9.85
Air Cargo	27.7	23.50	45.2	31.00
Urban Bus	16.3	2.03	24.4	2.25
Small Car	18.3	4.20	24.1	4.52
Standard Car	21.3	6.10	27.3	6.60

/a For Ocean Shipping, see para. 4.27.

4.10 The price paid for each mode increases in relation to the intensity of its fuel use, but the relative position of the modes does not alter significantly. Thus, at a price of crude of \$2.00/bbl (the situation prior to 1973) truck costs on the average are 6.4 times higher than rail, while at 57.00/bbl truck costs are 6.2 times rail costs. The only areas where some modal shifts might occur in response to changing fuel prices, are in air cargo -- to rail or truck and in pipelines -- to waterways. In the case of air cargo, it is because its price increases relative to all other modes. In the case of pipelines, it is because energy is an important part of total costs (88% at \$7.00/bbl) and where geographic conditions permit, water transport could become more attractive.

4.11 Passenger traffic is even less responsive to shifts in fuel prices than in cargo. The importance of capacity utilization and price regulation combined with the essentially non-competitive nature of the modes supplying long distance travel makes this type of passenger travel unresponsive to changes in fuel prices. In air travel, for example, a 75% increase in fuel prices couls be offset by increasing load factors from an average of 50% to 60%. This can be seen by examining Table 2 in Annex II for a 707 aircraft. Raising fuel cost from 0.68¢/pass.-mi. at \$3/bbl. of crude oil to 1.9¢/pass.-mi. But increasing the load factor from 50% to 60% reduces average total cost at \$7/bbl. from 7.31¢/pass.mi. to 6.09¢/pass.-mi. (50/60 x 7.31), a decrease of 1.22¢/pass.-mi.

4.12 The price of automobile and bus travel, particularly in urban areas, will only be marginally affected by increasing crude prices. The tax and distribution margins make up the major part of the price of fuel for motor vehicle transport. This is more so in both Europe and the developing countries than it is in the US. Thus, increasing crude prices by more than three times (from $2.00/bbl to $7.00/bbl) in the US, increases the pump price by less than 50%. At prices of fuel of more than a dollar/gal. the increase in the final price is in the range of 10 to 15%.

4.13 Changes of these orders of magnitude are unlikely to shift traffic from automobiles to public transport (buses or rail) in the urban areas. The private cost of operating an automobile per passenger kilometer, remains several times (depending in load factors) that of the urban bus or rail system and even at these cost differentials, difficulties are encountered in encouraging use of public transport. Higher fuel prices alter the margins slightly in favor of public transport but this margin could be offset by a small improvement in the efficiency of automobile use.

C. Effects on Equipment and Construction Costs

4.14 In the above analysis of modal split, it was assumed that only fuel prices vary. Energy is required in addition in the manufacturing of transportation equipment and in the construction of guideways -- roads and rails. The manufacturing of transportation equipment is not energy intensive. The 1966 input-output matrix for the US shows the energy input requirements in the manufacture of transportation equipment ranging from 0.09% of gross value of output for aircraft to 0.04% for motor vehicles, for an average of 0.29%. Tripling the price of energy would still make the gross value of output added by energy less than one percent.

4.15 In addition to the energy requirements in transportation equipment production, there are the energy requirements of materials inputs into equipment production to be taken into consideration. These inputs (steel, aluminum, rubber, plastics, etc.) vary considerably by type of equipment and the importance of energy or petroleum in their processing. They all tend to be capital intensive, however, and while it is not possible to be precise, it is doubtful that higher energy prices will increase the final price of these inputs sufficiently to have more than a marginal impact on the capital costs of transportation equipment.

4.16 Track or guideway costs for transportation systems are usually less than 20% of the total ton mile costs of transport. The major portion of the costs of these guideways is accounted for by civil work construction. The following is an illustrative example of the relative role of petroleum in civil works construction.

Table IV-3

Cost per Kilometer of a Typical Indian National Highway
(equipment intensive method)

		1972 Prices	Petroleum Double Prices
1.	Equipment	11,936	11,936
2.	Fuel and Lubricants	3,869	7,738
3.	Labor	2,838	2,838
4.	Bitumen	1,600	3,200
5.	Engineering Overheads and Management	20,343	20,343
		40,686	46,055

The doubling of fuel lubricant and bitumen prices would increase the per kilometer costs by approximately 13%. This would translate into a less than 2% increase in final cost of transport.

4.17 Although minor differences will be found from mode to mode, it is unlikely that the increase in costs of infrastructure (equipment and guidways) will increase final transport prices by more than 2 to 3%. The differences between mode would not be sufficient to change the relative prices of any of the modes. The direct operating costs of vehicles and equipment are the major component of transport costs and it is here that fuel prices have their main impact.

D. Adjustments Within Modes

4.18 Although higher energy prices are unlikely to significantly alter modal choice and thus investment patterns in transportation, they will, undoubtedly, encourage some adjustments within modes which will result in a more efficient utilization of fuel. Some of these possibilities for each mode are discussed below.

Railways

4.19 Rail transport is already an efficient user of fuel and there is little scope for adjustments. The diesel locomotive still remains the most efficient form of prime mover, even with much higher fuel prices. A return to coal burning steam locomotives would not be justified under any conceivable range of diesel fuel prices. The overall costs of rail transport approximately double with the use of steam locomotives; diesel fuel prices would have to increase nearly 15 times before steam and diesel were competitive.

4.20 Higher diesel oil prices may encourage, however, the more rapid electrification of some lines if other fuels, particularly coal, are available for electricity generation at a lower price than the equivalent amount of petroleum. The benefits of the electrification of rail lines is not in the form of fuel savings, since approximately the same amount of energy is required in both cases. The benefits of electrification result from the lower maintenance costs of the combination of electric locomotives and electric power generating plants. This maintenance savings is obtained only with higher capital expenditures.

4.21 Lower fuel costs and lower total costs would be obtained provided other conditions for electrification (e.g., traffic densities) existed and coal was available at a lower price than oil. However, the fuel savings are only obtainable at substantial additional capital costs. If overall capital or budgetary constraints are such that there are already shortages of electric power the issue becomes one of whether or not electrification or railways is the most appropriate use of these scarce resources (coal and capital). The diesel locomotive is a relatively efficient user of petroleum and if conversion to electricity results in scarcities of electricity elsewhere in the economy, it may lead to such inefficiencies as auto-generation of electric power or the very energy intensive use of kerosene for domestic lighting.

Highway Freight Transport

4.22 Only minor adjustments can be expected here. In most countries the trucking industry is relatively competitive and normal pressures have been exerted to insure the development of fuel efficient engines. Higher fuel prices will undoubtedly encourage the use of more fuel efficient larger trucks and accelerate the trend from gasoline to diesel powered trucks. The higher operating costs of vehicles as a result of higher fuel prices should also tend to require higher design standards for roadways. Here again it would mean trading-off higher capital costs against fuel savings.

Urban Transport

4.23 The price of energy is not expected to be a major factor in urban transport although over the long run higher energy prices may encourage a more compact city form. The amount of energy required for urban transport is more a function of the spatial distribution of the city and population density than the mode of transport. Public transport tends to be as energy intensive as private transport. If, for example, the city pattern is one of widespread low density suburban development, the fuel economies associated with rail system or urban bus network are not available because these are offset by low load factors. An urban bus with a less than 50% load factor is an energy intensive form of transportation. 4/

4.24 The major options for energy savings in urban transport are confined largely to the US. The switch to smaller cars will be the principal source of this energy savings, together with some minor changes in load factor and more efficient use of public transport. For most of the rest of the world, these options are not available, since the bulk of urban transport, particularly in developing countries, is already by public transport and the size of cars tends to be much smaller than in the US.

4.25 The renewed interest and investment in urban public transport in both the US and Europe--because of growing congestion (street space crisis rather than energy crisis)--has created severe bottlenecks on the supply side. Since most developing countries have to import this equipment, they

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4/ The large urban bus saves on road space, not energy. Less energy per passenger kilometer is required to operate a mini bus than a large urban bus.

can expect increasing difficulties (and higher prices) in obtaining it. Buses in particular are in short supply and likely to remain so for nearly a decade. The US capacity for urban bus production, for example, is 6,000 buses per year, or roughly the current replacement demand. Diverting 20% of existing private car commuters to bus transport in the US would require an additional 250,000 buses! The situation is similar in Europe.

Air Transport

4.26 Considerable excess capacity has traditionally existed in this industry. While air transport is slightly more sensitive to fuel price changes than other modes, the existence of this excess capacity, particularly in international routes, means that there is much scope for more efficient utilization of capacity to offset higher fuel prices.

Ocean Shipping

4.27 Traditionally, fuel costs have constituted 7 to 10% of the operating costs of a vessel. Residual fuel oils which used to power the larger ships have been available at prices slightly below the price of crude oil. 5/ Thus, the rising price of crude is likely to be translated almost directly into an equivalent rise in the price of these oils. At a price of $2.00/bbl of crude, heavy fuels have sold for $1.70/bbl or US 4¢/gal. Assuming that this crude to product relationship continues, at $7.00/bbl crude, heavy fuels would sell for US 14¢ per gal. This implies an increase of 19% in the costs of ocean freight (see Table 3 Annex II). Higher fuel prices will accelerate the trend towards larger ships. Significant economies of scale occur in the use of fuel. A 400,000 DWT Tanker requires 17% less fuel per ton mile than a 100,000 DWT tanker.

5/ If the price were above the price of crude (which has happened in the short run) these vessels could burn the crude directly.

E. Administrative Measures

4.28 The above discussion has been in terms of transport prices that would prevail under various assumptions concerning the price of crude oil. The reaction of users of the transport systems has been judged in light of these prices. In view of the likely minimal impact of price changes in these decisions, there may be a tendency to shift traffic to less fuel intensive modes through administrative fiat.

4.29 With a few exceptions, such shifts will not reduce costs but will merely shift their incidence. Shifting traffic to the railroad, for example, may reduce fuel costs per ton mile but may, at the same time, increase inventory costs and reduce the reliability and flexibility of the transport system. Since shippers are willing to pay two or three times the rail freight rates for road transport of certain goods on some routes, the rates undoubtedly reflect the higher value of the service provided.

4.30 In any case, administrative measures used to shift traffic should be regarded as short-term measures, usually to take advantage of any excess capacity that might exist, as for example, in the airline industry. Should such measures prevail for any length of time, their implications for investment decisions must be evaluated. Shifting traffic to the railroad may require very substantial investments in new capacity once any excess capacity has been utilized. Similarly, the decision to electrify a rail line will not serve to solve any immediate problem but has important longer term implications for investment.

V. AGRICULTURE

A. Introduction

5.01 While increased energy costs will significantly affect farm production in LDCs in a number of ways, these effects are likely to be small relative to those of the prevailing shortage of fertilizers (a situation which the "energy crisis" has exacerbated in some degree). Further, the direct effects of the energy cost changes are obscured by the current buoyancy of farm commodity prices and the uncertainty that surrounds them. However, these factors are considered to be essentially short-run in nature and are expected to decline in significance by 1980, while the energy cost effects will remain.

B. Changes in Farm Input Costs

5.02 The prices paid by farmers for fuel and lubricants, fertilizer and other chemicals, and for other inputs, are expected to rise due to changes in crude oil prices--prices for fuel and lubricants are expected to rise by as much as 2.5 times, nitrogenous fertilizer may rise by 50 percent or more and other fertilizers and chemicals by some 30 percent, while the cost of other inputs (including machinery and replacement parts) will rise by smaller amounts, depending on the energy component in their production and distribution.

5.03 To assess the effect of these expected changes on farm operating costs an analysis was made of expenditure patterns for a number of crop types in various countries, the results of which are summarized in Table V-1. If, as has been assumed in the exercise, the farm input and output mix remains

Table V-1: ESTIMATED CHANGES IN FARM OPERATING COSTS RESULTING FROM CHANGES IN ENERGY COSTS
(1972 = 100, constant dollar basis)

Crop	Country/Type of Farm		Operating Costs[a/]
RICE	Philippines:	Traditional	103
		Mechanized	109
	India :	Bullock Farms	100
		Tractor - Irrig.	115
		Tractor - Part Irrig.	111
	Indonesia :	South	102
		North	101
WHEAT	India :	Bullock Farms	101
		Tractor - Irrig.	119
SUGARCANE	India :	Tractor - Irrig.	105
		Customs Farms	104
TOBACCO	India :	Bullock Farms	101
		Tractor Farms	107
		Custom Farms	107
MILLET	India :	Bullock Farms	101
		Tractor - Part Irrig.	110
		Tractor - Irrig.	110
		Custom Farms	108
RUBBER	Malaysia :		110
	Indonesia :		101
COTTON	Nigeria :	Traditional	-
		Improved	111
		Advanced	112
	Tanzania :	Traditional	-
		Advanced	111
	Sudan :		115
	India :	Bullock Farms	101
		Tractor - Irrig.	104
		Custom Farms	105

Table V-1 (Continued)

Crop	Country/Type of Farm		Operating Costs [a/]
JUTE	Bangladesh:	Traditional, Unirrig.	101
		Improved, irrig.	103
		Improved, irrig. no flood control	103
		Improved, irrig., flood control	103
WHOLE FARMS	Brazil :	Small Farm	116
		Medium Farm	124
		Large Farm	139
	Sao Paulo :	Medium Farm	112

a/ Assumes changes only in energy intensive inputs, viz. fertilizer, pesticides, fuel and lubricants, and machinery inputs. Prices used are based on 1980 expectations, assuming unusually high current prices for fertilizers have returned to more normal levels. The figures reflect no input substitution by farmers -- thus they tend to overestimate cost effects.

Sources: These indices are derived from farm budgets based on field survey data taken from various studies -- they have not been standardized across countries.

unchanged, farm operating costs may increase by amounts varying from 1 to 20 percent. Those farms using traditional modes of production will be least affected, while those with irrigation, tractors and high-yielding varieties will be most seriously affected. Accordingly, the average cost increase for the agricultural sector will be higher in those countries where the more advanced technology is most widespread, e.g., Taiwan, Korea, India, Turkey, Mexico and Brazil.

5.04 The impact on production costs will tend to be somewhat less than indicated above as there is some scope for adjustments in the production methods to substitute for fertilizer. The means of achieving this saving in fertilizer use include: (i) more intensive use of irrigation areas, through better technology use supported by improved institutional arrangements and services, (ii) modified field practices, such as direct placement of fertilizer, better weeding and spacing, (iii) use of better balanced crop rotations, inter-cropping and green manuring using nitrogen fixing legumes, (iv) developing alternative sources of nitrogen, especially those produced from biological fixation, (v) indirect fertilizer savings might also be achieved by production savings, such as better pest control and more adequate storage to reduce losses. Further, price subsidies and taxes might be modified in some countries to offset the higher input costs.

5.05 While changes of these proportions are not insignificant, they are marginal in a farming context where much greater fluctuations in income are commonly experienced due to seasonal and market effects. Consequently, it is likely that there will be no massive adjustment to the changing costs. Generally, the profitability of mechanized farming will be reduced, but given the financial returns from mechanization there is unlikely to be any significant reduction in this area. There could be a significant reduction in the use of pesticides, however, since they are known to have a high price elasticity of demand. For small predominantly subsistence farms even small changes in cash costs may be large in relation to cash receipts. If this is the case, there could be some reduction in the use of fertilizer and tractor services on these farms. In general, as shown for Brazil in Table V-1, the smaller farms are likely to be least affected in terms of total costs.

C. Changes in Farm Output and Income

5.06 In spite of these increases in operating costs, net farm incomes are likely to continue to rise for many types of farms given current market price expectations for crops. However, this judgment is based on world market prices for commodities which may not be reflected in prices at the farm gate, since agricultural commodities are subject to administered price arrangements in many countries.

5.07 There are likely to be changes in the production pattern of farms with a move away from crops requiring high application levels of fertilizer, notably cotton, and a shift toward those where market prices are more favorable. There may also be a return to local varieties of cereals away from the new high yielding varieties which are much more fertilizer dependent--HYV rise is known to yield lower than some local varieties of rice when no fertilizer is used.

5.08 The overall effect of higher energy costs will probably involve a somewhat slower rate of adoption of new technology, and lower rates of output growth. Consumers are likely to be more adversely affected than farmers since they are likely to experience both short-run scarcities and higher prices due to current dislocations in production. In the longer term the prospects are somewhat better but it would seem inevitable that the higher input costs will be reflected to some extent in higher product prices.

VI. TOURISM

A. Introduction

6.01 It appears that the primary factor affecting the growth of foreign travel from the U.S. and Japan has been the growth of real income. Price factors have been relatively much less significant, except that in the growth of foreign travel from Europe. However, income growth has probably been the dominant factor there also. The rate of growth of foreign tourist arrivals from the main tourist markets may well drop in 1974 and 1975 but in the longer run to 1980, expansion approximating past growth rates may reasonably be expected. Projections for the five main tourist markets suggest that tourism expenditures in current prices will be little affected in the aggregate during the latter half of the 1970s. However, the short-term impact is expected to be somewhat severe, and the rate of recovery will vary among the main markets. It seems unlikely that the very rapid growth in Japanese travel abroad can now be maintained. Nevertheless, it seems probable that the rate of growth of total tourist arrivals from 1974-80 would not be significantly lower than that over the period 1958-72.

6.02 The impact of the energy crisis on the costs of foreign travel will be greatest in respect of air and road transport. Higher fuel prices will affect air fares of charter airlines much more than those of scheduled airlines. The impact on the cost of the holiday package should be greatest for relatively distant destinations served by charter airlines. However, tour operators' reports, and hotel occupancy statistics for early 1974, suggest that so far demand is being well sustained for the more distant destinations. With many developing countries facing drastically higher fuel import bills, additional tourism projects may well be justified in a number of areas with relatively favorable market prospects in view of the high returns of tourism projects in terms of foreign exchange earnings.

B. Growth of the Sector

6.03 While statistics on international tourism are incomplete and often of dubious quality, the best figures available record an increase in international visitor arrivals (including vacationers, business and other visitors) from 25 million in 1950 to almost 200 million in 1972. International tourism receipts (in current prices) are estimated to have risen from $2.1 billion to $24 billion over the same period. The major tourist generating countries are the United States and Canada, the more wealthy European countries and in recent years Japan. Among Bank member countries, Part I countries accounted for approximately two-thirds of tourist arrivals and tourism receipts in 1972 and Part II countries for the remaining one-third.

6.04 Among Part II countries, those closest to the main tourist generating countries attracted the greater visitor flows: from Europe to Spain, Yugoslavia, Greece, Morocco, and Tunisia; from the U.S. and Canada to Mexico and the Caribbean; from Japan to Korea and Taiwan. However, certain more distant destinations such as Kenya, Senegal, Thailand and Singapore have attracted sizeable visitor flows from the main market countries, and there have been growing intra-regional visitor flows between, for example, Thailand, Malaysia, Singapore and Indonesia and between Argentina, Uruguay and Brazil.

6.05 The growth of international tourism in the past twenty years has been associated with the continued growth in per capita incomes in the developed world which has meant a steadily higher proportion of income being available for spending on leisure activities including holiday travel, which has now become an accepted part of consumption patterns--rather than a luxury or novelty--for substantial segments of the population.

C. Factors Affecting the Growth of Tourism

6.06 Within the limitations of existing data a statistical analysis of economic time-series has been made of some principal factors affecting total foreign travel from the United States to Europe and the Mediterranean, to Mexico and to the Caribbean (excluding Puerto Rico), and total foreign travel from Japan. The principal factors isolated in the analysis were the growth in real per capita disposable income, the real costs of travel by air and the relative change in costs of services in the destination area as compared with the United States. These factors are three among many influencing the decision to travel abroad, such as fashion, levels of education, degree of urbanization, longer statutory holidays, extent of car ownership, etc. The three factors studied, however, seem among the most important and are most readily quantified.

6.07 It appears that for the U.S. and Japanese markets the primary factor affecting the growth of foreign travel has been the growth of real income. The decline in real costs of travel by air has been relatively much less significant. The income elasticity of demand for foreign travel (numbers travelling) from the United States to Europe and the Mediterranean, Mexico, and the Caribbean over the period 1958-72 appears to have been in the range 3.4 to 4.5. Similarly the income elasticity of demand for foreign vacation travel from Japan over the period 1965-72 appears to have been approximately 3.5. The elasticity of demand (expressed in numbers of travellers) in relation to the price of holiday travel in both markets appears to have been approximately -1.0.

6.08 A similar analysis of European travel to the Mediterranean 6/ suggests that price factors have had a greater impact on the growth of foreign travel in Europe than in the U.S. or Japan. This may reflect both geographical factors and the fact that much wider segments of the population in many European countries travel abroad on vacation. The income elasticity of demand for foreign travel from Europe to the Mediterranean over the period 1958-72 appears to have been approximately 1.8. The price elasticity of demand with respect to the cost of holiday travel (including relative rates of inflation) ranges from -1.5 to -2.0. Thus reductions in the real costs of foreign travel, which have occurred partly as a result of the fast growth of air charter package holidays organized by large European tour wholesalers, have opened up entirely new market segments. The principal destination for such low cost holidays by air has been Spain, including Majorca. In the United States, partly because of the great size of the country, the proportion of the

6/ Spain, Greece, Turkey, Yugoslavia, Cyprus, Egypt, Lebanon, Israel, Morocco and Tunisia.

population going abroad on vacation is much smaller than in many European countries (4-5% as compared with 10-30% in the richer European countries). In Japan also, where foreign vacation travel has expanded very fast but only in the last eight years, the proportion of the population going abroad on vacation is still small (only 2%).

6.09 The results of the analysis made so far must be treated with caution, but it may be said with some confidence that despite rises in the costs of international travel, international tourist arrivals will continue to increase even with relatively lower growth in per capita real incomes in the developed world. Preliminary results of other studies, based on similar assumptions, support this conclusion in general terms, and indicate that total expenditures on international travel from the five main generating countries 7/ may grow, in current prices, at an average of about 16% annually over the period 1972 to 1980.

D. Effect on Holiday Prices

6.10 A provisional analysis has been made of the likely impact of higher fuel costs on the prices of some typical "inclusive tour" holidays. It is clear that the impact of higher fuel prices is greater for holidays by air charter than for holidays by scheduled airline and that the impact is greater for more distant destinations. The probable increase in scheduled airline fares is expected to be of the order of 15-20% as a result of the increase in fuel costs, while the increase in air charter fares is likely to be of the order of 30-50%. The effect of these increases on the selling prices of inclusive tours by scheduled airlines and for nearer destinations by charter

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7/ USA, UK, W. Germany, France, Japan.

airlines is relatively small, but the impact on the inclusive tour selling price for more distant destinations by charter airline is substantial, reflecting the higher component that fuel accounts for in charter airline costs. The overheads of charter airlines are very much smaller than of scheduled airlines and the load factors of the former have been much higher. Hence the potential offset to higher fuel costs from economies in overhead or from better load factors is very small.

E. Prospects

6.11 On the basis of the likely income growth rates and higher transport costs it seems likely that the rate of growth of numbers travelling abroad from the U.S. to 1980 may be within the range 10 to 12% compared with an average annual growth rate of 13% between 1960 and 1972. Similarly the growth rate of numbers of Japanese travelling abroad on vacation in this period may be approximately 20% annually, as compared with 57% annually from 1965-73. While these projections of growth rates cover the period to 1980, there is some evidence already available that the growth in foreign travel from the major European markets in 1974 is likely to be significantly less than in 1973 and there may even be some absolute decline. These difficulties may continue into 1975. For world international tourism as a whole, it is expected that 1974 and 1975 will be years of little or no growth but that from 1976 the necessary readjustments will have been made and growth rates should be somewhat higher than the annual average of about 8-9% for the period as a whole.

SECTION A: DIESEL GENERATING COSTS*

Table 1

Capital and O&M Costs by Output Size

Net Output (KW) Type of Fuel	500 Gas Oil	3000 Gas Oil	3000 Fuel Oil	10,000 Fuel Oil
Total capital cost $/KW	250.00	220.00	400.00	380.00
Annual capital cost $/KW a/	32.87	28.92	44.07	41.86
Fixed O&M $KW/yr. b/	12.50	6.60	8.00	7.60
Heat rating Btu/KWh	10,000	10,000	10,000	10,000

a/ Cost of capital 10%. Amortization in 15 years for the Fast Diesel; 25 years for the Slow Diesel.

b/ 5% of total capital cost for the 500 KW plant; 3% for the 3000 KW gas oil plant and 2% for the fuel oil plants.

*Fuel Costs:

Gas Oil : 72 US¢/MBtu Jan. 1973; 216 US¢/MBtu Jan. 1974

Fuel Oil: 37 US¢/MBtu Jan. 1973; 111 US¢/MBtu Jan. 1974.

SECTION A: DIESEL GENERATING COSTS*

Table 2

Unit Costs for 30% Plant Factor
(mills per KWh)[a/]

Net Output (KW) Type of Fuel	500 Gas Oil	3000 Gas Oil	3000 Fuel Oil	10,000 Fuel Oil
Capital cost	12.5	11.0	16.8	15.9
O&M costs	4.8	2.5	3.0	2.9
Fuel costs	7.2	7.2	3.7	3.7
Total Jan. '73	24.5	20.7	23.5	22.5
Additional fuel cost	14.4	14.4	7.4	7.4
Total Jan. '74	38.9	35.1	30.9	29.9
% increase	59	70	31	33

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a/ US$ 1.00 = 1,000 mills

*Fuel Costs:

Gas Oil : 72 US¢/MBtu Jan. 1973; US¢/MBtu Jan. 1974
Fuel Oil: 37 US¢/MBtu Jan. 1973; US¢/MBtu Jan. 1974

SECTION A: DIESEL GENERATING COSTS*

Table 3

Unit Costs for 50% Plant Factor
(mills/KWh)

Net Output (KW) Type of Fuel	500 Gas Oil	3000 Gas Oil	3000 Fuel Oil	10,000 Fuel Oil
Capital cost	7.5	6.6	10.1	9.6
O&M costs	2.9	1.5	1.8	1.7
Fuel costs	7.2	7.2	3.7	3.7
Total Jan. '73	17.6	15.3	15.6	15.0
Additional fuel cost	14.4	14.4	7.4	7.4
Total Jan. '74	32.0	29.7	23.0	22.4
% increase	82	94	47	49

*Fuel Costs:

Gas Oil : 72 US¢/MBtu Jan. 1973; 216 US¢/MBtu Jan. 1974
Fuel Oil: 37 US¢/MBtu Jan. 1973; 111 US¢/MBtu Jan. 1974

SECTION B: GAS TURBINES GENERATING COSTS[a/]

Table 4

Capital and O&M Costs by Output Size

Net Output (MW)	10	20	45
Total capital cost $/KW	200.00	180.00	150.00
Annual capital cost $/KW*	26.29	23.67	19.72
O&M costs $/KW	3.00	3.00	3.00
Plus mills/KWh	0.5	0.5	0.5
Heat rates Btu/KWh	16,000	15,000	14,000

* Cost of capital 10%, 15 years life.

a/ Fuel cost: Gas oil 72 US¢/MBtu January 1973; 216 US¢/MBtu January 1974.

SECTION B: GAS TURBINES GENERATING COSTS[a/]

Table 5

Unit Costs for 10% Plant Factor
(mills per KWh)

Net Output (MW)	10	20	45
Capital cost	30.0	27.0	22.5
O&M fixed costs	3.4	3.4	3.4
O&M variable costs	0.5	0.5	0.5
Fuel costs	11.5	10.8	10.0
Total Jan. '73	45.4	41.7	36.4
Additional fuel cost	23.0	21.6	20.0
Total Jan. '74	68.4	63.3	56.4
% increase	51	52	55

a/ Fuel cost: Gas oil 72 US¢/MBtu Jan. 1973; 216 US¢/MBtu Jan. 1974

SECTION B: GAS TURBINES GENERATING COSTS[a/]

Table 6

Unit Costs for 30% Plant Factor
(mills per KWh)

Net Output (MW)	10	20	45
Capital cost	10.0	9.0	7.5
O&M fixed costs	1.1	1.1	1.1
O&M variable costs	0.5	0.5	0.5
Fuel costs	11.5	10.8	10.0
Total Jan. '73	23.1	21.4	19.1
Additional fuel cost	23.0	21.6	20.0
Total Jan. '74	46.1	43.0	39.1
% increase	100	101	105

a/ Fuel cost: Gas oil 72 US¢/MBtu Jan. 1973; 216 US¢/MBtu Jan. 1974

SECTION C: STEAM TURBINES GENERATING COSTS[a/]

Table 7

Capital and O&M Costs by Output Size

Net Output (MW)	50	100	200	300	400	500	600
Total capital cost $/KW	390.00	348.00	279.00	239.00	222.00	210.00	193.00
Annual capital cost S/KW/yr*	45.81	40.88	32.77	28.07	26.08	24.67	22.67
O&M mills/KWh	1.30	1.05	0.60	0.50	0.40	0.35	0.35
Heat rating Btu/KWh	11,000	10,700	10,000	9,500	9,200	9,000	8,900

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* 20 year life, 10% cost of capital.

a/ Heavy fuel oil prices estimated at 35 US¢/MBtu in Jan. 1973 and 105 US¢/MBtu in Jan. 1974.

SECTION C: STEAM TURBINES GENERATING COSTS[a/]

Table 8

50% Plant Factor

(mills/KWh)

Net Output (MW)	50	100	200	300	400	500	600
Capital Costs	10.46	9.33	7.48	6.41	5.95	5.63	5.18
O&M costs	1.30	1.05	0.60	0.50	0.40	0.35	0.35
Fuel costs	3.85	3.75	3.50	3.33	3.22	3.15	3.12
Total Jan. '73	15.61	14.13	11.58	10.24	9.57	9.13	8.65
Additional fuel cost	7.70	7.50	7.00	6.66	6.44	6.30	6.24
Total Jan. '74	23.31	21.63	18.58	16.90	16.01	15.43	14.89
% increase	49	53	60	65	67	69	72

* 20 year life, 10% cost of capital.

a/ Heavy fuel oil prices estimated at 35 US¢/MBtu in Jan. 1973 and 105 US¢/MBtu in Jan. 1974.

SECTION C: STEAM TURBINES GENERATING COSTS[a/]

Table 9

80% Plant Factor
(mills/KWh)

Net Output (MW)	50	100	200	300	400	500	600
Capital cost	6.54	5.83	4.68	4.01	3.72	3.52	3.23
O&M costs	1.30	1.05	0.60	0.50	0.40	0.35	0.35
Fuel costs	3.85	3.75	3.50	3.33	3.22	3.15	3.12
Total Jan. '73	11.69	10.63	8.78	7.84	7.34	7.02	6.70
Additional fuel cost	7.70	7.50	7.00	6.66	6.44	6.30	6.24
Total Jan. '74	19.39	18.13	15.78	14.50	13.78	13.32	12.94
% increase	66	71	80	85	88	90	93

a/ Heavy fuel oil prices estimated at 35 US¢/MBtu in Jan. 1973 and 105 US¢/MBtu in Jan. 1974.

Table 10

CASE No.	1	2	3	4	5	6	7	8	9	10
Function	Oil (1) direct	Oil (2) power plant	Gas (1) direct	Gas (2) power plant	Coal (1) direct	Coal (2) conv. power plant	Coal combined cycle	Coal (12) low Btu gas-direct	Coal (14) high Btu gas-direct	Coal high Btu power plant
Preparation at mine/wellhead	98.0	98.0	96.5(6)	96.5	95.2(7)	95.2(7)	95.2	95.2	95.2	95.2
Transportation to conversion plant										
-process/refinery	99.3									
-power plant		98.3		97.3		99.3	99.3	99.3		97.3
Conversion										
-process plant	87.5(3)	87.5						70.0(13)	69.4(15)	69.4(15)
-power plant (4)		29.7		31.2		33.0	37.0(10)			31.2
Transportation/distribution system										
-direct fuel	98.5		93.9(8)		98.3(8)			96.5	93.9(8)	
-electric (5)		90.0		90.0		90.0	90.0			90.0
Net efficiency to consumer	83.9	22.5	90.6	26.4	93.6	28.1	31.5	63.9	62.0	18.1
Utilization efficiency (11)										
-central furnace	63.0		75.0		50.0(9)			75.0	75.0	
-resistance heaters (16)		100.0		100.0		100.0	100.0			100.0
-central heat-pump		225.0		225.0		225.0	225.0			225.0
Total net efficiency of energy usage										
-central furnace	52.8		68.0		46.8			47.9	46.5	
-resistance heaters		22.5		26.4		28.1	31.5			18.1
-central heat-pump		50.7		59.3		63.2	70.8			40.6

(1) Railroad/truck for coal and pipeline for oil/gas direct to domestic user.
(2) Railroad for coal and pipeline for oil/gas to boiler in conventional power plant; electricity to user.
(3) Refinery only - heating value of crude input used in refining marketable products from crude.
(4) Approximate average USA experience (1969-70) with reasonably modern plants.
(5) Total electric system losses (transmission, transformation, distribution).
(6) Drilling, pumping, extraction, stripping, etc.
(7) Includes mining and preparation before shipment.
(8) Includes all transportation from mine to domestic user.
(9) Average value; hand-fired furnaces 45%, stoker-fired furnaces 55%.
(10) Low-Btu coal gasification plant on power plant site; this value considered best attainable by about 1980; present efficiency in range of 34-35%; rated output of 550 MW.
(11) Assumes structures are insulated only to present standards.
(12) 300-450 Btu/ft^3 gas generated, by Koppers method, within system service area and injected into existing natural gas pipelines at rate of about 7% of normal rated flow.
(13) Process provides H_2 only; if CO & H_2 produced efficiency will be 76%.
(14) 900 Btu gas generated at mine and transmitted by conventional gas pipeline.
(15) Lurgi process for high Btu gas from coal gasification.
(16) Assumes individual controlled room heaters.

SECTION D: UTILIZATION EFFICIENCIES OF VARIOUS MODES OF USE OF PRIMARY ENERGY

Table 11

Total Net Efficiency of Various Modes of Use of Primary Energy

			Percent Efficiency			
			Central Furnace		Room resistance heaters	Central heat pump
Case No. (a)	Primary fuel	Mode of Utilization	Primary fuel	Electricity		
1	Oil	Direct	52.8			
2	Oil	Electric power plant			22.5	50.7
3	Gas	Direct	68.0			
4	Gas	Electric power plant		25.1	26.4	59.3
5	Coal	Direct	46.8			
6	Coal	Electric power plant		26.7	28.1	63.2
7	Coal	Combined cycle electric power plant		29.9	31.5	70.8
8.	Coal	Low Btu gas - direct	47.9			
9	Coal	High Btu gas- direct	46.5			
10	Coal	High Btu gas - to electric power plant		17.2	18.1	40.6

(a) See previous page for definition of case numbers.

SECTION E: BREAKEVEN COSTS OF NUCLEAR, HYDRO, COAL, AND OIL PLANTS

Table 12

Unit Capital Costs of Plant in January 1974[a/]

(US$ per KW)

Unit Size (MW)	Oil-fired	Coal-fired	Lignite	Nuclear
100	371.00	440.00	506.00	1,048.00
150	321.00	368.00	424.00	865.00
200	286.00	338.00	390.00	698.00
300	247.00	296.00	342.00	563.00
400	227.00	272.00	316.00	493.00
600	201.00	234.00	273.00	414.00
800	184.00	215.00		367.00
1,000	167.00	206.00		323.00

a/ These costs do not include special environmental features such as cooling towers, near zero-radiation releases and desulfurization of oil and coal exhaust gases. It is assumed that in most LDCs their use may be avoided by proper siting.

SECTION E: BREAKEVEN COSTS OF NUCLEAR, HYDRO, COAL, AND OIL PLANTS

Table 13

Breakeven Fuel Oil Costs
(US¢/10^6 Kcal) a/

Oil - Nuclear

Unit Size	Plant Factor - 70% Interest Rates		Unit Size	Plant Factor - 50% Interest Rates	
MW	8%	12%	MW	8%	12%
100	468	685	100	791	1152
200	313	451	200	520	752
300	246	351	300	398	572
400	224	318	400	353	510
600	188	267	600	296	426
800	153	239	800	264	379
1000	136	206	1000	228	326

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a/ Breakeven fuel oil costs to give total energy costs equal to total energy costs of nuclear plants - (US¢/10^6 Kcal - in LDCs.

(1 ton of oil = 10^7 Kcal)

SECTION E: BREAKEVEN COSTS OF NUCLEAR, HYDRO, COAL, AND OIL PLANTS

Table 14

Breakeven Coal Costs
(US¢/10^6 Kcal)a/

Coal - Nuclear

Unit Size	Plant Factor - 70% Interest Rates		Unit Size	Plant Factor - 50% Interest Rates	
MW	8%	12%	MW	8%	12%
100	417	608	100	704	1049
200	274	392	200	446	661
300	209	298	300	331	486
400	188	264	400	290	431
600	161	227	600	246	360
800	145	201	800	216	314
1000	121	161	1000	170	250

a/ Breakeven coal costs to give total energy costs equal to total energy costs of nuclear plants in LDCs - US¢/10^6 Kcal.

(1 ton of coal = 0.7×10^7 Kcal)

SECTION E: BREAKEVEN COSTS OF NUCLEAR, HYDRO, COAL, AND OIL PLANTS

Table 15

Breakeven Coal Costs
(US¢/10^6 Kcal) a/

Coal - Oil

Plant Factor - 70%

Unit Size	Assumed Interest Rates: 8%		12%			16%	
	Fuel Oil Costs (US$/bbl)						
MW	$6	$8	$6	$8	$10	$6	$8
100	353	483	327	460	593	299	429
150	355	485	340	469	599	322	445
200	364	497	346	478	611	361	494
300	367	500	350	483	616	329	463
400	366	499	349	482	615	330	462
600	374	507	360	493	631	343	476
800	372	504	358	490	623	341	474
1000	371	504	356	489	622	338	471

a/ Breakeven coal costs to give total energy costs equal to total energy costs of oil-fired plants - US¢/10^6 Kcal - in LDCs.

(1 ton of oil = 10^7 Kcal, 1 ton coal = 0.7 ton of oil)

SECTION E: BREAKEVEN COSTS OF NUCLEAR, HYDRO, COAL, AND OIL PLANTS

Table 16

Breakeven Coal Costs
(US¢/10^6 Kcal)[a/]

Coal - Oil

Plant Factors - 50% and 10% - Interest Rate of 12%

Unit Size	Plant Factor 50%		Plant Factor 10%	
	Fuel Oil Costs (US$/bbl)			
MW	$6	$8	$6	$8
100	278	411	*	*
150	319	444	*	102
200	307	436	*	62
300	316	445	*	104
400	318	445	*	104
600	336	465	74	203
800	340	468	93	221
1000	329	457	37	164

* - less than zero

a/ Breakeven coal costs to give total energy costs equal to total energy costs of oil-fired plants - US¢/10^6 Kcal - in LDCs. (1 ton of oil = 10^7 Kcal, 1 ton coal = 0.7 ton of oil)

SECTION E: BREAKEVEN COSTS OF NUCLEAR, HYDRO, COAL, AND OIL PLANTS

Table 17

Breakeven Hydro Costs
(US$/KW)[a/]

Hydro - Oil

Unit Size	Fuel Oil Cost - $8/bbl			Fuel Oil Cost - $6/bbl		
	Plant Factors			Plant Factors		
MW	70%	50%	10%	70%	50%	10%
100	1150	847	524	963	746	504
150	1053	768	450	878	673	432
200	1003	714	405	833	620	386
300	980	686	370	810	592	352
400	952	667	354	782	573	335
600	935	642	327	770	548	308
800	918	626	313	748	532	293
1000	901	611	294	731	516	275

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a/ Breakeven hydro plant capital cost to give total energy costs equal to total energy costs of oil-fired plants - US$/KW - 50 years life - sinking fund depreciation. Annual operation and maintenance costs - 1.5% of capital cost - 12% interest rate.

Table 1

Estimated Fuel Cost per Passenger- or Ton-Mile for the Various Modes (US Cents)
USA Data

F.O.B. Price of Persian Gulf Light Crude (US$/bbl)	Water Transport[a/]		Rail[b/]		Pipeline[b/]		Truck[b/]		Auto-Standard[c/]		Auto-Small[c/]		Urban Bus[b/]		Air Cargo[d/]	
	fuel cost/ gal.	cost/ ton-mile	fuel cost gal.	cost/ ton-mile	fuel cost gal.	cost/ ton-mile	fuel cost gal.	cost/ ton-mile	fuel cost gal.	cost/ pass-mile	fuel cost/ gal.	cost/ pass-mile	fuel cost gal.	cost/ pass-mile	fuel cost gal.	cost/ ton-mile
15	30	.11	48	.26	48	.64	55	.93	76	2.62	76	1.59	55	.92	51	25.50
14	28	.10	45	.24	45	.60	52	.88	73	2.52	73	1.52	52	.87	48	24.00
13	26	.09	43	.23	43	.57	49	.83	70	2.42	70	1.46	49	.82	45	22.50
12	24	.09	40	.22	40	.53	47	.80	67	2.31	67	1.40	47	.78	42	21.00
11	22	.08	38	.21	38	.51	44	.75	64	2.21	64	1.34	44	.73	39	19.50
10	20	.07	35	.19	35	.47	42	.71	61	2.11	61	1.27	42	.70	37	18.50
9	18	.06	32	.17	32	.43	39	.66	58	2.00	58	1.21	39	.65	34	17.00
8	16	.06	29	.16	29	.39	36	.61	54	1.87	54	1.13	36	.60	31	15.50
7	14	.05	26	.14	26	.35	33	.56	52	1.80	52	1.09	33	.55	28	14.00
6	12	.04	24	.13	24	.32	30	.51	49	1.69	49	1.02	30	.50	25	12.50
5	10	.04	21	.11	21	.28	27	.46	45	1.56	45	.94	27	.45	22	11.00
4	8	.03	18	.10	18	.24	25	.42	43	1.49	43	.90	25	.42	19	9.50
3	6	.02	16	.09	16	.21	23	.39	40	1.38	40	.84	23	.38	16	8.00
2	4	.01	13	.07	13	.17	20	.34	36	1.25	36	.75	20	.33	13	6.50

a/ Bunker C. Fuel
b/ Diesel
c/ Gasoline
d/ Jet Fuel

Table 2

Fuel Cost as a Percentage of Total Operating Cost Air Passenger Transport*

4-Engine Regular Body (DC8, 707) - USA Data

F.O.B. Persian Gulf Price of Light Crude (US$/bbl)	Estimated Fuel Price (US¢/gal)	Average Total Cost (US¢/pass-mi)	Fuel Cost (US¢/pass-mi)	Fuel Cost/ Total Cost (%)
15	51	8.88	3.47	39.1
14	48	8.67	3.26	37.6
13	45	8.47	3.06	36.1
12	42	8.27	2.86	34.6
11	39	8.06	2.65	32.9
10	37	7.93	2.52	31.8
9	34	7.72	2.31	29.9
8	31	7.52	2.11	28.1
7	28	7.31	1.90	26.0
6	25	7.11	1.70	23.9
5	22	6.91	1.50	21.7
4	19	6.70	1.29	19.3
3	16	6.09	.68	11.2

* 50% load factor.

N.B. Data for 747, 727 and DC9 show similar variations.

Table 3

Fuel Cost as a Percentage of Total Operating Cost 276,000 DWT Tanker - Bunker C Fuel*

F.O.B. Persian Gulf Price of Light Crude (US$/bbl)	Estimated Fuel Price (US¢/gal)	Average Total Cost (¢/long ton-mi)	Fuel Cost (¢/long ton-mi)	Total Cost (%)
15	30	.0370	.0141	38.1
14	28	.0361	.0132	36.6
13	26	.0351	.0122	34.8
12	24	.0342	.0113	33.0
11	22	.0332	.0103	31.0
10	20	.0323	.0094	29.1
9	18	.0314	.0085	27.1
8	16	.0304	.0075	24.7
7	14	.0295	.0066	22.4
6	12	.0285	.0056	19.6
5	10	.0276	.0047	17.0
4	8	.0267	.0038	14.2
3	6	.0257	.0028	10.9
2	4	.0248	.0019	7.7

* Assumes operating at full capacity.

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DOCUMENT OF
INTERNATIONAL DEVELOPMENT ASSOCIATION

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IDA/SecM74-230

FROM: The Deputy Secretary

July 16, 1974

INDONESIA - State Electricity Company

During discussion of the West Java Thermal Power Project (IDA/R73-48) at the meeting held on May 29, 1973, Mr. McNamara accepted a suggestion that, in about a year's time, a note would be distributed to the Executive Directors on the progress made in improving the managerial and financial situation of Perusahaan Umun Listrik Negara (PLN) - the State Electricity Company in Indonesia. The attached note has been prepared in response to the suggestion made at the meeting.

Distribution:

Executive Directors and Alternates
President
Senior Vice President, Operations
Executive Vice President and Vice President, IFC
President's Council
Directors and Department Heads, Bank and IFC

INDONESIA

Perusahaan Umun Listrik Negara (PLN)

MEMORANDUM ON PROGRESS UNDER THE RECOVERY PLAN

I. PURPOSE OF THE REPORT

1.01 The documents for the West Java Thermal Power Project [1/] (Credit 399-IND) presented to the Executive Directors on May 29, 1973 explained that the managerial and financial situation of PLN (the Indonesia State electricity company) was so weak that, without a special management improvement effort, the company's independent existence would be jeopardized. The Bank Group was faced with the choice of either abandoning PLN with the probability of further deterioration, or of attempting to help its recovery by a concentrated and organized effort on the part of PLN, its consultants (SOFRELEC) and the Bank Group. The latter was proposed, and a "recovery plan" was made an integral part of the project.

1.02 In approving the Credit the Board requested a special report, after about a year, outlining the progress being made. This is in response to that request.

II. BACKGROUND

2.01 Although the state of the power sector was clearly chaotic at the time of the Bank Group's first involvement with it in 1969, it took several years for the dimensions of the problem to emerge. It was initially apparent that a concentrated consulting and technical assistance effort would be required for the rehabilitation of PLN and the sector. Financed from the proceeds of Credits 165 and 334-IND, PLN employed the French firm of SOFRELEC as its management consultant and also its engineering consultant for the rehabilitation of the Jakarta distribution system, a project financed under these credits.

2.02 It took time to engage SOFRELEC and once engaged and in the field more time before SOFRELEC could formulate an approach to PLN's problems. Records had to be reconstructed and assets physically identified; large outstanding consumer accounts had to be verified and means found for their settlement; tariff levels and structure had to be studied. At the same time a training program had to be initiated. This initial phase of the consultant's work took about two years and although much of what was done could be characterized as fact finding, it was essential. The main accomplishments during the period included:

(i) recommendations for a uniform code of accounts, central cash control and cash management, inventory control, consumer administration, mechanization, budgeting, etc;

1/ President's Report, Appraisal Report, Credit and Project Agreements (IDA/R73-48)

(ii) revaluation of assets (introduced as of December 31, 1971) and comprehensive recommendations on all aspects of financial management;

(iii) draft of a new electricity act (promulgated with some modifications in mid-1972);

(iv) recommendations on a new structure and level of tariffs (introduced with a 40% overall increase in June 1973);

(v) recommendations on personnel administration, job analysis, etc;

(vi) recommendations on a streamlined organization (introduced with some modifications in March 1973); and

(vii) initiation of training courses for key personnel, particularly in financial matters.

III. PHYSICAL STATUS OF ON-GOING PROJECTS

3.01 The Bank Group is assisting in financing the rehabilitation of the Jakarta distribution system and the construction of a 2 x 100 MW conventional oil-fired power plant through the three credits made to date.

3.02 Early difficulties were experienced on the Jakarta distribution project; the almost total lack of information on existing facilities made detailed project design very difficult and subsequently, there were many delays in the procurement of equipment and materials, chiefly on account of PLN's lack of experience in this area and the cumbersome Government procurement procedures it was obliged to follow. Now, however, procurement and project implementation have improved and the project is beginning to move, though it is currently 18-20 months behind schedule.

3.03 The situation is much better for the generation project. Consultants have been appointed (Black & Veatch of the U.S.), the bid documents are nearing completion and invitations to bid will be issued shortly. Bids are expected towards the end of October 1974. The project is only slightly behind schedule and should be commissioned about the middle of 1977.

IV. RECOVERY PLAN

4.01 Appraisal of the generation project in late 1972 was based on data either much improved or non existent at the time of the two previous appraisals in 1969 and 1971. By late 1972 SOFRELEC had been at work for about two years. The appraisal findings were that PLN's situation was even worse than previously expected and the Board's request for this special report resulted in part from the discussion of the proposed "recovery plan".

Recovery Plan

4.02 The financial recovery plan as included in Schedule 2 of the Development Credit Agreement for Credit No.399-IND is dependent upon advice and assistance, including training, by PLN's consultants. Improvements over a wide spectrum of activities described in SOFRELEC's Terms of Reference are designed to gradually improve PLN's operations and, as a consequence, its financial situation. ?

4.03 The recovery plan obligates PLN to take all steps necessary to ensure that its revenues by 1978/79 will cover all operating costs including depreciation, provision for bad debts, interest, and taxes, if any. In addition PLN agreed to make all efforts to achieve as interim targets 80% revenue/cost coverage in FY 1974/75 and 90% in FY 1976/77. To facilitate supervision and management control of the activities necessary for recovery, PLN will prepare:

(i) annually, a detailed program of measures to be implemented during the following fiscal year. The Bank Group's comments thereon are to be taken into account. The first program for 1974/75, which lays particular emphasis on personnel training, was submitted on time and is presently being implemented; and

(ii) semi-annually, reports on PLN's financial situation and progress made in achieving financial recovery.

Present Situation

4.04 Annex 2 shows the detailed activities of the recovery plan at the time of Board consideration of Credit 399-IND and their present status of implementation. Most of the activities are proceeding as scheduled, with some modifications made when expectations for better results required re-arrangement of priorities. Improvements achieved in financial management, in particular PLN's authority to adjust tariffs to compensate for inflation and a restructuring of tariffs to charge appropriately various users, rank among the real successes of the recovery plan. Impressive action is also being taken in improving system operations. The training effort has begun to show results which, however, are occasionally impaired by the continued lack of proper personnel management and by salaries considerably below private industry levels; in particular the latter causes trained PLN personnel to move to better paid jobs in other organizations. This matter is under close review by PLN.

4.05 A major problem remaining to be solved is associated with the construction department. In part because of PLN's improving, but still weak management, and in part because of cumbersome Government regulations the construction process is so slow that it could jeopardize financial recovery if not corrected quickly. To remedy the situation, the consultants have proposed a crash program to train key personnel, particularly in contract administration, and to generally streamline project execution procedures. Activities and progress in this area will be closely monitored by Bank Group supervision missions.

Future Outlook

4.06 On balance, PLN's situation has developed favorably since the end of 1972. The activities on management improvement, outlined in Annex 2, have been accepted by PLN and satisfactory implementation is expected.

4.07 Annex 1 attempts to quantify the financial results of the recovery period. Future results are based on best estimates made jointly by PLN, SOFRELEC and the Bank Group, and on facts known as of March 1974. The projections indicate that PLN will attain the first interim target of an 80% operating ratio in FY 1974/75, and also the 90% target in FY 1976/77, achieving full cost coverage by revenues in 1978/79. It is believed at this time that the prospects for PLN's gradual improvement and financial recovery as set forth in the Credit and Project Agreements for Credit No.399-IND are favorable.

East Asia and Pacific Region
July 15, 1974

Annex 1

INDONESIA

Perusahaan Umum Listrik Negara (PLN)
Actual and Forecast Income Statements 1971-1978/79
(in Rp billion unless otherwise indicated)

1971-1973: Fiscal Years Ending December 31 1974/75 Onwards: Fiscal Years Ending March 31	Actual			Forecast				
	1971	1972	1973	1974/75	1975/76	1976/77	1977/78	1978/79
Energy Sales (GWh)	1,786	1,903	2,174	2,583	2,996	3,475	4,066	4,757
Average Revenues per kwh Sold (Rp)	8.6	8.9	11.1	13.9	16.7	16.7	16.7	19.2
Operating Revenues								
Revenues from Sales of Power	15.4	17.0	24.1	35.9	50.0	58.0	67.9	91.3
Other Operating Revenues	1.1	1.7	0.3	0.5	0.5	0.5	0.5	0.5
Total Operating Revenues	16.5	18.7	24.4	36.4	50.5	58.5	68.4	91.8
Operating Expenses								
Purchased Power	0.7	0.7	0.7	1.0	1.3	1.3	1.3	2.0
Fuel	3.3	4.4	5.6	11.7	14.7	17.4	21.5	25.9
Personnel Expenses	)	5.7	7.5	12.0	15.0	16.3	17.5	20.1
Material for Operation, Maintenance and Administration	)8.5)	4.7	6.1	7.2 2/	9.8	11.3	13.0	15.0
Depreciation	9.6	10.4	11.2	13.2	15.1	17.6	20.8	24.9
Total Operating Expenses	22.1	25.9	31.1	45.1	55.9	63.9	74.1	87.9
Operating Income	(5.6)	(7.2)	(6.7)	(8.7)	(5.4)	(5.4)	(5.7)	3.9
Other Income (net)	0.4	0.4	(0.5)	-	-	-	-	-
Interest (net)	-	(0.3)	-	-	-	-	0.1	0.5
Interest During Construction	-	-	-	-	-	-	(0.1)	(0.5)
Interest Charged to Operation	-	(0.3)	-	-	-	-	-	-
Net Profit/Loss	(5.2)	(6.5)	(7.2)	(8.7)	(5.4)	(5.4)	(5.7)	3.9
Provision for Bad Debts	0.1	(0.4)	(6.5) 1/	-	-	-	-	-
Other Adjustments	0.5	-	-	-	-	-	-	-
Previous Year's Accumulated Profit/Loss	(1.3)	(6.1)	(12.2)	(12.9)	(21.6)	(27.0)	(32.4)	(38.1)
Accumulated Profit/Loss	(6.1)	(12.2)	(12.9)	(21.6)	(27.0)	(32.4)	(38.1)	(34.2)
Percentage of Operating Expenses (incl. provision for bad debts) Covered by Operating Revenues	78%	76%	98%	81%	90%	92%	92%	104%
Above Percentage Disregarding the Extraordinary Receipts in 1/	-	-	77%	-	-	-	-	-

1/ Government payment of arrears.
2/ Excluding Rp 1.3 billion for half of the diesel spare part replenishment program.

INDONESIA

Perusahaan Umum Listrik Negara (PLN)
Status of Activities on Management Improvement

The following provides information on the present status of activities being undertaken by PLN and its management consultants, SOFRELEC, to improve PLN's total activities. The listing of activities follows largely the schedule as attached to Side Letter No. 5 (June 22, 1973) of the 399-IND Credit documents.

(a) Schedule as included in Side Letter No. 5.
(b) Actual and presently planned status of activity.

No. of Activity in Annex to Terms of Reference	ACTIVITY (2)	Responsibility of PLN and Consultant: Basic data available to Consultant (3)	Responsibility of Consultant: Submission of recommendations by Consultant to PLN (4)	Responsibility of Consultant: Preparatory work for implementation undertaken by Consultant (5)	Responsibility of PLN: Start of implementation with assistance of Consultant (6)	Areas of implementation: Head Office	Areas of implementation: Java Areas	Areas of implementation: Other Areas	Government involvement	REMARKS
I.	PLANNING									
1/2	Investment Program and Cash Flow									
	(a)	June 1973	Review Oct.1973	-	April 1974	yes	yes	yes	Approval Jan.1974	This item was important in view of the Second Five-Year Development Plan 1974/75-1978/79 of which PLN's investments form part.
	(b)	July 1973	Review Oct.1973	-	April 1974	yes	yes	yes	Approval Jan.1974 (in principle)	
62	Overall Long-Range Planning									
	(a)	July 1973	September 1973	November 1973	Study Jan. 1974	yes	yes	yes	Support	It was decided to postpone the overall system planning activities until after the Java System Development Study, financed under Credit 399-IND will be in an advanced stage. This will forestall overlapping of activities and permit gaining of experience. The delay, though not desirable, is justified under the circumstances.
	(b)	early 1975	early 1975	early 1976	mid-1976	yes	yes	yes	Support	
3	Central Data Bank									
	(a)	-	November 1973	March 1974	June 1974	yes	-	-	-	It was decided to postpone this activity until the end of all other management consulting efforts. After initial establishment the effort will be kept up continously.
	(b)	-	end 1975	early 1976	1976	yes	-	-	-	
II.	PERSONNEL AND TRAINING									
4/5/6/ 7/8/10	Personnel, Salaries and Wages, Pensions, Dismissal, Recruitment, Assessment, Transfers, Restructuring Program									
	(a)	Complete	Complete-July 1973	Oct.-Dec. 1973	Dec.1973-Feb.1976	yes	yes	yes	Regulation by Oct. 1973	SOFRELEC's proposals as agreed to by PLN and IDA break the rules set by the Government for public enterprises on salary level structure, etc. It is therefore that a special Government Regulation is required. The consultant's recommendations were submitted to the Ministry of Public Works and Power in April 1974 and are presently being discussed among the ministries concerned (industry, public works, finance, etc.). Considering the importance of the matter, the delay is undesirable.
	(b)	Complete	Complete-July 1973	Oct.-Dec. 1973	Jan.1975 onwards	yes	yes	yes	Not yet provided	
9	Job Analysis, Organogram, etc.									
	(a)	Complete	June 1973	August 1973	October 1973	yes	yes	yes	-	
	(b)	Complete	June 1973	August 1973	October 1973	yes	yes	yes	-	
11	Training and Training Centers									
	(a)	Complete Dec. 1973	Start June 1973	-	June 1973	yes	yes	yes	-	With funds provided from Credits 165 and 334-IND and from a French grant the following huge training effort has been started:
	(b)	Complete Dec. 1973	Start June 1973	-	June 1973	yes	yes	yes	-	

(a) Schedule as included in Side Letter No. 5.
(b) Actual and presently planned status of activity.

No. of Activity in Annex to Terms of Reference	A C T I V I T Y	Responsibility of PLN and Consultant Basic data Available to Consultant	Responsibility of Consultant Submission of recommendations by Consultant to PLN	 Preparatory work for implementation undertaken by Consultant	Responsibility of PLN Start of implementation with assistance of Consultant	Areas of implementation Head Office	 Java Areas	 Other Areas	Government involvement	R E M A R K S
										A. Training Centers 1. Slipij (opened 1972): Finance and administration . 150 employees per year in 8-24 weeks groups. At present 150 employees trained. 2. Ancol (opened 1972): Distribution engineering. 200 employees per year in 12-32 weeks groups. At present 460 employees trained. 3. Cibogo (opened 1973): Distribution and diesel operation. Capacity 350 employees per year in 8-12 weeks groups. 4. Tanjung Priok (opening planned for late 1974): Operation of steam stations and gas turbines. Planned capacity 60 employees per year. 5. Surabaja) Medan) Distribution and diesel operation. Opening planned for early 1975. Joint capacity 400 employees per year. B. Other Training Activities 1. On-the-job training for operation of steam plants. 9-month course completed in Surabaja and started in Tanjung Priok. 7 engineers (teachers). 2. On-the-job training in the important areas in accounting finance, mechanization, etc. 4 expatriate and 10 local teachers. 3. Training of 20 key officials abroad. 4. Continuous education program for local instructors. 5. Future training of construction engineers (see item "Construction"). With the exception of item B5 which will be introduced shortly, the training program is on schedule.
12/27/63	Office Management Procedures									
	(a)	May 1973	Jan.-June 1974	Mar.-Sept.1974	April/Oct.1974	yes	yes	yes	-	Lack of time and involvement in matters more immediately important on the part of the consultants explain the undesirable slippage.
	(b)	Jan.1975	late 1975	early 1976	early 1976	yes	yes	yes	-	
13	Safety Regulations									
	(a)	Complete	June 1974	July-Dec. 1974	Jan. 1975	yes	yes	yes	-	
	(b)	Complete	June 1974	July-Dec. 1974	Jan. 1975	yes	yes	yes	-	
III.	FINANCE									
14/59	Consumer Administration									
	(a)	Complete	Complete	Complete	Jan.1973-Aug.1974	-	yes	yes	Regulation	Implementation completed in Java end 1973. 5 consultants visit other areas regularly (normally one-week trips) with the aim of implementation throughout PLN by October 1974
	(b)	Complete	Complete	Complete	Jan.1973-May 1974	-	yes	yes	Regulation	
15/61	Commercial Policies and Conditions for Connection									
	(a)	June 1973	Dec. 1973	-	June 1974	yes	yes	yes	Regulation	Implementation as and when required, including necessary updating of Government regulation.
	(b)	June 1973	Dec. 1973	-	Continuous	yes	yes	yes	Regulation	
16	Mechanization of Consumer Administration									
	(a)	-	Complete	Underway	Underway	-	yes	}selected	-	On target. Jakarta and Medan in operation, other selected areas in preparation.
	(b)	-	Complete	Complete	Underway	-	yes	}areas		
17/18/64	Cash Accounting and Management									
	(a)	-	Dec. 1973	March 1974	July 1974-July 1975	yes	yes	yes	-	Implemented in Java, other areas will follow in regular intervals.
	(b)	-	Dec. 1973	Jan. 1974	Mar. 1974-July 1975	yes	yes	yes	-	

(a) Schedule as included in Side Letter No. 5.
(b) Actual and presently planned status of activity.

No. of Activity in Annex to Terms of Reference	ACTIVITY	Responsibility of PLN and Consultant: Basic data Available to Consultant	Responsibility of Consultant: Submission of Recommendations by Consultant to PLN	Responsibility of Consultant: Preparatory work for implementation undertaken by Consultant	Responsibility of PLN: Start of implementation with assistance of Consultant	Areas of implementation: Head Office	Java Areas	Other Areas	Government involvement	REMARKS
19/26/28	Uniform Accounting									
	(a)	-	Continuous	Continuous	Continuous	yes	yes	yes	Information	The uniform accounting manual has been distributed.
	(b)	-	Continuous	Continuous	Continuous	yes	yes	yes	Information	Correct application is continuously supervised by consultants.
20/45/58	Inventory Control									
	(a)	Complete	Complete	August 1973	Jan. 1974	yes	yes	yes	-	Delayed review of consultants' recommendations by PLN.
	(b)	Complete	Complete	Jan. 1974	Jan. 1975	yes	yes	yes	-	Delay not crucial for operation at the moment.
22/23/30	Fixed Asset Administration									
	(a)	-	June 1974	Dec. 1974	April 1975	yes	yes	yes	Information	
	(b)	-	June 1974	Dec. 1974	April 1975	yes	yes	yes	Information	
22	Depreciation Policy									
	(a)	-	June 1973	-	April 1974	yes	yes	yes	Approval	
	(b)	-	June 1973	-	May 1974	yes	yes	yes	Approval	
24/25/32	Budget									
	(a)	-	Continuous	Continuous	Continuous	yes	yes	yes	-	
	(b)	See remarks under "Construction" in item IV and body of the report.								
29	Internal Audit									
	(a)	May 1973	Dec. 1973	Jan.-Mar.1974	April 1974	yes	yes	yes	Information	Recommendations are presently being prepared. The delay
	(b)	May 1973	July 1974	Jan. 1975	April 1975	yes	yes	yes	Information	is not crucial for PLN's activities.
31	Insurance									
	(a)	Dec. 1973	Jan. 1974	Jan. 1975	-	yes	yes	yes	Approval	The delay, caused by larger than expected difficulties
	(b)	Dec. 1973	July 1974	July 1975	-	yes	yes	yes	Approval	encountered by the consultants, is not desirable.
33	Tariffs									
	(a)	Complete	Annual review	in due time	in due time	yes	yes	yes	Approval	Recent experience shows that the improvements in the tariff adjustment process rank among the greatest achievements
	(b)	Complete	Annual review	in due time	in due time	yes	yes	yes	Approval	of PLN and SOFRELEC. The rate making process works efficiently.
IV.	CONSTRUCTION									
34-36 67	All Activities									

Only some initial work has been done concerning "Basic Technical Standards". Construction activities in general and the construction department in particular are plagued by severe problems and shortcomings, such as stringent and cumbersome budget regulations by the Government, deficient construction planning, deficient contract management, etc. Although some of the problems can finally only be solved in a context broader than provided by one isolated sector, major deficiencies clearly exist within PLN. The situation is aggrevated by the fact that PLN's construction department is short of qualified engineers; furthermore, the construction department is the one most exposed to Government interference in budget matters. Although PLN is presently trying to institute some improvements (for instance speeding-up of Government investment fund allocations), the situation is unlikely to improve noticeably as long as PLN is financially dependent on the Government.

As a consequence of the above, the originally envisaged assistance program has to be revamped. It is now planned to train first an adequate number of engineers and later embark on immediate activities leading to improvement. Preparation of the teaching material will take until about November 1974 when activities will start. The time schedule as included in the Terms of Reference is outdated and all activities are seriously delayed, a very undesirable situation.

No. of Activity in Annex to Terms of Reference	ACTIVITY	Basic data Available to Consultant	Submission of Recommendations by Consultant to PLN	Preparatory work for implementation undertaken by Consultant	Start of implementation with assistance of Consultant	Head Office	Java Areas	Other Areas	Government involvement	REMARKS
V/VI/VII	OPERATION									
37/48/49 56	Improvement of Operation and Maintenance Procedures									
	(a)	Complete	Dec.1973-Feb.1974	-	Jan.-Mar.1974	-	yes	yes	-	Implementation started from important areas such as steam power plant, distribution offices in Jakarta, Bandung, etc.
	(b)	Complete	Dec.1973-Feb.1974	-	Jan.-Mar.1974	-	yes	yes	-	Important improvement can be observed in maintaince scheduling of generating plant.
38-44 68	Fuel and Plant Location									
	(a)	Complete-Dec.1974	July 73-Feb. 75	-	Oct.1973-Apr.1975	yes	yes	yes	Support	The delay is caused by the uncertainties surrounding the world fuel situation.
	(b)	Complete-Dec.1974	end 1974-early 1976	-	early 75-mid 76	yes	yes	yes	Support	For the same reason item 41 - "Long Term Fuel Contract" has been dropped.

(a) Schedule as included in Side Letter No. 5
(b) Actual and presently planned status of activity.

No. of Activity in Annex to Terms of Reference	ACTIVITY	Responsibility of PLN and Consultant: Basic data Available to Consultant	Responsibility of Consultant: Submission of Recommendations by Consultant to PLN	Responsibility of Consultant: Preparatory work for implementation undertaken by Consultant	Responsibility of PLN: Start of implementation with assistance of Consultant	Areas of implementation: Head Office	Areas of implementation: Java Areas	Areas of implementation: Other Areas	Government involvement	REMARKS
46/54	Directorates of Generation and Distribution									
	(a)	Complete	Complete	Sept. 1973	Jan. 1974	yes	-	-	Approval	
	(b)	Complete	Complete	Sept. 1973	Jan. 1974	yes	yes	yes	Approval	The Government decree approving PLN's new organization was actually issued in March 1973. Its implementation, however, was effectuated in January 1974.
47/51	Plant and System Protection									
	(a)	Complete	Dec. 1973	-	April 1974	-	yes	yes	-	
	(b)	Complete	end 1974-end 1975	-	end 1975-end 1976	-	yes	yes	-	Delay due partly to heavy involvement of consultants' expert in training efforts and partly to need for cordination with Java System Study.
50/55 69	Load Dispatch and Regional Distribution Centers									
	(a)	Complete	Dec. 1973-June 1974	-	Apr. 1974-Jan. 1975	-	yes	yes	Support	
	(b)	Complete	end 1974-mid 1975	-	early 1975-early 1976	-	yes	yes	Support	The delay is mainly due to the slow progress in the reconstruction of the Jakarta distribution network.
52	Appropriate Technical System Standards									
	(a)	June 1973	March 1974	-	June 1974	yes	yes	yes	Support	
	(b)	June 1973	end 1974	-	early 1975	yes	yes	yes	Support	Delay due to occupation with more urgent matters: not crucial for PLN's operations.
53/57	System Loss Reductions									
	(a)	-	Continuous	Continuous	Continuous	-	yes	yes	Support	
	(b)	-	Continuous	Continuous	Continuous	-	yes	yes	Support	Continuously being attacked through system reinforcement, maintenance programs, meter reader training, etc. Substantial results are likely to emerge only slowly due to overloading of the system, particularly in Jakarta.

FORM NO. 678
(7-73)

Mr. Willoughby

CONFIDENTIAL

INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT
INTERNATIONAL DEVELOPMENT ASSOCIATION

POLICY REVIEW COMMITTEE

PRC/s/C/74-10

July 2, 1974

THE ECONOMIC EVALUATION OF PUBLIC UTILITIES PROJECTS

STAFF REVIEW

The attached paper, "The Economic Evaluation of Public Utility Projects," prepared by the Public Utilities Department is circulated for information. Any comments should be sent directly to Mr. Dennis Anderson (Ext. 5350, Room D-701) by close of business July 19. It is not intended to hold a review meeting on this paper unless a substantial number of requests for a meeting are made to this office.

Frank Vibert
Secretary
Policy Review Committee

Distribution:

Chief Economists
IBRD Department Directors
Assistant Directors-Projects (Regions)
Division Chiefs-Power (Regions)
Program Coordinators
Mr. Qureshi (IFC)

ECONOMIC EVALUATION OF PUBLIC UTILITIES PROJECTS

Prepared by Public Utilities Department
July 2, 1974

CONTENTS

ECONOMIC EVALUATION OF PUBLIC UTILITIES PROJECTS

SUMMARY AND CONCLUSIONS

i. This paper attempts to place in proper perspective the significance of the internal economic return (IER) calculation as applied to investments in the public utility sectors, which are defined here to include water supply, power and telecommunications. The paper is explanatory in nature, and does not raise new conceptual issues.

ii. Economic evaluation of such projects involves consideration of three basic factors:

(a) the demand forecast;

(b) the least-cost method of meeting the predicted consumption; and

(c) the comparison of project costs and benefits.

This analysis should be carried out in the context of a development program for the whole of the relevant sector. This involves consideration of competing demands of various types of consumer, of overall institutional implications, and of technical systems effects on costs of supply.

iii. With respect to demand estimates, a useful distinction can be made in less developed countries between established markets, where consumers have adapted to the supply of public utility services, and potential new markets, where people currently do not obtain public water supply, electricity or telephone service. In the case of established markets, projections of past growth trends have generally been the principal basis for demand forecasts. This technique is often subject to considerable error, particularly where there has been a history of shortages, for example, supply of water for only a few hours a day, power outages, and waiting lists for telephone service. However, it is difficult to prescribe a general remedy.

iv. Where new markets are being considered, it is even more difficult to make predictions of demand. Surveys of the current reliance on alternatives, income, and ability to pay, may be helpful. In new low-income markets it is important to determine the "threshold" level of development where demand begins to develop. This involves consideration of agricultural and industrial activity in the region, government plans for the area, local wage levels, householders' priorities and needs, and the income levels at which the utility services will be used. The Bank is currently carrying out a number of research projects in this area.

v. However, accurate prediction of demand, at given prices, is not an end in itself. The basic question is whether the predicted rate of consumption is desirable in the sense that project benefits - broadly defined to include economic and social goals - exceed, by as much as possible, project costs.

vi. This requires that two considerations be satisfied. First, projects need to be built and operated as cheaply as possible to meet a given level of output at a given standard of service. Selection of least-cost facilities, including proper timing and sizing of projects, is based on comparison of the present worth of the construction, operating and maintenance costs of various feasible alternatives, using the opportunity cost of capital as the discount rate. Shadow pricing is employed as considered necessary to determine the least-cost solution from the viewpoint of the economy.

vii. Second, the expected benefits should exceed the costs (of the least-cost program). A comparison of project costs and benefits (such as are carried out, for example, for agricultural and industrial projects) is usually frustrated in the case of public utilities by the difficulty of quantifying benefits. Some attempts have been made to quantify benefits by examining the contribution which project outputs make to other activities and so assessing their value.1/ Research of this nature has been undertaken in the telecommunications sector in Pakistan, and other studies are currently underway in El Salvador (village electrification) and Costa Rica (telecommunications). Similarly, attempts have been made to estimate the benefits from water supply and sewerage projects by determining the impact of such investments on property values, and a number of unsucessful attempts have been made to measure the health benefits of improved water supplies. The general conclusion reached is that this approach to quantification of benefits of public utility projects is generally too difficult and time consuming to be applied routinely in the appraisal process. The only case where benefits can be quantified straightforwardly is in the productive applications of electricity in rural areas.

viii. Revenues are normally used as a measure of the economic benefits of public utility projects. However, revenues are only a partial expression of economic benefits (measured in monetary terms). People generally do value service by more than the amount they may be paying for it, and for this reason economic rate-of-return calculations based on revenues provide only a "minimum measure of benefits." In addition there may be external benefits, such as community health benefits from improved water and sewerage supplies. It follows that if prices (and thus revenues) reflect costs, benefits will be at least as large as costs.

ix. In order to arrive at economically sound investment decisions, consumers should be asked to pay a price for service which reflects the cost of supplying additional output. This would require the conventional accounting approach to tariff setting to be replaced by one that not only provides a satisfactory financial performance but relates to the costs (the marginal or incremental costs) of providing additional capacity and output. Practical problems of implementing this latter approach, including analysis of tradeoffs between various objectives - financial, economic and income distribution - of pricing policy, are currently being studied within the Bank.

1/ Similar to the measurement of the benefits of irrigation projects which are evaluated not in terms of sales of irrigation water, but of induced increases in agricultural output.

x. Project evaluation in the course of the Bank's appraisal process includes a calculation known as the internal financial return (IFR) adjusted to be the economic return (IER). The IFR is the discount rate which equalizes the present worth of incremental construction and operating costs and incremental revenues due to the project over its life; it is an estimate of the financial profitability of the project. The IER is, in principle, the rate of discount which equates the present worth of economic benefits and costs. In practice, however, an estimate of the IER is derived from the IFR by adjusting costs in economic terms (e.g., through the substitution of shadow prices for market prices), while using revenues as a minimum measure of benefits. Hence it simply shows the relationship between the price and the cost of additional - or incremental - output. This means that the IER requires a special interpretation.

xi. To interpret the IER, it is necessary to distinguish between existing and new markets. In existing markets, rejecting projects (on account of low IERs) would quickly lead to severe disruptions to economic activity on a large scale and, in the case of water, present a health hazard. The relevant alternative to be considered in the IER calculation is whether the growth of demand should be slowed down by increasing prices. This alternative can be evaluated by comparing the cost-savings of postponing the project with the lost revenues (i.e. by comparing incremental costs with the incremental revenues generated by postponement). If the IER is low, this suggests that prices should be raised or restructured so as to slow down the rate of growth of demand. (Often, this does not mean postponing the project in question since prices take a long time to act or to be changed.)

xii. In the case of new markets, postponing a project for long periods, or rejecting it, is often feasible because people are adapted to the use of substitutes. A comparison of expected revenues with costs will provide a minimum measure of the benefits of accepting the project. If the IER, based on a revenue-cost comparison, is low, this indicates that either the tariffs are too low or that the project is not justified, or both.

xiii. In rural areas, low IERs based on revenue-cost comparisons can sometimes be expected to be low. There may be economic reasons for keeping prices down in the early years (to promote use of the service) and social reasons (to help small businesses). It is then necessary to look beyond the revenues and estimate additional benefits people obtain (though this is, as discussed in para. (vii), a difficult excercise).

xiv. In both new and established markets, the IER thus provides a test of pricing policy, as well as of project acceptability. When the IER is low, the required action is to revise prices; this has the effect of revising the level and growth of demand such that the benefits to consumers exceed the costs of supply.

But what if prices not at all related to costs of supply & so cross-subsidization?

I. INTRODUCTION

1.1 This paper discusses the significance of the internal economic return (IER) calculation as applied to investments in the public utility sectors, which are defined here to include water supply, power and telecommunications. The paper is explanatory in nature, and does not raise new conceptual issues.

1.2 The IER is generally used in the Bank as a test of a project's economic desirability; high IERs are interpreted to signify an acceptable project, low IERs one that, on economic grounds, should be rejected. With Public Utility projects there is a complication to this rule in that the utility has extensive monopoly control over

- the whole market, and

- pricing policy,

and rejection of projects in existing markets (on grounds of low IERs or other reasons) would reduce the continuity and quality of service. This can disrupt industrial and economic activity on a large scale, and, in the case of water, present a health hazard. When IERs are low, the main option is to alter demand levels gradually through pricing policy. (This is, by definition, a problem that relates to established markets, where consumers have adapted to the use of public utility services, rather than to potential new markets such as village electrification.)

1.3 Indeed, while the IER derived from the existing tariff structure may provide a rough initial guide as to the merits of a proposed investment, it usually reveals more about the adequacy of the level of the utility's tariffs. Since the IER is derived from revenues, and therefore reflects the level of tariffs, it can point to the way in which prices should be adjusted in order to provide a better signal for the justification of investment. Tariffs are thus important, not only from the viewpoint of the enterprise's financial viability, but also because they can influence consumer behavior and thus eventually the allocation of resources.

1.4 This paper, in reviewing the procedures for Public Utility project evaluation, discusses such interpretations of the IER.

1.5 The economic evaluation of public utility projects involves consideration of three basic factors:

(1) the demand forecast;

(2) selection of the least-cost method of meeting the predicted rate of consumption; and

(3) comparison of project costs and benefits.

1.6 These three aspects are dealt with in order in the rest of the paper. It is, however, important to emphasize at the outset that in the case of public utilities the "project," as defined by the Bank, may be a somewhat arbitrary concept. It is necessary for project evaluation to be dealt with in the context of a development program for the whole of the water, power or telecommunications sector. On the demand side, there are many markets to study, new areas to be served, and demands stemming from many types of consumer; on the supply side the institutional implications of project selection and operation have to be considered and the technical impact of a project on the operation of the whole utility system estimated. Project evaluation can frequently be performed satisfactorily only when it stems from or is accompanied by a study of the sector.

II THE DEMAND FORECAST

2.1 The first stage of appraisal consists of a forecast of demand. While any forecast requires an assessment of the quantity and quality of service demanded by various categories of consumer - urban, rural, domestic or industrial - a particularly useful distinction in the context of less developed countries is that between established markets, where there is historical and current evidence about demand by existing consumers, and new markets, where no such evidence exists.

2.2 In the case of an established market where supply has been reasonably adequate, the customers have had access to service for some time and have taken its availability into account in establishing their living patterns and consumption habits. In such cases it is common to find sustained trends in the growth of demand of various consumer groups. Although simple trend projections, supplemented by econometric or other analysis of the industrial and domestic markets and of government plans, are subject to considerable error, it is difficult to make general recommendations as to improvement in generally accepted techniques.

2.3 There are, however, many instances of established markets where supply has fallen short of demand, so that past consumption levels and trends provide no firm basis for estimating future trends in growth of demand. Proposed investments frequently do little more than bring the quantity and quality of service to a level that matches the existing level of (unsatisfied) demand. Such improvement, necessary to catch up on overdue investment, is often an important economic justification of projects, which may be reinforced by pressing social needs, for example, to ensure minimum health or sanitary conditions.

2.4 These considerations are illustrated by the following examples:

(i) Bombay Water Supply and Sewerage Project

"...unless urgent measures are taken to improve water supplies and sanitary systems, living conditions will be intolerable. This program is to improve living conditions by (i) alleviating the existing water shortage and increasing the present 3-5 hours of intermittent supplies to 7-8 hours supply daily; and (ii) mitigating the present dangerous and offensive sanitary conditions by providng an effective sewerage and sewage disposal system." 1/

"Currently 71% of the domestic demand is estimated to be satisfied, by irregular and inconvenient supply hours, but by 1981, supply hours would be doubled and about 80% of domestic demand satisfied."

(ii) Istanbul Power Distribution Project

"...between 1967 and 1971 system outages increased by 20% annually in number and 24% in duration... In 1971 at least 70% of the outages were due to inadequate facilities. "...local

1 This and other quotations in this paragraph are from the appraisal reports for these projects.

industry lost working days...(with a) resulting loss in industrial output...conservatively estimated at US$20 million."

2.5 Where established markets have become dependent, at least in part, on the availability of a service, there may be a prima facie case for installation of new facilities to meet increasing demand or to maintain the quality of service at a reasonable standard. Without such additional facilities the inevitable consequences are deterioration in the quality and continuity of supply and ultimately, rationing; subsequent water or power shortages can disrupt industrial production; commercial activity may be damaged by congested telephone networks; water shortages may endanger health. In these cases, short-term demand may be so great as to clearly warrant investment in additional facilities, although tariff increases to reflect rising costs of supply may dampen further growth of demand.

2.6 A different situation obtains in the case of new markets. Where service is not yet provided, the possibility of continued reliance on alternatives must be taken into account, and since there is no direct experience of consumers' willingness to pay for the service provided by the utility, surveys of income and ability to pay for service may be necessary. In new high-income markets, forecasts can be made by comparison with the consumption of similar existing customers in other areas. For new, low-income markets, forecasting is more difficult. One problem is that of estimating the "threshold" level of development in a region, above which the project's output will be demanded. It becomes necessary to consider the extent of agricultural and industrial activity in the region; government plans for the area; local wage levels; householders' priorities and needs; and the income levels at which the utility service will be used.

2.7 In view of the increasing emphasis being placed on rural development, research in these areas is now underway. Bank-sponsored research activities in El Salvador (village electrification) and in Costa Rica (telecommunications) projects are being studied in various environments to develop an understanding of the factors which affect consumer behavior. For the same reason the Bank is also paying particular attention to monitoring the results of projects of this type. This approach is being followed in Ecuador (village electrification), in Brazil (Minas Gerais water supply) and initiatives are being taken elsewhere in telecommunications, as well as power and water supply. In general, these studies seek information in five major areas:

(i) the use of substitutes, which generally declines following the project's operation;

(ii) the quality of supply, particularly in the case of water, where decisions must be made between house connections and use of standpipes;

(iii) the aims of the project, which may be e.g., the use of more water per capita or use of electricity for agro-industries;

(iv) more comprehensive understanding of the consumer: literacy, income level, business profitability, etc.; and

(v) better appreciation of the community: local infrastructure, credit availability, government support, etc.

Development of this information gives a clearer picture of a project's impact, desirability, and areas of possible improvement, which in turn will form a more reliable basis for predicting the success of potential projects in similar areas.

2.8 Much can be done along the above lines to improve demand forecasts, but no matter how sophisticated the predictive method, uncertainties remain. Changes in tastes, in the composition of industrial output and - particularly in the case of water supply - in the location of economic activity, all introduce an element of risk and indicate that continual updating of demand projections is necessary.

2.9 One such uncertainty is associated with the impact of price changes on demand. In practice, demand forecasts are rarely adjusted to reflect projected changes in tariffs. This is due to a variety of reasons, such as the knowledge that forecasts are, at best, only approximations; information on price elasticity is limited; price changes are usually slight in real terms, being made largely to keep pace with inflation rather than to reflect changes in marginal costs of supply; and there is often a pre-existing inadequacy of supply. While this failure to adjust demand forecasts is a short-coming of the conventional approach, it may not be too serious in the short run as price changes have in practice to be implemented gradually. Rather more serious is that while predictive accuracy is an important objective of utility management, much less attention is paid to whether or not the predicted demand target should in fact be met. This is discussed further in Section IV.

III. THE LEAST COST SOLUTION

3.1 The second principal stage in the appraisal of a public utility project is a consideration of all realistic alternatives to assure that the one selected will provide the service required at the least cost. Techniques for doing so are straightforward in principle (although their application may be complex) and generally well understood by public utility engineers. Systems effects are of course important. The addition or removal of a component of a water, power or telephone system may affect the behavior of other components. Therefore, what must be compared is not simply the costs of alternative components, but the costs of expanding and operating the whole system with alternative components.

3.2 In the basic cost comparisons outlined above, it is appropriate to incorporate the use of shadow pricing in the decision-making process. Hydro projects, for example, usually require more capital than thermal projects but much less foreign exchange, and exchange rates may not correctly value the latter. Similarly, the choice between coaxial cable and microwave systems for long-distance telecommunications extensions are materially affected by the use of a shadow price for labor when substantial unemployment exists, because the proportionate labor content for coaxial systems is much higher.

3.3 In such situations it is important to recognize the difference between the least cost solution to the utility and the least cost solution to the country. The use of financial cost criteria produces the least cost solution to the utility; substitution of shadow prices results in the least cost solution to the economy. In the latter case the utility has to pay actual market prices, e.g., for labor which may have been shadow priced at zero; this involves greater cash outlays than are required by the solution which is least (financial) cost to the utility. The principle that consumers should pay for the costs for which their consumption is responsible suggests that the additional financial cost should be met by raising prices, but there may be circumstances in which subsidy from general government funds may be preferable (particularly in water supply and sewerage projects where tariff problems are more severe).

?

What about extra fx costs?

3.4 The problems of uncertainties in costs and effects of changes in growth of demand or delay in construction, and combinations of these factors, are treated by sensitivity analysis. This gives a range of the probable alternative solutions. However, sector studies of power, energy, water resources or communications may be a necessary prelude to this. Moreover, there is often a long lead time between the initial sector study and selection of the appropriate investment program. System planning techniques may have to be improved, research in low cost technology, and feasibility studies considering a wide range of technical options may be required. Least cost solutions are sometimes not found because of failure to devote adequate time and effort to study and research.

3.5 The project selection process is carried out by the utilities or their consultants often with guidance from the Bank from the early stages of the project cycle. When the choice between alternatives is particularly doubtful and complex, or involves issues beyond the scope of utilities and consultants, the Bank often makes its own investigations. Particularly significant examples include the Indus Basin Development in Pakistan, the Elbistan lignite-fired plant in Turkey, and the water supply project in Nairobi.

IV. MEASUREMENT OF THE BENEFITS OF PUBLIC UTILITIES PROJECTS

4.1 Comparison of the costs and benefits of public utility projects is usually frustrated by the difficultues of benefit measurement. Some attempts have been made to quantify the benefits which result from public utility projects by examination of the use made of project outputs and assessing their value. Such calculations are being undertaken in the study of village electrification in El Salvador for a variety of farm, commercial, and agro-industrial activities. The process of quantifying such benefits is difficult and can generally only be done in special cases. In the study in El Salvador it was necessary to consider and quantify benefits arising from such items as lighting, ironing, refrigeration, water pumping, radio and television in homes, motive power for farms and for sugar, cotton and coffee processing, and electric welding. Projects supplying large urban markets are even more difficult to evaluate by this approach. Since project outputs are normally both final consumer goods and intermediate goods used for a wide array of commercial and industrial activities, the information required to permit an independent assessment of their value is normally overwhelming. Generally, it is only possible to undertake such studies routinely when the applications are less diversified and more elementary (though nevertheless important) such as in the productive uses of electricity in rural areas.

4.2 Similar research work done in the Bank in water supply and telecommunications confirms the research experience in village electrification, namely the difficulty of estimating project benefits by means other than the demonstrated willingness of consumers to pay a price established by the public utility or regulatory authority. Attempts have been made by the Bank to estimate the benefits of water supply and sewerage projects by determining the impact of such investments on property values. Data on property transactions in Nairobi and Kuala Lumpur, two cities in which records are particularly good, were analyzed. It proved to be impossible to disentangle the impact of water sewerage investments from the many other variables influencing property values in the areas concerned.1/ Similarly, a survey of attempts to quantify the impact of improved water supplies on public health showed that statistically significant results were exceptionally difficult to obtain (despite large sample surveys) and were of little use in quantifying benefits. Problems arise not only in quantifying the economic and social benefits of an improvement in health, but also in disentangling the influences of improved sanitation facilities on health from all the many other influences, such as nutrituion, climate, and household income and assets.

4.3 Attempts have also been made to quantify the benefits that arise from investments in telecommunications projects, such as time savings, marketing advantages and so on, compared with alternative forms of communication. A particularly detailed analysis was carried out by the Bank in Pakistan. However, since the qualitative superiority of telecommunications over its laternatives is so great, it is not surprising that such studies are

1/ For example, in one case the installation of sewers was accompanied by a rezoning ordinance which simultaneously tended to increase property values.

unsuccessful in fully measuring benefits. The general conclusion stemming from these research efforts, and from Bank experience in public utilities is that benefit measurement along these lines is too difficult to be applied routinely in the appraisal process, though such studies have considerable heuristic value.

4.4 In many other sectors benefit measurement is somewhat easier. In the agricultural and industrial sectors, for example, it may often be possible to use import or export prices of products to measure the value of additional output, while certain transportation projects may be evaluated to some degree by the cost savings that accrue in the private sector. In irrigation projects measurement of benefits on the basis of water revenues faces similar difficulties as in public utilities, but benefits can be assessed by considering the impact on agricultural output. This latter approach, as pointed out above, has proven to be not feasible in public utilities.

4.5 In most cases therefore, it is necessary to make cost-benefit calculations with limited information. In public utility projects, the only concrete information available on the benefit side are the incremented revenues. This is generally a minimum measure of benefits because:

- people generally do value service by more than the amount they pay to obtain it;

- in the case of water and sewerage systems, there are additional health benefits to the community;

- in the case of telecommunications, new consumers also increase the benefits of telecommunications for existing consumers (because the extent and value of communications increases for the latter).

So generally, if incremental revenues cover incremental costs, an IER (based on incremental revenue-cost comparisons) will be sufficient to justify a project. Indeed, unless a subsidy is merited, this generally should be the case.

4.6 Two problems with using revenues as a minimum measure of benefits are that:

- price structure does not often correspond with cost-structure; and

- sometimes, average prices may be below costs.

The IER calculation just described will reveal this and will point to the need for reforms to pricing policy. Such reforms eventually have the effect of regulating demand to the point where the benefits of investment and output exceed the costs.

also question of margin: v. high returns to intra-marginal — but that is [illegible] [illegible] "economic".

V. PRICING POLICY AND THE INVESTMENT DECISION

5.1 While the Bank stresses the role of pricing as a means of achieving an efficient allocation of resources, this has not generally been accepted in the public utilities field. With the exception of fairly recent advances in Britain, France and Sweden, public utility pricing is usually dictated by accounting conventions aimed primarily at an equitable sharing of the utility's costs among consumers. This approach is rarely useful in helping to ensure that efficient investment decisions are being made or, in other words, that the benefits of projects exceed their costs by the maximum amount possible.

5.2 This is primarily because the accounting approach is concerned with the recovery of sunk costs, whereas for efficient resource allocation it is the actual resources used or saved by consumer decisions which are important. Prices are the amounts paid for increments of consumption and, social objectives aside, they should therefore be related to the increments of cost thereby incurred. If new consumers are connected to the system, or if existing ones increase the amount of power, water or telephone service they use, it is important that prices should signal to consumers the costs of such changes in their consumption. Hence prices need to be related to the value of resources used (or saved), and the valuation of these resources, the estimation of costs, requires a forward-looking estimate. The backward-looking estimate of the accounting approach creates the illusion that resources which can be used or saved are as cheap or as expensive as in the past; that is, that resources are as abundant or as restricted as in the past. On the one hand, this may cause over-investment and waste; and on the other, underinvestment and unnecessary scarcity.

5.3 The traditional approach to pricing is also pre-occupied with average costs, so that large discrepancies often appear between the structure of prices and costs. This (1) generates large cross subsidies and (2) often results in prices too low when demand is high, and too high when demand is low. To promote better utilisation of capacity, and to avoid unnecessary investments to meet peak demands (which tend to grow very rapidly), it is often useful to structure the prices by varying them according to the costs of serving demands:

- of different consumer categories;
- in different seasons;
- in different hours of the day;
- in different geographical areas.

5.4 Another shortcoming of the traditional approach is that the "fairness" aims are couched in the rather narrow terms that consumers should pay for the share of accounting costs allocated to them. Apart from the fact that, as just explained, these may very well differ from the costs which consumers are causing the economy, it is evident that though such cost allocation involves (often arbitrary) judgements, it cannot properly be judged either fair or unfair. Fairness is an attribute of tariffs in relation to consumers, not of costs considered in isolation. While questions of fairness and the need to raise sufficient revenue to permit system growth are relevant for tariff making, separate analysis of these aspects is necessary. Many of the fairness aims of the traditional approach were, in any case, conceived for urban projects in N. American or European conditions, and obviously do not relate to the problems of developing countries.

5.5 The foregoing suggests that if price is to be used to signal the economic justification of investment (social matters are discussed later), the traditional approach to tariff setting has to be replaced by one that allows price to reflect the cost of the resources used up in making additional consumption possible. This would permit consumers to reveal, expost facto, whether the value that they place upon additional output at least equals the additional (or incremental) cost of a water, power or telephone system, thus signalling the justification of investment in additional capacity. This policy requires, inter alia, that differences in incremental costs attributable to different consumers or types of consumption should be reflected in the prices charged. This may include variations in costs of supply according to the geographic location of consumers, or to the time pattern of consumption. A number of research studies into the problems of obtaining efficient pricing policies in public utilities have now been completed in the Bank.

5.6 If it is impossible, in practice, to establish price in the foregoing manner, economic justification of a project is made very difficult, for reasons explained in IV. If price is less than the incremental cost of expanding a power, water or telephone system, there is no evidence as to whether or not consumers would pay for it if they were given the choice. On the other hand, if price is greater than incremental system cost, demand may be unnecessarily restricted, and the project smaller than optimal; how much smaller is however unknown. Moreover, even if on average prices equal incremental system costs, project justification will not be automatically signalled by consumer behavior if differences in the cost of various types of consumption are not recognized in the tariff structure.

5.7 However, in addition to the problem of externalities, referred to earlier, there are a number of practical difficulties that confront us in attempting to rely upon pricing policy as a better means of signalling the justification of investment. These include:

(i) Cost of implementation: Pricing itself may be costly. For example, the cost of special metering of domestic consumers to distinguish peak from off-peak electricity consumption may be greater than the benefits. Furthermore, price changes themselves may be difficult - and costly - to implement.

(ii) Fiscal and financial constraints: Public utilities may be an efficient means of raising revenues for general governmental purposes. The gains from taxing them should therefore be weighed against or reconciled with the objective of using price to determine the justification of system expansion. Similarly, the financial viability of the public utility could conceivably be at odds with the approach to pricing described here, and reconciliation may be necessary.

(iii) Social objectives: As the pricing concept is related to an effective willingness to pay, it depends in part upon the pattern of income distribution in a particular society. Thus, the very poor may lack an effective willingness to pay for water from a public supply, but they should not therefore be denied access to service. In other words, social objectives complicate the basic concept of allocating resources in accordance with willingness to pay. Providing the service to the poor will then involve cross subsidization either by other consumers or by general tax payers in the municipality itself or the country at large. Subsidies and taxes should be made explicit and weighed in the overall assessment of the pricing policy for the service.

(iv) Forecasting problems: Investment decisions will certainly be assisted by pricing according to marginal cost. However, demand forecasting will be more difficult since it should reflect changes in income growth, taste, etc. as well as changes in price.

5.8 Reconciliation of the various objectives of pricing policy - efficiency in the allocation of resources, financial, fiscal, income distributional and other social goals - may be a complex task, as is being increasingly recognized in Bank appraisal reports. While tradeoffs between the various objectives may often by necessary (being reflected, for example, in tariff structures which allow poor consumers to obtain a basic supply of water for health purposes at a subsidized rate, while wealthier consumers pay more than cost), it remains true that pricing according to incremental or marginal cost remains the most direct, simple and practical method by which reasonable resource allocation can be achieved. In a well functioning private sector, prices are determined by market mechanisms. In the public sector, prices are determined by regulation. However, by attempting to reflect the level and structure of costs in tariffs, utilities also can secure an efficient use of resources; where necessary, they can adapt those tariffs to achieve social goals and mobilize resources for expansion.

VI. THE INTERNAL ECONOMIC RETURN

6.1 Project justification rests, as a rule, upon a calculation of the internal economic return (IER) which is the discount rate that equates the present value of economic benefits and costs associated with a project. Since benefits of public utility projects are only poorly approximated by its associated increases in revenue, economic appraisal normally starts with a calculation known as the internal financial return (IFR) on the project investment (or program of which the project is a part). This return is the discount rate that equalizes the present worth of incremental costs (construction and operating) and incremental revenues resulting from the project over its life. This rate presents an estimate of the financial impact of the project on the utility.

6.2 A similar calculation, using adjusted data for costs and benefits, produces a rough estimate of the IER. In this calculation, costs are adjusted so that they reflect costs to the economy as a whole rather than just to the utility, e.g., taxes on project inputs are not treated as economic costs, but subsidies are. Further adjustments may be made in cases where the market for productive factors does not provide an adequate measure of their real cost to society and shadow prices may be substituted for market prices. In both calculations, IFR and IER, revenues are used as a minimum measure of benefits. In the IER the benefits are adjusted to include such items as consumption taxes, and then compared with the social opportunity cost of capital, i.e., the return on capital in its most productive alternative use, in order that a judgement may be made as to the economic justification of the project.

6.3 To interpret the IER, it is necessary to distinguish between two markets

> Existing markets, where the local economy is highly adapted to service;
>
> New markets, where the local economy is adapted to using substitutes or doing without.

Existing Markets

6.4 The rate of growth of demand for the outputs of public utilities depends upon economic growth, the pace of industrialization and other such factors. It is also influenced by tariffs. Thus, while a utility cannot choose the rate of growth directly (except for the number of new consumers connected), it can influence the rate of growth by pricing policy. In the case of projects to supply existing consumers IER analysis can be used to indicate whether the rate of growth should be faster or slower, with corresponding implications for project timing. For this purpose, an IER should be calculated which equates the present value of the change in system costs from bringing forward or postponing the project - say by one year - with the present value of the change in revenues that would be gained or lost by the change in timing. Studies of the application of this concept to a number of public utility projects are currently in progress in the Bank.

What about reliability std?

6.5 In carrying out IER calculations, it is important to note that the addition to system operating costs in any one year will not be the same as the cost of operating the new capacity, i.e., there is usually a "systems effect." This is because the efficient operation of the system as a whole may involve fairly full utilization of the new, efficient plant and lower utilization of older existing capacity. Similarly, the relevant returns are neither the selling value of the production from the new capacity nor the whole of the year's increase in revenue. They consist only of the revenue from that part of this increase which could not have been achieved if the installation had been postponed. In most cases this will consist of revenue from extra peak sales, since existing capacity can normally accomodate some increase in off-peak sales.

6.6 If the rate of return so calculated on investment this year instead of next year is high, the message is that to expand capacity sooner rather than later will be profitable. If this rate of return is low, the message is that rapid expansion will subtract from the utility's performance. Extra capacity to meet an increase of peak or dry season sales is expensive; the economic message of a low return is that the resource costs to the country of providing the extra capacity are not covered by the extra revenues from those peak or dry season sales. The reason may be that consumers are getting the extra capacity too cheaply and tariffs should be raised, with the structure probably altered as between peak and off-peak or between wet and dry seasons, thus slowing down the general growth of demand for capacity and output. Or if tariffs do reflect the (short run) cost of additional supplies, it may signal that investment in additional capacity is premature.

one year only

What rate of return on capacity?

6.7 There are of course problems in raising tariffs suddenly: both equity and politics argue against it. In any case, demand may be fairly inelastic in the short run, since it takes time for consumers to adjust their usage of equipment that is competitive with or complementary to the services of the utility in question. In cases where capacity is fully utilized at a less than optimal price, some capacity expansion is likely to be justified to avoid the problems associated with water and power shortages, telephone service congestion, and so on, during the period required to revise tariffs upwards, and the growth of demand for services to adjust itself downward.

New Markets

6.8 In the case of a project serving new markets and connecting new consumers, as with rural water supplies or rural electrification, the rate of return has a somewhat different significance. Here costs include connections and the construction of the new distribution system as well as the addition to system costs of supplying water or power to the new network. The returns include the whole of the revenue from the new consumers. A high rate of return would then indicate that the geographical extension of the system is justified since, with the proposed tariffs, consumers value the new service at more than its cost. A low rate of return indicates either that the project is not economically justifiable, or that the proposed tariff is too low, or both. The point is again that the tariff and the project have to be considered together rather that separately. The question is whether there is any tariff which will lead to a consumption level and hence a revenue which will yield an acceptable rate of return. The rate of return may need to be calculated for several alternative tariff levels in order to see whether the initially calculated low return argues against the project or for a modification of the proposed tariff. If it argues against the project, the project should be postponed until development in the area has become more favorable for investment.

6.9 There is one special problem to note regarding projects serving rural areas. The IER based on revenues may often be below the opportunity cost of capital even if pricing policy is satisfactory:

- initial fixed costs, and thus the average costs in early years, are high; to promote use of the service, and also not to hold back consumption unnecessarily on account of large "sunk" costs, prices need to be below average costs in early years;

- the arguments for keeping prices down to help consumers from small businesses and low income families.

Often it may be necessary to look beyond the revenues and try to estimate some of the additional benefits consumers obtain. This can be done for productive uses of electricity in rural areas. But the extent to which it is necessary is partly a function of the acceptability of subsidising the project - if a long-run view is taken, recovery of sunk costs may be desirable. These matters are discussed in the issues paper on rural electrification.

Conclusion

6.10 In both established and new markets, the analysis of tariffs and their relation to the IER should consider both the structure and the levels of tariffs. Alternative tariff structures affect the IER directly through their impact on revenue and, to a varying degree, on the pattern of demand. Conversely, the tariff structure should reflect variations in costs of supply according to the type of service, the geographic location of consumers, or the time pattern of consumption.

6.11 The foregoing discussions of the role of pricing and the IER does not lead to any firm rules, but provides "guidelines" which need to be adapted to the circumstances of any particular project. The IER analysis is a starting point for the examination of both pricing policy and the justification of the proposed investment. It focuses on the relationship between price and marginal cost and tests investment decisions against the willingness of consumers to pay for additional consumption, rather than a more intuitive judgement that the project is economically justified.

does not allow for rigidities in large urban area tariff structures (Bogota case)

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REMARKS

Chris – For your interest, an anthropologist's view of r.e., undertaken as part of our study in El Salvador.

FROM	ROOM NO.	EXTENSION
Dennis		

RICARDO FALLA

COSTOS Y BENEFICIOS SOCIALES DE LA ELECTRIFICACION RURAL EN EL SALVADOR:

EL CASO DE ROSARIO DE LA PAZ

0. INTRODUCCION

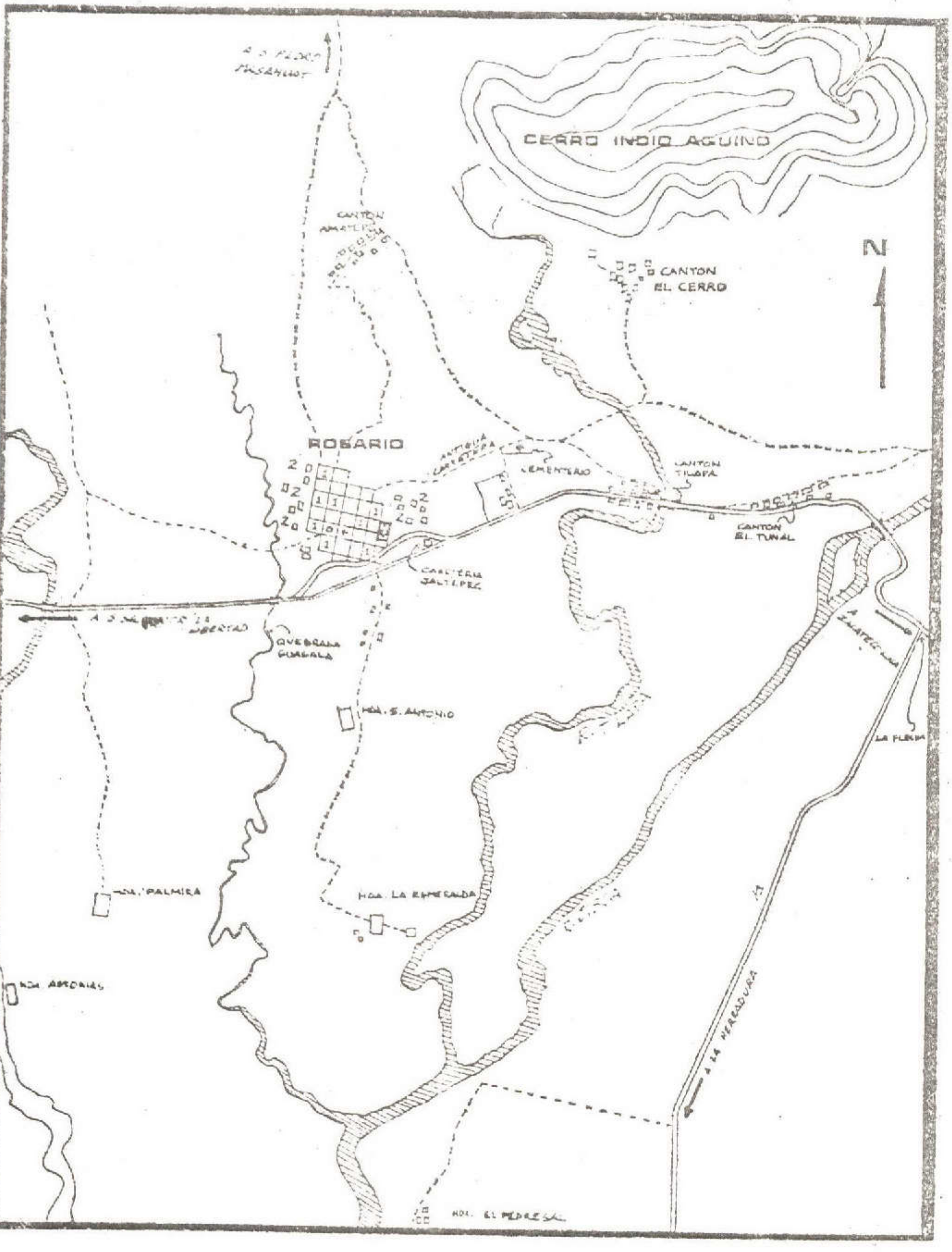
Pretendemos estudiar los costos y beneficios nacionales de la electrificación rural en una localidad concreta, Rosario la Paz, Departamento de la Paz. Después de una breve descripción del lugar, que puede servir como pauta de variables comunitarias relevantes al problema de la demanda de energía eléctrica, analizaremos, primero, el pueblo mismo de Rosario; luego, un cantón, o caserío cercano, llamado Tilapa; en tercer lugar, estudiaremos el impacto de la Arrocera San Francisco entre sus obreros provenientes de Tilapa, del pueblo de Rosario y de otros cantones; por fin, para completar el cuadro con un estudio del proceso de decisión comunitaria, analizaremos la solicitud del cantón El Cerro y las fuerzas que la han detenido o impulsado. De todo este material sacaremos algunas conclusiones provisionales acerca de las posibles variables que intervienen en la demanda de energía y que constituyen lo que podría subsumirse bajo el nombre de costos y beneficios.[1]

1. BREVE DESCRIPCION DEL LUGAR

1.1. Ecología

El Pueblo de Rosario la Paz está situado sobre la carretera del litoral, a unos 37 Kms. de distancia de la ciudad de San Salvador. Se encuentra entre el desvío de Comalapa, que cruza hacia el puerto de La Libertad y el de La Flecha, que va hacia las playas de la Herradura. Dos vertientes lo abrazan, el río Tilapa por el oriente y la quebrada de Guasala, al occidente. El pueblo está sobre una pequeña elevación de 100 metros sobre el nivel del mar y destaca sobre la planicie de la costa sur sembrada de algodón y poblada de ganado, donde se hallan las haciendas de Palmira, la Esmeralda, San Antonio, El Pedregal y otras. Al nordeste, una pendiente se yergue repentinamente: es el cerro del Indio Aquino. Este cerro, que no tiene más de 400 metros de altura sobre el mar, es una de las estribaciones rocosas de la sierra, que cae desde San Juan Tepezontes y que detiene el embalse del lago de Ilopango. Al noroeste del pueblo se extienden pequeñas propiedades con pastos para ganado con siembras de milpa y maicillo.

El municipio tiene varios cantones: el de (Asunción) Amatepeque, que es probablemente el más antiguo y está al norte del pueblo: El Cerro, al pie del cerro del Indio Aquino; El Tunal, sobre la carretera del litoral, en el lado oriente del río Tilapa; y Tilapa, sobre la carretera, al occidente del mismo río, entre este y el pueblo. El cantón El Pedregal se encuentra al sur del pueblo y su centro es una lotificación de la hacienda El Pedregal, en medio de campos de algodón. (Ver mapa).



Al norte del municipio se alinean otros municipios de origen indígena, que contrastan con este en su sentido de corporatividad, y en su antigüedad, tales como los tres Nonualcos, los dos Masahuat, los dos Tepezontes, y los dos Talpas.

Rosario tiene todas las trazas de ser un pueblo de quizás menos de siglo y medio de antigüedad. Nos referimos al pueblo viejo de Rosario, porque el actual fue cambiado de la antigüa localización hace solamente tres o cuatro generaciones.

1.2. Población

Daremos los datos de los Censos:

Cuadro 1: Población total, urbana y rural; y número de viviendas del municipio de Rosario la Paz en los años 1961 y 1971.

Año	Población total masc.	Población total fem.	Población urbana masc.	Población urbana fem.	Población rural masc.	Población rural fem.	Viviendas urb.	Viviendas rur.
1961	2033	1984	978	1012	1055	972	?	?
	4017		1990		2027		?	
1971	2780	2883	1301	1412	1479	1471	571	550
	5663		2713		2950		1121	

Fuente: Censos de 1961 y 1971.

La tasa de incremento de población para la década de 1961 a 1971 es de 4.1% por año en el total de la población, 3.6% en lo urbano y 4.6% en lo rural.[2] Como las definiciones de rural y urbano pueden variar para cada Censo, resulta arriesgado hacer muchas elucubraciones sobre la diferencia de tasas. Pero sí se puede apreciar que el crecimiento de la población es alto, aun con relación al de todo el Departamento de La Paz, que es 3.9%. En el área rural parece que sigue habiendo inmigración, aunque no tanto como antes del comienzo del cultivo del algodón, por 1955; en la urbana hay más bien emigración a la ciudad de personas que trabajan o estudian en San Salvador.

Creemos que habría sido muy interesante ver la composición por edades de la población, ya que allí se encuentra probablemente uno de los factores que interviene en la demanda de energía eléctrica, pero los Censos publicados no incluyen este dato.

1.3. Vida económica

Algunos de los habitantes, sobre todo, del pueblo son dueños de parcelas de pocas manzanas, donde crían vacas o alquilan lotes para siembra de maíz o maicillo a otros más pobres. Rosario la Paz es un municipio lechero y se ha hecho famoso por las quesadillas. Las mujeres las venden en los desvíos. Los que no poseen tierra, que forman la mayoría que vive en los cantones, adonde emigraron entre 1930 y 1955 principalmente, trabajan en las algodoneras en la época de corta, y siembran maíz, frijoles y maicillo en tierras alquiladas a 60 ó 70 colones la manzana cada año. Recientemente se ha instalado la Arrocera San Francisco cerca del cantón Tilapa, y ésta da trabajo a unas 80 personas del lugar. Muchos viven de las tiendas, tanto en el pueblo como, a menor escala, en los cantones. La colocación céntrica y bien comunicada del pueblo hace que mucha gente de las haciendas suba a comprar allí. Cerca de 12 tienen camiones para fletes o para negociar ellos mismos. Tres tienen tractores para sus cultivos o para atender a los de otros. Por fin, no deja de entrar dinero a Rosario a través de personas que viven en San Salvador y vuelven los sábados y de fueranos que trabajan en oficinas del pueblo.

1.4. Organización socio-política

Rosario es un pueblo actualmente muy politizado. La contienda electoral fue duramente reprimida con amenazas, golpes y cárcel por parte de la Guardia Nacional. Con el partido del gobierno se alían ordinariamente los ricos que tienen tierras, los que detentan puestos administrativos, los que por tradición y educación, pertenecen al ala gobiernista y practican un catolicismo, que antes encontraba su expresión en la celebración de las fiestas patronales. Los del cantón Amatepe, de familias más antiguas y hombres, que trabajan en la Policía en San Salvador tienden a ser también gobiernistas.

En la oposición se cuenta una mayoría creciente. Allí encontramos a los jóvenes que han salido a estudiar, aunque sean hijos de ricos, "viejos arrugados", y la mayoría de los maestros; un grupop, que aparentemente tiene una tradición protestante desde antes del General Martínez y que conlleva la tendencia de oposición a todo lo establecido; un núcleo de izquierdistas más radicales, cuya cabeza es un antiguo pastor protestante; y el gran número de campesinos de los cantones, que, por haber inmigrado hace menos de 40 años, carecen de tierras para cultivar o encuentran cada vez más caro arrendarlas. Por fin, en la oposición militan un par de personas más adineradas, dueños inclusive de extensiones considerables, que probablemente intentan un paso de movilidad política, como quizás un escaño de diputado.

1.5. Comunicación hacia fuera

Primera y principalmente está la carretera, que es "todo en el pueblo". En 45 minutos de bus, a ₡ 0.75 el pasaje, Zacatecoluca. Los buses de Zacatecoluca y de otros lugares, que desembocan sus transportes por la carretera del litoral, enfrente de Rosario pasan cada 15, 20 ó a lo sumo 30 minutos. La carretera pavimentada fue terminada en 1942.

En 1962 sólo había 3 automóviles en el pueblo. En la actualidad hay 10. Los domingos entran "montón de carros" de parientes que viven en San Salvador. Pero no hay más que un dueño de bus de una línea de la Herradura a San Salvador.

No hay Centro de Salud. Hay dos farmacias principales y una pequeña. Se acostumbra visitar a los Doctores de Zacatecoluca —₡ 5.00 la consulta— o de San Salvador.

Se reciben 80 periódicos diarios, 40 de La Prensa y 40 del Diario de Hoy. En domingos se distribuyen 120. En 1952 sólo se vendían 30 diariamente y los ofrecían entre la carne de los canastos. Se distribuyen de 45 a 50 Tribunas Populares, un rotativo semiclandestino, en el pueblo y entre colonos de algunas haciendas.

Rosario, se ha convertido en centro donde tienen sus oficinas regionales la CEL (Comisión Ejecutiva Hidroeléctrica del Río Lempa), la Supervisión escolar, el párroco con jurisdicción eclesiástica mucho más amplia que la municipal y, en fin, un grupo de agrónomos que viven allí, pero trabajan en las haciendas. Se ha ido desplazando a Rosario el centro del Distrito, que es San Pedro Masahuat, aun a disgusto de los sampedranos.

Sólo en el pueblo hay 18 profesores de las escuelas (6 grados) y del Plan Básico. Además existe una escuela en El Tunal, donde trabajan tres maestros, de los cuales dos viven en Rosario y la otra viaja a San Salvador diariamente. En El Amatepe también hay tres maestros para la escuela de allá y uno en el Pedregal para una escuela recién inaugurada. Se piensa que no se puede instalar un Instituto en el pueblo, porque los muchachos van a Santiago Nonualco o a San Salvador.

2. LA ENERGIA ELECTRICA

Veremos ahora cómo, en cuatro contextos del mismo municipio, la energía eléctrica ha sido aceptada y usada a través de un proceso diverso y/o con impactos también distintos. Primero nos centraremos en el casco del pueblo;[3] luego en el cantón Tilapa; en tercer lugar, la Arrocera San Francisco; y, por último, en el cantón El Cerro,[4] que aún no ha recibido la electricidad.

2.1. El casco del pueblo

2.1.1. Historia del ingreso de la electricidad

Antes de que la CEL instalara la luz en 1962, hubo ya, por el año 1940, una persona que tenía un motor Diesel con dínamo y daba electricidad a un par de casas, además de consumirla él mismo. Hemos tenido noticias también de otras dos personas por lo menos, que tuvieron un dínamo privado y pasaban luz a los vecinos. A finales de 1959 llegó a establecerse, proveniente de Olocuilta, un farmacéutico culto, que, aunque no había nacido en Rosario, había vivido varios años de niño en el lugar. Compró un motor Diesel de 8 HP con su generador de 1 KW, más cuatro molinos (uno de café y 3 de maíz) a uno de los señores, que con permiso del alcalde había ampliado el uso privado de la luz a 15 servicios y que, a veces, lo usaba para una cinquera. Además, compró otro motor de 12 HP y dos generadores más, de 2 y 2.5 KW. Los 15 servicios se le aumentaron en un año a 38 clientes. El dueño anterior del dínamo contaba el foco, la radio, la TV, etc., cada uno como un servicio. Este ya contó por clientes. Los 38 equivalían aproximadamente a 51 servicios.[5] El mismo hacía la promoción de su negocio ayudándoles a instalar los alambres, que ellos tenían que comprar. Cobraba a razón de 2 colones al mes por foco o lámpara de 25 ó 20 KW respectivamente. Había 6 personas que tenían TV y 6 que tenían radio. En dichos años no se habían popularizado los transistores. No había en el pueblo más que 3 refrigeradoras, y estas eran de gas,[6] únicamente para el consumo doméstico. El dínamo daba luz sólo de noche, de 6 a 10. No se podía usar, por eso, una refrigeradora eléctrica. Tampoco había planchas eléctricas, o tal vez, si alguien tenía una y la conect. ba a ocultas (750 W), la luz se debilitaba en todas las casas. Ante ese abuso, el dueño de los motores respondía quitándole la luz a toda la zona donde se encontraba el contrabandista. También daba luz gratis a la Iglesia (tres lámparas de 20) y a la Alcaldía (2 de a 20).

Pensaba extender su servicio al alumbrado eléctrico de las calles, cuando CEL comenzó a "postear" por Olocuilta. Vió que, por fin, de verdad llegaría CEL al pueblo y no prosiguió sus iniciativas. En efecto, a mediados de 1961 le llegaron a decir que quitara sus postes y alambres. En Agosto de 1961, al año escaso de haber comenzado con su servicio al pueblo —o con su negocio— tuvo que ir suspendiéndolo. En los últimos meses dicho negocio le dejaba ya posiblemente más de 100 colones,[7] pero no llegó a cubrir los gastos de las instalaciones de los motores y los generadores. Vendió los molinos, que usaba con los motores durante el día, a precio muy bajo, como también uno de los generadores y los motores. Almacenó el alambre. La CEL no le indemnizó.

El alumbrado de las calles consistía en unos faroles de mecha de gas colocados en las esquinas. Salía un señor a encenderlos a las 6 p.m. con su escalerita. Todos los solares "alumbrados" por dichos quinqués debían pagar un impuesto mensual de 2 centavos[8] por metro de acera. Todos los solares estaban gravados, porque la gente no pagaba. La luz era muy deficiente y el descontento grande. Hasta subastaron, por presión del Gobernador, algunos solares. Antes de vender o comprar un solar había que pagar el rezago, porque si no, la Municipalidad no daba el pase. Esta situación molesta, que parece haber sido general para muchos otros pueblos y que aún sirve de excusa en algunos lugares contra la instalación de la luz eléctrica, se terminó en 1949, cuando un alcalde liquidó dichas deudas y suprimió el impuesto. Cuando entró la CEL, de nuevo se exigió el impuesto municipal, esta vez a 4 centavos al mes por metro de acera. Lo cobra la Tesorería de la Alcaldía junto con el impuesto por acera no embanquetada (2 centavos metro). No se nota descontento en la actualidad, pues el servicio es bueno.

Alrededor de 1960 solicitaron algunos miembros de la Alcaldía la luz al Gobernador y tuvieron una reunión con representantes de Santiago Nonualco, y de Olocuilta, en Olocuilta, para solicitar juntos la luz desde Zacatecoluca. Salió luego en el Diario que iban a tener luz y San Pedro Masahuat se opuso, porque quedaba excluído, siendo así que es Cabeza de Distrito. Luego se les dio a conocer a los de Rosario, después de que los de San Pedro acudieron al Gobierno, según parece, que del Gobierno les vendría la luz a los 11 pueblos de la región dentro del Plan Piloto, en vez de venirles desde Zacatecoluca. "Todos se pusieron contentos, porque no iba a ser tanta la epidemia de estar en la oscuridad".

2.1.2. Historia del ingreso del agua

El informante, que nos narró parte de la historia de la electricidad y que tuvo que andar instando a la gente a que tomaran un foco, también estuvo en la Municipalidad luchando por el agua para que la gente tomara una paja hasta ajustar las 100. Según él, el agua, la luz y los grupos escolares fueron una misma cosa por la que lucharon. En Rosario la energía eléctrica posibilita el agua potable. Desde 1950 les había prometido el entonces Ministro del Interior, Coronel Lemus, que Rosario iría a la cabeza con sus necesidades, si él quedaba electo Presidente, pero cuando "él ya había ganado, pues la escalera que se le puso para que trepara, al final la botó, porque ya no nos dejó que trepáramos nosotros", y la promesa se desvaneció. Así quedó, hasta que con la luz ya instalada, gracias a la ayuda de la AID, que también contribuyó a la construcción de los grupos escolares, se inauguró el servicio de agua en Octubre de 1966.

Desde tiempos del General Martínez (por 1932) se traía agua por gravedad del Icaco, jurisdicción de S. Pedro Masahuat, cantón Sicahuite, de una presa que se construyó allí para aprovechar la vertiente. El caño volaba por grandes barrancos. A veces se obstruía. El agua que llegaba era buena, pero escasa. Primero sólo había como 6 chorros públicos en diversos barrios, pero luego algunos alcaldes vendieron pajas de esa agua como a 8 personas.

Como era escasa, por ejemplo, para construcciones, se traía agua en barriles del río Tilapa o de la quebrada Cepaquiapa. Era una caravana de carretas. Halaban unos 4 ó 5 viajes al día. La gente que tenía agua la vendía a 5 ó 10 centavos la lata de 25 botellas.

2.1.3. Consumo de energía eléctrica

A continuación presentaremos el número de usuarios del pueblo, según las diversas tarifas, y los usos a que dichos consumidores destinan la energía. Las tarifas son las siguientes:

1) **La doméstica** (D-3) a 1 colón los 8 KWH ó menos: a 0.12 Col. por cada KWH los primeros 70 KWH; a 0.10 col. por cada KWH, los siguientes 40 KWH; y a 0.05 col. por cada KWH de exceso.

2) **La general** (G-4), aplicada a establecimientos comerciales, como tiendas y oficinas, servicios, etc. a 3 col. los 20 KWH o menos; a 0.15 col. por cada KWH los primeros 50 KWH; a 0.12 col. por cada KWH los siguientes 50; y a 0.05 por cada KWH de exceso. Los bloques se aplican por kilovatio instado.

3) Fuerza Motriz a voltaje secundario para los servicios prestados a particulares, gobierno y municipio (F-5). Los primeros 50 KWH por KW instalado a razón de 0.14 col. por KWH.; los siguientes 50 KWH a 0.06 col. por KWH. El exceso se factura a 0.04 col por KWH. Al consumo mínimo es de 5.00 col. por mes.

4) Fuerza motriz a voltaje primario para los servicios prestados a particulares, gobierno y municipio (F-6). Los primeros 100 KWH por KW instalado a razón de 0.06 col. por KWH y su exceso a 0.045 col. por KWH. Hay un recargo por demanda de 5.00 col. por kilovatio.

5) Fuerza motriz a voltaje primario por períodos no mayores de seis meses consecutivos para fines específicos: beneficios de café, arroz y henequén; molinos de caña de azúcar, desgrane de maíz y desmote de algodón (F-9). Esta tarifa tiene los mismos precios que la F-6.

6) Regadío a voltaje primario para cargos conectados desde 15 KW. (R.II). Se factura a 0.0[illegible] col. por KWH cualquiera que sea el consumo.

7) Alumbrado público municipal (8). Se factura a 0.07 col. por KWH cualquiera que sea el consumo.

El número de usuarios de las diversas tarifas en el pueblo, según lista de la CEL de Diciembre de 1971, es el siguiente:

Cuadro 2: **Número de usuarios del pueblo de Rosario la Paz, según diversas tarifas a Diciembre de 1971.**

Tarifa	Número de usuarios
Doméstica	196
Comercial	30
Motriz	3
Alumbrado	3 (*)

Fuente: Lista de CEL, Diciembre de 1971, con la explicación de informantes sobre cuál de los usuarios es del pueblo y cuál no.

Hubiéramos querido presentar un cuadro de la historia del consumo eléctrico en el pueblo, pero esto suponía un trabajo para el cual no dispusimos de tiempo. La historia del consumo de toda la ruta, fácil de recopilar que incluye el pueblo y los diversos cantones, no sirvió a nuestros propósitos.

(*) Es el mismo usuario, la Alcaldía Municipal, con contadores, uno para cada zona de alumbrado.

2.1.3.1. Tarifa doméstica

Como hemos visto arriba, esta tarifa es la más generalizada. El que sólo tiene un par de focos, plancha, televisor (TV), refrigeradora (RF), mientras no se trate de una tienda grande, paga de acuerdo a esta tarifa. Su pago suele variar desde 1 colón (42 usuarios) hasta 15-16 colones al mes (3 usuarios).

La primera pregunta que nos hacemos es si todos en el pueblo tienen luz, aunque sea un par de focos o unas lámparas fluorescentes, y si no todos, por qué unos sí y otros no. Desde que el número de viviendas urbanas es de 571 y el de usuarios 196, está claro que hay una mayoría que no la tiene todavía. ¿Por qué no? La respuesta inmediata es la económica; la instalación del alambre en la casa cuesta, por lo menos, unos 60 colones. La luz misma, en cambio, ya vimos que puede salir a 1 colón mensual, más barato de lo que se suele gastar en gas para el candil: 1.50 al mes. Hay bastantes factores que trascienden la mera respuesta económica. En efecto, en una encuesta de 111 casas del pueblo[9] (cerca de una quinta parte del total de casas del pueblo), encontramos una diferencia significativa en el consumo de energía según el lugar de residencia dentro del mismo pueblo los "urbanizados", que viven en la zona cuadrada (de cuadras) del pueblo y los "no-urbanizados", que viven en los márgenes del pueblo, más o menos agrupados junto a callejoncitos en un declive que termina en la quebrada de Guasala, y detrás del campo de fútbol (ver en mapa 1, para "urbanizados" y 2, para "no-urbanizados"). Véase el cuadro 3, donde junto con el porcentaje de los que tiene luz entre los encuestados (84% para los "urbanizados" versus 36% para los "no-urbanizados") hemos detallado el porcentaje de diversos aparatos eléctricos. La razón por la cual se da esta diferencia es posiblemente porque los "no-urbanizados" se han establecido en el pueblo provenientes de otros lugares, y además de ser económicamente débiles, algunos ni son dueños de su casa y/o solar.

Cuadro 3: Consumo eléctrico y su aplicación por zona residencial, en el pueblo de Rosario la Paz.

"Urbanizados"	Número de encuestados	con luz	Plancha	RF	TV	Radio	Ventilador	Tocadisco	Licuadora	Estufa	soldador	Motor	Tijeras	Secadora	Timbre
+	61 100%	51 84%	32 52%	18 29%	17 28%	13 21%	8 13%	9 15%	7 11%	4 6%	2 3%	1 2%	1 2%	1 2%	1 2%
—	50 100%	18 36%	9 18%	4 8%	4 8%	1 2%	1 2%	1 2%	1 2%	1 2%					

Fuente: Encuesta a una quinta parte de casas del pueblo. (Ver Nota 9).

El Cuadro 3 también muestra que los "urbanizados" utilizan un porcentaje mayor de aparatos eléctricos y una gama más variada de ellos, que los "no-urbanizados". Además, la razón de usuarios de luz y número de aparatos es menor entre los primeros que entre los segundos (ver Cuadro 4), lo cual indica que los primeros aprovechan más la corriente que los otros. La diferencia de razones es más notable en cuanto a radios, ventiladores, tocadiscos, licuadora y estufa, que en cuanto a plancha.

Cuadro 4: **Relación entre número de usuarios de electricidad y número de aparatos eléctricos según residencia en el pueblo.**

Urbanizados	Plancha	RF	TV	Rad.	Vent.	Tocad.	Licuad.	Estuf.
+	1,6	2,8	3	3,9	6,4	5,7	7,3	12,8
—	2	4,5	4,5	13	18	18	19	18

Nota: el índice de la relación es la razón del primer número dividido por el segundo, según Cuadro 3.

Para indagar qué factores intervienen en el uso de la **televisión** (TV), anotamos con un cobrador de la CEL la lista de los usuarios domésticos que tenían TV y con otro informante su oficio. Los resultados de esta

Cuadro 5: **Lista de oficios de usuarios de electricidad (tarifa doméstica) por número de TV en el pueblo.**

Oficinistas	7		3
Profesores	4		2
Agrónomos	2		2
Sacerdote	1		0
Agricultor con tierra	9		4
Agricultor sin tierra	1		8
Molineros	2		0
Caporal	0		2
Comerciante maíz	0		2
Jornalero	0		6
Sastre	4		2
Dueño camión (bus)	3		1
Peluquero	1		0
Trabaja en SS.	5		5
Motorista	0		2
Herrero, panadero, albañil, liniero, carpintero, electricista, hojalatero	0		10
Enfermera	1		10
Cuaja leche	3		1
Tienda pequeña	4		4
Farmacia	1		1
Costurera	0		2
Quesadillera	0		3
Comedor	0		3
Agente (mujer) prensa	0		1
La ayudan hijos pero no de SS.	0		6
? ? ? ?	14		43
servicios repetidos		20	
Total	62 + 20 + 114 = 196		

Fuente: 2 informantes, uno para los oficios; otro para los TV.

información rápida no pueden ser muy confiables. Sin embargo, parece haber cierta constancia entre ciertos oficios y el uso de la TV (ver Cuadro 5). Debajo de esta constancia subyacen, por lo visto, dos factores. El primero es el **económico:** los agricultores con tierras, los dueños de molino, los dueños de camión, cuajadores de leche (con ganado propio), tienen más televisores que, los agricultores sin tierra, jornaleros, caporales, motoristas, quesadilleras. El segundo factor es la **orientación hacia la ciudad de San Salvador.** Tal es el caso de los que tienen la experiencia de haber vivido en San Salvador, o tienen vinculaciones políticas o administrativas con la capital. Ver los agrónomos, profesores, sacerdote, oficinistas, en comparación con el herrero, panadero, albañil, liniero, carpintero, electricista, hojalatero. Es curioso el caso de los sastres, entre los que por circunstancias, no sabemos si ajenas a su oficio o no, ha entrado la ideología radical de izquierda.

Aproximadamente hay el mismo número —alrededor de 65— de **refrigeradoras** en el pueblo.

La demanda de estos y otros aparatos ha tenido diversos efectos. La mera instalación de la corriente ha dado trabajo a los instaladores, algunos de los cuales son del pueblo y trabajan al amparo de licencias profesionales de otros. Se ha hecho posible la existencia de la Agencia de la Philips y de un electricista en el pueblo. Los aparatos han mejorado la vida de los habitantes del lugar, según la valoración de sus usuarios, pero no han contribuido a la producción. Se puede calcular que el precio de sólo las refrigeradoras y televisores juntos suman 100.100 colones, por lo menos,[10] cantidad que sale del pueblo, o que, por lo menos, si los aparatos han sido comprados con dinero ganado en San Salvador, sale del país. El hábito de dependencia a dichos instrumentos, a la constelación de valores que se propaga con ellos, sobre todo a través de la TV., a los modelos últimos, a los repuestos, etc., fortalece y enraiza hasta la gente del campo el vínculo político de El Salvador hacia los países que los fabrican.

Sin embargo, para completar un juicio de valor, que es lo que supone el título de nuestro estudio, "costos y beneficios sociales", hace falta oír los juicios favorables, aunque sea como ejemplificación, de la gente.

Sobre la **plancha:** "Antes se usaba plancha de carbón y todavía más antes sólo se ponía a calentar la plancha junto al fuego. No se planchaba todos los días. Ahora a cualquier hora".

Sobre la **refrigeradora:** "Sirve para negocio y para servicio de la casa. Muchos vienen a tomarse una cerveza helada. Hacemos paletas de tamarindo. Guardamos fruta, verduras, carne. Antes, la carne se salaba y asoleaba. La verdura se conserva fresca durante varios días. Se venden bolis (jugos en plástico). ¡El agua! Sobre todo para el clima caliente.... Uno revive con un poco de agua fresca".

Sobre la **televisión:** "Ella —se trata de una señora de 50 años— aprovecha la TV de 12 a 2 p.m. y de 5 a 9 p.m. Lo único que le satisface es ver TV para no vivir amargada". De otra familia: "La señora ve novelas; los niños, chiquilladas; y el señor, tal vez la lucha libre". De una señora: "Por dedicación al negocio (la tienda) no puede salir a divertirse. Al empleado, en cambio, le quedan sábado y domingo para salir y pasear. Ella, si sale, es por negocio. Es en esa ocasión —ante la TV— cuando aprovecha para descansar".

Sobre el ventilador: "esto puede satisfacer al señor que viene cansado. Sólo es propio de gente con comodidad, que trabaja. Es para descansar después de una jornada". "En verano el lugar es muy caliente. A veces se pone el ventilador en la tienda, para que se sienta fresca la gente al llegar".

Sobre el tocadiscos: "Leo en tiempos desocupados y oigo música. Lo usamos para fiestas de familia, para fiestas bailables, veladas, rifas, turnos y coronaciones. Con orquesta sale muy caro. XX compró aparatos para eso. Alquila sus aparatos. Cobra 5 colones la hora; por 5 horas, 26 colones. En Rosario nunca ha habido orquesta. Antes, con la excepción de las fiestas patronales, no había muchas fiestas. Eran amenizadas con marimba. Los que tocaban eran de Rosario. Pero ya no pagan, porque la música va cambiando. Aquí el 31 de Diciembre, sin luz eléctrica, estaría muerto. Antes, para Navidad, la gente se iba a las pastorelas. Ahora, no. Por lo general, hay fiestas de familia. Los hijos de San Salvador tienen radiola o radio. El trabajo (de construcción de) la Iglesia se ha acelerado por las fiestas organizadas para recaudar dinero".

2.1.3.2. Tarifa comercial

En el pueblo se distribuye energía según la tarifa comercial a oficinas, como la Supervisoría Docente, la Comandancia local, la oficina de Antel (telecomunicaciones), la Guardia Nacional, la CEL; a escuelas; a las Iglesias católica y centroamericana; y a 13 negocios, dos de ellos expendios, otros, una abarrotería (licores más finos), un salón de prostitutas muy concurrido, un bazar, la Agencia de Philips, y tiendas de diversos tamaños y mercaderías. Una de las tres farmacias del pueblo está incluída en esta tarifa, y dos quintas de recreo de huérfanos también. Además, se cuentan en esta tarifa un motor trifilar de molino y la cafetería de quesadillas Jaltepec, junto a la carretera del litoral. Hay 14 RF en esta tarifa, seis de ellas en negocios, dos en residencias contiguas a oficinas, una en el salón, otras cuatro en Jaltepec y una en una quinta. Las 8 TV comprendidas en esta tarifa se usan para atraer gente a los negocios, como al salón y alguna tienda, donde se les vende a los niños "charamuscas" heladas (líquido de distintos sabores helados en bolsitas de plásticos). Hay dos, respectivamente, en el Plan Básico y la Escuela para la TV educativa. El resto, para el uso privado de sus dueños. El negocio de la cafetería Jaltepec, visitado por cientos de turistas nacionales en días festivos, tiene, además de sus refrigeradoras y su televisor, según nuestra encuesta, dos licuadoras, dos ventiladores, una batidora, un molino, una conservadora, una cocina, hornos, molino y bomba.

La energía eléctrica, por tanto, ha estado presente en la prosperidad de los negocios. Los negocios hacen un servicio a la gente, esta deja su dinero en ellos y los hace crecer. El dinero se mueve, pero no se explotan nuevos recursos, a no ser por la cafetería Jaltepec, que explota el turismo y distribuye algo de ese dinero a la gente del lugar. (No hemos hecho un estudio minucioso sobre sus costos y beneficios sociales). También hay que considerar que, ya que los negocios son el canal más rápido de movilidad económico-social, si la energía los promueve, acentúa la estratificación de la localidad. El juicio sobre la creciente estratificación rura llevaría otro trabajo aparte.

2.1.3.3. Tarifa motriz

Hay en el pueblo tres molinos de nixtamal. Dos de ellos consumen de 130 a 150 KWH al mes, equivalente a cerca de 20 colones. El tercero es el más concurrido, de más de 500 KWH mensuales: de 40 a 50 colones

El número de molinos y su demanda están limitados por el número de personas que necesiten sus servicios. Uno de ellos se ha retirado recientemente.

2.1.3.4. Alumbrado público

Gracias al alumbrado se mantienen las tiendas abiertas hasta las 9 p.m. Cuando se apaga la luz, los comerciantes no se arriesgan a abrir pasadas las seis. Con la luz hay más gente, que pasea por las calles de noche. Las mujeres, cuando —también gracias a la electricidad— se avisa por el parlante del techo de la Iglesia a todo el pueblo, que se quitará la luz, se abstienen de salir de noche. Pero si hay luz, la gente se visita. Un paseo por el pueblo a las 8 p.m. le muestra a uno el grupo de amigos jóvenes reunidos en la acera junto a una lámpara; los hombres de cuatro en cuatro o de cinco en cinco conversando; las familias con las puertas abiertas por el calor platicando en sus salitas; palomillas de niños junto a la lámpara, quemando cohetes, o jugando con "corcholatas" (tapas de gaseosas); hasta un que otro estudiante en período de exámenes con el libro abierto bajo la luz de la calle, que alumbra más que el foco de su casa. La iluminación municipal se refuerza por las lámparas de las tiendas, que atraen clientes. Hay casas, como la del que fue candidato de la UNO, a la Alcaldía que no sólo atraen a los viejos que hablan de política dentro, sino que juntan a niños en la calle a la luz de una farmacia en el sector nocturno más concurrido del pueblo. Cuando recorrimos el pueblo de noche en un día de difuntos, contamos como 200 personas por las calles. Hay, sin embargo, algunas familias, las de casas mejor construídas, que no dejan salir a sus hijos; por eso les han comprado TV y mantienen sus puertas cerradas al pueblo menudo.

2.1.4. El agua

Como hemos dicho, la energía eléctrica ha hecho posible el agua potable en gran cantidad. ANDA (Administración Nacional de Acueductos y Alcantarillados), con la ayuda del AID hizo un pozo junto al desvío de San Pedro, de donde se sube el agua por bomba eléctrica a un depósito junto al camino del Sicahuite. Desde allá baja por gravedad. Cuando se instaló en Octubre de 1966, había 47 pajas en la Zona 1 (Sur) y 106 en la Zona 2 (norte): total 153. En Octubre de 1972 son 67 y 95 respectivamente con un total de 162.

Se puede medir el consumo de agua por el consumo eléctrico de ANDA a lo largo de los 3 últimos años:

Cuadro 6: Consumo eléctrico de ANDA en el pueblo de Rosario la Paz (1969-1971).

Año	KWH
1969	22.698
1970	29.684
1971	36.084

Los meses de mayor consumo son los de verano, ordinariamente abril y mayo. Aquellos en que menos se consume, los de invierno, en especial, junio, y a veces, también septiembre y octubre. En verano se construyen casas. Gracias al agua se fabrican los adobes y tejas cerca del sitio de construcción. Por el agua se pueden regar jardines de flores y plantas. Se lava la ropa en las casas, mientras que antes se les pagaba a lavanderas, que iban al río. Todavía existen algunas mujeres con este oficio, ya que los fuereños les dan su ropa. Se puede uno bañar a toda hora. El agua es potable y sabrosa. "Tome agua clara para que vuelva", nos dijo una señora entre risas.

Ha habido una disminución en la mortalidad de la zona urbana desde 1950 hasta la actualidad. Posiblemente se debe también a las campañas de fumigación de DDT desde 1951, al acceso fácil a los doctores de Zacatecoluca y del Hospital Rosales en San Salvador, a la fumigación de las algodoneras, que ha hecho desaparecer el zancudo y casi por completo el paludismo, y al ingreso del agua potable. Las cifras de defunciones en el urbano han disminuido desde 1966, fecha de la instalación del agua, hasta 1970 (ver Cuadro 7) y, más aún, la tasa de mortalidad, que en la década de 1951-1969 fue de .0172, en la década siguiente de .0088 y en los últimos cinco años .0077 (eso que 1969 es un año irregular, cuya oscilación demográfica parece que se debe al sarampión).

Cuadro 7: **Defunciones en zona urbana de Rosario la Paz (1951-1970).**

Año	Defunciones	Año	Defunciones
1951	1	1961	31
1952	11	1962	30
1953	20	1963	21
1954	31	1964	25
1955	20	1965	28
1956	24	1966	20
1957	28	1967	15
1958	33	1968	19
1959	14	1969	35
1960	19	1970	16

Nota: la población total urbana de 1961 fue 1990; y de 1971 fue 2713.

2.1.5. Urbanismo

La luz y el agua han contribuido, según la gente del lugar, a hacer del pueblo casi una pequeña ciudad, donde es grato residir. La cercanía con San Salvador —45 minutos y 75 centavos, en bus— hacen que se viaje con frecuencia a la capital. Todavía no hay quienes, salvo raras excepciones, trabajen en San Salvador y vivan en Rosario, pero hay muchos que vuelven cada sábado. Así como la carretera, pavimentada desde 1942, "es todo en el pueblo", la electricidad hace agradable la vida para personas acostumbradas a la ciudad, como el personal de la Supervisión Docente, de la CEL, los agrónomos y el párroco (desde 1964), elementos todos que, a su vez, atraen gente al pueblo, le dan un nivel regional y son un incipiente aparato burocrático conectado a otros municipios. Esta regionalización le confiere importancia como centro económico. Por ejemplo, la parroquia se extiende hasta las playas del cantón Las Isletas, El Achotal, El Pimental, fuera del municipio de Rosario, y los católicos llegan a bautizar a los niños desde allá y compran su ropa en el pueblo.

2.2. En cantón Tilapa

2.2.1. Descripción del cantón

Tilapa está compuesto de 32 casas colocadas a ambos lados de la carretera del litoral, junto al río Tilapa. Al lado derecho del río está este caserío, y al izquierdo El Tunal. Se les suele considerar a ambos, junto con el "cantón" El Cerro, como un solo cantón, con un solo comandante local y una sola patrulla. Hace más de 10 años, como se ve en el Censo de 1961, al grupo de los tres caseríos se le llamaba cantón El Cerro y la patrulla era del Cerro, pero ahora, debido a que muchos del Cerro han emigrado hacia el Tunal-Tilapa por la proximidad de la carretera y que en El Cerro hay apenas 17 casas, se le suele llamar cantón el Tunal o Tilapa, más genéricamente. Pero también sólo al caserío Tilapa, contradistinto del Tunal, como lo estudiamos aquí, se le llama cantón.

Tilapa se comenzó a formar alrededor de 1944, después de la construcción de la nueva carretera. Pero ya pocos años antes, un grupo de parientes de raigambre chalateca alquilaron tierra para sembrar en ese lugar y descuajaron el bosque. El terreno está en una pequeña elevación y recibe una brisa "maretón", que confortaba a los nacidos en climas más frescos. El trazo de la carretera, además, dejó una tira de terreno entre ella y un meandro del río. El terreno de siembras quedó dimidiado, pero resultó ser un sitio muy apropiado, por la cercanía del agua y de la carretera, para los que se instalaron allí. Fueron comprando solares de una manzana a 200 y 250 colones. Un pariente fue animando a otro y así se fue formando Tilapa.

2.2.3. Análisis del Cuadro 8

De esas 32 casas prescindiremos de 13, que carecen de luz, ya que están lejos del tendido y, por eso, se encuentran en una situación distinta del resto.

De las 19 restantes, 11 tienen luz y 8 no (ver Cuadro 8).[11] La conexión más temprana data del 20 de diciembre de 1966. Ese año se conectaron dos, uno de los cuales es de los que actualmente más consumen y el que tiene la única TV del lugar. En 1967, se conectaron dos más. En 1968, dos más; en 1969, tres y en 1970, dos. De allí están incluidos en la tarifa doméstica.

En cuanto a la demanda de más energía por usuario (columnas 12 y 13) no ha habido prácticamente ningún cambio entre el consumo promedio del año 1970-71 (de Octubre a Octubre) y del año 1971-72. Por falta de tiempo no logramos datos del consumo anterior a 1970. Sin embargo, a través de las fechas (aproximadas) de las compras de aparatos eléctricos, podemos deducir la existencia de varios tipos de usuarios, según el aumento en diversa medida de su demanda eléctrica.

El primer tipo es de aquellos dos (1 y 2), que no han aumentado su consumo. No tienen ni siquiera plancha. Estos, aunque en algunos aspectos difieran, pues el primero no es dueño ni del solar de su casa, y el otro, además del solar, tiene 200 manzanas de terreno, coinciden en la **provisionalidad de su residencia.** El primero tiene poco tiempo de haber llegado, mientras el segundo no vive allí.

El segundo tipo es de aquellos que sólo han aumentado su consumo con una plancha y, en algunos casos, un radio (Nos. 3 a 7). Aunque no tenemos la fecha de la compra del radio, se nota que casi todos los que no tienen radio eléctrico, tienen radio de transistores (columna 29). El

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	TIENE ELECTRICIDAD?	FECHA DE INSTALACION.	INSTALO EL/ELLA?	NUMERO DE FOCOS	PLANCHA? (FECHA)	RADIO?	REFRIGERADORA? (FECHA)	TELEVISION? (FECHA)	VARIA	VARIA	KWH AL MES: 1970	KWH AL MES: 1971	EDAD	FECHA QUE LLEGO A TILAPA	RESIDE ALLI?
1	+	1967	+	6	–	–	–	–	–	–	7	6	65	1960	–
2	+	1967	–	3	–	–	–	–	–	–	12	9	22	1971	+
3	+	1969	+	3	+	–	–	–	–	–	5	6	48	1950	+
4	+	1969	+	3	69	–	–	–	–	–	6	10	60	1948	+
5	+	1958	+	3	+	+	–	–	–	–	8	7	75	1965	+
6	+	1966	+	5	69	+	–	–	–	–	13	17	60	1965	+
7	+	1970	+	2	71	+	–	–	–	–	12	26	36	1969	+
8	+	1969	+	5	70	+	70	–	–	–	31	27	77	1946	+
9	+	1966	+	9	68	+	70	70	–	–	58	50	66	1947	+
10	+	1970	+	3	71	+	70	–	70	TOCA-DISCOS	105	106	35	1970	+
11	+	1968	–	8	+	+	–	–	BOM-BA	VENTI-LADOR	24	27	55	1967	–
12	–	–	–	–	–	–	–	–	–	–	–	–	80	1952	+
13	–	–	–	–	–	–	–	–	–	–	–	–	72	1962	+
14	–	–	–	–	–	–	–	–	–	–	–	–	55	1957	+
15	–	–	–	–	–	–	–	–	–	–	–	–	60	1952	+
16	–	–	–	–	–	–	–	–	–	–	–	–	21	1968	+
17	–	–	–	–	–	–	–	–	–	–	–	–	24	1962	+
18	–	–	–	–	–	–	–	–	–	–	–	–	46	1962	+
19	–	–	–	–	–	–	–	–	–	–	–	–	45	1951	+

Cuadro 8: Variables del consumo eléctrico de los hogares del cantón Tilapa, Rosario la Paz.

17	18	19	20	21	22	23	24	25	26	27	28	29
NACIO EN:	SEXO.	SOLAR PROPIO?	INGRESO MENSUAL.	MANZANAS DE TIERRA.	PARIENTES QUE LE AYUDAN.	PARIENTES QUE SOSTIENE.	OFICIO.	LEE?	AÑOS DE ESCUELA.	HA VIVIDO EN SAN SALVADOR?	TIENE HIJOS EN SAN SALVADOR?	RADIO TRANSISTOR?
AMATEPE.	M	+	200	—	0	6	DUEÑO DE TIERRAS	+	1	—	+	—
TUNAL	M	—	70	—	0	2	CORRALERO DE HACIENDA	+	2	—	—	+
S. PEDRO	M	+	30	—	0	6	JORNALERO	+	2	—	+	+
CHALATE	M	+	20	—	1	3	AGRICULT. (ARRIENDA)	—	0	—	—	+
LA FLECHA	M	+	80	—	1	3	ALBAÑIL	+	1	—	+	+
CHALATE	F	+	40	—	1	2	VENDEDORA AMBULANTE	+	1	—	+	—
ROSARIO	F	+	70	—	1	0	(ARROCERA)	+	1	—	+	—
OPICO	M	+	0	—	3	1	—	—	0	—	—	—
S. PEDRO	M	+	0	—	3	3	TIENDA	+	1	—	—	—
TUNAL	M	+	90	—	0	2	TRACTORIS. TIENDA	+	0	+	—	—
SAN SALV.	M	+	60	—	0	4	COMERCIA CON CAMION	+	3	+	+	—
CHALATE	F	+	20	—	1	3	LAVANDERA	—	0	—	+	—
OPICO	F	—	20	—	0	1	HACE PUROS Y LAVA	+	1	—	—	+
S. JOSE LA PAZ	M	+	30	—	0	4	COMERCIANTE	+	0	—	—	—
CHALATE	F	+	0	—	3	0	—	—	0	—	+	+
CERRO	M	—	84	—	0	3	(ARROCERA)	+	3	—	—	—
CHALATE	M	—	84	—	0	1	(ARROCERA)	—	0	—	—	+
BARAHONA	M	—	30	—	0	0	JORNALERO	—	0	—	—	+
CHALATE	M	—	25	—	0	3	JORNALERO Y PESCADOR	—	0	—	—	—

Nota: Las columnas 4 y 14 en adelante se refieren al jefe del hogar.

uso del eléctrico no está muy generalizado. Notemos que, de las 19 casas, 14 tienen radio y que de las que tienen luz, sólo una no tiene. En cuanto a la plancha: es el primer aparato que se compra y el principal y primer aumento relativamente grande para el gasto mínimo de energía de estos consumidores. A estos difícilmente les alcanza la economía para comprar una RF.

El tercer tipo es el de aquellos tres (Nº 8 a 10), que han comprado varios aparatos más, además de la plancha, siendo el más común la RF. En dos casos el jefe de familia no tiene ningún ingreso, pero recibe el aporte de pariente solteros. Si cada uno de los que aportan, por trabajar en la Arrocera, gana 84 colones al mes, el ingreso de la casa con tres parientes arroceros es de 252 colones. Notemos que los ingresos del otro (Nº 4) que también tiene RF. son relativamente altos. Tres coinciden en comprar aparatos alrededor de 1970. Parece que han dependido para ese progreso económico de una **fuente común** de ingresos, como la Arrocera, que ya comenzaba a dar trabajo a los vecinos y que benefició indirectamente a los que tenían tiendas, porque los trabajadores de la industria compraban en ellas.

Por fin, en un último tipo se puede englobar al Nº 11: es dueño de otras 60 manzanas además del solar y tiene instalada una bomba para dar agua al ganado. Sin embargo, no tiene RF. porque vive en San Salvador. Su hermano, quien cuida el lugar, es el dueño de la plancha y el radio. Este caso podría desdoblarse en varios: el dueño, por un lado, que habría de ser analizado como consumidor doméstico según categorías urbanas de San Salvador; el hermano, que se incluiría en el tipo segundo (sólo con plancha y radio); y, por fin, el dueño como explotador del terreno con la bomba de agua. Este tercer aspecto es el que se engloba en el que llamamos último tipo y se caracteriza por el uso de la energía con fines de explotación de los recursos naturales.

A diferencia del Nº 1, que tiene dinero y podría también comprar una bomba para sacar agua del pozo, este posee un terreno colocado estratégicamente en el centro de varios potreros y le resulta apropiado para abrevar los animales, mientras que el solar de Nº 1 está bloqueado por el río. La diferencia entre ambos está en la **explotabilidad** del terreno. Por eso Nº 1 no tiene bomba y Nº 11, sí.

De estos cuatro tipos únicamente los dos últimos indican una forma de ganarse la vida distinta, posibilitada por la energía: el tercer tipo, el comercio; y el cuarto, la posible explotación de los recursos naturales.

2.2.3.2. **Factores de los que no consumen energía**

Si comparamos a los que han conectado (Nº 1-11) con los que no (12-19) encontramos una diferencia: **la tenencia del solar** de la casa. No se trata de la tenencia de la tierra de cultivo, sino del solar donde está edificada la casa. Todos los que han conectado residen sobre un solar propio. Aun el caso (Nº 2) del que vive en solar ajeno no es excepción, pues no instaló él la luz, sino que, cuando se pasó a vivir a esa casa, ya tenía ésta corriente. Por otro lado, de los que no han conectado y están sobre solar propio: uno está sobre solar hipotecado, cosa equivalente para el caso a no ser dueño, y el otro está en vía de hacer la conexión, pues ha conseguido el poste. De modo que el factor de la tenencia del solar parece explicar todos los casos, tanto de los que no consumen como de los que sí consumen electricidad.

Otro factor que parece relevante es el número de **parientes que ayudan** al jefe del hogar económicament (columna 72). Entre los que no tienen [illegible] todos, menos uno (Nº 15), carecen de alguien que les ayude dentro del hogar. Entre los que sí tienen, dos (Nº 1 y 11) son tan pudientes, que no necesitan que sus hijos les ayuden, y más bien hasta los tienen en la Universidad; otro (Nº 2) es el que, decíamos que encontró la luz ya instalada y tampoco tiene quién le ayude. De los ocho restantes, todos menos dos, cuyos casos no sabemos explicar, tienen parientes que les ayudan. Estos parientes suelen ser hijos solteros, hombres y mujeres, que trabajan como personas mayores, ya sea en la Arrocera o en San Salvador. Ellos son los que muchas veces pagan la instalación

2.2.4. Decisión en cada uno de los casos tabulados

Ahora pasaremos a dar información pormenorizadas de cada uno de los casos tabulados, para que se ilumine por qué se decidieron o no se han decidido a conectar la electricidad y a comprar diversos aparatos. Le damos tanta importancia al caso concreto, porque consideramos que es a partir de su realidad, con su viveza, de donde sale la inspiración para elaborar hipótesis, y uno de los fines de este estudio es precisamente elaborarlas. Estuvimos trabajando con un informante y por falta de tiempo no acudimos a cada persona a que relatara su proceso de decisión. Es el informante el que habla. Sus palabras no están recogidas textualmente. Solamente tomamos notas por escrito mientras él hablaba.

2.2.4.1. Con electricidad

1er. caso: este solar es de don NN. Cuando andaban instalando la luz, él dijo que no le hacía falta y que iba a comprar dos candiles carreteros para alumbrarse. Estos son unos candiles, con mecha adentro, que los bueyes llevaban sobre el yugo. El no quería la luz. Es un hombre que se ha hecho muy rico. Es analfabeto, pero tiene mucha astucia para hacer cálculos de cabeza. Es intermediario de terrenos. No se pone zapatos, más que en fiestas. Es de los que atrapan todo colón para que no se le vaya. Pero, por fin, se convenció y puso la luz. Tal vez los ladrones lo asustaron o tal vez otro comisionista, que ha andado en vueltas para la instalación de la luz en otro cantón, le hizo ver su beneficio. Tal vez los mismos hijos lo convencieron. Uno es contador, otro es universitario, otros estudiantes. Uno de sus hijos reside aquí en este solar cerca del corral del ganado.

2º caso: allí vive el hermano del dueño de ese solar con su mujer y dos hijos (2 y 4 años). El dueño vive en El Tunal. Cuando compró la casa por unos 4.000 colones en 1969, ya tenía la instalación. Ambos hermanos trabajan en la hacienda de ganado San Cayetano, actualmente de los Tinoco Dueñas; el dueño de la casa, como mandador; y su hermano, como corralero. El dueño de la casa, además, tienen tienda en El Tunal, donde da ropa fiada a los mozos de la hacienda.

3er. caso: perdimos los datos.

4º caso: allí vive un señor de 60 años con su mujer, dos hijas solteras (una de ellas con niño) y otro hijo, que trabaja en la Arrocera. El papá hace su media manzana de milpa y la mamá trabaja en una tienda grande de Rosario. La señora pagó la luz con un marrano que vendió. También ella compró la plancha.

5º caso: allí vive un señor, (un albañil), con su mujer y tres hijos, ya mayores, pero todos solteros. Uno de ellos es entenado del señor (hijo sólo de su mujer). El entenado trabaja con ABC y los dos hijos en la Arrocera. Otra hija trabaja desde hace poco en los EE.UU. A iniciativa de esta última, que trabajaba antes en San Salvador, se instaló la luz.

6º caso: allí vive una viuda con su hijo, la mujer de este, un nieto y dos hijas, todavía solteras, de la viuda. Vende carne en canasto de casa en casa. El hijo es arrocero y una de las hijas también. Su marido ya difuntó **instaló** la luz. Una hija de San Salvador le regaló la plancha.

7º caso: allí vive una señora joven, viuda, cuyo marido (hermano del hombre del 10º caso) murió el año pasado en accidente de carro. Ella se quedó con 6 hijos, pero tiene una hija de 24 años, que trabaja de secretaria en San Salvador, le manda dinero, y le lleva cosas para los cipotes (niños) por el valor de 50-175 colones al mes. La viuda trabaja en la Arrocera, empacando. La **luz** la instaló el marido, aún en vida. Era un campesino, a quien le gustaba economizar y quedarse en casa, porque, si salía, se embolaba (emborrachaba). Alquilaba tierra para su milpa. Era originario de Rosario, pero tal vez, por estar en ambiente más de campo, por criar gallinas y marranos y salir a pescar, vendió su solar de Rosario y compró el de Tilapa. La **plancha** la compró la hija en San Salvador.

8º caso: allí habitan un hombre de 77 años con esposa y cuatro hijos, de los cuales dos trabajan en la Arrocera y uno hace poco dejó de trabajar allí. La **luz** fue obsequio del sacerdote a uno de los hijos, que ya no vive allí y que trabajaba de sacristán. Uno de los hijos, a quien le gusta armar y desarmar aparatos, compró el **radio.** Antes tenían de baterías. El sacerdote le regaló también al hijo sacristán la RF por la ayuda que le prestó en la distribución de fertilizantes.

9º caso: en esa casa viven el señor de 66 años con su mujer y tres hijos, de los cuales dos son arroceros y una, modista. En un cuarto, pero con economía aparte (cf. caso 16), vive una hija con su marido, también arrocero, con tres hijos. El señor, jefe de la casa, descansa ya, pero la señora, originaria de Chalatenango y parienta de sus vecinos y de la dueña de la otra tienda (Nº 10), vende artículos de primera necesidad. Entre la madre y el hijo mayor han tenido la iniciativa de la **luz** y demás aparatos. El señor es más bien callado. Lee la Biblia. La señora gastaba 1 botella de gas (0.15) en dos días, porque acostumbraba dormir con la luz encendida. Además, hacían camándulas y con la luz les queda más tiempo en la noche para ensartar. La modista compró la **plancha.** La señora compró el radio y el hijo mayor, que ahorra mucho dinero, la TV y la RF. Llegan como 10 muchachos, muchos de ellos arroceros, a ver TV de 7 a 9 de la noche. Antes iban hasta El Tunal a ver TV, del otro lado del río. Allí se juntaban como 40. El señor de la casa les ponía sillas, como butacas, y cobraba 5 centavos. Aquí en cambio no cobran. Pero se venden cosas de la RF, a la vez. En el día las mujeres ven novelas.

10º caso: allí vive un hombre de 35 años con su mujer y dos hijas, una de las cuales ya sacó el 6º grado y la otra lo está ganando. El señor trabaja como tractorista en La Flecha, con un dueño de hacienda, cuya esposa era sobrina del General Martínez. Tiene **RF** para vender fruta helada, etc. a los de la Arrocera. El **negocio de la RF** es como sigue: se meten en la RF naranjas, guineos, mamey, bolis, pescado, carne, verduras, es lo que más se vende. Hacen, hasta 7 veces al día, 2 bandejas. Cada bandeja tiene 12 helados. Cada 3 horas se congelan. Se venden a 2 por 5. Los hacen de piña. Se pica la piña como para refresco. Al día se van 5 piñas, o 0.60 la grande, la corriente a 0.35. Se va una libra de azúcar para las dos bandejas. Los bolis se venden a 5 centavos cada uno y se compra el ciento a 2.50. Compran 100 una vez a la semana. El carro que viene de Zacatecoluca los deja en el Bazar de Rosario y este se los distribuye. Se vende 1 docena de gaseosas al día, sobre todo, a los caldereros de la Arrocera. Se compran a 3.30 la caja de dos docenas y venden, cada gaseosa, a 0.20. En algunos otros lugares dan a 0.25, la helada, y a 0.20 la tibia. Los **guineos:** de las partes más frescas de la RF van metiéndolos, según se venden, en el "friser". Allí caben 7, se venden a 0.05 cada uno y se compran, por ciento, a 3 colones. La señora se va el lunes y sábado a San Salvador a traer 200 guineos. Se le va 1.50 en el pasaje de ida y vuelta. La INCA (línea de buses) no cobra por carga. El **pescado** se lo llevan a las 7 a.m. del mar. Parte, lo vende en la mañana; parte, en la tarde. Le llevan dos colones siempre y la gente le compra por 0.25, por 0.10, por 0.05. Ella les da crédito a los arroceros, quienes le pagan semanalmente. Antes que ella se instalara, llegaban señoras con canastos a vender a los trabajadores el pescado del mar y del río Jiboa ("chimberas"). No llegaban diariamente. Ella en cambio, si le sobra, lo guarda en la RF. Se calcula que, entre todo lo que vende le quedan alrededor de 3 colones diarios de ganancia promedia. En Tilapa no hay más que otra tienda con RF (Nº 9). Sobre el **tocadiscos:** un pariente se lo vendió al señor, a quien le gusta la música. Algunas veces lo alquila por 2 colones la hora. Pero suele darlo "de choto" (gratis). En sábados y domingos, cuando hay cumpleaños de cipotes y hay luz en la casa de la fiesta, llevan el tocadiscos. Gracias a él lograron recoger 60 colones en una coronación para la escuela de La Flecha. La hija de la señora quedó en segundo lugar.

11º caso: Don NN. del 1er. caso, vendió el solar y la casa con la luz ya instalada a don XX. Este vive en San Salvador, donde tiene sus comodidades, como la RF. Aquí solo viene en fines de semana. En esta casa vive de asiento un hermano suyo con la mujer. De ellos es la **plancha.** Tienen, además, un depósito de agua para el ganado. La bombean de un pozo gracias a un **motor** eléctrico. Los hijos del dueño llegan a visitar el terreno, pero ellos están en la Universidad. Para trabajar en cultivos de zacate (irrigar) hace falta más dedicación. Por eso tal vez, no se aprovechan del agua para regar los potreros. Tienen **luz** en el establo, pero la apagan a las 10 p.m.

2.2.4.2. Sin electricidad

12º caso: allí vive una señora de 80 años, su nieta de 20, la hijita de esta última, de 1 año, y otro nieto de 10 años. La señora tiene una hija (madre de sus nietos) que trabaja en San Salvador. Antes tenían **luz** en esta casa. Un entenado de la anciana se la pagaba. Este, a su vez, le quiso comprar el solar a su madrastra y cuando ya tuvo la escritura en las manos, dejó de pasarle dinero. La señora está acostumbrada a vivir en la oscuridad. Si quisiera, podría pagar los 3 colones de la reconexión, pero no le hace falta la luz. Vino de Chalatenango para Tilapa. Es de las que pasó con la cabeza amarrada por San Salvador por el olor de gasolina. Ha sido una mujer acostumbrada a trabajar como hombre, con la cuma (machete) y la carga de leña. La señora está contenta, si tiene sus naipes, su café y su tabaco. Todavía se la encuentra jugando naipes hasta las 10 de la noche a la luz de un candil con algunos muchachos. La nieta, que va a la escuela, todavía está chiquita para pedirle la luz.

13º caso: allí vive otra señora anciana con su nieta de 15 años. Cuando se murió el marido del cantón El Carmen de San Pedro Masahuat en 1962, compró la casita donde vive, sobre el solar de su hermano vecino (8º caso). Esa casita se hizo a raíz de una Misión: una cuñada del dueño del solar, por miedo al infierno, se apartó entonces de su marido, con quien vivía hacía tiempo, sin estar casada por la Iglesia. Levantó esa casa para sí sola junto a su hermana. La casa quedó vacía, cuando dicho marido cedió ante su esposa chalateca e hicieron la boda. Parece que, por pobre, por anciana y por no estar sobre solar propio, no instala la luz.

14º caso: vive allí un señor de 55 años, muy pobre, con su mujer y cuatro hijos, de los cuales dos van a la escuela. El señor trae fruta de lo más chueca (mala) y la vende por los campamentos de las algodoneras con dos yegüitas viejas. Tuvo cinco manzanas de terreno, pero las vendió para comerciar, cuando murió su madre. Era hijo único. Bebe, baila y le gusta la fiesta. Tiene su solar empeñado. En dicha pobreza e inestabilidad económica nos parece encontrar la raíz de su falta de luz.

15º caso: vive allí una señora de 60 años con cuatro hijos, uno de los cuales esta casado. Este, con su señora y otro hermano menor, trabajan en la Arrocera. La hija menor sirvió el año pasado en San Salvador, pero ahora sólo cuida la casa y no trabaja. Están en vías de poner la luz. Ya tienen el poste.

16º caso: esta es una casita nueva, todavía no tiene luz. Se trata de una familia de tres hijos, que vive en la casa del caso 9º. No se han pasado aún.

17º caso: emigrados de Chalatenango por un asesinato perpetrado contra un familiar de ellos, se establecieron en casa de un pariente la mamá y dos hijos, más el padrastro de estos. Uno de los hijos se casó y pasó a vivir a esta casita en solar, según parece, del suegro. Se llevó consigo a su madre y hermano. Trabaja en la Arrocera. Posiblemente no han puesto luz, porque no hace mucho que se pasaron y el solar no es propio.

18º caso: allí vive una pareja y un hijo, que no les pasa dinero a sus padres, por ser algo bolo (borracho). Es hijo sólo de la señora. Viven sobre terreno nacional en una esquina del camino que conduce al cantón El Cerro y de la antigua carretera. El rancho es de paja y queda algo distante de los tendidos. Es un hombre pobre y por eso, quizás, no instalan la luz.

19º caso: allí vive un hombre de 45 años con su mujer y tres hijas, una de las cuales es entenada de él. Se pasaron a esa casa amenazados por un vecino y pariente político. Además de ser pobres, quedan algo distantes de la luz y, por eso, quizás, no la instalan.

2.3. La Arrocera San Francisco

Nos interesa estudiar el efecto que ha causado la instalación, desde finales de 1968, de la Arrocera San Francisco, que es el consumidor número uno de la CEL en su ruta de cobros Nº 7. Describiremos la Arrocera misma, según la información de algunos de sus trabajadores, Por premura de tiempo no pudimos visitarla personalmente y platicar con el dueño.

2.3.1. Descripción de la Arrocera

Está situada junto a la carretera del litoral, entre el pueblo de Rosario y el cantón Tilapa. Tanto de la orilla del pueblo, como de Tilapa se llega a pie en 10 ó 15 minutos.

Está colocada en un punto estratégico en El Salvador. Al oriente tiene la zona de producción de arroz, Zacatecoluca, Santiago Nonualco, etc., y al occidente, la ciudad capital y Santa Tecla, donde se deposita el producto. Por quedar junto a la carretera los camiones centroamericanos, que cargan el arroz precocido, único en Centro-América, tienen fácil acceso a la fábrica.

Actualmente se compone de las secciones siguientes: las secadoras, por donde pasa el arroz húmedo; los molinos, donde se trilla y empaca el arroz; la sección del precocido con sus calderas, donde se suelta el grano quebrado. Luego, las bodegas, el patio de la granza (cascarilla), la báscula, el comedor, los transformadores de la corriente en una esquina del predio, junto a ellos, la garita de la Guardia Nacional, los depósitos de Shell para el diesel, las pilas del precocido junto a las calderas y, en fin, un par de pozos de agua. En el lado norte del predio hay un terreno rústico donde se pueden seguir ampliando las instalaciones.

El dueño, que es un español venido de Cuba y reconocido, por sus obreros, como un hombre de muchas ideas, ha ido gradualmente ampliando las instalaciones y proveyendo con más trabajo a la gente del lugar. El primer año comenzó con 12 personas y sólo el molino. Ese mismo año añadió la secadora con otras seis personas y la primera caldera con siete personas. Al terminar ese año dispuso no recibir más arroz de particulares para trillar, sino sólo para precocer.

Con el fin de dar una idea del uso de la energía eléctrica, damos la lista de motores que se utilizaban en las primeras fases de la historia de la empresa: 1) motor para el ventilador, que sopla la granza hasta los árboles por la calle; 2) motor para mover los rodillos que desgranzan el arroz; 3) motor para las elevadoras, que trasladan el arroz; 4) motor para la separadora; 5) motor para pulir el arroz; 6) motor para terminar de afinarlo; 7) motor para otra elevadora; 8) motor para la clasificadora; 9) motor para la limpiadora.

Respecto al consumo de energía: comenzó un servicio a 3 de octubre de 1963, pero no fue sino en septiembre de 1970, cuando se le abrió el servicio motriz F-6. La lectura de este servicio por meses es la siguiente:

Cuadro 9: Consumo eléctrico en KWH de la Arrocera San Francisco por meses, desde octubre de 1970 a septiembre de 1972.

Año	Ener.	Feb.	Mar.	Abr.	May.	Jun.	Jul.	Ago.	Sept.	Oct.	Nov.	Dic.
1970										18720	11840	12000
1971	18640	25280	6160	13840	20080	17280	17680	16080	22480	15680	30800	18160
1972	21280	22800	26400	20800	24800	24720	22320	26960				

Según la lista de la CEL de diciembre del año 1971, la Arrocera pagó 1.298.05 colones sólo por el consumo de 18.160 KWH de ese mes.

La Arrocera compra el arroz verde o seco a 7-8 colones y 10-10.50 colones el quintal, respectivamente. Los precios oscilan. El verde rebaja bastante: si le echan 120 sacos a la secadora, pueden salir 85 ó 90. El seco, que viene en granza, rebaja unas 25 lbs. por quintal. Se le quita la cascarilla. De 20 sacos de cascarilla sale uno de pulimento, que se vende a 6 colones el quintal. El arroz en oro se vende, según las clases, a 24 colones el quintal del Inferior; a 30-33 colones, del Superior; y a 40-45 colones, del Cocinero. Como un 75% de la producción es del Inferior. Del 25% restante una mayor proporción es del Superior que del cocinero.

Podemos sólo estimar la producción total. Los maquinistas dicen que pueden sacar 500 qq. de arroz en oro cada 24 horas. Es lo que puede dar ese molino. La máquina trabaja toda la semana, menos el domingo. También se puede calcular la producción por los viajes del camión de la Arrocera, que lleva a Sta. Tecla de 150 a 250 qq. diarios. Además llegan trailers de otros países y se van con 400 y 500 qq. cada uno. Por otras informaciones se dice que se trillan como 300 a 400 qq. diarios, es decir, como

110.000 qq. al año (trabajando 310 días). Esto indica que se han comprado como 150.000 qq. de los productores. Comprados a 11 colones, son 1.650.000 colones. Vendidos los 110.000, el 75% a 2[illegible] colones, el 20% a 32 colones y el 5% a 43 colones, suman 2.811.000 colones. Sin contar los gastos de electricidad, diesel, mano de obra y la inversión, queda un saldo de 1.160.000 colones. Estos son cálculos burdos, pero nos indican por dónde se mueven las cantidades.

Los gastos de mano de obra en la planta de Rosario suben a 110.000 colones para trabajadores permanentes y unos 20.000 - 25.000 de no-permanentes. Se pueden redondear dichos gastos en unos 135.000 colones, (no incluimos a los empleados y trabajadores de Santa Tecla).[12]

De los 81 trabajadores que estaban empleados a finales de octubre de 1972, 69 eran del municipio de Rosario y cerca de las 2/3 de estos eran de Tilapa, El Tunal y El Cerro. De Tilapa, que es el poblado cantonal más cercano a la fábrica, hay aproximadamente tantos como del pueblo de Rosario, i.e. como 23.

De esos 69 del municipio de Rosario, 62 son permanentes. La suma de dinero que queda en los bolsillos de los 69 equivale a 115.000—120.000 colones, y lo que queda únicamente en Tilapa ha de oscilar entre 25.000 y 30.000 al año. Ese dinero se filtra a las tiendas de Tilapa y las ha hecho levantarse.

El salario mínimo y más ordinario de los trabajadores de Tilapa es 84 colones al mes. El salario promedio de los mismos, alrededor de 100 colones mensuales.

2.3.2. Inversiones de los trabajadores

Con uno de los trabajadores pasamos revista a 40 obreros de la Arrocera, para darnos cuenta, en líneas generales, de la dirección que toman los dineros allí ganados.

De esos 40, la mitad están ya acompañados o acompañadas, pero solo un 40% tienen hijos. En la mayoría de los casos se trata de matrimonios jóvenes. En esos hogares el dinero ganado sostiene a la familia.

La otra mitad, que es de solteros jóvenes, pasa una cantidad, que puede ser de 20 colones mensuales, a sus padres por los gastos de manutención. Entre ellos se da la costumbre de gastar unos 12 colones al mes para pagar la tienda, de donde sacan al crédito guineos, gaseosas, helados, quesadillas, etc. "Los que trabajan pesado necesitan comer bien".

Otra categoría de gastos incluye la ropa y el calzado. Los trabajadores de la Arrocera van notablemente mejor vestidos que los del campo. Un estimativo de gastos de un hombre es el siguiente:

1 par de calzado ADOC	20 col.
2 par de calzado (ordina.)	20
4 pantalones	70
4 camisas	40
12 calzoncillos	18
6 pares de calcetines	9
3 camisetas	5
Total	180 colones al año.

Algunos compran ropa en Rosario, o en Santiago, o aun en San Salvador, donde aprovechan para ir al cine.

El vestido del trabajador de la Arrocera es una señal de un tipo de gente distinta en el lugar. Se trata de un obrero, no ya campesino, aunque ha tenido la experiencia de salir a las algodoneras y a la milpa. Su nivel de vida es más alto. "Le gusta andar chainiado (muy elegante)". Aunque estos trabajadores parecen estar contentos, puesto que trabajan más cerca unos de otros, se comunican y algunos comentan la política, están más propensos a la organización que el campesino. No hay sindicato en la fábrica, porque, si el dueño se entera de algún intento de organización a través de dos o tres "orejas", despide a los organizadores y les paga su indemnización. El dueño les ha alquilado el campo de fut y les patrocina el equipo. Les da compensaciones a los que le trabajan mejor, porque él está muy cerca y se ha desarrollado una relación personal, aunque siempre asimétrica, entre él y ellos. La compensación no consiste únicamente en dinero, sino también en lo que significa su aprobación. Hará cuanto pueda, dentro de ciertos límites, para mantenerlos contentos, y despide a los que volteen a su gente. Algunos anotan que esto es paternalismo, pero se sienten solos como para organizarse.

Un buen número, sobre todo de solteros, deben más porque ganan más. Todos ellos son hombres. De los 29 hombres de la muestra de 40, suelen beber, aunque en diferente medida, cerca de 18. De estos, los que tienden a beber más, algunos hasta 15 colones a la semana, son de edad relativamente más avanzada, por ejemplo, de 25 años para arriba. Estos trajeron a la fábrica el hábito de la bebida y la existencia de más dinero les posibilita beber más. Entre ellos también hay algunos que tienen mujer e hijos. En cambio, entre los que o son menores de 20, o andan por los 22 ó 23, tienden a estar los que beben, algunas veces con exceso, pero no habitualmente. Aquí están los solteros. Cuando se acompañan y se responsabilizan de una familia, dejan de beber.

Aunque hemos preguntado si ahora se bebe más, en general, que antes de la instalación de la Arrocera, la respuesta no es clara y no hemos podido constatar si se vende más guaro que antes, y si los expendios y los locales donde se vende en los cantones (y probablemente en el pueblo también) el clandestino, han prosperado. Es de suponer que sí han prosperado.

Unido al problema de la bebida va el de los solteros, como vimos. Se gasta dinero en el salón de las prostitutas. Según algunos, por eso hay tanto soltero: entre campesinos, como entre arroceros, aunque entre estos últimos en grado menor, los jóvenes no quieren responsabilizarse de una mujer y se satisfacen sexualmente. "Se ven a palitos (en apuros) ya con mujer". Las prostitutas trabajan en los salones. En épocas de corta de algodón han funcionado tres salones junto a la carretera, algunas veces hasta con 50 mujeres. También debajo de los puentes merodean los grupos de 5 ó 7. Ellas, salvo alguna excepción, no son de Rosario.

Los arroceros solteros, gracias a su sueldo, han logrado ir saliendo de esa vida. Hemos contado 7 entre los 15 hombres ya acompañados de la muestra, que "despuesito de trabajar allí, se han acompañado". Parece que es el camino que seguirán los demás solteros jóvenes. Para la fiesta de la unión, que todavía no es matrimonio legal y eclesiástico, pero que conlleva la intención de formalizarse, se suelen invertir unos 300 colones. El que no hace nada gasta 100 ó 50,, con una media comidita y unos vestiditos, que él le compra a la muchacha.

Por fin, se gasta en reparaciones y ampliaciones de la casa o en la construcción de una nueva y, como ya vimos en el apartado de Tilapa, en la compra de aparatos eléctricos. También en símbolos de prestigio u objetos de comodidad, como medallas, cordones de oro, relojes, alguna pistola, como de hierro, etc.

2.4. Solicitud del cantón El Cerro

La solicitud formal del cantón El Cerro para que la CEL le extendiera sus servicios de energía eléctrica data del 1 de marzo de 1971. Por estar todavía vivos en la memoria los trámites iniciales y proseguir aún las vueltas resulta un caso fácil de analizar para comprender qué fuerzas mueven una solicitud y cuáles la detienen y limitan.

Según la reconstrucción de los hechos, fue un señor, que hasta ha sido presidente de la Asociación de Ganaderos, quien, después de levantar una casa en las inmediaciones de Rosario y haber comprado una propiedad donde vivir en su invalidez, movió la solicitud a través de un comisionista de terrenos, que le había servido de intermediario en la compra del suyo. El comisionista vive en Tilapa y no tiene luz tampoco. Así que les interesaba, tanto al señor como al comisionista, conseguirla. Después de haberse aconsejado con un rosareño, que trabaja en CEL, el comisionista hizo la solicitud para el cantón El Cerro, no para sí, ni para el señor. Así tomarían ambos la energía de los tendidos primarios que se hicieran para El Cerro.

El comisionista movió a los del Cerro y consiguió algunas firmas. Lo hizo a través de otro señor, que sin ser propiamente líder, es el "que les pasa cualquier noticia" a las 17 casas remontadas en las faldas del cerro del Indio Aquino. Casi todos ellos son parientes consanguíneos o afines, como dijimos al hablar de Tilapa. Son descendientes de Potonico y Cancasque, Chalatenango.

El comisionista consiguió, no sabemos de quién, que le escribieran a máquina la solicituyd. El ha dicho algo vagamente que se la hicieron en la Alcaldía. La llevó al cantón, donde "el que pasa cualquier noticia" fue consiguiendo las firmas. Las estamparon verticales al margen superior y derecho de la hoja. Las firmas del comisionista y del señor ganadero aparecen calzando la solicitud en el lugar de responsabilidad, pero sin ningún título explicativo. Todas son firmas tortuosas, excepto la de una señora. Se conoce que algún letrado firmó por ella.

Se negaron a firmar ocho jefes de casa. La resistencia principal partió de un hombre de unos 65 años, que, según algunos vecinos, pensaba que, si acaso después de instalada la luz se retrasaran en sus pagos, les embargarían los terrenos. Ese señor "no tiene lado" por donde atraerle. Sus dos hijos, "por no darle que sentir al papá", tampoco firmaron. Otro señor, que es un "gato de monte", que "ni aunque le dijeran que se la van a regalar" la pondría, pues vive en un ranchito de paja, tiene un gran pánico a los truenos y a los huracanes y, cuando hay tormenta, se sale con su niñito a pasarla en casa de un vecino, tampoco firmó. Otros dos colonos, un viejito muy pobrecito, y una señora tan pobre, que entre varios le habían levantado recientemente su casa, tampoco firmaron.

El cantón ya tuvo experiencia de luz eléctrica. Un hombre del cantón, que trabajaba en San Salvador como chofer de una señora muy rica, se robó a una muchacha de servicio de una casa vecina la escondió en El Cerro y, para que estuviera contenta, le puso un motor diesel con dinamo para una radiolita. Esto sucedió por 1962 y 1963. Le regalaba luz a su hermano que es "el que pasa cualquier noticia".

Sólo firmaron, pues, siete, además del comisionista y el ganadero, porque los dos restantes hasta ajustar el total de 17 con los no firmantes, parece que no estaban a mano. En la solicitud se exagera, porque se habla de que hay más o menos 20 hogares y además se dice que "los suscritos y los demás habitantes del sector rural por donde pasarían los ramales conductores... estamos dispuestos a pagar las cuotas".

En CEL recibieron la solicitud a 4 de marzo de 1971. Se estancó por un mes hasta que el alcalde, que se ha mostrado muy atento con el ganadero, solicitó una respuesta a la anterior solicitud., añadiendo que había una cuadrilla en esos días efectuando introducciones de energía en los lugares carentes de ella.

A los 15 días —14 de mayo de 1971— envió el Subdirector Ejecutivo de la CEL un memorándum al Administrador de la Zona 15 pidiéndole el esquema y la información necesaria del lugar.

El Administrador se presentó al Cerro. La gente dice que era un ingeniero. El hombre viejo, que se resistía, le dijo que él sembraba maíz y que tenía bastantes tusas para alumbrarse de noche. El Administrador se fue molesto, a pesar de que los que deseaban la luz le insistieron que no pusiera cuidado con lo que tal señor le había dicho. Pero el Administrador informó, que harían falta 1000 Mts. de línea primaria, 450 Mts. de línea secundaria y un transformador de 10 KVA. Según él, no valía la pena suministrar la energía, ya que solo cinco de los solicitantes harían uso de la luz. Además, la carretera estaba en malas condiciones. Al Administrador le importaba guardarse las espaldas, no fuera que, como ha sucedido en otros lugares, se juntaran firmas, pero después la gente no instalara la luz.

Entonces, con esa información, respondió el Subdirector Ejecutivo al alcalde una carta diplomática el 15 de Julio de 1971, sin hacer mención del informe del Administrador, diciendo simplemente que, "dicho cantón no está incluído en el programa actual de Electrificación rural" y que, "ya se está estudiando la posibilidad de servicio en el futuro".

Allí se estancó todo. Ha corrido la voz entre algunos del Cerro que, como son de la oposición y el alcalde es del PCN, se les ha bloqueado el paso de la luz, siendo así que la concesión de la CEL ya estaba en la alcaldía. Han sido rumores y ellos reconocen que no saben si son verdaderos o no. Por otro lado, el comisionista no se movió más, parece que porque le indicaron de CEL que para él le resultaría más fácil hacer la extensión directamente desde la carretera y para la línea del Cerro convenía tomar la energía más arriba, y no, como pensaba él, de cerca de su casa en la carretera.

Así quedó el comisionista eliminado como solicitante. El tampoco se ha movido por su cuenta para hacer su extensión, porque su línea requeriría un poste y este debe clavarse en terreno de un vecino. No se ha atrevido a pedirle el permiso escrito para clavar el poste. El comisionista ha sido de la directiva del PCN. El vecino, que es pariente estrecho de los del Cerro, pertenece a la oposición y sus hijos hasta fueron golpeados a raíz de las elecciones pasadas.

Por otro lado, tanto el comisionista como el ganadero afirman que el alcalde recientemente le ha dicho al ganadero que la luz está ya concedida. Se han expresado en el sentido de que también El Cerro recibiría la luz y no sólo el ganadero, quien afirma que él solo consumirá lo de 30 casas, pues hasta pondrá bomba de agua. Pero las cosas no están claras. En la correspondencia de CEL a Rosario la Paz no se ha encontrado otra referencia más reciente que la carta del 15 de julio de 1971. Si el alcalde le ha dicho semejante cosa al ganadero no, los del Cerro, por ser de la oposición, no se encuentran en libertad para ir a preguntárselo directamente al alcalde y exigir ver la nota.

Los del Cerro fueron arrastrados en la solicitud como pantalla para obtenerle la luz al ganadero y, fuera de unos pocos, no se han mostrado interesados. Ni parece tampoco que "el que lleva cualquier noticia" sea expedito para dar las vueltas que sabe dar el comisionista. No es vínculo hacia afuera del municipio, sino sólo hacia afuera del cantón.

La pequeñez del cantón, sus pocas posibilidades de crecer, su composición demográfica de gente mayor y resistente al ingreso de nuevos modos de vida, la incapacidad del dirigente cantonal de elevarse a un nivel más alto de comunicación y la misma falta de comunicación política han servido para detener el débil intento del cantón para atraer la energía eléctrica.

3. CONCLUSIONES

Expondremos, primero, los factores que intervienen para la demanda de energía, entre los cuales hay algunos, que denominaremos **individuales**, porque intervienen en la decisión a nivel de las unidades de consumo para iniciar o aumentar la demanda; y otros, que llamaremos **comunitarios**, porque establecen el marco de valoración, dentro del cual se toman las decisiones individuales y colectivas. Para que una comunidad alejada del tendido solicite eficazmente la energía, hace falta una decisión comunitaria; para que los individuos prosigan su instalación, una vez ha entrado ya la energía, hace falta una decisión individual, que está influida por el marco de valoración (sistema de prestigio) de la comunidad. Para proseguir en la segunda fase (ver Nota 1) la investigación sobre la demanda individual, hace falta un cuestionario individual; para el de los factores comunitarios, se necesita un cuestionario sobre rasgos de un universo de comunidades comparables.

En segundo lugar expondremos los costos y beneficios sociales debidos a la electrificación. Algunos de estos, desde otro punto de vista, pueden considerarse como factores de demanda. Otros, en cambio, no, porque no operan a nivel consciente. No pretenderemos aquí mostrar en cada caso cuál opera a nivel consciente y cuál no.

3.1. Factores de demanda individual

3.1.1. Económicos:

+ Ingresos: ya sea medidos directamente, o indirectamente por el precio de la casa, extensión de terrenos y otras posesiones. Cierto nivel de ingresos es una condición necesaria para la instalación. Hay un nivel intermedio de personas que poseen los ingresos necesarios para la instalación, pero que no la llevan a cabo necesariamente; por fin, un nivel un poco más alto, en el que la generalidad de las personas electrifican. Hay que definir estos tres niveles.

+ Solar propio: en solar ajeno, aunque se trate a veces de casa propia, no suele conectarse la electricidad.

+ Explotabilidad de la energía:

— Tenencia de la tierra: si el individuo carece de tierra, no puede irrigar o hacer pozo para ganado. No se puede pensar en aumentar la demanda de energía entre el campesinado con fines productivos, sin reformar la tenencia de la tierra.

— Posibilidad de comercio: esta posibilidad se puede medir por el número de tiendas instaladas en el lugar durante los últimos 10 ó 15 años y el crecimiento de su capital. A mayor posibilidad de comercio de una zona, mayor demanda de energía.

3.1.2. **Sociales**

+ Número de parientes solteros que vivan en la misma casa y que trabajen: mienthas más hay, más dinero habrá y más gente joven habrá en el hogar.

+ Número de parientes cercanos en San Salvador: por su experiencia urbana son elementos innovadores, y por su mayor afluencia envían dinero y objetos eléctricos.

3.1.3. **De mentalidad:**

+ Edad: hay personas viejas, que están acostumbradas a vivir sin luz, o que ya no emprenden una nueva instalación (p. ej. de una bomba), por falta de ánimos, aunque tal vez tengan el dinero y la tierra.

+ Apertura:

— por oficio, puesto administrativo, actividad política: los oficios, puestos y actividades que implican vinculaciones extracomunitarias son una pre-disposición para cierto tipo de aparatos, como la TV, que posibilitan la comunicación fuera de la comunidad.

— por experiencia urbana: el que ha vivido en la ciudad exige ciertas comodidades en el pueblo, posibilitadas por la electricidad.

3.2. **Factores comunitarios**

3.2.1. **Condiciones de posibilidad de la instalación:**
en términos de número de casas, distancia de la ciudad y viabilidad de caminos.

3.2.2. **Estructura demográfica**

+ Pirámide de edades: si hay pocos jóvenes y muchos viejos, no habrá ambiente de novedades. Hay que contrapesar, sin embargo, este factor, con el de número de parientes cercanos en San Salvador, ya que los jóvenes, cuya ausencia se nota en el campo, pueden estar residiendo en la ciudad y estar mandando dinero, aparatos e ideas al pueblo.

+ Emigración: si la hay, por la razón anterior y por las pocas fuentes de ingreso que subyacen a la emigración, no habrá dinamismo.

- Inmigración: si la hay, es señal de lo contrario de la emigración. Hay que contrapesar este factor, sin embargo, con la tenencia del solar, ya que donde hay mucha gente recién llegada es de prever que estarán alquilando casa y por esto no tendrán el aliciente para instalar la electricidad.

3.2.3. **Experiencia previa de luz eléctrica:** el cantón que ha gozado de corriente, gracias a un motor diesel, por ejemplo, tiene más probabilidad, en igualdad de circunstancias, de conectarse en una red nacional, que el que no.

3.2.4. **Presencia de líderes locales que sepan moverse a nivel regional:** estos líderes han de vivir en el lugar y tener contactos extramunicipales para tramitar la solicitud.

3.2.5. **Apertura** (en términos de):

- Burocracia con alcances regionales.
- Politización, medida en términos de la fuerza de lo oposición.
- Comunicación con la ciudad:
  - transportes: precio, tiempo y frecuencia del pasaje.
  - periódicos: número de ellos.
- Existencia de Agencias de aparatos eléctricos.
- No corporatividad de la localidad: medida en términos de historiantes (bailadores tradicionales), mayordomías, tradición indígena, hostilidad ante el impuesto del alumbrado. Los lugares corporativos son más cerrados.

3.3. **Costos y beneficios sociales**

Una nota previa para distinguir entre la descripción de los procesos y su evaluación. En la selección de dichos procesos de parte del investigador interviene una forma mental de dividir lo bueno y lo malo; sin embargo, todavía allí se puede distinguir la pura descripción de su evaluación y se incluyen juicios de valor de parte del investigador. Lo decimos claramente, para que en cada caso que se emitan, pueda el lector tener la alternativa consciente para disentir. Calificaremos los costos (—) y los beneficios (+) con señales explícitas. Nuestra investigación ha sido demasiado rápida y superficial como para darnos cuenta, de una forma más rigurosa, de la valoración de la gente ante los efectos de la luz. Cuando la sepamos, la expondremos.

3.3.1. **Efectos de la electrificación en el nivel de vida:**

- Disminución de la mortalidad por el agua potable (+). No hemos encontrado entre la gente una clara conciencia de la asociación entre el agua potable y la disminución de la mortalidad.
- Urbanización de los hábitos del pueblo:
  - Por esta urbanización se atrae a gente de fuera a vivir en el pueblo (+). La gente del lugar juzga este efecto como un bien.
  - Las personas atraídas por la urbanización suelen gozar de nexos regionales. El pueblo adquiere realce en la región (+), de lo cual los rosareños se enorgullecen.

— Se atrae a compradores y el comercio local se beneficia (+) Los comerciantes lo juzgan como un gran bien.

— Con los nexos regionales se politiza más el lugar. Posiblemente es (+). Los de la oposición desean dicha politización, los gobiernistas no.

+ Posibilitación de nuevos gustos:
se toman más helados, se debe agua fría, se ven novelas, etc. La novedad de los gustos depende de la electricidad, pero el poder o no satisfacerlos depende de la existencia de más dinero. Juzgamos algunas de estas satisfacciones como positivas (+), p. ej. las que alimentan y las que en sí mismas alegran. Si, en cambio, dichas satisfacciones tenen un posible sustituto, las juzgamos como negativas (—), por significar una salida de dinero del lugar. La gente las juzga en general, al menos en su juicio espontáneo, como positivas.

+ Crecimiento de las tiendas:
de aquellas que por los aparatos eléctricos ganan compradores de esas novedades. Para los comerciantes es provechosa. No conocemos el juicio de los que no son comerciantes. En sí el auge de los comerciantes es positivo (+).

+ No se aumenta la productividad:
expresamos esto, que consideramos negativo (—), aunque sea de algo que no se da, para evitar el espejismo de la electricidad. Sólo se aumenta la productividad del lugar, en cuanto que se atrae a más compradores de fuera a través de la urbanización o de otras empresas fuertes (cf. siguiente punto).

3.3.2. **Efectos de la electrificación por la industrialización:**

+ Se aumenta la productividad (+) y se come más y mejor (+)

+ Se da trabajo fijo (+). La gente del lugar lo juzga positivo. Los que no están empleados parecen dar este juicio con más entusiasmo, que los empleados.

+ Se disminuye la emigración (+).

+ Se posibilitan negocios pequeños (+)

+ Se viste mejor, lo cual es señal de una nueva actitud, la del no campesino (+), pero a la vez es señal de que no hay fáciles canales para inversión más productiva (—).

+ El consumo de la bebida crece (—), aunque de esto no es culpable la electricidad o el aumento de la productividad, así como tampoco dicho aumento de la productividad es su medicina, a no ser a través del punto siguiente.

+ Se establece nuevos hogares (+): el aumento del ingreso posibilita los matrimonio. Se disminuye así el consumo de la bebida (+) y aumentan los nacimientos (—).

3.3.3. **Efectos de la electrificación en la estratificación:**

+ Fortalecimiento de la estratificación nacional existente (—). La industria da trabajo, pero el industrial se enriquece más. Políticamente esto es negativo (—), porque impide la libertad, basada en poder, del destituido. El obrero se siente contento (+) de tener empleo fijo, pero se siente amarrado (—). Esto no se debe a la electricidad, aunque dicha tecnología insustituíble esté a la base de la productividad, sino a la estructura social dentro de la cual se aplica dicha tecnología.

+ Acentuación de la estratificación rural: hay que distinguir entre el crecimiento de los negocios, que tienen RF, pero que con RF o sin ella crecerían, porque corre dinero en la región (p. ej. porque existe el algodón), del crecimiento debido a la industrialización local posibilitada por la electricidad. No sabemos, por ahora, dar un juicio sobre la estratificación rural.

NOTAS

1) Una redacción previa de este trabajo fue presentado al Seminario de Electrificación Rural tenido del 9 al 11 de Noviembre de 1972 en la Universidad Centroamericana, El Salvador. Allí se discutieron otros trabajos de ingenieros, economistas y sociólogos. El Seminario fue la culminación de la primera fase de una investigación a largo plazo acerca de los Costos y Beneficios sociales de la electrificación rural en El Salvador financiada y promovida por el Banco Mundial y encomendada a la UCA.

Para este trabajo dedicamos: una semana invertida en la selección de la comunidad; cuatro semanas en el trabajo de campo (alternado con clases en la Universidad) y otras dos semanas de redacción. La escasez de tiempo explica, en parte, la provisionalidad de las conclusiones. Se pretendía más levantar hipótesis. que sacar conclusiones definitivas.

Elegimos Rosario la Paz por haber allí oficinas de la Compañía Hidroeléctrica del Lempa (CEL) (los correspondientes a la Zona 15), y porque dicho pueblo está situado en un lugar céntrico, desde donde pensábamos coordinar otras investigaciones, que unos grupos de estudiantes habían de realizar en la misma Zona. Por sus buenas comunicaciones, además, resultaba un lugar cómodo para viajar a diario a la Universidad.

Aunque la UCA promovió el estudio del Cerrón Grande publicado en el número de Octubre de 1972 en ECA, el Seminario que sirvió de marco a nuestro trabajo, prescindió de él.

2) Usamos la fórmula $\frac{a-b}{10b} \times 100$, donde a es la población de 1971 y b la de 1961. Dividimos por 10 pues se trata de 10 años.

3) En el "casco del pueblo" o "el pueblo" incluiremos la población llamada "urbana" de los censos

4) En el Censo de 1961 se incluyó bajo este nombre también a los cantones o caseríos de El Tunal y Tilapa.

5) Agradezco al pionero D. Ismael Campos por las listas de los usuarios y su consumo.

6) Gastaba 2 galones de gas a la semana.

7) 167 colones por las tarifas, menos el gasto del diesel.

8) El informante no estaba muy seguro de esta suma.

9) Realizamos estas encuestas el día sábado 4 de Noviembre de 1972 de 11 a.m. a 5 p.m. con la ayuda de un grupo de 12 estudiantes del Plan Básico, sobre todo de 9º, de Rosario la Paz. Presentado por el Director les hablé a los 8º y 9º el Viernes 3 en la mañana y les propuse el trabajo. Se apuntaron 18 para recibir la explicación el día siguiente a las 7:30 a.m. y para ser seleccionados. Les expliqué la encuesta y se la pasaron ellos entre sí, como prueba. Las corregí una por una delante de ellos y seleccioné a los 12 mejores. También el factor edad influyó en la selección. Todos resultaron mayores de 16 años. Se les explicó luego sobre el mapa del pueblo, dibujado en el pizarrón, la ruta que cada grupo de dos debía seguir. Las rutas fueron trazadas por mí con la intención de cubrir las diversas secciones del pueblo.

10) Al precio de la RF Philips C-840, que al crédito cuesta 899 colones y de la TV Philips de 17', que al crédito cuesta 700, los cálculos dan un resultado (56 x 899) + (71 x 700) de 100.100 colones.

11) Los datos de esta tabulación provienen de un informante crecido en Tilapa, exceptuados los de las columnas 3, 12 y 13, que son de la CEL.

12) Los salarios de los 81 trabajadores (octubre 1972)

6 secadores a 84 col. al mes cada (3 diarios) cada uno.

3 maquinistas a 140 col. al mes cada uno.

9 de la trilla a 84 cada uno.

3 maquinistas del molino, a 280, 200 y 100 respectivamente.

5 empacadores a cerca de 120 cada uno.

11 empacadoras por libra de cerca de 150 cada una.

12 del precocido a cerca de 160 cada uno.

3 maquinistas de las calderas a 180 cada uno.

3 mecánicos a 280 cada uno de dos y el otro a 120.

2 ayudantes de mecánicos a 60 cada uno.

3 en oficios varios a 84 cada uno.

3 que costuran sacos a cerca de 50 cada uno.

1 representante del dueño a 400.

1 bodeguero a 200.

2 secretarios a 300 y 90.

1 cocinera a 240.

2 vigilantes a 120 cada uno.

2 guardias nacionales: su comida.

2 albañiles a 140 cada uno.

2 ayudantes de albañiles a 84 cada uno.

1 armador a 140 colones.

1 motorista de camión a cerca de 400.

3 mozos del camión a cerca de 150 cada uno