DOE/NASA/0197-1
NASA CR-165287

International Market Assessment of Stand-Alone Photovoltaic Power Systems for Cottage Industry Applications

(NASA-CR-165287) INTERNATIONAL MARKET ASSESSMENT OF STAND-ALONE PHOTOVOLTAIC POWER SYSTEMS FOR COTTAGE INDUSTRY APPLICATIONS Final Report (IIT Research Inst.) 290 p HC A13/MF A01 CSCL 10B G3/44

N82-16494

Unclas 08859

Therese M. Philippi
IIT Research Institute

November 1981

Prepared for
National Aeronautics and Space Administration
Lewis Research Center
Under Contract DEN 3-197

for
U.S. DEPARTMENT OF ENERGY
Conservation and Renewable Energy
Division of Photovoltaic Energy Systems

DOE/NASA/0197-1
NASA CR-165287

International Market Assessment of Stand-Alone Photovoltaic Power Systems for Cottage Industry Applications

Therese M. Philippi
IIT Research Institute
Chicago, Illinois 60616

November 1981

Prepared for
National Aeronautics and Space Administration
Lewis Research Center
Cleveland, Ohio 44135
Under Contract DEN 3-197

for
U.S. DEPARTMENT OF ENERGY
Conservation and Renewable Energy
Division of Photovoltaic Energy Systems
Washington, D.C. 20545
Under Interagency Agreement DE-AI01-79ET20485

ACKNOWLEDGEMENTS

We wish to express our thanks to DHR, Inc., Associates in Rural Development, Inc., and Mr. Robert J. Lapen for providing their technical and international expertise in support of this study.

TABLE OF CONTENTS

LIST OF EXHIBITS

LIST OF EXHIBITS (continued)

EXECUTIVE SUMMARY

This study was sponsored by the NASA-Lewis Research Center in support of the Photovoltaic Technology Development and Application Program that NASA manages for the U. S. Department of Energy (DOE).

Purpose

The purpose of this study is to assess the international market for small-scale, stand-alone photovoltaic systems for applications in cottage industries. For this study, cottage industries are defined as small rural manufacturers, employing less than 50 people, producing consumer and simple products. It was known that stand-alone photovoltaic systems are not cost competitive with grid generated electricity. Therefore, the study focused on rural areas of non-industrialized countries, where commercial power is not available. Countries with centrally planned economies were not viewed as a viable market for U.S. exports and were also excluded.

The underlying motivation for this study was two-fold. Primarily, it was believed that applying electricity to rural cottage industry production would help raise the standard of living for the rural sector by increasing employment and providing supplementary income. It was also the intention to promote the widespread usage of photovoltaic power systems.

Approach

The project approach was to initially establish the existence of a "potential" market, to examine the economic advantages of a photovoltaic system as compared to alternative means of supplying electric power, to quantify the electric power needs of typical cottage industries, and to identify countries which appeared to represent early market opportunities for rural, small-scale decentralized sources of electric power. This portion of the study was done based on information obtained from secondary sources within the U.S.

It was the original intent of the study to look at systems 15 kilowatt peak (KW_p) and smaller. For an industry operating 8 hours a day, this would represent only 6.76 kilowatts capacity (KW_c). It was found that the electric power requirements of typical cottage industries ranged from 750 watts (W) to over 90 kilowatts (KW) in capacity. Therefore, systems of capacities as large as 100 KW were considered.

This approach also considers the DOE price reduction goals through 1986 which are expected to bring the photovoltaic system price from $\$13/W_p$ to $\$6/W_p$.

Statistical data on cottage industries is extremely limited, especially in developing nations. Many cottage industries exist outside the formal economy and few are registered legal businesses. However, they are deeply entrenched within the culture and rural economy of a country and are recognized as such. Therefore, it was necessary to take an in-depth look at how photovoltaics could "fit" in the cottage industry sector of specific developing countries.

Four countries were selected for this in-depth analysis -- the Philippines, Mexico, Morocco and Brazil. In-country field investigations were made in the Philippines and Mexico. Studies were made of Morocco and Brazil based on U.S. available secondary and expert sources. Detailed reports of these studies can be found in Appendixes A, B, C and D of this report.

"Potential" Market

The "potential" market is a theoretical estimate of the gross demand for small-scale decentralized sources of electric power for rural cottage industry applications in non-industrialized countries, with non-centrally planned economies. The underlying assumptions are that the rural producer desires electricity and that the purchaser can afford it. Factors considered in determining the "potential" market include: rural population, importance of manufacturing and cottage industry to the economy, the number of people engaged in fundamental industries and the power consumption of typical cottage industries. It was also considered that: some rural industries are electrified or soon to be electrified by a grid network, in some areas hydro or wind power may be more appropriate, and some rural areas will have insufficient solar radiation for effectively utilizing photovoltaics. The remainder of the market is assumed to be the potential market for stand-alone photovoltaic systems, diesel-driven generator sets or gasoline-driven generator sets. Based on these factors, the "potential" market for applications requiring source capacities of less than 100 KW_c was found to be 70,000 megawatts (MW) of electric power.

Exhibit I illustrates a cumulative market curve as a function of source capacity based on the "potential" market and the typical power requirements of various cottage industries.

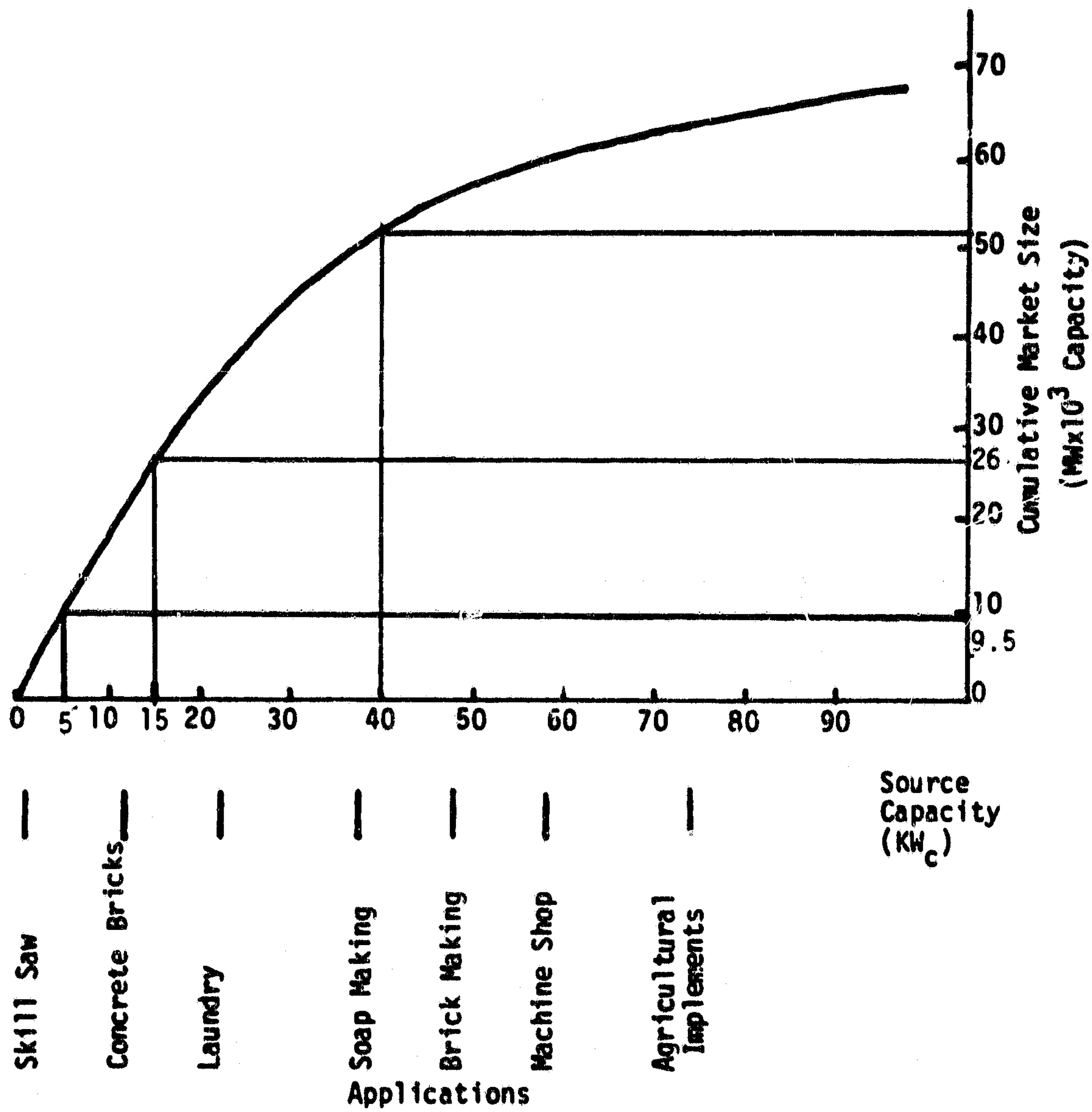


Exhibit I

CUMULATIVE MARKET SIZE AS A FUNCTION OF SOURCE CAPACITY

The exhibit illustrates that, for powering industries that use 5 KW_c or less, the potential market is 9.5 MW. For those using 15 KW_c or less the potential is 26 MW and for those using 40 KW_c or less the market is 52 MW.

Objectives

After estimating the theoretical "potential" market for rural power, the next course of action was to determine the feasibility of attaining that potential or, in other words, to determine the "real" market for photovoltaic systems.

The most significant factors which will determine the "real" market for stand-alone photovoltaic systems in cottage industry applications are:

1. Is the system affordable to the purchaser?
2. Does the system demonstrate itself to be the best option for the purchaser over his current power source or the available alternatives?
3. Will the system be accepted and utilized by the end-user?

To answer these questions the study addressed the following objectives:

- Determine the break-even price at which photovoltaics are as economical a choice as alternative electric power sources.
- Determine the life-cycle cost of a photovoltaic system versus its alternative.
- Determine the cash flow requirements associated with the purchase.
- Identify those countries which appear to be representative markets for small, decentralized power sources in cottage industry applications.
- Characterize rural cottage industries in terms of processes used, products, assets, available means of financing, marketing channels, size and raw materials.
- Characterize the rural cottage industry producer.
- Establish the role of cottage industry within both the rural and national economy.
- Establish the electric power needs of typical cottage industries.
- Identify the purchaser.

Economic Analysis

For the rural cottage industry producer who does not have access to grid generated electricity, the most viable alternative for electric power to a stand-alone photovoltaic system is a diesel-driven or gasoline-driven generator. There are some instances where hydro or wind are more appropriate, but these are isolated situations. The smallest diesel-driven generator commercially available is 3 KW. Below 3 KW, the alternative would be gasoline-driven generators. However, diesel fuel is much cheaper than gasoline fuel. Therefore, most cottage industries requiring low power would find it more cost-effective to purchase an oversized diesel and underutilize it.

An economic analysis was performed to determine the breakeven cost required for photovoltaics to be cost-competitive with diesel generators. Details of this analysis are given in Appendix E of this report.

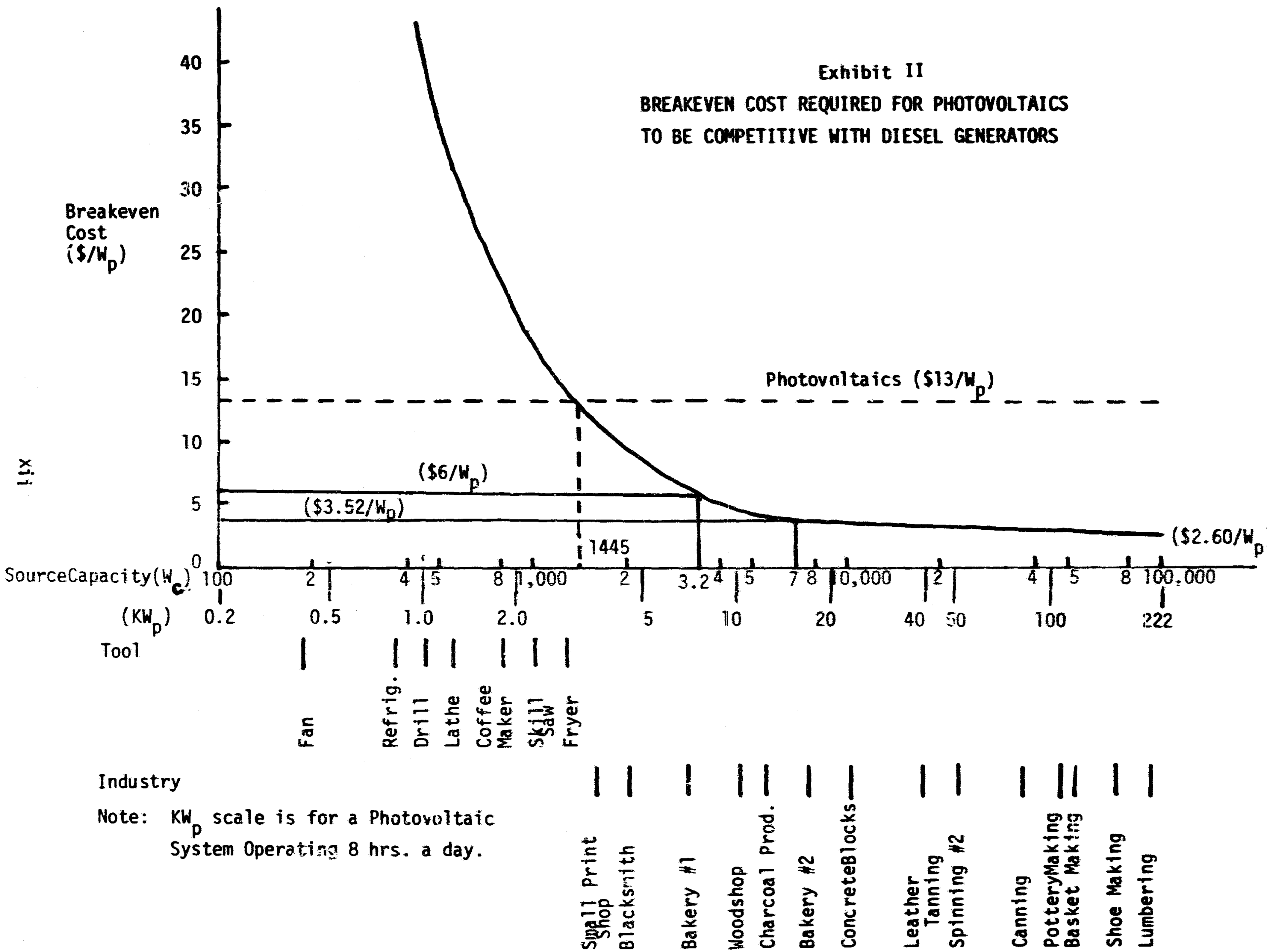
Exhibit II illustrates the break-even price curve for diesel fuel costing \$3.00 per gallon and a discount rate of 15%. The portion of the curve for a source capacity of 7 KW and greater is from the data given in Exhibit E-10. The lower portion of the curve assumes a 7 KW diesel generator is used and underutilized. Under these conditions, a photovoltaic system 1445 watts or smaller costing \$13/W_p, is competitive with a 7 KW diesel generator. At \$6/W_p, photovoltaic systems with 3200 watts capacity are cost competitive with a 7 KW diesel generator.

In comparing a 3 kilowatt capacity (KW_c) diesel generator and photovoltaic system in the Philippines (where the Cost/W_c = \$1.20 and diesel fuel is \$1.42), the photovoltaic system would have to cost \$2.73 per peak watt to be cost-competitive. This is based on 12 hours per day of operation.

Further economic analysis determined the life-cycle costs of photovoltaic systems, diesel-driven generators and gasoline-driven generators at various source capacities, costs of fuel and costs of photovoltaics. The results of these analyses for a system operating 8 hours per day are summarized in Exhibit III. Similar graphs for systems operating at 4 and 12 hours are also given within the report. From this graph, it can be seen that a photovoltaic system is cost competitive at 3500 watts capacity when diesel fuel is \$4.26 per gallon and photovoltaic systems are \$3 per peak watt.

Exhibit II

BREAKEVEN COST REQUIRED FOR PHOTOVOLTAICS TO BE COMPETITIVE WITH DIESEL GENERATORS



Note: KW_p scale is for a Photovoltaic System Operating 8 hrs. a day.

COMPARISON OF A GENERATOR SYSTEM AND A PHOTOVOLTAIC SYSTEM OPERATED 8 HRS./DAY

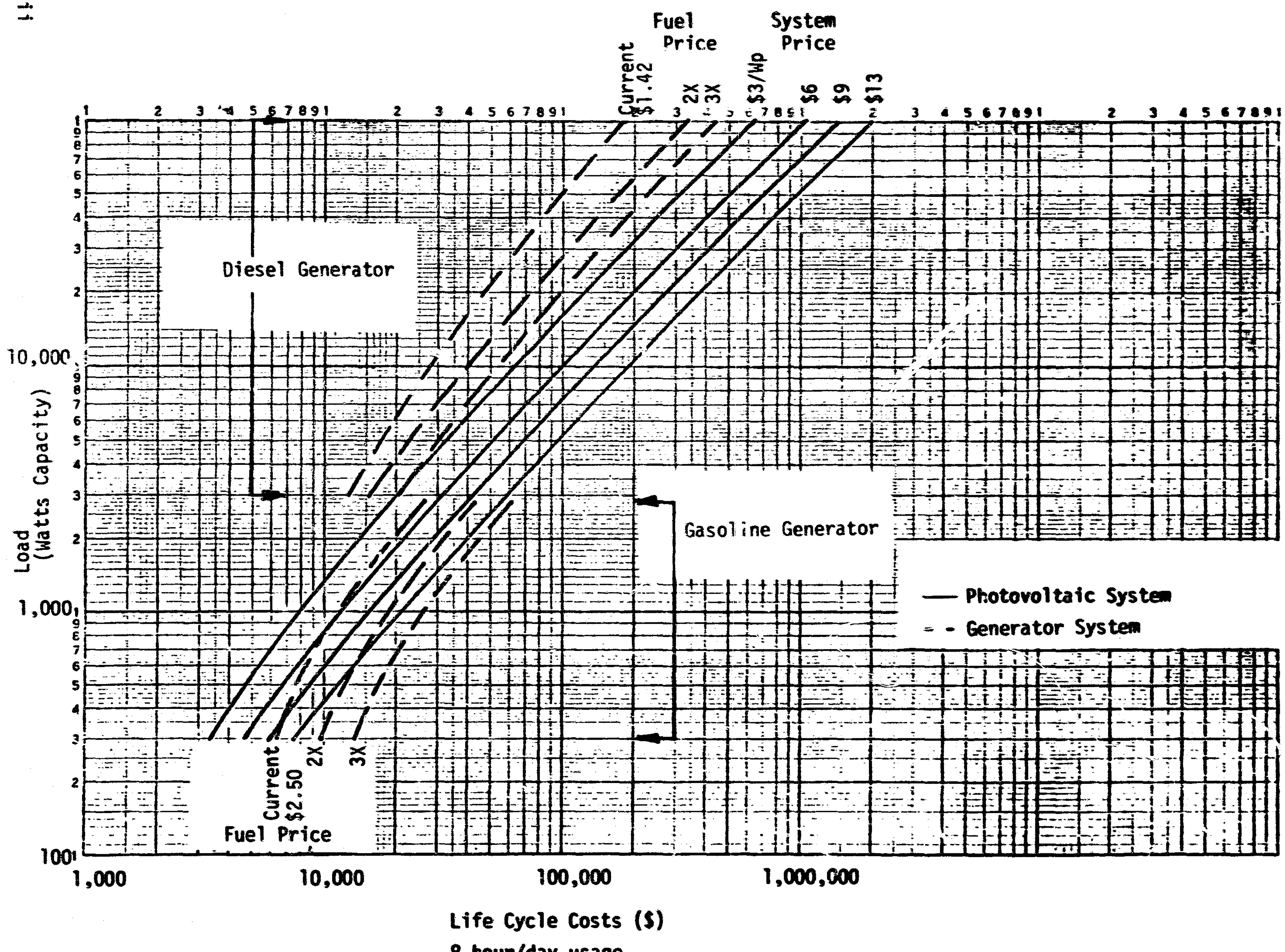


Exhibit III

To further illustrate, at $1.42 a gallon diesel fuel in the Philippines is very close to world market price. If the price were to increase by 24.6% a year, for five years, it would then be three times the current price or $4.26. If, in five years, the system price for photovoltaics came down to $6/W$_p$, it would still be more economical to use a diesel generator.

Characteristics of Rural Cottage Industries

Although each culture is unique, many general characteristics of rural cottage industries can be seen throughout the world. This study took an in-depth look at cottage industries in Sub-Sahara Africa, Morocco, the Philippines and Latin America, including the Andes, Brazil, Mexico, Central America and the Caribbean. From these, the following observations were drawn.

- Countries at a very early stage of industrial development, as in Sub-Sahara Africa, have a bimodal industrial distribution. There are large, modern urban industries and the small and artisan sector. Large scale industries are highly energy intensive, while the small, artisan sector is largely dependent on hand or mechanical labor. As these industries grow and develop, there will be a need for power, but at present familiarity with the use of electrical equipment is not widespread.

- Countries in which all segments of industry (artisan, small, medium and large scale) are developed will be more likely to apply an electric power source to their rural cottage industries. The Philippines, Brazil and Mexico would be included in this category.

- For many producers, cottage industry is a part-time or seasonal activity. Seldom do people consider themselves as a potter or weaver, but rather as a homemaker or farmer.

- Cottage industry production is frequently the only source of income to the producer to supplement a subsistent farm production.

- Cottage industry producers learn their craft either through apprenticeship or formal training. Formal training would usually be through government extension service or missionaries. However, in most cases, the craft is handed down from father-to-son, mother-to-daughter. They are slow to alter their methods of production.

- The typical cottage industry has a single proprietor and employs four or five persons. These are usually members of his family and they are seldom paid.

- Very few opportunities for financing are available to the cottage industry owner. Most cottage industries are not registered legal businesses and do not qualify for government loans. An individual wishing to borrow from a bank must produce collateral. In Mexico, the average assets of a cottage industry are $2,000 to $3,000 and in Morocco, they average about $1,000. These would hardly be sufficient to finance capital equipment.

- As they exist today, the vast majority of rural cottage industries neither require nor utilize electrical energy. At several sites visited in rural Mexico, where electricity had been made available, it was noted that electricity was used for domestic purposes, but not in cottage industry production. Rural cottage industries remain essentially the same as they had before the introduction of electricity. In the Philippines, where cottage industry is very important, the producer is encouraged to make everything by hand, even his tools. A summary of the forms of energy currently used by cottage industries is given in Exhibit IV.

- Finally, the products themselves are dependent on the local availability of raw materials and the markets they serve. Most goods are produced for local and regional markets and are simple and utilitarian. Export markets usually demand goods of higher quality and uniform appearance. As an example, embroidered shirts made in Latin America must conform to commercially accepted sizes or a set of pottery plates and cups must all be the same shape and size.

A summary of the predominant cottage industries in the various countries of the world which were studied is given in Exhibit V.

Exhibit IV

FORMS OF ENERGY CURRENTLY USED

Wood and charcoal, primary source
Animal traction
Solar (simply drying in the sun)
Water wheels (Micro-hydro)
Diesel generators
Grid
Kerosene
Butane or propane
Agricultural residue; Mill waste
Conventional electricity

Exhibit V

SUMMARY OF PREDOMINANT COTTAGE INDUSTRIES IN VARIOUS REGIONS OF THE WORLD

	AFRICA	ANDES	BRAZIL	CENTRAL AMERICA	MEXICO	MOROCCO	PHILIPPINES
Rural	Wood products Textiles - weaving, tailors dyes Bakeries Ag. implements Grain mills Well-digging Masonry and carpentry Furniture Bicycle repair	Weaving (wool) Spinning Pottery Jewelry Woodworking Basketry	Weaving Bakeries Ceramics Food processing	Weaving (cotton) Pottery Woodworking Rush reed products	Pottery Metalworking Furniture Woodworking Basketry (reed) Weaving	Weaving Carpet-making Pottery	Food processing Textiles, clothing Wood products Metalworking Furniture Woodworking
Urban		Leather goods Bakeries Food processing	Blacksmithing Light engineering Mechanical Shops Metalworking Gunmaking (hunting rifle) Cutlery Popular crafts: toys, dolls, printshops, brickmaking, tilemaking			Leather Tile-making	

Purchaser

The primary purchaser of stand-alone photovoltaic systems in cottage industry applications will clearly be from the government sector. The principal reason being money. Photovoltaic systems are initially capital intensive and require long-term usage to be economical, if at all. Considering the characteristics of typical cottage industries, it is highly unlikely that a rural cottage industry would have the financial means necessary to support such a purchase.

Conclusions

Based on the nature of rural cottage industries in developing nations and the economic analyses of this study, the near term market for photovoltaics in rural cottage industries appears to be limited to demonstration projects and pilot programs.

The two major reasons supporting this conclusion are: (1) Stand-alone photovoltaic systems, at a system cost of $\$6/W_p$ to $\$13/W_p$ are not the most economical means of providing small, decentralized sources of electric power for cottage industry applications, and (2) cottage industries are not a high priority for development.

It is the usual objective of a developing nation to make a positive impact on the standard of living for the greatest number of its people. The highest priorities in a government's developmental plan will be food production, the provision of safe drinking water and medical facilities.

Once the basic necessities have been filled, the next level of priorities is to provide education and infrastructure. Schools, educational television, communication systems and highways would be the next facilities and services provided.

Cottage industry production beyond the needs of a village requires skilled producers, adequate supplies of raw materials and a marketing infrastructure for the goods produced.

A country having attained this stage of development would then begin to consider developing the rural economy either to provide goods regionally or to create an export trade. Also, skilled labor creates a need for employment and cottage industry production tends to be labor-intensive. Funding for projects to develop cottage industries and train labor is usually low. Mexico, which has one of the most ambitious plans in this area has committed $27.4 million to electrifying 4,705 small rural industries. This gives an average of $5,834 per industry.

Finally, consider what effects the application of electric power could have on rural cottage industries. Basically there are three effects:

- Production of more goods
- Production of goods with a higher value-added
- Better utilization of labor

Production of more goods is desirable only if there is a demand in the marketplace. Usually this situation is limited to export-oriented producers. Most cottage industries produce simple goods for local and regional markets and their production levels are in balance with the rural economy. It is unlikely that this producer will want to produce more goods, since this may actually reduce the price obtained for his goods. Roads, transportation, storage and intermediaries must all be present. For many isolated rural industries an adequate supply of raw materials may also be a problem.

Another effect is to produce a more profitable product. Production of goods with a higher value-added is a good rationale for adapting electricity to manufacturing and there have been many successful cases demonstrated. This is especially true in the furniture and woodworking industries. The major drawback is, again, there must be a demand in the marketplace for higher value-added goods. Another problem is maintaining the integrity of the product. The value of many cottage industry products lies in their visible manual craftsmanship and cultural expression. This is especially true for clothing, carved goods and painted goods. In an export market, hand-made goods also enjoy considerably lower tariffs and duties than machine-made goods.

The third effect of applying electricity is better utilization of labor. The purpose is to free the laborer from tedious, low-value manual tasks to either produce a more valuable product or use his or her time in a more profitable manner. However, this frequently requires a total program of education and facilities. Unemployment is a major problem in many countries and, often, underemployment of labor rather than introducing powered equipment is preferable.

An opportunity that may exist for stand-alone power sources is in the extraction, transportation, storage and processing of raw materials used in cottage industry applications. Semifinishing processes, finishing processes and finishing accessories are also segments of cottage industry that could easily utilize stand-alone, decentralized power sources. Exhibit VI contains a list of potential uses and their relative applications.

Exhibit VI

POTENTIAL USES OF SMALL-SCALE POWER SOURCES IN COTTAGE INDUSTRIES

<u>Use</u> (Equipment)

- lighting
- mixers for the extraction and mixing of clay
- grinders
- centrifuges
- lathes, bandsaws circular saws, sanders grinders
- lathes soldering irons buffers polishers

<u>Application</u>

- general usage
- pottery cooking vessels construction material
- cornmeal grinding
- fishmeal grinding
- jewelry making
- religious articles
- furniture and wood products construction materials
- metalworking

INTERNATIONAL ASSESSMENT OF STAND-ALONE PHOTOVOLTAIC POWER SYSTEMS FOR COTTAGE INDUSTRY APPLICATIONS

1. INTRODUCTION

The purpose of this study was to assess the international market for small-scale, stand-alone photovoltaic energy systems with respect to the energy needs and resources available to cottage industry applications. Stand-alone photovoltaic systems are not cost-competitive with grid generated electric power. Therefore, they have their greatest utility in rural areas where commercial power is not available. Therefore, the study focused on the rural cottage industry sector of non-industrialized countries with non-centrally planned economies. Throughout the world, cottage industry has many meanings and usually encompasses both artisan and small-scale industries. For this study, cottage industries are defined as small rural manufacturers employing less than 50 people, producing consumer and simple products.

The original intent of the study was to examine industries which would utilize a maximum power supply of 15 kilowatts peak (KW_p). A 15 KW_p system can supply 5 kilowatts capacity (KW_c) of constant power over a 12 hour period, or 6.75 KW_c of power over an 8 hour period. However, the energy needs of typical cottage industries were found to range from 750 watts capacity to over 90 kilowatts capacity. Therefore, in order to derive a better understanding of cottage industry needs the economic portion of the study considered systems as large as 100 KW_c.

Initially a preliminary assessment of the worldwide market identified countries for further study that would be representative of cottage industries throughout the world. This assessment was based only on data and information available in the United States.

The methodology used to make a preliminary assessment of the market was to (1) estimate the "potential" market for photovoltaics, (2) examine the economics of photovoltaic systems in relation to their most viable competitor -- diesel driven generators, and (3) assess values of photovoltaics other than economics by examining the strategic implications of introduction of photovoltaics for the small businessman and for the importing country.

Fourteen countries which appeared to have a healthy cottage industry sector were profiled. At least three developing countries were chosen from each of the four regions of the world. For each country, consideration was given to the extent of rural electrification, the importance of cottage industry, and the potential of stand-alone power systems within the current government policies for energy, industry and the general economy. The 14 countries which appeared representative of world cottage industry producers are:

Central and South America

- Argentina
- Brazil
- Mexico

Mediterranean and Middle East

- Egypt
- Spain
- Greece
- Morocco

Sub-Sahara Africa

- Kenya
- Cameroon
- Nigeria

Southeast Asia

- India
- Republic of Korea
- Philippines
- Malaysia

From these 14 countries, four were selected for in-depth study. They include the Philippines, Mexico, Brazil and Morocco. In-country field investigations were made in the Philippines and Mexico. Studies of Brazil and Morocco were made based on information from expert sources in the U.S. Detailed reports of these studies are given in Appendixes A, B, C and D.

Statistical data on rural cottage industries is extremely limited. In most parts of the developing world, rural cottage industries are not perceived as such, but rather are regarded as a part-time activity of families and farmers. Frequently, they function outside the formal economy and rarely will they be registered legal entities. An exception to this may be in Asian cottage industries, but, even here, data is incomplete. Hence, for the purpose of this study, emphasis has been placed on the analysis of the qualitative application of stand-alone photovoltaic systems in cottage industries, rather than a statistical evaluation of the numbers of industries and establishments that could utilize the technology.

2. NATURE OF COTTAGE INDUSTRY IN LESS DEVELOPED COUNTRIES

In order to determine the market potential of an electric power source for use in cottage industry, it is necessary to gain an understanding of cottage industries as they exist in the developing regions of the world. The major factors to be considered are the processes used by cottage industries, how energy is utilized, how easily the producer could apply photovoltaic systems and the overall fit of cottage industry in the rural economy. It is also important to consider, to some degree, what effect the introduction of electricity would have on the production and marketing of cottage industry goods.

The following sections probe this objective by examining the nature of cottage industry in Sub-Sahara Africa, regions of Latin America, Morocco and the Philippines.

2.1 Sub-Sahara Africa

With the exception of South Africa and the People's Republic of the Congo, Sub-Sahara Africa consists of primarily agrarian economies with at least 50 percent of the labor force of each country employed in agriculture. As characteristic of countries at an early stage of industrial development, African nations tend to exhibit a bimodal distribution of industry. This is a "stage of industrialization in which a large number of small craft-based enterprises coexist with a limited number of large scale, foreign or state-owned firms."[1] The absence of small factories and medium-size enterprises is obvious. In Africa, small and artisan enterprises which employ less than 50 workers account for 95 percent of those employed in manufacturing. Within the small and artisan sector there are two factions. The traditional crafts are rural, the modern small industries are urban. A community is considered rural if it has a population of less than 20,000 people.

African cottage industry as an economic entity is just beginning to emerge with the majority of firms still belonging to the informal economy. Most small-scale industries, especially urban, are less than 15 years old. Characteristic of countries which have been under colonial rule, a significant expansion in the number of cottage industries can be seen, beginning with each country's independence. However, these industries are those which require very low technical skills. The goods produced are simple and frequently unfinished or inferior. This appears acceptable to the local, low-income markets they serve, but goods sold in the formal economy are produced by formally trained artisans.

Tailoring, furniture making, carpentry and vehicle repair are primarily urban industries. In the rural sector, there is a definite linkage between agriculture and small-scale industry. Agricultural processing and agricultural implements predominate, although weaving, mat making and pottery are also significant. Most of the agricultural processing involves grain milling,

---

[1] John M Page, Jr., Small Enterprises in African Development: A Survey, World Bank Staffing Paper No. 363, .P. 4.

especially rice mills. Oil seed processing is also important. Rural blacksmithing represents an estimated one percent of the agricultural output. The major activities are tool repair and the production of machetes, hoes, knives and axes. The goods are not of high quality and lack standardization.

Cottage industry, for the rural producer, tends to be a part-time activity with two-thirds of his time being spent farming. The business has a household nature and either relies heavily on family labor or is a single worker, sole proprietorship enterprise. With the exception of Ghana, cottage industry is primarily a male occupation. The incidence of wage employment in small-scale industries increases with the size of populations and is usually urban. Cottage industry producers, in general, earn larger incomes than solely agricultural producers.

African cottage industries, both urban and rural, produce simple consumer goods for local markets. Goods are commonly produced on demand for individual customers and marketing is through personal contact between the producer and the customer. One reason for this is the shortage of working capital which plagues most small-scale enterprises. However, production on demand also contributes to the lack of quality control and standardization.

In Sub-Sahara Africa, skills are learned through an apprenticeship program. This applies to both the technical skills of the manufacturing process and the skills of business ownership. West and East Africa exhibit distinct methods for teaching cottage industry production. West African apprenticeship programs are large, extremely organized and traditionally oriented. East African programs have been formulated more recently and are less structured. All, however, utilize on-the-job training. Few cottage industry producers have formal education or training and a large percentage lack basic literacy and numerical skills. In the urban sector, less than 15 percent of the business owners have received school training.

The typical producer is a "craftsmen, entrepreneur technically proficient in the manufacturing process, but without extensive training in financial management or business organization." [2] Formal education or vocational training have a high opportunity cost. Once basic technical skill has been acquired,

---

[2] John M. Page, Jr., IBID. P. 29

most artisans prefer to begin generating income, rather than advance their capabilities. Training and education are not readily available nor easily accessible. Most vocational schools are academically oriented and have high entrance requirements. Also, they are usually located in large cities, making them physically out of reach for the rural entrepreneur.

The lack of basic business skills in organization and management severely hinders rural cottage industries. Because it serves as a symbol of social status, most tend to hold excessive stocks of goods and raw materials. Raw materials are poorly stored and results in considerable spoilage and waste. Inapplicable, unused capital equipment is another status related problem.

Production improvements for workshops could be made in the inefficient layout of machinery. Poor maintenance of tools and equipment is a major problem as well as obtaining production inputs and spare parts which are imported. Small enterprises are usually the last to get delivery on imported goods and do not enjoy the duty and license advantages of larger firms.

Most African small-scale enterprises are unregistered businesses. The two main reasons are to avoid taxes and a general inability to cope with the bureaucracy. Compliance with health and safety regulations is also a problem for small business and discourages legal registration. Again there exists some distinction here between regions. Registration requirements for West African nations are relatively uniform throughout the country. Registration of small firms usually means greater government assistance to them. In East African nations, registration of business is usually done at the local level so that requirements, fees and enforcement policy vary.

The major drawback to non-registration for a small business, is the lack of available financing. Insufficient working capital is considered the biggest constraint for small-scale and artisanal enterprises. Part of the problem is that the business must extend credit to its purchasers, but must pay cash to its suppliers. This, coupled with generally poor management, creates a major cash flow problem. Exhibit 1 shows the results of several surveys taken to identify sources of capital for small African businesses. Personal savings is, by far, the greatest source of money.

Sources of Finance for Initial Investments By Small Enterprises in Some African Countries

(Percentage of Initial Investment by Source)

<table>
<tr><th></th><th colspan="2">Nigeria</th><th rowspan="2">Ghana</th><th rowspan="2">Tanzania</th><th rowspan="2">Sierra Leone</th><th rowspan="2">Uganda</th></tr>
<tr><th></th><th>Western Region</th><th>Ibadan</th></tr>
<tr><td>Own Savings</td><td>97.7</td><td>59.0</td><td rowspan="2">90.8</td><td>78.0</td><td>60.2</td><td>77.5</td></tr>
<tr><td>Relatives</td><td>1.9</td><td>35.0</td><td>15.0</td><td>19.5</td><td>-</td></tr>
<tr><td>Banks</td><td>.02</td><td rowspan="3">2.0</td><td>10.8</td><td>1.0</td><td>0.9</td><td>0.8</td></tr>
<tr><td>Government</td><td>-</td><td>-</td><td>1.0</td><td>-</td><td>-</td></tr>
<tr><td>Money Lenders</td><td>.03</td><td>-</td><td>-</td><td>0.9</td><td></td></tr>
<tr><td>Other</td><td>-</td><td>4.0</td><td>-</td><td>6.0</td><td>18.3</td><td>21.7</td></tr>
</table>

Sources:
- Nigeria: Aluko et al (1972)
- Ghana: Steel (1977)
- Tanzania: Schadler (1968)
- Sierra Leone: Liedholm and Chuta (1976)
- Uganda: Bosa (1969)

Exhibit 1

Public and commercial banks are rarely a source of capital and government development agencies are just beginning to finance small business. Government policies, while encouraging cottage industry, usually favor funding for large-scale, modern enterprises and large loans. Private banks will make loans to small businesses, but the cost of borrowed capital for the small business is much higher than for the large borrower. This, however, is a real cost and reflects the greater risk associated with small business and the high administrative costs of processing small loans.

It is anticipated that the demand for cottage industry goods will increase with incomes and the overall development of each country. However, imported goods may be favored over African goods because of the desire for finished quality. Many countries also anticipate a demand for traditional and cultural goods for export and tourist markets.

There will be a need for better technical processes and equipment, such as electrified tools, looms, ovens and similar products, but this is not an immediate need. The biggest problem presently is the lack of education, especially in finance and business management. Although there is considerable effort being made in African rural industrial development, it is insufficient to support the widespread introduction of a small-scale decentralized electric power source into the cottage industry sector.

2.2 Latin America

The cottage industry sector of a country is deeply entrenched in the history and culture of its people. Culture is the root of a society from which stems its attitudes towards commerce, labor and production. The first step in analyzing an international market is to perceive the attitudes and behavior of the potential end-user.

In Latin America, two distinct cultural influences predominate. The upper and middle classes tend to be of Spanish-Portuguese descent, while the lower classes and less developed population is largely the indigenous Indian population. The Spanish and Portuguese, considered manual labor degrading; hence, they have historically viewed cottage industry as a lower-class occupation, reserved for the poor. Cottage industry goods were perceived as inferior, while machine-made European goods were the preferred choice. In the last 10 years, as many countries have begun to adopt nationalistic industrial policies, this attitude is beginning to show signs of change. Also, improved rural incomes and development of infrastructure are bringing about a deeper appreciation of rural cottage industries.

Among the indigenous Indian populations, the cottage industry producer enjoys a considerable amount of respect, but few people consider themselves as such. Even though cottage industry production may be the sole source of income for a rural dweller, he or she will still call themselves farmers or housewives. Nevertheless, cottage industry is very important to the informal economy of rural Latin America.

This section will consider the nature of cottage industry in the Andes, Brazil, Central America and the Caribbean and Mexico. A more detailed discussion of Brazil and Mexico is given in the Appendix of this report.

2.2.1 Andes

The Andes mountains form a distinct rural region in South America which includes Bolivia, Peru, Ecuador and Northern Chile.[1] The lifestyle of these Andean people is closely tied to their physical environment. Sheltered fertile valleys and rugged mountains form the Andean region. Agriculture and ranch herding are the primary occupations of most people, but all members of a family will never be engaged in the same work. For example, one may be a farmer, one a herder, one a pottery maker. This is to ensure against unemployment and loss of income to the family. Even farming is done vertically and varied. That is, a farmer will plant at various altitudes and not only in one area.

The culture of the rural people in this region is highly indigenous, dating back to the Incas. The power of the community and local government still exists today. The community consists of a highly structured organization. This may encompass several villages or there may be more than one community within a single village. This is because the male population may go off to farm in another area or altitude, but they still belong to their original community. The community leadership, the Elu, dictates all tasks and chores and decides who will produce what. This ensures employment and provides for all the diversified needs of the community.

In the Andean countries, weaving is, by far, the greatest employer in cottage industry and blankets, clothing and carryalls are the principle products. In Ecuador, they weave cotton, sheep wool and orlon. In Bolivia, Peru and Northern Chile they use alpaca and some llama. This industry is so important to the informal economy that Bolivia and Peru each have a federal Ministry of Wool. Pottery, wood products, bakeries and basketry are also important, but not to the extent of weaving. Jewelry making is important because of its high monetary value. Peruvian cottage industries work in silver, while Bolivians produce tin and pewterware.

In the Andean countries, the commercial intermediary is an integral component of the rural infrastructure. The commercial intermediary is a rural entrepreneur who finances, organizes and markets the products of cottage industries. He will

[1] Note: Columbia and Venezuela are also members of the Andean Pact Group, whereas Chile is not. However, Columbian and Venezuelan cottage industries are not described here.

either finance raw materials through credit or distribute piecework. Piecework is especially common in the clothing industry where women do embroidery and handwork rather than cutting and assembly. In very remote areas, the intermediary is usually from the community or a nearby town. In larger rural communities, with populations of over 3,000, he is usually a self-made businessman from the middle or upper class or the local clergyman.

The priest or missionary is very important in Latin America and exerts a tremendous influence on the people. A missionary or padre will set up a total community facility in a larger, but rural oriented city, that provides equipment, materials, warehousing and whatever is necessary for supplying and marketing cottage industries. He will then form a network of producers in the nearby rural areas within a radius of 80-100 km. Occasionally, there will be some industry already there, but usually a teacher is brought in and the processes and techniques used are introduced. For example, a common strategy is for the priest to organize a mother's club in the rural community. He then brings in a sewing teacher and the local sewing circle evolves into an industry. The goods are usually marketed within the formal economy and are produced for export or tourist trade.

Many view the commercial intermediary as an exploiter of rural artisans; however, the intermediary must provide credit to the producer, supply the raw materials and market the goods. A product may go through several intermediaries before it is actually exported and each step in the chain increases the cost. Also, the product then must compete with industrial produced goods, as in the sewing industry, as well as other foreign producers. There is also a risk associated with being an intermediary since most cottage industries are non-registered businesses and occasionally operate illegally. Illegal businesses may be found in areas where raw materials are extremely scarce and privately owned or federally controlled. An example may be forestry or fishing related industries.

In the rural informal sector the goods produced are utilitarian and cultural. The informal sector is that which is outside the monetary economy. Here, goods are frequently bartered and prices are often set by the local leader, the Elu. The majority of cottage industry producers are employed in this sector. Their articles and designs are intended for the informal market and they have a functional purpose, usually religious. Not every city or village will have cottage industry, but where it is found it is usually the sole source of income for the producer combined with a subsistence agriculture. Cottage industry is an essential contributor to the informal economy and balances agricultural production.

The processes used are traditional and usually learned by apprenticeship. Since their techniques are so closely tied to their lifestyles, it is very difficult to introduce new technology. One example is in spinning wool. The women of the Andes use a portable spinning device called a *Rueca*. The spinning wheel will never replace a *Reuca*, because the portable device allows them to do the herding and spin their wool at the same time.

The principal sources of energy for rural, Andean cottage industries are wood, charcoal, hydro power and diesel generators. Wood and charcoal are used by bakeries which produce empanadas, the daily staple. Empanadas are like a turnover which are filled with meat or fish. They are made fresh each morning.

Grinding mills are run on animal traction or hydro power. In and near the mountains they make good use of water wheels for operating mills. Other food processing industries use wood and charcoal or diesel.

Diesel generators are used quite extensively throughout the Andean region. In Bolivia and Peru, fuel is so highly subsidized that, in 1977, diesel fuel was retaining below the world market price. Even so, the cost and operation of diesels is considered extremely expensive, especially in the El Beni region of Bolivia.

Since the people are so deeply entrenched in their cultural patterns, the introduction of any new technology would be difficult and lengthy. It is doubtful that weaving and pottery would adapt to electricity since these industries are so closely integrated with everyday activities. There may be some potential in wood-working and jewelry making, but a great deal of training would be necessary.

2.2.2 Brazil

Brazil is a semi-industrialized nation with all levels of industry present ranging from singular home producers to major multinational corporations. Cottage industry in Brazil is fairly well developed in both the urban and interior sectors. Brazilians do not talk about the rural sector, but rather refer to it as the interior. Thirty-nine percent of the population or 48,500,000 people live in interior Brazil.

The majority of rural cottage industry activity is in Northeast Brazil. The Northeast is a distinct geographical region which comprises "the Brazilian Bulge". This area is the most economically deprived, is overpopulated and frequently is subject to drought.

The goods produced in Brazil, as in most of Latin America, tend to be functional and reflect the culture and traditions of the people. Weaving is, by far, the most important cottage industry, followed by bakeries, ceramics or pottery and food processing. Again, these are industries which provide necessary goods. Hammocks and blankets are extremely important products with entire towns engaged in hammock making. Printshops, brickmaking, limemaking and tilemaking are also readily seen, as well as popular crafts, such as toys and dolls.

Blacksmithing, light engineering, mechanical shops, metalworking, cutlery and hunting rifles are important cottage industries, but these are usually found closer to urban centers. Shoemaking is also becoming an urban industry. More and more interior Brazilians are wearing oriental rubber thongs and the demand for locally produced shoes is declining.

Of the processes used, some are traditional, but many have been introduced by an intermediary, missionaries or, frequently, by one charismatic individual.

The cottage industry producer learns his craft either through an apprenticeship or an intermediary. Apprenticeship is usually to a family relation, but the strong direct transfer of a family profession as seen in Mexico and Morocco does not prevail in Brazil.

In the interior sector, there are several types of intermediaries including commercial, government and upper class.

Commercial intermediaries in Brazil function essentially the same as in the Andean region. One difference is that the Brazilian intermediary is beginning to reorganize cottage industries and do more actual development of cottage industries.

Government extension programs are frequently found where a commercial intermediary has already existed. Their purpose is usually to provide a more efficient means of marketing goods and organizing producers. Overall, most projects are not much more successful than using a commercial intermediary. The problems of infrastructure are the same and there is little improvement of wages for the producer. Since government projects are evaluated on the volume of goods sold, there is no incentive to produce a more valuable product. The advantages a government intermediary does have for the artisan are in the introduction of new designs and in the technical assistance which a government extensionist can provide.

The upper class intermediary is either a non-profit organization or a financial entrepreneur. Both are based in large cities and seek to provide alternative outlets for the cottage industry producer to market his wares. They will also seek to improve production by bringing in new equipment and instructors for the interior artisan. Some are very successful and fairly large commercial enterprises. The upper class intermediary, however, encounters the same problems as government intermediaries in dealing with the interior infrastructure and do not really provide much more of a market.

The type of intermediary he or she deals with makes little difference to the interior producer. Essentially, he or she lives a day-to-day, hand-to-mouth existence. The artisan is still paid on a piecework basis and prices are set by the intermediary.

Because of the predominant Catholic population in Brazil, the padre or missionary is often a very important intermediary. As in the Andes and Mexico, he will organize the people, teach them a craft and then find markets for products. A prime example of this is in the Carira region of Ceara in Northeast Brazil. Cottage industry was first introduced there by a mystical padre named Cicero. From its simple artisan beginning, this region is now a strong center of small, artisan and medium-scale industry.

Cottage industry is extremely important to the interior economy, especially in Northeastern Brazil. Here, if agriculture is the primary activity, it is usually at a subsistent level and cottage industry provides the sole source of income. Typically, cottage industry will provide an interior family with enough coffee, sugar and approximately two meters of cloth per person per year.

As in the Andes, not every village will have a cottage industry, but, within a region, one can find the entire spectrum of necessary cottage industry goods. In many small villages, there will be only one industry which is based on either the geography of the village or the available raw materials. Eventually, all the products will make their way to one marketplace.

Basically, Brazilian goods are produced for local and regional markets. Those produced for only local consumption are usually seasonal goods or a part-time occupation. Most Brazilian cottage industry goods are produced for sale in the formal economic sector by persons engaged full-time in that industry. Even for a housewife, it is not uncommon to see household chores turned over to the children and the mother working full-time at a trade such as pottery-making or embroidery. It has been found that communities which have a strong base in cottage industry have a greater ability to economically survive natural disasters, such as drought. This can be seen, especially, in the very dry regions of Northeastern Brazil.

There is a tremendous amount of internal commerce in Brazil. Goods produced in the interior of Northeast Brazil will flow into a large marketing network and, through informal channels, end up in the large marketplaces of São Paulo and Rio de Janeiro. Internal trade is an important factor in the narrowing of income disparity between the interior and urban sectors. It also provides an educational awareness of urban lifestyle to the interior population. That is, they have an understanding of electricity, mechanical equipment, communication and transportation equipment and sanitary facilities. Most Brazilians that own mechanical equipment such as generators, trucks or bandsaws have little trouble maintaining and repairing it. The biggest problem in the interior is obtaining spare parts, especially goods which are imported and have import quotas.

Evidence of the interior Brazilians' ingenuity can be seen in their use of scrap material in cottage industries. Frequently, the scrap material will have been generated by a highly energy intensive process, but the interior craftsperson uses little or no electricity in recycling the material into a useful product. For example, cutlery is made from used files and rasps, gun barrels are fashioned from used car axles and old tires provide rubber for planters and insect guards.

The primary source of energy for cottage industry is wood and charcoal. Ceramics and pottery use both wood and charcoal, but brickmaking, limemaking, bakeries and food processing primarily use wood. Bakeries are an extremely important industry since they produce the daily staple, french bread. Food industries use wood to make farina, guava paste, banana paste and for processing crude sugar and dried fruits. Wood is very expensive and not too readily available, especially in Northeast Brazil.

Animal traction is another important energy source for transporting raw materials and finished products and running grinding mills for rice and sugar production. Coconut shell is frequently burned for ceramic-making instead of the usual wood or charcoal.

Diesel generators are used extensively in Brazil, but mainly in major cities as backup to the grid. There are some places in Brazil where an entire town will be electrified by diesel. The population of such a town would range between 1,000 and 3,000 people. More frequently, only parts of a town will have grid-connected electricity while the rest uses diesel generators. Many times the only use made of the diesel generator is to run the loudspeaker. In Brazil, every town has a loudspeaker which broadcasts music, news and political rhetoric. The loudspeaker operates continuously, all day, every day.

Agricultural applications of diesel generators are usually seen on large farms and ranches owned by the upper class. These people may live on their farms a large part of the time and desire the same electrical conveniences as in the city. Diesels are also used for processing cacao, coffee and Brazil nuts. Occasionally, diesel will be used for cottage industry when a sharecropper can draw off the estate's generator to run a small appliance, such as a grinder.

The Brazilian government recognizes the economic importance of cottage industry and actively supports its development. The government is, characteristically, a long-term planner, and beginning with a study done in 1958, several assistance programs have been set up specifically to help "micro" industries. These programs are not only government sponsored, but private projects and mixed government and private programs also exist. The government also has a consistent cooperative program for rural areas which focuses on forming legal business entities. At present, there are approximately sixty of these co-ops in Northeastern Brazil.

The Bank of Brazil slates 70% of its loanable funds to be consistent with government policy for national priority programs. Development of small and artisan industry would be among those priorities. Priority programs are reviewed and changed annually. Last year there were 65 programs for which the bank established 22 different rates. Special rates are given to small and artisan industries and very special rates are given to the North and Northeastern Regions. Small and artisan industries are defined based on their sales volume in cruzieros or rather, standard capital units. Standard capital units are adjusted monthly to reflect inflation. Rates for agriculture are based on yield of crop per land area, stressing the importance of productivity in Brazil Regardless of the special rate given to interior development, inflation is running at 100% and the bank is allowed only 15% loan expansion per year. Hence, money is very expensive and very tight with little or no opportunity for the small borrower.

2.2.3 Central America and the Caribbean

Central America and the Caribbean are comprised of middle income countries which earn the majority of their Gross Domestic Product in services. Haiti is the one notable exception, being a low-income country and an agrarian economy. Cottage industry is not highly visible in the formal economy, but it is important to the informal economy.

The populations of Central American countries are largely indigenous. Hence, the processes they use for cottage industry and their products are traditional and culturally oriented. Many of the designs and patterns used will tell a story or signify who the designer is. Styles of clothing produced also reflect the culture of the people. Weaving and rush reed products are the most predominant industries, but pottery and wood-working are also significant.

As in many other countries, most small businessmen lack skills in management. Inefficient use of production time and poor shop layout are common problems. Production is on a small-scale level, employing four to five persons. Since most cottage industries are family shops and produce individually, productivity is not high. Another result is that cottage industry products lack standardization, especially in clothing production.

Because of the deep seeded culture and tradition of their products, Central Americans are slow to alter their methods and adapt to changing markets.

Caribbean cottage industry is somewhat unique because of their geographic location. Raw materials are scarce and most of the islands lack the indigenous cultures of Central America. Some goods are produced for tourists, but most production is for local markets.

Another problem in both Central America and the Caribbean is the monetary structure which, in many cases, is tied to the U.S. dollar. Even though the producer is earning a low income in his economy, he is not cost competitive with Asian-produced goods. One example can be seen in the Dominican Republic. In the early 1970's, a commercial intermediary organized 250 cottage industries together to produce braided rush reed mats and rugs. The product was a copy of one produced in the Philippines and was intended for sale in the international market.

The Caribbean product was more expensive than the Philippine, but of superior quality. At that time, the Chinese entered the market with an equal product at a lower price. The Philippines quickly adapted and met the competition, but the Caribbean produced product was soon squeezed out of the market.

Energy is a major problem for Central America and the Caribbean. Trinidad and Tobago is an exception. It is a net oil exporter with significant potential for further exploration. The remaining countries, however, import over 75% of their oil for commercial demand. Even Guatemala, which is an oil producer, must import over 75% to meet its commercial demand.

The primary energy source for cottage industry is wood and charcoal. However, wood is in rapidly diminishing supply not only as a fuel source, but as a raw material for cottage industry production. Haiti already has a serious deforestation problem and by the year 2000, Honduras and El Salvador will also.

Several organizations are investigating the feasibility of renewable energy sources throughout Central America and the Caribbean. Solar cookers, biogas, wind and solar dryers appear to be the most promising. Biogas systems are emerging as a potential energy source for rural industry. Regardless of the technology, experience shows that a tremendous amount of technical assistance and training is necessary to implement a new process. Energy systems will certainly be no exception.

2.2.4 Mexico

Mexico is a rapidly developing country experiencing tremendous economic growth. Fifty-seven percent of the labor force is engaged either in services or in industry other than manufacturing. Another 8.8% is engaged in manufacturing and 34% is in agriculture. Overpopulation, urban migration and unemployment are major problems. The population is 66 million with an average annual growth rate of 2.8% and an urban migration rate of 4.5%. In 1980, 33% of the population was rural compared to 49% in 1960. A rural community is one having less than 10,000 people. Officially, 10% of the labor force is unemployed, but an estimated 45% have no regular jobs.[1]

The industrial sector is well developed in all stages of large-scale, medium-scale, small-scale and artisan enterprises.

(1) "Survey: Mexico," World Business Weekly, 29 June 1981, p. 29.

Rural Mexican cottage industry would fall under the category of small-scale and artisan enterprises. Small-scale industries are those which employ less than 25 people and have a net worth of 50,000 to 7 million pesos (U.S. $2,173 to $300,000).[1] Artisan enterprises are those which employ five to six people and have a net worth of less than 50,000 pesos (U.S.$2,173). There are over 41,000 registered artisans and nearly 70,000 small businesses.

According to the National Fund for Handicraft Promotion (FONART), an estimated 1.2 million heads of households are engaged in full-time cottage industries and employ an average of five workers per establishment. This gives a total of six million people employed in cottage industry, or nearly 10% of the total population. However, the majority of workers participate on a part-time or seasonal basis. This is especially true for women, who work at cottage industry production between household activities.

Cottage industries are either culturally oriented or based on available raw materials. Industries which are culturally oriented produce festival and ceremonial accessories. Usually, one village will produce goods for the entire region. A village having a festival products industry would make musical instruments, fireworks, ex-votive offerings, piñatas and similar products. A village engaged in making ceremonial accessories would produce masks, canes, dolls and items used in folk dances. Religious and folk festivals are considered a social and cultural obligation and purchases for such events are frequently the single largest expenditure a family will make at any given time over the year.

Most cottage industries are based on the raw materials available within the region. In Mexico, these include clay, basic minerals, animal fibers, vegetable fibers, wood and, to a lesser extent, metals. The major industries that are raw material based include lumbering, pottery, copper forging, silversmithing, furniture making, fishmeal production, grain milling, tanning and tilemaking. Rural bakeries are not as important in Mexico as in the Andes and Brazil since the people eat tortillas which they usually bake themselves.

---

(1) Based on 23 pesos per dollar.

The use of many raw materials is controlled by the government and, as in the Andes, there are quite a few illegal cottage industries. The authorities tolerate this to some extent as long as the effect is negligible.

The goods produced by Mexican cottage industries are primarily utilitarian and produced for local and regional consumers. Products made by potters include vessels for storing food and water for cooking and tableware. Weaving industries use wool primarily and produce clothing and blankets. Basket industries produce mats, ornaments, straw figures, hats and, more importantly, shelter construction and baskets for harvesting, transporting and storing field crops. Woodworking is an important industry. Its products include spoons, scoops, tools, ox yokes, handles, bowls, crates, statuary, furniture and carpentry products, such as doors and window frames. Grinding mills are a basic utilitarian industry. They produce mainly cornmeal and fishmeal.

Simple and utilitarian goods are made in the rural sector for local and regional purchases. A rural cottage industry region is usually found around a moderately sized city which will have a large central popular market. Examples can be seen in cities such as Uruapan, Morelia, Quiroga, Patzcuaro and Oaxaca. The central city market is an important trading and distribution center. It serves not only as an outlet for rural products, but also as a source of urban produced supplies. The principal products being supplied to the rural region are those made by blacksmiths, tanneries and confection industries. They include products such as metal spurs, stirrups and bits, hardware, leather shoe stirrups, machetes, rope, saddles and drygoods.

Mexico has an unique system of production in which there is a chain of value adding processes from village to village. This can best be understood through an example. A copper pitcher may have its origin in a very remote village. Originally it is a piece of barely formed metal which is sold to another village. The metal workers there will pound it out into a normal spouted shape. It is then sold to another village closer to the city where it is polished and cleaned. It will then go to an urban or fringe-urban artisan who adds a handle and sells it in the central market. A similar case can be seen in furniture. Rurally produced chairs are very crude, but they are channeled from village to village with each place adding more detail until finally a well-crafted product reaches the urban market. This system is quite unique. Frequently, the entire cottage industry sector of a village will specialize in that village's phase of production.

The typical rural cottage industry will either be in the home or in a small shop. The owner is the manager and usually the principal worker. The establishment is a sole proprietorship. Common production facilities are not shared. The production facility is usually rudimentary and serves only as basic shelter. Characteristically, the shop layout is very inefficient and the comfort and safety of the workers are seldom considered.

Few, if any, production needs, such as tools, are purchased outside the community. Rural cottage industry production is cyclic in direct relation with the agricultural cycle and the seasonal availablity of raw materials is an important consideration for the rural entrepreneur.

The technology of production in rural Mexico is traditional, with many of the processes used dating back to Pre-Colonial times. As in many other parts of Latin America, the technology of the processes used tends to be introduced rather than evolved.

The origin of Mexican cottage industry processes falls into three groups. The first is the pure Indian craftsman who uses the same techniques as did his or her Aztec ancestors as in Chiapas. The second group uses those processes which were introduced by Spanish guilds when feudal land systems flourished as in Puebla. The third group is those settled and developed by the clergy. These regions tend to have strong cottage sectors and the artisans of these regions tend to be more entrepreneurial. Evidence of this can be seen in the region of Michoacán where the techniques used today were introduced by Bishop Don Vasco de Quiroga.

The family unit is very important to the rural Mexican and contributes to the preservation of traditional processes. Unfortunately, it also serves as a barrier to new technology. The skills of a craft are handed down from father to son, mother to daughter. Occasionally, a new producer will learn his or her craft through an extended family member, such as a cousin or uncle.

Other social factors could also be a barrier to new technology as in the distinction between male and female tasks. For example, pottery in one village may be a male occupation and in another, female. However, men and women would not be potters in the same village. Weaving is done by both men and women, but both do not use the same technique. Women use the tedious backstrap loom, while the more comfortable and efficient colonial upright loom is strictly used by men only.

As in other Latin American countries, although it is meager, cottage industry is frequently the sole source of income to the producer. The majority of cottage industries are non-registered, informal businesses that have no legal identity. The average assets of a rural cottage industry range between 2,000 and 3,000 U.S. dollars and all earnings are viewed as personal income. The workers are usually members of the family and are seldom paid. The primary objective of the rural producer is not necessarily to increase his income, but to provide employment for as many members of his family as possible.

According to 1977 estimates, in villages with populations of less than 2,500, less than 21% of households had a total family income which equalled the minimum wage of 123 pesos per day (U.S. $5.35). Furthermore, 45% of the households derived, from all sources, a total income below one-half of the minimum wage or 61.5 pesos (U.S. $2.67).[1]

There is no hard, reliable data on the exact income derived from cottage industry, but, at full employment levels, a typical producer earns an estimated 25 to 50 pesos per day or 1 to 2 U.S. dollars. The highly productive industries served by FONART earn a family income of 450 to 1500 pesos per month or 1 to 3 U.S. dollars per day. However, the average for the total rural sector would be much lower and, lower still, in highly remote regions.

Opportunities for financing rural cottage industry are extremely limited. Options include commercial banks, FOGAIN (Fund for the Guaranty and Development of Small and Medium Industry), a patron, the Rural Development Bank, a cooperative purchase and the Fund for Artisans (FONART). Commercial banks and FOGAIN will work only with registered businesses, which most cottage industries are not. Short-term commercial loans are for up to one year at 30% annual interest. Long-term loans are for seven to eight years with a fluctuating interest rate. The current rate is 32%. The Rural Development Bank finances only government sponsored projects and the Fund for Artisans has very little money. The most feasible alternative for the rural producer is to find a wealthy patron or for several families to purchase capital equipment together. A cooperative purchase would not favor photovoltaics. It would be more reasonable to purchase a large generator system and have several industries utilize it simultaneously.

---

(1) Source: Ministry of Programming and Budget, Mexico

2.3 Morocco

Morocco's cottage industry sector is one of the oldest and most established in the world. It offers two broad categories of products. The first is handicrafts and the second is utilitarian products. Handicrafts primarily serve the tourist trade and export markets. Utilitarian goods serve domestic consumption both at or near the production site as well as in other regions of the country.

Traditionally, Morocco has had an established reputation as a tourist attraction and source for quality handicraft products. These products include primarily rugs, baskets, blankets, robes, pottery, leather goods, and metal-ware. Handicrafts are tied closely to the cultural and artistic heritage of the population, with its strong Arabic and Berber influence.

Production of handicrafts is divided between the urban and rural sectors. Handicraft production in Morocco is highly concentrated and found principally in the urban centers. The urban sector has ready access to export market distribution, and a greater tendency to adopt equipment which will increase production. The rural sector for handicraft production is, to a greater extent a part-time, seasonal occupation for agricultural workers. Also, in the rural sector, there is a greater dependence on traditional community open markets for selling products.

Both the urban and rural handicraft operations are more likely to be characterized by full production of a product at one site. There is still a greater emphasis on traditional, hand production processes using simple tools as opposed to use of modern tools and automation. The government recognizes the importance to the tourist and export trade of maintaining high quality in its handicraft products. It encourages training programs which combine the best of hand craftmanship with tools that offer greater life and utility. The supply of handicraft products, particularly in the rural areas, is quite readily able to serve demand. Thus, there is little incentive to substantially increase production.

Those employed in the handicraft sector are generally less educated and have lower standards of living than those employed in other sectors, particularly in the urban areas. Each handicraft occupation position represents an average $1,000 of annual income. Women and men both participate in making handicrafts, though women appear to play a greater role in the carpet making field. Selling in the marketplace is strictly male.

Utilitarian products also represent a significant portion of the cottage industry sector. For the most part, they serve the agriculture sector and, to some extent, other urban-based sectors of the economy. Primary utilitarian products are foodstuffs, textiles, metal, and leather. The major food groups indigenous to Morocco which are processed and consumed locally include grain, citrus fruits, and vegetables.

Cottage industries which serve the tourist trade have traditionally received the attention and support of the government. However, in the rural sector there are no agencies for special development and extension services are very weak.

Cottage industry growth is tied inextricably to the agrarian economy of most of the rural population. In poorer (generally less irrigated) agriculture regions the economic growth is noticeably less than in more productive regions. Handicraft production is less dependent on local economies than it is on tourist volume.

Only slightly greater than 10% of the rural areas are electrified, representing approximately 6% of the population. Much of the rural power needs are met by strategically located diesel generators that serve one or more communities. For the most part, cottage industries utilize little energy. The primary use is in lighting; and secondary uses consist of powering saws and other basic implements.

2.4 The Philippines

The Philippines is a capital-poor country with no high value export such as oil or gold. Fifty-two percent of the population is of employable age (15-64) and 83% of the people over age ten are literate. The country is said to have one of the most literate and skillful populations in Southeast Asia. Ironically, for the most part, labor force is underemployed.

Industrial activity in the Philippines can be broken down into four basic categories. These categories are Large Scale Industry (LSI), Medium Scale Industry (MSI), Small Scale Industry (SSI), and Cottage Industry (CI). The criteria used by the Philippine government to place an establishment in one of these categories is shown in Exhibit 2 . For the purpose of this study, the establishments of most interest are those classified as Cottage industries and those at the lower end of the SSI category.

In 1975, it was estimated that there were 71,084 SSI establishments and 7,698 CI establishments. These establishments accounted for 98.6% of the industrial establishments officially registered with the Philippine government. Experts feel that the real number of cottage and small industries is much larger than that registered. It should also be noted that 68,738 of the SSI establishments were in the smallest sub-sector, 5-19 workers.

While accounting for 98.6% of the industrial establishments, SSI and CI account for less than 50% of the industrial employment, less than 25% of the total industrial production. The general tendency is for productivity and wages to decline with decreasing scale. The reasons given for this are many, but generally tend to be under capitalization and poor management.

The goods typically produced by the cottage and small scale industry in the Philippines tend to have a high labor content, are relatively abundant, and have a wide variance in quality. As a result, the producers and distributors of these goods are finding increasingly stiff competition in both the international and domestic marketplace competing against other developing countries and newly industrialized countries.

INDUSTRIAL CLASSIFICATION IN THE PHILIPPINES

CRITERIA

Category	Type of Activity	Organization	Capital Assets	Employees
Large Scale Industry	-manufacturing and service -capital intensive	-specialized and complex line management	> $540,000	≥ 200
Medium Scale Industry	-manufacturing and service	-specialized staff in line management	$135,000-$540,000	100 - 199
Small Scale Industry	-manufacturing and service	-owners-managers not engaged in production	$ 13,500-$135,000	5 - 99
Cottage Industry	-manufacturing and service	-carried on in home for profit -owner manager participates in production -employees are usually family members	< $13,500	< 5

Exhibit 2

In recent years the increase in the price of oil has caused havoc in the Philippine Economy. Prior to 1977, over 90% of the energy used in the Philippines was supplied by imported oil. Unable to diversify to other energy sources, the Philippines was forced to import increasing quantities of oil at increasing prices. At the same time, the country was experiencing a decline in prices for its commodity exports such as copper, sugar, and coconut. This was an experience similar to many other developing countries. Fortunately, the country is largely self-sufficient in food.

This "energy crisis" and the resulting deficits in the country's current and trade accounts, for the most part shape the country's current development plans and energy plans. In capsule form these plans are:

Industrial Development Plan - The government encourages and supports investments and industries which will employ large numbers of people, earn foreign exchange, reduce the need for imports, and not disrupt the domestic markets. The government welcomes and encourages foreign investment which will support these goals, and it is pursuing its own programs such as the development of a copper smelter, aluminum smelter, etc., which will change and improve the industrial base of the country.

Energy Program - The government is pursuing a very aggressive program that will reduce imported oil to 50% of the energy demand of the Philippines by 1985. This will largely be done by diversifying to other sources of energy such as geothermal and hydroelectric and by developing the country's reserves of oil and coal.

The Philippine government recognizes and is well aware of the close dependence between industrial development and energy consumption. For this reason, the government is trying to electrify the country by 1985. The aim of this electrification program is fourfold:

1. Provide infrastructure in rural areas which will encourage industrial development and lead to the growth of employment opportunities.

2. Enhance the well being of the people in rural areas.

3. Reduce the migration to the overpopulated urban areas by improving employment opportunities and the quality of life in the rural areas.

4. Distribute the benefits of geothermal and hydroelectric power to other areas of the country and reduce their use of oil for electric power generation.

Obviously, the country has a very complete and comprehensive development program and strategy. This program will take time and there will be occasional setbacks, such as blackouts.

It can be seen that the role and emphasis on cottage and small scale industries in this plan is low. The reasons should be rather obvious. By their very nature, cottage and small scale industries tend to have low capital requirements. This, combined with the small impact that they could have on the under-employment and trade deficits of the country are the reasons why the government has left the development of the cottage and small scale industry sector to the guiles of the small entrepreneur. It is felt that this sector does not need the direct resources and attention of the government as much as other areas.

For human and social reasons, the government has not totally ignored this area, and there are sections of the government specifically established to aid and assist small scale and cottage industries. The emphasis and funding of these governmental agencies is low and they do not do much more than assist in establishing marketing channels and providing some technology transfers. These services, however, are second rate compared to those offered by some of the private, profit motivated distributors of cottage industry and small scale industrial goods.

It is felt that cottage industry and small scale industry goods have the value they have and receive the tariff free treatment they do from other countries because of their handmade nature. As a result, no technological improvements or introductions will be made into the process which will affect the hand finishing. As a result, improvements will only be allowed and encouraged in the pre-processing steps. These steps such as the processing of logs or the mixing of clay are possible applications for stand-alone photovoltaic systems.

The Philippine enterpreneur is a highly motivated, creative, and innovative individual. This is a skill that is honed from years of coping with scarcity. He must make tools and equipment function and operate when most others would discard them. However, he is a highly risk adverse individual not willing to try new products or processes because their failure could severely impact both him and his family. Therefore, he is almost forced to stick to tried and proven methods and procedures. As a result, while he is able to keep a small motor running well beyond its normal life, in operations beyond its original design, he may not be anxious to try a new power source.

It is this environment with which photovoltaic energy systems will have to compete, both on a performance and economic basis, with other sources of power. These could include animal and human power, gasoline and diesel driven power, and grid supplied electricity. The government has explicitly said that it does not feel that photovoltaic systems are competitive with these other systems now, nor do they feel that they are as close to competitiveness as other sources of power such as biomass and dendro thermal. For this reason, and because of the high risks involved in the development of photovoltaics, the government has left their development to the private sector.

With no government assistance, photovoltaics must compete with the government's electrification program and with well established maintenance and distribution channels for diesel and gasoline driven engines. This, combined with the large initial up-front cost in a country where capital is scarce are formidable obstacles for photovoltaics to overcome in the Philippines.

3. THE "POTENTIAL" MARKET FOR SMALL, DECENTRALIZED ELECTRIC POWER SOURCES IN COTTAGE INDUSTRY APPLICATIONS

The "potential" market is a theoretical estimate of the gross demand for small-scale decentralized sources of electric power for rural cottage industry applications in non-industrialized countries, with non-centrally planned economies.

To estimate the "potential" market for stand-alone photovoltaic systems, it was assumed that the rural population of the non-industrialized, non-centrally planned countries desired electrical power and could afford it. The value assessment of stand-alone photovoltaic systems was studied separately from the "potential" market. As illustrated in Exhibit 3 the "potential" market for small, decentralized power sources in rural cottage industry applications is estimated to be 70,000 MW. To arrive at this estimate, 14 countries were studied in detail, and the results from these countries were used to characterize the market in the non-industrialized, non-centrally planned world. The 14 countries studied are shown in Exhibit 4.

Given these 14 countries, the rural industrial employment in fundamental industries as a percent of total rural industrial employment was estimated for each country. These estimates are shown in Exhibit 5.

The industries chosen as fundamental were considered as such because the 32 typical cottage industries given in Exhibit 6 would be classified under these industrial classes using Standard Industrial Classification (SIC) codes. It can be seen that the cottage industries listed in Exhibit 6 and the fundamental industries listed in Exhibit 5 are basic to everyday life. It was therefore assumed that employment proportions for these industries in the total country could be applied to the rural areas. There are possibly some variations due to the differences in the scale of industry and location of raw materials for fundamental industrial employment for the total country compared to rural areas, but these are probably minor.

The total rural industrial employment was estimated based on the percent of population that is rural, the percent which is of employable age and the percent employed in agriculture, industry and services. The rural industrial employment as a percent of rural population was then determined.

POTENTIAL MARKET FOR PHOTOVOLTAIC SYSTEMS IN COTTAGE INDUSTRY APPLICATIONS

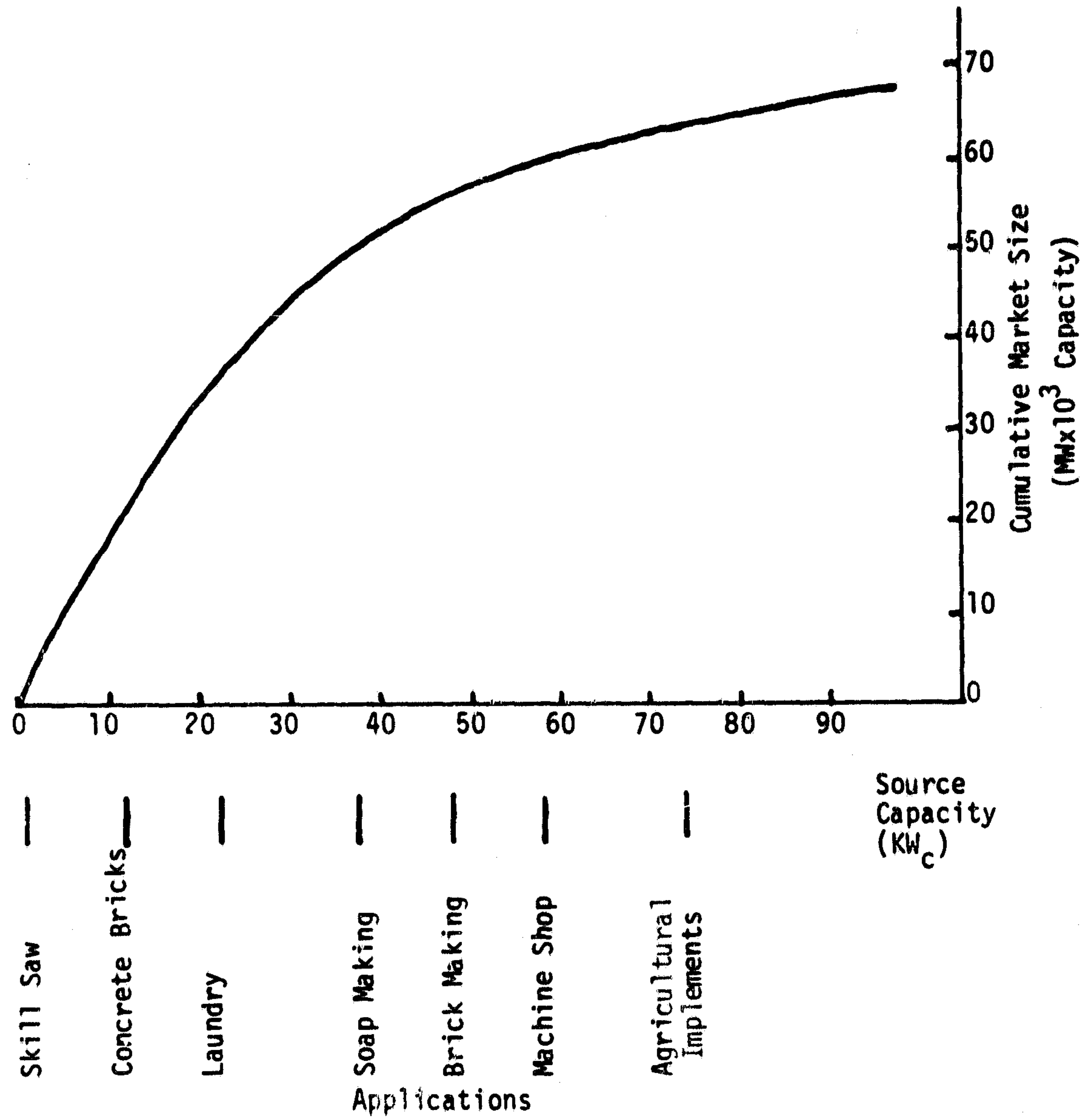


Exhibit 3

COUNTRIES STUDIED IN DETAIL

Central & South America

Argentina

Mexico

Brazil

Mediterranean & Middle East

Egypt

Spain

Greece

Morocco

Sub - Sahara Africa

Kenya

Cameroon

Nigeria

Southeast Asia

India

Korea, Rep. of

Philippines

Malaysia

Exhibit 4

EMPLOYMENT IN FUNDAMENTAL INDUSTRIES AS A PERCENT OF TOTAL RURAL INDUSTRIAL EMPLOYMENT

Fundamental Industry	COUNTRY Philippines	Korea	Spain	Egypt	Greece	India	Nigeria	Kenya	Malaysia	Average
Food Processing	34.15	11.83	20.09	23.20	26.50	34.88	17.33	50.49	22.46	26.77
Spinning	14.70	28.85	-	50.02	18.60	21.70	36.80	9.01	9.96	21.07
Wearing Apparel	9.87	22.00	9.22	1.76	10.40	1.71	9.87	5.00	7.10	7.54
Leather	0.72	3.05	2.43	1.05	2.38	1.35	1.34	1.69	0.42	1.60
Footwear	1.89	1.55	5.39	1.50	3.83	0.28	3.34	1.69	0.97	2.27
Wood	13.63	5.48	3.57	1.15	6.24	7.42	7.66	10.10	29.37	9.41
Furniture	3.45	1.05	14.00	1.05	4.73	0.72	4.33	1.96	2.97	3.81
Printing	4.65	3.98	6.43	3.49	4.44	7.96	7.05	4.56	9.84	5.82
Other Chemicals	6.83	5.11	6.78	6.32	5.45	6.48	7.21	4.60	4.33	5.90
Pottery	0.68	0.94	5.39	0.52	1.69	0.85	0.24	0.63	0.74	1.30
Glass	2.18	1.50	2.87	2.40	1.09	1.02	0.34	0.63	1.14	1.46
Metal	5.56	6.47	22.5	7.08	12.5	12.70	12.10	8.42	9.37	10.75
Other Industries	1.72	8.21	1.3	0.46	2.10	2.94	1.33	1.24	1.34	2.29
	100.04	100.02	99.97	100.00	99.95	100.01	99.94	100.02	100.01	99.99

Exhibit 5

SUMMARY
COTTAGE INDUSTRIES AND ENERGY INTENSITIES

Cottage Industry	Annual Output Energy Intensity	Employee Energy Intensity*
Agricultural Handtools	.811 kwh/tool	5964.7 kwh
Agricultural Implements	86.20 kwh/unit produced	4310 kwh
Bakery, Example One	--	5908 kwh
Bakery, Example Two	1.5 kwh/gallon dough	1046.4 kwh
Barrel Making	.621 kwh/barrel	5642.4 kwh
Blacksmithing	--	1040 kwh
Brick-Making, Example One	.053 kwh/brick	4170.12 kwh
Brick-Making, Example Two	--	--
Broom Making	.155 kwh/broom	2327.5 kwh
Button Making	1.03 kwh/gross	4310 kwh
Canning	.023 kwh/lb. of food	--
Charcoal Production	27.79 kwh/metric ton	--
Concrete Blocks	.047 kwh/block	2586 kwh
Crate & Basket Making	.155 kwh/unit	2216.7 kwh
Electrical Repair Shop	--	846 kwh
Foundry	68.69 kwh/ton	--
Ice Making	164 kwh/ton	9811 kwh
Jute Yarn	617 kwh/MT	4849 kwh
Laundry	.165 kwh lb/laundry	5817.5 kwh
Leather Tanning	0.0104 kwh/square feet	--
Lumbering	.067 kwh/board foot	22,413 kwh
Job Machine Shop	--	13,488 kwh
Machine Shop, Example Two	--	--
Porcelain Making	3.72 kwh/piece	3209.96 kwh
Pottery Making	525.31 kwh/ton	--
Sea Salt	.621 kwh/ton	775.82 kwh
Small Print Shop	--	2714 kwh
Shoe Making	3.1 kwh/pair of shoes	3166.69 kwh
Shoe Repair	--	873 kwh
Soap Making, Example One	.6 kwh/kg.	--
Soap Making, Example Two	.571 kwh/kg.	3526.5 kwh
Spinning - Cotton Yarn	.238 kwh/kg. of yarn	--
Spinning - Example Two	0.18 kwh/lb., cotton	4235.6 kwh
Tailoring	--	2542 kwh
Weaving - Cotton Cloth	.094 kwh/meter, cloth	3539 kwh
Woodshop	--	956.8 kwh

*Given for employee-years

Exhibit 6

Given the rural industrial employment as a percent of rural population and the employment breakdown in the fundamental industries for the 14 countries, the results were averaged and applied to the total non-industrialized, non-centrally planned world.

The rural population of the non-industrial, non-centrally planned world is determined to be 1,498.9 million people. Approximately 56% of these people or 839.38 million are of employable age (15-64 years) and 67.8 million are estimated to be employed in industry. Thus rural industrial employment represents 4.5% of the rural population or 8.1% of the rural labor force. Applying the breakdown by fundamental industries given in Exhibit 5, these 67.8 million rural industrial workers are estimated to be employed in the 13 fundamental industries as shown in Exhibit 7.

Having established the cottage industry employment by fundamental industry given in Exhibit 7, the energy consumption data for the 32 typical cottage industries was used to arrive at an energy usage estimate. Using SIC codes the 32 cottage industries were placed under the appropriate fundamental industry and the average energy consumption by employee and the average load for the industry was found. This data is shown in Exhibit 8. The energy consumption per employee was multipled by the number of employees in that industry to arrive at the energy consumption by fundamental industries given in Exhibit 9.

Since the energy consumption figures shown in Exhibit 8 are based on an 8-hour 260-day work year, the energy consumption figures given in Exhibit 9 can be converted to a power consumption by dividing by (8 x 260) hrs/yr. The power that is estimated to be consumed by cottage industry by various fundamental industrial class is shown in Exhibit 10.

The figures presented in Exhibit 10 assume that all cottage industries are similar to the 32 described in Exhibit 6 and that they all have the same work cycle scale of economy, and efficiencies as those listed in Exhibit 6.

RURAL INDUSTRIAL EMPLOYMENT IN THE NON-INDUSTRIALIZED, NON-CENTRALLY PLANNED WORLD BY FUNDAMENTAL INDUSTRY

Fundamental Industry		Employment (Millions)
Food Processing		18.11
Spinning		14.27
Wearing Apparel		5.11
Leather		1.08
Footwear		1.54
Wood		6.38
Furniture		2.58
Printing		3.94
Other Chemical		4.00
Pottery		0.88
Glass		0.99
Metal		7.28
Other Industry		1.55
	Total Employment	67.75

Exhibit 7

ENERGY CONSUMPTION PER EMPLOYEE AND ESTABLISHMENT
LOADS BY FUNDAMENTAL INDUSTRY

Fundamental Industry	Energy Consumption per Employee (KWH/yr)	Electric Load Requirements of An Average Establishment (KW)
Food Processing	5588.5	5.5, 37.5(1)
Spinning	4207.9	20.2
Wearing Apparel	3426	23.2
Leather	1747.2	17.5
Footwear	2019.9	74.6
Wood	3929.6	97.0
Furniture	957	4.6
Printing	2714	1.6
Other Chemical	3526.5	37.4
Pottery	3322	48.5
Glass	3322	75.4
Metal	6200	2.0, 56.0(1)
Other Industry	1587	29.8

Exhibit 8

(1) These industries can have two types of operations.
One is very simple requiring very low loads of electric power (5.5 KW and 2.0 KW)
The other is more sophisticated in terms of electric power usage.

RURAL INDUSTRIAL ENERGY CONSUMPTION BY FUNDAMENTAL INDUSTRY

Fundamental Industry		Energy Consumption (KWH/year) x 10^6
Food Processing		101,375.4
Spinning		60,046.7
Wearing Apparel		17,506.9
Leather		1,887.0
Footwear		3,110.7
Wood		25,070.9
Furniture		2,469.1
Printing		10,693.2
Other Chemical		14,106.0
Pottery		2,923.4
Glass		3,288.8
Metal		45,136.0
Other Industry		2,459.9
	Total*	290,073.7

Exhibit 9

* The per capita electrical energy consumption in the U.S. was 10,060 KWH/year in 1978. So the energy that could be consumed by rural industry in non-industrial, non-centrally planned countries is about the same as the energy consumed by 13% of the U.S. population.

RURAL INDUSTRIAL POWER
BY FUNDAMENTAL INDUSTRY

Fundamental Industry	Power Consumption (MW)
Food Processing	48,738
Spinning	28,869
Wearing Apparel	8,417
Leather	907
Footwear	1,496
Wood	12,053
Furniture	1,187
Printing	5,141
Other Chemical	6,782
Pottery	1,405
Glass	1,581
Metal	21,700
Other Industry	1,183
TOTAL:	139,459

Exhibit 10

The power consumption figures by industry given in Exhibit 10 were divided by two to account for cases where the rural area is electrified or about to be electrified by an electrical grid, other forms of electrical power such as hydro or wind might be more appropriate, or there is not enough solar insolation to permit the consideration of photovoltaics. The remaining market was assumed to be the market for either photovoltaics or diesel driven generators.

Given the "potential" market for photovoltaic systems or diesel generators by fundamental industry (Exhibit 10) and the typical power requirement for an establishment within that industry (Exhibit 8), the cumulative "potential" market as a function of source capacity was found. This was shown in Exhibit 3. From Exhibit 3, it can be seen that the total market for power sources below 40 KW of capacity is 52,000 MW. Implicit within this "potential" market estimate is the assumption that manufacturers do not form cooperatives to buy power capacity beyond the capacity being considered. For example, two users of 30 KWs each could cooperate and buy a 60 KW system, however the market estimate presented assumes that each buys a 30 KW system if the market for 40 KW and less systems is being considered. On the other hand, two users of 20 KW who cooperate to buy a 40 KW system would be included within the 40 KW and less market estimate.

Placing these estimates in perspective, 140,000 MW (the total power consumption of rural industry) for 67.8 million employees suggests that the average rural industrial consumption per employee is 2,065 watts for his immediate tools and support services. As a basis of comparison, the typical power and energy requirements for appliances and equipment are shown in Exhibit 11. From this information, it appears that the estimates previously developed are reasonable.

Exhibit 11

POWER AND ENERGY REQUIREMENTS OF HOUSEHOLD APPLIANCES AND FARM EQUIPMENT IN COMMON USE

IN THE HOUSE

	Watts	Hrs/MO	kWHRS/MO
Air conditioning, central	-	-	620*
Air conditioning, window	1566	74	116*
Blanket	50-200		15
Blender	350	3	1
Broiler	1436	6	8.5
Clock	1-10		1.4*t
Clothes dryer, electric	4600	20	92*t
Clothes dryer, gas heat	325	18	6*t
Clothes washer, automatic	512	17.3	9*
Coffee maker	800	15	12
Coffee percolator	300-600		3-10
Cooling, attic fan	1/6-3/4HP		60-90*t
Cooling, refrigerator	3/4-1-1½ ton		200-500*
Corn popper	460-650		1
Dehumidifier	300-500		50*
Dishwasher	1200	30	36*
Disposal	375	2	1*
Electric baseboard heat	10,000	160	1600
Electronic oven	3000-7000		100*t
Fan, attic	370	65	24*t
Fan, kitchen	250	30	8*t
Food blender	200-300		1/2
Food warming tray	350	20	7
Floor polisher	200-400	8	1
Freezer, food, 5-30 cu ft	300-800		30-125*
Freezer, frost free	440	180	57*
Fryer, cooker	1000-1500		5
Frying pan	1196	12	15
Furnace, electric control	10-30		10*
Furnace, oil burner	100-300		25-40*
Furnace, blower	500-700		25-100*t
Furnace, stoker	250-600		3-60*t
Griddle	450-1000		5
Grill	650-1300		5
Hair drier	200-1200		1/2-6*
Heat lamp	125-250		2
Heater, portable	660-2000		15-30
Heating pad	25-150		1
Hi-Fi Stereo			9*
Hot plate	500-1650		7-30
House heating	8000-15000		1000-2500
Humidifier	500		5-15*
Iron	1100	12	13
Knife sharpener	125		1/8*
Lawnmower	1000	8	8*t
Lights, 6-room house in winter			60
Light bulb, 75	75	120	9
Light bulb, 40	40	120	4.8
Mixer	125	6	1
Movie projector	300-1000		
Oil burner	500	100	50*
Oil burner, 1/8 HP	250	64	16*
Polisher	350	6	2
Power tools			3
Pump, water	450	44	20*t
Radio, table	40-100		5-10*
Range	8500-16000		100-150
Record player	75-100		1-5
Record player, transistor	60	50	3*
Recorder, tape	100	10	1*
Refrigerator	200-300		25-30*
Refrigerator-freezer	200	150	30*
Refrigerator-freezer/frost free	360	500	180*
Roaster	1320	30	40
Rotisserie	1400	30	42*
Sauce pan	300-1400		2-10
Sewing machine	30-100		1/2-2
Shaver	12		1/10
Skillet	1000-1350		5-20
Skill saw	1000	6	6
Sunlamp	400	10	4
TV, BW	200	120	24*
TV, color	350	120	42*
Toaster	1150	4	5
Typewriter	30	15	5*
Vacuum cleaner	600	10	6
Vaporizer	200-500		2-5
Waffle iron	550-1300		1-2
Water heater	1200-7000		200-300
Water pump (shallow)	1/2 HP		5-20*t
Water pump (deep)	1/3-1 HP		10-60*t

AT THE BARN

	Capacity HP or Watts	Est. KWh
Barn cleaner	2-5 HP	120/yr*
Clipping	fractional	1/10 per hr
Corn, ear crushing	1-5 HP	5 per ton*t
Corn, ear shelling	¼-2	1 per ton*t
Electric fence	7-10	7 per mo *t
Ensilage blowing	3-5	½ per ton
Feed grinding	1-7½	½-1½ per 100 lbs*t
Feed mixing	½-1	1 per ton*t
Grain cleaning	¼-½	1 per 100 bu*t
Grain drying	1-7½	5-7 per ton*t
Grain elevating	¼-5	4 per 1000 bu*t
Hay curing	3-7½	60 per ton*t
Hay hoisting	½-1	1/3 per ton*t
Milking, portable	¼-½	1½ per cow/mo*t
Milking, pipeline	½-3	2½ per cow/mo*t
Sheep shearing	fractional	1½ per 100 sheep
Silo unloader	2-5 HP	4-8 per ton*
Silage conveyor	1-3 HP	1-4 per ton*
Stock tank heater	200-1500 watts	varies widely
Yard lights	100-500 watts	10 per mo
Ventilation	1/6-1/3 HP	2-6 per day* per 20 cows

IN THE MILKHOUSE

Milk cooling	½-5 HP	1 per 100 lbs milk*
Space heater	1000-3000	800 per year
Ventilating fan	fractional	10-25 per mo*t
Water heater	1000-5000	1 per 4 gal

FOR POULTRY

Automatic feeder	¼-½ HP	10-30 kWh/mo*t
Brooder	200-1000 watts	½-1½ per chick per season
Debeaker	200-500 watts	1 per 3 hrs
Egg cleaning or washing	fractional HP	1 per 2000 eggs*t
Egg cooling	1/6-1 HP	1½ per case*
Night lighting	40-60 watts	10 per mn
Ventilating fan	50-300 watts	1-1½ per day*t per 1000 birds
Water warming	50-700 watts	varies widely

FOR HOGS

Brooding	100-300 watts	35 per brooding period/litter
Ventilating fan	50-300 watts	½-1½ per day*t
Water warming	50-1000 watts	30 per brooding period/litter

FARM SHOP

Air compressor	¼-½ HP	1 per 3 hr*
Arc welding	37½ amp	100 per year*
Battery charging	600-750 watts	2 per battery charge*
Concrete mixing	½-2 HP	1 per cu yd*t
Drill press	1/6-1 HP	½ per hr*t
Fan, 10"	35-55 watts	1 per 20 hr*t
Grinding, emery wheel	¼-1/3 HP	1 per 3 hr*t
Heater, portable	1000-3000 watts	10 per mo
Heater, engine	100-300 watts	1 per 5 hr
Lathe, metal	¼-1 HP	1 per 3 hr
Lathe, wood	¼-1 HP	1 per 3 hr
Sawing, circular 8"-10"	1/3-½ HP	½ per hr
Sawing, jig	¼-1/3 HP	1 per 3 hr
Soldering iron	60-500 watts	1 per 5 hr

MISCELLANEOUS

Farm chore motors	1/2-5	1 per HP per hr
Insect trap	25-40 watt	1/3 per night
Irrigating	1 HP up	1 per HP per hr
Snow melting, sidewalk and steps, heating-cable imbedded in concrete	25 watts per sq ft	2.5 per 100 sq ft per hr
Soil heating, hotbed	400 watts	1 per day per season
Wood sawing	1-5 HP	2 per cord

* AC power required

t Normally AC, but convertible to DC

NOTE: Kilowatt-hour usage can be cut up to 50% through energy conservation.

Source:
Rockwell International

4. COMPETITIVE ANALYSIS OF STAND-ALONE PHOTOVOLTAIC SYSTEMS AND DIESEL DRIVEN GENERATORS

This section is a comparison of stand-alone photovoltaic systems and its most viable competitor - diesel driven generators in terms of life cycle costs, the required life cycle cash flows, the appropriateness of the technology and the strategic implications for both the private purchaser

4.1 The Private Purchase

The private sector purchaser would be an individual, a patron, a group forming a cooperative, or, as in Latin America, an intermediary. Regardless of who the purchaser is, the power source would be considered a capital expenditure and the cottage industry business would be expected to support the purchase. Assuming the potential user desires an electrical source, the questions that arise are: (1) Can the business afford it? and (2) What option is the best choice for the job?

Required Cash Flows to Support Purchase - Basically, the question of affordability addresses whether or not the purchaser has the financial means to make the down payment and the monthly payments required by the capital investment. To get some idea of the affordability of photovoltaics, the annual before and after tax cash flows that would be required for the purchase and operation of a 3 KW photovoltaic system and a 3 KW diesel driven system are shown in Exhibit 12 and Exhibit 13. The cost conditions used are those found in the Philippines and photovoltaics at $\$13/W_p$. Both systems analyses are for 8 hours of operator per day. The assumptions and conditions that were used are given in Exhibits 14,15 and 16. A 3 KW diesel generator system was used since this is the smallest size most manufacturers make. Smaller systems would be driven by gasoline engines. If the business planned for growth, it would be wiser to oversize the system and purchase a larger diesel. The results of this analysis are summarized in Exhibit 17.

From Exhibit 17, it can be seen that the annual cash requirements are about five times greater for the photovoltaic system and the initial down payment is 23 times greater.

While this analysis indicates there is significant difference in the cash required to own and operate a photovoltaic system compared to a diesel generator system, it does not completely answer the question of affordability.

CASH FLOW ANALYSIS OF 3 KW DIESEL GENERATOR USED 8 HRS/DAY

This is the analysis for a diesel generator
The System Capacity is 3,000 Watts, operating for 8 hr. per day.
The cost of the system is $3,000.00.
The initial cash cost is $600, representing a 20% down payment.

Year	Fuel	Maintenance	Replace	Cash Flow Before Fin. (Negative)	Annual Finance Payment	Cash Flow After Fin. (Negative)	Tax Benefit	Cash Flow After Taxes (Negative)	Principal (Beg. of Year)	Depreciation
1	899.	700.	0.	1599.	1591.	3190.	1026.	2163.	2400.59	2000.00
2	899.	700.	0.	1599.	1591.	3190.	719.	2470.	1814.39	1000.00
3	899.	700.	1801.	1599.	1193.	2792.	795.	1997.	1800.59	1200.33
4	899.	700.	0.	1599.	1193.	2792.	602.	2190.	985.79	600.17
5	899.	700.	1801.	1599.	1193.	2792.	795.	1997.	1800.59	1200.33
6	899.	700.	0.	1599.	1193.	2792.	602.	2190.	985.79	600.17
7	899.	700.	1801.	1599.	1193.	2792.	795.	1997.	1800.59	1200.33
8	899.	700.	0.	1599.	1193.	2792.	602.	2190.	985.79	600.17
9	899.	700.	1801.	1599.	1193.	2792.	795.	1997.	1800.59	1200.33
10	899.	700.	0.	1599.	1193.	2792.	602.	2190.	985.79	600.17
11	899.	700.	1801.	1599.	1193.	2792.	795.	1997.	1800.59	1200.33
12	899.	700.	0.	1599.	1193.	2792.	602.	2190.	985.79	600.17
13	899.	700.	1801.	1599.	1193.	2792.	795.	1997.	1800.59	1200.33
14	899.	700.	0.	1599.	1193.	2792.	602.	2190.	985.79	600.17
15	899.	700.	1801.	1599.	1193.	2792.	795.	1997.	1800.59	1200.33
16	899.	700.	0.	1599.	1193.	2792.	602.	2190.	985.79	600.17
17	899.	700.	1801.	1599.	1193.	2792.	795.	1997.	1800.59	1200.33
18	899.	700.	0.	1599.	1193.	2792.	602.	2190.	985.79	600.17
19	899.	700.	1801.	1599.	1193.	2792.	795.	1997.	1800.59	1200.33
20	899.	700.	0.	1599.	1193.	2792.	602.	2190.	985.79	600.17

The present value of after tax cash flows discounted at 0.170 is $12,687.85.

Exhibit 12

CASH FLOW ANALYSIS OF A 3 KW PHOTOVOLTAIC SYSTEM USED 8 HRS/DAY, COSTING $13/Wp

This is the analysis for a photovoltaic system.
The system capacity is 3000 Watts, operating for 8 hr. per day.
The system size is 5334 peak Watts.
The initial cash cost is $13,870,00, representing a 20% down payment.

Year	Fuel	Maintenance	Replace	Cash Flow Before Fin. (Negative)	Annual Finance Payment	Cash Flow After Fin. (Negative)	Tax Benefit	Cash Flow After Taxes (Negative)	Principal (Beg. of Year)	Depreciation
1	0.	350.	0.	350.	11914.	12264.	20337.	-8073.	55477.57	69346.34
2	0.	350.	0.	350.	11914.	12264.	2987.	9277.	55214.34	0.00
3	0.	350.	0.	350.	11914.	12264.	2970.	9294.	54895.84	0.00
4	0.	350.	0.	350.	11914.	12264.	2950.	9314.	54510.45	0.00
5	0.	350.	0.	350.	11914.	12264.	2925.	9339.	54044.13	0.00
6	0.	350.	12001.	350.	16015.	16365.	4526.	11840.	65480.38	4000.17
7	0.	350.	0.	350.	16015.	16365.	4207.	12158.	63216.38	3200.13
8	0.	350.	0.	350.	16015.	16365.	3863.	12502.	60476.95	2400.10
9	0.	350.	0.	350.	16015.	16365.	3489.	12876.	57162.24	1600.07
10	0.	350.	0.	350.	16015.	16365.	3078.	13287.	53151.44	800.03
11	0.	350.	12001.	350.	16015.	16365.	4254.	12112.	60298.87	4000.17
12	0.	350.	0.	350.	16015.	16365.	3878.	12488.	56946.76	3200.13
13	0.	350.	0.	350.	16015.	16365.	3465.	12901.	52890.71	2400.10
14	0.	350.	0.	350.	16015.	16365.	3007.	13358.	47902.89	1600.07
15	0.	350.	0.	350.	16015.	16365.	2495.	13870.	42044.42	800.03
16	0.	350.	12001.	350.	16015.	16365.	3548.	12817.	46859.38	4000.17
17	0.	350.	0.	350.	16015.	16365.	3024.	13341.	40684.98	3200.13
18	0.	350.	0.	350.	16015.	16365.	2432.	13934.	33213.95	2400.10
19	0.	350.	0.	350.	16015.	16365.	1757.	14608.	24174.01	1600.07
20	0.	350.	0.	350.	16015.	16365.	983.	15382.	13235.67	800.03

The present value of after tax cash flows discounted at 0.170 is $59,626.59.

Exhibit 13

COST CONDITIONS USED FOR PHOTOVOLTAIC SYSTEM ANALYSIS

Photovoltaic System

Assumptions

- For every peak system watt, there is 4.5 Watt-hr of usable power per day
- Primary batteries replaced every 1,800 cycle.
- Battery discharge is 20% and cost $100/kW-Hr.
- Maintenance $350/yr.

Exhibit 14

COST CONDITIONS USED FOR GENERATOR SYSTEMS ANALYSIS
(Costs are for use in the Philippines)

GENERATOR COSTS

Gasoline Driven

Size (kW)	Cost	Cost/W_c
0.3	$ 570	$ 1.90
1.2	910	0.76
2.0	1,530	0.77
2.8	1,760	0.63

Diesel Driven

Size (kW)	Cost	Cost/W_c
3.0	$ 3,000	$ 1.20
4.0	3,887	0.97
7.0	6,300	0.90
15.0	8,550	0.57
30.0	11,850	0.57
45.0	14,850	0.33
60.0	18,600	0.31
90.0	25,200	0.28
100.0	26,000	0.26

FUEL COSTS (current)

Gasoline $ 2.50/gallon

Diesel Fuel 1.42/Gallon

MAINTENANCE COSTS

Diesel - $700/year

- Engine replaced every 5,000 hr. (Typical service is minor overhaul every 6,000 hrs. and major overhaul at 18,000 hrs.)
- Units are sold with a one-year full warranty on parts and labor.

Gasoline - $0.0/year

- Replace unit every year
- Units are sold with a one-year full warranty on parts and labor.

Exhibit 15

FINANCIAL ASSUMPTIONS FOR BOTH SYSTEMS

Initial System	- 20% down
	- 80% loan @ 21%
	- 5-year term for every $5000 or portion thereof to a maximum of 20 years
	- The photovoltaic system has a 20-year loan
	- The diesel system has a 2-year loan
Replacement Cost	- 100% loan @ 21% for life of the replacement
	- The diesel engine must be replaced every 2 years
	- The photovoltaic batteries are replaced every 5 years
Depreciation	- Photovoltaic system is fully depreciated in year of purchase
	- Generator and replacements use SYO (Sum of the year) digits method
Tax rate	- 25%
Tax benefit	- (Depreciation + Interest) x 25%
After Tax Discount Rate	- 17%

Cash flow in year 1 does not include the initial down payment

Exhibit 16

COMPARISON OF CASH FLOWS REQUIRED BY A 3 KW PHOTOVOLTAIC SYSTEM AND A 3 KW DIESEL DRIVEN SYSTEM

	Photovoltaic	Diesel Driven
Down Payment	$ 13,870	$ 600
Cash Flow Before Taxes		
Maximum Payment in Any Given Year	16,365	3,190
Minimum Payment in Any Given Year	12,264	2,792
Cash Flow After Taxes		
Maximum Payment in Any Given Year	15,382	2,470
Minimum Payment in Any Given Year	(8,073)[1]	1,997
Life Cycle Cost After Taxes	$ 59,627	$ 12,688

[1] By fully depreciating the system in year one, year one would show a positive after tax cash flow of $8,073. However, year 2 has the next lowest payment of $9,277.

Exhibit 17

The question that remains is, How many rural cottage industries in developing nations, which use 3 KW of power could afford $16,000 per year over and above the other costs and expenses of doing business? In Mexico, the average assets of a rural cottage industry range between $2000 and $3000 and in Morocco the average annual income of a handicraft producer is $1000. To generate this large of a cash flow, the business would have to approach the category of small-scale manufacturing. However, the energy requirements of a small scale manufacturer would also be greater.

Assuming there are some cottage industries that could support the required cash flows, the next question is which system will the potential buyer choose.

The "best" choice will again vary from case to case. The deciding factor could be delivery time, serviceability, low maintenance, special features, but, in general, the system demonstrating the greatest economic value will be the one chosen. This is especially true if the system will be financed by a third party such as a bank or development agency.

Life Cycle Costing of Competitive Power Systems - To establish the economic value of each option, the cash flows required by competing systems must be compared by a time value method. In other words, how much more should be spent today to save in the future, or how much should be saved today if more must be spent in the future. The "life cycle cost" method or discounted cash flow method is the accepted means for making this comparison.

Life cycle cost is the sum of the costs of a system discounted over a period of time. Costs considered here are for a 20-year operating period and include the following:

- fuel costs
- financing costs
- maintenance costs
- initial system costs
- cost of replacing the system or parts of it.

The results of calculating life cycle costs for a photovoltaic system and a diesel generator system in the Philippines are shown in Exhibits 18, 19, and 20. The cost assumptions used for the analysis are given in Exhibits 14, 15 and 16.

COMPARISON OF A GENERATOR SYSTEM AND A PHOTOVOLTAIC SYSTEM OPERATED 4 HRS./DAY

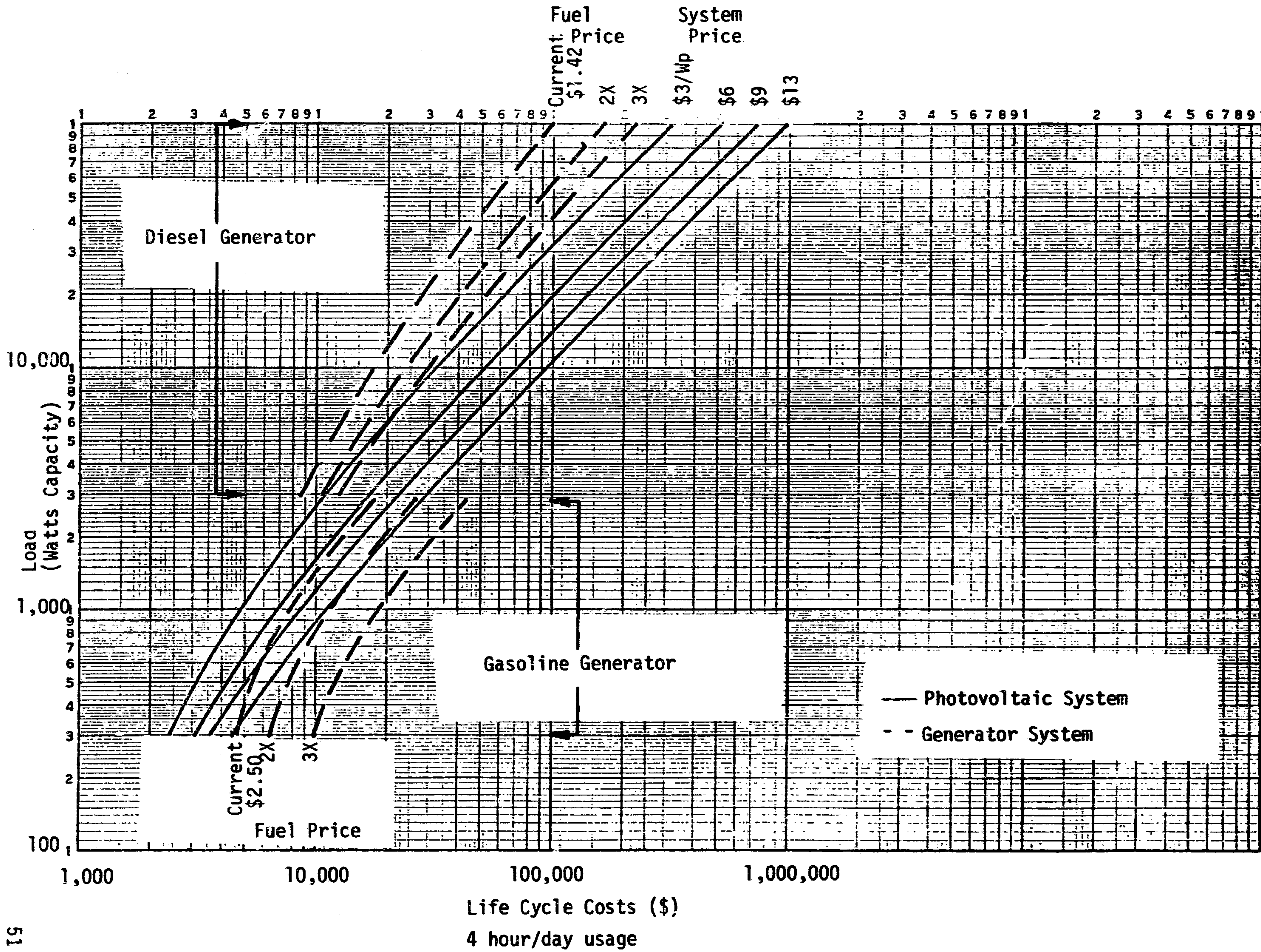


Exhibit 18

COMPARISON OF A GENERATOR SYSTEM AND A PHOTOVOLTAIC SYSTEM OPERATED 8 HRS./DAY

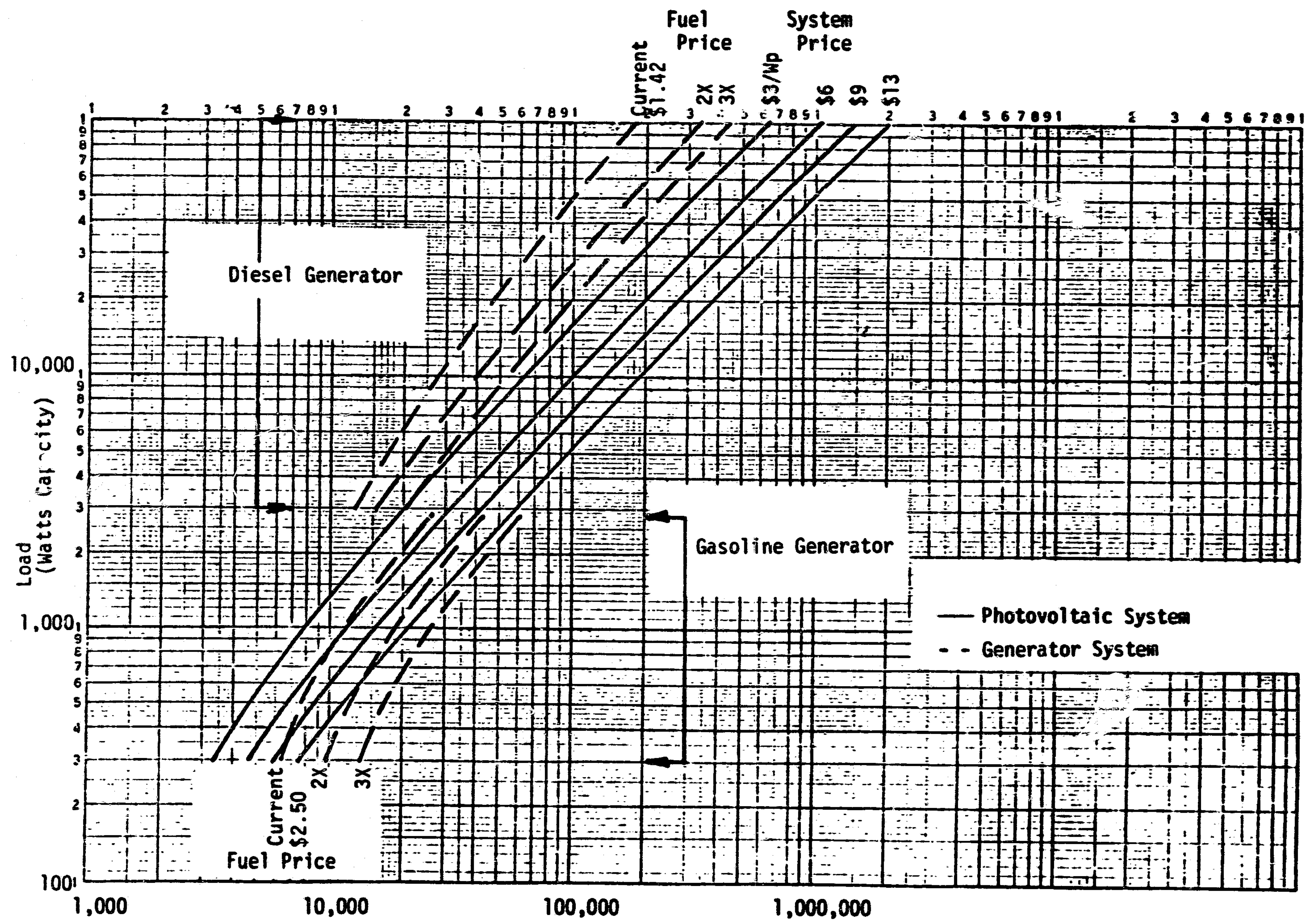
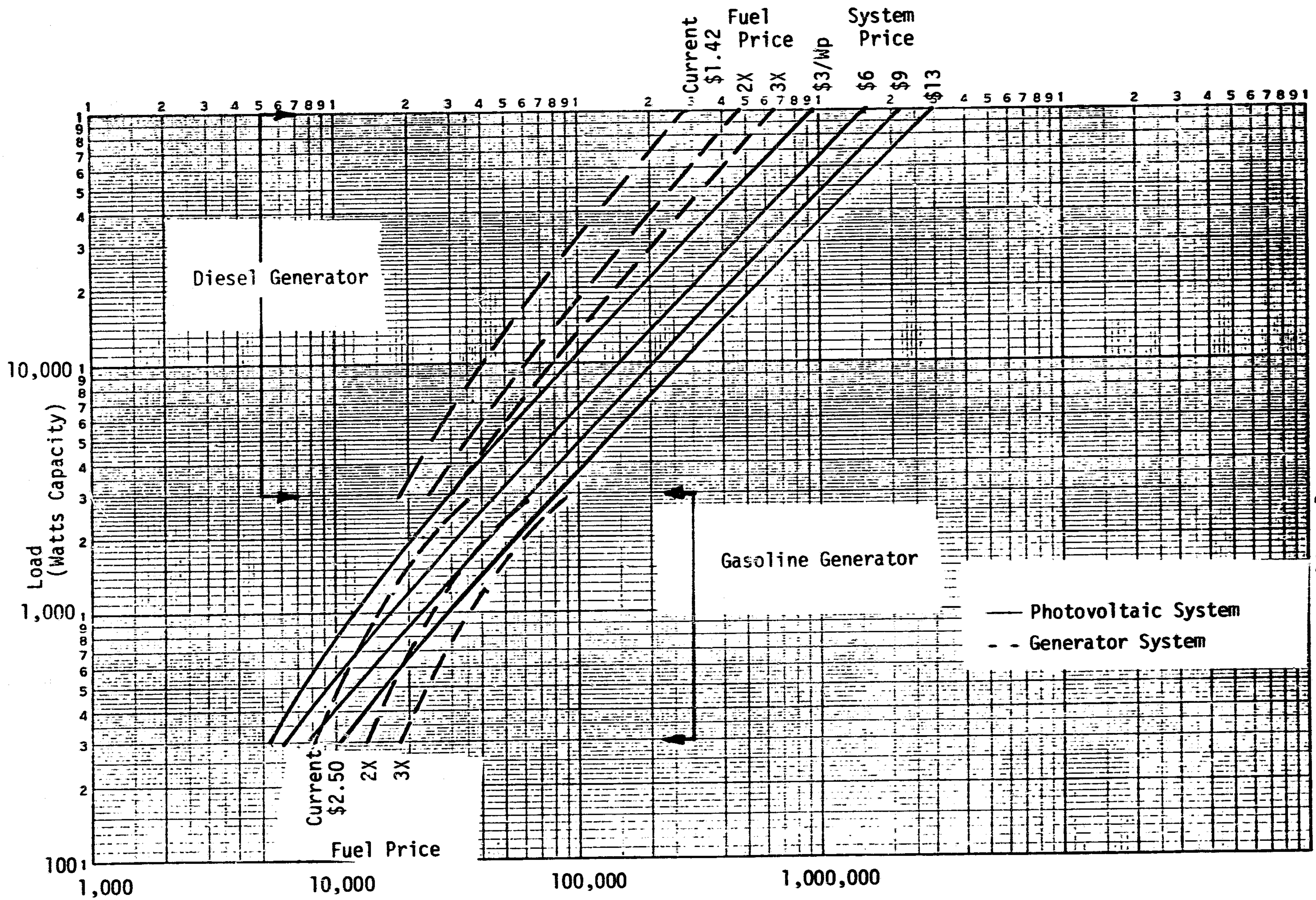


Exhibit 19

COMPARISON OF A GENERATOR SYSTEM AND A PHOTOVOLTAIC SYSTEM OPERATED 12 HRS./DAY



Life Cycle Cost ($)

12 hours/day usage

Exhibit 20

Shown in these exhibits are the life cycle costs of owning and operating a system for 4, 8, and 12 hours per day at current fuel prices, two times current, and three times current with photovoltaic systems costing \$13, \$9, \$6, and \$3 per peak watt (W_p).

From these exhibits, it can be seen that, at current fuel prices and at photovoltaic system prices of \$13/W_p, photovoltaics compete favorably with conventional diesel or gasoline driven generators only when very small amounts of power are required. As fuel prices increase and photovoltaic system prices decrease, the range in which the systems are competitive increases, but the competitive range still remains relatively narrow. This demonstrates the scale of economy advantage that diesel generator systems have over photovoltaic systems. The cost per Watt-Hr of energy decreases more rapidly for diesel systems than for photovoltaic systems. Therefore, it is to the advantage of users to form cooperatives whenever possible, to achieve these economies of scale.

Cash flow analyses for various sized systems and the development of life cycle cost equations for comparative purposes are presented in Appendix E and Appendix F. These two appendixes present a reasonable costing model for anyone considering investment in high initial cost systems.

4.2 The Government Purchase

From the discussion of Section 2, we have seen that throughout the world, the majority of rural cottage industry producers, with no access to electricity, exist at a level barely above subsistence. Frequently these enterprises exist outside the formal economy and are the only source of income to the producer. They function to provide the producer with basic utilitarian goods, supplemental food and about the equivalent of two meters of cloth per person per year. A cottage industry with capital resources would be a rare exception. Therefore, in non-industrialized countries, the purchaser of a power source for cottage industry applications will, most probably, be the government.

Assuming a government intends to provide electricity to cottage industry and can afford it, the government will have several basic concerns regarding the purchase. They include:

- Protecting domestic industry
- Minimizing trade deficits
- Providing for the most people with the resources they have available
- Choosing the system which is the most economical, overall.

The first condition limiting a purchase is whether parts of the power system are produced domestically or abroad. If a suitable portion of the system is produced domestically, there is an increased opportunity for it to penetrate the market.

The next issue to be considered is minimizing the potential for a trade deficit. The purchasing country will seek to minimize imports; however, if the product imported will substantially increase exports, the purchase may be warranted.

It is the objective of any developing nation to raise the standard of living of as many people as possible. Therefore a government will strive to allocate available resources to its best advantage.

The final consideration is the optimum investment choice considering intangibles such as social benefits. The system chosen should be an appropriate technology and in balance with the rural economy. Other factors would include cultural acceptance of the product, technical adaptability, maintenance, service, flexibility of the product and the ecological impact. These factors are highly qualitative and vary from site to site.

The factor of greatest importance is which system is cost-effective in providing electricity. The decision in most cases would be based on an analysis of "life cycle costing." The government purchaser will usually consider the best alternative over the long-term and will probably have the capital resources to afford a longer term payback. An example of life cycle costing for a photovoltaic system and a diesel generator system has been given in Section 4.1. Taxes would not be considered in a government evaluation. (In the example given in Section 4.1, deleting the tax factor would not significantly change the evaluation.)

The example given in Section 4.1 is a "financial" analysis based on cost conditions prevailing within the country. Many governments would also consider an "economic" analysis which would evaluate the opportunity costs of the market on an international basis. This analysis considers fuel at world market prices and costs in world currency dollars. However, the relevancy of the "economic" analysis method depends on the overall resource base of the country and world trade position.

4.3 Appropriate Technology

In introducing electricity to the cottage industry sector, some industries, such as wood-working, will adapt readily. Others, such as pottery and weaving, would require a great deal of extension service assistance and training. Recent trends in foreign development policies have stressed that new technology introduced in the rural sector be "appropriate technology". In other words, it should be in harmony with the rural society. For cottage industry, an "appropriate" process should liberate the artisan from labor activities which are low income producers and redirect his or her efforts to processes which will generate greater income. In altering the processes used, such as using electrified tools, care must be taken to preserve the unique quality of the product. The final product must remain semi-artisanal rather than semi-industrialized, yet there must be a visibly higher value in the product made by the new process or improved technology.

The utilization of any energy source for a rural development project would require that it be of an appropriate technology. In Mexico, renewable energy technologies must conform to the criteria established by the Institute for Electric Studies to evaluate projects for integrated energy systems for rural communities. They require that the technology be:

- low cost
- utilize local rural materials and labor for installation
- labor intensive, providing utilization of local labor
- maintainable by the local community
- simple in design and flexible for adaptation under widely diverse conditions
- modular in order to increase capacity as required
- compatible with the local culture and customs
- compatible with the social and economic needs of the groups using the technology
- based upon local environments and ecological systems with minimal adverse impact upon these systems.

Although the exact criteria and local interpretations vary, the essence of what is an appropriate energy source remains the same. In the rural sector of less developed countries, power systems should be simple, locally maintainable, provide more use of local labor and be socially acceptable.

4.4 The Strategic Implications for the Small Manufacturer

In order to assess the market for photovoltaic systems in cottage industry applications, it is necessary to go beyond the pure economic numbers of the decision. This is done by assessing the non-economic value of photovoltaic systems by considering their strategic implications for the small manufacturer and for the importing country.

The strategic implications of photovoltaics for the small manufacturer can be assessed by relating the advantages and disadvantages of a photovoltaic system and diesel generator to the needs and desires of the user. In this way the non-economic value of photovoltaics may be discovered.

The characteristics of a photovoltaic system and diesel generator system are summarized below and categorized as either an advantage or disadvantage. This categorization is usually done by advocates of photovoltaic systems and therefore represents their perception. What must actually be determined is how the characteristics of these two stand-alone power systems will be perceived and valued by the end user.

Photovoltaic System

- Advantages
  - No fuel required
  - Low maintenance
  - Benign environmental impact
  - Modularity
- Disadvantages
  - High initial cost
  - Requires large land area
  - Technical complexity
  - Rapidly changing technology
  - Appliance adaptability

Diesel Generator System

- Advantages
  - Low initial cost
  - Compact
  - Transportable
  - Decreasing marginal cost
- Disadvantages
  - Fuel required
  - Noise and air pollution
  - Maintenance required

Assuming that a small manufacturer in the non-industrial, non-centrally planned world would think similarly to a small manufacturer in this country, his main concerns will be:

- Ability to Pay/Cost of Capital - A small manufacturer has a limited amount of investment dollars. He wants the greatest impact for the fewest dollars, and must constantly tradeoff between present costs and future benefits.

- Operational Flexibility - The small manufacturer wants to be able to adjust his expenses to his business revenues. If sales are down, he reduces production and reduces his total variable costs. These are the costs that vary directly with production level such as labor, materials, and fuel. The cost of plant and machinery is a fixed cost and is independent of production level. Controlling operational flexibility is very important to the small manufacturer and is one of the factors that determines his ability to weather bad times.

The small manufacturer also wants a plant that can change to conditions. He wants to be able to grow and change or augment his product line if opportunities are present. Therefore he does not want to invest in inflexible equipment.

- Financial Flexibility - Financial flexibility is the ability of the small manufacturer to raise money when he needs it. If the small businessman has unlimited resources, this is no problem. However, this is seldom the case. The small manufacturer will usually have to go to a local lender for additional debt, and if the business already has a large debt outstanding, the lender will be extremely reluctant to loan more money. Additional borrowing becomes more risky and consequently more expensive.

- Control - The concept of control is related to the small manufacturer's flexibility. He wants to be able to control the costs of his inputs. For example, if the small manufacturer is buying an input supplied by only one supplier, that supplier controls its cost and the manufacturer must pay the supplier's price if there is no substitute. On the other hand, if the input is a commodity item, he can go to an alternate supplier.

- Timing - Timing is a very important element in the competitive strategy of a small manufacturer. If a manufacturer buys equipment just before a technological breakthrough affects that equipment, he is at a competitive disadvantage with his competitors because he has obsolete equipment which cannot be easily sold, and he has probably expended his investment dollars. With rapidly changing technologies, therefore, timing is a crucial element of competitiveness.

Having explained some of the concerns of the small manufacturer, it must now be determined how the characteristics of the photovoltaic system might be perceived by the small manufacturer to determine if there is any value over and beyond the economic values considered in the previous section.

Photovoltaic System

- High Initial Cost - The initial cost of the photovoltaic system required for various cottage industries was indicated in Sections 3.1 and 3.2. It can be seen that in most cases the cost of the photovoltaic system is many times the cost of other equipment. It is probably unlikely that the small manufacturer would have the ability to pay for the system in these cases and would eliminate any financial flexibility in the business if he did buy the system.

- No Fuel Required - This would eliminate the need for the small manufacturer to buy fuel, the price of which he has no control over. However, he is trading off buying fuel with a large initial investment. Fuel purchases will follow his production maintaining operational flexibility, but the large initial investment results in a fixed cost reducing his operational flexibility and financial flexibility.

- Requires Large Land Area - Not only must the small manufacturer pay for this land, but he must maintain it and protect it. It also exposes him to more risks such as damage due to storm or accident.

- Low Maintenance/Technical Complexity - While the maintenance required under normal circumstances is extremely low for photovoltaic systems, the small manufacturer will consider a "what if" situation. If the system should fail the technical complexity means that he will not be able to fix it and spare parts are beyond his control.

- Rapidly Changing Technology - The price of photovoltaic systems is projected to decrease substantially. If this is the case, why should he buy the system now with a very high initial cost? Would he not be better off to buy a diesel generator now and fuel it with diesel fuel while fuel is still relatively cheap and then buy the system in the future at a lower cost? For example, modules cost approximately \$10.00 per W_p now and are projected to cost \$2.80 in two years. This would represent a savings of \$7.20 per W_p if purchase is delayed. For a 15 KW_p system, this saving totals \$108,000.

- Modularity - Modularity is claimed to be a positive factor for photovoltaics in that the system can be expanded to meet the needs of the user. However, the marginal cost of each additional unit of photovoltaic capacity is the same while marginal cost decreases for the diesel generator. As a result, if growth is expected the diesel generator would be preferred due to decreasing costs and shorter lifetimes resulting in greater flexibility.

- Benign Environmental Impact - This will be of little value to the small manufacturer. Environmental impact is a social cost which he may be concerned about, but only after all other concerns are satisfied.

- Appliance Adaptability - If special tools can only be used along with the photovoltaic system, the small manufacturer will be limited in his choice of tools and manufacturers. He loses both control and flexibility.

Based on the analysis above, a stand-alone photovoltaic system does not appear to be the answer to the electrical power needs of the small manufacturer. An electrical grid is probably the best solution since the small manufacturer is not in the business to generate power, but only to use it. If the grid option is not available, photovoltaics would be attractive under limited conditions, however a diesel generator would appear to be a wiser choice for most small manufacturers.

4.5 The Strategic Implications for the Importing Country

So far we have examined the decision of the small rural manufacturer, assuming minimal interference from the government. It is possible that the government could establish policies and incentives which would make the decision to buy photovoltaic systems more attractive. To understand why this can be done, it is necessary to understand the strategic implications for the importing country.

A typical country in the non-industrial, non-centrally planned world which would import photovoltaic systems is trying to improve the welfare of its people. To do this in today's world, the country must produce the goods it requires domestically, or produce goods to sell in the international market to earn the foreign exchange it needs to buy the goods it requires from other nations. To achieve this situation, the only strategy that the country can follow for an extended period of time is to limit imports to essential items and items required for industry formation. The country must develop industries within its means that can sell goods internationally or replace imports. It is now important to determine how photovoltaics may fit within this strategy.

The idea behind selling photovoltaics internationally for cottage industry applications is to:

A. Lessen the dependence of the importing country on non-renewable oil.

B. Provide a source of electrical power in remote areas of the country to improve industrial production and the life of the people.

The escalating price of oil has caused havoc on the economics of many developing countries. They were forced to buy this essential product at higher prices and to fund their purchases through deficit spending. As a result many of the developing countries are over-extended in debt, and have a very great desire to reduce their import of oil. Photovoltaics will reduce this dependence on oil.

Photovoltaics, however, represents an import of much greater value than oil unless the country produces the system domestically. The question is whether the production of photovoltaic systems and their applications fits within the industrial development strategy of the country.

Photovoltaics can be broken down into modules, storage, structural support, and controls. The modules are a high technology component requiring significant investment in equipment and people. As a result, it is unlikely that a developing country could develop this industry domestically. The storage is usually lead acid batteries and the structural support is simple steel structures. Both of these products are technically simple and would seem to be an industry within the capabilities of most developing nations. There is some question as to how these products fit into the industrial development strategy of the country, whether the country may achieve a comparative advantage in these or an auxiliary product, and what the conditions in the international market for these products or the auxiliary product may be.

The application of photovoltaics and its fit within the industrial development strategy of the country is the next area of concern. For the purpose of this report, the application of photovoltaics is limited to rural cottage industries or rural small manufacturers. It has been a strategy in some countries to promote cottage industries because, typically they require little capital investment, employ a significant number of people and produce basic essential products. Photovoltaics and the capital they require may change this outlook towards cottage industries if they were to be adapted.

The strategic implications of photovoltaics for the small manufacturer have already been discussed. It was concluded that were the manufacturer given an independent choice between photovoltaics and a disel generator, the diesel generator would most likely be chosen. The question is whether the importing country wishes to push this decision the other way. This can be done either through a tax policy or through direct subsidies. If direct subsidy is used the cost/benefit for the country must be considered. It would appear that more manufacturers could be supplied with more power if diesel generators were to be supplied than if photovoltaic systems were bought.

5. CONCLUSIONS

The near term market for photovoltaics in rural cottage industries in the non-industrialized, non-centrally planned world, is estimated to be 70,000 MW. However, further in-depth study has revealed that this "potential" appears nonobtainable within the next 10 years. Furthermore, the near term market for photovoltaics in rural cottage industry applications appears to be limited to demonstration projects and pilot programs.

Several major factors contribute to this conclusion:

1) Photovoltaic (PV) systems demonstrate their greatest utility in highly remote sites where fuel, transportation and maintenance costs are excessive. For this situation to exist, there would also be a definite lack of physical and marketing infrastructure, both of which are necessary to support a thriving cottage industry trade.

2) PV systems in the range of $6/$W_p$ to $13/$W_p$ are not the most cost-effective means of supplying power to rural cottage industries. An exception would be very remote, isolated sites, but the likelihood of these cottage industries being electrified is negligible.

3) PV systems do not use indigenous resources, nor do they create more employment than other alternative products. In many countries the use of diesel generator sets is encouraged, since maintenance of these systems creates employment.

4) The introduction of electricity, especially photovoltaics, may require extensive training. The peripheral equipment of a PV system (controls, inverters, regulators) all require careful monitoring. In general, an understanding of these systems is beyond a peasant's comprehension.

5) The technology of photovoltaics is not fully developed. Many countries are aware of the potential of photovoltaics as a rural energy source. However, those who would seriously consider it perceive significant technical advances and cost reductions forthcoming. Therefore, they will delay their purchases until the technology is more fully developed.

Furthermore, in marketing small-scale decentralized power systems for cottage industry applications two distinct situations emerge. One is the demand for only a general power source. The other is a demand for a total system. A general power source would have its greatest markets in countries such as the Philippines and Brazil. However, in Mexico or Sub-Sahara Africa, the preferred product would be turnkey systems. Turnkey PV systems packaged with cottage industry appliances, such as lathes and saws, are not available in the marketplace at present.

6) Most cottage industries in non-industrialized countries do not use decentralized electric power sources for production. It was found that even in the Philippines and Brazil, where diesel generators are used extensively, they were not widely used for producing cottage industry goods.

7) Electrification of cottage industry is not a high priority for development. People fulfill their needs in a hierarchy with physiological needs being primary. Food, shelter, clothing and freedom from disease are considered minimal for subsistence. For many countries of the world, particularly the very low-income countries, overpopulation and inadequate natural resources create a constant struggle to provide even these basic minimal needs.

It is the usual objective of a developing nation to make a positive impact on the standard of living for the greatest number of its people. The highest priorities in a government's developmental plan will be food production, the provision of safe drinking water and medical facilities.

Once the basic necessities have been filled, the next level of priorities is to provide education and infrastructure. Schools, educational television, communication systems and highways would be the next facilities and services provided.

Cottage industry production beyond the needs of a village requires skilled producers, adequate supplies of raw materials and a marketing infrastructure for the goods produced.

A country having attained this stage of development would then begin to consider developing the rural economy either to provide goods regionally or to create an export trade. Also, skilled labor creates a need for employment and cottage industry production tends to be labor-intensive.

For rural electrification of cottage industries to be a significant development issue, the country would be at least middle-income and possibly upper middle-income.

8) Finally, consider the effects of utilizing electricity. Basically, the application of electricity to cottage industry production could have three effects:

- Production of more goods
- Production of goods with a higher value-added
- Better utilization of labor.

In most rural industries production of more goods is not a high priority and, if so, it is usually an export oriented producer. More goods are desirable only if there is the demand in the marketplace. Cottage industries that serve local and regional markets would be unlikely to want to produce more goods, since this may actually reduce the price obtained for their goods. It also requires an accompanying infrastructure for marketing those goods. Roads, transportation, storage and intermediaries must all be present. For many isolated rural industries an adequate supply of raw materials may also be a problem.

Production of goods with a higher value-added is a good rationale for adapting electricity to manufacturing and there have been many successful cases demonstrated. This is especially true in the furniture and woodworking industries. The major drawback is, again, there must be a demand in the marketplace for higher value-added goods. Another problem, as stated previously, is maintaining the integrity of the product. The value of many cottage industry products lies in their visible manual craftsmanship and cultural expression. This is especially true for clothing, carved goods and painted goods. In an export market, hand made goods also enjoy considerably lower tariffs and duties than machine-made goods.

The third effect of applying electricity is better utilization of labor. The purpose is to free the laborer from tedious, low-value manual tasks to either produce a more valuable product or use his or her time in a more profitable manner. However, this frequently requires a total program of education.

An additional result of this study was to recognize some aspects of cottage industry production which could utilize stand-alone sources of electric power. This does not mean that these applications are a market for photovoltaics, but that they are potential applications.

One case where the application of stand-alone power sources could be considered as appropriate technology is in the extraction, transportation, storage and processing of raw materials used in cottage industry production. This specific group of activities are characterized as being heavily labor intensive, yet extremely low income generating activities. In some cottage industries these processes are viewed as domestic duties of the household and are not considered as costs attributable to the cottage industry production. Frequently these processes are not even detectable in the final product.

Improved methods of raw material preparation represent an opportunity for existing industries as well as for new industries in the rural sector.

This also represents an area where modern, high technology has successfully penetrated the rural cottage industry market, not necessarily because it has been appropriate, but because it was the only alternative to traditional methods. In many cases, high technology material processing has been incompatible with rural cottage industry production and has had a negative impact on the quality and value of traditional production. As rural cottage industries develop, however, the need for appropriate rural processing of raw materials for cottage industry production will become the major challenge for appropriate technology applications.

Semifinishing processes, finishing processes and finishing accessories are also cases where the application of electricity to cottage industry may be considered an appropriate technology. An excellent example of electricity applied to a semifinishing process can be seen in the village of Cuanajo, Mexico. Here, electricity was used to power circular saws in furniture making. A table leg, sawed by hand from a log requiring many hours of labor, is indistinguishable from a table leg sawed by circular saw in a few minutes. The value of the Cuanajo artisan's work was not their skill with a hand saw, but their skill with a mallet and chisel in providing the sculptured designs which decorate their finished work.

Many rural produced goods are poorly finished or sold unfinished because the artisan has neither the time nor the tools to produce a finished product. Finishing accessories such as buttons, drawer pulls, fasteners and similar products are also lacking. Here, simplification of early process stages would again allow the artisan to concentrate on producing a more valuable product. However, this may also require some initial training of new skills.

Exhibit 21 is a summary of predominant cottage industries in various regions of the world. Forms of energy currently used by cottage industries are given in Exhibit 22 and potential uses of small amounts of electric power are given in Exhibit 23.

EXHIBIT 21

SUMMARY OF PREDOMINANT COTTAGE INDUSTRIES IN VARIOUS REGIONS OF THE WORLD

	AFRICA	ANDES	BRAZIL	CENTRAL AMERICA	MEXICO	MOROCCO	PHILIPPINES
Rural	Wood products Textiles - weaving, tailors dyes Bakeries Ag. implements Grain mills Well-digging Masonry and carpentry Furniture Bicycle repair	Weaving (wool) Spinning Pottery Jewelry Woodworking Basketry	Weaving Bakeries Ceramics Food processing	Weaving (cotton) Pottery Woodworking Rush reed products	Pottery Metalworking Furniture Woodworking Basketry (reed) Weaving	Weaving Carpet-making Pottery	Food processing Textiles, clothing Wood products Metalworking Furniture Woodworking
Urban		Leather goods Bakeries Food processing	Blacksmithing Light engineering Mechanical Shops Metalworking Gunmaking (hunting rifle) Cutlery Popular crafts: toys, dolls, printshops, brickmaking, tilemaking			Leather Tile-making	

EXHIBIT 22

FORMS OF ENERGY CURRENTLY USED

Wood and charcoal, primary source
Animal traction
Solar (simply drying in the sun)
Water wheels (Micro-hydro)
Diesel generators
Grid
Kerosene
Butane or propane
Agricultural residue; Mill waste
Conventional electricity

EXHIBIT 23

POTENTIAL USES OF SMALL-SCALE POWER SOURCES IN COTTAGE INDUSTRIES

Use (Equipment)	Application
- lighting	- general usage
- mixers for the extraction and mixing of clay	- pottery cooking vessels construction material
- grinders	- cornmeal grinding
- centrifuges	- fishmeal grinding
- lathes, bandsaws circular saws, sanders grinders	- jewelry making - religious articles - furniture and wood products construction materials
- lathes soldering irons buffers polishers	- metalworking

6. BIBLIOGRAPHY

"Alcohol Fuels Hit a Rocky Road", World Business Weekly, July 6, 1981, P. 16

Allio, Rob J., and Pennington, Malcolm W. Corporate Planning, Techniques and Applications. New York: AMACOM, 1979

American Embassy, Brasilia, Alternate Energy Technologies: Production and Use of Alcohol in Brazil. U.S. Dept. of State Airgram, Jan. 2, 1980

"Annual Report 1979", Furnas (Electrobras, Centrais Electricas Brasilieras, S.A.) Rio de Janeiro, Brazil

Araujo, Jose Theodoro Alvesde. Investments in Brazil - Basic Legal Aspects, Brazil, Minas Gerais: The Industrial Development Institute of Minais Gerais, May, 1979

Bautista, R. and John H. Power & Associates, Industrial Promotion Policies in the Phillippines, (Philippines: Philippine Institute for Development Studies), 1979.

Board of Investments, The Investment and Export Incentives Acts, (Manila, Philippines: Government Printing Office), 1978.

"Brazil Solar Energy Country Notebook", PRC Energy Analysis Company, Virginia: March 21, 1979

"Brazil, The Energy Crunch", Latin America Daily Post Special Energy Supplement, 1979

"The Brazilian Economy: 1979", American Chamber of Commerce for Brazil

"Brazilian News Briefs", The American Chamber of Commerce for Brazil Sao Paulo: April 28, 1980

The Brazilian Nuclear Program. Federative Republic of Brazil, 1977

Business Latin America. Business International Corporation New York: February 20, 1980

"Business Outlook Abroad: Mexico", Business America, April 6, 1981

"Businessmen Guide Brazilian Economy", Visao, Nov. 17, 1980

Cals, Ceasar. The Brazilian Energetic Policy. Minister of Mines and Energy. Fed Rep. of Brazil.

Comision Federal de Electricidad, "National Electric Sector", Mexico: 1979.
NEA 1979 Annual Report. (Manila, Philippines: National Electrification Administration), 1979.

Comision Federal de Electricidad. Plan Nacional de Electrificacion Rural 1979-1982. Mex. City, Mexico.

"Credito para Empresas Medias e Pequenas," Banas, 1977

Darrow, Ken and Pam, Rick. Appropriate Technology Sourcebook. Volunteers in Asia Publication. June, 1978.

De Ocampo, N.J., "DBP Schedule of Interest Rates, Fees, and Other Charges," (Manila: Development Bank of the Philippines), February 14, 1980.

Development Bank of the Philippines, 1979 Annual Report.

"Development of a Decision-Making Model for Energy R & D". (Philippines: Center for Nonconventional Energy Development).

Pakistan Basic Facts 1974-75, Pakistan, Islamabad; Government of Pakistan, 1975

The Economy: 1980 Summary and Preview of 1981. Info Brazil, Center of Brazilian Studies, Vol. 2, No. 3. (February, 1981).

Economy of Greece 1976-78. Greece: Chronopoulos, Vassiliades & Co. with Hellenews, October, 1978.

Editors of Fortune, Businessmen Around The Globe, Pennsylvania: Ginigen/ Stackpole, 1965

Foster, George M., Tzintzuntzan: Mexican Peasants in a Changing World, Boston: Little, Brown and Co., 1961

Greece: A Portrait, Athens: Research and Publicity Center, KEDR LTD, November 1979.

Guerrero & Torres., Primer on Doing business in the Philippines, 1980, (Makati, Metro Manila, Republic of the Philippines).

Harlow, Carol S. Philippine Energy Issues. (Prepared for the U.S.A.I.D. Asia Bureau Conference, Energy, Environment and Forestry, Nov. 12-16, 1979 Manila.)

Handbook of Statistics, 1978. New Delhi, India: Association of Indian Engineering Industry, Jan. 1979.

"Helping Small Business Attain Greater Productivity", Brazilian Business, April, 1978.

Hershey, Robert D. Jr., "Gasohol's Market Share Is Meager 1%-2% in U.S.", New York Times, Oct. 13, 1980

Hoge, Warren, "Effort Spurred by Loss of Iraq Oil Supplies", New York Times, October 13, 1980

Hull, Galen. Strategies for Development for the Rural Enterprise Development Project in the Eastern Region ORD of Upper Volta. Partnership for Productivity. January 1980.

International Economic Report of the President, U.S. Government Printing Office Washington, D.C., January, 1977

International Labor Organization, Sharing in Development: A Programme of Employment, Equity and Growth for the Philippines, Geneva: ILO, 1974.

International Monetary Fund, Bureau of Statistics, International Financial Statistics, English, Vol. XXXIII, No. 7, Washington, D.C.: International Monetary Fund, July 1980.

International Monetary Fund, World Economic Outlook, Washington, D.C.; May 1980.

International Trade Guide, Chicago: International Banking Group, Harris Trust and Savings Bank, Jan. 1978.

"Investigacion en Energia Solar" PNUD - UNESCO: Dec. 1978

Investment Guide - Morocco. Citibank - Maghreb, Morocco.

Investments in Brazil, Basic Legal Aspects, Instituto de Desenvolvimento Industrial de Minas Gerais - Indi. Brazil: 1975

Investment Opportunities in the Philippines, (Manila, Philippines: Board of Investments), September 1980.

Jhirad, David J. Brazilian Trip Report. National Center for Analysis of Energy Systems, Brookhaven National Laboratory, December, 1980.

Kidder, Tracy, "The Future of the Photovoltaic Cell", The Atlantic Monthly, June, 1980, p. 68-76.

Kinkead, Gwen "Trouble in D.K." Fortune April 20, 1981 (Brazil)

Knight, Petert., et al. Brazil: Human Resources Special Report. A World Bank Country Study. Latin America and the Caribbean Regional Office, The World Bank. Washington, D.C., Oct. 1979.

Lima, Sergio E. Moreira. Cooperative Alcohol Seminar. Brazilian Embassy Energy Office, December 1980.

Lima, Sergio E. Moreira. Use of Alcohol as a Fuel in Brazil. Brazilian Embassy Energy Office: September, 1980.

Lof, George O.; Duffie, John A.; Smith, Clayton O.; World Distribution of Solar Radiation, University of Wisconsin: Solar Energy Laboratory, July 1966.

Manibag, F. R. Patterns of Energy Utilization in Philippine Village: Sources, End-Uses and Correlation Analyses (Draft Report prepared for the International Energy Agency, OECD and to the Rockefeller Foundation), December 1979.

Market Research Summary: Energy and Power Generation Systems (Prepared for "AMPRO/ASEAN "80", American Products Exhibition, March 11-15 1980, Manila, Republic of the Philippines).

Martin, Everett G., "Argentina Is Pushing Firms to Modernize, But Many Fear Imports May Swamp Them", The Wall Street Journal, July 30, 1980, p. 36.

de Mendoga, Antonio Aureliano Chaves. The Brazilian Energy Question. Brasilia: 1980

Instituto Mexicado de Comercio Exterior. Mexico, 1980. Mexico: 1981.

"Mexico, Flush with Oil, Remembers Rural Poor," The New York Times, September 21, 1980.

"Mexico Manufacturing Sector: Situation Prospects and Policies" World Bank Country Study, March, 1979.

"Mexico Spends Billions to Foster Growth Outside Bursting Capital", The Wall Street Journal, January 20, 1981.

Ministry of Economy, Argentine Economic Development, April, 1976 - June 1979, Argentine Republic, Buenos Aires: La Tecnica Impresora. 1979

"Monthly Information Review", Banque Marocaine du Commerce Exterieur, January/February 1981, November/December 1980, July/August 1980.

Moskow, Michael H., Strategic Planning in Business and Government, New York: Committee for Economic Development, 1978.

Murray, Charles A. A Behavioral Study of Rural Modernization: Social and Economic Changes in Thai Villages, New York: Praeger Publishers, 1977

National Census and Statistics Office: Monthly Bulletin of Statistics April 1980 (Manila: NEDA), 1980

National Economic Development Authority. Five Year Philippine Development Plan, 1978-82. (Manila, Philippines), September 1977.

National Economic Development Authority. Long-Term Philippine Development Plan Up to the Year 2000. (Manila, Philippines), September 1977.

National Economic and Development Authority. 1979 Philippine Statistical Yearbook. (Manila, The Philippines: NEDA) 1979.

National Foreign Assessment Center, C.I.A. Handbook of Economic Statistics 1978, A Research Aid, U.S. Government Printing Office, Washington, DC, Oct. 1978

The National Nonconventional Energy Resources Development Program Progress Report, January 1980. Prepared by the Ministry of Energy, Center for Nonconventional Energy Development, Republic of the Philippines.

National Statistical Service of Greece, Statistical Yearbook of Greece 1978, Greece, Athens: 1978.

"O Drama das Pequenas e Medias Empresas", Negocios en Exame, Nov. 5, 1977.

Overview of Small- and Medium - Sale Industries (SMI) in the Philippines. Research Department Institute for Small-Scale Industries. Quezon City, Metro Manila: University of the Philippines, April, 1980.

Pacific Northwest Laboratory, Export Potential for Photovoltaic Systems, prepared for U.S. Dept. of Energy, Asst. Sec. of Conservation and Solar Applications, Office of Solar Applications, April, 1979.

Patil, P., et al. Solar Energy Commercialization in India, Malaysia, Philippines and Singapore (Prepared for U.S. DOE by Systems Consultants, Inc.), 1979.

Palmedo, Philip F., et al, Energy Needs, Uses and Resources in Developing Countries, prepared for U.S. Agency for Intl. Development, NERDA/TAB - 995-18-76 with the U.S. Dept. of Energy, New York, Upton: Policy Analysis Div. Natl. Center for Analysis of Energy Systems Brookhaven Natl. Laboratory Assoc. Univ., Inc. March, 1978.

Petroleo, Bralileiro S.A., Brazil and Petrobra's. Social Communication Service, 1980.

Petroleo, Bralileiro S. A., Brazil and Petrobra's. Social Communication Service, 1980.

Philippines Investment Guide. Citibank, Financial Planning and Management Division. Manila, Philippines: June, 1978

Philippine Yearbook 1979. (Manila, Republic of the Philippines: National Economic and Development Authority), 1980.

III Plano Nacional de Desenvolvimento - 1980-85. Republica Federative do Brazil September 1979

Policy Strategies for the International Marketing of Photovoltaics, Final Reports, Volumes I and II. Report prepared by IIT Research Institute, Chicago, Illinois for Jet Propulsion Laboratory, California Institute of Technology under Contract No. 955463, (August, 1979).

PDCP, 1979 Annual Report, (Philippines: Private Development Corporation of the Philippines).

PDCP Long-Term Financing, (Philippines: Private Development Corporation of the Philippines).

"Questions & Answers on Foreign Investments in the Philippines," (Philippines: Board of Investments), June 1980.

"Renewable Energy Sources for the World's Poor: A Review of Current International Development Assistance Programs." Solar Energy Research Institute. Colorado: October, 1979.

Rodrigues, Eduardo Celestino. Crise Energetica. Editoras Unidas Ltda. Sao Paulo, Brazil, Nov. 1979.

Rosenblum, Bifano, Hein, and Ratajczak. Photovoltaic Power Systems for Rural Areas of Developing Countries. NASA Technical Memorandum 79097 presented at Interregional Symposium on Solar Energy for Development, Tokyo, Japan (February, 1979).

Shetty, M. C., Small-Scale and Household Industries in a Developing Economy, Bombay: P.S. Jayasinghe, Asia Pub. House. 1963

Sir William Halcrow and Partners. Testing and Demonstration of Small-Scale Solar-Powered Pumping Systems: State of Art Report, UNDP Project GLO/78/004, London: The World Bank, Dec. 1979

Smith, Douglas V. "Small Scale Energy Activities in India and Bangladesh" Trip Report - March 17-31, 1977 and April 3-14, 1977. Energy Laboratory Working Paper, Massachusetts Institute of Technology: August 31, 1977.

"Solar Electric Generator Systems: Principles of Operation and Design Concepts." Solar Power Corp, Woburn, Massachusetts.

Solar Engineering Group. Definitional Mission on Solar Energy Applications in Brazil (for Trade and Development Program, International Development Cooperation Agency Washington, D.C.), Princeton, New Jersey, Aug. 1980.

Staley, E., Morse, R. Modern Small Industry For Developing Countries, New York: McGraw-Hill Series in Intl. Development, 1965.

Steiner, George A., Strategic Planning, London: The Free Press, 1979.

Sullivan & Claycombe, Fundamentals of Forecasting, Reston Pub. Co., Inc. Reston, VA, Prentice-Hall 1977

Systems Consultants, Inc., Overview of Energy Programs/Solar Energy Commercialization Status In Selected Countries, U.S. Government Printing Office, Washington, D.C., Dec. 1978.

"Technological Program on Ethanol" Ministry of Industry and Commerce, Brazil: 1978

Ten Year Energy Program, 1979-1988, (Manila, Philippines: Ministry of Energy), 1979.

Usmani, I. H., "Characteristics of a Typical Village in the Solar Belt of the Developing Countries of Asia, Africa and Latin America, Proceeding of the Semi-annual Photovoltaic Review", U.S. D.O.E., Washington, D.C., Nov. 8, 1978.

U.S. Congress. House. Report to the Committee on Science and Technology. Oversight of Energy Development in Africa and the Middle East, 96th Congress, 2nd sess., April 1980.

U.S. Congress, Office of Technology Assessment, "Chapter X-Energy Conversion With Photovoltaics", Application of Solar Technology to Today's Energy Needs, Vol. 1, Washington, D.C.: U.S. Govt. Printing Office, June 1978.

U.S. Department Of Commerce, International Trade Administration. "Marketing Mexico", U.S. Govt. Printing Office Washington: May, 1981.

U.S. Department of Energy. A Guide to U.S. Solar Energy Systems for International Applications U.S. Govt. Printing Office Washington D.C.: May 1980.

Vicker, Ray, "Crisis in Cairo", The Wall Street Journal, Aug. 22, 1980, p. 32

Walton, J. D., Jr., A State of The Art Survey of Solar Powered Irrigation Pumps, Solar Cookers and Wood Burning Stoves for Use in Sub-Sahara Africa. Georgia Institute of Technology. Georgia: January, 1978. For Al Diriyyah Institute of Geneva, Switzerland.

Weiss, Charles and Pak, Simon. Developing Country Applications of Photovoltaic Cells, Science and Technology Report Series, No. 7, Washington, D.C.: The World Bank, 1976.

Weiss, Charles, Solar Photovoltaic Cells In Developing Countries, Science And Technology Report Series, Washington, D.C.: The World Bank, Nov. 1976.

Westfield, James D. and Mellby, Eric D. K., "Solar and Wind Power For a Rural Tunisian Village and Surrounding Agricultural Uses." Presented at the 7th Energy Technology Conference, March 24-26, 1980, Washington, D.C.

"Why Brazil Believes It is on The Right Economic Track," World Business Weekly, November 3, 1980.

"Will Argentina's New Competitiveness Survive?" Business Week, July 21, 1980, pp. 78-84.

The World Bank. World Development Report, 1979, New York: Oxford University Press, 1979.

Yambot, Efren. Philippine Almanac & Handbook of Facts 1975. Phil. Almanac Printers, Inc.

SERIES

Price, Waterhouse and Company.
International Information Guide Series.

Country-USA: Ernst & Whitney International Series

Foreign Area Studies, The American University, Area Handbook Series
U.S. Government Printing Office, Wash. D.C.

Touche Ross International Business Studies
U.S. Dept. of Commerce, Overseas Business Reports, U.S. Government Printing Office; Washington, D.C.

U.S. Dept. of Commerce, Foreign Economic Trends, U.S. Government Printing Office; Washington, D.C.

U.S. Dept. of Energy, Solar Energy Commercialization for African Countries, U.S. Govt. Printing Office, Wash. D.C. 1978.

WORLD BANK STAFF WORKING PAPERS

Chenery, Hollis B., "The Changing Composition of Developing Country Exports", No. 314. Washington, D.C., January 1979.

Choksi, Armean, "State Intervention in the Industrialization of Developing Countries: Selected Issues", No. 341. Washington, D.C., July 1979.

Fallen - Bailey, D. G. and Byer, T.A., "Energy Options and Policy Issues in Developing Countries", No. 350. Washington, D.C., August 1979.

Hughart, David, "Prospects for Traditional and Non-Conventional Energy Sources in Developing Countries", No. 346. Washington, D.C., July 1979.

Jallade, Jean-Pierre, "Basic Education and Income Inequality in Brazil: The Long-Term View", No. 268. Washington, D.C., 1977.

Keesing, Donald, "Trade Policy for Developing Countries", No. 353 Washington, D.C., August 1979.

Page, John M. Jr., "Small Enterprises in African Development: A Survey", No. 363. Washington, D.C. 1979.

Wolf, Martin, "Adjustment Policies and Problems in Developed Countries", No. 349. Washington, D.C., August 1979.

C - 2

A. THE PHILIPPINES

PREFACE

This report presents the findings of an in-depth market assessment of stand-alone photovoltaic energy systems for small industrial applications in the Philippines. Information to support this study was collected in the Philippines between October 25th and November 19th, 1980. A list of organizations contacted during this period is given at the end of Appendix A.

1. THE COUNTRY AND ITS PEOPLE

The Philippines is an archipelago consisting of 7107 islands scattered over an area of about 300,000 square miles. Of the 7107 islands, only 1000 are populated, and only 462 are a square mile or larger. In 1979, population was estimated to be 46 million people, with 8 million people or 17% of the population living in the Metro Manila area. The populations of the ten most populous areas are shown in Exhibit A1. The country is undergoing a rapid urbanization movement with 36% of the population being urban in 1980 compared with 30% in 1960. This represents an annual growth rate of over 3.6% for urban areas compared to an annual population growth of approximately 2.8% for the country as a whole.

The climate is tropical, having only two seasons, wet and dry. The dry season extends from March to June and the remainder of the year has heavy rainfall. Typhoons are prevalent from June to December, with one exception, the island of Mindanao is rarely subject to tropical depressions. Seismic disturbances are frequent throughout the islands. The average annual hours of sunshine range from 1800 - 2200 hours. Quezon City has an annual mean solar radiation of 383 Langleys per day.

The country has sixty one natural harbors and innumerable rivers, bays and lakes. These provide irrigation, transportation, hydro-electric power and contribute to the fishing industry.

The 1978 GNP of the Philippines was $23.2 billion,representing a per capita income of $500. The average annual real growth of GDP was 5.6% between 1960 - 1978 and real per capita GNP grew 2.6% during the same period. Inflation averaged 5.8% from 1960 - 1970 and 13.4% from 1970 - 1978. Agriculture contributes 29% to the GDP, industry 35% and services 36%. Of the 35% contributed by industry, 25% of the GDP is from manufacturing. Hence, the economic importance of manufacturing can be clearly seen.

The delineation of wealth in the Philippines is sharp. The majority of the population is living at the subsistence level with 53.9% of the total household income going to the top 20% of households.

Exhibit A1

Population of Ten Most Populous Urban Areas

Area	Population (millions)	Island
Manila	8.0	Luzon
Davao	0.6	Mindanao
Iloilo	0.3	Panay
Zamboanga	0.3	Negros
Angeles	0.2	Luzon
Butuan	0.2	Mindanao
Isabela	0.2	Luzon
Cagayan de Oro	0.2	Mindanao
Cavite	0.2	Luzon
	10.4 million	

The Philippines is said to have one of the most skillful and literate populations in Southeast Asia with 83% of the population over age ten able to read and write. The government encourages schooling and offers free elementary education to all. The Philippines has a young population with 57% of the population under age 20, and the median age being 17 in 1977. 52% of the population is of employable age (15-64 years), and the labor breakdown is shown in Exhibit A2.

Exhibit A2

Labor Breakdown

Type of Labor	Percent of Labor Force
Agriculture, forestry, fishing	60%
Manufacturing	12%
Commerce	10.5%
Government and Services	10.5%
Transport, storage, communication	3.5%
Construction	3%
Other	0.5%

The country is rich in both mineral and biological resources. Fifty-three percent of the land is forested, providing major industries in timber, lumber and veneer. The Philippines is basically an agricultural state, being the world's largest producer of coconuts and the third in copra production. Rice, sugar, fish and orchids are also major products. The country is unique in production of abaca, also known as Manila hemp.

The Philippines is also rich in mineral resources. Gold, iron, copper, zinc, lead, chromium, cement, salt, asbestos, granite, pearls and shells are all found in quantity. This abundance of natural resources provides a good supply of raw materials for cottage industries.

2. THE PHILIPPINE CULTURE

Within the Philippine culture, the most important underlying values are family and a sense of mutual social respect and pride. The Philippine extended family includes not only blood relatives, but also "compadres" - sponsors at a child's baptism and wedding who assume familial responsibilities for that child. The family is the basic unit of society. It offers its members tremendous support and security. Whereas Americans draw strength from being able to act independently, Filipinos find security in interdependence coming from within the family group, where family members are responsible for one another. Wealthy family members, and those in positions of power are expected to assist less fortunate family members. Major decisions are rarely reached independently, and generally, the decision reflects the concensus of the family. Likewise, family obligations take precedence over one's civic responsibility, obligations to an employer, or one's own personal preferences.

Just as Filipinos are interdependent within the family unit, they are interdependent in society as well. Interdependence is fostered through a series of "debt of gratitude" or "reciprocity" relationships. It is a network of favors asked, and favors repaid. The favor may be as direct as finding someone employment, or it may mean performing duties a Westerner would consider "his job". A Filipino is under an obligation to repay these favors in whichever way he can. An individual is "charged" according to his ability to pay. (While a poor employee may never be able to repay a large loan, she can, for example, volunteer her services in preparing for a family celebration). A Filipino is honored to be asked a favor. On the other hand, he is not ashamed to ask for a favor in return.

Smooth social interaction is a most important Philippine value. Filipinos believe that relationships, whether with a store clerk, a business associate, or a family member, should not have open conflict. In a Filipino organization, it is as important to preserve good relationships as it is to get the job done. The individual who gets along best with his co-workers, is as apt to be rewarded as the one who does the best work. To compliment someone's skill at social interaction is the highest compliment that one can give.

The last point of note is that the Filipinos have a tremendous sense of pride. A Filipino is expected to be sensitive to the feelings of others, so that the self-esteem of others is not hurt. A Filipino will go to great lengths to avoid causing others shame or embarrassment, because he is so sensitive to embarrassment himself.

2.1 The Industrial Sector

The Industrial Sector in the Philippines is broken down into four categories, Large Scale Industry (LSI), Medium Scale Industry (MSI), Small Scale Industry, (SSI), and Cottage Industry (CI). The criteria used to place an establishment in one of these categories is number of employees, value of total assets, organization, and type of activity. The definition of each category is shown in Exhibit A3.

2.2 Establishments

In 1975, 79,889 industrial establishments were registered with the Philippine government. The breakdown of these establishments between Large Scale, Medium Scale, Small Scale, and Cottage Industry is shown in Exhibit A4. It can be seen that small scale industry and cottage industry account for the largest number of establishments, 78,782 establishments or 98.6% of registered establishments. Of those establishments considered small scale, 96.7% or 68,738 establishments belonged to the smallest subsector, 5-19 workers.

It should be noted that, as in most non-industrialized nations, a large number of cottage industry establishments are thought to be operating that are not registered with the government. As a result, the real number of cottage industry establishments is most likely greater than the 7,698 registered. It was not possible to estimate the real number of cottage industry establishments.

2.3 Employment

In 1975, 754,128 workers were employed by the registered industrial establishments. The breakdown of these workers by type of establishment is shown in Exhibit A5. Of the 754,128 workers, 357,869 or 47.5% were employed by small scale and cottage industries. Therefore, while small scale and cottage industry accounted for 98.6% of the registered industrial establishments, they accounted for only 47.5% of the employment.

Exhibit A3

INDUSTRIAL CLASSIFICATION IN THE PHILIPPINES

CRITERIA

Category	Type of Activity	Organization	Capital Assets	Employees
Large Scale Industry	-manufacturing and service -capital intensive	-specialized and complex line management	> $540,000	≥ 200
Medium Scale Industry	-manufacturing and service	-specialized staff in line management	$135,000-$540,000	100 - 199
Small Scale Industry	-manufacturing and service	-owners-managers not engaged in production	$ 13,500-$135,000	5 - 99
Cottage Industry	-manufacturing and service	-carried on in home for profit -owner manager participates in production -employees are usually family members	< $13,500	< 5

Exhibit A4

TOTAL NUMBER OF ESTABLISHMENTS IN THE
ORGANIZED MANUFACTURING SECTOR,
BY INDUSTRY SCALE
1972, 1975

Year	CI (0-4 workers)		SSI (5-99 workers)		MSI (100-199 workers)		LSI (200 & over workers)		Total Organized Manufacturing	
	No.	%	No.	%	No.	%	No.	%	No.	%
1972	4,141	6.29	60,906	92.6	307	0.5	443	0.7	65,797	100.0
1975	7,698	9.64	71,084	89.0	501	0.6	606	0.7	79,889	100.00
Average annual growth rate (1972-75)		23.0		5.3		17.7		11.0		5.4

Sources: NCSO data, NACIDA

Exhibit A5

AVERAGE TOTAL EMPLOYMENT
BY INDUSTRY SCALE
1975

Industry Scale	Total Employment	% Share
Cottage Industry (CI)	25,770	3.4
Small Scale Industry (SSI)	332,099	44.0
Medium Scale Industry (MSI)	56,371	7.5
Large Scale Industry (LSI)	339,888	45.1
TOTAL	754,128	100.0

Source: NC 50 Data

2.4 Wages and Salaries

The average wages and salaries of paid workers in the Large Scale, Small Scale, and Medium Scale Industry categories are shown in Exhibit A6. Information about Cottage Industry was not available. It can be seen that the average wage is highest for Large Scale Industry and lowest for Small Scale Industry. While Small Scale Industry accounts for 89% of registered industrial establishments, and 44% of employment, it accounts for less than 24% of all industrial wages.

Exhibit A6

Average Annual Wages and Salaries
By Industry Scale
1975

Industry Scale	Number of Paid Workers		Wages & Salaries		Average Annual Wages and Salaries Per Worker
	(000)	%	Value ($US)	%	($US)
SSI	233.0	37.0	96,554	23.4	414
MSI	56.4	9.0	39,676	9.6	703
Total SMI	289.4	46.0	136,230	33.0	470
LSI	339.6	54.0	276,405	67.0	814
TOTAL	629.0	100.0	412.635	100.0	655

2.5 Labor Productivity

Labor productivity (defined as the goods and services produced per unit of labor) for the various industrial categories is shown in Exhibit A7.

Exhibit A7

Labor Productivity of Small- and Medium-Scale Industries ($Produced/Worker)

Year	SSI	MSI	Total SMI	LSI	Total Mfg.
1968	770	1,851	1,006	1,973	1,541
1970	959	2,459	1,288	2,702	2,095
1973	1,243	3,014	1,662	3,622	2,824
1974	1,581	3,919	2.172	5,203	3,973
Annual growth rate (%)					
1968 - 1974	12.7	13.3	13.7	17.5	17.1

Source: NCSO data

Productivity is seen to decline with reduction in scale. This is generally explained by undercapitalization in the Small Scale industries compared to the overcapitalization of Large Scale Industry. An in-depth look though at the various sub-categories within the Small Scale Industry sector as shown in Exhibit A8 shows the same trend of declining productivity with scale. This may indicate that the productivity trend is caused by more than capitalization.

Exhibit A8

Labor Productivity by SSI Subsectors
($ Produced/Worker)

Year	No. of Workers in SSI Subsector			
	5 - 19	20 - 49	50 - 99	Total SSI
1968	500	946	1,149	770
1970	581	1,108	1,664	959
1973	581	1,649	2,095	1,243
1974	608	2,054	2,905	1,581
Average annual growth rate (%) (1968 - 74)	3.3	13.8	16.7	12.7

Source: NCSO data

2.6 Value-Added

The Value Added of the various industrial categories is shown in Exhibit A9.

Exhibit A9

Census Value-Added
By Industry Scale
1972, 1975

Industry Scale	1972 Value-added ($US 1000)	1972 %	1975 Value-added ($US 1000)	1975 %	Average Annual growth rate (%) (1972 - 1975)
SSI	217,748	19.0	469,509	16.6	29.2
MSI	137,443	12.0	829,973	29.4	82.1
Total SMI	355,191	31.0	1,299,482	46.0	54.1
LSI	792,711	69.0	1,527,632	54.0	24.4
TOTAL	1,147,902	100.0	2,827,114	100.0	35.0

Source: NCSO data

Again, information on Cottage Industry was not available. The effect of declining productivity with decreasing scale is obvious. Small Scale Industry accounted for less than 17% of total industrial value added while accounting for 44% of the employment. Since manufacturing industries accounted for 20.4% of GNP, Small Scale Industry accounted for less than 4% of GNP compared to approximately 12% for Large Scale Industry.

2.7 Distribution by Industry

In 1975, wearing apparel manufacturing (excluding footwear) had the largest number of establishments (37.85% of the total SSI establishments) followed closely by food manufacturing at 36.23%. These two industries combined account for around three-fourths (74.07%) of all SSI. As can be seen from Exhibit A10 the light industries such as the food, textiles and wood products industries had overwhelmingly large numbers of establishments compared with such industries as metal products, machinery and chemicals, whose shares in the total number of establishments were comparatively very small.

The cottage industry sector as shown in Exhibit A11 is dominated by Embroidery, Woodcraft, Metalcraft, and Leathercraft. These four product types accounted for 53% of the cottage industry establishments and 53% of the cottage industry employment in 1978.

2.8 Distribution by Region

As of 1975, 65.5% and 79.9% of the total number of establishments in SSI and MSI, respectively were concentrated in Luzon. Particularly in Metro Manila and Southern Tagalog where the concentration of SSI establishments was as high as 32.4%. This is due to the well-organized physical and institutional infrastructure in Manila and its surrounding areas, and the concentration of business and other economic activities benefiting from the regions' external economics. The same pattern was marked in MSI where 65.1% of the total medium-scale establishments were concentrated in Metro Manila and Southern Tagalog. Exhibit A12 shows the geographical distribution of organized industry.

Exhibit A10

Number and Percent Distribution
of Establishments of SSI
By Industry Group
1975

	Number	% Share
Wearing Apparel Except Footwear	26,906	37.85
Food Manufacturing	25,750	36.23
Manufacture of Textiles	3,243	4.56
Fabricated Metal Products Except Machinery & Equipment	2,640	3.71
Furniture and Fixtures Except Primarily of Metal	2,394	3.37
Wood and Cork Products Except Furniture	2,207	3.10
Footwear, Except Vulcanizing or Molded Rubber or Plastic Footwear	1,244	1.75
Other Non-Metallic Mineral Products	1,201	1.69
Printing, Publishing and Allied Industries	975	1.37
Other Manufacturing Industries	888	1.25
Machinery and Equipment Except Electrical	692	0.97
Beverage Industries	668	0.94
Transport Equipment	530	0.75
Pottery, China and Earthenware	382	0.54
Others*	1,364	1.93
Total	71,084	100.00

* Including Tobacco, Leather Products Except Footwear, Paper Products, Chemicals, Rubber Products, Plastic Products, Glass Products, etc.

Exhibit A.11

Cottage Industries Registered with NACIDA

Industry	# Establishments 1979	# Establishments 1978	# Factory Workers 1979	# Factory Workers 1978
Embroidery	964	1,009	4,473	4,084
Woodcraft	767	716	3,323	2,915
Metal Craft	551	551	2,090	2,061
Leather Craft	304	375	1,301	1,344
Ceramics	367	328	1,309	1,189
Bamboo & Rattan Craft	292	290	1,432	1,332
Food Preservation	239	285	1,030	1,240
Piggery	68	181	148	385
Shell Craft	98	126	535	569
Poultry	79	109	208	258
Fiber Craft	41	96	230	484
Loom Weaving	43	69	148	256
Needle Craft	50	42	219	199
Toy Craft	19	27	64	134
Mat Weaving	6	26	44	97
Rubber Craft	18	25	79	69
Hat Weaving	3	21	12	78
Poultry & Piggery	14	21	31	46
Small Agricultural Hand Tools	12	13	46	56
Machine Parts	8	4	21	30
Related Crafts	228	277	1,151	1,405
Other Industries	479	390	1,869	1,495
Total	4,650	4,981	19,763	19,726

Exhibit A12

Number of Establishments in the Organized Manufacturing Sector By Industry Scale and By Region 1975

Region	SSI		MSI		LSI		Total	
	No.	% share	No.	% share	No.	% share	No.	% share
I - Ilocos Region	7,551	10.6	20	4.0	11	1.8	7,582	10.5
II - Cagayan Valley	3,362	4.7	15	3.0	5	.8	3,382	4.7
III - Central Luzon	7,423	10.4	29	5.8	27	4.5	7,479	10.4
IV - Metro Manila	13,418	18.9	285	56.9	375	62.0	14,078	19.5
IV-A - Southern Tagalog	9,628	13.5	41	8.2	50	8.3	9,719	13.5
V - Bicol Region	5,245	7.4	10	2.0	5	.8	5,260	7.3
VI - Western Visayas	6,540	9.2	9	1.8	29	4.8	6,578	9.1
VII - Central Visayas	3,955	5.6	31	6.2	45	7.4	4,031	5.6
VIII - Eastern Visayas	2,163	3.0	7	1.4	5	.8	2,175	3.0
IX-A - Western Mindanao	232	.3	-	-	1	.2	233	0.3
IX-B - Western Mindanao	1,764	2.5	7	1.4	4	.7	1,775	2.5
X - Northern Mindanao	3,017	4.2	20	4.0	17	2.8	3,054	4.2
XI - Southern Mindanao	4,354	6.2	18	3.6	20	3.3	4,392	6.1
XII - Central Mindanao	2,432	3.4	9	1.8	12	2.0	2,453	3.4
Total	71,084	100.0%	501	100.0%	606	100.0%	72,191	100.0%

Source: derived from NCSO data.

3. PHILIPPINE INDUSTRIAL DEVELOPMENT PLANS

The Philippine Industrial Development Plan is a two-prong plan. The first part of the plan is to assist and promote medium and small scale industries in order to provide meaningful employment opportunities throughout the country that will improve and enhance the skills and well-being of the workforce. The second part of the plan is to develop an industrial infrastructure in the Philippines through government direct investment in capital intensive projects. President Marcos, in September 1979, announced the developing of the following eleven industrial projects:

1. a copper smelter project,
2. a phosphatic fertilizer project,
3. an aluminum smelter project,
4. a heavy engineering industries project,
5. an integrated steel mill project,
6. a petrochemical complex project,
7. a diesel engine manufacturing project,
8. a cement industry expansion project,
9. a project to rationalize and re-organize the local coconut industry,
10. an alcogas development program, and
11. a pulp and paper project.

Beyond capital infrastructure investments such as the projects above and the country's electrification program, the government does not directly assist large scale industry other than acting as a coordinator with other government projects and as a protector from foreign competition. Cottage industry as viewed by the government is a part time supplemental income source, usually conducted by the family. As such, the government recognizes the importance of cottage industries to social welfare, but it also realizes the limits of cottage industries in an international market with an over supply of cottage industry type goods. As a result, the government assists cottage industries to the point of establishing better supply and distribution channels for cottage industry producers and granting exempt tax status for five years for those registered. However, to retain favorable tariff treatment by importing countries, the government discourages and will not support any program which will change the hand-crafted nature of cottage industry goods.

3.1 Role of Small and Medium Scale Industries

The Ministry of Industry has instituted a program for the promotion and development of small and medium industries (SMI) separate from its program of growth and expansion of large-scale industries. This program is principally concerned with technical assistance for existing and potential small business entrepreneurs, to encourage their investments in SMI projects and to guide the growth of SMI projects to success. The development of small and medium-scale industries has the following objectives:

- to help provide non-farming jobs in rural areas and arrest migration to the urban centers from the countryside.
- to use traditional skills and indigenous resources that large-scale industries cannot use due to their small quantity and non-uniform quality.

Toward the attainment of these objectives, the 1978-1982 Five-Year Development Plan of the Philippines includes industrial policies providing greater access to institutional finance, intermediate technology and marketing schemes for the SMI sector.

The current assistance programs for SMI is coordinated by the Commission on Small and Medium Industries (CSMI) of the Ministry of Industry, which is composed of 11 government agencies. The CSMI was created in June 1974, to develop and execute an effective and comprehensive national program to accelerate the development of SMI. Its primary function is to integrate and coordinate the activities of the member-agencies which are:

1. Central Bank of the Philippines (CBP)
2. Development Bank of the Philippines (DBP)
3. Ministry of Agriculture (MA)
4. Ministry of Local Government and Community Development (M LGCD)
5. Ministry of Industry/Bureau of Small and Medium Industries (MI/BSMI)
6. Ministry of Natural Resources (MNR)
7. Ministry of Trade (MT)
8. National Economics and Development Authority (NEDA)
9. National Manpower and Youth Council (NMYC)
10. National Science Development Board (NSDB)
11. University of the Philippines Institute for Small-Scale Industries (UPISSI)

The details of the development plans are provided at the end of this chapter. The majority of the effort appears to be in the provision of managerial and technical assistance and financing up to a maximum of $135,000 for plant equipment and working capital. The loans tend to be of medium length terms, five-years, and to be below market rates. These programs are designed to increase employment in manufacturing in rural areas, provide for the transfer of idle agricultural resources to productive use, and to increase real per capita income in the rural areas.

Studies have shown that of 166 small scale firms studied between 1972 - 1979, 28.9% went bankrupt or discontinued operations. Similarly, of 273 firms studied between 1972 - 1975, 25.6% went bankrupt or discontinued operations. The reasons given for bankruptcies and discontinued operations include:

Management Weaknesses

- poor and inadequate records
- poor financial management
  money in fixed assets and no working capital
- poor organization
- poor production control
- poor training
- poor marketing
- poor decision making

Worldwide Economic Conditions

- recession
- stiff competition

High Costs and Lack of Raw Materials

These difficulties, besides leading to bankruptcy, are also cause for the poor productivity and profitability of the small scale industry demonstrated in previous exhibits. It was noted that small scale industry employs the second highest number of workers, pays the lowest wages, and has the lowest productivity rate.

These problems are the prime concerns of the Commission on Small and Medium Industries (CSMI) in trying to assist small and medium scale industry.

CSMI'S SMALL AND MEDIUM INDUSTRY DEVELOPMENT PROGRAM

In accordance with the CSMI's Countryside Development Program, member-agencies are grouped to form functional working teams. The following programs were outlined by the Commission in September 1978:

Enterprise Project Development

- Medium and Small Industries Coordinated Action Program (MASICAP), MI. MASICAP is a field project promotion organization with around 50 teams consisting of three young college graduates per team spread throughout the country assisting entrepreneurs in preparing feasibility studies and coordinating directly with financing institutions. In the past four years of its operations, over 4,000 SMI enterprise projects have been assisted, of which nearly 2,000 have been established and are in operation.

- Metro Manila Barangay Industrial Development Program (MMBIDP), MI. The program aims to promote the establishment of small cooperative industries in depressed Metro Manila barangays, thus, tapping idle or underemployed manpower resources and stimulating income-generating economic activities in the community.

- Agri-business Development Center (ADC), MA. For agro-industrial development of the countryside, the ADC's encourage the establishment of agri-business enterprises and render assistance and extensive information dissemination on modern agricultural technology.

- Fisheries Program in the Countryside, MNR. The program promotes the maintenance of fishery resources all over the country in optimum productive condition and accelerates the development of the fishing industry.

- ESCAP Industrialization Project in Non-Metropolitan Areas. The first phase of this project aims to identify specific growth centers in non-metropolitan areas of the country and the study of pilot industry projects which will create significant forward and backward linkages in generating socio-economic benefits to the selected rural areas. The CSMI and its Regional Councils will undertake a second phase to implement the identified enterprise projects.

Entrepreneurial Development

- Entrepreneurship Development Program (EDP), UP ISSI. The program seeks to stimulate self-employment for potential entrepreneurs and to provide employment opportunities for others. Its coverage includes motivational development, management skills training, feasibility study and project preparation, and Philippine entrepreneurship characteristics.

Innovative Financing Assistance Programs

1) Development Bank of the Philippines (DBP). The DB provides major financing assistance to SMI projects in rural areas and in export-oriented activities. It offers loans at terms more favorable than those given to large-scale industries. Its countryside financing program is pursued in support of the overall national SMI development program through its 41 branches, 13 sub-branches and 14 agencies throughout the country servicing SMI loan applications. The DBP SMI Financing Scheme has the following features:

   a) Lending Program for Small and Medium Scale Industries

      The target market for this loan package is small and medium scale industries in the rural areas. The loans are intended for the acquisition, construction, or improvement of fixed assets (such as plant sites, buildings, machinery and equipment) and for use as working capital. As a rule, small scale industries can borrow loans of from $13,500 to $135,000, while medium scale industries can acquire loans ranging from $135,000 to $305,000.

   b) Home Industries Financing Program

      Beneficiaries of this program are cottage industries fully owned by Filipino nationals. The assets of these cottage industries after having obtained the loan should be below $13,500. Priority is given to firms in rural areas. Funds obtained under this program could be used for the purchase, construction, or improvement of fixed assets and/or as working capital.

   c) DBP-MSSD Financing Program for Rural Home Industries

      This program aims to assist the Ministry of Social Services and Development (MSSD) in complementing the second phase of its Self-Employed Assistance Program (SEAP) to uplift the living standard of below minimum level income families.

2) Private Development Corporation of the Philippines (PDCP). PDCP is a private institution engaged in the financing of small and medium scale industry projects. Under its Small and Medium Term Lending Program, PDCP offers the following types of loans:

   a) Facility Loan Package

      This package finances the acquisition of machinery and equipment and of land to be used as plant site. The amount that can be secured from this package ranges from $6,750 to $135,000. A four-year amortization period is required after a one-year grace period.

b) The Working Capital Loan Package

This package is provided for permanent working capital loan requirements of SMIs. The value of loans that can be acquired ranges from $6,750 to $27,000.

Both types of loans are available simultaneously as long as the total amount secured does not exceed $135,000. Preference is given to firms in priority investment areas, which include industries which are export oriented, import substituting, utilizing locally produced raw materials, labor intensive, and ancillary.

3) Industrial Guarantee and Loan Fund (IGLF). IGLF is a government financial institution whose function is to extend financial assistance and credit guarantee to small and medium scale industries. The following are the types of IGLF's loan programs for SMIs:

a) Special Time Deposit/Guarantee Program

Under this program, IGLF lends to accredited financial institutions, upon their request, funds in the form of special time deposits for loans to SMIs. In the granting of requests for funds, the IGLF makes its own evaluation of the project proposals. Under this program, IGLF guarantees up to 60% of the total value of the loan.

b) Loan Guarantee Program

Under this program, IGLF guarantees up to 80% of loans made to SMIs by accredited financial institutions. The latter can themselves process and approve the loans without having to send the applications to the IGLF for approval.

4) Philippine National Bank. The PNB provides loans for SMI to finance their working capital requirements and export activities.

5) Financing of Export-Oriented Firms: To support the thrust towards the promotion and development of non-traditional exports, the Central Bank initiated several credit relaxation measures to encourage increased financial assistance of banking institutions to SMI.

In addition to the programs outlined above, there are a number of other technical and consultancy services offered by the government. These are explained in detail below.

o Consultancy Services

1) Small Business Advisory Center (SBAC), MI. There are 12 SBAC regional centers spread out in various parts of the country. SBAC provides managerial and technical consultancy services to small business establishments to improve their productivity, efficiency and profitability.

2) Trade Assistance Center (TAC), MT. Marketing Services by the TAC provide research and information on market channels, trade opportunities and sales promotion for SMI. There are 13 regional centers all over the country.

3) Technology Services. These are provided to SMI throughout the country through the CSMI delivery systems which tap the technology resources of various government institutions, such as NSDB, Design Center Philippines, Food Terminal, Inc., and other specialized industrial institutions.

4) Project Padrino, MI. The CSMI and the BSMI have organized a group of volunteer management experts in Metro Manila and have made their services available to client enterprises in the regions. At present, 40 volunteer experts from professional associations are available on a need-call basis.

o Regional Project Promotion

1) Subcontracting Promotion Program, CSMI & TAC. CSMI's Manufacturers Subcontracting Development Office (MSDO) and TAC's Regional Subcontracting Development Offices (RSDO) provide the means for contractors to locate subcontractors, and for subcontractors to be identified as to their capabilities.

2) Collective Marketing Schemes, MT. The program seeks to organize SMI producers in various regions into marketing associations and corporations so they can gain economic advantage in collective purchasing and selling operations.

3) Export Development Program, Board of Investment. The BOI conducts its regular course on "How to Get Started in Exports" for prospective entrepreneurs who would like to know the mechanics of the export business and holds its product development clinics where businessmen can bring their products for evaluation as to their competitiveness in the international market.

4) Batasang Pambansa. In support to CSMI's program, Batasang Pambansa No. 44 (An Act to Promote Investments in Less Developed Areas) was recently passed to promote investments in "less developed areas" of the country and accelerate the dispersal of industries in the countryside.

o Technical Assistance Projects

1) Local Study Mission, Development Academy of the Philippines. The project is organized to expose selected small businessmen from the rural areas to modern processes and techniques and better systems of operation being used by their advanced counterparts in the urban centers. It is also expected to create possible business tie-ups and subcontract arrangements between large and small-scale firms.

2) CSMI Export Promotion Project for Leather Goods (UNIDO-sponsored). CSMI, BOI and the Philippine International Trading Corporation are working together to assist a group of leather goods producers to combine their unutilized production capacities to serve common export orders. They are being organized on group marketing concept and given technical assistance specifically on promotion and export marketing by a UNIDO consultant on leather goods.

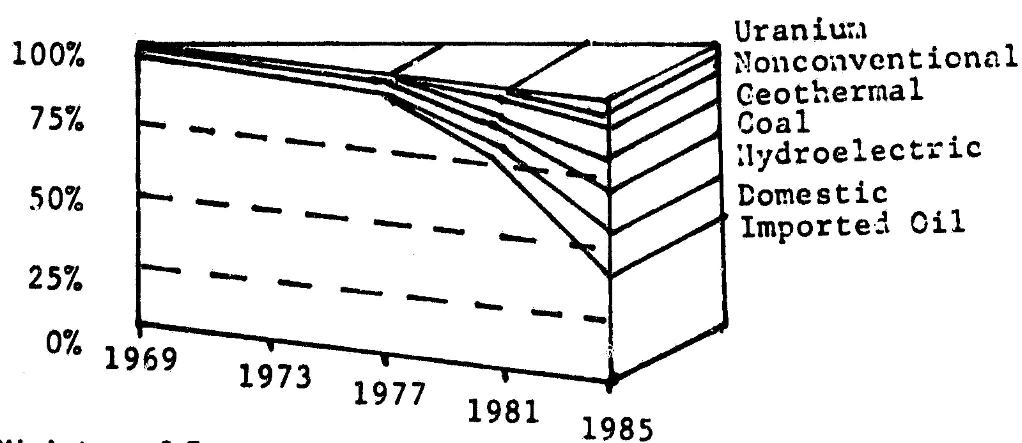
3) CSMI Technology Services Delivery System (UNIDO-sponsored). This is formulated to provide a model of transferring available technology resources to the user-enterprise units in the countryside, utilizing the SBAC as the delivery medium.

4) CSMI Quality Control and Productivity Improvements Systems Project (UNDP-sponsored). This will involve field trips by local and foreign experts who will render consultancy services during plant visits and industry workshops. Studies on product standards dissemination, product design improvement alternatives, infrastructure support, assessment and manpower skills will likewise be conducted.

3.2 Five-Year Energy Program 1981 - 85

The Philippines is undergoing a major diversification effort in their energy mix, trying to switch from foreign oil to other sources of energy. As shown in Exhibit A13, prior to 1977 over 90% of the energy needs of the Philippines were supplied by foreign oil. By 1985, the dependence on foreign oil is planned to drop to less than 50% of total energy needs as indigenous sources such as coal, geothermal, and hydroelectric contribute more to energy requirements.

Exhibit A13
HISTORICAL AND PROJECTED ENERGY MIX
(in percent)



Source: Ministry of Energy

Electrical power generation in the Philippines accounts for approximately 33% of all energy consumption. The remaining energy is consumed by transportation and industrial process heat. By 1985, it is expected that electrical power generation will account for 40% of total energy consumption as industry grows from 41.88 million barrels of oil equivalent (MMBOE) energy consumption in 1981 to 63.51 MMBOE energy consumption in 1985. Together with residential consumption growing from 3.03 MMBOE in 1981 to 18.05 MMBOE in 1985, these sectors account for the fastest growing electrical energy users. The energy source mix and sectored consumption mix are shown in Exhibits A14 and A15.

Exhibit A14

NATIONAL ENERGY SOURCE MIX
(In million barrels-of-oil equivalent, MMBOE)

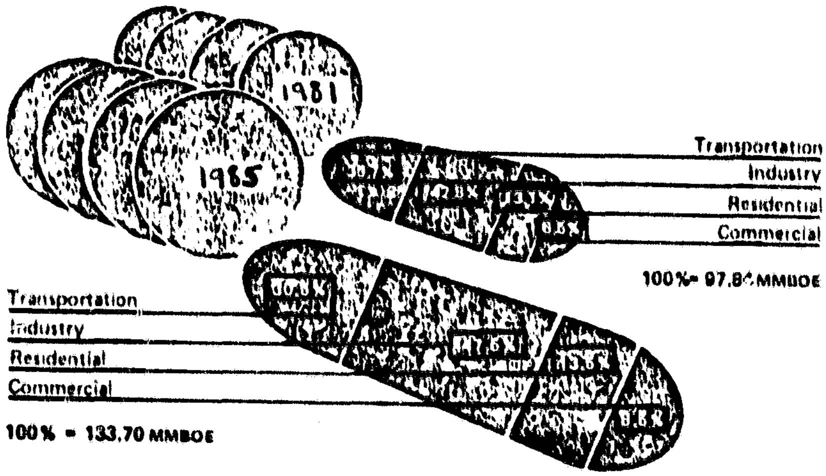
	1980		*1981*		*1985*	
	Volume	*Percent*	*Volume*	*Percent*	*Volume*	*Percent*
Power						
Hydro	6.62	7.21	7.26	7.42	17.08	12.78
Geothermal	3.84	4.19	5.34	5.46	16.34	12.22
Coal	0.42	0.46	1.15	1.18	8.38	6.27
Oil/diesel	19.39	21.13	19.50	19.93	7.02	5.25
Nuclear	—	—	—	—	2.81	2.10
Nonconventional	—	—	0.09	0.09	1.37	1.02
Subtotal	30.27	32.99	33.34	34.08	53.00	39.54
Nonpower						
Oil	60.92	66.39	63.16	64.55	66.44	49.70
Coal	0.52	0.57	1.17	1.20	9.55	7.14
Nonconventional	0.05	0.05	0.17	0.17	4.71	3.52
Subtotal	61.49	67.01	64.50	65.92	80.70	60.36
Total commercial energy	91.76	100.00	97.84	100.00	133.70	100.00
Oil share	80.31	87.52	82.66	84.50	73.46	54.94
Total indigenous	16.51	17.99	22.48	22.97	65.37	48.89
Per capita		1.90		2.00		2.47
Nonenergy consumption*	3.10		3.40		3.70	
Memo total**	94.86		101.24		137.40	

*Nonenergy consumption refers to petroleum only.
**Memo total is the sum of total commercial energy and nonenergy consumption.

Source: Ministry of Energy

Exhibit A15

PROJECTED ENERGY CONSUMPTION: SECTORAL MIX
(In million barrels-of-oil equivalent, MMBOE)



The policy of the Philippines towards non-conventional energy sources is clear and explicitly stated in their publications. The Philippines has been severely impacted by the energy crisis and they are looking at all possible alternatives. However, the country has neither the money nor the resources to engage in research or invest in high risk energy alternatives. For this reason, they show a very small energy contribution from non-conventional sources and these are mini-hydro, dendro-thermal, and biogas sources.

The non-conventional energy sources that the Philippines is considering and their attitude towards them is shown in Exhibit A16. Here it can be seen that photovoltaic systems must compete against a large number of alternative systems, many of which can be remote and small scale and some of which the Philippines views as either being economically viable now or in the near future. Given this attitude, that photovoltaics are not now economically viable or close to viability, the Philippine Government has left the development of photovoltaics to the private sector.

Exhibit A16

Nonconventional energy technologies

Direct solar
- □ Water heating*
- □ Process–steam generation
- □ Refrigeration
- □ Air conditioning
- □ Distillation
- □ Drying of crops, lumber, etc.*
- □ Water pumping
- □ Electricity generation
  - – photovoltaic cells
  - – solar-thermal conversion
  - – ocean-thermal energy conversion (OTEC)

Wind
- □ Water pumping*
- □ Electricity generation

Small hydro
- □ Rural electrification/irrigation*

Biomass
- □ Fuel alcohol*
- □ Drying of crops, lumber, etc.*
- □ Process–steam generation*
- □ Biogas generation
- □ Pyrolytic production of charcoal, gas, oil
- □ Electricity generation
  - dendro thermal
  - waste thermal*
  - producer gas systems

Hot springs
- □ Drying of crops, foodstuffs, lumber*
- □ Absorption refrigeration
- □ Electricity generation by organic Rankine engines

Waste heat
- □ Co-generation
- □ Air conditioning
- □ Drying of crops, lumber, etc.
- □ Motive-power generation
- □ Steam generation

**Presently economically viable or close to viability*

Source: Ministry of Energy

3.3 Electrical Generation and Distribution in the Philippines

To better understand the role photovoltaics may play in the Philippines, it is important to understand how electricity is generated and distributed. This responsibility is split. The generation of electricity is the responsibility of the National Power Company while the distribution of energy is the responsibility of the National Electrification Administration.

The primary role of the National Power Company is the generation of large amounts of electrical power and its transmission to large industrial users or to electrical cooperatives for distribution.

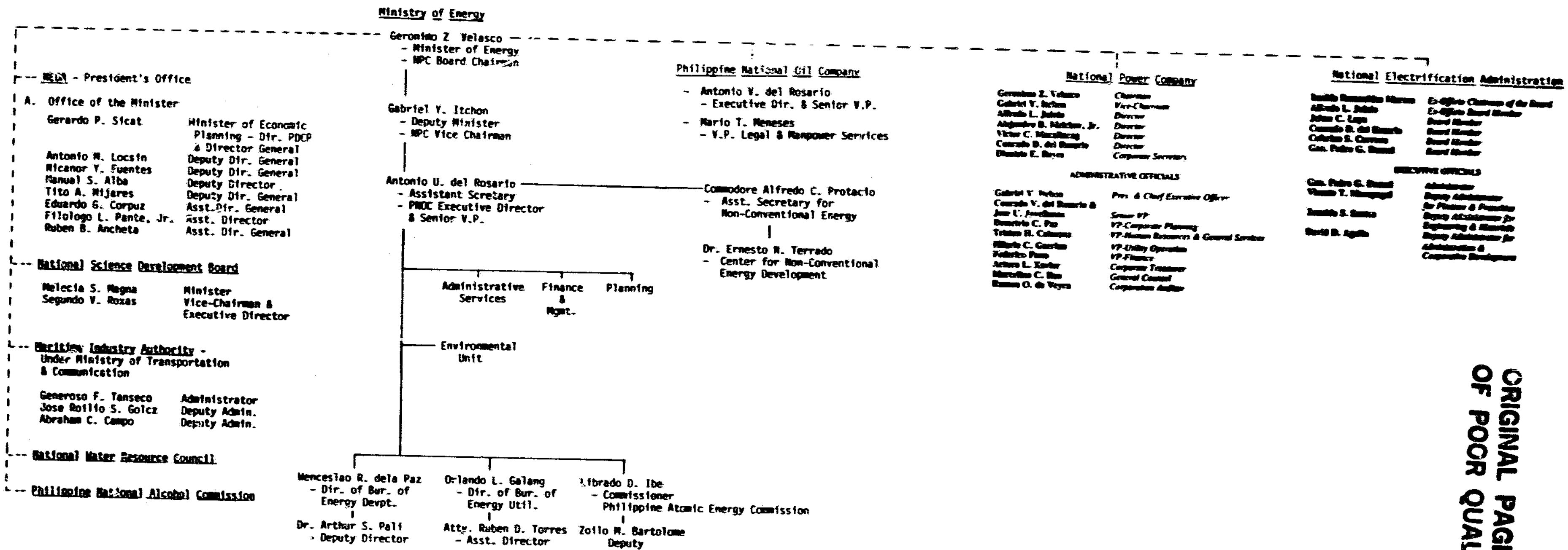
The current chairman of the National Power Company is also the Minister of Energy and the Deputy Minister of Energy is also the president of the National Power Company. The Center for Non-conventional Energy, the government body apparently most responsible for the adaptation of photovoltaic systems is also under the Ministry of Energy. The organizational structure is shown in Exhibit A17. This organization could have a very important bearing on the attitude toward photovoltaics. From the organization chart it can be seen that the head of the Center for Nonconventional Energy reports to the Assistant Secretary. Given this reporting relationship and the interests of the Minister and Deputy Minister, it may be inferred that the Ministry of Energy is primarily concerned with the generation of large amounts of power and small non-conventional sources may not be a high priority.

The National Electrification Administration on the other hand, is responsible for the distribution of electrical power through electrical cooperatives and the development of self-generating cooperatives where transmission from a NPC generation station is not practical. The National Electrification Administration is directly under the Office of the President.

The goal of the National Electrification Administration is to have the Philippines electrified during the first half of the 80s. Exhibit A18 shows the status of implementation. The National Electrification Administration executes its plans through independent electrical cooperatives. However, the electrical cooperatives are controlled by the National Electrification Administration through attractive financing terms, the selection of management, and technical assistance.

Exhibit A17

MINISTRY OF ENERGY ORGANIZATION CHART



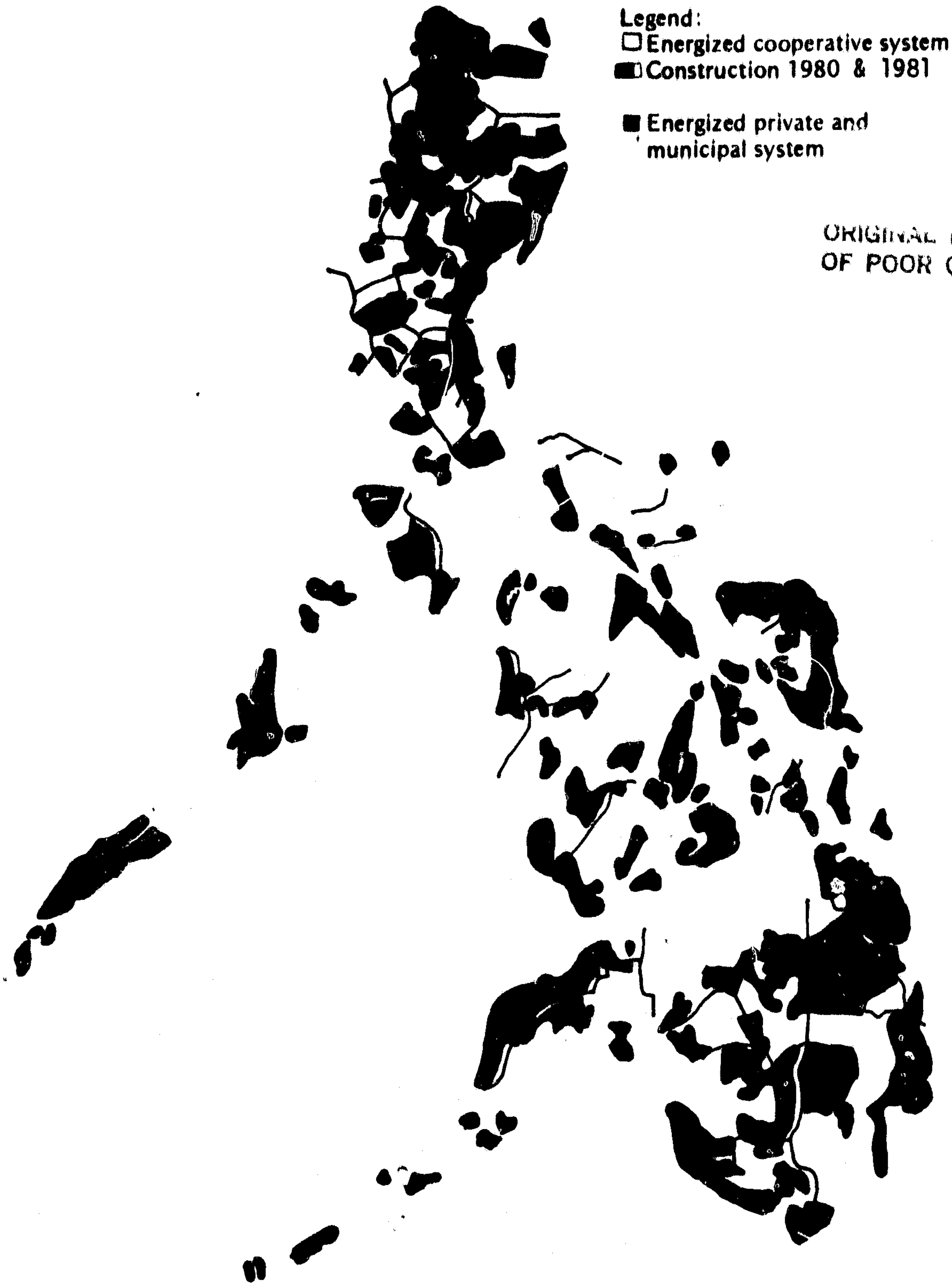
ORIGINAL PAGE IS OF POOR QUALITY

Exhibit A18

NATIONAL ELECTRIFICATION ADMINISTRATION
ELECTRIFICATION PLAN

Status of implementation

As of December 31, 1979



Electrical Cooperatives are basically of two types, self-generating and connected. There are 111 cooperatives in the country. Of these 49 generate their own power and 62 buy power from the National Power Company. The main source of self-generated power is diesel, but there are specific directions to develop dendro-thermal and mini-hydro resources. The smallest generating plant the National Electrification Administration will consider is around 200 kW.

From the breakdown of responsibilities between the National Electrification Administration and the National Power Company and its close relation to the Ministry of Energy, it would appear that the development of Non-Conventional Energy would be the responsibility of the National Electrification Administration since non-conventional energy sources would need to be recommended and financed by them for adaptation.in self generating cooperatives. However, because of the manner of operating at the National Electrification Administration, i.e., through electrical cooperatives, the Center for Non-Conventional Energy may not fit appropriately.

This division of responsibility and interests may be a potential problem for the development of non-conventional energy source including photovoltaics.

4. POTENTIAL IMPACT OF PHOTOVOLTAICS ON SMALL MANUFACTURERS

The University of the Philippines, Institute of Small Scale Industry, lists several distinctive characteristics of small and medium scale industries. Among these are:

1. Relatively little specialization in management
2. Close personal contacts within the company.
3. Handicaps in obtaining credit and capital.
4. No bargaining strength in buying inputs or selling end products.
5. Close integration with local community.
6. The following competitive strengths:
   - Flexibility to sudden and drastic business changes and changing economic conditions.
   - Fast decision making.
   - Flexibility of production with respect to volume, product, and quality.

In order to assess the appropriateness of photovoltaic energy systems for the small manufacturer, it is necessary to assess the impact the system may have on these characteristics. To do this, advantages and disadvantages of a photovoltaic energy system given in Exhibit A19 will be assessed. It should be noted that these are the perceptions of photovoltaic advocates, not the perceptions of photovoltaic users. The purpose of this section is to assess how photovoltaics may impact the small manufacturer.

One of the advantages of photovoltaic energy systems is no fuel cost. This is a very desirable characteristic and one that would be welcomed by all small manufacturers. However, the absence of fuel costs is at the expense of a high capital investment. This high capital investment will be one of the biggest barriers to market penetration. In this section only the strategic implication of the capital investment will be assessed. The economic issues are addressed in Section 5.

Exhibit A20 presents a comparison between the initial capital required for the equipment in some small business and the cost of an appropriate photovoltaic system. It can be seen that the cost of the photovoltaic system is often many times the equipment cost and will nearly exhaust, if not exceed, the $135,000 borrowing ceiling the government has placed on small industries.

Small scale businesses are already handicapped in obtaining credit and capital, and this situation will only be exacerbated by the acquisition of a large capital intensive asset. The cash flow of small manufacturers will

Exhibit A19

CHARACTERISTICS OF STAND ALONE POWER GENERATING EQUIPMENT

Photovoltaic System

- Advantages

  No Fuel Required

  Low Maintenance

  Benign Environmental Impact

  Modularity

- Disadvantages

  High Initial Cost

  Requires Large Land Area

  Technical Complexity

  Rapidly Changing Technology

  Appliance Adaptability

  Limited Scales of Economy

Diesel Generator System

- Advantages

  Low Initial Cost

  Compact

  Transportable

  Mechanical

  Decreasing Marginal Cost

- Disadvantages

  Fuel Required

  Noise and Air Pollution

  Maintenance Required

Exhibit A20

EQUIPMENT COST AND COST OF A PHOTOVOLTAIC
SYSTEM FOR VARIOUS COTTAGE INDUSTRIES

Industry	Power Required	Equipment Capital Required	Cost of Photovoltaic System Required $43/W$_c$ ($13/Wp)
Agricultural Hand Tools	97.5 KW	$ 462,272	$ 4,192,500
Agricultural Implements	74.6 KW	546,518	3,207,800
Bakery	7.5 KW	36,722	322,500
	3.6 KW	NA	154,800
Barrel Making	29.84 KW	283,412	1,283,120
Blacksmithing	2.00 KW	NA	86,000
Brick Making	48.1 KW	1,028,232	2,068,300
	37.5 KW	NA	1,612,500
Broom Making	11.2 KW	43,851	481,600
Button Making	74.6 KW	151,211	3,207,800
Canning	37.5 KW	NA	1,612,500
Charcoal Production	5.5 KW	NA	236,500
Concrete Blocks	11.19 KW	114,488	481,170
Crate & Basket Making	52.2 KW	343,464	2,244,600
Electrical Repair Shop	1.6 KW	NA	68,800
Foundry	56.0 KW	NA	2,408,000
Ice Making	3.4 KW	11,881	172,000
Jute Yarn	18.7 KW	51,844	804.100
Laundry	22.4 KW	106,927	963,200
Leather Tanning	17.5 KW	421,229	752,500
Lumbering	97.0 KW	108,008	4,171,000
Machine Shop	208.0 KW	336,984	8,944,000
Porcelain Making	44.8 KW	624,284	1,926,400
Pottery Making	48.5 KW	NA	2,085,500
Small Print Shop	1.6 KW	546,518	68,800
Sea Salt	14.92 KW	293,781	641,560
Shoe Making	74.6 KW	365,066	3,207,800
Shoe Repair	1.7 KW	NA	73,100
Soap Making	37.5 KW	NA	1,612,500
	37.3 KW	128,313	1,603,900
Spinning-Cotton Yarn	17.9 KW	NA	769,700
	22.4 KW	62,644	963,200
Tailoring	19.2 KW	NA	825,600
Decorative Tile Manufacture	75.4 KW	NA	3,242,200
Weaving Cotton Cloth	27.2 KW	NA	1,169,600
Woodshop	4.6 KW	NA	197,800

support only so much credit. If this credit is exhausted, they will not have the financial flexibility to borrow working capital for supplies and repairs or long term capital for additional equipment.

One of the competitive strengths of the small manufacturer lies in his ability to change with market and economic conditions. This means that expenses closely follow production level. This would not be the case if a capital intensive photovoltaic system were acquired. Loan commitments are fixed payments while fuel and maintenance vary with equipment usage and production levels.

Low maintenance requirements are probably desirable from the point of view of the small manufacturer, but not of the government. The government views small scale industry as a labor intensive, low capital industry. Low maintenance could mean less employment and, if so, photovoltaic systems would be given a low social benefit/cost ratio by the Ministry of Energy. This is compared to dendro-thermal systems whose ratio is higher and therefore preferred. Since the government is the ultimate financial backer in most cases, this is an important consideration.

It should also be remembered that service was not a critical element in the users' decision to buy a diesel generator. Therefore, while low maintenance may be desirable, initial cost and technical complexity may far outweigh the advantage. The user, being unfamiliar with the photovoltaic technology, may be reluctant to rely on a system which he does not understand. This is especially true since the system is a critical element in his operation and represents a substantial investment.

One of the competitive strengths of small manufacturers is the ability to change production with respect to volume, product, or quality rapidly. They must be able to add or delete labor, equipment, and supplies as required. As a result, the energy sources used by the operation must be flexible, power must be there when required, and it must be in an appropriate form.

Under most circumstances, the photovoltaic system could meet these requirements. However, it is a question of costs. The manufacturing operation most likely cannot be sun synchronous. As a result storage is required. Various tools or appliances requiring AC power would be used with the system, therefore, an inverter is necessary. If operations expand or contract, power requirements will change. Photovoltaic systems are long life systems with no apparent scales of economy. As a result, capacity additions are costly and deletions are difficult. Thus, while modularity may appear to be an advantage, when system life and economies of scale are considered, this advantage must be questioned.

Another market barrier to photovoltaic systems is the rapidly changing technology. Since the system is long lived and costly, the purchaser must be prepared to live with the system for a long time. With the rapidly changing technology and the expected price reductions, anyone who buys the system today may not be able to compete with his neighbor who buys the system five years from now. Substantial price reductions are expected, as a result the competitor will be able to buy a system at a much lower price while the first time buyer is still paying off his debt. Timing is crucial, and it is not always best to be first.

Photovoltaic systems also require a large land area. A typical 40 Wp panel occupies an area of 13.2 in. x 47.2 in. This means that a 15 kWp system would occupy 1,622.5 sq. ft. or 0.04 acres for modules. The small manufacturer must have the rights to such an area, and maintain and protect it.

Besides considering just the apparent advantages and disadvantages of photovoltaic systems, it is important to consider the possible sociological impact as well. As was noted, the small manufacturer has a very close integration with the local community, and the effect of a very expensive and obvious photovoltaic system on this community integration must be considered. Will the manufacturer be considered a rich industrialist exploiting the workers, or will he be considered an ingenious innovator concerned about the petroleum crisis and the environmental impact of air and noise pollution.

Given these considerations, a photovoltaic system does not appear to be the best power choice for the small manufacturer. It represents a backward integration move into power production which he most likely would prefer not to take, especially given the country's electrification plans. The photovoltaic option also has implications that could severely impact the competitive strengths of a small business.

5. COMPETITIVE ENERGY SYSTEMS

To assess the market for photovoltaic energy systems, it is necessary to understand the present competition, diesel driven and gasoline driven generators and multi-purpose engines. The competition in this market is fierce. There is no local manufacturer of internal combustion engines for use with generators, but firms from all over the world are represented by local distributorships and dealers.

It is estimated that 5,050 generator sets were sold in 1979 and 3,777 in 1978. The breakdown by size is given in Exhibit A21.

Exhibit A21

Generator Sets Sold in The Philippines

Size	Units 1979
0 - 1.5 kW	2100
1.5 - 2.5 kW	1475
2.5 - 3.5 kW	630
5 - 100 kW	254
100 - 300 kW	338
300 - 600 kW	169
600 & Above	84
	5,050

It has been estimated that 75 - 90% of these systems, with most estimates tending to the higher range, were sold as backup units. Only 10 - 25% were used as the prime source of power. The location in which most of the systems were to be used are:

Urban	67%
Rural	20%
OEM	13%

The prime user for the smaller systems were contractors and small businesses such as banks and stores needing backup. The larger units were sold primarily to plants and factories and to large high rise buildings for backup. Distributors felt that the country's electrification program helped their sales. It appears that once electricity becomes available, people become dependent on it. Also, the country has undergone a major construction program and industrial development program creating the need for reliable electrical power.

The distributors who sell the gasoline driven generators also distribute multi-purpose engines. It is estimated that approximately 150,000 of these units were sold in 1979. The breakdown by size is given in Exhibit A22.

Exhibit A22

Multi-Purpose Gas Driven Engines Sold

Size	Units Sold (1971)
2.5 - 8 Hp	42,700
10 Hp	2,300
14 Hp	25,000
16 Hp	80,000
	150,000

It is estimated that of the 150,000 multi-purpose engines sold in the Philippines in 1979, approximately 112,000 units were bought by fishermen. Fishermen predominantly buy the higher horsepower engines for use in their crafts. Farmers and construction contractors are estimated to have purchased 32,000 and 6,000 units respectively. These users typically buy the lower horsepower units.

The distribution channels for diesel driven generators, gasoline driven generators, and multi-purpose engines are wide and varied. There are several full line dealerships which carry a full line of products. That is, they carry small, medium, and large engines and generators. They tend to carry the product of several manufacturers, but only one manufacturer's product in a certain range. For example, they will carry manufacturer A's small generator, but manufacturer B's medium generator. They do not receive much assistance from the manufacturer and their basic goal and interest appears to be to sell the product. As a result, there is not much emphasis on service or parts availability and these are provided only to meet competition.

These dealerships are to be contrasted with the larger distributorships. The larger distributorship tends to be the exclusive distributor of one manufacturer's product. As a result, the product line is limited. However, they do receive manufacturer assistance and are more concerned about service and parts availability.

The larger size diesel generator market, 60 - 300 kW, appears to be dominated by two of these large distributorships. Both are distributors of earth moving equipment and the diesel generator market is of secondary interest to them. However, because of the use of diesel engines in both applications, there is synergism and they are able to maintain a large service network and parts supply. One distributor felt that their emphasis on parts and service was one of their keys to success in the marketplace. For this reason, to maintain control, they owned and operated all outlets. They appeared to have a strong desire to provide good service and planned to remain in the market for the long term rather than to take quick profits.

The distribution of small gasoline driven generators and multi-purpose engines is not as clear. This market appears to be more fragmented with the long time dominant leader being threatened. Again in this market, there is the presence of both exclusive distributorship and multi-product dealerships. However, because of the nature of the product, the exclusive distributors are willing to sell to dealers who will retail the product in competition with the distributor. The distributors need these dealers to market the product, but while requiring certain standards for service and parts, do not rely on dealers to perform this function entirely. These distributors, while selling generators and multi-purpose engines also sell such products as motorcycles and pumps. Therefore, while generators and multi-purpose engines may not be their prime product, there is a synergism similar to that mentioned before. This allows these dealerships to maintain roving service and training people in the field to enhance their long term market prospects. These distributors are also taking a long term view of remaining in the market.

6. PHOTOVOLTAICS IN THE PHILIPPINES

For the past three years, Robert Puckett, first as president of Natural Energy systems and now as president of International Solar has been trying to sell photovoltaic systems to both the private sector and to the government. He was born and raised in the Philippines, is the grandson of the former vice president, and has family and friends in business. He has advertised extensively in magazines and newspapers (some of his advertisements are shown in Exhibits A23 and A24), and has held press conferences and has tried to get all the publicity he can. He offers both parts and systems along with consulting and installation services. Despite his many efforts, he has not been able to sell enough product to keep his exclusive distributorship.

Mr. Puckett attributes his marketing problems in the Philippines to cost and lack of awareness. He has tried to improve awareness by working with the government to establish demonstration projects and by advertising and press. Demonstration projects have been offered by both the U.N. and ARCO-Solar, but the Philippine Government turned these down because of future contingencies. In the case of one project, the Philippine Government could experiment with a 10kW village power system for a year at no cost. If the system were acceptable, the Philippines would pay $100,000 for it and agree to buy more systems in the future. If the system were not acceptable they could return it at no cost. This offer was rejected.

The German Government and AEG Telefunken are presently working with the Philippine Government to build and demonstrate a village power system. This deal is apparently at no cost and has no future commitments. It is awaiting site selection and bureaucratic proceedings.

People who are aware of and knowledgeable about photovoltaics are familiar with the DOE price goals. These goals however do not encourage someone to buy the system now and many people are taking a wait and see attitude.

Exhibit A23

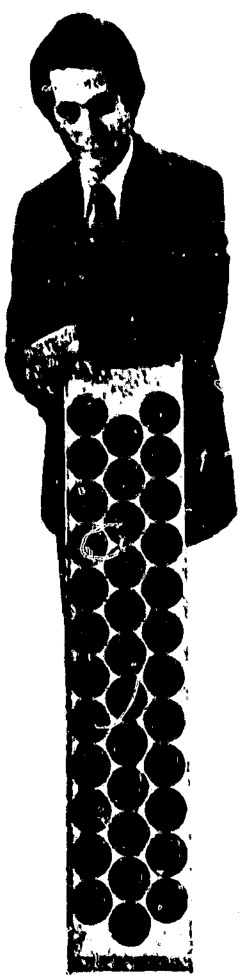
PHOTOVOLTAIC ADVERTISEMENT APPEARING
IN A MAJOR PHILIPPINE NEWSPAPER

THE EXPONENT OF PHILIPPINE PROGRESS

BULLETIN TODAY

VOL. [illegible], NO. [illegible] ★★ SUNDAY MORNING, NOVEMBER 18, 1979 [illegible] PAGES w/PANORAMA — P1.00 IN GREATER MANILA

BULLETIN TODAY, SUN., NOV. 18, 1979



"You're looking at an ARCOpower Solar module"

— two to ten of these rugged 20 watt panels plus a photovoltaic storage battery will keep most remote communications systems at work year round — virtually without maintenance

Solar Energy requires no fuel consuming generators or costly transmission lines. It is infinitely renewable, ecologically impeccable, CLEAN AND IT'S FREE. At a wide variety of isolated repeater sites where power needs are moderate, solar energy storage is the most logical answer. At NATURAL ENERGY SYSTEMS, we can accurately compute the required number of these solar modules and storage battery capacity required for a continuous and efficient delivery at any remote area in the Philippines.

These solar modules are built alike but they're used differently. A microwave repeater may need dozens of these modules, while an ordinary house that needs to power its electrical needs may only require a handful of these ARCOpower modules.

The illustration at left with our solar man himself shows the ARCO 16-1200 solar module which can generate 20 peak watt. Depending on the location, it will give out 100 to 150 watt hours per day.

NATURAL ENERGY SYSTEMS believes these ARCO modules to be the most technically advanced, and most competitive solar panels being produced in the world.

May we prove it to you with figures? See or call us at our office.

ARCO Solar, Inc.

REPRESENTED SOLELY IN THE PHILIPPINES BY

natural energy systems

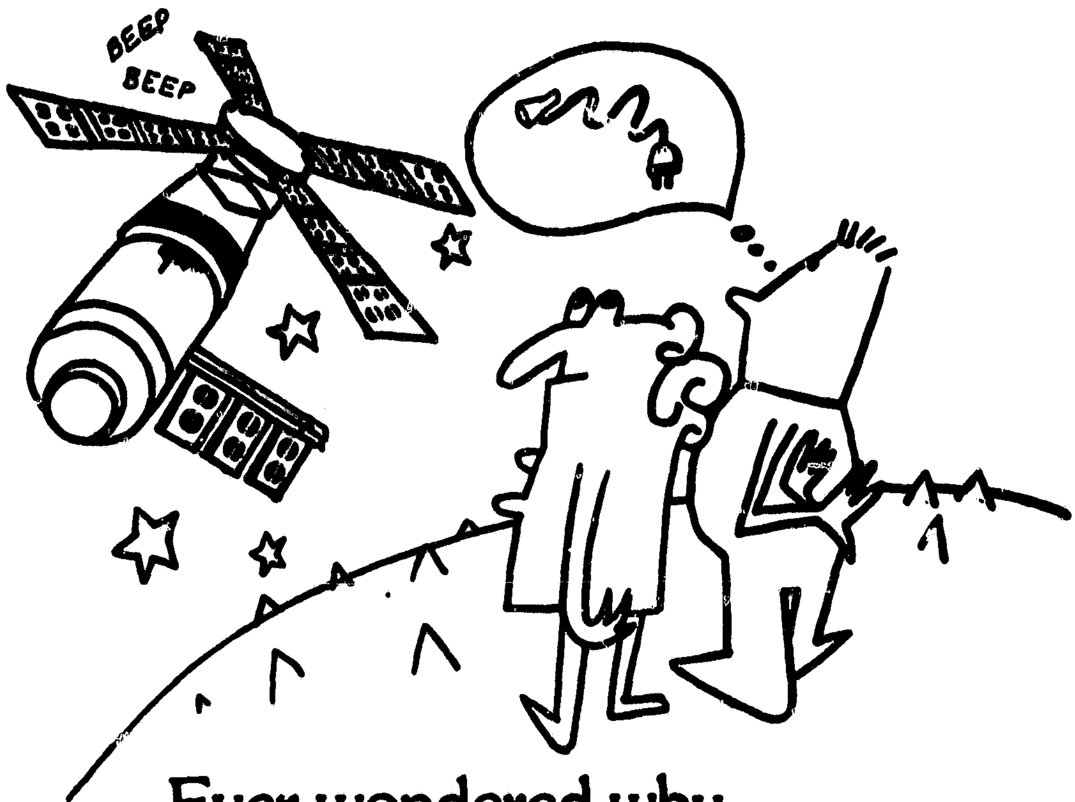
Putting the sun to work for you

* A similar advertisement also was run in Time magazine.

Exhibit A24

PHOTOVOLTAIC ADVERTISEMENT APPEARING
IN A MAJOR PHILIPPINE NEWSPAPER

Business Day Monday, October 29, 1979



Ever wondered why spaceships have no plugs?

Solar photovoltaic cells have been used in space since 1958 on Vanguard TV-4. Since then, Telstar, Apollo, Intelsat-IVA and several other space vehicles have used the sun as a source of electric power. Power to run its environmental, communications and guidance control systems. Just imagine, if a spaceship had to be plugged to an electrical outlet on earth, it would have an extension cord thousands and thousands of miles long!

Today, solar technology is ready to power your home or business needs. And here in the Philippines, Natural Energy Systems, a bright, down-to-earth company with powerful ideas is ready to put the sun to work for you. We have various solar systems and devices that can light up your home or office. Cool your place. Heat your water. And even entertain you! Plug into the sun. See or call us today.

natural energy systems

Putting the sun to work for you.

C. Rivilla Bldg., Aguirre St. Legaspi Village, Makati
Tel. 818-4435 • 89-97-51 local 20
TELEX: SOLAR PN 63621

7. FOREIGN INVESTMENT IN THE PHILIPPINES

Foreign investment in the Philippines is welcomed and encouraged to the extent that the business is in keeping with the plans and policies of the Philippine Government, is not in conflict with existing Filipino businesses and is not in restraint of trade. The Philippine policy on foreign investment is summarized in Exhibit A25.

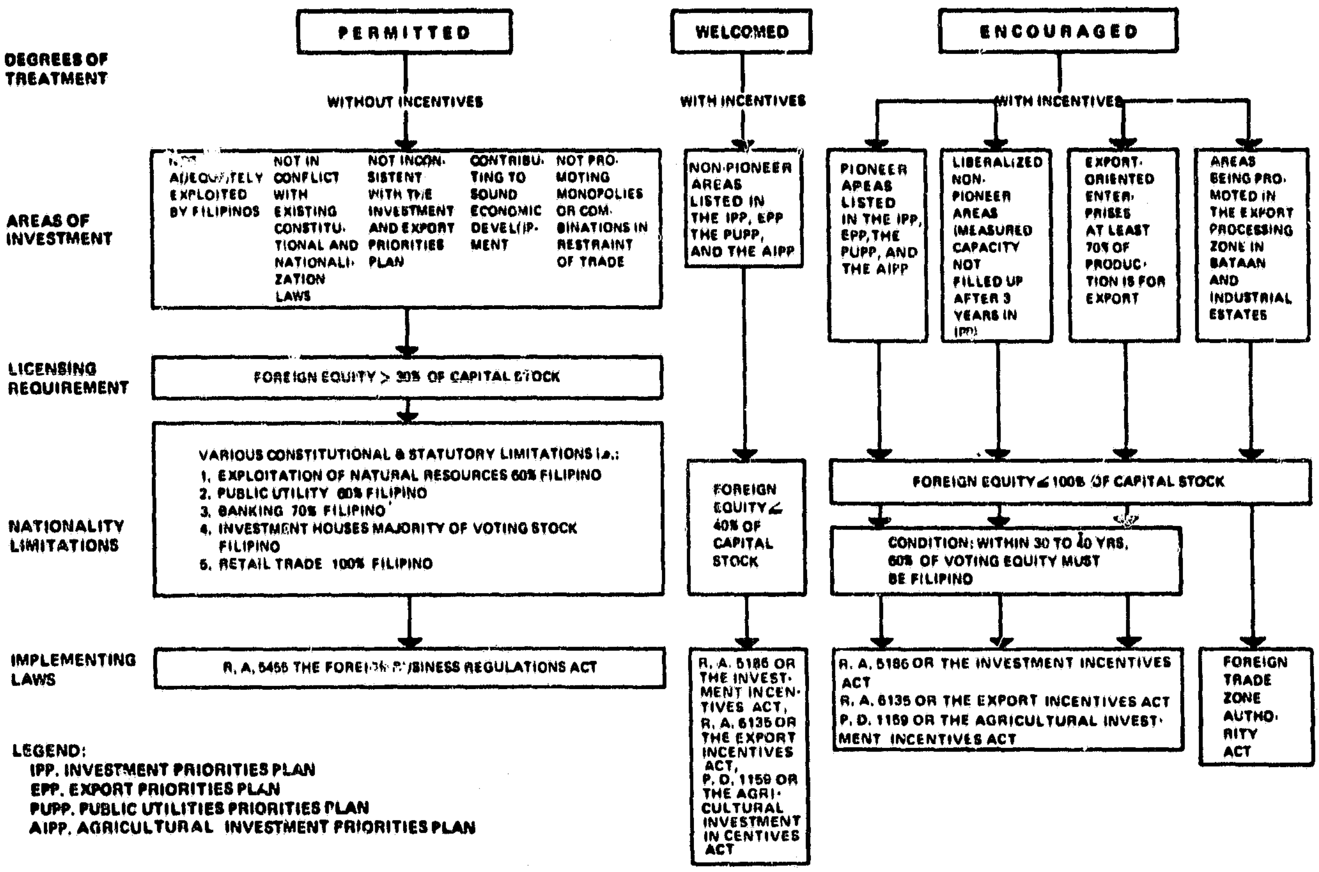
Setting up a business in the Philippines requires application and registration with several government bodies. These include the Board of Investment, the Central Bank, the Securities and Exchange Commission, the Bureau of Customs, National Housing Authority, Export Processing Zone Authority, Bureau of Commerce, Bureau of Internal Revenue, National Pollution Control Commission and local authorities. To assist foreign businessmen in establishing a business an assistance team for foreign investments was created in the Board of Investments. This government help along with assistance from private sources such as accounting firms, consultants, and lawyers, is highly recommended.

The manufacture of photovoltaic energy systems in the Philippines is considered a preferred pioneer industry. This means that the business will receive the incentives of a preferred pioneer enterprise which include protection from government competition and foreign dumping, along with tax and tariff incentives. Unlike a preferred non-pioneer industry, though, it can also be 100% foreign owned for at least 30 years. In addition, the preferred pioneer industry will receive post-operative tariff protection not to exceed 50% of the dutiable value on the importation of products similar to those manufactured and a scheduled exemption from all taxes under the National Internal Revenue Code except income tax. This appears to be a very attractive incentive package.

Financing of a business and the repatriation of profits and investments is governed by the Central Bank of the Philippines. The rules depend upon the amount of domestic borrowing, amount of foreign investment, and extent of product exported. The rules are established to encourage exports and foreign capital investment and borrowing, and go as far as regulating debt/equity ratios if domestic peso borrowing is desired.

Exhibit A25

PHILIPPINE POLICY ON FOREIGN INVESTMENTS



Philippine Key Contacts

Mr. Deo Acupan
Norkis Trading Company
11 Calbayog Corner Libertad
Mandaluyong
Manila, Philippines

Mr. Constantino Aguilar
General Manager
Polygon Argo-Industrial Corp.
1197 E. de Los Santos Avenue
Quezon City
Metro Manila, Philippines

Mr. Jose C.F. Allado
Director, Financial Services
Technology Resource Center
Ministry of Human Settlement
TRC Building, Buendia Avenue, Ext.
Makati
Metro Manila, Philippines

Mr. Emmanual O. Almonte
Head Coordinator
Bureau of Small & Medium Industry
5th Floor
Industry & Investment Building
385 Buendia Avenue, Ext.
Makati
Metro Manila, Philippines

Mr. Arthur M. Alvendia
Director General
Technology Resource Center
Ministry of Human Settlement
TRC Building, Buendia Avenue, Ext.
Makati
Metro Manila, Philippines

Mr. Dorotee Antonio
Forester
Ministry of Natural Resources
Quezon City
Manila, Philippines

Mr. Romeo V. Aquino, Director
Regional Office
Ministry of Agriculture
Region IV
Iloilo City, Philippines

Dr. Jose A. Azercon
Energy & Information Technology
401 Exechem Building
Salcado & Herrera Streets
Logaspi Village
Makati
Metro Manila, Philippines

Dr. S.I. Bhuiyan
Department of Irrigation & Water
Agricultural Economics Department
International Rice Research Institute
P.O. Box 933
Manila, Philippines

Dr. C.W. Bockhop, Head
Agricultural Engineering Department
International Rice Research Institute
P.O. Box 933
Manila, Philippines

Mr. Felipe Buenflor
Forester
Ministry of Natural Resources
Quezon City
Manila, Philippines

Mr. Arnold Caoili
Assistant Secretary
Ministry of Natural Resources
Quezon City
Manila, Philippines

Mr. Rufo Colayco, Principal
SGV & Company
SGV Development Center
105 De LaRosa
Makati
Manila, Philippines

Mr. John Crance, Chief
Fisheries Division
USAID/Manila
APO
San Francisco, California 96528

Mr. Bobby M. Crisostomo
Sales Engineer
Usiphil
Buendia Avenue
Makati, Philippines

Mr. Lino T. Datu
Sales Manager
Alpha Machinery & Engineering Corp.
1167 Pasong Tamo
Makati
Manila, Philippines

Dr. Bart Duff
Agricultural Economist
Agricultural Engineering Dept.
International Rice Research Institute
P.O. Box 933
Manila, Philippines

Mr. Ralph Edwards
Agriculture Division
USAID/Manila
APO
San Francisco, California 96528

Mr. Lawrence Ervin
Senior Energy Advisor
USAID/Manila
APO
San Francisco, California 96528

Mr. Hector L. Fajardo
A. Soriano Corporation
A. Soriano Building
Paseo de Roxas
Makati
Manila, Philippines

Mr. James Ferrara
Catepillar Tractors,
Philippines, Inc.
2123 Pariaso Street
Das Marinas Village
Manila, Philippines

Mr. Jerry Francisco
Ministry of Energy
PNOC Building, Room 1104
Makati Avenue
Manila, Philippines

Mr. Arthur Gamilla
Senior Industrial Engineer
National Grains Authority
Republic of the Philippines
Quezon City
Manila, Philippines

Mr. B.G. Gertes
Managing Director
Cinter for Appropriate Technology
Metro Manila, Philippines

Mrs. Consuelo E. Gomez
Forecasts and Estimates Secretary
De Los Santos Building
582 Quezon Avenue
Quezon City
Manila, Philippines

Mrs. Nelia T. Gonzalas
Assistant Secretary
Republic of the Philippines
Ministry of Agriculture
Quezon City 3008
Manila, Philippines

Mr. Bruce Graham
Consultant
De Los Santos Building
582 Quezon Avenue
Quezon City
Manila, Philippines

Dr. Perfecto K. Guerrero
Science Attache
Embassy of the Philippines
1617 Massachusetts Ave., NW
Washington, D.C. 20036

Mr. S. Gutiarezz
Assistant Director
Equipment Management Group
NIA Building
National Government Center
E. De Los Santos Avenue
Quezon City, Philippines

Mr. Everit Hendricks
Agriculture Division
USAID/Manila
APO
San Francisco, California 96528

Dr. Robert W. Herdt
Agricultural Economist
International Rice Research Institute
P.O. Box 933
Manila, Philippines

Dading Hizon
Executive Vice-President
V R Corporate Management and
Development Incorporated
Command
V R J Building
1643 Dian Street
Makati
Metro Manila, Philippines

Dr. Fufino H. Ibarra
Solar Energy Division
Center for Nonconventional Energy
Development
Diliman
Quezon City
Manila, Philippines

Dr. Tirso J. Jaramandre
President
Jaramandre Industries, Inc.
88 Rizal Street, LaPaz
Iliolo City, Philippines 5901

Mr. Vincente Jayme
President, PDCP
PDCP Building
Ayala Boulevard
Makati
Metro Manila, Philippines

Miss Jimenez
Information Officer
Board of Investments
Industries and Investments Bldg.
Buendia Avenue, Ext.
Makati
Manila, Philippines

Mr. Mark R. Johnson
Development Load Officer
USAID/Manila
APO
San Francisco, California 96528

Dr. Rayaldo Lantin, Dean
Institute of Agricultural Engineering
U.P. at Los Banos
Laguna, Philippines

Mr. Y.G. Lee
President and General Manager
Motorola, Philippines Inc.
Boraheco Building, KM17
West Derica Road, South
Superhighway, Paranaque
Metro Manila, Philippines

Dr. Aida Librero, Director
Socio-Economic Research Division
PCARR, Los Banos
Laguna, Philippines

Dr. Amado Maglinao, Director
Farm, Resources & Systems
PCARR, Los Banos
Laguna, Philippines

Mr. Hermingildo Magsuci
Regional Director
Bureau of Fisheries & Aquatic Resources
Region VI
Iloilo City, Philippines

Mr. Jaunito B. Maiig
Assistant Director for Conservation
and Aquatic Resources
860 Quezon Avenue
Quezon City
Manila, Philippines

Emil B. Mascardo, Jr.
Sales Manager
Cummins Diesel Sales & Service
Corporation of the Philippines
2nd Floor, Park View Building
112 Gamboa Street
Legaspi Village
Makati
Metro Manila, Philippines

I. Bill Obligacion, Jr.
Oriental Machineries
P.O. Box 640
Greenhills
Metro Manila, Philippines

Mrs. Christina Pablo
Manager, Regional Office
Development Bank of the Philippines
Iloilo City, Philippines

Mr. M. Pasquel
Development Administration
National Cottage Industries
Pacific Bank Building, Ramon
Magsaysay Boulevard, Santa Mesa
Metro Manila, Philippines

Mr. Robert Puckett
The International Solar Corp.
C. Rivilia Building
Aguirre Street
Makati, Philippines

Mr. Gil G. Puyat, Jr.
President
Eastern Seaboard Insurance Co., Inc.
Manila Bank Building
Makati
Metro Manila, Philippines

Mr. Tom Ranada
Institute of Small Scale Industries
UP Diliman, Quezon City
Manila, Philippines

Dr. Jose A. Remula, Director
Research and Development
FSDC
2nd Floor Rudgen Building
Shaw Boulevard
Pasig
Metro Manila, Philippines

Mr. Francisco G. Rentutar
Director
Bureau of Agricultural Ext.
Diliman
Quezon City
Metro Manila, Philippines

Dr. Jim Riess
Electrical Engineer-General
NEA Advisory Services Team
Stanley Consultants
c/o NEA
1050 Quezon Boulevard, Ext.
Quezon City
Manila, Philippines

Dr. Gil Rodgigues, Jr.
Economic Research Division
De Los Santos Building
582 Quezon Avenue
Quezon City
Manila, Philippines

Dr. B.M. Salini
Associate Agricultural Engineering
and Head
Department of Irrigation & Water
Management
International Rice Research Institute
P.O. Box 933
Manila, Philippines

Dr. D.C. Salita, Chairman
NRC of the Philippines
University of the Philippines (UP)
Diliman
Quezon City
Manila, Philippines

Dlemente San Augustin, Esq.
Manager, Marketing Intelligence
International Harvester, Philippines, Inc.
744 Romualdez Avenue
Manila, Philippines

Dr. Vic Sandoval
Energy & Information Technology Corp.
401 Exechem Building
Salcado and Herrera Streets
Legaspi Village
Makati
Metro Manila, Philippines

Dr. Aldwyn C. Santos
Technical Assessment Division
Center for Nonvonventional Energy
Development
Diliman
Quezon City
Manila, Philippines

Mrs. Zenaida A. Santos
Deputy Administrator for
Engineering and Materials
National Electrification Administration
1050 Quezon Avenue
Quezon City
Manila, Philippines

Mr. Herminigildo Sayco
Governor, Board of Investments
Industry and Investments Building
Buendia Avenue, Ext.
Makati
Manila, Philippines

Mr. Tom Schlinker
Finance Advisor
U.S. Embassy/Manila
APO
San Francisco, California 96528

Mr. Curtis Stone
Economic Advisor, Energy
U.S. Embassy/Manila
APO
San Francisco, California 96528

Ms. Daisy Ann S. Tabtab
Planning Services
Ministry of Energy
PNOC Building, Room 1104
Makati Avenue
Manila, Philippines

Dr. Quintin Tan
Head Coordinator
Bureau of Small & Medium Industries
5th Floor, Industry & Investment Bldg.
385 Buendia Avenue, Ext.
Makati
Metro Manila, Philippines

Mr. Dick Tayler
TIME Magazine
B&S Investment & Development Corp.
151 Paseo de Roxas
Makati
Manila, Philippines

Dr. E.M. Taylor, Director
Institute of Small Scale Industries
University of the Philippines
E. Virata Hall
UP Campus, Diliman
Quezon City, Philippines

Dr. Alberto R. Tegano
Acting Manager
Development Bank of the Philippines
Makati
Metro Manila, Philippines

Dr. Ernesto N. Terrado, Ph.D.
Administrator, Ministry of Energy
Center for Nonconventional Energy Development
PNPC Merrit Road
Ft. Bonifacio, Makati
Manila, Philippines

Mr. J. Marsh Thomson
Executive Vice President
American Chamber of Commerce of the Philippines, Inc.
2nd Floor Corinthian Plaza
Paseo de Roxas
Makati
Metro Manila, Philippines

Ms. Piedad F. Thoza
Senior Research Assistant
Institute of Small Scale Industries
University of the Philippines, Diliman
Quezon City
Manila, Philippines

Mr. Edilberto A. Uichanco
Senior Vice-President
1200 E. De Los Santos Avenue
Quezon City
Manila, Philippines

Mr. Mauricio R. Valdez
Chief of Division
Industrial Services & Development Div.
National Grains Authority
Republic of the Philippines
Quezon City
Manila, Philippines

Sergio C. Valenzuela
Operations Manager, Mariwasa, Inc.
Mi-Aurora Branch, Mariwasa Bldg.
717 Aurora Blvd.
Quezon City
Manila, Philippines

Mr. Herman J.J. Van Engelen
Professor, Department of Physics
University of San Carlos
Cebu, Philippines

Mr. Stephen P. Wade
Deputy SEA Regional Manager
P.O. Box 1995, MCC
Makati, Philippines

Mr. James Young
Sales Engineer
Usiphil
Buendia Avenue
Makati, Philippines

B. MEXICO

PREFACE

This report is an in-depth study of Mexico and its potential for using stand-alone photovoltaic systems in cottage industry applications. The study was performed based on information obtained in an in-country visit March 16 to March 27, 1981. The areas visited included the Federal District of Mexico, the State of Morelos and the State of Michoacan. A list of organizations contacted is given at the end of this section.

The information contained in this report describes the physical, cultural and economic environment, as well as government policy on industrial and rural development, energy, rural electrification, a discussion of Mexican cottage industry, the status of photovoltaics in Mexico, an estimate of the potential for its application (excluding market barriers and constraints) and a summary of the site visits of rural cottage industry.

1. Geography

The United Mexican States or "Mexico" is the northernmost country in Latin America. It lies on the southern quarter of the North American continent between 14^{0} 32' north latitude and 32^{0} 43' north latitude. Longitudinally, the country extends from 86^{0} 42' west to 117^{0} 46' west. Mexico has a total land area of 1,978,800 sq. km. and borders the U.S.A. to the north, the Pacific Ocean to the west, the Gulf of Mexico to the east and Belize and Guatemala to the southeast. (Refer to map on the following page).

The Mexican territory can be divided into three geographical regions: the Baja, the Mainland and the Yucatan. Baja California is a peninsula which runs along the Pacific Coast for 1,200 km. parallel to the mainland, forming the Gulf of California. The extreme east of Mexico is the Yucatan peninsula. The entire region is a single limestone plateau. The Mainland is diverse in terrain. Mountains run along the west, to the south and in the east. Over two-thirds of the land is at an altitude of 500 meters. The most densely populated region is the Valley of Mexico, located on a dry central plateau. The coastal lowlands of Mexico are tropical in both climate and topography. In the tropical regions, most people live at elevations above 900 meters or the "temperate land".

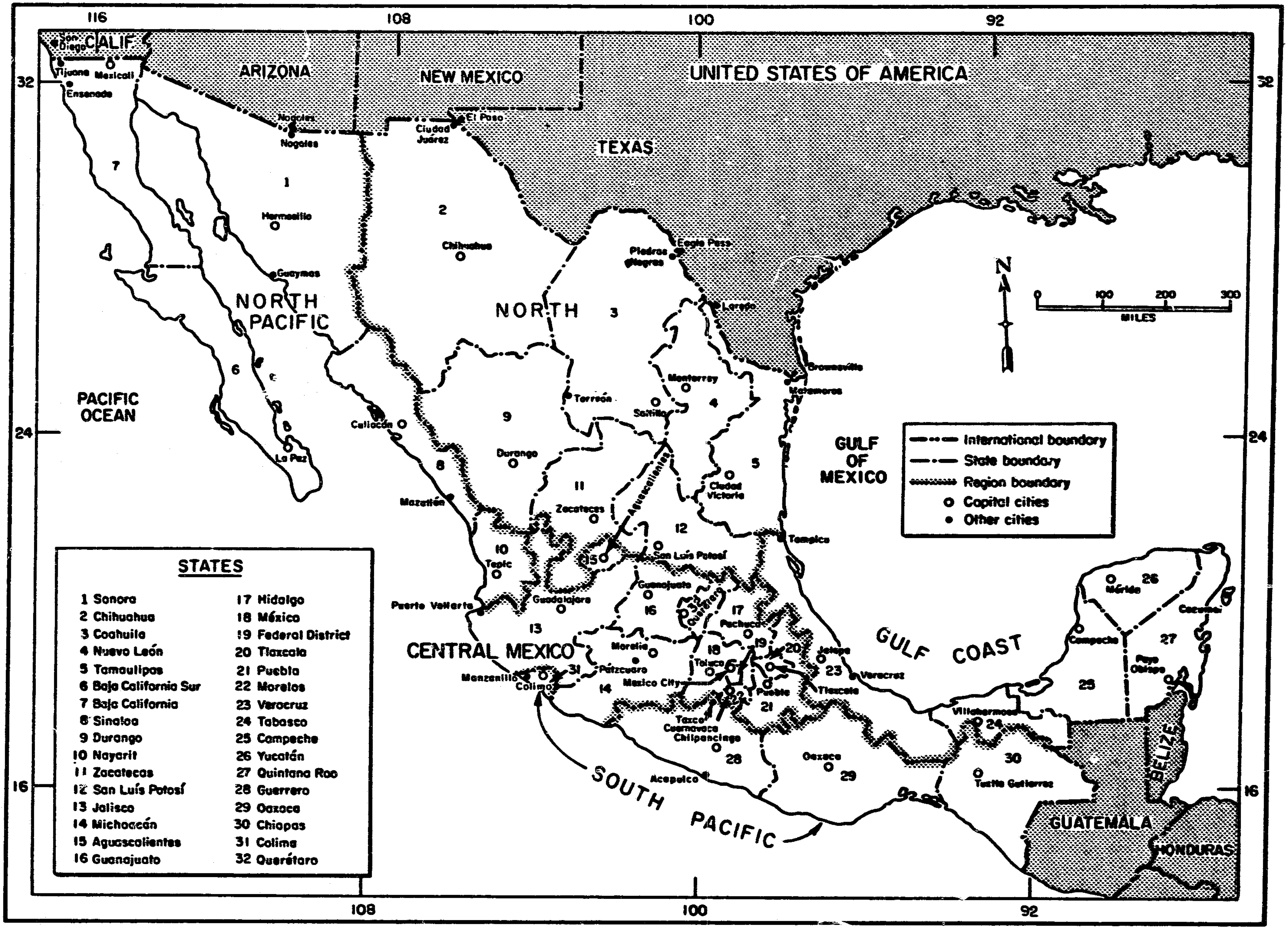
The climate tends to be dry and temperate, but varies with altitude. Rainfall is highly irregular requiring that most of the cultivatable land be irrigated. Mexico is extremely arid, except in the extreme southeast and Gulf Coast regions where they receive intense tropical rainfall. The annual mean solar radiation is 446 Langleys per day and the sun shines an average of 2400 - 3200 hours per year.

2. Infrastructure

At present, Mexico has 210,000 kilometers of federal highway. This represents 0.1 kilometer of highway for one square kilometer of land.

The rail system is fairly well-developed with 25,100 kilometers of track. Over 99% of the rail system is government-owned.

Air transportation has been developed significantly. There are 2,084 airfields, 150 of which have permanent-surface runways and 25 cities



Mexico, Geographic Regions and Political Subdivisi...

Source: Area Handbook for Mexico

with international airports. The two largest airlines are Mexicana de Aviacion and Aeromexico, S.A. Two U.S. airlines, American and United, also serve Mexico.

The telecommunications system is well-developed and a segment to which the government has a strong commitment to further improve. Telephone service is a government enterprise, Telefonas de Mexico, S.A. (TELMEX). There are, at present, over 4.4 million telephones installed. Mexico has one Atlantic Ocean satellite ground station, 574 A.M. stations, 109 F.M. stations and 163 television stations.

Distribution systems seem well-established and do not represent a large barrier to business in the rural sector. Transportation costs vary, but they also do not appear to be a major inhibitor of rural business.

3. Natural Resources

Mexico is the world's largest producer of silver, has large reserves of copper and gold, and is among the world leaders in producing lead, zinc and sulphur. Fluorspars, manganese, salt, uranium, iron ore, coal and natural gas are also important resources. Indigenous gems include opals, amethysts, turquoise, agates and onyx.

At present, Mexico's most important natural resource is oil, in which it currently ranks 4th in world production and 5th in world hydrocarbon reserves.[1]

Agricultural resources for export include coffee, cotton, cattle, sugar, shrimp, tomatoes and fruit. Fish are an important resource and a significant Mexican industry.

Forty percent of the land can be used for pasture, 12% is cropland and 22% is forested.

4. Population

The population of Mexico is 66,114,000 with an average annual growth rate of 2.8%. In 1980, the urban sector accounted for 67% of the population, leaving 33% as rural. The average annual growth rate of the urban population

---

[1] Chemical Week, May 27, 1981, p. 31

is 4.5%. There are three major cities: Mexico City (13.2 million people), Guadalajara (2.3 million), and Monterrey (1.9 million). There are thirteen more cities with populations over 300,000. They are: Ciudad Juarez, Puebla, Tijuana, Chihuahua, Mexicali, Cuernavaca, San Luis Potosí, Veracruz, Hermosillo, Culiacán, Torreón, León and Mérida.[1]

The structure of the population is as follows:[2]

Age Range (yrs.)	% of the Population
0 - 15	48
16 - 30	25
31 - 50	17
50 and over	10

5. Education

Education is extremely important to Mexicans and is regarded as the major instrument to achieving the goals of the Revolution of 1910. The desire for an education is a large cause of urban migration by people seeking better educational opportunities in the city. Although education is free and compulsory for the first nine years, many children in the rural areas do not attend school. The adult literacy rate is estimated at 75%.

6. Labor

The Mexican labor force numbers 18 million, with 34% in agriculture, 25% in industry and 41% engaged in services. Unemployment is currently at 10% and 40% of the labor force is considered underemployed. The government estimates that 700,000 new jobs are needed each year. The labor force in Mexico City is easily trainable for both skilled and semiskilled jobs. Outside of Mexico City, the labor force, for the most part, is unskilled. For white collar positions, there is a surplus of qualified workers. However, there is an unfilled demand for top-level executive personnel.

---

[1] IMCE 1980

[2] 1977, Sec. de Prog.y Presupuesto

7. Religion

Religion has had a strong influence in Mexico and 97% of the people are Roman Catholic. Traditional Christianity prevails in the northern states and in major urban areas. In most rural areas, especially the Yucatan and peripheral populated regions, religion is a fusion of Christianity and preconquest indigenous practices. Indians do not distinguish between religion and culture. Although they have adopted many of the symbols of Christianity, especially saints, they reject Monotheism because it is in conflict with their beliefs of afterlife.

Saints, however, are very important. Every village and region will have patron saints which are honored by shrines, pilgrimages and fiestas. The most common religious symbol is the cross. The cross is believed to protect the faithful from fear, thievery, and similar evils. Failure to pay one's spiritual obligations is believed to cause disease, crop failure, and other such tragedies.

8. Society

One of the most stable and important institutions of Mexican society is the family. The nuclear family consists of parents and unmarried children, but extends the family by ritual kinship. Family relationships play a key role in rural-urban migration. The urban migrant will frequently get his first job through his family and usually settles near extended family members, but still retains ties with rural relatives.

The family functions as a basic economic unit and rural male-female roles reflect the economy. Female activities center in the household and include child-rearing, domestic duties and production of domestic goods, such as pottery and clothing. Male activities include crafts, agriculture and commerce. At peak agricultural times, women also work the fields. In some areas, as in Oaxaca, men are engaged only in agriculture, while women tend the marketplace. Interestingly, Oaxaca is renowned for its pottery.

As a result of the strong family unit, cultural values, behavior and skills are strictly transmitted from father-to-son, mother-to-daughter.

Even though an individual's status and security originates in the family, Mexican society allows for considerable vertical social mobility. Through education, the peasant becomes a laborer, the laborer a professional.

Mexicans are extremely proud of their heritage and they strive for social reform. Most artistic and intellectual works focus on social issues rather than universal ideology.

Spanish is the official language and is spoken by everyone. English is understood by most business personnel. Some remote villages still speak Indian dialects, but this is very rare.

9. Government

Mexico is a federal democratic republic comprised of 31 states and a Federal District. The present constitution was adopted in 1917 and divides the federal government into three branches: executive, legislative and judiciary. The legislative branch is a bicameral national congress, elected by universal adult suffrage. The Senate has 64 members (two from each state and the Federal District) who serve a six-year term. The Chamber of Deputies consists of congressmen elected for three-year terms. Each state has at least two deputies and any political party that polls over 1.5% of the total vote may seat five of its candidates as "party deputies". The number varies with voting percentages. The maximum number of deputies would be 258.

The judicial authority is administered through the Supreme Court of Justice and a system of federal and state courts. The supreme court has four chambers: civil, criminal, administrative and labor.

The superior power of the government lies in the executive branch and is vested in the president, who is elected for a six-year term. The president can be elected for only one term. This office is currently held by Jose López Portillo until 1982. The government is administered through sixteen ministries, two departments and several autonomous agencies, which operate with their own funds subject only to the presidential authority. The ministries having the greatest influence on the adoption of photovoltaics for cottage industry would be the Secretary for Patrimony and Industrial Development, the Secretary for Industry and Commerce and the Secretary for Public Works. Also among presidential powers is the tax courts and public education at the primary and secondary levels.

Each individual state has its own constitution and elects its own governor and chamber of deputies. However, the president has the right to remove any governor for a broad variety of reasons. The Governor of the Federal District is appointed by the President.

10. Economy

The Mexican economy is experiencing dynamic growth. In 1980, for the third consecutive year, the annual growth rate was over 7%. However, since World War II, Mexico has maintained an average economic growth rate of 6%. The 1980 current account deficit did increase to $6.5 billion (U.S.), but this is mainly due to $4.8 billion (U.S.) in payments for financial services. Foreign exchange reserves are up by $1.15 billion (U.S.) due to a net inflow to capital accounts.

Factors which had the greatest impact on the Mexican economy in 1980 were:

- higher international interest rates
- an increase in value-added of in-bond industries
- a favorable international market for precious metals
- decreased tourism
- decreased border transactions
- low increase in productivity.

The investment climate is good. Both public sector and private fixed investments were at a record high in 1980. In the industrial sectors, strong real growth was seen in petroleum, petrochemicals and construction. Even agriculture, an historically slow performer, was up also.

Mexico's goals for economic expansion are extremely ambitious. A long term economic growth rate of 8% annually and self-sufficiency in food production by 1982 are foremost. The present administration is committed to improving the balance of international payments, reducing the rate of inflation (which is currently near 30%), and increasing employment. Private investment that encourages employment receives considerable incentives. Government deficits are quite high, but controls on government expenditures are improving the situation.

The Mexican monetary unit is the peso (PS). There are one hundred centavos to a peso. The exchange rate varies, but averages at 23 pesos per dollar. The official exchange rate as of July 29, 1981 was 24.6 pesos to one U.S. dollar.

The average minimum wage in 1979 was U.S. $4.65 per day in the urban areas and U.S. $4.23 per day in the rural areas.

11. Industry

The major industries are transportation equipment; mining; basic metals and related products; textiles and clothing; processing of food, beverages, and tobacco; chemicals; and petroleum related industries. The oil and petrochemical industry (PEMEX) is a government-owned monopoly. The government has large interests in several other major industries as well. Manufacturing, however, is predominantly private. The manufacturing sector contributes 28% of the G.D.P. with a total industrial contribution of 36%.

Mexican industry is well developed in each of the four sectors (large, medium, small-scale and artisan). In 1980, by definition,

- Large-scale industries are those employing more than 250 persons and having a net worth of at least 60 million pesos (U.S. $2,600,000).

- Medium-scale industries are those employing 26 to 250 persons having a net worth of 7 million to 60 million pesos (U.S. $300,000 to $2,600,000).

- Small-scale industries are those employing less than 25 persons and having a net worth of 50,000 to 7 million pesos (U.S. $2,173 to $300,000).

- Artisans are those industries which employ five to six people and have a net worth of less than 50,000 pesos (U.S. $2,173).

Small and medium size industry (SMI) is a vital component of the Mexican economy, accounting for 45% of production and 60% of employment. SMIs are present in nearly all sectors of industry, especially in food processing and garment making.

Based on size, small industries account for 58% of all manufacturing enterprises and 18% of the total number employed in manufacturing. Small industries have an average of four employees and fixed assets per employee of $1,772 (U.S.)[1]

Medium industries represent only 6.5% of all manufacturers, but employ 37% of the manufacturing labor force. The average number of employees is 75 and average fixed assets per employee are $5,429 (U.S.).

---

[1] Exchange Rate: U.S. $1.00 - 23 pesos.

Ninety-three percent of the small enterprises are sole proprietorship, whereas medium and large establishments tend to be publicly held.

There are over 41,000 artisan enterprises, accounting for 34.6% of all manufacturers. With an average of two employees per establishment,they employ approximately 5% of the manufacturing labor force.

For the performance of this study, cottage industry is defined as small rural manufacturers employing less than 50 people, producing consumer and simple products. There are four classifications of Mexican industry. However, Mexican "cottage" industry falls under three categories: medium-scale, small-scale and artisans.

Exhibits B1 and B2 give a general profile of Mexican manufacturing. Both exhibits are based on the 1970 industrial census before the devaluation of the peso. Exhibit B1 is based on equity capital and Exhibit B2 is based on size of establishments. It should be noted that only registered businesses are included and that the majority of cottage industries are not registered. From these two exhibits, it can clearly be seen that the majority of manufacturers are small-scale or artisan businesses, but these account for less than 23% of the employment by size and only 8% of the equity capital invested.

There are several weaknesses in the Mexican manufacturing sector, but the potential for growth is quite good. Low labor costs, a good base of raw materials and moderate transportation costs due to adequate infrastructure are all factors favorable to a healthy manufacturing sector. The biggest weakness in small and medium size manufacturing is the general lack of management skills, especially in planning and finance. Historically, productivity has been low.

Previously, most products were made for local and domestic consumption, but the trend is to increase exports of manufactured goods. Hopefully, larger markets for simple manufactured goods will provide more employment.

> Financing of SMI by the banking system is supplemented by three public sector trust funds all of which are administered by Nacional Financiera (NAFINSA). These are FOGAIN (Fondo de Garantia y Fomento a la Industria Mediana y Pequena), FOMIN (Fondo Nacional de Fomento Industrial), and FIDEIN (Fideocomiso de Conjuntos, Parques y Ciudades Industriales).[1]

---

[1] "Mexico Manufacturing Sector: Situation, Prospects and Policies." A World Bank Country Study. March, 1979.

Exhibit B1

CLASSIFICATION OF MANUFACTURING ENTERPRISES[1]
BASED ON EQUITY CAPITAL (1970)
(Amounts in millions of pesos)

	Large Industry		SMI		Artisan Industry	
	Quantity	%	Quantity	%	Quantity	%
No. of Enterprises	523	0.44	76,753	64.64	41,464	34.92
Invested Capital	43,430	29.64	102,312	69.83	766	0.52
Gross Production	52,088	25.60	149,260	73.36	2,105	1.03
Value Added	18,772	23.68	59,810	75.45	685	0.86
Fixed Assets	37,846	37.32	62,933	62.06	629	0.62
Total Employment	170,770	11.23	1,298,256	83.21	84,549	5.56

[1] Including enterprises engaged in repair and service of machines and metal working industries.

Exhibit B2

ANALYSIS OF INDUSTRIAL ENTERPRISES ACCORDING TO SIZE (1970)[1]

	Large (>250 Employees)	Medium (26-250 employees)	Small (up to 25 employees)	Artisan (Equity less than Mex $25,000) (U.S.$2,000.00)
Number of Establishments	1,065	7,820	69,614	41,464
Equity Capital Invested (million pesos)	87,263	48,620	11,122	766
Gross Fixed Assets (million pesos)	62,329	31,713	6,226	628
Gross Production	113,435	78,320	18,531	2,105
Value Added	44,700	29,463	7,533	685
Total Employment	630,444	586,635	279,619	84,549
Gross Fixed Assets/Employee (US$ equivalent)	7,914	5,406	1,781	595
Equity Capital Invested/Employee (US$ equivalent)	11,072	6,624	3,200	725
Value Added as Percentage of Gross Production	39,4%	37.6%	40.6%	32.5%
Value Added per Unit of Capital Invested	51.2%	60.6%	67.7%	89.4%
Value Added per Year per Employee (US$ equivalent)	5,680	4,000	2,160	640
Number of Employees per Establishment	592	75	4	2
Total Annual Remuneration per Employee (pesos)	31,000	24,000	15,000	3,000
(US$,1970)	2,480	1,920	1,200	240

[1] Excluding Petroleum and Basic Chemicals Industries

Exchange Rate: $1 U.S. = 22.87 pesos

FOGAIN is the largest organization and a viable opportunity for small enterprises. FOMIN and FIDEIN have less resources and most of their transactions are with medium and large industries.

Based on our in-country research, the cottage industry that would be a potential user of photovoltaics is rural, located in a community of more than 30 persons, is located more than seven miles from a power distribution line, employs less than 25 people and has a total net worth of $2,000 (U.S.) to $3,000. Therefore, all artisans and some small-scale industries would be considered in this study.

The decision to enter a market must take into account the local business environment for the seller, as well as the purchaser. Therefore, it is important to note some of the intrinsic characteristics of Mexican business. In 1960, Mexico adopted a protectionist policy -- the "Mexicanization program." The motivation for this is to ensure that the Mexican people will participate and benefit in their own development. The policy is designed to develop capabilities within Mexico for greater economic independence. Basically, the policy says that if an acceptable substitute can be manufactured in Mexico, the product cannot be imported and the majority of a company's control must be Mexican. Compliance with this policy is insured by requiring import licenses, permits and levying tariffs. However, if a venture or product can demonstrate that it is good for the general welfare of the people, the policy is flexible and terms are negotiable.

Characteristically, Mexican business investors favor low-risk ventures with short-term returns on investments. The usual payback for a Mexican business is a 45% to 50% return within one year. The average industrial return is 35% to 40%. This is not unrealistic considering short-term money is at 30% and long-term is at 32%. Also, many investors are apprehensive of long-term investments, such as a photovoltaic distributorship, before the installation of the new administration in the summer of 1982.

Mexican industry tends to be highly concentrated in terms of control and there are approximately 550 parastatal government entities. Chambers of Commerce are very strong in Mexico and all registered businesses must belong to at least one. The chamber serves a dual purpose, as a surveilling device for the government and as a lobbying and development device for its members.

12. Government Policy on Industrial Development

Energy is perceived as Mexico's lever for development and the National Plan for Industrial Development is very closely integrated with the National Energy Program. Each is interdependent upon the other. The National Industrial Development Plan covers the period from 1979 to 1982, but it also includes long-term goals from 1982 to 1990. However, Mexico's sexennial political cycle does not insure continuity of policy beyond 1982.

The Industrial Development Plan has three underlying motivations:

- to eliminate unemployment and underemployment
- to consolidate the bases for a development process capable of being self-supporting
- to guarantee at least minimum well-being to the whole population

To achieve the goals of the Plan, financial incentives are provided for investment in industries which either provide employment, improve the balance of payments, enhance industrial decentralization or develop specific geographic areas.

For encouraging incentives, the country is divided into three economic zones. New industrial activity in Zone I receives the greatest incentives. Zone I locations are principally those related to the national distribution network for natural gas and oil. It includes the industrial parts of Coatzacoalcos, Tampico, Salina Cruz, and Lazaro Cardenas as well as the corridor of land between Querétaro and León. Industries which build in these areas receive substantial discounts on industrial energy supplies and tax credits.

Zone II includes municipalities that are considered a priority for development by the individual state. These also receive considerable tax benefits for new industry.

Zone III consists of the Valley of Mexico, the Toluca Valley, Puebla and Tlaxcala. This is divided into two areas: the central area which is of controlled growth and within which no expansion or new investment is encouraged, and another (a belt around this regulated space). known as the area of consolidation, which includes all the capital cities of the states surrounding the Federal District (Toluca, Cuernavaca, Puebla, Tlaxcala and Pachuca).

The industrialization plan is flexible, but each incentive has a targeted result. In the small business sector (those with assets of less than $500,000), a liberal 25% investment tax credit is given for expansion or new industry outside Mexico City. The desired result is the creation of labor-intensive plants along the U.S.-Mexican border and the sea coasts. These locations are ideally situated for export oriented industries, thereby improving the balance of payments and creating employment away from the urban areas. The major thrust of industrial development is, however, related to and in support of the energy sector.

13. Rural Development

Mexican rural development programs strongly reflect the goals of the National Industrial Development Plan. They stress social services, food production, employment and availability of basic consumer goods. A major sub-sector of the industrialization plan is the Mexican Food System. The goals of this program are to make Mexico self-sufficient in food production and to improve the diet of lower income groups.

Another issue addressed in the industrial plan is the manufacturing of basic consumer goods at relatively low prices. Increased production of simple basic consumer goods in the rural sector provides employment and helps to offset the impact of inflation on lower income groups.

The Mexican government is very aware of the needs and importance of its rural inhabitants. Under President López Portillo, eleven government organizations which dealt with rural development were brought together under one new organization - COPLAMAR. The purpose for this restructuring was to form a total integrated approach to improving living conditions and to ease poverty in the rural sector. COPLAMAR provides the finances and direction, while using other agencies to actually execute its programs. The most prominant of these agencies is PIDER (program of public investments for rural development). The proposed budget for COPLAMAR is more than U.S.$4 billion over the next three years.

The rural population of Mexico is widely dispersed,both socially and geographically, with many people being nomads and migrants. COPLAMAR's strategy is to bring the isolated population together into stable communities. To achieve this, they intend to provide them access to medical facilities, regular food supplies and potable water. The agency also plans to build 15,000 miles of feeder roads to provide infrastructure for bringing these people together. In 1980, the commitment to the Human Settlement Program was 1.4% of the total federal budget.

By September 1980, the agency had built over 2100 rural medical units, each capable of treating 5000 people, and 41 new hospitals in economically depressed rural regions. Further plans include a project to build 200 large food storage areas to serve as distribution centers for over 6000 villages. Among other programs are a project to bring potable water to 15 million people, another to build 37 boarding schools for children from remote regions and a project to create 300,000 new jobs in agriculture and reforestation.

In keeping with their total integrated approach, frequently light industry will also be introduced to a new settlement to provide employment and income. However, development of small-scale industry is not as high of a priority as food and medicine and therefore would follow the provision of these services.

It should be kept in mind that the lifestyle of the rural Mexican is deeply imbedded in his heritage and family and that change must come slowly and without conflict with the Mexican culture. Mexicans are a proud and independent people. This is why participation of the local community is so important in rural development. If the people feel they have contributed and earned these improvements, they will utilize and maintain them.

14. Government Policy on Energy

In the management of energy, Mexico is a long-range planner. The current national energy program sets concrete objectives to 1990, yet maintains a horizon of reference for the year 2000. Mexico is extremely wealthy in energy resources and, at present, its proven hydrocarbon reserves rank it fifth in the world. The country also has large reserves in uranium, hydropower, coal and geothermal energy.

The primary objectives of the national energy program are to ensure an adequate supply of energy and generating capacity to support Mexican industry, to utilize energy commodities to support an overall,balanced, economic development and, for the very long term, to diversify their primary sources of energy.

The strategy for achieving their objectives is two-fold. One pathway is to stress management of their existing renewable and non-renewable resources. Mexico, like many energy-rich countries, is considered energy inefficient. This is illustrated by their high rate of energy consumption per unit of Gross Domestic Product. Conservation of energy in transportation and industry could represent significant savings of valuable resources.

The other course of action is to observe world-wide technical developments in energy production and remain scientifically at the forefront of those technical developments. The country is currently paying very close attention to world-wide developments in nuclear, geothermal, biomass and solar energy.

Being a key factor in Mexican economic development, the National Energy Program is closely integrated with the purposes and policies of the National Program of Employment, the Mexican Food System, and the National Plan of Urban Development.

The program focuses on the role of energy in three areas: industrialization, regional development and the foreign sector.

In the area of industrialization, development will be in vertical integration of the petroleum industry and in energy intensive industries. As mentioned in the industrial plan, there are considerable financial incentives for new industries in regions related to energy resources, especially Chiapas and

Tabasco. Industries that are strongly encouraged include refining, petroleum processing, and production of heavy machinery used by the energy industry.

Politically, vertical integration of the energy business is an excellent strategy. Currently, the largest purchasers of Mexico's energy commodities are also the primary suppliers of its extraction equipment, as well as the major processors of gas and petroleum. Developing their own capacity in these segments will give Mexico a considerably better strategic position in world-wide marketing of oil and natural gas.

Because of its abundant indigenous energy resources, Mexico also perceives itself as having a competitive edge in energy intensive industries, especially steel and transportation equipment. Utilization of their own resources for developing these industries is an important part of the total energy plan.

In the regional development faction of the energy plan, the goal is to develop positive industrial centers near or along the route of energy centers. The extraction, production and processing of hydrocarbons is making a tremendous impact on the economy of the regions where it is located. To avoid a "boom" and "bust" economic situation, the government is seeking to control the amount of hydrocarbons that can be taken from a region and to promote other industrial activity to complement energy production. The government is also concerned with providing infrastructure, social services and environmental protection to these areas.

The energy plan has five objectives in relation to the foreign sector. They are:

1) Once internal demand is met, to export hydrocarbons in balance with foreign imports.

2) To obtain a higher value added for energy exports

3) To use energy exports to diversity Mexico's foreign trade partners

4) To use energy export receipts to develop a world position in the capital and manufactured goods market

5) To cooperate with other countries in the development of oil supply and in the search and exploitation of local sources of energy.

Controlled levels and desinations of hydrocarbon exports will be the chief instrument for achieving these objectives.

15. Electricity

The generation and distribution of electricity is the responsibility of the Federal Electric Commission (CFE (Comision Federal de Electricidad)). The CFE is an autonomous government agency, directly under the executive branch of the government. The commission is segmented into twelve divisions and the central company for Mexico City. Exhibit B3 shows the twelve divisions and the states which are included in each.

Exhibit B3

DIVISIONS OF THE CFE AND THEIR CORRESPONDING STATES

Division	States Included
1. Baja	North Baja South Baja
2. Northeast	Sonora Sinaloa
3. North	Durango Chihuahua Coahula
4. Gulf-North	Nuevo León Tamaulipis
5. Bajio	Aguascaliente Zacatecas Guanajuato San Luis Potosí Querétaro
6. Jalisco	Jalisco Nayarit
7. Center West	Michoacán Colima
8. Center South	Guerrero Morelos State of Mexico
9. Center West	Puebla Tlaxcala Hidalgo
10. West	Veracruz
11. South East	Oaxaca Chiapas Tabasco
12. Peninsular	Quintana Roo Campeche Yucatán

The Baja region and the Yucatan peninsula each have separate systems. The remainder of the country is interconnected into a South System and a North System. At present, Mexico's interconnected source capacity is 60% thermal power, 35% hydro power and the remainder is supplied by diesel stations and geothermal plants. Exhibit B4 gives a detailed breakdown of capacity by source and region.

Exhibit B4

CAPACITY IN OPERATION AS OF DECEMBER 31, 1979
(in KW)

	Hydroelectric	Thermoelectric					TOTAL
		Steam	Combined Cycle	Turbogas	Internal Combustion	Geothermal Electric	TOTAL
TOTAL NATIONAL	5,218,517	6,716,375	720,000	1,259,170	233,488	150,000	14,297,550
National Electric System	5,217,017	6,135,375	720,000	1,143,170	48,152		13,263,714
Northern Interconnected System	358,700	1.791,000	240,000	531,620	12,480		2,933,800
Northwest Area	327,200	811,000		106,370			1,244,570
North Area		323,000	240,000	288,250	12,480		863,730
Northeast Area	31,500	657,000		137,000			825,500
Southern Interconnected System	4,858,317	4,344,375	480,000	611,550	35,672		10,329,914
Central Area	1,998,726	2,196,800		431,170			4,626,696
Western Area	320,191	992,875		82,780	17,602		1,413,448
Eastern Area	2,539,400	1,154,700	480,000	97,600	18,070		4,289,770
Tijuana - Mexicali		307,000		74,000		150,000	531,000
Peninsular		199,000		42,000	18,350		259,350
Small Independent Systems	1,500	75,000			166,986		243,486

Source: CFE of Mexico

With their ambitious plans for industrial expansion, providing sufficient, reliable generating capacity is a major objective for the Mexican energy sector. Exhibit B5 gives a comparison of seven countries and the percent of theoretical capacity each uses.

Exhibit B5

COMPARISON OF CAPACITY USED IN RELATION TO THEORETICAL CAPACITY

	Capacity (million Kw)	KwH Produced Annually billions)	% of Theoretical Capacity Utilized
Mexico	14.30	58.1	46.5
Brazil	24.50	88.2	41.1
Kenya	0.42	1.3	35.3
Korea	6.90	31.4	51.7
Morocco	1.30	3.5	30.7
Philippines	4.50	16.4	41.2
United States	579.20	2,200.0	43.4

$$\text{Maximum Theoretical Capacity (Kwh/yr)} = \text{Capacity (Kw)} \times 24 \text{ hours/day} \times 365 \text{ days/year}$$

$$\% \text{ Utilized} = \frac{\text{Kwh produced annually}}{\text{Maximum Theoretical Capacity}} \times 100$$

As can be seen from the above exhibit, Mexico uses 46.5% of its maximum theoretical capacity, while the U.S. uses only 43.4%. Among the developing nations, only India and Brazil generate more electricity than Mexico.

The proposed annual growth of electrical capacity is expected to continue at approximately 12%, giving Mexico a 1982 capacity of 20 GW and a 1990 capacity of 40 GW. In 1990, geothermal energy is expected to provide 620 MW of power, nuclear will supply 2500 MW and carbo-electric plants will supply 3600 MW. The remaining 78% will be a mix of hydroelectric and thermal energy.

The CFE serves 20,434 towns and 85% of the total population has access to electricity. This is not to say that they all use it. At present 61% of the population consumes 98% of the energy for domestic purposes, the next 11% of the population consumes 2% and 28% of the population either has no access or does not use electricity at all. As would be expected, the consumption of electricity reflects and rises with income levels. Exhibit B6 gives a breakdown, by division, of the number of towns with service, the number of users, and the total amount of energy purchased.

Exhibit B6

NUMBER OF TOWNS SERVED, NUMBER OF USERS, AND QUANTITY OF ELECTRIC ENERGY SOLD BY DIVISION

Division	Number of Towns with Service	Number of Users (x 1000)	Energy Sold (million Kwh)
Baja California	219	295	1,761
Northeast	1,459	466	3,308
North	1,815	706	4,946
Northern Gulf	1,276	724	5,344
Bajio	3,204	820	4,124
Jalisco	1,267	725	2,795
Central West	1,450	462	1,500
Central South	2,372	525	1,174
Central East	1,848	496	2,218
East	2,106	630	5,223
Southeast	2,231	477	1,155
Peninsular	650	265	870
CLFC (in liquidation)	537	2,510	14,779
TOTAL	20,434	9,101	49,197

The cost of electricity in Mexico varies widely. There are twelve different rate categories based on the purpose for usage and the wattage used. Exhibit B7 designates the various categories, the quantity of energy sold in each category and the number of users in each category.

Exhibit B7

ELECTRIC ENERGY SOLD AND NUMBER OF USERS BY RATE CATEGORY (1979)

Rate Category	Electric Energy Sold (million Kwh)	Number of Users (x1000)
1. Domestic	4,896	5,068
1A. Domestic - regions with very hot summers	4,314	2,779
2. General Usage up to 40 Kw	3,877	1,107
3. General Usage greater than 40 Kw	1,325	11
4. Cornmeal Mills	202	33
5. Public Lighting	1,537	22
6. Potable Water Pumps	1,808	11
7. Temporary Usage	92	8
8. General High Tension	15,692	28
9. Agricultural Irrigation	3,328	34
10. High Tension	297	24
11. High Tension for Mining	1,235	307
12. General Usage, 5MW or more, at 66 KU or more	10,594	94
TOTAL	49,197	9,101

One of the objectives of the tariff policy is to safeguard the purchasing power of the low-income consumer and to provide reasonable protection to Mexican manufacturers. Small scale and artisan industries would be included in rate number 10, *alta tension para reventa*.

16. Rural Electrification

In 1979, the population of Mexico was estimated to be 65.4 million. Of these, 10 million people or 32% of the rural population did not have access to electricity. In an effort to bring electricity to a greater proportion of the rural population, a total of 9,621.5 million pesos ($418 million (U.S.)) has been committed to rural electrification.

The task of electrifying rural Mexico is the responsibility of the CFE and the agency maintains a rural electrification office in each of the 31 states. The decision to electrify an area is made by a committee within each state. Each committee consists of the constitutional governor, a representative of CFE and one or two members of the state government. Each state has its own developmental plan. The locations chosen for electrification are selected on the basis of fit within that plan.

The current National Rural Electrification Plan of Mexico covers the period from 1979 through 1982. In analyzing the need for electricity and the population served, the plan excludes the Federal District, but does consider the remainder of the State of Mexico. By definition, a rural community is one having a population of less than ten thousand people. Within the overall plan, there are three programs:

- Electrification of Population Centers
- Electrification of Public Services
- Electrification for Production.

The objective of the program for centers of population is to provide electricity to a larger number of persons in rural villages and fringe-urban communities.

The program for public services is aimed at providing rural communities with electricity for basic services and the standard necessities of life. Things included would be lighting for training schools, medical attention units and pumps for potable water.

The third program, Electrification for Production,is concerned with increasing agricultural production and creating employment. Included here would be electrification of irrigation pumps, agroindustries and all types of production that will utilize more manual labor. Electrification of cottage industries would fall in this category.

The goals of the program were set based on an analysis of the demand. Three criteria were considered: socioeconomics, technical considerations and investment requirements. The purpose of the socioeconomic criteria is to select those areas for electrification that will demonstrate the maximum social and productive impact. The technical criteria considers the feasibility of improving the load factor and foreseeing the growth and development of the overall network. The third criteria, investment requirements, seeks a rational financial investment to maximize usage of resources with the least cost incurred.

Exhibit B8 illustrates the structure of demand for electricity by population, number of rural communities without access to electricity and the number of persons living in those communities.

Exhibit B8
STRUCTURE OF RURAL DEMAND FOR ELECTRICITY

Range of Population	Number of Rural Communities	Number of Rural Communities Without Electricity	Number of Rural Inhabitants	Number of Rural Inhabitants Without Electricity
1 to 30	57,176	39,713	1,786,311	696,243
31 to 99		16,006		1,010,626
100 to 249	16,582	13,101	3,212,258	2,492,759
250 to 499	12,150	6,667	4,857,809	2,690,631
500 to 999	7,384	2,618	5,696,437	2,063,046
1000 to 2499	4,073	548	6,920,598	1,015,229
2500 to 10,000	1,544	15	9,039,417	89,624
TOTAL	98,909	78,668	31,512,830	10,058,158

Based on an analysis of the demand, the plan segments rural Mexico into three zones: Electrified, Saturation and Integration. The Electrified zone is all areas which are already electrified. The Saturation zone includes those areas within seven miles of an existing distribution line and represent the best conditions technically and economically. This area would be electrified first within each state's schedule. The remainder of the rural sector is in the Integration zone. Areas in this zone would be electrified for two reasons. One is if there are a large number of potential users who, through specific projects, will cause significant growth of the network. The second is where a socioeconomic analysis can justify the installation of electricity. In cases where there is justifiable demand, but the site is beyond seven miles of a distribution line, an alternative power source is used. The choice is usually a diesel generator system. However, CFE tries to avoid equipment alternative to the grid, since it prefers to control and maintain operation of its own equipment. If an alternative to the grid is used, CFE establishes and trains a committee from the town itself to care for the facility.

It is assumed that stand-alone photovoltaic systems would have no viable potential in areas which are readily accessible to the grid either presently or in the future. Legally, in areas where the grid network is available they could be used only as emergency back-up systems. Economically, stand-alone photovoltaic systems are not cost competitive with grid generated electricity. Therefore, potential usage would be restricted to areas designated to be in the Integration zone.

Exhibit B9 illustrates the number of non-electrified rural communities by each state. It also breaks out the number of rural communities of less than thirty residents and more than thirty residents. No communities of less than thirty inhabitants are being considered for electrification. Characteristically, communities of less than thirty people consist of transient nomadic people, who do not represent a stable group. Exhibit B9 also indicates the number of communities in each state which are in the Saturation zone and the number in the Integration zone.

Exhibit B9

NUMBER OF RURAL COMMUNITIES WITHOUT ELECTRICITY (BY STATE)

State	Total	Number of Communities: Having Less than 30 Residents	Having More than 30 Residents	In the Saturation Zone	In the Integration Zone
Aguascalientes	613	431	182	92	90
Baja Calif. Norte	345	257	88	87	1
Baja Calif. Sur	1,445	1,265	180	89	91
Campeche	496	421	75	31	44
Coahuila	1,352	1,263	89	49	40
Colima	424	330	94	24	70
Chiapas	7,037	3,823	3,214	32	3,182
Chihuahua	4,805	3,232	1,573	491	1,082
Durango	2,441	1,183	1,258	53	1,205
Guanajuato	3,787	983	2,804	2,140	664
Guerrero	2,671	583	2,088	272	1,816
Hidalgo	1,547	152	1,395	386	1,009
Jalisco	8,724	4,986	3,738	452	3,286
Mexico	1,534	337	1,197	990	207
Michoacan	4,908	1,850	3,058	639	2,419
Morelos	46	18	28	12	16
Nayarit	969	690	279	58	221
Nuevo Leon	3,688	2,911	777	359	418
Oaxaca	2,379	288	2,091	747	1,344
Puebla	1,826	413	1,413	514	899
Queretaro	708	129	579	265	314
Quintana Roo	449		449	23	426
San Luis Potosi	3,071	966	2,105	186	1,919
Sinaloa	2,882	1,394	1,488	221	1,267
Sonora	4,414	3,659	755	109	646
Tabasco	777	49	728	167	561
Tamaulipas	4,617	3,424	1,193	307	886
Tlaxcala	195	150	45	17	28
Veracruz	6,436	2,511	3,925	1,416	2,509
Yucatan	1,327	1,024	303	86	217
Zacatecas	2,755	991	1,764	823	941
TOTAL	78,668	39,713	38,955	11,137	27,818

In addition to the classification of Saturated or Integrated zone, each state is further categorized by the number of locations, within each state, that will be electrified in the near, medium, and long term. Exhibit B10 illustrates the proposed schedule for electrifying each state. The communities which appear to represent the best opportunities for stand-alone photovoltaics would be those in the integration zone of states scheduled for electrification in the medium and long term. These states are illustrated in Exhibits B11 and B12 (maps). However, those communities in near term integration zones can also be regarded as potential opportunities.

Government efforts in the electrification of rural cottage industries are included in the CFE program -- Electrification for Production. The objectives of this program are: to increase the profitability of rural products, attain self-sufficiency in basic foods and increase rural employment. The program is divided into two sectors. One, is Agricultural Irrigation Wells and the other subsector is Rural Industries.

The total budget for the Electrification for Production Program is 2,246.2 million pesos ($98 million U.S.). The agricultural irrigation phase represents approximately 72% of the investment and will provide [illegible],645 watering units to irrigate 270,400 hectares of land.

The subprogram for electrification of rural industries will serve 4,705 industries and provide employment for 117,000 people. The plan calls for 1,014 industries to be electrified in 1979 with 865 kilometers of line. The remaining 3691 industries will be electrified in the period of 1980 to 1982, using 3008 kilometers of line. The cost is $6,000 (U.S.) per kilometer.

Four agencies will be responsible for executing the program. They include PIDER, CONASUPO, the Secretary of Tourism and the Department of Fisheries. The total budget for this subprogram is approximately 631 million pesos ($27.4 million U.S.). Distributed among 4,705 industries, this gives an average of $5,834 (U.S.) per industry. Exhibit B13 gives a summary of the agencies involved, the number of industries they will affect, and the approximate amount that will be invested.

EXHIBIT B10
SCHEDULE FOR ELECTRIFICATION BY STATE
(No. of Towns)

State	Near Term		Medium Term		Long Term	
	Sat.Zone	Int.Zone	Sat.Zone	Int.Zone	Sat.Zone	Int.Zone
Aguascalientes	92	90				
BajaCalif.Norte	87	1				
BajaCalif.Sur	89	91				
Campeche	31	44				
Coahuila	49	40				
Colima	24	70				
Morelos	12	16				
Nayarit	58	221				
Tlaxcala	17	28				
Yucatan	86	217				
Nuevo Leon	359			418		
Querétaro	265			314		
Quintana Roo	23			426		
Sonora	109			646		
Tabasco	167			561		
Chihuahua			491			1082
Durango			53			1205
Hidalgo			386			1009
Mexico			990			207
Puebla			514			899
Sinaloa			221			1267
Tamaulipas			307			886
Zacatecas			823			941
Chiapas					32	3182
Guanajuato					2140	664
Guerrero					272	1816
Michoacan					639	2419
Oaxaca					747	1344
SanLouis Potosi					186	1919

The States of Jalisco (3738) and Veracruz (3925) are to be electrified in the very long term.

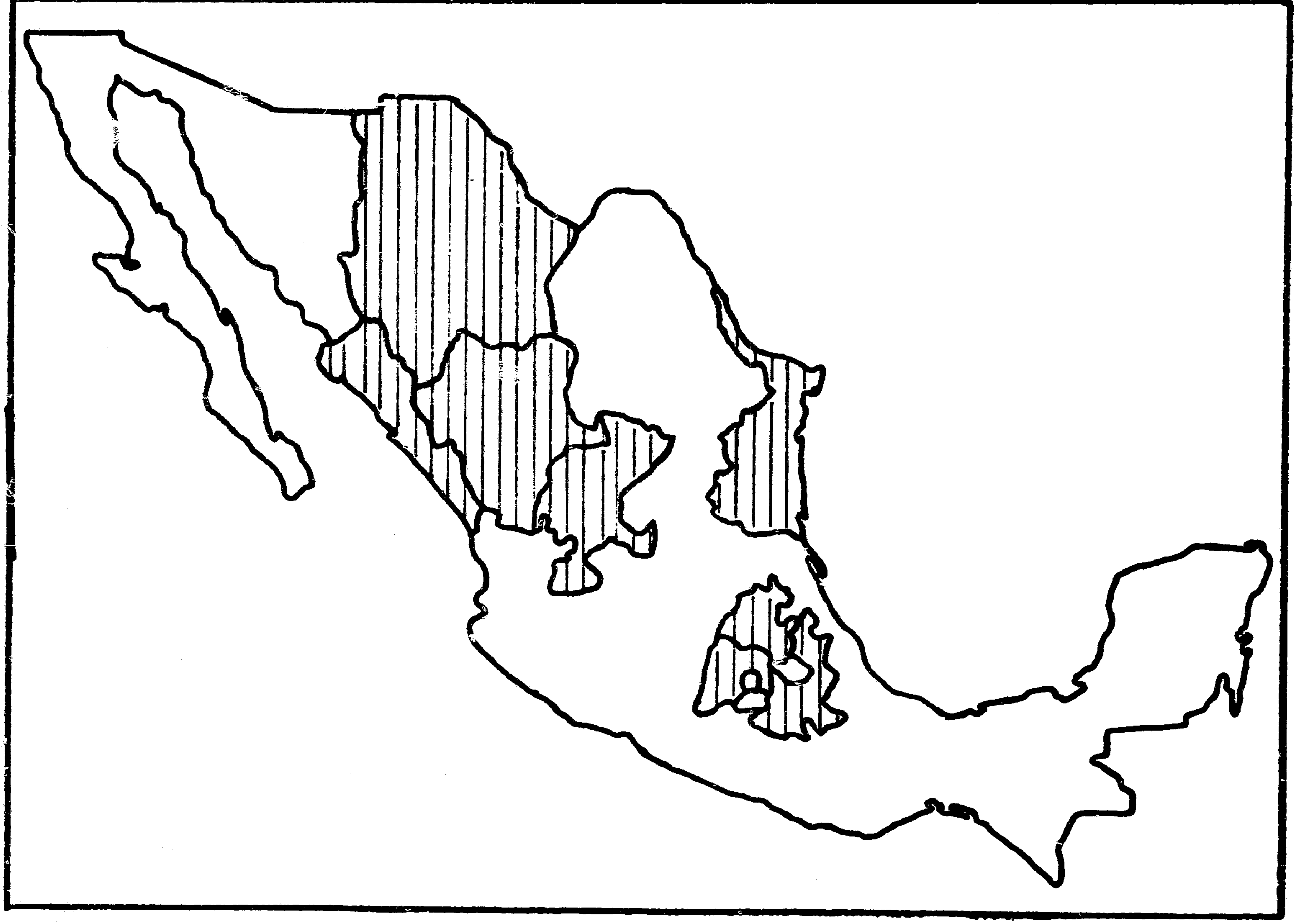


Exhibit B11

STATES TO BE ELECTRIFIED IN THE MEDIUM AND LONG TERM

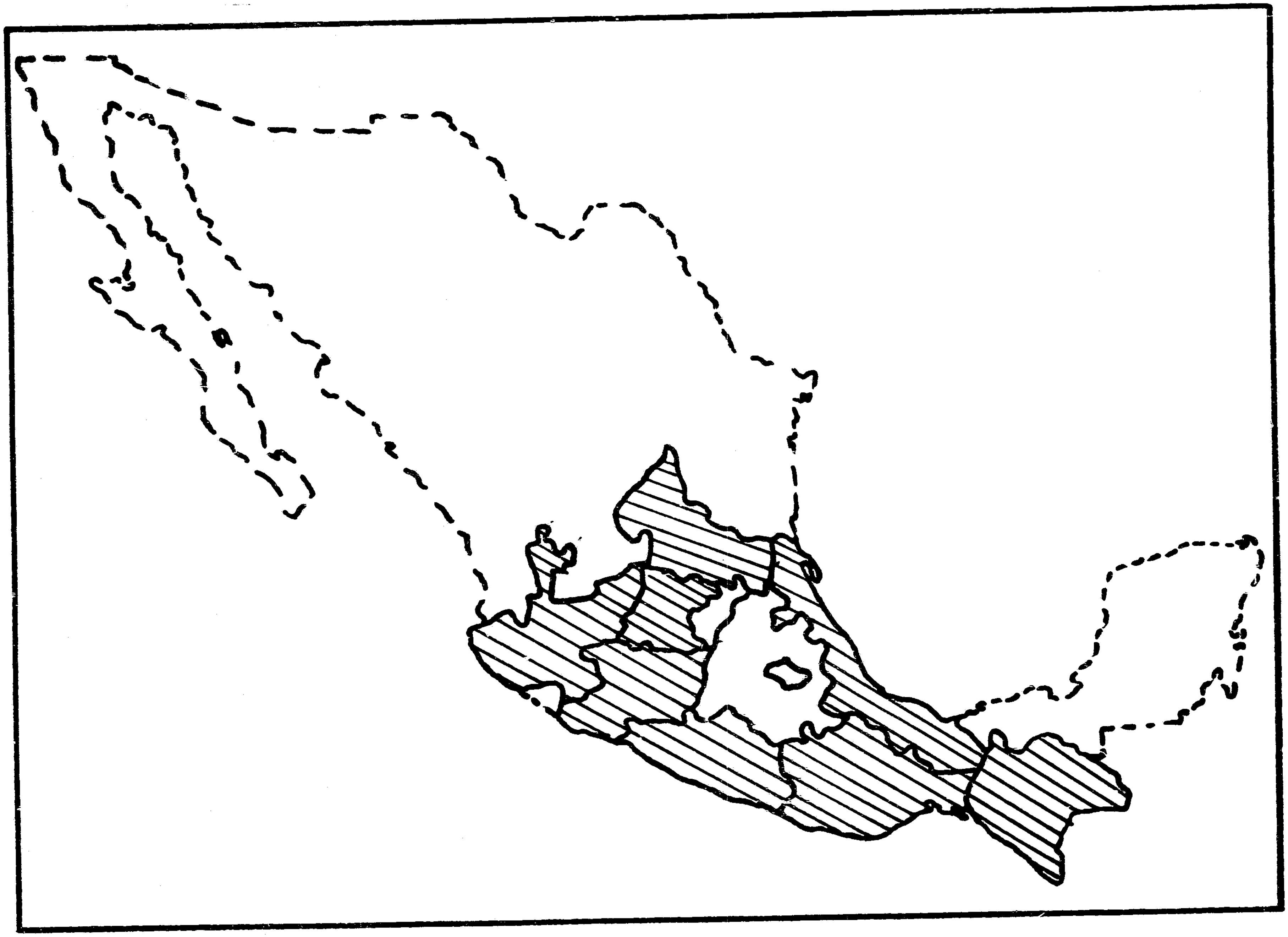


Exhibit B12

STATES TO BE ELECTRIFIED IN THE LONG AND VERY LONG TERM

Exhibit B13

SUMMARY OF AGENCIES AND COMMITMENTS TO ELECTRIFICATION OF RURAL INDUSTRY (1979 - 1982)

Agency		Number of Industries	Number of Employees	Investment (Thousands U.S.Dollars)
SPP PIDER	Fish Industry	1,205	30,125	
	Rural Industry	3,030	75,750	~ 26,000
	Tourist Development	366	9,150	
Secretary of Tourism		17[1]	405	235,000
Department of Fisheries		31	775	865,000
CONASUPO		56	845	261,000
TOTAL		4,705	117,050	27,361

[1] 11 Industries in Guerrero, 6 in Veracruz

Exhibit B14 gives a breakdown of the program budget for each state.

An example of a government-sponsored rural industry is a current project through PIDER to develop a clothing assembly business in Guerrero. The factory will make baseball caps and employ about 100 women. The total investment is 13 million pesos ($565,000 U.S.). This includes all plant facilities, supplies and 60 to 80 sewing machines. The energy source had not been chosen yet, but is anticipated to be a diesel generator, even though the plant site is within seven miles of an electric grid line.

Exhibit B14

PROGRAM OF ELECTRIFICATION FOR PRODUCTION

BY REGION AND STATE

Region	State	Watering Units	Hectares (000)	Rural Industries	Employees (000)	Investment (millions pesos)
Northeast	Coahuila	499	15.0	80	2.0	76.8
	Nuevo Leon	306	9.1	300	7.5	81.0
	Tamaulipas	233	8.1	324	7.8	108.9
North	Chihuahua	354	10.6	80	2.0	61.9
	Durango	156	4.7	94	2.4	61.9
Northwest	Baja Calif. North	235	7.1	178	4.5	60.6
	Baja Calif. South	534	16.1	190	4.7	128.1
	Nayarit	88	9.6	112	2.8	49.4
	Sinaloa	206	8.3	184	4.6	192.0
	Sonora	398	15.9	129	3.2	105.6
Peninsular	Campeche	153	3.9	115	2.9	42.9
	Quintana Roo	129	4.5	116	2.9	27.6
	Tabasco	89	3.6	135	3.6	45.3
	Yucatan	246	3.6	176	4.4	74.4
Central Pacific	Colima	382	13.3	116	2.9	49.1
	Jalisco	595	17.9	191	4.8	69.1
	Michoacan	92	3.2	230	5.7	62.1
Central Gulf	Veracruz	53	2.1	149	3.7	28.2
Central	Guanajuato	369	11.1	96	2.4	89.4
	Hidalgo	150	4.5	149	3.5	33.1
	Mexico	223	6.7	336	8.4	85.1
	Morelos	345	12.0	254	6.3	226.7
	Puebla	612	18.4	96	2.4	67.6
	Queretaro	110	3.9	70	1.7	22.4
	Tlaxcala	196	3.9	70	1.8	36.9
North Central	Aguascalientes	152	4.5	80	2.0	32.2
	San Luis Potosi	244	7.4	80	2.0	40.9
	Zacatecas	597	20.9	80	2.0	84.5
Southern Pacific	Chiapas	337	11.8	131	3.3	89.2
	Guerrero	56	0.5	184	4.6	39.1
	Oaxaca	506	15.2	170	4.2	74.2
TOTAL		8645	[illegible]	4705	117.0	2246.2

17. Mexican Cottage Industry

The key to successfully doing business in Mexico is to understand the cultural environment of the Mexican people. The Mexican today is characteristically, patriotic and proud and the spirit of reformation prevails. The influence of the Aztec civilization still remains, but the arts tend to depict social issues rather than the spiritual.

17.1 Historical Background

Cottage industries tend to reflect the material culture of a people. Mexico has one of the most highly developed cottage industry sectors in the world with many unique characteristics. In order to fully appreciate Mexican cottage industry as it exists today, one must consider its origins and the historical background in which it developed. There are, basically, three distinct periods: pre-Colombian, colonial and post-revolutionary.

The roots of Mexican culture began in the Mayan civilization of the fourth century. The Mayans were a highly advanced civilization whose demise remains a mystery today. They were followed by the Toltecs who settled the Valley of Mexico, present day Mexico City, and then by the Chicimec peoples. In the twelfth century, the Aztecs conquered the Valley of Mexico and formed an empire. The Aztecs were a highly developed civilization. They practiced trade, had a thriving economy and a deep appreciation of the arts. They were highly skilled at weaving, crafting gold and silver, and sculpture. Even today Aztec figures and designs are easily distinguishable. Religion was also an important part of the Aztec life. They worshiped many gods, were ritualistic and practiced human sacrifice.

A turning point in Mexican history is April, 1519 when the Spanish explorer, Hernan Cortes, landed at Veracruz. By 1522, Cortes had conquered the Aztecs and instituted the Spanish baronial land grant system, thereby creating individual fiefdoms for his fellow conquistadores.

Two important changes then occurred. One was the concentration and relocation of the Indian population to serve as feudal labor. The other was the migration of the Spaniards toward the southern region of Coatzacoalcos and to the north in search of gold. Hence, settlements began as mining camps and grew to market centers. At this point a social stratification began to emerge. The highest class was the Iberian-born, then the native-born "Criollas" of Spanish descent. The next class was the "Mestizo" or those of mixed Spanish and Indian blood. Then came the pure blooded Indian. The lowest class was the Negro, imported to work as slaves. These separations of class, coupled with the Spanish attitude of manual labor symbolizing servility, was an important factor in the evolution of Mexican cottage industry.

A third major instrument for resettlement was through the establishment of Jesuit and Franciscan missions.

During the 17th century, the Roman Catholic Church was the wealthiest corporation in Mexico, especially the Jesuit sector. They became the major financial lending agency and, through foreclosures, obtained nearly fifty percent of the land by the late 1800s. More importantly, the Jesuits introduced new technology and organization among the Indians in both agricultural production and manufacturing. One notable example is that of Bishop Don Vasco de Quiroga who developed a strong cottage industry sector based on the existing Indian culture in the State of Michoacán. Even today, this region has the largest concentration and the widest variety of cottage industries in Mexico.

In general, cottage industry processes in those regions settled by the clergy are quite distinct from those used by either the feudal trained labor or the pure Indian craftsmen. To a careful observer, the distinction is also visible in the final product.

The traditional Indian craftsman uses the same techniques and processes as did his ancestors in pre-Columbian times. Today, these techniques are still used in the States of Chiapas, Oaxaca and Guerrero.

The Spanish bureaucratic system also had a strong influence on the evolution of cottage industry. The Spanish ruled Mexico through a viceroy, provincial governors and judicial magistrates or mayors. These were all Iberian born. However, each town or city had a council of native-born Mexicans. The council was an oligarchy who survived using graft and nepotism. It was through the town councils that the European guild system was instituted. This meant that if a craftsman was not a member of a guild, he was barred from the craft. The guild system greatly hindered the development of cottage industry and stifled the processes which were indigenous to the people. In regions where the guild system flourished, the characteristics of the cottage industries mirror those used in Spain during the pre-Columbian period. A good example of this can be seen in the pottery industry of Puebla.

The campaign for Mexican independence began in the early 1800s. Discontent among the people arose in two forms: social and economic. One faction was the democratic idealists who sought social reform from the feudal landlords. The other was the Mexican elite who sought independence from colonial Spanish government and the Spanish mercantile monopolies. In 1808, upon Napoleon's occupation of Spain, the Mexican Indians rose up against the ruling Spanish class. It took another hundred years of reformation, culminated in the Revolution of 1910, to rid Mexico of the Spanish bureaucracy. In 1917, the Mexican Constitution was adopted and still provides the framework for today's government.

Out of the revolution rose the "Mestizo Spirit". The post-revolutionary government sought to give the Mexican a sense of national identity through the glorification of their Indian ancestry. Social stratification was changed in that, those of mixed blood were considered racially superior and the overall standard of living was raised through organized labor, agrarian reform and public education. From this spirit comes the extraordinary sense of patriotism and Mexican pride which is characteristic of the people today. Rural development has been a goal for fifty years and will continue to be a high priority of the Mexican government.

The revolution had a tremendous impact on cottage industry, as well, because it encouraged production and development of Mexican handicrafts and folk art goods. Prior to the revolution Mexican cottage industries had produced only utilitarian goods for rural and rural-oriented communities. In the post-revolutionary period, national pride created a greater market for products indigenous to the Mexican culture. The development of handicraft and folk art industries was further sparked by an impressive and influential handicraft exhibit held in Mexico City in 1921. The response of the urban upper classes marked an important step in bringing national and international recognition of the cultural and socioeconomic importance of rural cottage industry.

In other parts of Latin America, such recognition did not take place until the mid-1950s. The early recognition of Mexico as a handicraft producer was extremely important to its entering tourist and export markets.

17.2 Contemporary Cottage Industry

As is true the world over, the rural cottage industries of Mexico both respond to and reflect the needs of the rural culture and population. Where the needs and culture of the people have remained traditional, the cottage industries have also remained unchanged. In areas where high technology and methods of intensive agriculture have been applied, cottage industries have adapted to meet the changing needs.

Cottage industries are either culturally oriented or based on available raw materials. Industries which are culturally oriented produce festival and ceremonial accessories. Usually, one village will produce goods for the entire region. A village having a festival products industry would make musical instruments, fireworks, ex-votive offerings, piñatas and similar products. A village engaged in making ceremonial accessories would produce masks, canes, dolls and items used in folk dances. Religious and folk festivals are considered a social and cultural obligation and purchases for such events are frequently the single largest expenditure a family will make at any given time over the year.

Most cottage industries are based on the raw materials available within the region. In Mexico, these include clay, basic minerals, animal fibers, vegetable fibers, wood and, to a lesser extent, metals. The major industries that are raw material based include lumbering, pottery, copper forging, silversmithing, furniture making, fishmeal production, grain milling, tanning and tilemaking.

The use of many raw materials is controlled by the government and there are quite a few "illegal cottage industries". The authorities tolerate this to some extent as long as the effect is negligible. An example is cutting one tree a month to support local housing construction versus 15 trees a month to support a small scale lumber mill.

The goods produced by Mexican cottage industries are primarily utilitarian and produced for local and regional consumers. The most prevalent cottage industry, in both rural and urban Mexico, is pottery making, which employs the largest number of artisans.

Pottery making utilizes a vast number of methods and technologies of both hispanic and indigenous origins. Most of contemporary rural cottage industry combines elements of both Hispano-Moorish and indigenous influence, giving Mexican cottage industry and its products a distinctive national character. In the urban production centers, pottery making applies such contemporary techniques as high temperature gas and electric kilns and electric potter's wheels. However, within the rural regions traditional technologies still predominate. Products made by potters include vessels for storing food and water and tableware.

Weaving is the second most predominant cottage industry in rural Mexico. It, too, uses only traditional technologies. Wool is the usual raw material. Weavers produce clothing and blankets. Basket industries produce mats, ornaments, straw figures, hats and, more importantly, shelter contruction and baskets for harvesting, transporting and storing field crops. Woodworking is an important industry. Its products include spoons, scoops, tools, ox yokes, handles, bowls, crates, statuary, furniture and carpentry products, such as doors and window frames. Grinding mills are a basic utilitarian industry. They produce mainly cornmeal and fishmeal.

Simple and utilitarian goods are made in the rural sector for local and regional purchasers. A rural cottage industry region is usually found around a moderately sized city which will have a large central popular market. Examples can be seen in cities such as Uruapan, Morelia, Quiroga, Patzcuaro and Oaxaca. The central city market is an important trading and distribution center. It serves not only as an outlet for rural products, but also as a source of urban produced supplies. The principal products being supplied to the rural region are those made by blacksmiths, tanneries and confection industries. They include products such as metal spurs, stirrups and bits, hardware, leather shoe stirrups, machetes, rope, saddles and drygoods.

Mexico has a unique system of production in which there is a chain of value adding processes from village to village. This can best be understood through an example. A copper pitcher may have its origin in a very remote village. Originally, it is a piece of barely formed metal which is sold to another village. The metal workers there will pound it out into a normal spouted shape. It is then sold to another village, closer to the city, where it is polished and cleaned. It will then go to an urban or fringe-urban artisan who adds a handle and sells it in the central market. A similar case can be seen in furniture. Rurally produced chairs are very crude, but they are channeled from village to village with each place adding more detail until finally a well-crafted product reaches the urban market. This system is quite unique. Frequently, the entire cottage industry sector of a village will specialize in that village's phase of production.

Through this chain of production, rural Mexican industry has found a means to simulate factory assembly production. It has been an important factor in competing with goods from Asia in the international market. Unfortunately, this system of production also presents a significant barrier to adopting new technology. By introducing a new method or technology early in the chain the effect would be felt in several villages. It is highly likely that by helping the originating industries, actual unemployment could be created for those further down the cycle.

The typical rural cottage industry will either be in the home or in a small shop. The owner is the manager and usually the principal worker. The establishment is a sole proprietorship. Common production facilities are not shared. The production facility is usually rudimentary and serves only as basic shelter. Characteristically, the shop layout is very inefficient and the comfort and safety of the workers are seldom considered.

Few, if any production needs, such as tools, are purchased outside the community. Rural cottage industry production is cyclic in direct relation with the agricultural cycle and the seasonal availability of raw materials is an important consideration for the rural entrepreneur.

17.3 Fit With The Rural Economy

According to the National Fund for Handicraft Promotion (FONART), an estimated 1.2 million heads of households are engaged in full-time cottage industries and employ an average of five workers per establishment. This gives a total of six million people employed in cottage industry, or nearly 10% of the total population. However, the majority of workers participate on a part-time or seasonal basis. This is especially true for women, who work at cottage industry production between household activities.

There is no hard, reliable data on the exact income derived from cottage industry, but, at full employment levels, a typical producer earns an estimated 25 to 50 pesos per day or 1 to 2 U.S. dollars. The highly productive industries served by FONART earn a family income of 450 to 1500 pesos per month or 1 to 3 U.S. dollars per day. However, the average for the total rural sector would be much lower, and, lower still, in highly remote regions.

According to 1977 estimates, in villages with populations of less than 2,500, less than 21% of households had a total family income which equalled the minimum wage of 123 pesos per day (U.S. $5.35). Furthermore, 45% of the households derived, from all sources, a total income below one-half of the minimum wage or 61.5 pesos (U.S. $2.67).[1]

While rural cottage industry is insignificant in terms of GNP or balance of trade payments, it plays an increasingly important social and economic role at the village and regional level with important implications at the national level.

For the fifty percent of the farm population that is either landless or underemployed, cottage industry production offers the only alternative to migrant employment. For the many subsistence farmers, cottage industry provides the only income to meet their needs for purchasing food not produced on the farm plot, clothing, and the means to meet the expenses of cultural obligations.

(1) Source: Ministry of Programming and Budget, Mexico

The average assets of a rural cottage industry range between 2000 and 3000 U.S. dollars and all earnings are viewed as personal income. The workers are usually members of the family and are seldom paid. The primary objective of the rural producer is not necessarily to increase his income, but to provide employment for as many members of his family as possible.

Cottage industry production, unlike many types of large scale rural industry, does not create more jobs in the metropolitan centers than within the rural region itself, thus cottage industry development provides a viable deterent to migration. As demonstrated in the case of Puerto Rico during the 1950s, many industries which are implanted into the rural region actually encourage immigration into the larger cities. Cottage industry in rural Mexico is playing a small, yet important role towards achievement of national goals to deter immigration to the already overcrowded urban centers of Mexico.

Cottage industry also plays an important role in establishing the linkages with government institutions which enable the fostering of further development within the village. Much of the infrastructure and public services projects which have been implemented over the years have been directly related to existing cottage industry or the potential for cottage industry production.

If a rural producer is entrepreneurial and wishes to expand or modernize his business, the opportunities for borrowing capital are very limited. Options would include commercial banks, FOGAIN (Fund for the Guaranty and Development of Small and Medium Industry, a patron, the Rural Development Bank, a cooperative purchase and the Fund for Artisans. Commercial banks and FOGAIN will work only with registered businesses, which most cottage industries are not. Short-term commercial loans are for up to one year at 30% annual interest. Long-term loans are for seven to eight years with a fluctuating interest rate. The current rate is 32%. The Rural Development Bank finances only government sponsored projects and the Fund for Artisans has very little money. The most feasible alternative for the rural producer is to find a wealthy patron or for several families to purchase capital equipment together.

However, in adapting a new technology, the question of affordability goes beyond capital financing. In the city, a rural immigrant "earns as he learns" a new skill through on the job training. To learn a new skill or apply new processes and equipment to rural production, the artisan would have to disrupt production long enough to master the new technology. In many cases, this could represent a sacrifice of the total annual family income. This is a cost that no rural artisan can afford and a disruption of supply that the local region could ill adapt to.

18. Government Interest In Solar/Photovoltaics

To quote directly from the Mexican National Energy Plan,

> It is necessary to guarantee a trustworthy and economical supply of electric energy in rural areas. It will allow increasing farming and animal husbandry production by increasing the water pumping capacity for irrigation, encouraging the development of small industries and commercial establishments, increasing, therefore, the job possibilities in those areas. In the same way it will help satisfy minimum standards of well-being of groups up to now marginal, by extending electrical service to isolated communities. The attainment of these objectives supposes rationalizing the programs of rural electrification and giving them greater support, in accordance with the directives of the Mexican Food System.
>
> With the technological characteristics of the modern electrical systems, a greater degree of decentralization is needed. Very often, owing to the reduced quantity in local consumptions, it is not economical to extend the national distribution networks to isolated communities. Therefore, the programs must be directed to the application of technologies on a small scale, suitable for the countryside. This means making a greater effort of developing, adapting and publicizing those technologies. Among them the installation of electric micro-centers and making use of solar energy for heating water for domestic uses and for production, as well as for drying farm and animal produce, stand out.

From this, it can be clearly seen that the Mexican government is highly aware of the potentials for solar energy in rural electrification. However, the plan also clearly states that the widespread use of solar energy, in any form, is for the long term. Long term is interpreted to be beyond 1990. For the near and medium term, "its contribution to the energy balance will be nominal." (1)

---

(1) Mexican National Energy Program, paragraph 122; November, 1980.

In keeping with their strategy to observe the world-wide technical development in energy and to remain at the forefront of those technologies, Mexico is exerting a considerable effort in the research and development of solar energy, although the work is somewhat fragmented between academic and public works agencies. To a large extent, they look to solar work in the U.S. as a base for their own development.

18.1 Academic Sector

Solar research work is done by the academic sector. The principal institutes are CONACYT (National Council for Science and Technology), IPN (National Polytechnic University), UNAM (National Autonomous University of Mexico), Monterey Technical University, and IIE (Institute of Electric Research).

The IIE functions similarly to the Electric Power Research Institute in the U.S. Funding for the IIE comes from CFE and federal government. The Institute has a staff of 16 working in solar energy. Eight are in biogas and wind research and eight are in power plants, central receivers and photovoltaics. Their interest in photovoltaics is for rural electrification. Currently, all their work with photovoltaics is in system analysis and central receiver power stations. Projects proposed that would utilize only solar sources for electrifying rural communities have not been funded.

Photovoltaics are not considered the best choice for rural electrification because:

1) They do not increase the use of local labor for operation and installation.
2) Electrical problems are beyond the average rural dweller's skill.
3) They are not the most cost-effective means of providing electricity.

CONACYT is the national science council for Mexico. Their solar mission is to maintain scientific awareness of solar technology and its potential applications. The total 1980 budget for solar research is $4 million (U.S.), over 90% of which is slated for photovoltaic research. The Council feels, of all forms of solar energy, photovoltaics is the most promising, but not within the next ten years.

C-3

Recently, the agency performed a cost-benefit analysis of alternative energy systems for powering agricultural irrigation pumps. The alternatives considered were: grid extension, photovoltaics, wind, diesel generators, and gas generators. Diesel generators were the optimum choice.

Regarding the rural cottage industry sector, especially remote locations, the Council has several studies that show that introducing electricity has no significant impact.

The IPN is concerned with basic research of photovoltaic cell production. It is their desire to develop a domestic cell production capability in Mexico. All of the work, to date, has been at a pilot and laboratory level. The Institute has applied to the Federal Government for funds to build a photovoltaic cell factory capable of 60 Kw per day. Their strategy for obtaining funds has been to stress nationalism and independence from foreign business in Mexico.

Many sources feel it is unlikely that the project will be fully funded. Nevertheless, the production capability and technology is still being developed.

18.2 Public Work Sector

The development and implementation of solar energy is delegated to the various agencies for public works. The principal agencies involved are SAHOP (Secretary of Human Settlements and Public Works), DIGAASES (General Management for Saline Water and Solar Energy Development) COPLAMAR and PIDER. Other agencies that have some involvement in electrifying rural cottage industries are FONART, CFF and the Mexican Development Foundation. CFE uses grid extension or, in very rare cases, diesel generators. They do not, at present, use solar. FONART and the Mexican Development Foundation are interested in the potentials of photovoltaics, but do not have any plans to utilize it in the next two years. These agencies also have very little funds available and would require that an energy supply be an appropriate technology.

PIDER would be the agency most likely to fund a project for rural electrification. They would also provide the necessary technical and educational support for implementing a rural development project. At present, they have only one project to utilize solar energy and it provides domestic hot water to a residence. In choosing equipment for the rural sector, cost and upkeep are the criteria. The product must be the most cost-effective, easily maintainable and provide good, long-term service.

The primary interest in photovoltaics lies with the Ministry of Education. In a period of three to four years, the Ministry hopes to buy 50,000 package systems to provide basic needs for rural villages with populations of 500 or less. These packages include lighting for a hospital, a telex or radio-telephone and an educational television. The estimated cost of these systems would be PS $70,000 to PS $100,000 (U.S. $3043 to $4,348).

The energy source would be either photovoltaics or wind. Wind is appropriate in many areas of Mexico, especially in the coastal regions. These systems would probably have to be imported in order to obtain the quality necessary.

Photovoltaics would be obtained from the optimum source. Because of the large volume, a price break would be expected.

The financing of these purchases would be through an international source, such as UNESCO, who would grant a low rate (preferential rate) for a long-term.

Other government projects under consideration include a project to install 1000 rural telephone stations and another project to build 64 ports, 80 km apart starting at Baja, California. Photovoltaics could be the potential energy source in either of these projects.

It should be noted that these are long term proposals that may not be acted upon in the next federal administration.

19. Photovoltaics - Current Commercial Activities

The photovoltaic industry of Mexico is at the beginning stage of its development. Currently, there are seven photovoltaic manufacturers represented. They include:

- Solar Power, Distributed by Productos de Lorain de Mexico
- Applied Solar Energy, Distributed by SOLVIMEX
- Solarex, Represented through Electrotec-nica Medica
- Philips, Formerly represented by Grupa del Sol, S.C.
- Motorola
- Arco-Solar, Represented through PRECENCO
- A. E. G. Telefunken

The majority of these companies have been in the Mexican market for one to two years and, at present, none can be considered a clear market leader. Although each company has adopted a unique penetration strategy, several generalities and market characteristics can be seen.

First, consider the actual photovoltaic product. Reliability of the cells and strength of the panel itself are absolutely essential and can serve as a competitive strength for some manufacturers. Another important factor is the quantity that can be supplied within a desired time. If a decision were made to use photovoltaics for a major development program, the quantity of cells that could be supplied in a reasonable time period would be a key factor for the government agency in choosing the photovoltaic supplier. Another significant characteristic of the Mexican market is its preference for turnkey systems and total photovoltaic packages. It is reasonable to assume that this same preference would be seen in serving the cottage industry sector.

The Mexican government is perceived as the primary market. Hence, the point of sale will be Mexico City and the purchaser will be extremely knowledgeable of the product. The rural private sector is considered a potential secondary market. Sales would be through one of several rural distribution networks already established which sell light industrial equipment and hardware.

The form of business strategy most businesses have taken is in three phases. Phase one is to direct import through an agent or subsidiary who also provides the necessary peripheral equipment, such as inverters, batteries and control devices. The second phase of their strategy is to assemble the panel in Mexico. The third phase is the actual production of cells in Mexico, although this will require approval of the government.

Sales strategies range from mere response to requests for quotations to holding seminars and participating in trade shows. Brand name identity is important, especially since the purchaser is usually well-informed.

Cost is a major factor and strong price competition can be anticipated. Any large purchaser will expect a significant price break for quantity. Companies which sell total systems and peripheral equipment have greater flexibility for price negotiation and the type and size of equipment used. Transportation cost may also impact the price and a company's production strategy.

Import fees and taxes can represent a significant portion of the cost. Photovoltaic cells, unmounted, are registered as Brussels Tariff Number 85.21 A-12. The tariff rate is ten percent. If the cells are mounted, they are considered an apparatus and the tariff will vary according to the intended usage. In either case, there is an additional ten to fifteen percent fee for custom rights and another ten percent IVA (value added tax). If the rate were 10/10/10, this would add an additional 33% to the selling prices.

At present, the primary market for photovoltaics is in the field of telecommunications, especially microwave repeater systems. Also included are rural television, rural telephones, maritime signals, navigational aids and railroad signals. A viable market can also be seen in cathodic protection. Here the customer would be PEMEX, the national petroleum company. Social service packages, water pumps for irrigation and solar toys may also have future potential. Fisheries have been suggested, but thermal collectors have been demonstrated to be cheaper.

20. The Potential Market

As illustrated in Exhibit B8, according to CFE, 10,058,158 rural inhabitants living in 78,668 locations have no access to electricity. Of these 39,713 have populations of less than 30 people. These are usually migrant people and are not considered a stable community. It is also highly unlikely that an established, stable cottage industry would be found in this sector. These communities are not being considered for electrification within the national plan and are unlikely to be a market for stand-alone photovoltaic systems. This leaves a remainder of 38,955 rural communities with a population of more than 30 persons

As previously mentioned, CFE has classified all communities into one of three zones: electrified, saturated or integrated. A community in the electrified zone is one already served by CFE. The saturated zone is comprised of communities which are near the existing network lines and represent the best technical and economic conditions for extending the grid network. Obviously, these zones would not be a potential market for stand-alone photovoltaic systems. The remaining areas are in the integration zone. These would be the last areas to be electrified within each state's respective schedule. The potential for stand-alone photovoltaics would lie in communities in the integration zone. Of the 38,955 rural communities with 30 or more persons, 27,818 are in the integration zone and 11,137 are in the saturation zone.

In order to determine the population this represents, it is assumed that all communities of 500 or more are in the saturation zone, or 3,181 communities with a total population of 3,167,899. This leaves 35,774 communities with a population range of 30 to 399 residents. The total population for this sector is 6,194,016. Assuming the population number in each zone of this range to be normally distributed, 27,818 communities are 78% of the communities or a population of 4,830,000. Refer to Exhibit B15.

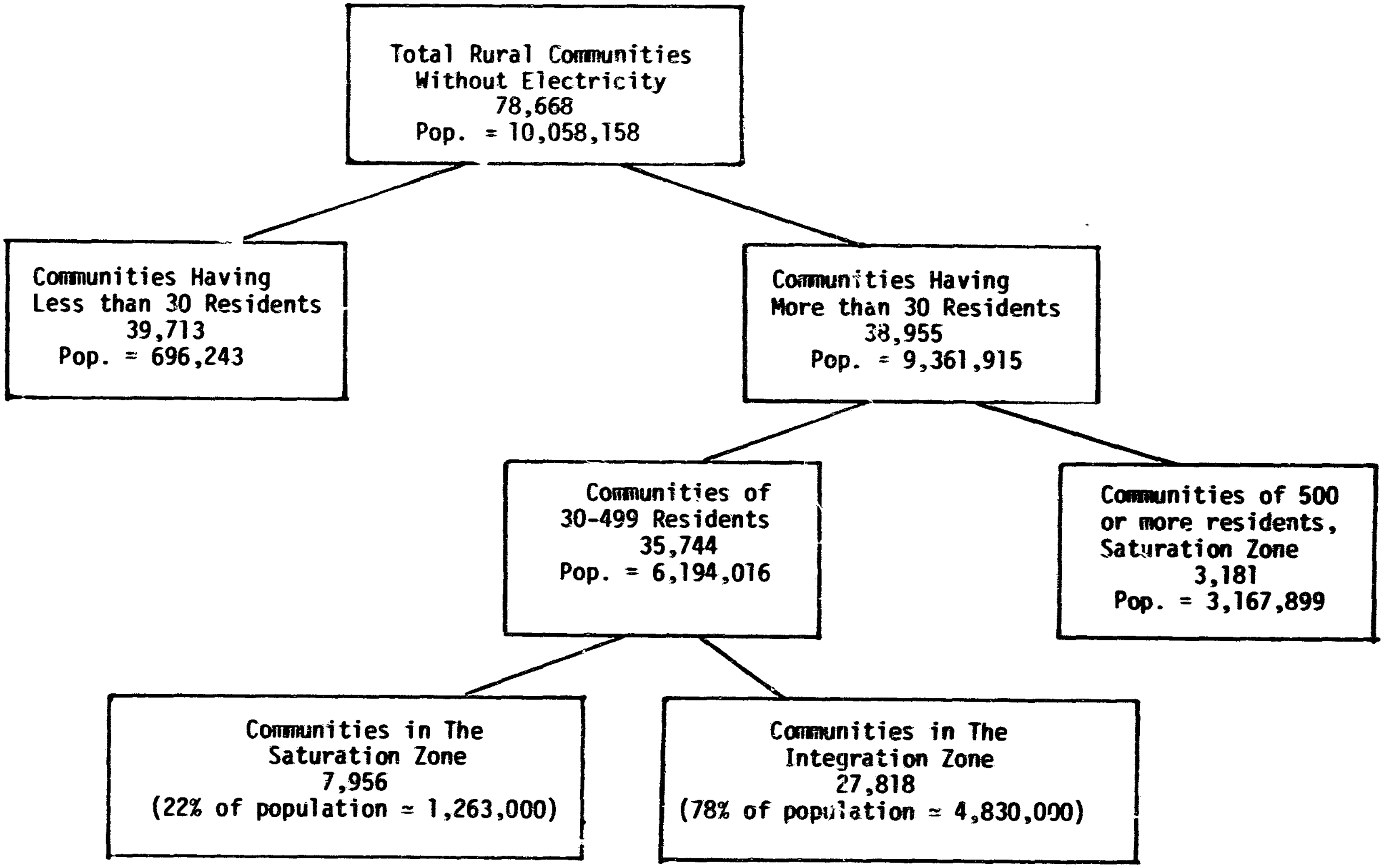

Total Rural Communities Without Electricity
78,668
Pop. = 10,058,158
Communities Having Less than 30 Residents
39,713
Pop. = 696,243
Communities Having More than 30 Residents
38,955
Pop. = 9,361,915
Communities of 30-499 Residents
35,744
Pop. = 6,194,016
Communities of 500 or more residents, Saturation Zone
3,181
Pop. = 3,167,899
Communities in The Saturation Zone
7,956
(22% of population ≈ 1,263,000)
Communities in The Integration Zone
27,818
(78% of population ≈ 4,830,000)

Exhibit B15

FONART estimates that 10% of the general population is engaged in cottage industry with approximately five employees per industry. Therefore, the number of potential cottage industries would be

4,830,000 residents x 10% = 483,000 persons engaged in rural cottage industry (with no access to electricity)

$$483{,}000 \div 5 \frac{\text{employees}}{\text{industry}} = 96{,}600 \text{ industries}$$

If the energy requirement of the average cottage industry is taken to be 1.5 horsepower (hp), this is equivalent to 2KWp per industry.

$$1.5 \text{ hp} \times 745 \frac{\text{watts}}{\text{hp}} = 1118 \text{ watts} \times \frac{8 \text{ hrs}}{\text{day}} = 8940 \frac{\text{watt-hrs}}{\text{day}}$$

1 Wp produces $4.5 \frac{\text{watt-hrs.}}{\text{day}}$

$$8940 \frac{\text{watt-hr}}{\text{day}} \div 4.5 = 1987 \text{ Wp or } 2 \text{ KWp per industry}$$

Of the 96,600 cottage industries with no access to the electric power network, assume that 25% could utilize electric power. Therefore,

96,600 x 25% - 24,150 potential industries

24,150 potential industries x 2 KWp per industry = 48,300 KWp or 48.3 MW of photovoltaics

The quantity 48.3 MW represents the total potential application of photovoltaics in the remote, rural cottage industry sector. However, in penetrating any market there are barriers and constraints to be considered, as well as an appreciation of the competitive product.

21. Summary of the Site Visits to the State of Michoacan

The mountain and lake region of the State of Michoacan was selected for site visits for this study because it presented an opportunity to observe a large variety of cottage industries which are typical to many rural regions in Mexico. Michoacan also allowed the observation of cottage industries under a variety of conditions within both private and institutional structures as related to cottage industry at both the regional and local level.

The rural population of Mexico is widely dispersed and, in general, neither the high concentration of cottage industry nor the ease of accessibility to the sites visited are typical of rural Mexico. A more typical region is the State of Chiapas which represents 11% of non-electrified rural Mexico. However, during an eight day field investigation of potential applications for Stand-Alone Photovoltaic Systems by the CIEA-IPN, the expedition failed to observe a single cottage industry.

Michoacan offered two viewpoints: the non-electrified potential users and the impact on cottage industry after electrification. It was essential for the field trip to gather broad observations in order not to exclude potentials which might exist within non-electrified Mexico. In addition it was important to view the impact on cottage industry after electrification and also the relationships between non-electrified and electrified rural areas.

The major findings of the field investigation were:

(1) Confirmation of the inadequacies in, and highly misleading nature of official data available on rural industries in general and specifically concerning the non-electrified rural areas. The industrial census of 1975, for example, would have one believe that less than 50,000 cottage industries exist in all Mexico as compared to unofficial estimates of 1.5 to 2 million such industries. In the specific case of Santa Clara del Cobre, the industrial census lists this urban center of 25,000 inhabitants as possessing one fruit crate factory employing over 400 workers. Such a factory is listed according to the census as a large-scale industry. A site visit to Santa Clara del Cobre revealed that no such large-scale factory exists, but rather approximately 400 small cottage industries were producing fruit crates on an individual small scale. Interviews with State and regional authorities

confirmed that this practice of grouping small cottage industries to appear as one large industry was common practice, although such methodology is not apparent to the casual observer of official data. It was further revealed that the census rarely went beyond small urban centers and that almost no reliable statistics are gathered in the rural area even for what is referred to as the rural industries census.

The most accurate information was found to be provided by those institutions and branches of institutions which maintained direct linkages with the rural area. These organizations, however, rarely publish their unofficial estimates which generally provide a more realistic view of cottage industry in rural Mexico than official statistics.

(2) Rural electrification does not stimulate adoption of electrical technology by traditional cottage industry. This fact, which is known to be true in most regions of the world and assumed to be true in Mexico, was confirmed for all traditional cottage industries observed on the field trip and by interviews with leading authorities on traditional cottage industry.

Observations were made of non-traditional and modern cottage industry adapting electrical technologies. However, all such cases were observed within urban centers of populations over 10,000 inhabitants or in specific fringe urban industries with their basic linkages to urban rather than rural community needs.

(3) Photovoltaics do not represent a substitute alternative to diesel generators. It was observed and confirmed through interviews that diesel generators are not commonly utilized by rural cottage industry, but rather that they are employed as a source of backup energy supply by industries located within the electrical grid. Generators are utilized by some fringe urban industry, agro-industry and, very occasionally cottage industry, but not to any significant extent within non-electrified rural villages of under 2500 inhabitants. This finding is considered to be country-specific to Mexico due to official definitions of "rural" and the extent of the rural electrification grid in Mexico.

(4) Observation of the highly sophisticated linkages between rural and urban cottage industry processes: The impact of Hispanic culture on cottage industry entrepreneurship results not only in the tendancy for cottage

industry to be organized as a family enterprise, but also as a very independent and self-sufficient enterprise which resists cooperative production ventures. Often in order to maintain the independence of the productive unit or in order to further its best interests, specialization in a cooperative production process may occur. This is not considered to be unusual in other Latin American countries, but the degree of sophistication of this system, as observed in Michoacan, had not been anticipated. Especially in the wood products industry, it was found to be quite common for a network of individual cottage industries to specialize in one specific process in the chain of processes leading to the production of a specific final product. This network of cottage industries was found to stretch from village to village in the rural area and then to a series of urban cottage industries where the product was finally finished and marketed. This finding could point to potential application of electrification of the rural industry in cases where the next higher link in the process chain currently utilizes or might adapt electrical technologies. In other words, electric technologies may transfer back along the process chain from more advanced urban cottage industries to the less advanced rural cottage industries.

Exhibit B16 is a summary of the sites visited and their related industries.

Exhibit B16

SITES VISITED IN THE STATE OF MICHOACAN

Town	Population	Types of Industry	Comments
MORELIA	-	Various	Seat of State Government
QUIROGA	50,000	Wood Products, Furniture	Market Center
TZIN TZUN TZAN	6,000	Pottery, Wheat Straw Products, Furniture	Electrified, but Used Only for Lighting
PATZCUARO	50,000-60,000	Wool, Lacquerware, Furniture, Weaving	Extension of Other Rural Industries
VILLA ESCALANTE OR SANTA CLARA	25,000	Copper Products, Fruit Crate Parts, Fine Furniture	Electrified
VILLA LAZARO CARDENAS	100	Pottery, Straw Products	Non-Electrified - Immigrants from Tzin Tzun Tzan
TOCUARO	350	Ceremonial Accessories	Electrified, but Used for Lights Only
PATAMBICHO	1,500	Sandstone Ornaments	Electrified, but They Use No Electricity in Industry
TINGAMBATO	8,000	Crate Manufacturing, Meal Grinder, Carpentry	Electrified
IHUATZIU	3,000	Tuli (Rush Reed) Products	Fishing Village, Electrified, but Used Only for Lights
SAN ABRIA	2,000	Fishmeal	Non-Electrified (but On Line) Used Diesel for Equipment and Lights
URUAPAN	Large City	Terrazo Manufacturer	Electrified, Fringe Urban Industry

LIST OF ORGANIZATIONS CONTACTED IN MEXICO CITY

AMERICAN CHAMBER OF COMMERCE OF MEXICO
Lucerna 78, 3° Floor
Mexico 6, D. F. 905/566-08-66

Lic. John Bruton, Executive Vice-President
Lic. Jesus Rosales B., Subdirector of Commercial Information
Ester Hovocamp
Rosio Sponholtz

BANAMEX
Madero 21 3° piso 905/585-0066

Ken Schwedel

BANCOMER

Roger Johnston

CALENTA DORES SOLARES DE MORELIA S.A.
(Private flat plate solar heater manufacturing)
Morelia, Michoacan 3-0968

Lic. Ignacio Torres, President

CIEA-IPN CENTRO DE INVESTIGACION Y DE ESTUDIOS AVANZADOS DEL INSTITUTO POLITECNICO NACIONAL
(Center of Research and Advanced Studies of the National Polytechnical Institute)
Apartado Postal 14740
Mexico 14, D. F. 754-0200 ext. 189 or 247

Dr. Juan Luis Del Valle, Principal Researcher

COMISION FEDERAL DE ELECTRICIDAD (Federal Electricity Commission)
Gerencia de Distribucion
Rio Rodano No. 14-3er Piso
Mexico 5, D. F. (905) 553-65-96 - 553-71-31 ext. 2030

Ing. Jorge Gutierrez Vera, General Manager
Sr. Navaraez, 17 Elba, Mexico 5, D. F.
Jose Luis Aburto Avila - Leibnitz 14, 3er Piso, Mexico 5, D.F. 011 525 553 7061
7133 x 2767

CONACYT
Consejo Nacional de Ciencia y Tecnologia
National Council for Science & Technology
Insurgentes Sur 1677
Mexico 20, D.F. 905/524-09-87

Dr. Ignacio Gutierrez Arce, Adjunct Director of Technical Development
Ubg, Agystub Sabcgez Vazqyez, Chief

DIGAASES
DIRECCION GENERAL DE APPROVECHAMIENTO DE AGUAS SALINAS Y ENERGIA SOLAR
General Management for Saline Water & Solar Energy Develop.
Bulevar Pipila No. 1
Tecamachalco Presa San Joaquin
Mexico 10, D. F. 011 525 589-0166

Javier Ibarra Herrera, Director General

ESCUELA ARTESANAL DE SANTA CLARA DEL COBRE
(Vocational Craft School of Santa Clard del Cobre)
Santa Clara del Cobre, SN. Michoacan

Sr. Jesus F. Perez Ornelas, Copper Master (Federal)

ESCUELA NACIONAL DE ARTESANIAS
(National School of Crafts)
Casa del Artesono,
Morelia, Michoacan

Sr. Raul Arrollo, Capuca Group Manager

FAIRBANKS-MORSE (Manufacturio)
1338 Cuauhtemoc 2º piso
Mexico 13, D. F. 905/559-12-33

Lic. Marico Gasque
Inc. Enrique Vega

FDM - FUNDACION DE DESARROLLO MEXICANO
(Mexican Development Foundation)
Avenida Ejersito Nacional 599 - 12 piso Mexico 5, P. F. 531-8518

Lic. Humberto Marrero, Executive Director

FOGAIN
National Financiera, S. A.
Fondo de garantia y fomento a la industria mediana y pequana
Dinamarca No. 84, 2º piso
Mexico 6, D. F. 905 592-02-99

Lic. Rafael Molina Zaldivar, General Credit Manager

Lic. Eutimio Tobar, Director - Portal Matamores 70, Morelia, Michoacan 2-1841

FONARTE - FONDO NACIONAL PARA EL FOMENTO DE LAS ARTESANIAS
(National Fund for Fostering Cottage Industry)
Avenuda Patriotism 691
Mexico 19, D. F. Mexico 563-8840

Lic. Alberto Dias de Cossio C[illegible]bajal, Technical Director

GRUPO DEL SOL, S. C.
Costa 209
Colonia Las Aguilos
Mexico 20, D. F. 905/511-8050

Roberto J. Martin

IGSA
Paseo de la Reforma 5287
Mexico 10, D. F.

Sr. Orazca, General Sales Manager

INSTITUTO DE INVESTIGOCIONES ELECTRICAS
Interior Internado Palmira, A Postal 475
Cuernavaca, Morelos
Mexico 4-21-71 Telex: 0178351

M. en C. Ana Martinez
Dr. Eduardo Gleason Garcia, Investigador
Dr. Pablo Mulas del Pozo, Director de la Division

INTERMARK DE MEXICO, S. A. DE C. U.
Fuente de pegaso no. 34
Lamas de Tecamachdco
Mexico 10, D. F. 905/294-13-33

Patrick F. Kavanagh, Dir. General , President

INSTITUTO DE INVESTIGACIONES ELECTRICAS (IIE)
Interior Internado Palmira
Apartado Postal Num. 475
Cuernavaca, Mor. - Mexico

Dpto Fuentes no Convencionales
Div. Fuentes de Energia 4-13-51 Directo
6 4-14-33, 4-21-47 ext. 31

Dr. Eduardo Gleason Garcis, Investigador
Dr. Pablo Mulas del Poxo, Director de la Division

NAFINSA PIN - NATIONAL FINANCERA S. A. - PROGRAMA DE APOYO
INTEGRAL A LA INDUSTRIA PEQUENA Y MEDIANA
(National Finance S. A. - Program of Integrated Support to Small & Medium industry)
Portal Matamores 70, Morelia, Michoacan 2-1835

Ing. Humberto Gonzalez Ramirez, Industrial Extensionist

PIDER
Izazaga 38, 2º piso 905/585-5077 ext. 249

Srta Kim Conroy
Lic. Guillermo Saenz

SAHOP
SECRETARIA DE ASENTAMIENTOS HUMANOS Y OBRAS PUBLICAS
Boulevard Pipila No. 1
Tecamachalco
Mexico 10, D. F. 905/589-40-11

Lic. Jose Fco. Rios Coello, Subdirector of Studies and Programs

SECRETARIA DE FOMENTO INDUSTRIAL
(State Secretary of Industrial Development)
Avenida Lazaro Cardenas 1677-3 piso
Morelia, Michoacan 24800

Dr. Alberto Alcara Zatimirano, Chief Economist

SECRETARIA DE FOMENTO RURAL
(State Secretary of Rural Development)
Guilermo Preto 57
Morelia, Michoacan

Ing. Tomas Torres Magana, Director of Agroindustry

SECRETARIA DE PROGAMACION Y PRESUPUESTO
(State Secretary of Planning and Budget)
Polacio
Morelia, Michoacan 2-4446

Information Desk Officer

SECRETARIA DE PATRIMONICO Y FOMENTO INDUSTRIAL (SPFI)
Insurgentes sur 552 8º piso
Mexico 7, D. F. 905/564-8000
General directorate of foreign investment & technology transfer

Lic. Hector Hernandez Vinas, Chief-Dept. of Statistical Analysis 584-83-38
Lic. Abreu Abreu, 26 Hermosilla 5º piso Mexico 7. D. F.

SECRETARIAT OF COMMERCE
Director General of Control of Foreign Trade
Cuauhtemoc No. 80
Planta Baja 578-8029

V. A. Marco Antonio Guzman Orozco, Chief, Dept. of "orientacion y dificion"

SOLVIMEX, S. A.
Paseo de la Reforma 5287
Mexico 10, D. F.
A.D. 82-011 905.510-35-88 Tx 1776360

Rosanna Aldarao, Administrator of Sales
Mario Sanchez Miles 570-04-25

TOUCHE ROSS INTL.
Galaz, Carstens, Chavero, Yamazaki y Cia.
Lagrange 103
Mexico 10, D. F. 905/395-0455 ext 147 Telex 1771621 TRIME

Lic. Javier Labrador

TRADEMEX IMPORTACION - EXPORTACION
Paseo de la Reforma 95-601
Mexico 4, D. F. 535-6047
In San Diego 714-421-6338

Ing. Alejandro Portillo de la Lama
Ing. Jose Lasa 905/573-1659

U.S. TRADE CENTER
Apartado Postal
M-2805
Mexico City 1, D. F.

James L. Blow, Director

C. MOROCCO

PREFACE

This report is a profile of Morocco in the context of photovoltaic systems, with a specific focus on cottage industry applications. Unlike the companion reports on the Philippines and Mexico, this study was made on the basis of secondary information only and without travel to the country.

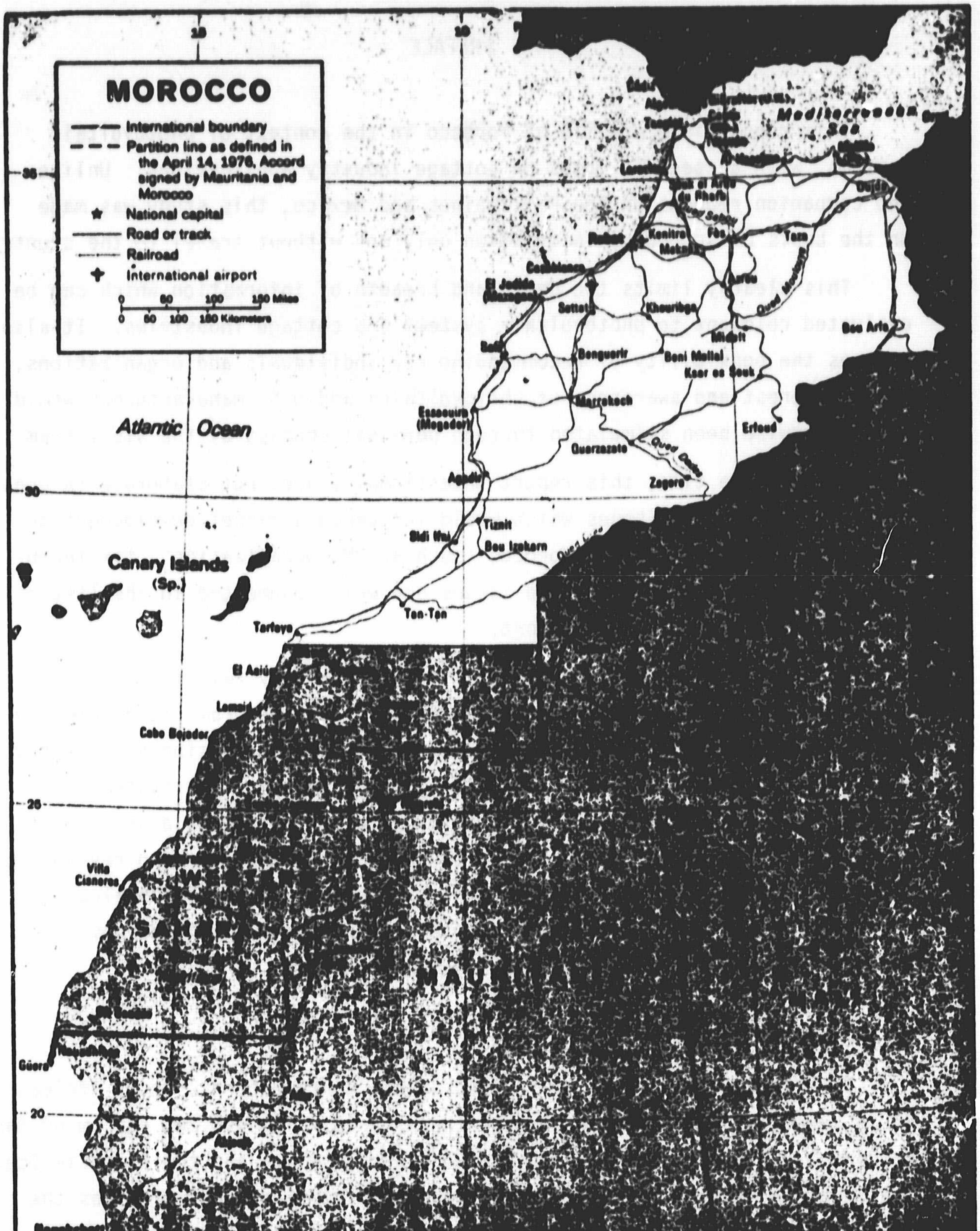
This clearly limits the depth and breadth of information which can be evaluated relevant to photovoltaic systems and cottage industries. It also removes the possibility of recommending key individuals and organizations, whose interest and awareness of photovoltaics and U.S. manufacturers would have otherwise been stimulated through personal contact by the study team.

At the same time, this report intentionally does not elaborate in great detail on all of the issues which would influence a market development or joint venture investment in Morocco (such as "Moroccanization", tax incentives, tax requirements). These issues are well documented in the list of references included in this report.

Despite the somewhat limited utility of secondary research, it is valuable in achieving the broader objectives of the program, to develop this profile of Morocco. Each country is unique in terms of business infrastructure, cottage industries, and the potential for photovoltaic systems. Nevertheless, each major region of the world also represents a unique set of conditions and potentials. As a result of prior analysis and review, it has been determined that Morocco offers a reasonable focus for evaluating the problems and opportunities for photovoltaic systems applications to cottage industries in the North Africa/Mideast region.

1. OVERVIEW

The Kingdom of Morocco is located at the northwestern edge of Africa, in an area frequently referred to as the Maghrib. The 490,200 sq. km of land borders Algeria, Western Sahara, the Mediterranean Sea and the Atlantic Ocean. The Strait of Gibraltar separates the country from Spain and provides the gateway to the Mediterranean. Refer to the map on the following page.



503101 12-76 (542932)

Source: U.S. Department of State

Mountain ranges segment Morocco into five geographic regions. To the north, are the Atlas ranges and the Riff Mountains which face the Mediterranean. The western plains are rich and fertile, while the southwest is alluvial. The central plateaus are the heart of agriculture in Morocco. The southeast is arrid and desert, being in the pre-Sahara. The coastal regions have a mild, Mediterranean climate, the mountains are cool with considerable snowfall.

2. THE ECONOMY

The development and growth of the Moroccan economy is strongly influenced by government initiatives, balance of trade issues, sources of external capital, the mix of natural resource-based industries, and demographic factors. In addition, the current military engagement in the Western Sahara represents a long-term drain on Morocco's financial resources and national focus. It is true that the factors mentioned above are primary influences in any economy, but, in Morocco, each is accentuated by the limited set of options available to provide economic stability and growth consistency. The Morocco-specific impacts of government planning programs, export fluctuations in demand for phosphates, and the cost of imported energy have combined to cause wide fluctuations from year to year in the performance of the economy.

For the most recently estimated period, 1980, the Gross Domestic Product (GDP) stands at about $17 billion (U.S.). This represents a real growth of just over 7% averaged over the last five years. The GDP is comprised of a 19% contribution from agriculture, 17% from manufacturing, 5% from mining, 4% from energy, and the remaining 55% from government services and public works.

As a constitutional monarchy under King Hassan II, Morocco has implemented a series of development plans over the past two decades. As with many such plans, the results have been mixed. Each plan has had somewhat different emphasis as priorities shift and conditions change.

For example, the sixth development plan (1973-77) focused on industrial expansion, maximizing employment, and redistributing wealth. At least the first of these was achieved with some success. The seventh plan (1978-82) focuses on expanding exports, reducing imports, and expanding labor-intensive industries. This plan has been modified as the economy deteriorated due to falling phosphate prices and a weakened world economy. Modifications emphasized austerity and sacrifice by focusing on restrictive credit policies, restrictive import policies, and conservative government spending policies. This succeeded in reducing the trade deficit and debt service, but at the same time dampened foreign investment and industrial development.

The new plan (1980-1985) is expected to emphasize regional development and industrial decentralization. Particular areas of focus will be mining, agricultural productivity for improved exports, and energy diversification (i.e., self-sufficiency). In addition, the new plan will give great importance to small industry development and labor intensive industries.

The priorities represented by these plans reflect the problems which have been emerging in Morocco for some time. This includes trying to bring stability to its foreign trade, on which so much of the economy hinges. It also includes trying to slow the concentration of population in a few urban areas. This continued migration to areas such as Casablanca and Rabat places great stress on existing facilities and increases the imbalance in employment and wealth in the population.

Since the balance of trade plays such a significant role in development planning, it is useful to review the basic issues which influence export/import performance. The critical element on the import ledger is energy, specifically imported crude oil from Iraq and Libya. The energy is needed to sustain economic development, but most importantly to support the phosphate mining industry. With phosphate as the critical export element, a desirable increase in phosphate exports requires an increase in energy imports. This situation can only be alleviated by developing indigenous energy resources. This is the strategy currently being planned.

The export ledger is also influenced by agricultural production, tourism, and manufacturing. One objective of the development plan is to realize a greater contribution to exports by agriculture. This is expected to be complicated by increased competition in selling to the European Economic Community (EEC), arising from the entry of both Greece and Spain into the EEC by 1984. (Greece entered the EEC in 1981.)

A second broad objective is to displace imported manufactured goods through a greater emphasis on local manufacturing. This has tempered the "Morrocanization" policy by encouraging foreign firms to establish manufacturing facilities in Morocco, whether for sale to the Moroccan market or for export from Morocco. Extra investment incentives are offered for establishing facilities in the less developed regions. This will be further encouraged by investing in development of the infrastructure (roads, telecommunications, electric power) to better serve the less developed areas.

Morocco is in the fortunate position of being granted a $1.1 billion stand-by credit for three years by the International Monetary Fund. This is intended to help cover the balance of payment deficits. At the same time, Morocco has been given $3 discounts on every barrel of oil purchased from Iraq, which supplies most of Morocco's oil. Financing for such purposes has also been generous. It is also expected that Morocco will be assisted in its rural electrification efforts through the participation of the World Bank.

3. INDUSTRIAL PRODUCTION

The Moroccan economy, as mentioned previously, is supported by four major industries: agriculture, minerals, manufacturing, and tourism. The first three sectors in particular play a critical role in improving the livelihood of the population, and in providing the opportunity for improving the export performance of the country. The major characteristics and forces of change for the three sectors are described in the following paragraphs.

3.1 Agriculture

Agriculture and related activities support more than 50% of the working population, about 2.5 million people. Approximately one-third of domestic requirements are satisfied by current agricultural production. The remaining two-thirds, primarily in the form of wheat and sugar, is imported.

Fish, fruit, vegetables, grain and wool are the primary agricultural resources. Twelve percent of the land is forested and represents a significant industry, wholly owned by the state. Production of vegetables, citrus fruits, and fish contribute 33% to the export trade of Morocco. Much of this is derived from modern farms which represent the most productive agricultural real estate. The output capacity of the millions of small traditional farms is only sufficient to serve local, indigenous food needs.

Moroccan government and rural development planners (e.g., at the World Bank) recognize that the agriculture production potential is considerably underdeveloped. Through investment in irrigation projects, and training programs, the stability and level of production are expected to be enhanced. This will help to further improve the export trade and reduce dependence on imports as well. Examples of the types of agricultural operations in Morocco include 8000 small flour mills, 8000 commercial vegetable farms, and 150 small fish canneries.

3.2 Minerals

The most significant mineral resource in Morocco is phosphate. Deposits of this mineral in Morocco are estimated at three-fourths of the world reserves. The phosphate rock mining industry employs approximately 21,000 people. Iron ore, anthracite, copper, zinc and lead are also present in substantial quantities. Phosphate offers the potential of providing Morocco with long term economic leverage in world markets. Short term supply/demand conditions, however, do not provide an encouraging balance of trade situation. This situation is exacerbated by the increasingly high cost of and demand for crude oil imports.

3.3 Manufacturing

Manufacturing in Morocco, as in most countries of this region, is characterized by both large modern operations and small-scale traditional artisan, handicraft, and other activities. Manufacturing employs about 20% of the labor force. Modern operations employ about 250,000 and represent 60% of production by value. Traditional operations employ as many as 750,000 and represent 40% of production by value.

The primary manufacturing sectors are food and beverage processing, textiles, metal processing, and chemicals. Products most likely to be produced by rural, small-scale manufacturers include rugs, pottery, cork, light metal objects, bricks, glassware, leather goods, wrought iron, and mosaic tile. The small manufacturers employ between 10 and 50 people and have assets less than $1,250,000.

Morocco has limited indigenous raw materials to support manufacturing. Therefore, imports, and their associated costs and availability, have a strong influence on in-country manufacturing and subsequent exports. Because of imports, as well, most manufacturing establishments, even cottage industries are located in urban areas (particularly Casablanca) which are readily accessible to transportation and trade-supporting services.

The textile industry, as an example, employs 25% of the industrial workforce. An estimated 80% of the establishments are in only two cities--Rabat and Casablanca. The traditional rural sector of industry accounts for about 4% of the industrial labor force. Therefore Morocco has a rather weak rural industrial base.

4. SOCIAL STRUCTURE/DEMOGRAPHICS

Morocco's long and colorful history is vividly reflected in its population, culture, industry, and government. The Berbers, Arabs, French, Spanish, and Portuguese have all influenced the cultural and business environment in Morocco. The language is officially Arabic, although a strong French influence remains, particularly in government and business sectors. Islam is practiced by over 98% of the population, with most belonging to the Sunni Sect.

The government is a constitutional monarchy under King Hassan II and has been politically independent from France since 1956. The stability of the government has at times been threatened, but King Hassan II has retained control for 20 years.

The most recent estimates place the population of Morocco at 20 million. This reflects an average annual growth over the last five years of 2-3%. The rural population currently represents 57% of the total, a decline of 4% since 1976. Just over 50% of the workforce of 5 million are engaged in agriculture and related activities. Refer to Exhibit C1 for the distribution of the working population by economic sector.

Exhibit C1

DISTRIBUTION OF ECONOMICALLY ACTIVE POPULATION BY ECONOMIC SECTOR, 1971

Economic Sector	Employers and Self-Employed	Salary and Wage Earners	Family Workers	Others and Status Unknown	Total	Percent
Agriculture, forestry, hunting, and fishing	694,003	418,732	872,444	2,851	1,988,030	50.0
Mining and quarrying	3,481	39,891	974	194	44,540	1.1
Manufacturing	124,085	214,238	25,485	5,456	369,264	9.3
Electricity, gas, and water	571	9,946	122	171	10,810	0.3
Construction	29,395	138,305	2,752	1,243	171,695	4.3
Wholesale and retail trade, restaurants, and hotels	193,224	78,704	14,980	2,174	289,082	7.3
Transport, storage, and communication	26,968	71,400	1,587	530	100,485	2.5
Financing, insurance, real estate, and business services	2,597	2,881	93	31	5,602	0.1
Community, social, and personal services	34,697	445,624	19,036	2,371	501,728	12.6
Activities not adequately described*	29,882	65,173	6,638	53,719	155,412	3.9
Unemployed	. . .	. . .	. . .	. . .	343,900	8.6
TOTAL	1,338,943	1,484,894	744,041*	412,640*	3,980,518	100.0

. . . not applicable

*Figures do not add to total, figures as given in source

Source: Based on information from *Yearbook of Labour Statistics, 1976*, Geneva, 1976, p. 51.

Source: "Morocco - A Country Study", The American University, 1978.

The population of Morocco is becoming increasingly concentrated in the urban coastal areas (e.g., Casablanca and Rabat) and in specific regions of Morocco (e.g., center and northwest). Refer to Exhibit C2 on the following page.

This has influenced government planning, economic development, balance-of-trade, and distribution of wealth. Urban concentration has increased for several reasons. The manufacturing sector (including many handicraft industries) is dependent on the import of raw materials into such port cities as Casablanca and Rabat. A large proportion of handicraft production is also located in urban areas to serve the tourist and export trade. The infrastructure has naturally become more developed in response to this concentration, which in turn has amplified the difference between urban and rural development and wealth.

The rural areas have remained relatively underdeveloped. The rural population is agriculture-oriented, with most of the small-scale agricultural production serving local consumption (as opposed to export consumption). Handicraft and artisan activities offer supplementary income for the rural population during the off-season.

Exhibit C2

URBAN AND RURAL POPULATION BY PROVINCE AND PREFECTURE, MID-1975

Province and Prefecture	Urban	Rural	Total
Agadir	164,000	683,900	847,900
Al Hoceima	33,000	240,000	273,000
Azilal	22,100	343,000	365,100
Beni Mellal	142,400	347,300	489,700
Boulemane	11,200	118,600	129,800
Chaouen	30,700	247,900	278,600
El Jadida	121,600	534,300	655,900
El Kelaa-Sraghna	57,300	458,400	515,700
Essaouira	51,200	353,700	404,900
Fès	463,9[illegible]	666,800	1,130,000
Figuig	24,900	73,700	98,600
Kenitra	320,100	723,400	1,043,500
Khemisset	67,000	320,600	387,600
Khenifra	71,000	204,100	275,100
Khouribga	173,200	198,800	372,000
Ksar es Souk	43,100	323,800	366,900
Marrakech	423,300	686,000	1,109,300
Meknès	386,700	300,300	687,000
Nador	63,300	468,000	531,300
Ouarzazate	46,000	535,400	581,400
Oujda	356,600	313,100	669,700
Safi	193,500	401,800	595,300
Settat	146,700	597,400	744,100
Tangier	240,900	89,800	330,700
Tarfaya	32,700	47,000	79,700
Taza	95,800	492,600	588,400
Tétouan	293,200	314,200	607,400
Tiznit	44,200	345,200	389,400
Casablanca Prefecture	1,864,400	146,400	2,010,800
Rabat Prefecture	635,700	110,100	745,800
TOTAL	6,619,000	10,686,000*	17,305,000*

*Figures do not add to total because of rounding.

Source: Based on information from Morocco, Secrétariat d'Etat auprès du Premier Ministre chargé du Plan et du Développement Régional, *Le Maroc en Chiffres, 1975*, Casablanca, 1975, p.14.

Source: "Morocco - A Country Study", The American University, 1978

The government has been attempting to encourage decentralization of economic production. Ideally, this will improve the distribution of wealth by placing greater emphasis on the development of the rural and small-scale urban infrastructure. This includes developing the electric power grid and increasing the irrigation capacity (hence the yield) of the available land. It is hoped that this will at least stabilize the current population, improve the productivity of existing operations, and ultimately encourage appropriate industries to locate in the smaller urban areas.

5. BUSINESS INFRASTRUCTURE

The infrastructure for efficiently doing business in Morocco is still in the development stages. The Government of Morocco recognizes that much has to be done to provide a network of ports, roads, railroads, utilities, and communication systems which will attract new industries and encourage greater development in outlying regions. This section is intended to offer a summary assessment of the key factors which define the infrastructure. In addition to those mentioned above, we will briefly consider the labor force, education, housing, financing, channels of distribution, investment requirements, and incentives.

The Moroccan government continues to invest in the expansion and improvement of existing transport facilities, as well as in new facilities. Part of the objective is to reduce the burden on existing facilities serving Casablanca and Rabat, and to encourage greater decentralization of industry. Thus new ports, new roads, new railroads as well as new power generation plants and communications stations are intended to not only improve service to existing industrial plants, but also encourage new business centers in the currently less populated areas. The communications system is adequate, though much could be done to make it more reliable for business use.

The optimistic goals of these development projects must be tempered by the reality of an economically depressed time period. While in the long term Morocco will assuredly make considerable progress in improving its infrastructure, as in most planned economies, this is likely to take longer than formal plans generally recognize. At the same time, Morocco's ports and transportation network is regarded as the best available in Africa.

The labor force consists of approximately five million men and women. Specific information regarding industry sectoral distribution and geographical distribution of the population were presented in a previous section. Regarding housing, there is a recognized shortage which it is hoped will be alleviated by the construction of about 40,000 dwellings per year. The World Bank has provided assistance in this area. Education is regarded as a key ingredient in raising the standard of living, and some emphasis is being placed on expanding facilities for primary and secondary schools as well as universities. But the adult literacy rate remains at about 28%.

There is an established financing and credit system in Morocco, led by the Banque du Maroc, the official government bank. There are also 15 private commercial banks. Major U.S. banks include Citibank and Continental Illinois. Foreign owned banks must be at least 50 percent owned by Moroccan interests according to Moroccanization requirements. There are, as well, specialized credit institutions. For example, Banque Nationale pour le Development Economique (BNDE) provides financing for private manufacturing, while Caisse Nationale du Credit Agricole (CNCA) provides financing for agriculture.

Reflecting the dichotomy of traditional and modern industry in Morocco, there are also traditional and modern distribution and sales channels. The traditional sector, serving local sales and consumption, is represented by about 1000 weekly markets. Bargaining is the key ingredient. Those who frequent the markets are self-sufficient farmers or villagers (roughly two-thirds of the population) who purchase very few imported products.

The modern sales and distribution sector has been strongly influenced by Moroccanization -- a government program for assuring that Moroccan interests are represented in commercial and light industry. The government itself controls the marketing of goods considered critical to the economy: fruits, vegetables, handicrafts, fish, phosphate, etc. Casablanca remains the center, the entry point for goods to be distributed throughout Morocco by private, family-owned wholesale and retail operations.

As mentioned previously, Moroccan investment requirements demand that for most service and manufacturing industries 50% of the ownership must be Moroccan. Such firms also must have a Moroccan chairman and a majority of Moroccans on the board of directors. Examples of such industries include automobile and tractor assembly, chemical products, steel, tanning, and textile activities.

At the same time there are specific incentives to encourage investment in Morocco. This includes exoneration from customs duties on imported capital goods, 2% rebate on individual long term loans from BNDE and CIH, partial or total exoneration from income tax for up to ten years, and guaranteed transfer of dividends and repatriation of foreign capital invested in case of sale or liquidation. In addition, there are special incentives for establishing plants or offices in the outlying areas which are targets of economic development.

6. ENERGY

Morocco's energy resources are limited. Currently, Morocco satisfies 80% of its energy needs through crude oil imports. The remainder is contributed by coal, gas, and hydroelectric power. Energy resources which have been unexploited to-date consist of off-shore oil, oil shale, additional hydroelectric power, phosphate-based uranium, and renewable energy. The renewable energy resource includes biomass and solar insolation. Exhibits C3 & C4 on the following pages provide an energy resource profile of Morocco.

Near-term demand for energy is expected to be satisfied by continued import of petroleum, domestic coal and hydroelectric resources. In the long-term, coal, oil shale, and hydroelectric power will dominate, as well as a new commitment to nuclear power beyond 1990.

Renewable energy is viewed as a supplement or special application resource (e.g., desalination) for Morocco -- not as a major energy reserve. The newly established solar energy center at Marrakesh is the focal point for such developments. Working with this center is the U.S. Agency for International Development, in order to study the energy prospects for Morocco, and identify energy projects of interest to both the U.S. and Morocco.

Exhibit C3

ENERGY RESOURCE PROFILE OF MOROCCO

1979 STATISTICS

ENERGY PRODUCTION

	1978	1979	% change
Net electric energy (million kw/h)	4,100.0	4,500.0	+ 9.8
of which :			
- thermal	2,707.0	2,943.0	+ 8.7
- hydraulic	1,393.0	1,556.5	+ 11.7
Anthracite (1,000 tons)	720.0	710.0	- 1.4
Crude petroleum oil (1,000 tons)	24.3	18.6	- 23.5
Natural gas (million m3)	84.5	75.0	- 7.8

PRODUCTION OF REFINED PETROLEUM PRODUCTS

	1978	1979	% change
Petrol (1,000 m3)	198.5	210.6	+ 6.0
High grade petrol (1,000 m3)	330.9	399.9	+ 20.8
Gas oil (1,000 m3)	842.7	1,424.9	+ 69.1
Kerosene (1,000 m3)	85.0	89.4	+ 5.1
Jet fuel (1,000 m3)	185.6	309.0	+ 66.4
Fuel oil (1,000 tons)	1,265.9	1,864.3	+ 47.2
Butane (1,000 tons)	61.5	153.7	+ 149.9
Propane (1,000 tons)	8.4	26.5	+ 215.4
TOTAL REFINED PETROLEUM (1,000 tons)	2,747.0	4,440.2	+ 61.6

CONSUMPTION OF ENERGY

	1978	1979	% change
Anthracite (1,000 tons)	770.6	602.8	- 21.8
Hydroelectricity (million kw/h)	1,423.2	1,590.0	+ 11.7
Fuel oil (1,000 tons)	1,417.2	1,740.0	+ 22.8
Gas oil (1,000 m3)	1,229.9	1,558.3	+ 26.7
Petrol (1,000 m3)	534.1	585.9	+ 9.7
Kerosene (1,000 m3)	75.2	81.2	+ 8.0
Natural gas (1,000 m3)	81.4	75.0	- 7.9

IMPORTS OF ENERGY PRODUCTS AND LUBRICANTS

	1979	
	Tons	DH 1,000
Coal, agglomerates, and coke	39,177	19,739
Crude petroleum oil	4,541,618	2,436,876
Petrol	6,080	9,595
Kerosene	199	136
Gas oils and fuel oils	48,062	50,602
Lubricating oils	54,176	63,481
Petroleum gases and other hydrocarbons	133,897	125,411
Parraffin wax	14,855	23,008
Bituminous products	491	995
Other energy products	22,508	39,493
TOTAL	4,861,063	2,769,336

Sources : Direction de la Statistique, Office des Changes, Office National de l'Electricité, Charbonnages Nord Africains, SAMIR, S.C.P.

Source: Banque Marocaine du Commerce Exterieur

Exhibit C4

THE ENERGY BALANCE

(Thousands of petrol equivalent tons)	1974		1975		1976		1977		1978	
	TOTAL	%	TOTAL	%	TOTAL	%	TOTAL	%	TOTAL	%
CONSUMPTION										
Coal	344	11	431	13	469	13	434	11	459	11
Petroleum products*	2,517	77	2,640	77	2,927	79	3,178	79	3,331	79
Natural gas	62	2	54	2	60	1	66	1	62	1
Hydroelectricity	330	10	273	8	270	7	359	9	368	9
Total	3,252	100	3,398	100	3,276	100	4,037	100	4,220	100
DOMESTIC PRODUCTION										
Anthracite	325	44	412	55	449	57	414	48	432	49
Crude oil and natural gas	83	11	70	9	67	9	86	10	85	10
Hydroelectricity	330	45	273	36	270	34	359	42	368	41
Total	738	100	755	100	786	100	859	100	885	100
DEFICIT	2,514		2,643		2,940		3,178		3,335	
Percent of total consumption		77		78		79		79		79

*excluding lubricants, asphalt

CONSUMPTION OF ENERGY

	1970	1971	1972	1973	1974	1975	1976	1977	1978
Petroleum products:									
Light products (1,000 m3) :									
- petrol	206.8	200.9	191.9	194.3	199.3	189.9	192.0	206.1	201.3
- high grade petrol	215.9	243.5	279.8	310.5	270.4	302.7	321.3	330.7	332.7
- kerosene	91.9	94.6	96.2	91.1	92.0	90.4	93.3	85.1	75.2
- gas oil	558.9	594.6	649.1	734.2	798.7	930.9	1,095.9	1,200.0	1,229.9
Heavy products (1000 t) :									
- fuel oil	547.7	605.5	638.8	839.3	988.8	1,006.7	1,158.8	1,249.6	1,417.2
Liquefied gas (1000 t) :									
- butane	72.3	86.0	103.5	116.0	134.0	157.8	179.7	201.7	227.2
- propane	5.4	6.7	8.5	8.9	9.0	9.9	11.6	13.6	13.4
Electricity (million kw/h)	1,794.2	1,953.9	2,158.7	2,420.0	2,600.0	2,667.4	2,995.4	3,331.7	3,639.1
Coal (1000 t) :									
• anthracite	441.3	372.1	569.9	582.3	573.2	727.4	792.2	739.3	770.5
• imported coal	63.8	56.7	58.2	24.5	29.2	27.8	29.8	31.0	41.5

Sources : Minist/re de l'énergie et s mines,
Office national de l'électricité

ELECTRIC ENERGY
INSTALLED CAPACITY AS OF THE END OF 1978
(in kilowatts)

I - HYDRAULIC PLANTS	448,790
Afourer	93,600
Bin el Ouidane	135,600
Daourat	17,000
Mansour ed Dahbi	10,000
Mohammed el Khamis	23,200
El Kansera	14,200
Moulay Youssef	24,000
Fez amont	1,200
Fez aval	1,890
Idriss 1st	40,000
Imfout	31,200
Kasba Zidania	7,120
Lalla Takerkoust	8,800
Si Saïd Maâchou	20,800
Bou Areg	6,400
Other plants	14,380
II - THERMAL PLANTS	569,769
Jerada	165,000
Casablanca	152,000
Kenitra	75,000
Tangier	46,400
Agadir	40,000
Sidi Kacem	22,700
Tetouan	40,000
Oujda	17,000
Other plants	11,669

Source : Direction de la statistique

ADDITIONAL CAPACITY

III - HYDRAULIC PLANTS COMPLETED IN 1979 AND 1980	160,000
Oued el Makhazine	34,000
Al Massira	126,000
IV - THERMAL PLANTS NEARING COMPLETION	
Kenitra	300,000
Mohammedia	600,000

INVESTMENT CARRIED OUT IN THE ENERGY SECTOR DURING 1973-1977
(in thousands of dirhams)

- O. N. E.	1,363,515
- Coal (C.N.A.)	165,060
- Petroleum exploration	519,253
of which by :	
. B.R.P.M.	343,472
. Private enterprises	175,781
- Refining and distribution of petroleum products	1,149,000
. Refining	858,000
. Distribution	291,000
- Exploration and studies (oil shale)	22,540
- Energy studies	375
TOTAL	4,888,936

Source : 1978-80 Three-year-plan

Source: Banque Marocaine du Commerce Exterieur

In 1977, the national grid served all major cities, 70% of the small towns and 11% of the rural areas. The first stage of a 15-year rural electrification program was scheduled for 1980 with an $85 million budgeted cost. The first stage will take four years to electrify 220 villages in 17 rural provinces. The long-term goal is to connect 1,800 villages with the national grid. Currently rural power needs are served through about 400 generator sets which serve small communities.

Over 90% of the electric energy produced in Morocco is controlled by the government through the Office National de l'Electricite (ONE). Nearly half of this electric power is consumed by industry -- the phosphate industry in particular. Electricity costs approximately $0.08 per kilowatt hour, while gasoline costs about $0.60 per liter.

7. COTTAGE INDUSTRIES

The cottage industry sector in Morocco reflects many of the same fundamental activities which characterize traditional industries in other developing countries throughout the world. Small, non-grid connected enterprises in Morocco represent two main activities. First, they support the local economies - which are primarily agriculture-based - by offering tools, utensils, pottery and other basic, utilitarian products, as well as by processing the agricultural products for local consumption. Second, these enterprises, which consist for the most part of farmers and their families, supply the handicraft products which serve the export market. They use this work to keep themselves employed during the off-season. (Many additional handicraft businesses are located in the cities, near the export facilities and tourist sites.)

The major product categories which serve the utilitarian needs of the local economies are: foodstuffs, textiles, metal, and leather. The product categories which serve the export and tourist trade for the most part consist of: rugs, baskets, blankets, robes, pottery, leather goods, and metalware. In nearly every case there is a modern industrial counterpart, most likely located in or near the large cities, which produces similar products. With regard to handicrafts, the current challenge in both the traditional and modern sectors is to maintain the quality and product consistency which exporters and tourists have come to expect. Training of artisans to assure production consistency is in fact one of the programs which the government has been supporting.

As examples of the types of small-scale operations which serve mostly local needs, there are, in Morocco, 8000 small flour mills, 150 small fish canneries (although these do serve the export market), and 160 small textile factories. As mentioned previously, small-scale industry represents three-fourths of the total industrial employment and 40 % of production by value. In addition, there are an estimated 250,000 artisans producing handicrafts. This includes both urban and rural craftsmen.

Small-scale industry has had, at least until recently, a limited access to financing credit and government programs. The primary source for long-term financing for industrial projects (and these are mostly large-scale projects) is through BNDC, the national economic development bank. Short and medium term financing for industrial development is through the 15 commercial banks. Most credit applications are short term, indicating that the capital requirements are needed more to sustain current operations (i.e., raw material, consumables, utilities, etc.) rather than invest in plant and equipment.

8. POTENTIAL FOR PHOTOVOLTAICS IN COTTAGE INDUSTRIES

Renewable energy is a new factor in economic planning by the government of Morocco. This is a direct consequence of the rise in petroleum imports and prices which have contributed to a deteriorated balance of trade. As a result, the government is planning for greater long term energy self-sufficiency by developing to the maximum its indigenous energy resources. The greatest proportion is expected to be contributed by coal, oil shale, and nuclear power. But the government has also specifically indicated that renewable energy will also receive attention. It is the nature and extent of this attention which appears crucial in exploring the opportunities for photovoltaics in various applications. There is currently very little research or application activity in photovoltaics in Morocco. While a center for renewable energy has been established, it is still too early to expect any specific commitment or results regarding use of photovoltaics.

There are both U.S. and foreign photovoltaic manufacturers who have a presence in Morocco. Their current interest is in pursuing opportunities for such traditional photovoltaics applications as telecommunications and remote signaling and warning devices.

Morocco is considered to have strategic market development importance. This is due to its European connections, and its access to Mideast and other African markets, as well as its labor force and favorable business climate which encourage local manufacturing. Morocco enjoys the reputation of having the best port and transportation network in Africa, and a receptivity (developed through years of French presence) to modern business methods and new technologies.

All of these factors notwithstanding, there appears to be little to encourage consideration of cottage industries as a practical opportunity for photovoltaic market development in Morocco. This is true for reasons which have also been touched on in the other country studies in this program. The chief barriers to consideration of photovoltaics in cottage industries are economic justification and financing. The small-scale establishments and individual artisans which comprise the cottage industry sector simply cannot afford photovoltaic systems for use in lighting or for powering tools. The government of Morocco itself is unlikely to appropriate the money for photovoltaics in such applications as opposed to proceeding with conventional grid extension. The available money for achieving economic development goals has a much greater impact if directed to more fundamental problems. This includes improving agricultural productivity through improved irrigation and planting techniques, and increasing the skill of the labor force through training programs and use of modern equipment.

It appears much more feasible to consider photovoltaics in regard to the 400 generator sets which serve regions or communities in the rural sector. In these situations, the demand for electric power is already established, and the training and maintenance are likely to be more manageable. If such generator sets are located in regions not likely to be served by grid extension for some time, it may also be more feasible to gain government or other world agency financing support. Again, this depends on a careful evaluation of the benefits vs. the costs. But this does not represent a stand-alone cottage industry application, even though cottage industries are likely to benefit as they now do through the use of the generator sets.

The government of Morocco has also established several training centers throughout Morocco for development of artisan skills and introduction to new techniques and equipment. It is conceivable that as an awareness mechanism such training centers could be equipped with appropriate photovoltaic systems. This would provide the cottage industry sector with an opportunity to see how photovoltaics could serve them. It would also provide photovoltaic suppliers with an initial demonstration and market test "vehicle" for exploring application possibilities. Again, the financing will more than likely come through either the government or such organizations as the World Bank.

D. BRAZIL

PREFACE

This report is a brief discussion of Brazil including its demographic factors, government policies, energy resources and energy plans which would affect the Brazilian market for stand-alone photovoltaic systems in cottage industry applications.

The information collected to support this report is from secondary domestic sources only and, hence, represents a general overview of the Brazilian market.

1. GEOGRAPHY

Brazil is the fifth largest country in the world, covering a total land mass of 8,521,100 sq. km. The country covers half of South America and borders each of its countries with the exception of Chile and Ecuador. Nearly 7500 km of Brazil's coast borders the Atlantic Ocean (Refer to the map on the following page). There are five geographic regions. The North region lies entirely in the Amazon Basin. The Northeast region comprises "the Brazilian bulge." This area is the most economically deprived, is overpopulated, and frequently is subject to drought. The Southeast region covers only 11% of the land, but has 80% of the financial capital, 85% of the industrial production and employs 70% of the industrial workers. The South region is characterized by its coffee estates, cattle ranches and coal deposits. The Central-West is sparsely populated and is regarded as the new agricultural frontier.

The river system is one of the most extensive in the world with 50,000 km of navigable inland waterways. Principal rivers include the Amazon, Parana, Paraguay, and the Saõ Francisco.

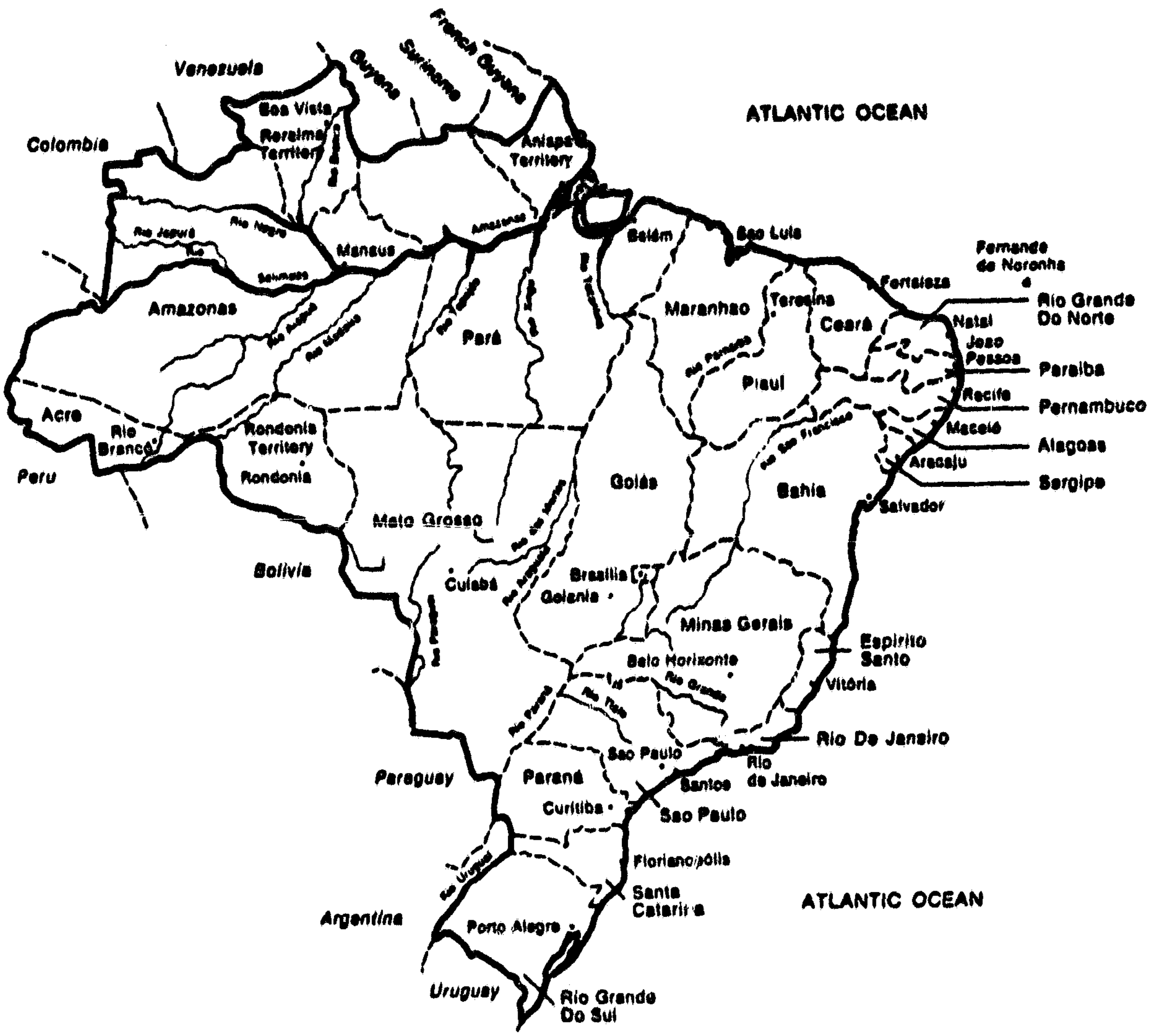
There are three climatic zones -- tropical, subtropical and temperate. The average annual sunshine ranges from 1400 to 3200 hours and the average mean solar radiation is 411 Langley's per day.

2. POPULATION

Brazil's population is presently estimated at 124.4 million, being the sixth most populous nation in the world. It accounts for 35% of the total population of Latin America and is presently growing at a rate of approximately 2.8% a year. Population density within Brazil averages 33 inhabitants per square mile, varying from three inhabitants per square mile in the north and Amazon region to 129 per square mile in the southeast.

3. GOVERNMENT

The Brazilian government is presently under military rule and has been since the revolution of April 1964. Since the revolution, Brazil's presidents have been selected by Armed forces high command and formally elected by an electoral college similar to presidential elections in the U.S. The president



Federative Republic of Brazil

Source: U.S. Department of Commerce

and vice-president are elected for five-year terms, and the electoral college is comprised of members of the national congress and delegates chosen by state assemblies. Under Brazil's constitution it is mandatory for all persons of legal age to vote in elections.

The last Brazilian presidential election was in March of 1979, at which time General Joso Baptista de Oliveria Figueiredo was elected by the Brazilian electoral college and is publicly committed to lead Brazil toward greater democracy.

Factors that are important to a modern Brazil are advocacy of pluralism or federalism, personalism, economic regionalism, a relative absence of violent conflict, ethnic harmony, and widespread influence of the Roman Catholic Church. These factors all have deep roots in the 450-year history of Brazil.

4. ECONOMY

Inflation has been a major problem in Brazil since the late 1950s. Major reforms within the government, along with the re-evaluation of the Brazilian Cruzeiro, contributed to a steady decline in the annual inflation rate until 1973. The inflation rate increased from 15.7% in 1973 to 34.5% in 1974, mainly due to the 1970 oil crisis and Brazil's dependence on foreign oil.

On June 30, 1979 Brazil's foreign debt was U.S. $46.5 billion, an increase from 12 to 13% per annum representing almost a half billion dollar increase in interest rates. In 1979, Brazil paid U.S. $4.9 billion in interest fees and U.S. $2.9 million in net terms. The GDP for 1979 was U.S. $213 billion. This represents a 6.4% growth in constant Cruzeiros. The 1980 GDP was U.S. $237 billion with a real growth of only 6.5%. The 1979 per capita income was U.S. $1780.

Inflation has accelerated steadily until August 1980, peaking at 109% before turning down to 104%. This was the highest in Brazil's history. At the same period wholesale prices increased 120% among construction materials and cost-of-living index, which is measured by the Rio de Janeiro cost-of-living index. Public service cost increased some 122% as previously controlled prices were adjusted upward.

Brazilian imports of oil, which supply about 80% of the country's petroleum needs, hit an all time high of 1.1 million barrels per day (bpd) in the first half of 1980. The average amount of oil consumed is presently 1.1 million bpd with Brazil only producing a predicted 350,000 bpd and a possible 150,000 bpd as based upon discoveries not yet made. However, Brazil is attempting to reduce the amount of imported oil by producing alcohol fuel. In 1980 an estimated 4.1 billion liters of alcohol fuel was produced.

Since March 1979, emphasis has been placed on agriculture. Agricultural programs are aimed at achieving self-efficiency in basic foodstuffs and generating increased foreign exchange earnings through expanding the volume of resources for the alcohol fuel program.

Through August 1980 the foreign trade deficit alone was U.S. $2.5 billion, some 78% above the equal period in 1979. In 1979, the total annual trade deficit was U.S. $2.7 billion. Oil imports continues to be the principle feature of Brazil's balance of trade. Total imports in oil for 1980 was about $24 billion, a 30% increase over 1979.

In the first eight months of 1980, the value of exports increased 31%. However, commodity exports in 1979 experienced sluggish expansion, and the trend carried over into 1980.

Brazil borrowed some U.S. $12 billion in foreign loans in 1979. Exports of industrial goods continues to increase at a slow rate, however, the import costs of petroleum and the need to import great amounts of capital goods to expand industry are still major problems.

For the remainder of 1981 and into 1982, foreign investment in Brazil should continue, even with growth in Saõ Paulo being restricted by the government. Joint ventures between foreign companies and Brazilian manufacturers are being given high priority in those areas where technology requirements are high.

5. CULTURAL ENVIRONMENT

5.1 Language

The national language of Brazil is Portuguese and is spoken by more South Americans than is Spanish. The Brazilian takes pride in his national language and seeks new ways to express himself, inventing colorful phrases. Therefore, Portuguese spoken in Brazil often differs from that taught in schools. Names of businesses and even foreign agricultural colonies must be in Portuguese.

5.2 Education

In 1971 legislation was enacted to reform the primary and intermediate school system. As a direct result the adult literacy rate is an estimated 76%. Enrollment in basic education, as a whole increased to 85% or 18.6 million by 1974, while the population of children within the age of 7-14 years was 21.7 million.

Secondary education enrollment, grades 9-12, grew to an estimated two million students in 1974. At the same time higher education enrollment stood at almost one million in 1975, with an additional 36,000 enrolled in graduate programs.

The new program was designed to reduce the number of grade repetitions and dropouts. The program called for a revision of the curriculum and greater flexibility. Under the 1967 Constitution, a 1971 law requires that no less than eight years of basic education be mandatory for all children between the ages of seven and fourteen. Within the restructuring of the school system, these eight years are to be followed by a program designed to provide skills needed for immediate employment or continue on to a higher education.

By geographic regions, attendance in primary and middle schools is highest in the Southeast and South. The Northeast has been regarded as an educationally deprived area.

Approximately one half of the students completing primary classes go on to middle level schools. This is due to the lack of schools to attend in the case of most rural children and to extreme crowding of urban facilities.

Many teachers are unqualified and a large portion of those at the middle level have positions within industry and teach part-time. Enrollments in institutions of higher education remains highly concentrated. Gaining admission to an institution of higher education is extremely difficult because of required entrance examinations. Many students find it necessary to take a one-year preparatory course one or more times.

Teachers in Brazil must be Brazilian citizens and over the age of eighteen. Rules concerning their qualifications, rights and responsibilities are laid down by state governments, which operate most of the schools at the primary and middle levels.

In 1970 there were almost 440,000 teachers in the primary program plus 25,000 in the supplementary program. Two-thirds were in urban localities with only about 10% being fully qualified professors. Nearly one-half of the remainder had not completed the lower middle school cycle of normal school. In rural areas, many teachers have no more than a primary education.

5.3 Religion

Brazil is the largest Roman Catholic country in the world. An estimated 93% of the population are baptized church members. The Roman Catholic Church provided the first systematic medical services in Brazil and missionary priests were responsible for establishing some of the first schools in rural areas. A direct result of Roman Catholic influence is the existence of a real separation of church and state with religion and other spiritual movements practicing with complete freedom.

The clergy has been very active in organizing urban and rural organizations such as labor unions, student groups, businessmen's associations, and Catholic Action volunteers groups. Student volunteers in urban squatter settlements and in countrysides worked with the clergy in an effort to make peasants and workers aware of their rights as citizens in an effort to improve relations between the people, industry and the Brazilian Government.

The military government under President General Erenesto Geisel, elected in 1974, recognized the churches influence and publicly acknowledged the influence of the Catholic Church with Brazil's government. The church continues today in its efforts to help the people take a leavening role for the construction of a better Brazil and world.

5.4 Social Organization

Social relatives, kinsmen, accept a great deal of responsibility. Young boys may visit an uncle for the first time and remain several years. During this period he is treated as one of the family;receiving food, shelter and an education. Godparents may be called upon to house a godson while he attends school in an urban center. Rural peasants who migrate to the cities in search of work can be followed by kin. Those remaining at home help finance the trip, with relatives in the city expected to help the newcomer find work, and support him while looking for work as well as sharing their often one room dwelling.

Those who own their own businesses often place their own kin in positions of trust. The owner has an obligation to provide a job for a relative within the relative's limits.

Family loyalties also extend into politics in well-established rural towns more than in urban areas. Family support is of great importance to the local politician, with his election dependent more upon his relatives than his platform. Officials often owe favors to their supporters and are expected to secure appointments for them. Failure by the politician to carry out his obligations to his family is severely critized.

6. INFRASTRUCTURE (HIGHWAYS, RAILROADS, PORTS AND TELEPHONES)

Since colonial times transportation from populated coastal areas to the interior of Brazil has been a problem. The usual means of commuting were along the lengthy coastline, on the rivers of the Amazon Basin in the north, the São Francisco River system running in a north-south direction, and the Parana-Paruguay River system in the South.

When roads, and later railroads were built, they were developed in a pattern running from the interior to the various ports on the coast. In the early 1970s, about 70 percent of all freight and 90 percent of all passengers moved on highways. There are approximately 1.7 million kilometers of roadways in Brazil today moving 95 percent of passenger and 75 percent of cargo transportation. Railroads for the most part are confined to the coastal areas and run inland for short distances only. The furthest line running inland is from the coast to Brasilia, the Federal District. Interconnection of the various rail lines is made difficult due to the fact that the various track gauges differ. The interconnections exist only in the vicinity of Rio de Janeiro and Saõ Paulo. Travel to neighboring Argentina and Uruguay is also hampered by the differences in track gauges. In late 1973, the first Atlantic-to-Pacific train was capable of running from Santos, Brazil to Antofagasta, Chile.

Brazil's rail system presently consists of approximately 31,000 kilometers of track and is made up of eight companies. Since the beginning of the petroleum crisis of 1974, the railroads have received priority attention from the Government. The Brazilian railroad system is almost entirely operated by Government-owned enterprises. In 1977, of the eight railroad companies, the three largest were controlled by the Federal Government.

Brazil's railroad system is presently in dire need of maintenance. The two Government-owned railway companies, which control 96 percent of the nation's track, are presently in a critical financial state. The large investments necessary to bring the rail system up to the needed efficiency will impede the rail system from playing an important role in Brazil's overall transportation system.

Brazil's port facilities are maturing into efficient and competitive forces in international waters. Consisting of nearly 1040 merchant ships having a capacity of 5.5 million dead weight tons, 51 percent of Brazil's international trade is shipped by Brazilian flag vessels. There are some 250 sea and inland ports; however, in 1977 only 30 possessed mechanical handling equipment and adequate storage facilities to accommodate international freight lines. Despite the small number of ports possessing mechanical handling equipment, some 143 million tons of overseas freight was moved in 1977. Another 54 million tons were moved at inland ports.

In 1977 the Brazilian telephone network consisted of 4.5 million installed telephones serving some 3300 municipalities. Approximately 90% of the telephone network is installed and operated by government-owned telephone companies. During 1977, some 688,000 new installations took place.

Direct distance dialing was made available in 1977 to all 21 Brazilian states and some 533 municipalities. International dialing is possible to the United States, Canada, and ten other countries from Rio de Janeiro, Curitiba and 150 other Brazilian cities.

In 1980 Telex was installed in over 200 cities with the number of terminals exceeding 36,000. Between 1977 and 1978 some $125 million was invested into expanding the Brazilian telecommunications telex services.

Telecommunicacoes Brasileiras S.A., the largest telephone subsidiary in Brazil, estimates that by 1982 some 7.1 million telephones, and 62,000 telex terminals will have been installed.

7. ENERGY RESOURCES

Brazil is one of the few countries having six natural resources available for energy needs. The resources are petroleum, gas, wood, coal, uranium, and hydro. Brazil, despite its resources still has a critical energy problem, specifically liquid fuel. Present energy sources are inadequate to meet the needs of the country. The only abundant means of energy in Brazil are hydroelectric for electric power, and resources for alcohol production to replace petroleum.

Many contributing factors make up Brazil's energy problem. Heading the list are oil production and transportation needs. Dependency on foreign oil to the extent of 80% results in high transportation costs. Need for technology and energy related equipment has deprived areas of electrical energy for decades. High sulfur content and low energy rating of coal reserves makes use of coal inefficient. High inflation rate and large trade deficit has discouraged imports and slowed the advancement of electrical energy to rural areas.

Wood was Brazil's greatest source of energy before the 1950s, especially in rural areas and small towns. Wood was used for both small industry and domestic uses. Firewood, together with cane thrash and charcoal accounted for more than 50% of energy consumption. In 1970, with the modernization of Brazil, and low prices, wood only accounted for about 30% of the energy balance.

The oil crisis brought about a renewed interest in wood which could become an alternate source for the substitution of oil by-products. The renewed interest is brought about through the application of advanced technologies, higher yield patterns and the rational utilization of forest resources. As part of a pilot experiment, wood is being used for the production of alcohol. Wood charcoal is also being used for iron and steel metallurgy. However, only 50% of the iron and steel metallurgy using charcoal can be met using new reforestation practices.

Dependence upon foreign oil accounts for some 80% of Brazil's petroleum needs, or 1.1 million barrels per day. Forty-five percent of Brazil's primary energy is derived from petroleum. Imported oil represents, as of August 1980, 40% of all imports at a cost of U.S. $6 billion and is estimated to cost U.S. $11 billion by year end, a 61% increase over 1979. The first six months oil import was approximately 171 million barrels.

Transportation is presently the prime energy user. Until the world oil crisis in the 1970s, much of Brazil's transportation effort was in the development and expansion of their highway system. Prior to the 1970s, the majority of travel and transportation of goods was done by highway. Highway travel at that time was more economical than the money required to maintain and update Brazil's rail system.

The majority of Brazil's electrical service is hydroelectric and, until the Rural Electrification Program for 1976 to 1978, electrical service existed only in highly populated urban areas. Between 1976 and 1978 $230 million was invested to increase the number of farms having electrical service to 350,000, an increase of 83,000 farms with distribution lines in all of Brazil's 21 states.

In 1979 another $75 million was spent to serve an additional 22,500 homes. Almost all of this additional coverage was accomplished by extension of electric power lines. Yet, it is estimated that only 8% of Brazil's 4.5 million rural communities have electricity. Another possible 10,000 farmers, remote from the grid, use small gasoline or diesel generators for their electric power.

Thermoelectric generation is uneconomical, even with Brazil's coal reserve in excess of 3 billion tons and 600 million barrels of oil shale reserves. Only a small percentage of Brazil's coal from Santa Catarina can be utilized in coke furnaces.

Brazil's coal reserve is characteristically bituminous, high in ash content, low in heat value and highly sulfurous. The added costs of refining the coal, along with the processes necessary to utilize the 600 million barrels of oil shale, and the fact that 90% of all natural gas wells, an estimated 25 billion cubic feet in 1973, are in Northeast Bahia, makes production of these energy sources cost prohibitive.

The number of diesel-powered stand-by generators installed by individuals during the 1970s is inadequate to meet today's need of uninterrupted supply of electrical energy. Stand-by generators are mainly used by industry, hospitals, businesses, airports and other institutions. The actual number of these generators is unknown, however, it is known that the actual number is far below requirements. Several hospitals do not have emergency generators for critical areas, even though existing legislation makes such equipment compulsory.

Hydroelectric and nuclear power generation are, therefore, the most extensive means of producing Brazil's electric power. Installed generating capacity is estimated to be growing at 12% annually throughout the 1972-82 period. Emphasis is on hydroelectric power which will account for an estimated 85% of the total power generated in 1982 as compared to 92% in 1979. The total annual dollar investment since 1978 has been in the range of U.S. $500 million.

Brazil has made a heavy commitment to nuclear power for the generation of electrical energy. The first nuclear power plant was completed in 1979 and was obtained from the United States. The move toward nuclear power over hydroelectric was to help meet the demands for electrical energy in the industrialized southeast region. It is estimated that by 1990, a major portion of Brazil's hydroelectric potential in the southeast region will have been harnessed. In all, nine nuclear power plants were planned. However, opposition to nuclear power plants does exist because of the cost of technology and equipment that must be imported. It now appears that only three of the nine nuclear power facilities will be completed. The second and third facilities, Angra II and III, are being obtained from Germany. The two German facilities will only utilize about 50% Brazilian equipment and, at present, only site preparations have begun on Angra II which is scheduled for completion in 1987. The site for Angra III has yet to be approved by the Brazilian Nuclear Energy Commission. All three plants will be located in the State of Rio de Janeiro.

7.1 Energy Plans

To help reduce imports, between 1970 and 1977 Brazil initiated research on solar and geothermal energy sources of energy. However, formal support for such projects by the government controlled electric company, Electrobras, has been minimal.

In addition, thermoelectric plants have been receiving considerable attention throughout the 1970s in the Saõ Paulo metropolitan area. Solid waste will be utilized as fuel with the first plant, with an estimated capacity of 150 MW, expected to be in operation in 1982.

Nine hydroelectric plants are also under construction to serve 16 townships in the State of Amazonas and 51 townships in the northeast using water reservoirs. A larger hydroelectric plant, $8 billion Itaipu, is being built on the Brazil-Paraguay border with a projected 12,600 MW capacity. The plant is slated to be on line in 1983 and reach full capacity by 1988.

Extensive research and construction for the production of alcohol fuel has taken place. The Petrobras Curvelo Alcohol Plant can produce 20 million liters per year of alcohol from 370 tons per day of manioc. The plant will also yield, as by-products: 10,000 tons per year of carbon dioxide, for fire extinguishers, dry ice and cold storage of food; and 5000 tons per year of solid manioc residues for use as animal feed. In 1980, total production for all alcohol plants was 4.1 billion liters of alcohol with an anticipated volume of 14 billion liters being produced in 1985.

Under the National Alcohol Plan (PNA), alcohol derived from sugar is mixed with gasoline on a 1:4 ratio. Production is presently underway for vehicles that operate on 100% alcohol. Present plans were for some 200,000 new cars and 50,000 converted to be using alcohol fuel only in 1980.

Disregarding the cost of solar energy, research continues. An energy group at the University of Campinas (Unicamp) was formed in 1975 to develop alternative forms of energy. Areas under study are water heating and electrical energy which is being financed by the government funding agency - FINEP (Financing of Studies and Projects). In September 1979, solar energy was being researched for alternative forms of energy. The technology for solar water heating has been completely developed in Brazil. Research is still being conducted for the generation of electricity utilizing solar sources. Brazilian physicists are developing solar energy as a source of heat for water, to produce industrial vapor, and direct conversion into electrical energy. Electrical generation is expected to be viable in Brazil in 1982 and could represent 10 to 25% of Brazil's electrical need by the year 2000. Financing by the Brazilian government for solar research in 1979 came from part of the U.S. $1.2 billion special energy fund created to study alternative energy sources. Some sponsorship was also received from West Germany and France for the development of photovoltaic power.

In the City of Saõ Paulo, more than 600 houses are fitted with solar panels to heat water and generate electricity. There are presently 10,000 square meters of solar panels in use in Brazil. The average cost of a solar collector is U.S. $800 sold by a Brazilian company, FAET, which has exported a solar collector to Paraguay and expects to soon export solar collectors to Peru and Bolivia.

7.2 Control of Energy

Brazil's electric utility system is operated by over 40 federal and state-owned utilities and about 20 privately owned companies.

At the federal government level, ELECTROBRAS is responsible for planning, financing and coordinating the national electric power system, including generation, transmission, and distribution of electricity. A major portion of their administrative and operational responsibilities are delegated to four major subsidiaries, whose principle role is to build and operate the major nine power plants, and regional transmission grids. These four companies are: Furnas Centrais Electricas S.A. (FURNAS); Cia Hidroelectric do Sul Francisco (CHESI); Centrais Electricas do Sul do Brasil S.A. (ELECTROSUL); and Centrais Eltricas do Norte do Brasil S.A. (ELETRONORTE). The state-owned utility companies are also regulated by the four regional ELETROBRAS subsidiaries. Furnas is also responsible for Brazil's first nuclear power plant.

Petroleum production and the production of oil substitutes, alcohol and biogas, is governed by Petrobras, a state-controlled Brazilian petroleum company. Petrobras is the largest corporation in Brazil and a law decree of 1953 gave the company a monopoly over prospecting for and developing petroleum and other fluid hydrocarbons and natural gas. Seventy-five percent of the capital stock of PETROBRAS is held by the federal government, eight percent by general public and the balance by the state government.

8. IMPORT OF TECHNOLOGY

Import duties have increased on approximately 1500 items as well as a 15% tax on foreign exchange transactions. Foreign financing, ranging from 180 days to eight years, is required for imports exceeding $100,000 for most transactions now paid for in cash. Imports are expected to be very selective and limited to: high technology items, items not produced in Brazil, and items that Brazil will later export.

Prior to any technology imported by a Brazil firm, approval must be obtained by the National Institute of Industrial Property (INPI) and the Central Bank of Brazil. All controls of the transfer of technology, including selectivity and payment, are under the authority of the Ministry of Industry and Commerce through the INRI. The Central Bank of Brazil has final approval authority over contracts which involve remittances abroad. Following approval by INPI, the Central Bank must then issue a Certificate of Registration before the local recipient of the technology can remit payments.

The INPI often refuses to approve payment of technical assistance fees where the recipient has affiliation with a multinational company. Even if approved the recipient is not allowed to report the paid fees as a tax deduction. This holds true even if the receiver is controlled directly or indirectly by the supplying company, e.g., a multinational and its Brazilian subsidiary.

Even when payments for visiting technicians are approved, the INPI will often agree to pay only a small percentage of the total costs. This leaves the remainder to be negotiated between the Brazilian company and the technician. There is also no technical assistance payments for the transfer of technology related to projects. Fees payable for technical assistance varies from one to five percent of the net sales of the locally manufactured product being sold. Technical assistance must have also been applied to that product. The percentage received depends upon the importance of the product to the Brazilian economy.

All imports must be registered with the foreign trade department of the Central Bank (CACEX). Import duties vary from 25 to 60% on most goods and as high as 205% on others. All imports can be purchased directly by the private sector, however, both state and federal approval is required. At the present time, some solar products are easy to import because of no competition. However, once a Brazilian company becomes established in the manufacturing of a product, either for export or use within Brazil, further imports of that product becomes difficult. In the instance of solar energy or photovoltaics, once Brazil successfully manufactures its own panels, foreign companies would have to switch to individual components, for example, just the wafers or other supportive equipment.

At the present time the U.S. Department of Commerce estimates that there are about 50 companies manufacturing solar energy related products in Brazil, Solarex being the largest. Solarex is working in Brazil on a joint venture with the Brazilian Government to establish the manufacturing of solar related products in that country. Economic conditions have also had a negative effect on imports to Brazil.

NORTHEAST BRAZIL

The Northeast section of Brazil, which accounts for an estimated 19.6% of the total land, 37.5% of the housing, and 38.9% of the population is an extremely poor area. The region can be segmented between the highly populated urban centers along the Eastern Coast and the interior portion of the region. The urban centers account for 17.4 million people or 14% of the total population of Brazil. The interior population of Northeast Brazil is widely dispersed with a population density ranging from one to five inhabitants per kilometer.

In this region, sources of electric power are very limited. Many rural communities are located more than 15 kilometers from electric power grids, making grid extension extremely costly. Hydraulic energy and windfall power are also in short supply. The Northeast region is extremely arid and the average wind velocity is only 50% of that required to make windmills economic and efficient.

Internal combustion generators are capable of providing needed energy in a few areas near large towns, however the transportation of fuel, lack of spare parts and repair facilities preclude their adoption in outer rural areas. The cost of a generator, fuel and maintenance could amount to U.S. $1000 per annum to operate.

There is a large hydroelectric plant under construction in the Northeast which is scheduled for completion in 1983. When completed the new plant will only help provide the needs of those in the populated urban and nearby rural areas. The high cost per inhabitant in outlying rural areas appears to be the main obstacle. Few electric grid lines do exist throughout the vast rural area of the Northeast. However, until Brazil can establish a steady economy, those living over 10 KM from the main electricalpower lines, in low inhabitant areas, will remain without electric power.

APPENDIX E

ECONOMICS OF PHOTOVOLTAIC AND DIESEL GENERATOR SETS

In order to assess the economic advantage or disadvantage of photovoltaic systems in cottage industry applications, the photovoltaic system must be compared with its product substitute, the diesel generator. The parameters of these stand-alone power systems used for this assessment are given in Exhibit E1.

Exhibit E1
STAND ALONE POWER SOURCE PARAMETERS

Photovoltaic Systems:

Costs: $10/Wp Balance of System
$ 3/Wp Modules
→ $13/Wp System

Operating Conditions
- 1 Wp produces 4.5 WH/day
- Battery & Inverter Losses ≃ 20%

→ $13/Wp or $43/Wc

Diesel Generator Systems

Capacity	Cost	Cost/Wc
7 KW	$ 6,000	$0.86/Wc
11 KW	7,000	0.64
15 KW	8,000	0.53
30 KW	10,000	0.33
45 KW	13,000	0.29
50 KW	14,000	0.28
60 KW	16,000	0.27
75 KW	18,000	0.24
90 KW	19,500	0.22

Fuel Consumption 8.45×10^{-5} gallons/Wc-hr

0.37 gallons/Wc-yr (4380 hrs/yr)

The cost of a photovoltaic system was assumed to be:

Module Cost	\$3/Wp (Peak Watt)
Balance of System	\$10/Wp

The \$3/Wp Module Cost is the ARCO Solar estimate for 1983 and the \$10/Wp Balance of System Cost is the medium range of current Balance of System Estimates of \$6 - 13 Wp.

Given these estimates, it is necessary to convert the photovoltaic cost based upon peak watts to cost based on capacity watts. In a good site, 1 Wp of photovoltaic modules will generate about 4.5 WH of energy per day. Assuming battery and inverter losses of 20%, this leaves 3.6 WH of energy left for consumption. Assuming that the power load is even throughout a 12-hour day, it is found that for every 1 Wp of system there is .30 capacity watts of power. As a result, if the photovoltaic system cost is \$13/Wp, it costs \$43/Wc. This was determined by the following formula:

4.5 Wh/day x 20% loss = 3.6 Wh/day

3.6 Wh/day ÷ No. of hrs. of operation = Conversion Factor

Cost per Wp ÷ Conversion Factor = Cost per Wc

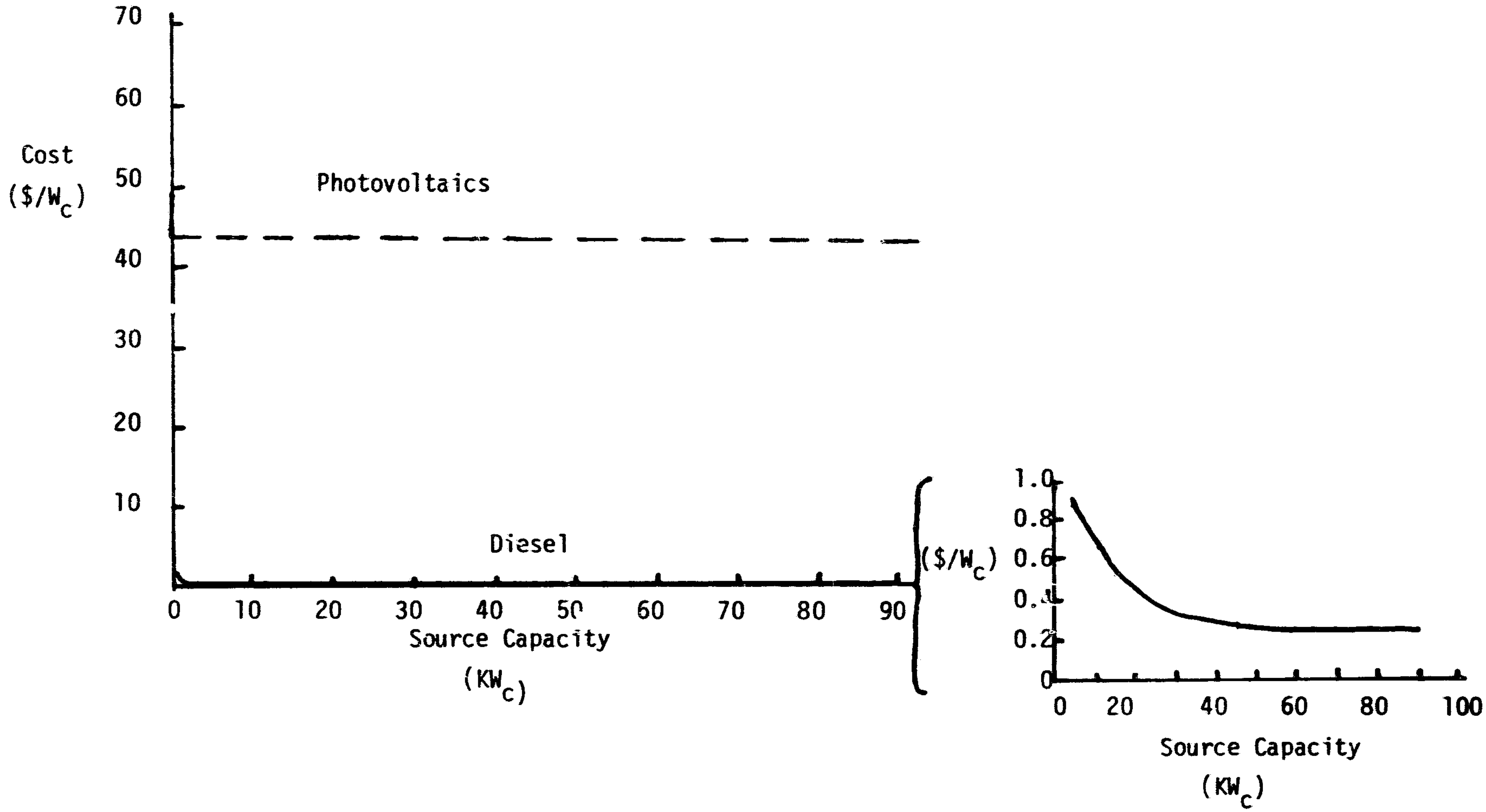
Because of the modularity of the photovoltaic system, this cost of \$43/Wc remains constant even with increasing capacity size of the photovoltaic system. With diesel generators on the other hand, there is some economy of scale as the cost per Wc of the generator system decreases with size. A comparison of the system cost is shown in Exhibit E2.

As can be seen from Exhibit E2, the initial system cost between photovoltaic systems and diesel generator systems are drastically different.

However, in making an economic design between these two systems, the life cycle cost of the systems must be considered. This is the discounted cost of operating and maintaining the system over the desired lifetime. For the purpose of this study, the lifetime is assumed to be 20 years.

Exhibit E2

INITIAL COST OF INSTALLED CAPACITY



For the diesel generator set, the costs to be considered over this time period are:

1. The initial system cost and installation cost
2. Fuel cost
3. Maintenance cost
4. Diesel engine replacement every 5000 hrs.

For the photovoltaic system, the costs to be considered over this time period are:

1. The initial system cost and installation cost
2. Maintenance cost
3. Battery replacement every 1800 cycles.

To make an estimate of the life cycle cost, it was assumed that the system would power a constant load 12 hours a day for 365 days a year. Taxes, credits and subsidies would vary by country and have been ignored for the purposes of this report. Also, these would not be considered if the system is a government purchase.

<u>Diesel Generator Life Cycle Cost</u>

<u>Initial System Cost</u>

- Equipment Cost - See Exhibit E1.
- Installation Cost - \$900

<u>Fuel Cost</u>

- A diesel generator will consume approximately .37 gal/W_c-year of fuel under the assumed load pattern

Using the formula:

Present value of an annual cost x for 20 years. $= \frac{x}{i}\left(1 - \frac{1}{(1+i)^{20}} + x\right)$

where i is the discount rate

The life cycle cost of fuel is:

$$W_c \times F \left(.37 + \frac{.37}{i}\left(1 - \frac{i}{(1+i)^{20}}\right)\right)$$

where F = cost of fuel per gallon

i = discount rate

W_c = capacity of generator in Watts

Maintenance Cost

Maintenance Cost on a diesel generator is claimed to be \$700/yr. Over the life of the generator, the discounted value of this cost is:

$$\text{Discounted Maintenance Cost} = \frac{700}{i}\left(1 - \frac{1}{(1+i)^{20}}\right)$$

Replacement Cost

The lifetime of a diesel generator is approximately 5000 hrs. of operation before the engine needs to be overhauled. If the generator operates for 12 hours a day 365 days a year, it receives 4380 hours of operation per year. As a result, it will be assumed that the diesel engine will be replaced every year. The diesel engine is approximately 60% of the initial system cost. The life cycle cost of replacement is:

$$\begin{array}{c}\text{Life cycle} \\ \text{replacement cost}\end{array} = \frac{.60\ (\text{Initial systems cost})}{i}\left(1 - \frac{1}{(1+i)^{20}}\right)$$

Combining the results above, the life cycle cost of the diesel generator when initial system cost is $W_c \times \frac{\text{Cost}}{W_c}$ and $\frac{\text{Cost}}{W_c}$ is the system cost per W_c is:

Life Cycle Cost of Diesel Generator (LCCDG)

$$= \left(W_c \times \frac{\text{Cost}}{W_c}\right)\left(1 + \frac{0.6}{i}\left(1 - \frac{1}{(1+i)^{20}}\right) + F\left(.37 + \frac{.37}{i}\left(1 - \frac{1}{(1+i)^{20}}\right)\right)\right) + \frac{700}{i}\left(1 - \frac{1}{(1+i)^{20}}\right)$$

For $i = 5\%$ $\quad \text{LCCDG} = W_c\left(7.48\frac{\text{Cost}}{W_c} + 4.98\text{xF}\right) + 8{,}724$

10% $\quad \text{LCCDG} = W_c\left(6.11\frac{\text{Cost}}{W_c} + 3.52\text{xF}\right) + 5{,}959$

15% $\quad \text{LCCDG} = W_c\left(4.76\frac{\text{Cost}}{W_c} + 2.69\text{xF}\right) + 4{,}382$

20% $\quad \text{LCCDG} = W_c\left(3.92\frac{\text{Cost}}{W_c} + 2.17\text{xF}\right) + 3{,}409$

The life cycle cost of a diesel generator for various fuel costs at various capacities at different discount rates is shown in Exhibit E3. For a photovoltaic system to be competitive, the life cycle cost of the photovoltaic system must be less than that of the diesel generator.

Exhibit E3

LIFE CYCLE COST OF DIESEL GENERATOR SYSTEMS

Discount Rate	Diesel Generator Capacity (KW)	Fuel Price $/Gal				
		1	2	3	4	5
5%	7	94633.6	129494	164354	199214	234074
	11	123203	177983	232763	287543	342323
	15	150840	225540	300240	374940	449640
	30	242076	391476	540876	690276	839676
	45	343488	567588	791688	1.01579E+06	1.23989E+06
	50	376444	625444	874444	1.12344E+06	1.37244E+06
	60	444900	743700	1.0425E+06	1.3413E+06	1.6401E+06
	75	534864	908364	1.28186E+06	1.65536E+06	2.02866E+06
	90	624828	1.07303E+06	1.52123E+06	1.96943E+06	2.41763E+06
10%	7	67381.2	92021.2	116661	141301	165941
	11	87693.4	126413	165133	203853	242573
	15	107334	160134	212934	265734	318534
	30	172048	277648	383248	488848	594448
	45	244095	402495	560895	719295	877695
	50	267499	443499	619499	795499	971499
	60	316141	527341	738541	949741	1.16094E+06
	75	379939	643939	907939	1.17194E+06	1.43594E+06
	90	443737	760537	1.07734E+06	1.39414E+06	1.71094E+06
15%	7	51867.2	70697.2	89527.2	108357	127187
	11	67482.4	97072.4	126662	156252	185842
	15	82574	122924	163274	203624	243974
	30	132206	212906	293606	374306	455006
	45	187550	308600	423650	550700	671750
	50	205522	340022	474522	609022	743522
	60	242894	404294	565694	727094	888494
	75	291812	493562	695312	897062	1.09881E+06
	90	340730	582830	824930	1.06703E+06	1.30913E+06
20%	7	42197.4	57387.4	72577.4	87767.4	102957
	11	54875.8	78745.8	102616	126486	150356
	15	67123	99673	132223	164773	197323
	30	107317	172417	237517	302617	367717
	45	152215	249865	347515	445165	542815
	50	166789	275289	383789	492289	600789
	60	197113	327313	457513	587713	717913
	75	236719	399469	562219	724969	887719
	90	276325	471625	666925	862225	1.05753E+06

Photovoltaic System Life Cycle Cost

Initial System Cost

- Equipment Cost - $43.00/W_c$

Maintenance Cost

- Assumed to be $700 per year, equivalent to the diesel generator maintenance cost.

Replacement Cost

- The batteries usually must be replaced after 1800 cycles assuming 20% depth of discharge. Assuming that the batteries are cycled 365 times a year. They must be replaced every five years. The cost of the batteries is approximately:

$W_c \times \frac{12 \times 0.1}{.2}$ where W_c is the capacity of the system and batteries are assumed to cost $100 per KwH. Battery Replacement cost is then given by:

$$\text{Battery Replacement Cost} = 6.00 \times W_c \left(\frac{1}{(1+i)^5} + \frac{1}{(1+i)^{10}} + \frac{1}{(1+i)^{15}}\right)$$

Combining the results above, the life cycle cost of the photovoltaic system is:

$$\begin{array}{l}\text{Life Cycle Cost of}\\ \text{Photovoltaic System}\\ \text{(LCCPV)}\end{array} = W_c \left(43 + \frac{6.00}{(1+i)^5 + (1+i)^{10} + (1+i)^{15}}\right) + \frac{700}{i}\left(1 - \frac{1}{(1+i)^{20}}\right)$$

For i =

5%	LCCPV = 44.20 W_c + 8,724
10%	LCCPV = 43.72 W_c + 5,959
15%	LCCPV = 43.42 W_c + 4,382
20%	LCCPV = 43.25 W_c + 3,409

These results are compared with results for diesel generators in Exhibits E4, E5, E6, and E7. It can be seen that at the current time for systems above 7 KW_c the photovoltaic system is uneconomical. To find the conditions necessary for breakeven, the LCCDG is set equal to LCCPV.

Discount Rate	
5%	$44.20 = 8.48 \frac{Cost}{W_c} + 4.98xF$
10%	$43.72 = 6.11 \frac{Cost}{W_c} + 3.52xF$
15%	$43.42 = 4.76 \frac{Cost}{W_c} + 2.69xF$
20%	$43.25 = 3.92 \frac{Cost}{W_c} + 2.17xF$

The fuel price at which photovoltaic systems would be competitive is found by:

Discount Rate	
5%	$F = \frac{44.20 - 8.48\ Cost/W_c}{4.98}$
10%	$F = \frac{43.72 - 6.11\ Cost/W_c}{3.52}$
15%	$F = \frac{43.42 - 4.76\ Cost/W_c}{2.69}$
20%	$F = \frac{43.25 - 3.92\ Cost/W_c}{2.17}$

These results are shown in Exhibit E8.

Exhibit E4

LIFE CYCLE COSTS OF PHOTOVOLTAIC SYSTEMS
AND DIESEL DRIVEN GENERATOR SYSTEMS
AT 5% DISCOUNT RATE

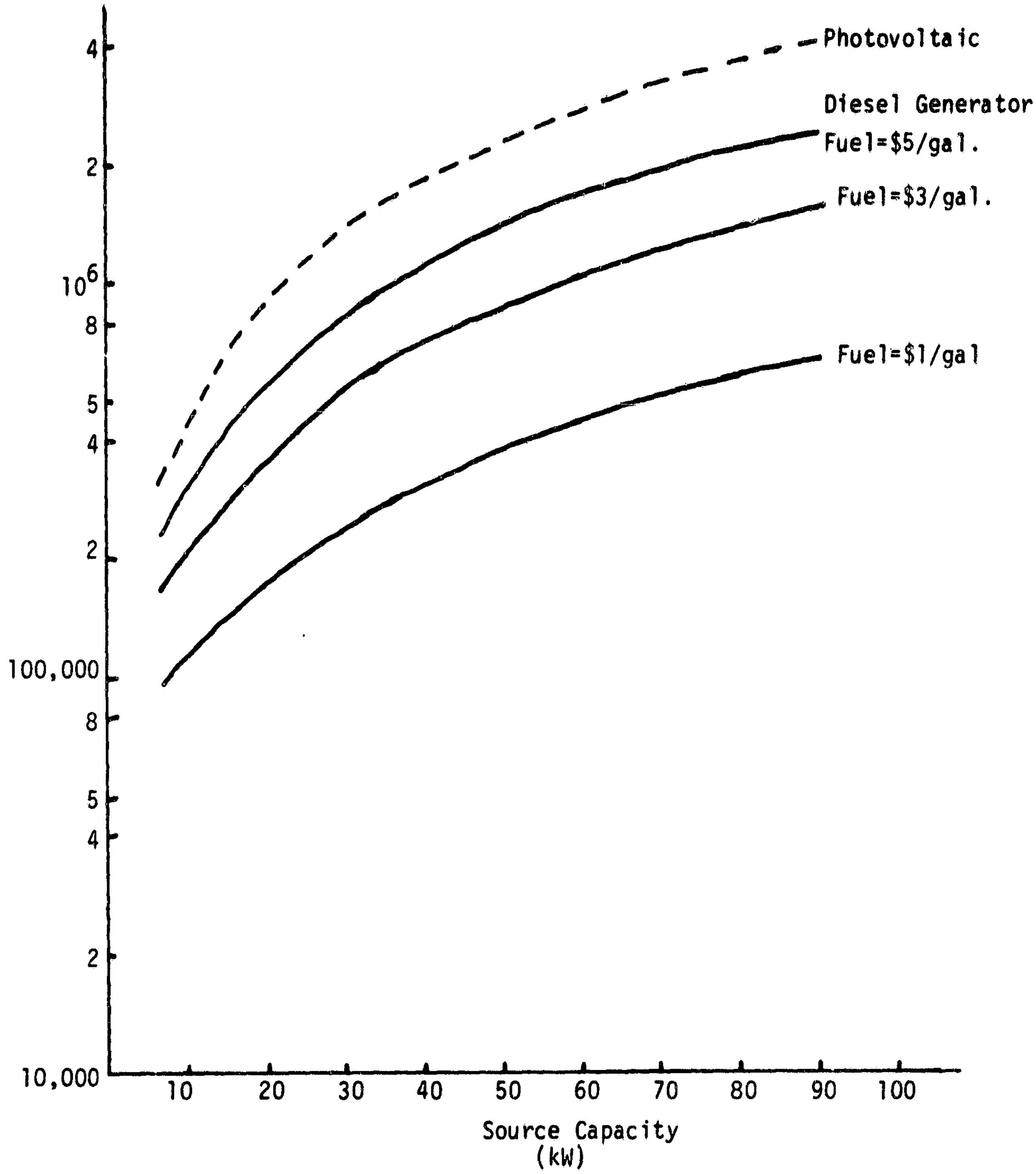


Exhibit E5

LIFE CYCLE COSTS OF PHOTOVOLTAIC SYSTEMS
AND DIESEL DRIVEN GENERATOR SYSTEMS
AT 10% DISCOUNT RATE

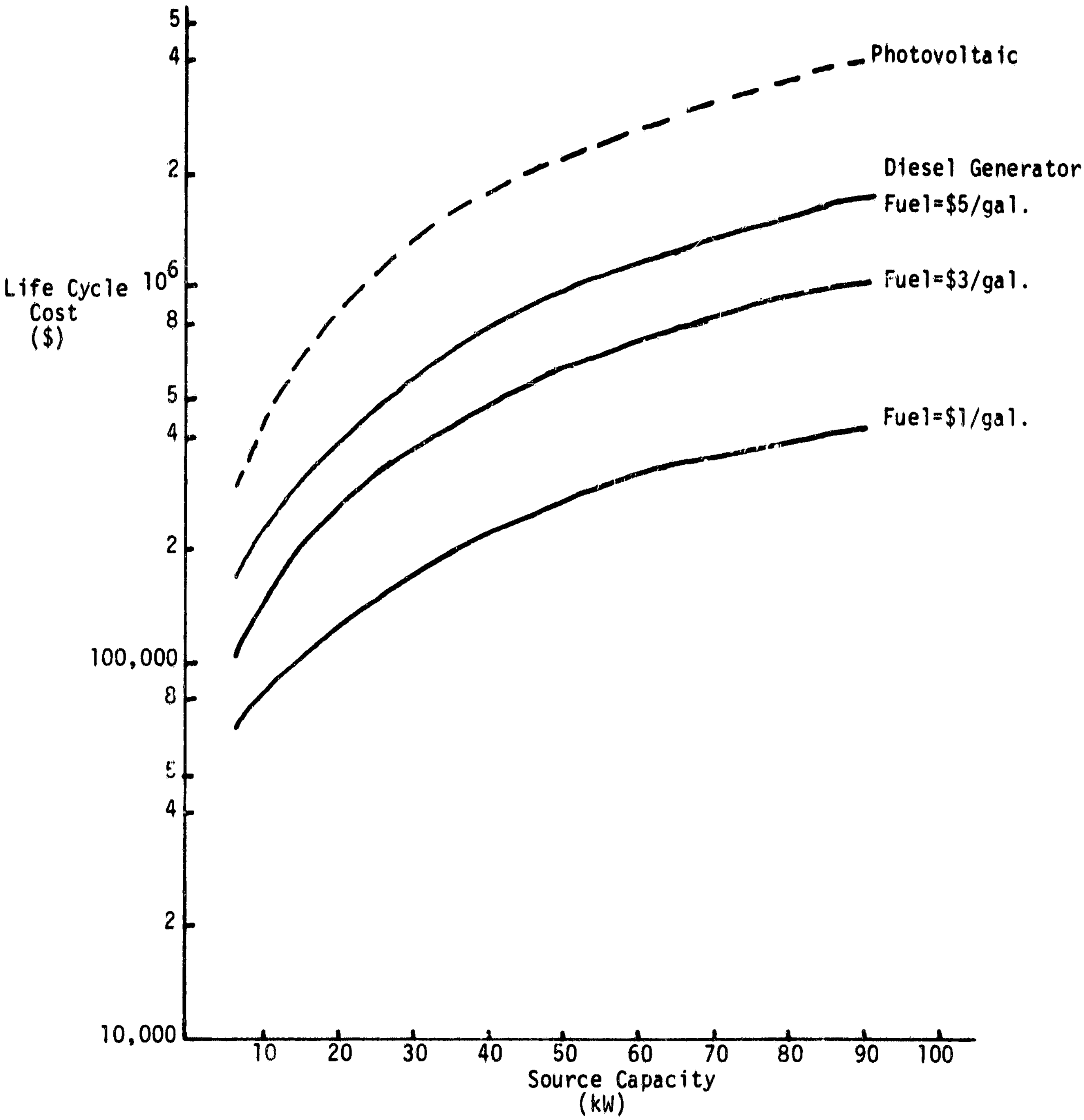


Exhibit E6

LIFE CYCLE COSTS OF PHOTOVOLTAIC SYSTEMS
AND DIESEL DRIVEN GENERATOR SYSTEMS
AT 15% DISCOUNT RATE

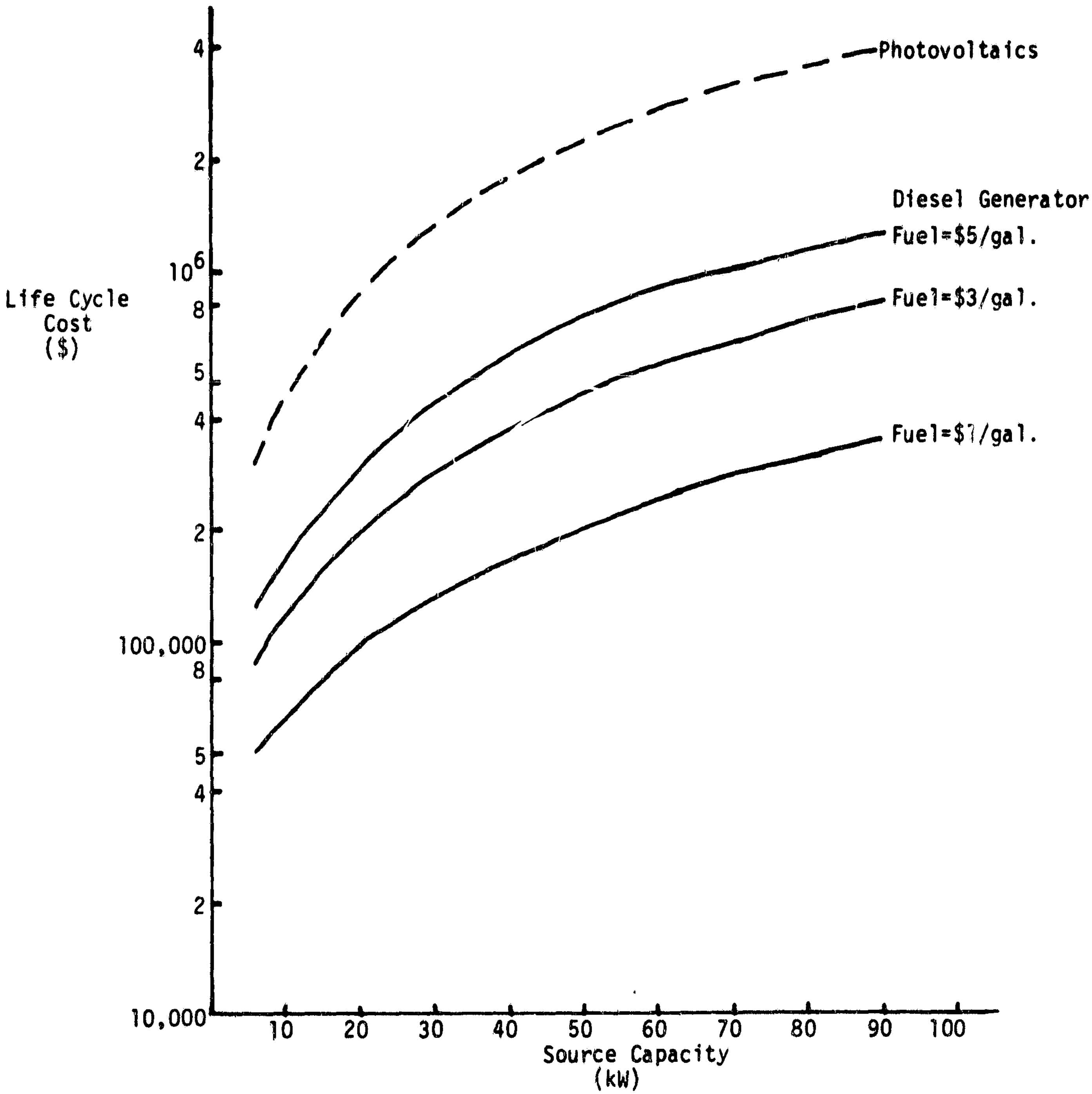


Exhibit E7

LIFE CYCLE COSTS OF PHOTOVOLTAIC SYSTEMS
AND DIESEL DRIVEN GENERATOR SYSTEMS
AT 20% DISCOUNT RATE

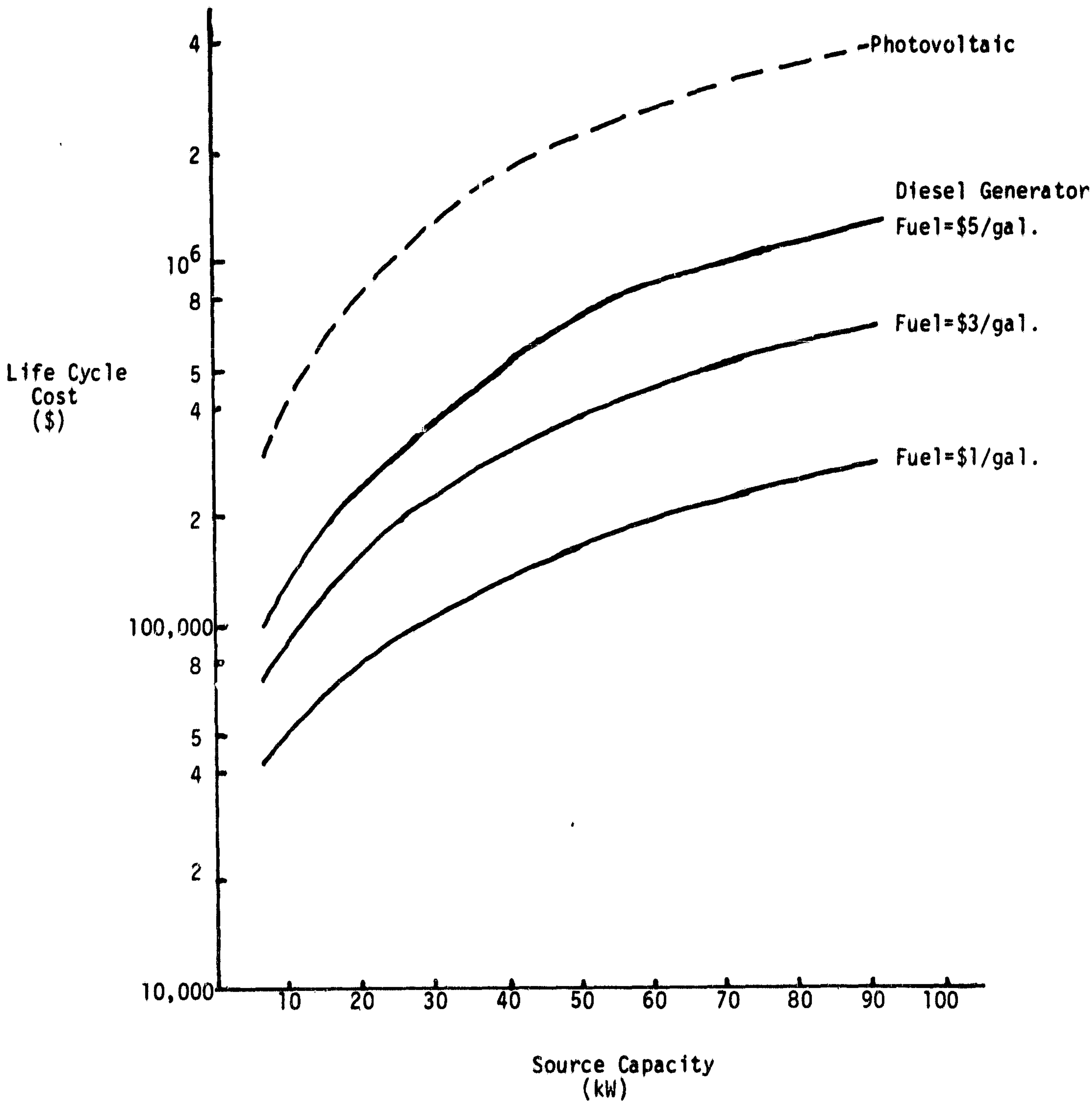


Exhibit E8

FUEL COST AT WHICH PHOTOVOLTAICS ARE COMPETITIVE WITH DIESEL GENERATORS FOR LOADS $\geq 7\ KW_c$

Load (KW)	Discount Rates 5%	10%	15%	20%
7	7.41108	10.9277	14.6195	18.3773
11	7.7857	11.3095	15.0088	18.7747
15	7.97302	11.5005	15.2034	18.9735
30	8.31357	11.8476	15.5573	19.3347
45	8.38169	11.9171	15.6281	19.407
50	8.39872	11.9344	15.6458	19.4251
60	8.41574	11.9518	15.6635	19.4431
75	8.46683	12.0039	15.7166	19.4973
90	8.50088	12.0386	15.752	19.5335

The cost per W_c for the photovoltaic system to be competitive at various fuel prices can also be found. This would be

Discount Rate	
5%	$Cost_{PV/W_c} = 8.48 \frac{Cost_{DG}}{W_c} + 4.98 x F - 1.20$
10%	$Cost_{PV/W_c} = 6.11 \frac{Cost_{DG}}{W_c} + 3.52F - .72$
15%	$Cost_{PV/W_c} = 4.76 \frac{Cost_{DG}}{W_c} + 2.69 x F - 0.42$
20%	$Cost_{PV/W_c} = 3.92 \frac{Cost_{DG}}{W_c} + 2.17F - 0.25$

The breakeven $Cost_{PV/Wc}$ for various fuel prices is shown in Exhibit E9 and the breakeven $Cost_{PV/Wp}$ for various fuel prices in Exhibit E10. The $Cost_{PV/Wp}$ is equal to 0.3 times $Cost_{PV/Wc}$

The above results establish the conditions under which photovoltaic systems become competitive for source capacities greater than 7 KWc, the smallest diesel generator considered in this analysis. To determine the cost at which photovoltaics become competitive with loads less than 7 KWc, it was assumed that a 7 KW diesel generator would be run below capacity. In making this analysis, it was assumed that an unloaded diesel generator would consume 50% of its full load fuel requirements and that the fuel consumption would increase linearly with load. The breakeven cost of photovoltaics is then determined by:

Exhibit E9

BREAKEVEN COST NEEDED FOR PHOTOVOLTAIC SYSTEMS ($/Wc) TO COMPETE WITH DIESEL GENERATORS

Discount Rate	Capacity (KW)	Fuel Cost $/Gal. 1	2	3	4	5
5%	7	11.0720	16.0520	21.0320	26.0120	[illegible].9920
	11	9.2072	14.1872	19.1672	24.1472	29.1272
	15	8.2744	13.2544	18.2344	23.2144	28.1944
	30	6.5784	11.5584	16.5384	21.5184	26.4984
	45	6.2392	11.2192	16.1992	21.1792	26.1592
	50	6.1544	11.1344	16.1144	21.0944	26.0744
	60	6.0696	11.0496	16.0296	21.0096	25.9896
	75	5.8152	10.7952	15.7752	20.7552	25.7352
	90	5.6456	10.6256	15.6056	20.5856	25.5656
10%	7	8.0546	11.5746	15.0946	18.6146	22.1346
	11	6.7104	10.2304	13.7504	17.2704	20.7904
	15	6.0383	9.5583	13.0783	16.5983	20.1183
	30	4.8163	8.3363	11.8563	15.3763	18.8963
	45	4.5719	8.0919	11.6119	15.1319	18.6519
	50	4.5108	8.0308	11.5508	15.0708	18.5908
	60	4.4497	7.9697	11.4897	15.0097	18.5297
	75	4.2664	7.7864	11.3064	14.8264	18.3464
	90	4.1442	7.6642	11.1842	14.7042	18.2242
15%	7	6.3636	9.0536	11.7436	14.4336	17.1236
	11	5.3164	8.0064	10.6964	13.3864	16.0764
	15	4.7928	7.4828	10.1728	12.8628	15.5528
	30	3.8408	6.5308	9.2208	11.9108	14.6008
	45	3.6504	6.3404	9.0304	11.7204	14.4104
	50	3.6028	6.2928	8.9828	11.6728	14.3628
	60	3.5552	6.2452	8.9352	11.6252	14.3152
	75	3.4124	6.1024	8.7924	11.4824	14.1724
	90	3.3172	6.0072	8.6972	11.3872	14.0772
20%	7	5.2912	7.4612	9.6312	11.8012	13.9712
	11	4.4288	6.5988	8.7688	10.9388	13.1088
	15	3.9976	6.1676	8.3376	10.5076	12.6776
	30	3.2136	5.3836	7.5536	9.7236	11.8936
	45	3.0568	5.2268	7.3968	9.5668	11.7368
	50	3.0176	5.1876	7.3576	9.5276	11.6976
	60	2.9784	5.1484	7.3184	9.4884	11.6584
	75	2.8688	5.0388	7.2088	9.3788	11.5488
	90	2.7824	4.9524	7.1224	9.2924	11.4624

Exhibit E10

BREAKEVEN COST NEEDED FOR PHOTOVOLTAIC SYSTEMS ($/Wp) TO COMPETE WITH DIESEL GENERATORS

Discount Rate	Capacity (KW)	Fuel Cost $/Gal. 1	2	3	4	5
5%	7	3.32184	4.81584	6.30984	7.80384	9.29784
	11	2.76216	4.25616	5.75016	7.24416	8.73816
	15	2.48232	3.97632	5.47032	6.96432	8.45832
	30	1.97352	3.46752	4.96152	6.45552	7.94952
	45	1.87176	3.36576	4.85976	6.35376	7.84776
	50	1.84632	3.34032	4.83432	6.32832	7.82232
	60	1.82088	3.31488	4.80888	6.30288	7.79688
	75	1.74456	3.23856	4.73256	6.22656	7.72056
	90	1.69368	3.18768	4.68168	6.17568	7.66968
10%	7	2.41638	3.47238	4.52838	5.58438	6.64038
	11	2.01312	3.06912	4.12512	5.18112	6.23712
	15	1.81149	2.86749	3.92349	4.97949	6.03549
	30	1.44489	2.50089	3.55689	4.61289	5.66889
	45	1.37157	2.42757	3.48357	4.53957	5.59557
	50	1.35324	2.40924	3.46524	4.52124	5.57724
	60	1.33491	2.39091	3.44691	4.50291	5.55891
	75	1.27992	2.33592	3.39192	4.44792	5.50392
	90	1.24326	2.29926	3.35526	4.41126	5.46726
15%	7	1.90908	2.71608	3.52308	4.33008	5.13708
	11	1.59492	2.40192	3.20892	4.01592	4.82292
	15	1.43784	2.24484	3.05184	3.85884	4.66584
	30	1.15224	1.95924	2.76624	3.57324	4.38024
	45	1.09512	1.90212	2.70912	3.51612	4.32312
	50	1.08084	1.88784	2.69484	3.50184	4.30884
	60	1.06556	1.87356	2.68056	3.48756	4.29456
	75	1.02372	1.83072	2.63772	3.44472	4.25172
	90	.99516	1.80216	2.60916	3.41616	4.22316
20%	7	1.58736	2.23836	2.88936	3.54036	4.19136
	11	1.32864	1.97964	2.63064	3.28164	3.93264
	15	1.19928	1.85028	2.50128	3.15228	3.80328
	30	.96408	1.61508	2.26608	2.91708	3.56808
	45	.91704	1.56804	2.21904	2.87004	3.52104
	50	.90528	1.55628	2.20728	2.85828	3.50928
	60	.89352	1.54452	2.19552	2.84652	3.49752
	75	.85824	1.50924	2.16024	2.81124	3.46224
	90	.83472	1.48572	2.13672	2.78772	3.43872

Discount Rate

$$5\% \quad \frac{Cost_{PV}}{W_c} = \frac{7{,}000\left(8.45\ (.86) + \frac{4.98F}{2}\right)}{W_L} + \frac{4.98F}{2} - 1.2$$

$$10\% \quad \frac{Cost_{PV}}{W_c} = \frac{7{,}000\left(6.11\ (.86) + \frac{3.52F}{2}\right)}{W_L} + \frac{3.52F}{2} - 0.76$$

$$15\% \quad \frac{Cost_{PV}}{W_c} = \frac{7{,}000\left(4.76\ (.86) + \frac{2.69F}{2}\right)}{W_L} + \frac{2.69F}{2} - 0.42$$

$$20\% \quad \frac{Cost_{PV}}{W_c} = \frac{7{,}000\left(3.92\ (.86) + \frac{2.17F}{2}\right)}{W_L} + \frac{2.17F}{2} - .025$$

The breakeven $Cost_{PV}/W_c$ for various fuel prices is shown in Exhibit E11 and the breakeven $Cost_{PV}/W_p$ for various fuel prices, in Exhibit E12. The $Cost_{PV}/W_p$ is equal to 0.3 x $Cost_{PV}/W_c$.

Using the equations developed above, the load at which photovoltaics costing \$13/W_p or \$43/W_c was determined. This load is determined by:

Discount Rate

$$5\% \quad 44.20\ W_L \le 7{,}000\ (8.48(.86) + \frac{4.98xF}{2}) + \frac{4.98F \times W_L}{2}$$

$$10\% \quad 43.76W_L \le 7{,}000\ (6.11(.86) + \frac{3.52xF}{2}) + \frac{3.52 \times F \times W_L}{2}$$

$$15\% \quad 43.42\ W_L \le 7{,}000\ (4.76(.86) + \frac{2.69xF}{2}) + \frac{2.69 \times F \times W_L}{2}$$

$$20\% \quad 43.25\ W_L \le 7{,}000\ (3.92(.86) + \frac{2.17xF}{2}) + \frac{2.17 \times F \times W_L}{2}$$

Exhibit E11

BREAKEVEN COST REQUIRED FOR PHOTOVOLTAICS SYSTEMS ($/Wc) TO COMPETE WITH AN UNDERUTILIZED 7 KW DIESEL GENERATOR

Discount Rate	Load (Watts)	Fuel Cost ($/Gallon) 1	2	3	4	5
5%	500	138.249	175.599	212.949	250.299	287.649
	1000	69.7696	89.6096	109.61	129.53	149.45
	1500	46.9431	61.0531	75.1631	89.2731	103.383
	2000	35.5298	46.7348	57.9398	69.1448	80.3498
	2500	28.6818	38.1438	47.6058	57.0678	66.5298
	3000	24.1165	32.4165	40.7165	49.0165	57.3165
	3500	20.8556	28.3256	35.7956	43.2656	50.7356
	4000	18.4099	25.2574	32.1049	38.9524	45.7999
	4500	16.5077	22.871	29.2344	35.5977	41.961
	5000	14.9859	20.9619	26.9379	32.9139	38.8899
	5500	13.7408	19.3999	25.059	30.7181	36.3772
	6000	12.7033	18.0983	23.4933	28.8883	34.2833
	6500	11.8253	16.9969	22.1684	27.3399	32.5115
	7000	11.0728	16.0528	21.0328	26.0128	30.9928
10%	500	99.2044	125.604	152.004	178.404	204.804
	1000	50.1022	64.1822	78.2622	92.3422	106.422
	1500	33.7348	43.7081	53.6815	63.6548	73.6281
	2000	25.5511	33.4711	41.3911	49.3111	57.2311
	2500	20.6409	27.3289	34.0169	40.7049	47.3929
	3000	17.3674	23.2341	29.1007	34.9674	40.8341
	3500	15.0292	20.3092	25.5892	30.8692	36.1492
	4000	13.2756	18.1155	22.9556	27.7956	32.6356
	4500	11.9116	16.4094	20.9072	25.4049	29.9027
	5000	10.8204	15.0444	19.2684	23.4924	27.7164
	5500	9.92767	13.9277	17.9277	21.9277	25.9277
	6000	9.1837	12.997	16.8104	20.6237	24.437
	6500	8.55418	12.2096	15.865	19.5203	23.1757
	7000	8.0146	11.5346	15.0546	18.5746	22.0946

Exhibit E11 (Continued)

BREAKEVEN COST REQUIRED FOR PHOTOVOLTAICS SYSTEMS ($/Wc)
TO COMPETE WITH AN UNDERUTILIZED 7 KW DIESEL GENERATOR

Discount Rate	Load (Watts)	Fuel Cost ($/Gallon) 1	2	3	4	5
15%	500	77.0654	97.2404	117.415	137.59	157.765
	1000	38.9952	49.7552	60.5152	71.2752	82.0352
	1500	26.3051	33.9268	41.5485	49.1701	56.7918
	2000	19.9601	26.0126	32.0651	38.1176	44.1701
	2500	16.1531	21.2641	26.3751	31.4861	36.5971
	3000	13.6151	18.0984	22.5817	27.0651	31.5484
	3500	11.8022	15.8372	19.8722	23.9072	27.9422
	4000	10.4426	14.1417	17.8401	21.5388	25.2376
	4500	9.38505	12.8223	16.2595	19.6967	23.1339
	5000	8.53904	11.767	14.995	18.223	21.451
	5500	7.84686	10.9037	13.9605	17.0173	20.0741
	6000	7.27003	10.1842	13.0984	16.0125	18.9267
	6500	6.78196	9.57542	12.3689	15.1623	17.9558
	7000	6.3636	9.0536	11.7436	14.4336	17.1236
20%	500	63.2218	79.4968	95.7718	112.047	128.322
	1000	32.0284	40.7084	49.3884	58.0684	66.7484
	1500	21.6306	27.7789	33.9273	40.0756	46.2239
	2000	16.4317	21.3142	26.1967	31.0792	35.9617
	2500	13.3124	17.4354	21.5584	25.6814	29.8044
	3000	11.2328	14.8495	18.4661	22.0828	25.6995
	3500	9.7474	13.0024	16.2574	19.5124	22.7674
	4000	8.63335	11.6171	14.6009	17.5846	20.5684
	4500	7.76687	10.5396	13.3124	16.0852	18.858
	5000	7.07368	9.67768	12.2817	14.8857	17.4897
	5500	6.50653	8.97244	11.4383	13.9043	16.3702
	6000	6.0339	8.38473	10.7356	13.0864	15.4372
	6500	5.63399	7.88745	10.1409	12.3944	14.6478
	7000	5.2912	7.4612	9.6312	11.8012	13.9712

Exhibit E12

BREAKEVEN COST REQUIRED FOR PHOTOVOLTAIC SYSTEMS ($/Wp) TO COMPETE WITH AN UNDERUTILIZED 7 KW DIESEL GENERATOR

Discount Rate	Load (Watts)	Fuel Cost ($/Gallon) 1	2	3	4	5
5%	500	41.4748	52.6798	63.8848	75.0898	86.2948
	1000	20.9389	26.9869	32.8829	38.8589	44.8349
	1500	14.0829	18.3159	22.5489	26.7819	31.0149
	2000	10.6589	14.0204	17.3819	20.7434	24.1049
	2500	8.60455	11.4432	14.2818	17.1204	19.959
	3000	7.23496	9.72496	12.215	14.705	17.195
	3500	6.25668	8.49768	10.7387	12.9797	15.2207
	4000	5.52297	7.57722	9.63147	11.6857	13.74
	4500	4.95231	6.86131	8.77031	10.6793	12.5883
	5000	4.49578	6.28858	8.08138	9.87418	11.667
	5500	4.12225	5.81998	7.51771	9.21543	10.9132
	6000	3.81098	5.42948	7.04798	8.66648	10.285
	6500	3.5476	5.09906	6.65052	8.20198	9.75344
	7000	3.32184	4.81584	6.30984	7.80384	9.29784
10%	500	29.7613	37.6813	45.6013	53.5213	61.4413
	1000	15.0307	19.2547	23.4787	27.7027	31.9267
	1500	10.1204	13.1124	16.1044	19.0964	22.0884
	2000	7.66533	10.0413	12.4173	14.7933	17.1693
	2500	6.19227	8.19867	10.2051	12.2115	14.2179
	3000	5.21822	6.97822	8.73822	10.4982	12.2582
	3500	4.50876	6.09276	7.67676	9.26076	10.8448
	4000	3.98267	5.43467	6.88667	8.33867	9.79067
	4500	3.57348	4.92281	6.27215	7.62148	8.97081
	5000	3.24613	4.51333	5.78053	7.04773	8.31493
	5500	2.9783	4.1783	5.3783	6.5783	7.7783
	6000	2.75511	3.89911	5.04311	6.18711	7.33111
	6500	2.56626	3.66287	4.75949	5.8561	6.95272
	7000	2.40438	3.46038	4.51638	5.57238	6.62838

Exhibit E12 (Continued)

BREAKEVEN COST REQUIRED FOR PHOTOVOLTAICS SYSTEMS ($/Wp) TO COMPETE WITH AN UNDERUTILIZED 7 KW DIESEL GENERATOR

Discount Rate	Load (Watts)	Fuel Cost ($/Gallon) 1	2	3	4	5
15%	500	23.1196	29.1721	35.2246	41.2771	47.3296
	1000	11.6986	14.9266	18.1546	21.3826	24.6106
	1500	7.89154	10.178	12.4645	14.751	17.0375
	2000	5.98803	7.80378	9.61953	11.4353	13.251
	2500	4.84592	6.37922	7.91252	9.44582	10.9791
	3000	4.08452	5.42952	6.77452	8.11952	9.46452
	3500	3.54066	4.75116	5.96166	7.17216	8.38266
	4000	3.13277	4.24239	5.35202	6.46164	7.57127
	4500	2.81551	3.84668	4.87785	5.90901	6.94018
	5000	2.56171	3.53011	4.49851	5.46691	6.43531
	5500	2.35406	3.2711	4.18815	5.10519	6.02224
	6000	2.18101	3.05526	3.92951	4.80376	5.67801
	6500	2.03459	2.87263	3.71066	4.5487	5.38674
	7000	1.90908	2.71608	3.52308	4.33008	5.13708
20%	500	18.9665	23.849	28.7315	33.614	38.4965
	1000	9.60852	12.2125	14.8165	17.4205	20.0245
	1500	6.48918	8.33368	10.1782	12.0227	13.8672
	2000	4.92951	6.39426	7.85901	9.32376	10.7885
	2500	3.99371	5.23061	6.46751	7.70441	8.94131
	3000	3.36984	4.45484	5.53984	6.62484	7.70984
	3500	2.92422	3.90072	4.87722	5.85372	6.83022
	4000	2.59001	3.48513	4.38026	5.27538	6.17051
	4500	2.33006	3.16189	3.99373	4.82556	5.65739
	5000	2.1221	2.9033	3.6845	4.4657	5.2469
	5500	1.95196	2.69173	3.4315	4.17128	4.91105
	6000	1.81017	2.51542	3.22067	3.92592	4.63117
	6500	1.6982	2.36623	3.04227	3.71831	4.39435
	7000	1.58736	2.23836	2.88936	3.54036	4.19136

or:

Discount Rate	
5%	$W_L \leq \frac{51,049.6 + 17,430\ F}{44.2 - 2.49F}$
10%	$W_L \leq \frac{36,782 + 12,320\ F}{43.72 - 1.76F}$
15%	$W_L \leq \frac{28,655.2 + 9,415\ F}{43.42 - 1.35\ F}$
20%	$W_L \leq \frac{23,598.4 + 7,595\ F}{43.25 - 1.09\ F}$

The result of this analysis is shown in Exhibit E13. In looking at these numbers it must be remembered that the photovoltaic system is economic only if the load always remains below the load determined by the equations above. If any load growth above those determined is anticipated in the near future, it would be more economical to buy the diesel generator system.

Exhibit E13

POWER LOADS UNDER WHICH IT WOULD BE MORE ECONOMICAL TO BUY A PHOTOVOLTAIC SYSTEM THAN UNDERUTILIZE A 7 KW DIESEL GENERATOR*

Discount Rate	1	2	3	4	5
5%	1641.8	2190.45	2813.49	3527.15	4352.74
10%	1170.21	1527.91	1918.37	2346.29	2817.35
15%	904.925	1166.14	1445.27	1744.22	2065.18
20%	739.881	944.446	1160.17	1387.98	1628.93

* It was assumed that the diesel generater under no load would consume 50% of its full load fuel consumption, and that the fuel consumption would increase linearly with load.

APPENDIX F

CASH FLOW ANALYSIS

This appendix presents the cash flow analysis for a diesel and gas driven generator system compared to a photovoltaic system. The conditions used in this analysis are current conditions and diesel fuel costs of $1.42/gallon and gasoline $2.50/gallon. The photovoltaic system costs $13/Wp. This is some of the data used to generate Exhibits 11, 12 and 13 of this report. Sample analyses are given for 1200 W_c, 2000 W_c and 4000 W_c systems.

LIFE CYCLE COST OF GAS GENERATOR AND PHOTOVOLTAIC ENERGY SYSTEM

Gas Generator

Capacity Load (Watts)	Hours of Operation		
	4 hrs/day	8 hrs/day	12 hrs/day
300	4,714	6,452	8,191
1200	8,925	13,100	17,275
2000	13,089	18,193	23,298
2800	17,878	26,567	35,262

Photovoltaic System

Capacity Load (Watts)	4 hrs/day	8 hrs/day	12 hrs/day
300	4,504	7,405	10,364
1200	13,192	24,744	36,371
2000	20,868	40,247	59,627
2800	28,619	55,751	82,882

LIFE CYCLE COST OF A PHOTOVOLTAIC ENERGY SYSTEM

Photovoltaic System

Capacity Load (Watts)	Hours of Operation		
	4 hrs/day	8 hrs/day	12 hrs/day
3,000	30,557	59,627	88,696
4,000	40,247	79,006	117,765
7,000	69,316	137,145	20[illegible],973
15,000	146,834	292,181	437,527
30,000	292,181	582,873	873,566
45,000	437,527	873,566	1,309,604
60,000	582,873	1,164,258	1,745,643
90,000	873,566	1,745,643	2,617,721
100,000	970,463	1,939,438	2,908,413

LIFE CYCLE COSTS OF A DIESEL GENERATOR SYSTEM

Diesel Generator

Capacity Load (Watts)	Hours of Operation		
	4 hrs/day	8 hrs/day	12 hrs/day
3,000	8,725	12,688	18,770
4,000	10,502	15,708	23,659
7,000	15,512	24,278	37,489
15,000	23,458	38,848	60,238
30,000	36,197	62,864	97,258
45,000	50,488	89.255	138,331
60,000	64,780	115,647	179,403
90,000	92,199	166,648	258,508
100,000	99,527	180,878	280,149

1200 WATT GASOLINE DRIVEN GENERATOR - $910.00

Annual Costs	Hours of Operation		
	4 hrs/day	8 hrs/day	12 hrs/day
Fuel	$ 989.04	$ 1,978.08	$ 2,967.12
Maintenance	0	0	0
Replace	910.00	910.00	910.00
CFBF	1,899.04	2,888.08	3,877.12
Finance	0	0	0
CFAF	1,899.04	2,888,08	3,877.12
Taxes	474.76	722.02	969.28
CFAT	1,424.28	2,166.06	2,907.84
Present Value	$8,925.00	$13,100.00	$17,275.00

Key: CFBF - Cash Flow Before Financing
CFAF - Cash Flow After Financing
CFAT - Cash Flow After Taxes

2000 WATT GASOLINE DRIVEN GENERATOR - $1,530

Annual Costs	Hours of Operation		
	4 hrs/day	8 hrs/day	12 hrs/day
Fuel	$ 1,209.00	$ 2,418.00	$ 3,627.00
Maintenance	0	0	0
Replace	1,530.00	1,530.00	1,530.00
CFBF	2,739.00	3,948.00	5,157.00
Finance	0	0	0
CFAF	2,739.00	3,948.00	5,157.00
Taxes	685.00	987.00	1,289.00
CFAT	2,054.00	2,961.00	3,868.00
Present Value	$13,089.00	$18,193.00	$23,298.00

THIS IS THE ANALYSIS FOR A PHOTOVOLTAIC SYSTEM.
THE SYSTEM CAPACITY IS 1200.00 WC FOR 4.00 HR PER DAY.
THE SYSTEM SIZE IS 1068. WP AND COSTS $ 13880.
THE INITIAL CASH COST IS $ 2776.
MONEY IS BORROWED AT A RATE OF 0.21.
THE TAX RATE IS 0.25.

YR	FUEL	MAINT	REPLACE	CFBF	FINANCE	CFAF	TAXES	CFAT	PRIN	DEPREC
1	0.	350.	0.	350.	2474.	2824.	4141.	-1317.	11104.23	13879.67
2	0.	350.	0.	350.	2474.	2824.	664.	2161.	10962.47	0.00
3	0.	350.	0.	350.	2474.	2824.	655.	2170.	10790.94	0.00
4	0.	350.	0.	350.	2474.	2824.	644.	2181.	10583.39	0.00
5	0.	350.	0.	350.	2474.	2824.	630.	2194.	10332.25	0.00
6	0.	350.	2401.	350.	3295.	3645.	941.	2704.	12428.87	800.17
7	0.	350.	0.	350.	3295.	3645.	865.	2780.	11744.88	640.13
8	0.	350.	0.	356.	3295.	3645.	781.	2863.	10917.25	480.10
9	0.	350.	0.	350.	3295.	3645.	689.	2956.	9915.81	320.07
10	0.	350.	0.	350.	3295.	3645.	585.	3060.	8704.07	160.03
11	0.	350.	2401.	350.	3295.	3645.	794.	2851.	9638.37	800.17
12	0.	350.	0.	350.	3295.	3645.	687.	2957.	8368.37	640.13
13	0.	350.	0.	350.	3295.	3645.	567.	3078.	6831.67	480.10
14	0.	350.	0.	350.	3295.	3645.	429.	3215.	4972.26	320.07
15	0.	350.	0.	350.	3295.	3645.	271.	3374.	2722.38	160.03
16	0.	350.	2401.	350.	821.	1171.	414.	757.	2400.52	800.17
17	0.	350.	0.	350.	821.	1171.	357.	813.	2084.22	640.13
18	0.	350.	0.	350.	821.	1171.	297.	874.	1701.50	480.10
19	0.	350.	0.	350.	821.	1171.	233.	938.	1238.41	320.07
20	0.	350.	0.	350.	821.	1171.	164.	1007.	678.07	160.03

THE PRESENT VALUE OF AFTER TAX CASH FLOWS DISCOUNTED AT 0.170 IS $ 13193.82.

THIS IS THE ANALYSIS FOR A PHOTOVOLTAIC SYSTEM.
THE SYSTEM CAPACITY IS 2000.00 WC FOR 4.00 HR PER DAY.
THE SYSTEM SIZE IS 1779. WP AND COSTS $ 23124.
THE INITIAL CASH COST IS $ 4625.
MONEY IS BORROWED AT A RATE OF 0.21.
THE TAX RATE IS 0.25.

YR	FUEL	MAINT	REPLACE	CFBF	FINANCE	CFAF	TAXES	CFAT	PRIN	DEPREC
1	0.	350.	0.	350.	3973.	4323.	6840.	-2517.	18499.79	23124.11
2	0.	350.	0.	350.	3973.	4323.	1055.	3269.	18412.01	0.00
3	0.	350.	0.	350.	3973.	4323.	1049.	3274.	18305.80	0.00
4	0.	350.	0.	350.	3973.	4323.	1042.	3281.	18177.29	0.00
5	0.	350.	0.	350.	3973.	4323.	1034.	3289.	18021.79	0.00
6	0.	350.	4001.	350.	5340.	5690.	1568.	4123.	21834.13	1333.50
7	0.	350.	0.	350.	5340.	5690.	1461.	4229.	21079.33	1066.80
8	0.	350.	0.	350.	5340.	5690.	1347.	4344.	20166.02	800.10
9	0.	350.	0.	350.	5340.	5690.	1222.	4468.	19060.92	533.40
10	0.	350.	0.	350.	5340.	5690.	1085.	4605.	17723.75	266.70
11	0.	350.	4001.	350.	5340.	5690.	1477.	4214.	20106.27	1333.50
12	0.	350.	0.	350.	5340.	5690.	1352.	4139.	18988.63	1066.80
13	0.	350.	0.	350.	5340.	5690.	1214.	4477.	17636.27	800.10
14	0.	350.	0.	350.	5340.	5690.	1061.	4629.	15999.93	533.40
15	0.	350.	0.	350.	5340.	5690.	891.	4800.	14919.95	266.70
16	0.	350.	4001.	350.	5340.	5690.	1242.	4449.	15624.67	1333.50
17	0.	350.	0.	350.	5340.	5690.	1067.	4624.	13565.88	1066.80
18	0.	350.	0.	350.	5340.	5690.	869.	4821.	11074.76	800.10
19	0.	350.	0.	350.	5340.	5690.	645.	5046.	8060.49	533.40
20	0.	350.	0.	350.	5340.	5690.	386.	5304.	4413.23	266.70

THE PRESENT VALUE OF AFTER TAX CASH FLOWS DISCOUNTED AT 0.170 IS $ 28967.61.

THIS IS THE ANALYSIS FOR A PHOTOVOLTAIC SYSTEM.
THE SYSTEM CAPACITY IS 1200.00 WC FOR 8.00 HR PER DAY.
THE SYSTEM SIZE IS 2134. WP AND COSTS $ 27746.
THE INITIAL CASH COST IS $ 5550.
MONEY IS BORROWED AT A RATE OF 0.21.
THE TAX RATE IS 0.25.

YR	FUEL	MAINT	REPLACE	CFBF	FINANCE	CFAF	TAXES	CFAT	PRIN	DEPREC
1	0.	350.	0.	350.	4767.	5117.	8190.	-3073.	22197.57	27746.33
2	0.	350.	0.	350.	4767.	5117.	1248.	3869.	22092.24	0.00
3	0.	350.	0.	350.	4767.	5117.	1241.	3876.	21964.80	0.00
4	0.	350.	0.	350.	4767.	5117.	1233.	3884.	21810.60	0.00
5	0.	350.	0.	350.	4767.	5117.	1223.	3894.	21624.02	0.00
6	0.	350.	4801.	350.	6408.	6758.	1863.	4894.	26198.75	1600.17
7	0.	350.	0.	350.	6408.	6758.	1736.	5022.	25293.04	1280.13
8	0.	350.	0.	350.	6408.	6758.	1598.	5160.	24197.12	960.10
9	0.	350.	0.	350.	6408.	6758.	1449.	5309.	22871.06	640.07
10	0.	350.	0.	350.	6408.	6758.	1285.	5473.	21266.52	320.03
11	0.	350.	4801.	350.	6408.	6758.	1755.	5003.	24125.54	1600.17
12	0.	350.	0.	350.	6408.	6758.	1604.	5154.	22784.45	1280.13
13	0.	350.	0.	350.	6408.	6758.	1439.	5319.	21161.73	960.10
14	0.	350.	0.	350.	6408.	6758.	1256.	5502.	19198.23	640.07
15	0.	350.	0.	350.	6408.	6758.	1051.	5707.	16822.41	320.03
16	0.	350.	4801.	350.	6408.	6758.	1472.	5286.	18748.16	1600.17
17	0.	350.	0.	350.	6408.	6758.	1263.	5495.	16277.82	1280.13
18	0.	350.	0.	350.	6408.	6758.	1026.	5732.	13288.71	960.10
19	0.	350.	0.	350.	6408.	6758.	756.	6002.	9671.88	640.07
20	0.	350.	0.	350.	6408.	6758.	446.	6312.	5295.52	320.03

THE PRESENT VALUE OF AFTER TAX CASH FLOWS DISCOUNTED AT 0.170 IS $ 24743.50.

THIS IS THE ANALYSIS FOR A PHOTOVOLTAIC SYSTEM.
THE SYSTEM CAPACITY IS 2000.00 WC FOR 8.00 HR PER DAY.
THE SYSTEM SIZE IS 3557. WP AND COSTS $ 46235.
THE INITIAL CASH COST IS $ 9248.
MONEY IS BORROWED AT A RATE OF 0.21.
THE TAX RATE IS 0.25.

YR	FUEL	MAINT	REPLACE	CFBF	FINANCE	CFAF	TAXES	CFAT	PRIN	DEPREC
1	0.	350.	0.	350.	7944.	8294.	13589.	-5295.	36988.68	46235.22
2	0.	350.	0.	350.	7944.	8294.	2021.	6273.	36813.18	0.00
3	0.	350.	0.	350.	7944.	8294.	2010.	6284.	36600.82	0.00
4	0.	350.	0.	350.	7944.	8294.	1996.	6298.	36343.86	0.00
5	0.	350.	0.	350.	7944.	8294.	1980.	6314.	36032.95	0.00
6	0.	350.	8001.	350.	10678.	11028.	3047.	7981.	43657.24	2666.83
7	0.	350.	0.	350.	10678.	11028.	2834.	8194.	42147.84	2133.47
8	0.	350.	0.	350.	10678.	11028.	2605.	8423.	40321.47	1600.10
9	0.	350.	0.	350.	10678.	11028.	2356.	8672.	38111.56	1066.73
10	0.	350.	0.	350.	10678.	11028.	2082.	8946.	35437.57	533.37
11	0.	350.	8001.	350.	10678.	11028.	2865.	8163.	40202.55	2666.83
12	0.	350.	0.	350.	10678.	11028.	2615.	8413.	37967.66	2133.47
13	0.	350.	0.	350.	10678.	11028.	2339.	8689.	35263.46	1600.10
14	0.	350.	0.	350.	10678.	11028.	2034.	8994.	31991.37	1066.73
15	0.	350.	0.	350.	10678.	11028.	1693.	9335.	28032.13	533.37
16	0.	350.	8001.	350.	10678.	11028.	2395.	8633.	31241.96	2666.83
17	0.	350.	0.	350.	10678.	11028.	2045.	8982.	27125.36	2133.47
18	0.	350.	0.	350.	10678.	11028.	1651.	9377.	22144.27	1600.10
19	0.	350.	0.	350.	10678.	11028.	1201.	9827.	16117.15	1066.73
20	0.	350.	0.	350.	10678.	11028.	685.	10343.	8824.33	533.37

THE PRESENT VALUE OF AFTER TAX CASH FLOWS DISCOUNTED AT 0.170 IS $ 40247.10.

THIS IS THE ANALYSIS FOR A PHOTOVOLTAIC SYSTEM.
THE SYSTEM CAPACITY IS 1200.00 WC FOR 12.00 HR PER DAY.
THE SYSTEM SIZE IS 3201. WP AND COSTS $ 41613.
THE INITIAL CASH COST IS $ 8323.
MONEY IS BORROWED AT A RATE OF 0.21.
THE TAX RATE IS 0.25.

YR	FUEL	MAINT	REPLACE	CFBF	FINANCE	CFAF	TAXES	CFAT	PRIN	DEPREC
1	0.	350.	0.	350.	7150.	7500.	12239.	-4739.	33290.90	41613.00
2	0.	350.	0.	350.	7150.	7500.	1827.	5672.	33132.95	0.00
3	0.	350.	0.	350.	7150.	7500.	1817.	5682.	32941.82	0.00
4	0.	350.	0.	350.	7150.	7500.	1805.	5694.	32710.55	0.00
5	0.	350.	0.	350.	7150.	7500.	1791.	5709.	32430.72	0.00
6	0.	350.	7201.	350.	9610.	9960.	2751.	7210.	39292.63	2400.17
7	0.	350.	0.	350.	9610.	9960.	2560.	7401.	37934.15	1920.13
8	0.	350.	0.	350.	9610.	9960.	2353.	7607.	36290.39	1440.10
9	0.	350.	0.	350.	9610.	9960.	2129.	7832.	34301.45	960.07
10	0.	350.	0.	350.	9610.	9960.	1882.	8078.	31894.82	480.03
11	0.	350.	7201.	350.	9610.	9960.	2588.	7373.	36183.30	2400.17
12	0.	350.	0.	350.	9610.	9960.	2362.	7598.	34171.87	1920.13
13	0.	350.	0.	350.	9610.	9960.	2114.	7846.	31738.04	1440.10
14	0.	350.	0.	350.	9610.	9960.	1840.	8121.	28793.10	960.07
15	0.	350.	0.	350.	9610.	9960.	1533.	8428.	25229.72	480.03
16	0.	350.	7201.	350.	9610.	9960.	2164.	7796.	28118.54	2400.17
17	0.	350.	0.	350.	9610.	9960.	1850.	8111.	24413.50	1920.13
18	0.	350.	0.	350.	9610.	9960.	1494.	8466.	19930.41	1440.10
19	0.	350.	0.	350.	9610.	9960.	1090.	8871.	14505.87	960.07
20	0.	350.	0.	350.	9610.	9960.	625.	9335.	7942.17	480.03

THE PRESENT VALUE OF AFTER TAX CASH FLOWS DISCOUNTED AT 0.170 IS $ 36371.20.

THIS IS THE ANALYSIS FOR A PHOTOVOLTAIC SYSTEM.
THE SYSTEM CAPACITY IS 2000.00 WC FOR 12.00 HR PER DAY.
THE SYSTEM SIZE IS 5334. WP AND COSTS $ 69346.
THE INITIAL CASH COST IS $ 13870.
MONEY IS BORROWED AT A RATE OF 0.21.
THE TAX RATE IS 0.25.

YR	FUEL	MAINT	REPLACE	CFBF	FINANCE	CFAF	TAXES	CFAT	PRIN	DEPREC
1	0.	350.	0.	350.	11914.	12264.	20337.	-8073.	55477.57	69346.34
2	0.	350.	0.	350.	11914.	12264.	2987.	9277.	55214.34	0.00
3	0.	350.	0.	350.	11914.	12264.	2970.	9294.	54895.84	0.00
4	0.	350.	0.	350.	11914.	12264.	2950.	9314.	54510.45	0.00
5	0.	350.	0.	350.	11914.	12264.	2925.	9339.	54044.13	0.00
6	0.	350.	12001.	350.	16015.	16365.	4526.	11840.	65480.38	4000.17
7	0.	350.	0.	350.	16015.	16365.	4207.	12158.	63216.38	3200.13
8	0.	350.	0.	350.	16015.	16365.	3863.	12502.	60476.95	2400.10
9	0.	350.	0.	350.	16015.	16365.	3489.	12876.	57162.24	1600.07
10	0.	350.	0.	350.	16015.	16365.	3078.	13287.	53151.44	800.03
11	0.	350.	12001.	350.	16015.	16365.	4254.	12112.	60298.87	4000.17
12	0.	350.	0.	350.	16015.	16365.	3878.	12488.	56946.76	3200.13
13	0.	350.	0.	350.	16015.	16365.	3465.	12901.	52890.71	2400.10
14	0.	350.	0.	350.	16015.	16365.	3007.	13358.	47982.89	1600.07
15	0.	350.	0.	350.	16015.	16365.	2495.	13870.	42044.42	800.03
16	0.	350.	12001.	350.	16015.	16365.	3548.	12817.	46859.38	4000.17
17	0.	350.	0.	350.	16015.	16365.	3024.	13341.	40684.98	3200.13
18	0.	350.	0.	350.	16015.	16365.	2432.	13934.	33213.95	2400.10
19	0.	350.	0.	350.	16015.	16365.	1757.	14608.	24174.01	1600.07
20	0.	350.	0.	350.	16015.	16365.	983.	15382.	13235.67	800.03

THE PRESENT VALUE OF AFTER TAX CASH FLOWS DISCOUNTED AT 0.170 IS $ 59626.59.

THIS IS THE ANALYSIS FOR A PHOTOVOLTAIC SYSTEM.
THE SYSTEM CAPACITY IS 4000.00 WC FOR 4.00 HR PER DAY.
THE SYSTEM SIZE IS 3557. WP AND COSTS $ 46235.
THE INITIAL CASH COST IS $ 9248.
MONEY IS BORROWED AT A RATE OF 0.21.
THE TAX RATE IS 0.25.

YR	FUEL	MAINT	REPLACE	CFBF	FINANCE	CFAF	TAXES	CFAT	PRIN	DEPREC
1	0.	350.	0.	350.	7944.	8294.	13589.	-5295.	36988.68	46235.22
2	0.	350.	0.	350.	7944.	8294.	2021.	6273.	36813.18	0.00
3	0.	350.	0.	350.	7944.	8294.	2010.	6284.	36600.82	0.00
4	0.	350.	0.	350.	7944.	8294.	1996.	6298.	36343.86	0.00
5	0.	350.	0.	350.	7944.	8294.	1980.	6314.	36032.95	0.00
6	0.	350.	8001.	350.	10678.	11028.	3047.	7981.	43657.24	2666.83
7	0.	350.	0.	350.	10678.	11028.	2834.	8194.	42147.84	2133.47
8	0.	350.	0.	350.	10678.	11028.	2605.	8423.	40321.47	1600.10
9	0.	350.	0.	350.	10678.	11028.	2356.	8672.	38111.56	1066.73
10	0.	350.	0.	350.	10678.	11028.	2082.	8946.	35437.57	533.37
11	0.	350.	8001.	350.	10678.	11028.	2865.	8163.	40202.55	2666.83
12	0.	350.	0.	350.	10678.	11028.	2615.	8413.	37967.66	2133.47
13	0.	350.	0.	350.	10678.	11028.	2339.	8689.	35263.46	1600.10
14	0.	350.	0.	350.	10678.	11028.	2034.	8994.	31991.37	1066.73
15	0.	350.	0.	350.	10678.	11028.	1693.	9335.	28032.13	533.37
16	0.	350.	8001.	350.	10678.	11028.	2395.	8633.	31241.96	2666.83
17	0.	350.	0.	350.	10678.	11028.	2045.	8982.	27125.36	2133.47
18	0.	350.	0.	350.	10678.	11028.	1651.	9377.	22144.27	1600.10
19	0.	350.	0.	350.	10678.	11028.	1201.	9827.	16117.15	1066.73
20	0.	350.	0.	350.	10678.	11028.	685.	10343.	8824.33	533.37

THE PRESENT VALUE OF AFTER TAX CASH FLOWS DISCOUNTED AT 0.170 IS $ 40247.10.

THIS IS THE ANALYSIS FOR A DIESEL GENERATOR.
THE SYSTEM CAPACITY IS 4000.00 WC FOR 4.00 HR PER DAY.
THE COST OF THE SYSTEM IS $ 3887.00.
THE INITIAL CASH COST IS $ 778.
MONEY IS BORROWED AT A RATE OF 0.21.
THE TAX RATE IS 0.25.

YR.	FUEL	MAINT	REPLACE	CFBF	FINANCE	CFAF	TAXES	CFAT	PRIN	DEPREC
1	596.	700.	0.	1296.	1225.	2521.	877.	1645.	3110.10	1554.80
2	596.	700.	0.	1296.	1225.	2521.	749.	1772.	2538.99	1166.10
3	596.	700.	0.	1296.	1225.	2521.	616.	1905.	1847.94	777.40
4	596.	700.	0.	1296.	1225.	2521.	475.	2046.	1011.77	388.70
5	596.	700.	2333.	1296.	919.	2215.	680.	1535.	2332.70	933.08
6	596.	700.	0.	1296.	919.	2215.	600.	1616.	1904.34	699.81
7	596.	700.	0.	1296.	919.	2215.	514.	1701.	1386.03	466.54
8	596.	700.	0.	1296.	919.	2215.	423.	1792.	758.87	233.27
9	596.	700.	2333.	1296.	919.	2215.	680.	1535.	2332.70	933.08
10	596.	700.	0.	1296.	919.	2215.	600.	1616.	1904.34	699.81
11	596.	700.	0.	1296.	919.	2215.	514.	1701.	1386.03	466.54
12	596.	700.	0.	1296.	919.	2215.	423.	1792.	758.87	233.27
13	596.	700.	2333.	1296.	919.	2215.	680.	1535.	2332.70	933.08
14	596.	700.	0.	1296.	919.	2215.	600.	1616.	1904.34	699.81
15	596.	700.	0.	1296.	919.	2215.	514.	1701.	1386.03	466.54
16	596.	700.	0.	1296.	919.	2215.	423.	1792.	758.87	233.27
17	596.	700.	2333.	1296.	919.	2215.	680.	1535.	2332.70	933.08
18	596.	700.	0.	1296.	919.	2215.	600.	1616.	1904.34	699.81
19	596.	700.	0.	1296.	919.	2215.	514.	1701.	1386.03	466.54
20	596.	700.	0.	1296.	919.	2215.	423.	1792.	758.87	233.27

THE PRESENT VALU F AFTER TAX CASH FLOWS DISCOUNTED AT 0.170 IS $ 10502.24.

THIS IS THE ANALYSIS FOR A PHOTOVOLTAIC SYSTEM.
THE SYSTEM CAPACITY IS 4000.00 WC FOR 8.00 HR PER DAY.
THE SYSTEM SIZE IS 7112. WP AND COSTS $ 92457.
THE INITIAL CASH COST IS $ 18492.
MONEY IS BORROWED AT A RATE OF 0.21.
THE TAX RATE IS 0.25.

YR	FUEL	MAINT	REPLACE	CFBF	FINANCE	CFAF	TAXES	CFAT	PRIN	DEPREC
1	0.	350.	0.	350.	15884.	16234.	27086.	-10851.	73966.46	92457.45
2	0.	350.	0.	350.	15884.	16234.	3953.	12282.	73615.51	0.00
3	0.	350.	0.	350.	15884.	16234.	3931.	12304.	73190.85	0.00
4	0.	350.	0.	350.	15884.	16234.	3904.	12331.	72677.02	0.00
5	0.	350.	0.	350.	15884.	16234.	3871.	12364.	72055.29	0.00
6	0.	350.	16001.	350.	21353.	21703.	6005.	15698.	87303.49	5333.50
7	0.	350.	0.	350.	21353.	21703.	5580.	16123.	84284.90	4266.80
8	0.	350.	0.	350.	21353.	21703.	5121.	16582.	80632.41	3200.10
9	0.	350.	0.	350.	21353.	21703.	4623.	17080.	76212.89	2133.40
10	0.	350.	0.	350.	21353.	21703.	4075.	17628.	70865.27	1066.70
11	0.	350.	16001.	350.	21353.	21703.	5642.	16061.	80395.16	5333.50
12	0.	350.	0.	350.	21353.	21703.	5141.	16562.	75925.81	4266.80
13	0.	350.	0.	350.	21353.	21703.	4590.	17113.	70517.91	3200.10
14	0.	350.	0.	350.	21353.	21703.	3980.	17723.	63974.34	2133.40
15	0.	350.	0.	350.	21353.	21703.	3298.	18405.	56056.63	1066.70
16	0.	350.	16001.	350.	21353.	21703.	4701.	17001.	62476.70	5333.50
17	0.	350.	0.	350.	21353.	21703.	4003.	17700.	54244.49	4266.80
18	0.	350.	0.	350.	21353.	21703.	3213.	18490.	44283.51	3200.10
19	0.	350.	0.	350.	21353.	21703.	2313.	19389.	32230.72	2133.40
20	0.	350.	0.	350.	21353.	21703.	1281.	20422.	17646.85	1066.70

THE PRESENT VALUE OF AFTER TAX CASH FLOWS DISCOUNTED AT 0.170 IS $ 79006.10.

THIS IS THE ANALYSIS FOR A DIESEL GENERATOR.
THE SYSTEM CAPACITY IS 4000.00 WC FOR 8.00 HR PER DAY.
THE COST OF THE SYSTEM IS $ 3887.00.
THE INITIAL CASH COST IS $ 778.
MONEY IS BORROWED AT A RATE OF 0.21.
THE TAX RATE IS 0.25.

YR	FUEL	MAINT	REPLACE	CFBF	FINANCE	CFAF	TAXES	CFAT	PRIN	DEPREC
1	1198.	700.	0.	1898.	2061.	3959.	1286.	2673.	3110.10	2591.33
2	1198.	700.	0.	1898.	2061.	3959.	888.	3071.	1702.82	1295.67
3	1198.	700.	2333.	1898.	1546.	3444.	986.	2458.	2332.70	1555.13
4	1198.	700.	0.	1898.	1546.	3444.	737.	2708.	1277.18	777.57
5	1198.	700.	2333.	1898.	1546.	3444.	986.	2458.	2332.70	1555.13
6	1198.	700.	0.	1898.	1546.	3444.	737.	2708.	1277.18	777.57
7	1198.	700.	2333.	1898.	1546.	3444.	986.	2458.	2332.70	1555.13
8	1198.	700.	0.	1898.	1546.	3444.	737.	2708.	1277.18	777.57
9	1198.	700.	2333.	1898.	1546.	3444.	986.	2458.	2332.70	1555.13
10	1198.	700.	0.	1898.	1546.	3444.	737.	2708.	1277.18	777.57
11	1198.	700.	2333.	1898.	1546.	3444.	986.	2458.	2332.70	1555.13
12	1198.	700.	0.	1898.	1546.	3444.	737.	2708.	1277.18	777.57
13	1198.	700.	2333.	1898.	1546.	3444.	986.	2458.	2332.70	1555.13
14	1198.	700.	0.	1898.	1546.	3444.	737.	2708.	1277.18	777.57
15	1198.	700.	2333.	1898.	1546.	3444.	986.	2458.	2332.70	1555.13
16	1198.	700.	0.	1898.	1546.	3444.	737.	2708.	1277.18	777.57
17	1198.	700.	2333.	1898.	1546.	3444.	986.	2458.	2332.70	1555.13
18	1198.	700.	0.	1898.	1546.	3444.	737.	2708.	1277.18	777.57
19	1198.	700.	2333.	1898.	1546.	3444.	986.	2458.	2332.70	1555.13
20	1198.	700.	0.	1898.	1546.	3444.	737.	2708.	1277.18	777.57

THE PRESENT VALUE OF AFTER TAX CASH FLOWS DISCOUNTED AT 0.170 IS $ 15707.97.

THIS IS THE ANALYSIS FOR A PHOTOVOLTAIC SYSTEM.
THE SYSTEM CAPACITY IS 4000.00 WC FOR 12.00 HR PER DAY.
THE SYSTEM SIZE IS 10668. WP AND COSTS $ 138680.
THE INITIAL CASH COST IS $ 27736.
MONEY IS BORROWED AT A RATE OF 0.21.
THE TAX RATE IS 0.25.

YR	FUEL	MAINT	REPLACE	CFBF	FINANCE	CFAF	TAXES	CFAT	PRIN	DEPREC
1	0.	350.	0.	350.	23825.	24175.	40582.	-16407.	110944.24	138679.67
2	0.	350.	0.	350.	23825.	24175.	5885.	18290.	110417.84	0.00
3	0.	350.	0.	350.	23825.	24175.	5851.	18324.	109780.88	0.00
4	0.	350.	0.	350.	23825.	24175.	5811.	18364.	109010.17	0.00
5	0.	350.	0.	350.	23825.	24175.	5762.	18413.	108077.61	0.00
6	0.	350.	24001.	350.	32028.	32378.	8963.	23415.	130949.71	8000.17
7	0.	350.	0.	350.	32028.	32378.	8325.	24053.	126421.91	6400.13
8	0.	350.	0.	350.	32028.	32378.	7638.	24740.	120943.28	4800.10
9	0.	350.	0.	350.	32028.	32378.	6890.	25488.	114314.14	3200.07
10	0.	350.	0.	350.	32028.	32378.	6068.	26309.	106292.88	1600.03
11	0.	350.	24001.	350.	32028.	32378.	8419.	23959.	120587.65	8000.17
12	0.	350.	0.	350.	32028.	32378.	7667.	24711.	113883.82	6400.13
13	0.	350.	0.	350.	32028.	32378.	6841.	25537.	105772.19	4800.10
14	0.	350.	0.	350.	32028.	32378.	5926.	26452.	95957.12	3200.07
15	0.	350.	0.	350.	32028.	32378.	4902.	27475.	84080.88	1600.03
16	0.	350.	24001.	350.	32028.	32378.	7008.	25370.	93711.13	8000.17
17	0.	350.	0.	350.	32028.	32378.	5960.	26418.	81363.24	6400.13
18	0.	350.	0.	350.	32028.	32378.	4775.	27603.	66422.29	4800.10
19	0.	350.	0.	350.	32028.	32378.	3426.	28952.	48343.74	3200.07
20	0.	350.	0.	350.	32028.	32378.	1878.	30500.	26468.69	1600.03

THE PRESENT VALUE OF AFTER TAX CASH FLOWS DISCOUNTED AT 0.170 IS $ 117765.13.

THIS IS THE ANALYSIS FOR A DIESEL GENERATOR.
THE SYSTEM CAPACITY IS 4000.00 WC FOR 12.00 HR PER DAY.
THE COST OF THE SYSTEM IS $ 3887.00.
THE INITIAL CASH COST IS $ 778.
MONEY IS BORROWED AT A RATE OF 0.21.
THE TAX RATE IS 0.25.

YR	FUEL	MAINT	REPLACE	CFBF	FINANCE	CFAF	TAXES	CFAT	PRIN	DEPREC
1	1795.	700.	0.	2495.	3764.	6259.	1759.	4499.	3110.10	3887.00
2	1795.	700.	2333.	2495.	2823.	5318.	1330.	3988.	2332.70	2332.70
3	1795.	700.	2333.	2495.	2823	5318.	1330.	3988.	2332.70	2332.70
4	1795.	700.	2333.	2495.	2823.	5318.	1330.	3988.	2332.70	2332.70
5	1795.	700.	2333.	2495.	2823.	5318.	1330.	3988.	2332.70	2332.70
6	1795.	700.	2333.	2495.	2823.	5318.	1330.	3988.	2332.70	2332.70
7	1795.	700.	2333.	2495.	2823.	5318.	1330.	3988.	2332.70	2332.70
8	1795.	700.	2333.	2495.	2823.	5318.	1330.	3988.	2332.70	2332.70
9	1795.	700.	2333.	2495.	2823.	5318.	1330.	3988.	2332.70	2332.70
10	1795.	700.	2333.	2495.	2823.	5318.	1330.	3988.	2332.70	2332.70
11	1795.	700.	2333.	2495.	2823.	5318.	1330.	3988.	2332.70	2332.70
12	1795.	700.	2333.	2495.	2823.	5318.	1330.	3988.	2332.70	2332.70
13	1795.	700.	2333.	2495.	2823.	5318.	1330.	3988.	2332.70	2332.70
14	1795.	700.	2333.	2495.	2823.	5318.	1330.	3988.	2332.70	2332.70
15	1795.	700.	2333.	2495.	2823.	5318.	1330.	3988.	2332.70	2332.70
16	1795.	700.	2333.	2495.	2823.	5318.	1330.	3988.	2332.70	2332.70
17	1795.	700.	2333.	2495.	2823.	5318.	1330.	3988.	2332.70	2332.70
18	1795.	700.	2333.	2495.	2823.	5318.	1330.	3988.	2332.70	2332.70
19	1795.	700.	2333.	2495.	2823.	5318.	1330.	3988.	2332.70	2332.70
20	1795.	700.	2333.	2495.	2823.	5318.	1330.	3988.	2332.70	2332.70

THE PRESENT VALUE OF AFTER TAX CASH FLOWS DISCOUNTED AT 0.170 IS $ 23658.90.