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Market Assessment of Photovoltaic Power Systems for Agricultural Applications in the Philippines

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and
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April 1981

Prepared for
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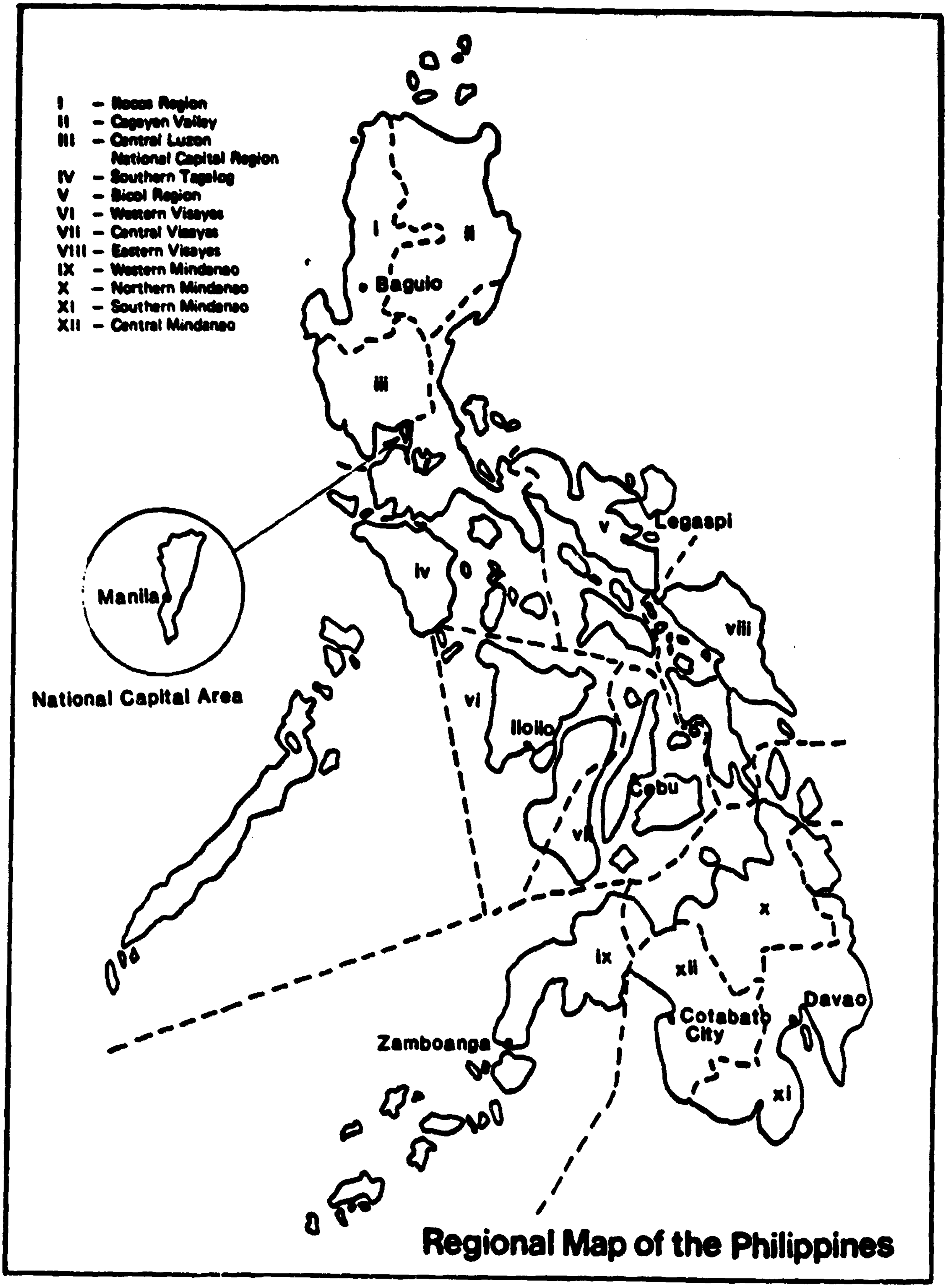
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Market Assessment of Photovoltaic Power Systems In Agricultural Applications

THE PHILIPPINES

Executive Summary

Objectives

The Photovoltaic Stand-Alone Applications Project Office of NASA/Lewis Research Center, Cleveland, Ohio is sponsoring a study to assess the potential market for remote photovoltaic (P/V) power systems in worldwide agricultural applications. The Philippines is the first of a series of countries to be assessed. The primary purpose of this Philippines study is to identify applications with high P/V sales potential so that P/V equipment suppliers and distributors could develop appropriate marketing strategies. The following essential information for the Philippines was gathered.

- Estimates of potential market size for P/V power applications in the agricultural sector.
- Power requirements and usage profiles for a wide variety of agricultural applications which are compatible with a P/V system.
- Operating and cost characteristics of gasoline and diesel power systems that would compete against P/V systems.
- Energy, agriculture and development goals, programs and policies which will influence P/V sales.
- Appropriate financing mechanisms and estimates of capital available for P/V system purchases.
- Channels for distribution, installation and maintenance of P/V systems.
- Appropriate methods for conducting business in the Philippines.

The types of applications considered are those requiring less than 15KW of power and operating in a stand-alone configuration without back-up power. These applications include irrigation, post-harvest operations, food and fiber processing and storage, and livestock and fisheries operations.

Study Approach

A team from DHR, Incorporated and Associates in Rural Development, Inc. conducted a month long study in the Philippines during October and November

1980. The major activities of the team were a series of meetings with Filipino energy, economic, financial, business and policy experts to obtain current data and their evaluation of factors important to introducing P/V power systems into the agriculture sector. Site visits were made to obtain power requirements and energy use profile data for several agricultural applications. In addition to data collection, the team members gave presentations on P/V systems, and distributed sets of brochures consisting of advertising material obtained from U.S. P/V companies and from U.S. government sources.

The information gathered served as a data base to characterize the environment in which P/V systems would be marketed and used. Data on applications was used to identify cost-competitive end-uses. The potential market size estimate was based on cost-competitiveness, availability of finance, business environment, and other factors. Due to the inherent uncertainties present in such analyses, three potential market estimates are presented - "Status quo," "Increased activity," and "Optimistic."

Status of P/V in Philippines Energy Development Plans

Philippines is highly dependent on foreign oil for commercial energy. In 1980, oil accounted for about 90 percent of the annual commercial energy consumption, or more than double the level of 15 years ago. The rising oil bill has made the Philippines extremely aware of the importance of changing its energy source mix and improving consumption efficiency. Domestic oil, geothermal, coal, hydroelectric and a number of other renewable and non-conventional energy sources are viewed as major possibilities for helping reduce oil imports. The Philippines have embarked on an ambitious five year program aimed at reducing their dependence on foreign oil. Strategy components supporting this plan include:

- The accelerated diversification from depletables to alternative sources of energy, with emphasis on indigenously abundant and regenerative forms.
- The establishment of support infrastructure to enable efficient processing, handling, storage, distribution and marketing of traditional and new energy resources.
- Application of appropriate decentralized energy facilities for areas difficult and costly to connect to centralized systems.
- The strengthening of collaborative efforts with other nations in emergency supply sharing and technical expertise interchange.
- The concentration of energy research and development on energy resources that are locally abundant for dispersed applications.

These strategies would favorably influence the use of P/V in the Philippines. However, the government has not included a significant role for P/V in their five-year energy plan. The major reason for this ommission is due to the thrust of government efforts to apply familiar and cost-effective technologies, and to wait for the more industrialized and developed countries to develop and reduce the costs of more experimental and newer technologies. P/V systems are clearly viewed as an experimental technology in the official government energy plans.

The Philippines has embarked on an ambitious rural electrification program which expects to fully electrify the country before the end of the decade. While this would dampen the demand for P/V use agriculture, DHR does not expect it to have too great an effect on the market. This is due to the fact that many agricultural applications would not be served by the "backbone" type rural electrification system being promoted in the Philippines.

Implications of Philippines Agricultural Development Plans for P/V Systems

There are several important development policies and programs within the government agriculture sector that relate specifically to opportunities for P/V systems. The interest in P/V systems for use in agricultural products being promoted by the government will be greater than in those products with a lesser role in the development plans. The major crops in which increased production is being strongly supported are rice and corn. Secondarily, programs in cattle, dairy, and cotton are considered of critical importance, although production has not been increasing as fast as intended. The crops discussed below are chosen due to their importance for P/V applications throughout all production phases of the crop.

- RICE--Though the Philippines has reached self-sufficiency in rice, a 4.4 percent annual increase in rice production has been targeted for the 1978-1982 period to keep up with population growth and provide an adequate buffer stock. Of more importance to P/V applications is the attempt by the government and farmers to reduce use of fossil fuels and nonrenewable energy in rice production and processing. Improved irrigation and methods of water pumping are a continuing priority. However, there have been increased crop losses recently due to nonuse of powered irrigation, as farmers have not wanted to pay the increased cost of gasoline. P/V systems would also be important in rice drying and milling.

- CORN--Increasing corn production for human consumption is a major emphasis at this time due to a large domestic production deficit, and the resulting importation of about 120,000 metric tons per year. Moreover, the key limiting factor to increasing animal production in the Philippines is the lack of feed grains. Production is targeted to increase by 20 to 25 percent over the next six years. This increased production is meant to reduce the need for imported corn and to increase the availability of corn as an animal feed. A role for P/V power is expected in irrigation, drying, and grinding.

- OTHER CROPS--There are several crops for which, although P/V does not seem a likely power source in actual production, it could be utilized in support facilities and at central building complexes on large farms. Sugarcane, bananas, pineapple, and casava are crops in this category. However, a role for P/V power systems for irrigation of high value crops such as spices, garlic, etc., is most feasible.

- FISH PRODUCTION--Aquaculture and commercial fisheries development are a priority area in the government development plans. A major role for P/V systems is in ice making for fish preservation and for water pumping and aeration in aquaculture.

Availability of Financing Mechanisms and Funds

The Philippines has an extensive financial network composed of both private and government-owned financial institutions. The majority of investment funds are controlled by the privately owned, commercial and savings bank sector. These funds are available as short-term working capital loans primarily invested in industry, consumption, commerce, real estate and public utilities. Long-term investment capital amounted to ₱6085.2 billion ($832 million) in 1977. Of this amount ₱731.5 million ($100 million) was loaned to the agricultural sector. The Development Bank of the Philippines is the major source of long-term capital for agriculture. DHR estimates that only a small part of this capital will be available for financing P/V systems.

National Electrification Administration (NEA) has been the source of funds for the expansion of rural electric cooperatives. While there is currently no policy committing NEA to financing of P/V systems, it could be a possibility since the purpose of rural electrification and P/V is similar. The status of NEA concessional loans as of December 1979 was nearly $1 billion, of which $218 million was from international sources such as US AID, World Bank, France, Norway, etc. In 1980, concessional loans for wood-fired and mini-hydro power plants were obtained from French and Norwegian sources. The very low interest loans being granted by NEA will most certainly improve the economic viability of P/V systems. Table 2 shows typical long-term loan terms currently available in the Philippines.

Table 1 LONG-TERM, LOAN TERMS FOR SELECTED INSTITUTIONS

Terms	DBP	PDCP	IGLF	National Electrification Administration
Interest Rate	12% - 14%	12% - 14%	12%	2% Power Generation Co-ops 3% NPC Connected Co-ops
Debt-Equity Ratio	85:15	N/A	80:20 (90:10 for depressed areas)	
Collateral Loan Values	90% on Titled Real Estate; 80% on Chattel	N/A	Guarantees on Non-Collateral Loan Portion	
Maturity/Repayment	10 Years-Fixed Assets	4-15 Years	3 Years-Working Capital 10 Years-Fixed Assets	25 Years with a 5 Year Grace Period
Loan Range	₱100,000-₱1,000,000* ($14,000-$140,000)	₱50,000-₱1,000,000 ($7,000-$140,000)	₱50,000-₱500,000 ($7,000-$70,000)	

*Loans above and below these amounts are available.

N/A - Not available

DBP - Development Bank of the Philippines

PDCP - Private Development Corporation of the Philippines

IGLF - Industrial Guarantee and Loan Fund

NPC - National Power Corporation

Considering that private venture capital in the Philippines tends to be short-term and loans have high interest rates (20-22% in 1980) there appears to be few alternatives to the development banks as a source of low interest, long-term loans. Lack of long-term capital will be most significant barrier to the marketing of P/V systems in the Philippines. American P/V manufacturers or distributors will either have to focus part of their marketing efforts on convincing these institutions that photovoltaics are economically and financially viable and worthy of long-term loans, or introduce innovative financial schemes to promote the sales of P/V systems. Table 3 summarizes the financial barriers/incentives to P/V market development.

Table 2 SUMMARY OF FINANCIAL BARRIER/INCENTIVES

Area	Present Status
Role and Responsibilities of Financial Institutions	• Government-run financial system would provide long-term financing for energy projects -- may evaluate projects on economic basis.
	• Privately-owned financial system provides short-term working capital (seed, fuel, fertilizer, etc.) — would evaluate projects on financial basis.
Attitudes to P/V	• Skepticism at banks project staff level.
	• Enthusiasm at banks program staff level.
Long-Term Investment Capital	• Long-term loans are primarily from government development banks.
	• Total long-term capital available for agriculture is small.
	• Priority for renewable energy projects in government-run financial institutions' lending programs.
	• Competition of P/V for loans against biogas and biomass projects.
Loan Terms for Long-Term Loans	• Interest rates between 12%-14%, below commercial loan rates.
	• High debt-equity ratio.
	• 10 to 15 years maturity.
	• Loans range from ₱50,000 ($7,000) to ₱1,000,000 ($140,000) or more.

Potential P/V Applications in Philippine Agriculture

During the visit to the Philippines, a number of agricultural applications that could use P/V power systems were identified. The criteria used in the selection were:

- Level of production and importance of the product in the Philippines.
- Type of operation and its adaptability to use a P/V power source.
- Extent of use of the operation in the Philippines.
- Extent of the current level of mechanization of the operation (e.g., use of conventional energy systems).
- Size of the power unit required for a typical operation.

The applications cover a wide range of power requirements (20W to 12KW capacity), diverse load profiles and varying operating environments. The applications cover fish/prawn hatchery operations, irrigation, maintenance facilities, grinding and milling, fish cultivation, salt production, ice manufacture and agricultural extension services. It is very likely that most other agricultural applications would fall within the operating and cost characteristics of the selected applications.

Table 3 CHARACTERISTICS OF APPLICATIONS ADAPTABLE TO THE USE OF P/V POWER SYSTEMS

Application	Power Required * Capacity(KW)	Power Required * Peak(KW)	Energy Required KWH/Year	DNR Estimate of the Current Extent of Use (Number of Units)	Total Power (KWp)
Hatchery-Fish Stock Gathering Pump	0.02	0.01	10	300	3
Radio Communication	0.1	0.03	100	15,000	450
Battery Charger-Logging Operations	0.14	0.08	110	200	16
Agriculture Extension Audio-Visual Equipment	0.4	0.07	100	2,000	140
Prawn & Fish Hatchery	0.9	5.1	6,720	300	1,530
Forestry Station	1.2	0.7	910	70	50
Commercial Farm Maintenance Yard	1.2	1.8	2,330	5,500	9,900
Rice Garden - 1HA**	1.9	2.0	2,620	Experimental	-
Corn Grinder	2.3	1.0-6.7	1,330-8,880	2,700	10,200
Rice Mill (small)	3.1	2.4	3,230	14,700	32,280
Rice Mill (average)	4.4	2.1	2,780	4,000	8,400
Rice Mill (large)	7.2	6.3	8,300	4,000	25,200
Irrigation for Rice Double Cropping (2HA to 6HA plots)	4.0-6.0	3.3-10.0	2,150-7,050	20,000-40,000	133,600
Irrigation for Rice Doubling Cropping + Single Crop Corn (2HA to 6HA plots)	4.0-6.0	3.3-10.0	3,190-10,170		
Fish Pond 10HA	5.0	7.4	10,640	2,500	18,500
Fish and Salt Ponds 10HA	5.0	7.0	9,480	250	1,750
Fish Pond 20HA	10.0	14.8	21,280	3,700	54,760
Small Ice Plant	11.0	73.0	96,360	400	29,200
Corn Roller Mill	11.2	6.0-37.0	8,030-48,720	700	14,000
Total Power Required					340,000

* - depending on hours of daily usage peak power requirements may be less than or greater than capacity power requirements.

** - HA - Hectare

Based on the above criteria the applications shown in Table 3 were identified as being technically viable markets for P/V systems, if other barriers such as cost, finance, marketing and awareness could be overcome.

The applications shown in Table 3 correspond to a total peak power demand of about 340MW. The Philippines Agricultural Machinery Manufacturers and Dealers Association (AMMDA) data indicates that agricultural machinery installation rate (replacement plus new installations) amount to about 10% per year of the existing stock. This is an indicator of number of agricultural equipment units that could be eligible for conversion to P/V power. Thus, under ideal conditions, the potential power needs could be as high as 34MWp per year. This represents an upper bound on the market.

Another indicator of the need for small mechanized power units in Philippine agriculture could be gauged by the projected sales of small gasoline engines, averaging 5hp each. These are shown in Table 4.

Table 4 PROJECTED DEMAND FOR SMALL GASOLINE ENGINES FOR AGRICULTURAL USES

	1981	1982	1983	1984	1985	Total
Engine Sales (Average 5hp)	27,000	30,000	33,000	37,000	40,000	167,000
Approximate P/V Power Equivalent (7KWp=5hp)* (MWp)	189	210	231	259	280	1,169

*7 KWp = 5 hp * 0.746 KW/hp * 8 hours/day/(4.3 peak sunlight hours/day).
SOURCE: Based on AMMDA Sales Projections.

Methods Used in Measuring Cost-Competitiveness of P/V Systems

Long-term financing of photovoltaic systems is likely to be handled through the government financial system. Most long-term financing in agriculture is directed through the development banks, which are in turn partially financed through multi-lateral donor agencies, such as the Asian Development Bank and the World Bank, and bilateral agreements between the Philippines and donor countries. These banks function not only as lending agencies but also as agents of government policy objectives. This dual function creates the need within the development banks to evaluate loans in terms of their economic benefits to the nation as well as their benefits to the potential applicant. An economic analysis measures the profit to the nation while a financial analysis measures the profit to an investor of a project. Interviews with the Development Bank of the Philippines planners indicated that the bank will in the future adopt economic analysis of projects as part of their evaluation of loans. Once this practice has been instituted, loans will be given according to the following criteria:

- Loans would be given if projects pass both an economic and financial analysis.
- If a project passes an economic analysis and not a financial analysis, it would be more likely to receive funding than if it passes a financial analysis and fails an economic analysis.
- Finally, if a project fails both an economic and financial analysis, it will not receive funding.

Considering that most long-term agricultural financing in the Philippines is presently directed through the Development Bank of the Philippines, photovoltaic firms wishing to sell to the government or to government-financed projects may have to justify on economic grounds the viability of these systems. DHR, in considering potential photovoltaic applications has included in its evaluation of photovoltaic systems both an economic and a financial analysis. The purpose of using both types of evaluations is to provide photovoltaic manufacturers with an idea of the economics under which these systems will be financed by the development banks and private entrepreneurs in the Philippines.

The assumptions used in the economic and financial analyses are shown in Table 5 and 6. Economic and financial life-cycle cost analyses were performed to determine how P/V systems would compete with conventionally powered systems currently in use. The analyses assumed that, below 1.2KW capacity P/V systems would compete with gasoline generators. The competitor for larger systems would be diesel. Table 7 shows the year in which P/V systems would be cost-competitive with conventional systems. It also shows the breakeven life cycle cost of P/V energy in $/KWH in the first year of cost competitiveness.

Table 5 ASSUMPTIONS USED IN COST ANALYSES

	Financial Analysis	Economic Analysis
Inflation	13%	-
Discount Rate	21%	12%
Loan Rate	14%	-
Life of Conventional System	Equipment Lifetime	Equipment Lifetime
Fuel Cost Escalation	16.4% (nominal)*	3% (real)
Fuel Cost in 1980	1.43 (diesel)	1.18 (diesel)
($/U.S. Gallon)	2.42 (gasoline)	1.18 (gasoline)
Analysis Lifetime	15 years	15 years
Depreciation		
I. P/V System	Lump Sum	-
II. Conventional System	Sum-of-Digits	-
Marginal Tax Rate	5%	-
Salvage Value	10%	-
Labor Cost	$1/hour	$1/hour

*16.4% nominal = 3% real
SOURCE: Development Bank of the Philippines and World Bank

Table 6 P/V SYSTEM COST PROJECTIONS

	1980	1982	1984	1986	1988	1990
System Cost ($/Wp)	20.85	11.73	9.14	6.55	5.28	4.40

SOURCE: Estimated from Jet Propulsion Laboratory, 1981 Photovoltaic Systems Development Program Summary Document data.

Table 7

FINANCIAL AND ECONOMIC ANALYSIS USING 3% REAL FUEL COST ESCALATION RATE*

APPLICATION	ARRAY SIZE (KWp)	FIRST YEAR OF COST COMPETITIVENESS: ECONOMIC ANALYSIS	FIRST YEAR OF COST COMPETITIVENESS: FINANCIAL ANALYSIS	LIFE CYCLE COST, $/KWH, IN FIRST YEAR OF COST COMPETITIVENESS: ECONOMIC ANALYSIS (CONSTANT 1980 $)	LIFE CYCLE COST, $/KWH, IN FIRST YEAR OF COST COMPETITIVENESS: FINANCIAL ANALYSIS (NOMINAL $) (16% INTEREST)
1) Standard Case: 0.3 KW	0.66	1981	1980	0.85	0.77
2) Standard Case: 0.8 KW	1.77	1984	1980	0.49	0.77
3) Standard Case: 2 KW	4.43	1990	1985	0.23	0.58
4) Standard Case: 4 KW	8.84	1990	1985	0.23	0.58
5) Standard Case: 10 KW	22.11	1990(+)[2]	1986	<0.23[3]	0.56
6) Standard Case: 20 KW	43.92	1990(+)	1989	<0.23	0.61
7) Fish Stock Gathering Pump	0.01	1980(-)[1]	1980	>1.08[3]	0.77
8) Transceiver	0.03	1980(-)	1980	>1.08	0.77
9) Agricultural Extension/Slide Projector	0.07	1981	1980	0.85	0.77
10) Logging Site	0.08	1981	1980	0.97	0.77
11) Corn Grinder, Low Use	1.01	1985	1983	0.43	0.59
12) Foresting Station	0.69	1986	1981	0.36	0.69
13) Maintenance Yard	1.76	1986	1981	0.36	0.69
14) Rice, Double Crop Plus Single Crop Corn, 1 HA	1.67	1988	1986	0.39	0.73
15) Rice Garden, 1 HA	2.04	1988	1984	0.31	0.60
16) Medium Rice Mill	2.11	1988	1985	0.30	0.58
17) Small Rice Mill	2.44	1988	1984	0.30	0.59
18) Prawn, Fish Hatchery	5.09	1988	1981	0.30	0.69
19) Rice, Double Crop, 1 HA	1.67	1989	1988	0.50	1.12
20) Corn Grinder, Avg. Use	3.68	1989	1984	0.27	0.59
21) Rice, Double Crop, Plus Single Crop Corn, 2 HA	3.34	1990	1985	0.30	0.76
22) Rice, Double Crop, 2 HA	3.34	1990	1988	0.44	1.12
23) Corn Roller Mill, Low Use	6.08	1990(+)	1987	0.23	0.58
24) Large Rice Mill	6.29	1990(+)	1986	<0.23	0.56
25) Corn Grinder, High Use	6.72	1990	1985	<0.23	0.58
26) Salt and Fish Farm, 10 HA	7.04	1990	1984	0.23	0.58
27) Fish Ponds, 10 HA	7.42	1990	1984	0.22	0.56
28) Rice, Double Crop, Plus Single Crop Corn, 6 HA	10.03	1990(+)	1986	<0.30	0.73
29) Rice, Double Crop, 6 HA	10.03	1990	1989	0.44	1.14
30) Corn Roller Mill, Avg. Use	14.60	1990(+)	1987	<0.23	0.58
31) Fish Ponds, 20 HA	14.83	1990(+)	1985	<0.22	0.55
32) Corn Roller Mill, High Use	36.90	1990(+)	1989	<0.23	0.61
33) Small Ice Plant	72.98	1990(+)	1988	<0.23	0.60

[1] 1980(-): Indicates cost competitiveness earlier than 1980.

[2] 1990(+): Indicates cost competitiveness at a date beyond 1990.

[3] <: Indicates break-even cost less than cost indicated.
>: Indicates break-even cost greater than cost indicated.

*See Appendix E for use profiles and other assumptions.

Table 7 shows that in the 1981-85 time-frame, only small applications are cost-competitive. Based on economic analysis criteria, only applications smaller than 2KWp are cost-competitive prior to 1987. Using financial analysis criteria, mainly due to the higher effective fuel cost, systems less than 2KWp become cost-competitive by 1984.

These results imply that if P/V systems sales depend on government financing, only small systems would be eligible for loans in 1981-85 time-frame. Thus the near-term market would be small. However, an examination of the types of low power applications show that many users of such systems could consider self-financing. These are applications used in corporate farms, or operations generating sufficiently large revenues. They include: fish stock gathering, transceivers, battery chargers for logging operations, forestry stations, maintenance yards, and fish/prawn hatcheries.

Market Assessment

The market size estimate is based on the hypothesis that a market will start developing when P/V systems are cost-competitive, on a life-cycle basis, when compared to its least-cost, practical alternative. At this point, the market share of P/V systems will be close to zero, as the conventional systems have the added advantage of existing supply and repair facilities, tradition, smaller initial cost, and corresponding greater flexibility. As the cost advantage of P/V systems grows so will its market share. We assume that once the cost equality point is passed, the rate of penetration of P/V systems will depend on other factors such as equipment turn-over rates, awareness, availability of finance, marketing strategies, availability of marketing channels, and other market-related factors. We also assume that P/V systems will first penetrate into areas where users are already using powered equipment. For example, they will be more acceptable to a farmers using a gasoline engine driven pump than one who irrigates the field manually.

The previous discussion showed that the size of the technically feasible market in the Philippines is large. However, there are several constraints to achieving this market. The most serious barriers are:

- Awareness--There is, in general, a lack of awareness among end-users, private and public banking and business communities, and government decision-makers as to the possibilities for P/V.

- Cost Competitiveness--P/V systems must be economically and financially cost-competitive with the least-cost practical alternative on a life-cycle basis before its use will be seriously considered. Furthermore, Philippine consumers are very sensitive to first costs.

- Financial--The availability of capital for long-term investments is very small and will hinder the development of a substantial market.

The last constraint is, in our opinion, the most serious barrier to developing a large P/V market. Based on the above mentioned constraints and the incentives described earlier, three market penetration estimates are given. They are based on the following scenarios:

"Status quo"--assumes that existing perceptions and attitudes of end-users, business community and government, persist and the level of activity of P/V manufacturers is unchanged. It also assumes that the basis for cost-competitiveness is an economic analysis based on the 3% fuel cost escalation rate, since loans would be primarily from government sources with minimal private sector purchases of P/V systems.

"Increased Activity"--assumes greater government interest, additional government financing, aggressive marketing by P/V companies, and considerable interest and awareness. It also assumes that larger operations or those generating large revenues would self-finance P/V systems. Thus cost-competitiveness is based on financial analyses using a 3% fuel cost escalation rate.

"Optimistic"--assumes a definite government commitment towards P/V, priority government financing, very strong interest and awareness, less affluent operations entering market, private sector financing, financial cost-competitive analysis, a greater fuel cost escalation rate, in addition to the incentives described in the previous scenarios.

Based on the current level of financing in the agricultural sector, DHR estimates of capital available for P/V systems financing is shown in Table 8. The estimates reflect the fact that there is a significant "learning" or awareness problem associated with P/V use and until that barrier is broken, no significant amounts of P/V systems will be installed. DHR estimates that it will be at least 1985 before this barrier is minimized. The data in Table 8 reflects only financing available from Filipino sources for commercial use of P/V, and does not take into account foreign funds supplied for demonstration projects. Estimation of funds available for the latter activities is highly uncertain. Thus, making such estimates would be fruitless.

Table 8 DHR CAPITAL AVAILABILITY ESTIMATES

Capital Available from Private and Public Filipino Sources (1000's of 1980 US$)

	SCENARIO		
Year	Status Quo	Increased Activity	Optimistic
1982	20	200	500
1983	40	600	1000
1984	60	1000	1500
1985	120	1600	2100
1986	200	2000	2500
1987	300	2200	3200
1988	500	2500	4700
1989	700	3000	6800
1990	1000	4000	10,000

On the more positive size, with greater P/V company activity, it assumes that most small applications, currently cost-competitive, will be purchased by the more affluent userc. These include transceivers, logging operation battery chargers, maintenance yard power supply, forestry stations, and prawn hatcheries. In most cases, the amount of capital required is well within the resources of the users (for example, annual revenue from an average prawn hatchery is about $60,000). In the 1981-85 time frame, cost competitive small applications used by the more affluent groups amount to about 8.5MWp of power for the financial analysis case, and about 1MWp for the economic analysis case. Table 9 shows the quantity of P/V systems that can be installed for financing levels shown in Table 8. This is based on P/V systems costs shown in Table 6.

Table 9

DHR MARKET SIZE ESTIMATES (KWp)

	SCENARIO					
	Status Quo		Increased Activity		Optimistic	
Year	Annual	Cumulative	Annual	Cumulative	Annual	Cumulative
1982	2	2	17	17	43	43
1983	4	6	57	74	96	139
1984	7	13	109	183	164	303
1985	15	28	204	387	268	571
1986	31	59	305	692	382	953
1987	51	110	338	1030	540	1493
1988	95	205	473	1503	890	2383
1989	151	356	647	2150	1466	3849
1990	250	606	1000	3150	2500	6349

Current Status of P/V in the Philippines

Public Sector

The primary public agency responsible for renewable energy technology development is the Philippine Center for Non-Conventional Energy Development (Non-Con Center). The Non-Con Center's major role is technology development, but is increasingly involving itself in technology delivery and information dissemination activities directed at users, especially in rural areas. The Non-Con Center has initiated several P/V irrigation pumping experiments to evaluate their suitability for use in Philippine conditions. Four small 200-250Wp demonstration irrigation systems have been installed under the auspices of the United Nations Development Program in cooperation with the Non-Con Center and the Farm Systems Development Corporation. Two of the systems were supplied by Solar Electric International, a U.S. company, and the other two are French systems. The German government has proposed a $4 million P/V system for electrifying a village. An agreement in principle has been worked out between the German government, the Non-Con Center and the Technology Resource Center. The system is expected to be in place by the end of 1981. AEG-Telefunken will supply the P/V system and train Filipino technicians to operate and maintain the system. The military is also experimenting with the use of P/V powered pumping systems for use in the southern part of the Philippines.

In moving beyond experimentation and demonstration to commercialization, government energy experts are skeptical as to the appropriateness or match of P/V to their needs. Their major concern or reservation was based on the high present market cost of P/V systems. This seemed to be the key inhibitor to a more widespread and higher level of interest necessary to move beyond demonstrations. They are taking a wait-and-see attitude toward P/V systems. Only an improvement in the relative first cost of P/V to competing energy sources will address this inhibiting factor, and create an atmosphere and possibility of increased interest. At that time, it will be possible to address remaining concerns about P/V performance (e.g., reliability and durability) that can only come with user experience in the field.

Entrepreneurial Interest

There is currently an active and enthusiastic entrepreneurial interest in photovoltaics by Filipino businessmen. In interviews with both large and small industrialists, there was the attitude that photovoltaics could develop as a viable energy industry in the Philippines. Both a large industrial corporation and a large commercial bank have expressed interest in financing economically viable photovoltaics projects, as well as establishing a local photovoltaic industry. Smaller firms, presently involved in selling flat plate collectors, have also expressed an interest in establishing contact with American photovoltaic manufacturers with the purpose of establishing joint manufacturing or marketing of photovoltaic systems.

In general, the level of knowledge and sophistication about potential applications, markets and photovoltaic systems is higher in larger firms. In addition, larger firms appeared to be interested in technology transfer arrangements with the United States, while smaller entrepreneurs expressed a willingness to act as dealers for photovoltaic systems. A number of entrepreneurs, both large and small, inquired about the possibility of setting up a regional production facility in the Philippines to service the ASEAN market (Singapore, Thailand, Indonesia, Malaysia and the Philippines). These entrepreneurs felt that it may be possible to obtain preferential tariff duties on an ASEAN photovoltaic facility from the ASEAN community. One firm has advertised small photovoltaic systems in Philippine newspapers with limited sales success. These systems were designed to power radios and electric fans and are geared to the upper-middle and upper-class market. To-date this businessman has not been able to penetrate this market successfully. One problem (often cited businessmen) is the fact that potential customers are familiar with much larger systems. For example, farmers irrigating their fields commonly use 5 to 10 hp pumps. Smaller photovoltaic systems (below 1KW) are viewed with skepticism by farmers who feel that P/V cannot do as good a job as a gasoline or diesel pump in irrigating their fields. Table 10 summarizes the current status of interest in P/V systems.

TABLE 10 PRESENT STATUS OF INTEREST IN P/V SYSTEMS

Area	Present Status
Public Sector	• Lack of information on P/V by government decision-makers. • Wait and see attitude towards P/V by energy officials. • Skepticism by planners that P/V could compete with biogas and biomass.
Private Sector	• Active and enthusiastic entrepreneurial interest in P/V by Filipino businessmen. • Interest by private businessmen in establishing contacts with P/V manufacturers in the U.S.

Business Environment for Marketing P/V Systems

Presently, American manufacturers of photovoltaic systems have several advantages in developing the Philippine market. First, there is an established dealer/service/wholesaler network that is extensive and familiar with American products and business practices. Second, photovoltaic systems have been granted a number of tax incentives in order to promote the use of these systems in the Philippines. Third, there are a number of entrepreneurs willing to invest in local production of photovoltaic systems in joint ventures with American firms. Finally, as a pioneer industry photovoltaic systems will be granted priority access to capital from all government-owned or controlled financing institutions.

Potential disadvantages to American development of the Philippine market is the presence by foreign firms currently being established through demonstration projects.

Table 11 summarizes the advantages and disadvantages of the present business climate for marketing P/V systems.

Table 11 CHARACTERISTICS OF THE PHILIPPINE BUSINESS CLIMATE

Area	Present Status
Foreign Competition	• U.S. leads in motor generator set field. • Strong competition by European and Japanese who are interested or are currently developing P/V markets. • Local P/V industry may develop in near future.
Investment Climate	• P/V designated pioneer industry. • Government offers a number of financial incentives to manufacturers to site plants in the Philippines.
Business Environment	• Dealers often act as exclusive agents for products.
Dealer/Importer/Manufacturer Relationship	• Sales are on indent basis. • Credit terms range up to 60 days for small equipment -- installment payment terms for large items (25% deposit, 2 year monthly installments).
Service/Maintenance	• Dealers do not usually stock high value parts. • Maintenance of small systems left to purchasers--large systems serviced by dealer. • Warranty terms are one and two years normally. • Manufacturer/dealers selling to government or government-financed projects must be accredited. • Current shortage of skilled workers.
Standards and Regulations	• Generally, all U.S. standards are acceptable • P/V exempted from all taxes. • BOS systems would have import duties and taxes levied. • Lump sum depreciation for P/V systems allowed.

Conclusions

There are many characteristics of the Philippine agriculture and energy sector that favorably influence the use of P/V systems. They include:

- Stated government policy towards promotion of renewable, and dispersed power sources.
- Financial incentives for the production and use of P/V systems.
- High cost of conventional energy supplies such as gasoline and diesel.
- Entrepreneurial interest in P/V systems.
- Cost-competitiveness of P/V systems when compared to gasoline and diesel power sources in a wide range of agricultural applications.
- Availability of suitable marketing channels for sale of P/V systems in the agricultural sector.
- The shortage of skilled labor for maintaining competing systems.

However, very significant and serious barriers prevent achieving the technically feasible, cost-competitive market for P/V systems in the agricultural sector. These include:

- The lack of awareness of the possibilities for P/V systems.
- The shortage of capital for financing P/V systems.
- High first costs of P/V when compared to competing systems.

Thus, if the status quo is maintained, the market for P/V power systems in the Philippine agricultural sector will be small. The most important reason for the limited market is the availability of capital for financing P/V systems. If this constraint could be relaxed, than the cost-effective market becomes larger by several orders of magnitude. Thus devising innovative financing schemes and promotional campaigns could have a very high payoff. The market would be mainly small power applications in the pre-1985 period with sales to affluent individuals or corporations. In the post-1985 period the market for larger systems could open-up if long-term financing is provided by the Philippine banking community.

MARKET ASSESSMENT OF PHOTOVOLTAIC POWER SYSTEMS IN AGRICULTURAL APPLICATIONS WORLDWIDE

REPORT NO. 1

THE PHILIPPINES

1.0 INTRODUCTION

1.1 Background

The United States National Photovoltaic (P/V) Program has been established by the U.S. Department of Energy (U.S. DOE) to bring P/V power systems to the economic marketing stage where they will be able to contribute significantly to the U.S. energy requirements by the end of this decade. Ongoing research, development and demonstrations are directed at achieving major system cost reductions and field experiences with P/V power systems. The program is managed by the U.S. DOE and consists of several project offices, one of which is the Photovoltaic Stand-Alone Applications Project Office at NASA Lewis Research Center, Cleveland, Ohio. This project office is conducting international market assessments to ascertain whether stand-alone P/V power systems can provide useful and economically productive power for various applications in developing countries, during the next several years.

1.2 Objectives

The Photovoltaic Stand-Alone Applications Project Office of NASA/Lewis Research Center (NASA/LeRC), Cleveland, Ohio has sponsored a contract to conduct an assessment of the potential for remote photovoltaics (P/V) power systems in worldwide agriculture. The types of potential photovoltaic applications considered in the contract are those requiring less than 15KW of power and operating in stand-alone configuration without back-up power. These applications include: irrigation, post-harvest operations, food and fiber processing and storage, and livestock and fisheries operations. A team of DHR, Incorporated and Associates in Rural Development, Inc. visited the

Philippines, October to November, 1980. The primary purpose of this Philippine report is to provide an assessment of the market for stand-alone photovoltaic systems in Philippine agriculture.

Since this contract intends to identify applications with high P/V sales potential so that photovoltaic suppliers and distributors could develop appropriate marketing strategies, this analysis provides the following essential market information for the Philippines:

- Estimates of potential market size for P/V power applications in the agriculture sector.
- Power requirements and usage profiles for a variety of agricultural applications which are compatible with a P/V system.
- Operating and cost characteristics of gasoline and diesel power systems that will compete against P/V.
- Energy, agriculture and development goals, programs and policies which will influence P/V sales.
- Appropriate financing mechanisms and capital available for P/V system purchases.
- Channels for distribution, installation and maintenance of P/V systems.
- Appropriate methods for conducting business in the country.

In addition to the data collection activities, the team members gave presentations on P/V energy systems, and their current applications. They also distributed sets of brochures consisting of advertising material obtained from P/V companies and from U.S. Government sources.

The types of applications being considered in this assessment are those requiring less than 15KW of power and operating in a stand-alone configuration with no conventional back-up power source.

1.3 Study Approach

The DHR study approach consists of a focused data collection visit to the country followed by a detailed analysis and a market assessment based on this data. This process is described in greater detail below.

1.3.1 Philippine Data Collection

The major activity of the team members was a series of meetings with a wide variety of Filipino experts to obtain current data and their evaluations of factors important to introducing P/V power systems in agriculture. Site visits were also made to obtain power requirements and energy usage profile data for several agricultural applications. Agencies and individuals contacted include businessmen, officials and scientists at the following:

- Ministry of Energy
- Ministry of Trade and Commerce
- Ministry of Rural Development
- Ministry of Agriculture
- Ministry of Labor
- Government and/or University Research Center
- Weather Bureau
- Banks
- U.S. and International Aid Organizations
- Energy Systems Distributors
- Agricultural Machinery Dealers and Associations
- Regional and Local Agriculture Offices
- Farmers and Agribusiness

Appendix A gives the names and addresses of about 90 individuals who were interviewed during the Philippine visit.

To assist in the data collection activities, DHR prepared a comprehensive workbook for use for all countries.[1] This workbook was designed to guide

[1] DHR, Inc., and ARD, Inc., Workbook for Market Assessment of P/V Power Systems in Agriculture. Prepared for NASA/LeRC, October 15, 1980 (revised January 28, 1981).

interviewers in collecting consistent, accurate and complete data. The type of data collected included the following:

- Aggregate statistics including: level of agricultural production; type of production; distribution of production by size of operation; solar insolation; production trends.

- End-Use system configuration description and characterization of: current agriculture practices in terms of: operations; machinery used/duration of use; availability of resources (labor, parts, energy, etc.); P/V impacts; economics; financing; and diesel/gasoline/electricity use.

- Balance of systems availability and barriers to the implementation of P/V systems that are related to: costs and availability of balance of system parts or equipment; skills of workforce.

- Government attitudes and policies including: the level of awareness or interest in P/V - especially units of less than 15KW for agriculture purposes and policies conducive to, or hindering, P/V marketing and use.

- Labor availability and cost and skills of workforce, nationally and regionally.

- Government energy policies, both planned and existing relative to: rural electrification; prices/supply; renewable energies; consumption; type of energy used; P/V systems.

- Government agricultural policies, both existing and planned, with regard to: crop production; introduction of new techniques equipment; role of P/V systems in agriculture; incentives (financial and other); land reform/land use; employment generation; import of agricultural systems; storage; research work; marketing.

- Marketing channels and identification of potential barriers/incentives in the marketing of P/V systems, including the present structure of markets; buying patterns; service/installation; profits; availability of equipment, and costs of competing systems.

- Financing mechanisms and availability of credit of P/V use in agriculture.

- Business environment, incentives and barriers that U.S. companies face when planning to conduct P/V business or organize joint ventures.

1.3.2 Data Analysis and Market Assessment

The information gathered during the visit is used to characterize the environment in which P/V systems would be marketed and used. This includes evaluation of the following factors:

- The national economic development, agriculture, and energy plans to determine the possible roles for P/V systems in agriculture.
- Roles and policies of financial institutions and mechanisms for funding P/V systems.
- Indications of private and public sector awareness and interest in investing in P/V systems.
- Suitability of the existing business and marketing structure for producing, distributing, installing, maintaining P/V systems.
- Current status of P/V systems in use and current attitudes and experience with these P/V systems.
- Cultural appropriateness of the applications.
- Cost-competitiveness of P/V compared to its least-cost practical alternative.

For economic comparisons of P/V power systems to alternatives, the data requirements includes power requirements; usage profiles; the extent of current and future use in Philippine agriculture; competing systems; cost, financial and economic parameters; solar insolation data; and P/V system costs. These economic and usage data were used in DHR's "P/V Market Assessment" computer model. This model computes life-cycle costs, and the year in which the P/V system first becomes cost-competitive with its nearest competitor. Figure 1.1 is an overview of the DHR methodology. Details on the DHR methodology market assessment and its application are given later.

It should be noted that market size estimation procedures used in this analysis assumes that if P/V is to obtain a <u>significant</u> market share, it must be cost-competitive with the least-cost, practical alternative. There are, of course, special cases where other advantages of P/V systems far outweigh cost concerns. One example of such an application is remote operation or a signaling of monitoring device. When appropriate, such applications will be noted.

The qualitative analysis, the cost-competitveness data, and the information on extent of use, are combined and used to obtain an estimation

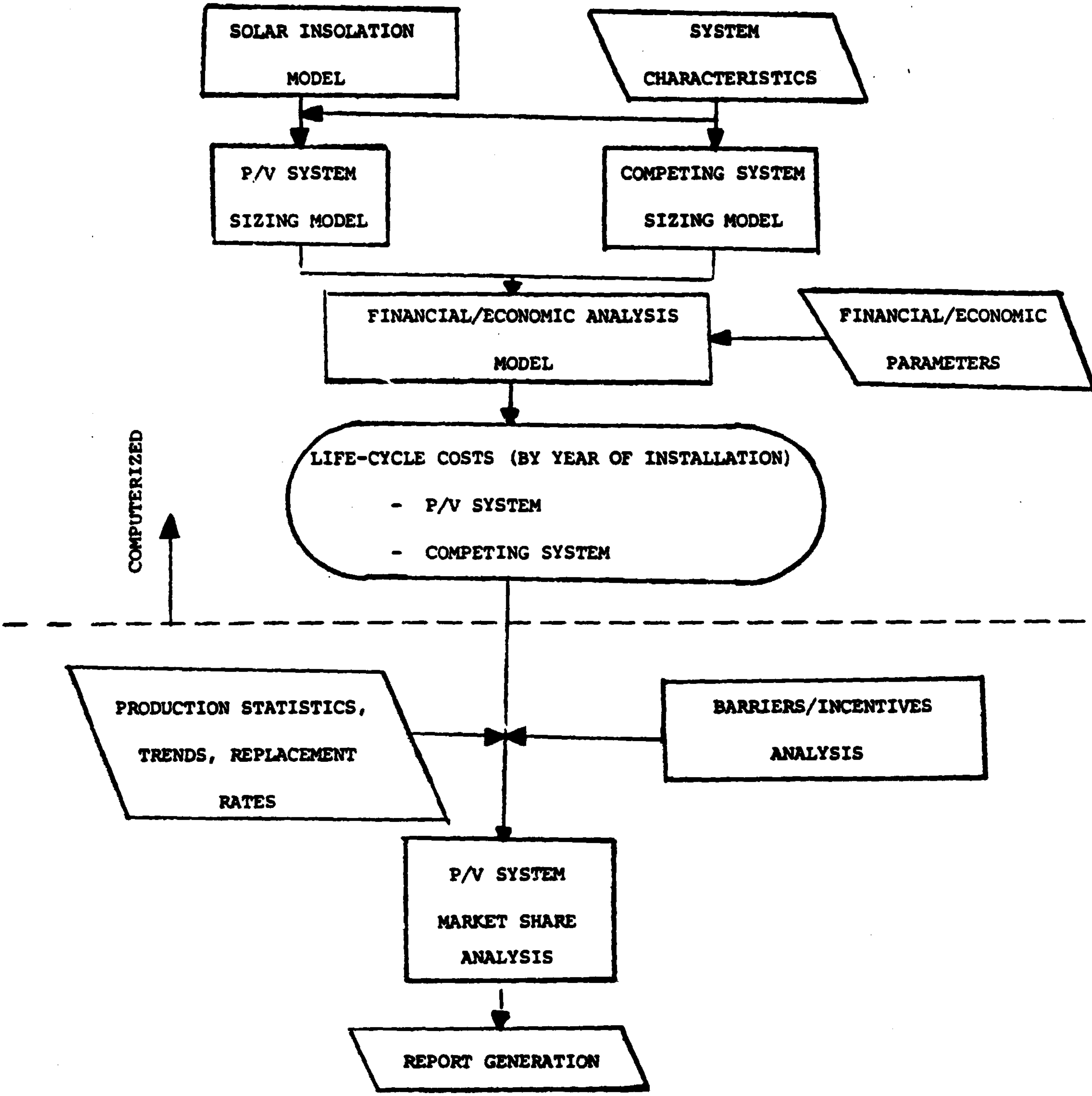

FIGURE 1.1 DHR P/V MARKET SIZE ESTIMATION PROCEDURE

of the probable annual market for P/V systems. Due to the inherent uncertainties present in such analysis, three sets of estimates are made based on "Most Likely", "Increased Activity", and "Optimistic" scenarios for the period 1982-1989.

1.4 Report Organization

Chapter 2 of this report presents a brief overview of the Philippines, in terms of important economic and demographic characteristics, its energy situation, relevant government organizations, climate, agricultural regions, and major domestic export crops. Chapter 3 describes development plans and policies as they influence P/V systems use in agriculture. Chapter 4 describes the financial institutions that can play a major role in financing P/V sales. Chapter 5 describes in detail potential applications, their power and energy requirements and the possible extent of use. Chapter 6 describes economic and financial analyses for selected applications and estimates the probable size of the market in the agricultural sector. Chapter 7 describes the business environment in the Philippines. This Chapter, together with Appendix B, "Doing Business in the Philippines," provides an overview of the relevant Philippines business community and the specific advantages and disadvantages for developing P/V markets.

2.0 DEMOGRAPHIC OVERVIEW

The Philippines has a population presently approaching 50 million, doubling within the last 25 years. The three percent annual average growth rate has resulted in a population whose median age is 17-18 years. The per capita gross national product (GNP) is about $500 (U. S.). Nearly one-tenth of the population lives in the capital of Manila and its suburbs, and another two-tenths reside in other urban areas. Seventy percent of the population is classified as rural.

Fifty percent of employment is within agriculture, fisheries, and forestry. However, this sector contributes only 25 percent of the GNP, as nearly seven out of 10 farmers are rice and/or maize semi-sufficient farmers. Less than one-third of the land is considered arable, and of the 11 million hectares of the land devoted principally to agriculture, 75 percent of it is badly eroded. The average farm size has been estimated at close to 3½ hectares.

The Philippines is an archipelago, about the size of Arizona, that is divided into three island groups: Luzon, Mindanao, and Visayas. Although it consists of 7,100 islands, 11 of them comprise in area more than 95 percent of the country's total area. Luzon, in the north, is the largest island. At present, central Luzon is the nation's rice bowl, and the bulk of irrigated land occurs in this section. However, by the year 2000, western and northern Mindanao are expected to provide the majority of the nation's rice needs. Mindanao is the second largest island and lies in the south.

The other nine islands, the Visayas, constitute 29 percent of the total area of the country. The northern regions (Ilocos, Cagayan Valley, and central Luzon), the western Visayas, and Mindanao are the most important areas of intensive crop farming.

Large-scale operations produce sugar, bananas, and pineapple for export, and are increasingly moving into poultry and swine production. Small-holders and subsistence farmers primarily produce food grains for domestic use and coconut for export. Although the farm population is more or less equally divided among regions, man-land ratios and farm size differences are quite marked. Regions with the most cultivable land resources per person are the Cagayan Valley, central Mindanao, and to a less degree, western Mindanao. (See Appendix F).

2.1 Energy Situation Overview

Energy demand has been increasing steadily in the Philippines over the last two decades. In the mid-sixties, average per capita annual energy consumption was the equivalent of 1.1 barrels of oil, but had risen by 1980 to two barrels.[1] Figure 2-1 and Table 2-1, on the following two pages, show the historical mix of energy consumption, as well as indicating the direction in which the government intends to move while reducing the present heavy reliance on imported oil. In fact, the Philippines is so highly dependent on oil for commercial energy that in 1980 oil accounted for about 90 percent of the annual

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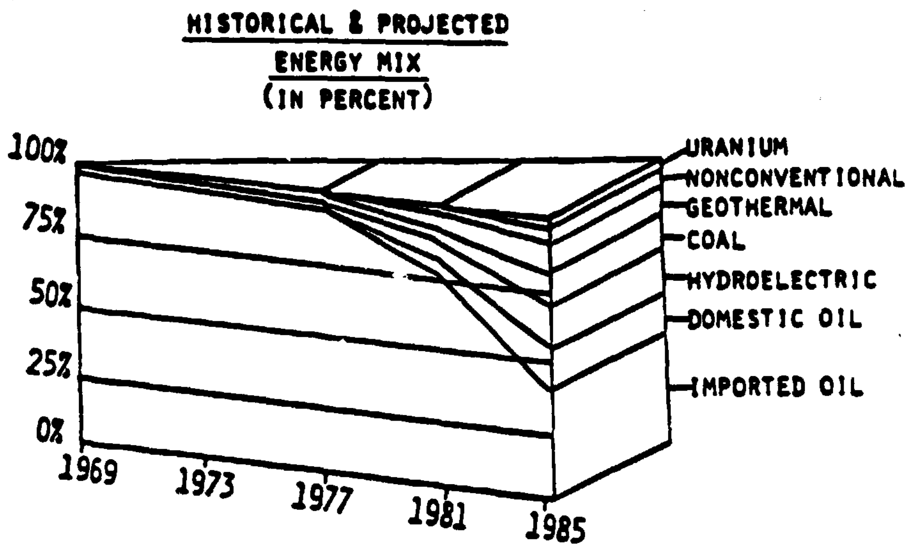
[1] Basic statistics and an overview of the Philippines energy situation, especially in terms of government development plans, can be found in the "Five-Year Energy Program, 1981-1985," available from the Ministry of Energy (MOE) in Manila.

Figure 2-1



Source: "Five-Year Energy Program, 1981-1985," Ministry of Energy, Philippines

Table 2-1

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	39.64
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: "Five-Year Energy Program, 1981-1985," Ministry of Energy, Philippines

commercial energy consumption total, or more than double the level of 15 years ago.

Consequently, the Philippines has become extremely aware of the importance of changing its energy source mix and improving consumption efficiency. Domestic oil, geothermal, coal, hydroelectric, and a number of other renewable and nonconventional energy resources are viewed as major possibilities for helping reduce oil imports and are presently under development.

- DOMESTIC OIL -- Extensive exploration and oil production have only recently begun in the Philippines. However, initial hopes during the late 1970s that oil production would climb above 10 million barrels annually, and provide eight percent or more of the national energy supply, are now being questioned.

- GEOTHERMAL -- The Philippines has an extensive geothermal development program underway, and this energy source has high potential for greatly increasing the electrical energy supply and for changing the energy supply mix. During the past eight years, geothermal power has increased from approximately 10 MW of capacity to about 1,200 MW of potentially feasible production. This resource does vary considerably, however, among the major islands, as it is not present on all nor is it equally distributed where it is present.

- COAL -- Domestic coal production has also increased quite dramatically, up eightfold in the past eight years to approximately 300,000 metric tons. According to Philippine government projections, further increases in production (and increased exploration of new reserves) will increase the volume of coal use from 2.4 percent of total commerical energy consumption in 1981 to 13.4 percent by 1985.

- HYDROELECTRIC -- There is still considerable potential for tapping hydroelectric power in the Philippines. This potential varies greatly from region to region and from island to island. Further information on locations and production projections are given in section 3.2 on rural electrification. Mini-hydroelectric systems are also a major focus of recent activity and are listed in Table 2-2 under nonconventional energy sources.

- OTHER RENEWABLE AND NONCONVENTIONAL RESOURCES -- Table 2-2 shows the Ministry of Energy's supply projections for what they consider to be the key technologies and sources for the Philippines. Of potential competitive importance is the development of the use of marsh gas/natural gas emanations, wind, agricultural wastes, or producer gas technologies. Although they are not yet in widespread use, potential development of these technologies is a factor for site-specific applications, where the government and the private sector are experimenting with their feasibility and performance. Of particular importance to the potential P/V market is the development of bio-gas technology, which, for example, can become a direct competitor with P/V in poultry, swine-raising, or feedlot operations.

  An energy supply plan presently under development is the growing of Ipil-Ipil, a fast growing tree, for dendro-thermal power plants. Another program is the ongoing effort to develop an alcohol fuel program using sugarcane and casava as feedstocks. The government and the private sector are pursuing this option with production and sales scheduled for 1981.

Implications of the Energy Situation and Government Energy Plans for P/V Systems

The widespread awareness of what the cost of imported oil is doing to the Philippine economy and the desire to seek and develop alternatives, provide a situation where P/V could be of benefit and interest. However, the government has not included a significant role for P/V in their five-year energy plan. The main rationale and thrust of government efforts is to apply well-known and cost-effective technologies, and to wait for the more industrialized and developed countries to develop and bring down the price of more experimental or newer technologies. P/V systems are clearly viewed in this latter category in the official government energy plans. However, although the projected role for P/V systems in the Philippines is low in total peak kilowatts when compared to present worldwide P/V production levels and sales, the Philippine market potential is significant.

Table 2-2

ENERGY CONTRIBUTION OF NONCONVENTIONAL ENERGY SYSTEMS
(In thousand barrels-of-oil equivalent, MBOE)

	1981	*1982*	*1983*	*1984*	*1985*
1 Alcogas					
Alcohol production	96.20	575.50	1,407.50	1,964.20	2,415.10
Bagasse:					
Used for alcohol production	55.10	329.40	805.70	1,125.60	1,430.30
Excess	–	150.40	441.70	617.40	792.00
2 Dendrothermal	86.00	233.00	433.00	682.00	973.00
3 Mini hydroelectric	140.00	390.00	737.00	1,133.00	1,610.00
4 Small water-impounding project	16.00	42.00	80.00	143.00	213.00
5 Solar water heating	1.70	2.70	4.90	7.60	12.00
6 Biogas	14.00	21.70	31.30	42.60	55.71
7 Solar drying	0.20	0.30	0.50	0.80	1.20
8 Producer gas	0.50	0.50	0.90	1.40	2.40
9 Windmill water-pumping	0.20	0.30	0.40	0.50	0.60
10 Other projects:					
Integrated energy systems	–	–	0.10	0.20	0.40
Solar pond	–	–	0.02	0.07	0.10
Hot spring utilization	0.02	0.04	0.09	0.14	0.14
Marsh gas	0.01	0.03	0.06	0.08	0.10
Agri/forestry utilization	0.05	0.10	0.20	0.30	0.40
Waste heat utilization	0.50	0.50	0.01	0.02	0.05
Total	410.50	1,746.50	3,953.40	5,718.90	7,506.51

Source: "Five-Year Energy Program, 1981-1985," Ministry of Energy, Philippines

2.2 Key Public Sector Organizations in the Energy Arena

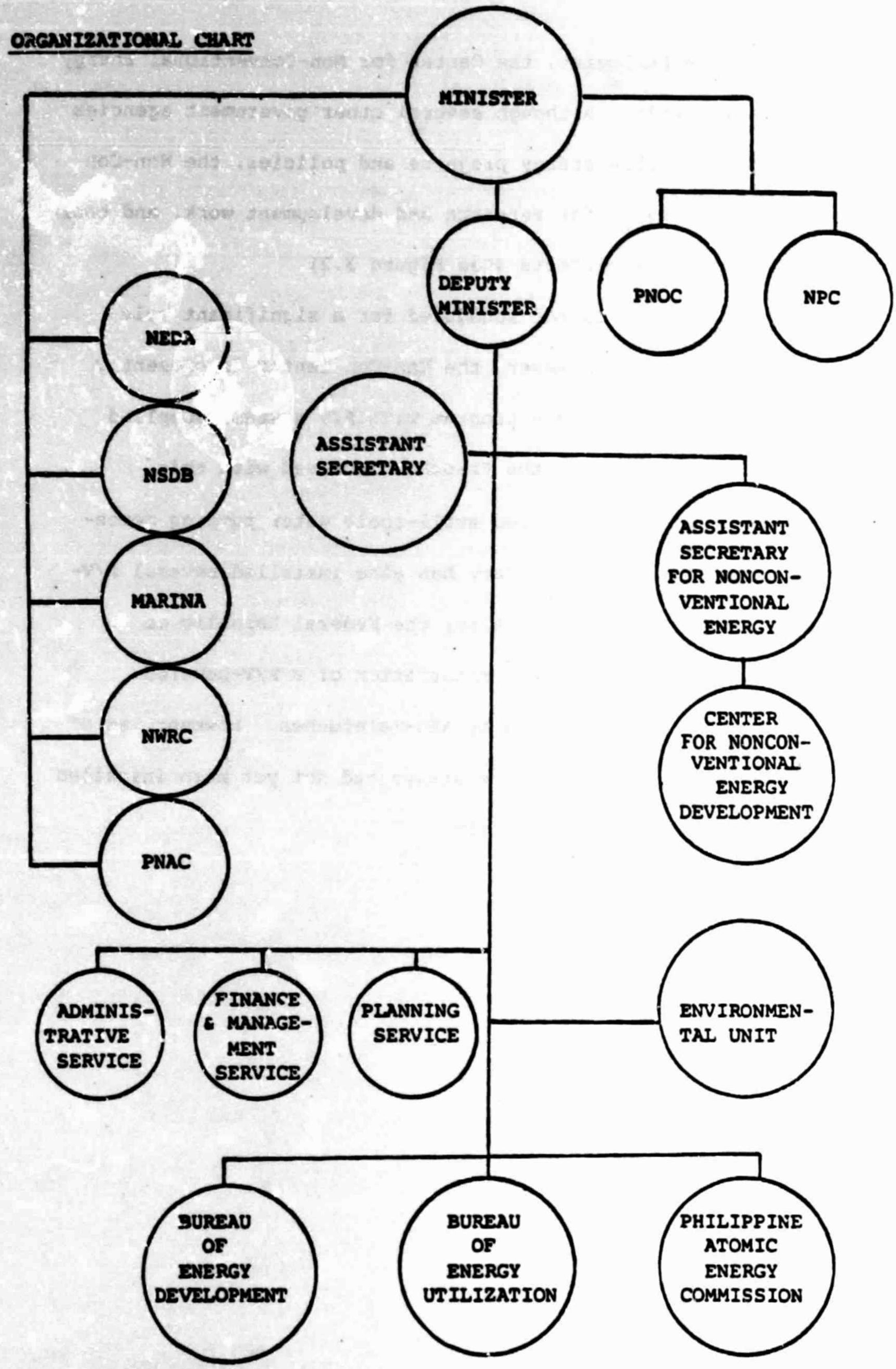
During the 1970s, a series of Presidential Decrees[2] determined guidelines and set the direction of national energy policy. These decrees made regulatory, research and development, and planning functions the broad responsibility of the Ministry of Energy.

Growing awareness of the seriousness of the energy problem, its potential for inhibiting the development plans of the Philippines, and the already strong negative effects on the Philippine economy, led the government in 1980 to compress its ten-year energy plan to five years, 1981 to 1985. The intent in compressing the plan is to speed up the development of indigenous energy resources and the adoption of energy strategies that will make the Philippines increasingly self-sufficient.

Figure 2-2 shows the organizational chart for the Ministry of Energy as it existed in late 1980. Due to the focus of the government on the development of hydroelectric goethermal and domestic fossil energy resources and the rural electrification program, the primary agencies for formulating energy policy and financing energy projects include the Philippine National Oil Company, National Power Corporation, the National Electrification Administration, and the National Rural Electrification Cooperative Association. Responsibilities and roles of these agencies is discussed in section 3.2 on rural electrification. In addition, energy-related research is being carried out by the University of the Philippines in Quezon City and at Los Banos by the National Institute of Science and Technology. Roles and activities of those agencies most directly involved in agriculture-related issues are discussed in section 3.3

[2]For example, Presidential Decrees 1206 and 1573.

FIGURE 2-2



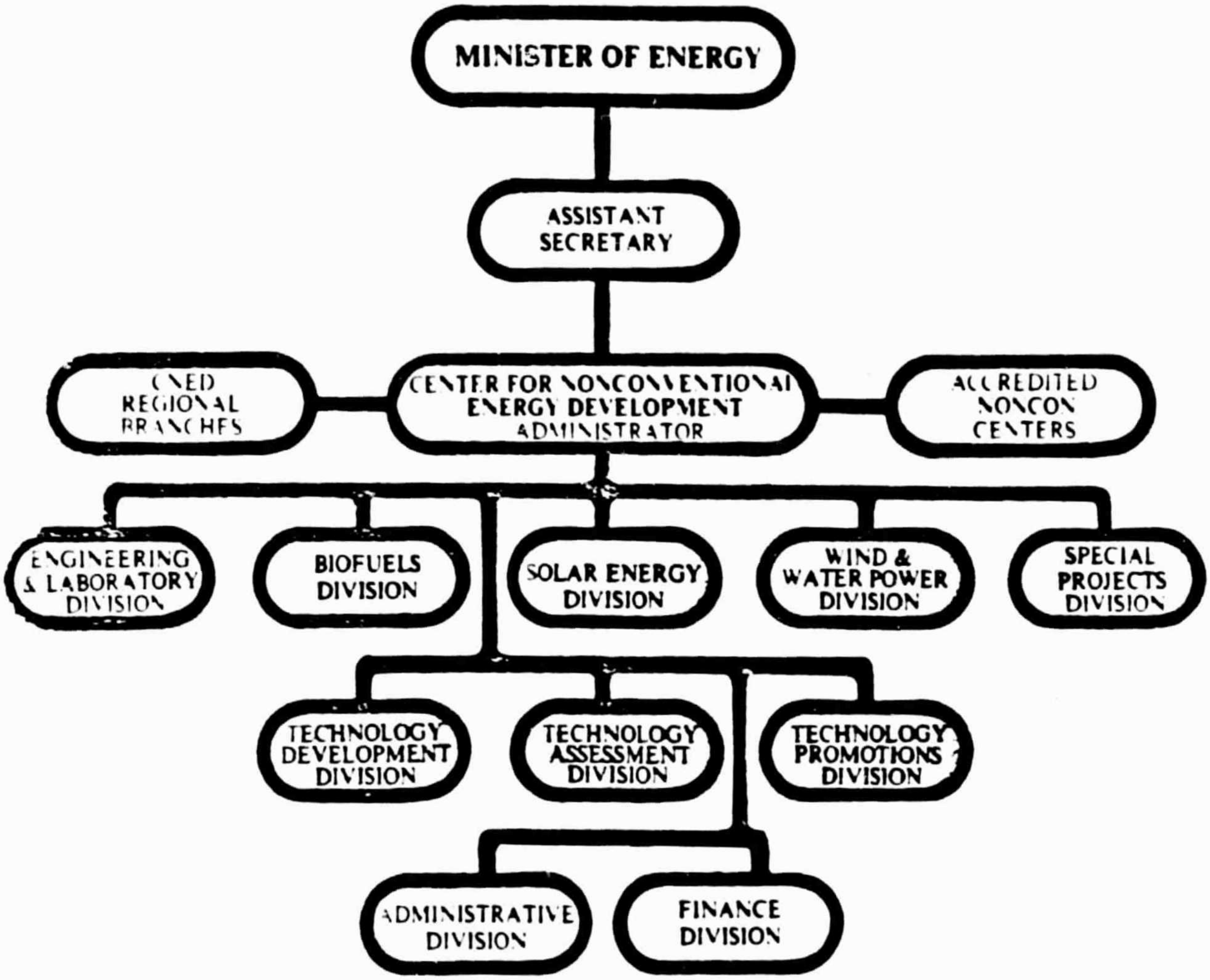
NEDA - National Economic and Development Authority
NPC - National Power Corporation
NSDB - National Science Development Board
NWRC - National Water Resources Council
MARINA- Maritime Industry Authority
ONAC - Philippine National Alcohol Commission
PNOC - Philippine National Oil Company

For solar-related technologies, the Center for Non-Conventional Energy Development has the lead role. Although several other government agencies are strongly pursuing renewable energy projects and policies, the Non-Con Center is presently responsible for research and development work, and coordination of P/V demonstration projects (See Figure 3.2).

As stated previously, P/V is not scheduled for a significant role in the government energy plan. However, the Non-Con Center is presently carrying out a small applied research program with P/V systems supplied by Solar Electric International and the French. Involved with this program is UNDP support of a P/V-powered small-scale water pumping demonstration project. The Philippine military has also installed several P/V-powered systems in southern Mindanao. Also, the Federal Republic of Germany is supporting an experimental demonstration of a P/V-powered village system (15 kwp) to be installed by AEG-Telefunken. However, as of the Philippine visit by the DHR team, the arrays had not yet been installed in the field and exact siting was uncertain.

FIGURE 2.3

Noncon Center Organization



3.0 PHILIPPINE DEVELOPMENT PLANS

3.1 Economic Development Plans

The modern industrial sector, composed primarily of manufacturing, construction, and mining and quarrying, is heavily concentrated around Manila and accounts for about one-third of gross domestic product. The large, mostly traditional agriculture and service sectors contribute the remaining two-thirds. Overall economic growth has averaged approximately six percent annually since 1970. In agriculture, this was mainly due to increases in rice and corn production.[1]

The economy is still heavily dependent upon the export of a few primary goods, i.e., sugar, coconut products, copper ores, and forestry products, for its foreign exchange earnings. Nontraditional exports, such as bananas and pineapples, however, have become increasingly important. Trade deficits have averaged one billion dollars for the past five years. This is roughly equivalent to the cost of crude oil imports, which represent more than one-fourth of the total imports. The increasing cost of oil-based energy, which represents 90 percent of the economy's energy requirements, is helping to fuel inflation at a current rate of 13 percent.[2]

The government believes that two key issues must be addressed by their overall development plan.[3] First, with a rapidly increasing

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[1] See "Country Development Strategy, FY 1982 -- Philippines," Agency for International Development.

[2] This is an official Philippines government estimate of the inflation rate in 1980.

[3] These overall goals are taken directly from the "Ten-Year Philippine Development Plan, 1978-1987", and the DHR team did find commitment among government officials and programs to the general thrust of the plan.

work force, there is a need to find productive work for people. Second, there exists the pressing need to correct the negative balance of payments situation. Consequently, the present government policy consists of two main components:

1) mobilization of the rural sector to expand labor-intensive agricultural production and labor-intensive small- and medium-scale industry to serve rural demand; and,

2) expansion of labor-intensive export products to earn needed foreigr exchange.

The government has stated that capital-intensive and high-risk activities, or those of a service nature, will be the government's main concerns. As is discussed in later sections of this report, the role of the private sector is vital in the government's economic development plans, and is clearly considered a primary actor in both energy and agricultural development activities. In sum, the government has adopted a strategy of developing energy self-sufficiency through increasing reliance on indigenous and renewable sources of energy, and has coupled this with a policy of increasing agricultural production and efficiency of fossil fuel use in most agricultural activities. Increasing energy self-sufficiency and agricultural production are to be brought about within the framework of developing more rural areas.

3.2 Rural Electrification

The Philippines has been rapidly accelerating their rural electrification program and view it as a major and important development goal. The aim of the government and the power development program is the total electrification of the country by 1985. Within this plan, electricity generation and transmission is the responsibility of the National Power Corporation (NAPOCOR), and the organization of electrical cooperatives is carried out by the National Electrification Administration (NEA) for power distribution and retail.

The power sector in the Philippines consists of over 800 public and private utilities, the majority of which either own and operate generating units of less than 10 MW capacity, or purchase and distribute power for base load requirements from NAPOCOR, the biggest single power-producing utility in the country. Average national energy availability from all power utilities was estimated in 1980 to be 3,301 MW. Small private utilities and municipal systems provide power in many areas not covered by the presently developed grid networks. Table 3-1 shows the installed generating capacity and the projections for 1985.

The NEA involves itself mainly in the electrification of rural areas, leaving the private sector to cover urban areas. Over the next five years, NEA will be concentrating on the distribution of power generally made available by NAPOCOR. This is to be accomplished primarily through the formation of cooperatives. In 1979, NEA set up six additional cooperatives, making the total of registered cooperatives 116. Table 3-2 shows the status of electrification in the NEA cooperative structure as of early 1980.

Figures 3-1, 3-2, and 3-3 show the present and planned generating capacity that will provide power for the rural electrification program. Part of the government's change in the new five-year energy plan has been to emphasize geothermal, hydroelectric, and coal plants as a move away from oil. NEA provides capital loans to cooperatives connected to the NAPOCOR grid at three percent interest for a 25-year term with a five-year grace period. For self-generating cooperatives, the interest rate NEA gives is two percent with a 25-year loan term and five-year grace period. Table 3-3 shows the cost in dollars of installing distribution lines and of hookups.

Table 3-1

INSTALLED GENERATING CAPACITIES BY REGION
(In megawatts, MW)

	1980		1981		1985	
	MW	Percent	MW	Percent	MW	Percent
Luzon						
Hydroelectric	549.00	16.63	567.50	17.03	1,516.50	24.28
Diesel/oil	2,312.00	70.04	2,318.00	69.54	2,364.00	37.84
Coal	–	–	–	–	600.00	9.60
Geothermal	440.00	13.33	440.00	13.20	1,045.00	16.73
Nuclear	–	–	–	–	620.00	9.92
Nonconventional	–	–	7.74	0.23	101.52	1.63
Subtotal	3,301.00	100.00	3,333.24	100.00	6,247.02	100.00
Visayas						
Hydroelectric	2.00	0.48	9.30	1.52	52.90	3.55
Diesel/oil	382.80	92.07	504.70	82.16	551.70	37.01
Coal	28.00	6.73	90.00	14.65	160.00	10.73
Geothermal	3.00	0.72	6.00	0.98	681.00	45.68
Nonconventional	–	–	4.26	0.69	45.26	3.03
Subtotal	415.80	100.00	614.26	100.00	1,490.86	100.00
Mindanao						
Hydroelectric	382.00	40.92	382.20	48.47	1,251.60	72.17
Diesel/oil	383.30	50.08	406.30	51.53	475.30	27.41
Coal	–	–	–	–	–	–
Geothermal	–	–	–	–	–	–
Nonconventional	–	–	–	–	7.22	0.42
Subtotal	765.30	100.00	788.50	100.00	1,734.12	100.00
Philippines						
Hydroelectric	933.00	20.82	959.00	20.25	2,821.00	29.78
Diesel/oil	3,078.10	68.68	3,229.00	68.18	3,391.00	35.80
Coal	28.00	0.62	90.00	1.90	760.00	8.02
Geothermal	443.00	9.88	446.00	9.42	1,726.00	18.22
Nuclear	–	–	–	–	620.00	6.55
Nonconventional	–	–	12.00	0.25	154.00	1.63
Total	4,482.10	100.00	4,736.00	100.00	9,472.00	100.00

Source: "Five-Year Energy Program, 1981-1985," Ministry of Energy, Philippines

Table 3-2

Rural Electrification -- Status of Energization

	As of December, 1978	1979	As of December, 1979
Co-ops energized	88	12	100
Towns energized	651	178	829
Barrios energized	6,995	1,823	8,818
House connections	845,137	272,858	1,117,995

Source: National Electrification Administration, 1979 Annual Report

Figure 3-1

Luzon Power Projects

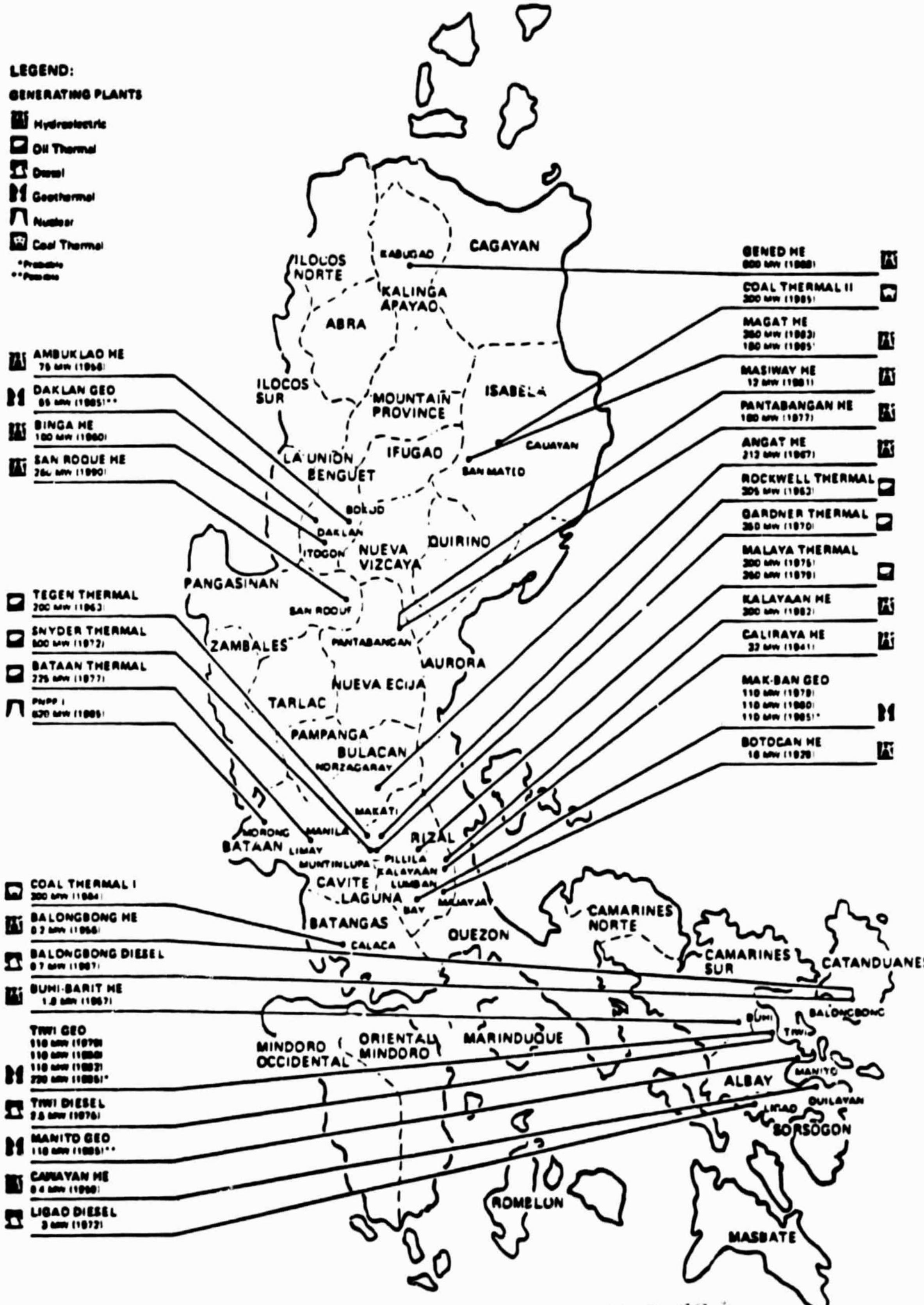

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Figure 3-2

Mindanao Power Projects

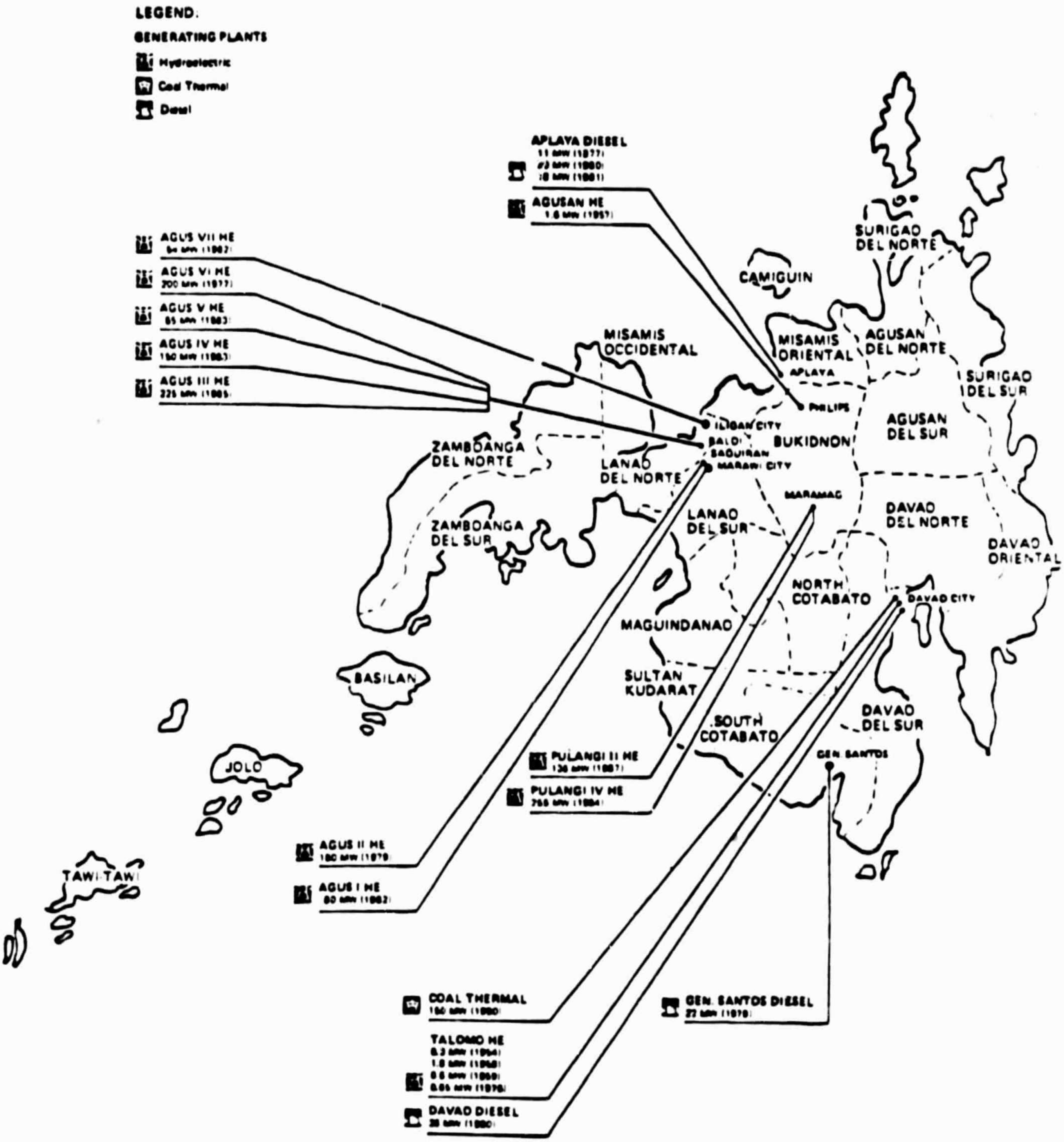

Figure 3-3

Visayas Power Projects

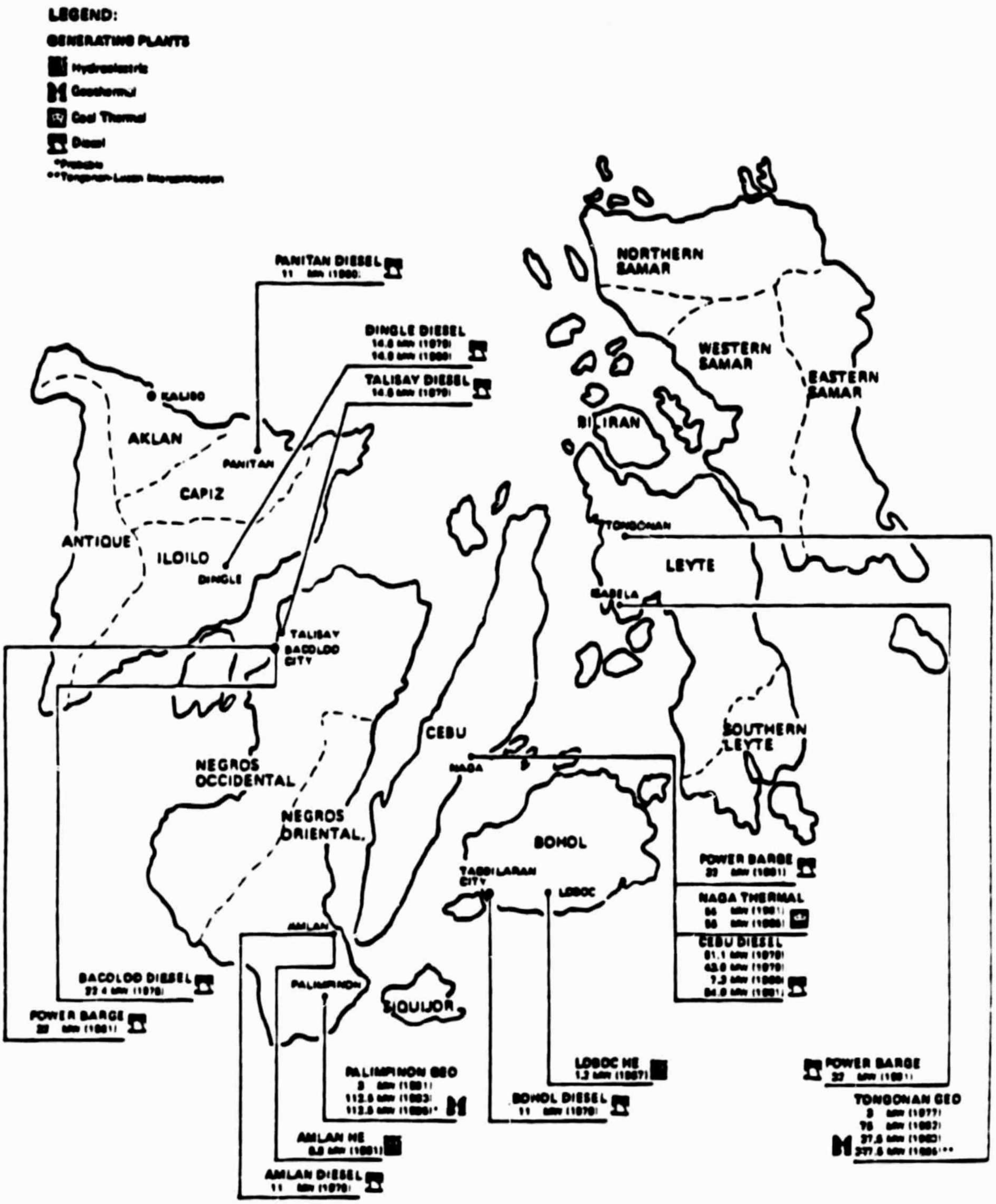

Table 3-3

Rural Electrification -- Costs

Distribution Lines: $1,981 per kilometer

Hookups:	Materials	Labor
Medium-size, 13.2 kv, phase-to phase, backbone type, 150 amp	$4,570	$1,640
Secondary line, 220 volts, single phase, 40-60 amp	1,640	910
Laterals, 220 volts, single phase	2,400	876
	plus $390 service charge	

Cost of meters, etc. per consumer = $40

Transformer per KVA = $28
(typical size is 15 KVA)

Cost to a consumer to join co-op = $0.67
(per year)

Source: Mrs. Santos, National Electrification Administration
Rural Electrification Program

The DHR team was told by NEA that the most consistent problems they faced were maintenance, overloads and illegal connections, and lack of trained manpower for installation and operation. NEA stated that 30 percent of the rural cooperatives operate an average of 24 hours a day, and that some operate only about six hours a day due to the cost of oil.

As already stated, the aim of the government and the power development program is the total electrification of the country by 1985. The country is presently considered to be approximately 45-50 percent electrified. However, almost all of this is in metropolitan areas or towns, and little has reached into rural areas. Of importance to P/V use is that it is necessary to interpret what 100 percent electrification will mean in actual delivery of electrical power to rural areas. The Philippines is using a backbone grid system and plans to connect secondary lines to the backbone at later times. This "100 percent" figure for rural areas means only that the backbone will be in main towns and villages. Many smaller villages, islands, and rural areas may remain unelectrified into the 21st Century. This fact was repeatedly confirmed by the DHR team in discussions in the Philippines.

There are two further facts concerning the meaning of 100 percent electrification that may impact upon the potential P/V market. First, most electrical distribution systems in the Philippines experience numerous breakdowns or brownouts, with resulting unreliable service. This is especially true in the more rural areas. In fact, most of the larger generators sold to industry in the Philippines are intended for use as backup generators. Second, due both to lack of reliability and, in some areas, the high price of electrical power, the DHR team found that some consumers involved in agriculturally related activities who had access to grid power preferred to buy a gasoline or diesel generator.

In summary, P/V systems will have to compete with grid power for those agriculturally-related processes; e.g., rice milling that can be located near the towns or villages that will be connected. However, even in these instances, P/V systems might occasionally be the preferred power source due to unreliability or to the cost of electricity produced by oil-generating plants. The grid will not be accessible to many field operations and to many of the smaller villages, probably until the 21st Century.

3.3 Agriculture

The major crops for which increased production is being strongly supported are rice and corn. Secondarily, programs in cattle development, dairy, and cotton are considered of critical importance, although production of these products has not been increasing as fast as intended. Table 3-4 is taken from the government's development plan, 1978-1982,[5] and indicates the key components of ongoing government programs.

However, there are several important development policies and programs within the government agricultural sector that relate specifically to opportunities for P/V systems. The crops discussed below are chosen due to their importance for P/V applications throughout all production phases of the crop.

- RICE -- Though the Philippines has reached self-sufficiency in rice, a 4.4 percent annual increase in rice production has been targeted for the 1978-1982 period to keep up with population growth and provide an adequate buffer stock. Of more importance to P/V applications is the attempt by the government and farmers to reduce use of fossil fuels and

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[5] "Five-Year Development Plan, 1978-1982".

Table 3-4

Priority Programs and Projects

Program/Project	Description	Implementing Agency
I. Production Programs		
1. Masagana 99	A major rice production program aimed to increase the yield per hectare of palay cropland. The program provides a package of technology consisting of high yielding variety seeds, fertilizer, agricultural chemicals and extension services.	NFAC
2. Palayan ng Bayan	A sister program to Masagana 99 which encourages the conversion of idle and virgin lands to production of staple crops, notably rice and corn.	DA
3. Corporate Farming Program	Primarily meant to augment rice production, the program directed big private corporations to supply their employees with their cereal needs either through direct importation or actual production.	NGA
4. Maisan 77	The program's operational scheme and strategy is patterned after that of Masagana 99. Its scope covers white corn, yellow corn, sorghum and soybeans. The goals are: to meet the requirements of the animal feeds industry and to provide for the growing human and industrial needs.	NFAC
5. Sugarcane Development Program	Designed to make the sugar industry competitive in the world market. The program calls for increased productivity, market diversification strategies, phasing out of sub-marginal sugarcane farms, and mechanization.	PHILSUCOM
6. Coconut Rehabilitation Program	The program involves the planting of new, high yielding coconut hybrids to replace gradually the old variety.	PCA
7. Integrated Cattle Development Program	This program aims at increasing beef production by rationalizing present production techniques. Three types of cattle-raising projects are planned: a) Opening of large-scale ranches (8,000-20,000 hectares) in idle grassland areas. b) Opening medium-sized ranches (500-2,000 hectares) to engage in seed grass production for commercial purposes. c) Promotion of backyard cattle raising/fattening as a supplementary source of income to small farmers.	BAI, LDC
8. Dairy Development Program	The program has the objective of increasing local production of milk and thus reducing yearly importation.	BAI

Program/Project	Description	Implementing Agency
9. Animal Dispersal Program	The main objective is to improve the farmers' capabilities to produce meat by providing them with the necessary animals on credit at liberal terms.	BAI
10. Regional Abbatoirs	The program involves the establishment and rehabilitation of regional abattoirs in strategic areas in the country to achieve economic and efficient production, transport and marketing of meat.	BAI
11. Rehabilitation of Stock Farms	The project is aimed at upgrading the eight stockfarms of the BAI through breeding stock development, pasture development, physical facilities development, and manpower development.	BAI
12. Expanded Fish Production Program	The program aims to accelerate the pace of fish production; to encourage the processing of import-substituting products, e.g. canned fish and fish meal; and to develop and expand exports of fishery products.	BFAR
13. Fruits and Vegetables Production Program	The program focuses more on the proper timing of planting, harvesting, and marketing of produce with the purpose of minimizing adverse effects of seasonality of production and inefficient marketing.	BPI, NFAC
14. Fruit Industry Development Project	The project aims to expand areas planted to indigenous fruits with export potential (mango, papaya, avocado, pomelo) by establishing new plantations, increasing production level and improving the quality of orchards to cope with increasing demand for said fruits.	BPI, NFAC
15. National Cotton Development Program	Basically, the program can be subdivided into: a) agricultural production phase-production of the required volume of seed-cotton over a given targeted hectarage; b) processing and marketing phase-purchase of all seed cotton harvests, processing into lint and seed, and marketing of output to the textile mills.	PCC
II. Marketing and Storage Facilities Programs		
1. DBP Grains Processing and Storage Financing	A program which seeks to develop and rehabilitate warehouses, mills, driers, and other facilities aside from providing part of the capital.	NGA
2. CB-IBRD Farm Mechanization Program	The program lends credit support to facilitate the acquisition of both production and post production facilities such as hand tillers, portable threshers and in-farm type driers.	

Table 3-4 - cont'd

Program/Project	Description	Implementing Agency
3. Grains Post-Harvest Technology Development	An integrated program of research, extension, manpower and skill development, credit, regulation and incentive designed to provide adequate and economic post-harvest facilities and equipment, upgrade and modernize existing facilities and practices, and institutionalize efficient in-farm and commercial processing and marketing techniques in order to reduce post-harvest losses from 15-37% to about 10-20%.	NGA
4. Feedgrains Marketing Program	Aimed to support the current government thrusts on feedgrain production, the program seeks to develop an efficient marketing system through modernization of feedgrain processing facilities, price support and other investment incentives, extension of improved techniques on feedgrains processing and marketing, and integration of all direct and input-supplying activities from feedgrain harvesting up to industrial processing or consumption.	NGA
5. Buffer Stock Maintenance Program	Designed to maintain sufficient stocks of food-grains against unexpected calamities and production lean seasons, the program is being carried out through expansion of government storage capacity of 1.5 million cavans annually, strategic procurement and dispersal, and promotion of quedan system of storage and distribution.	NGA
III. Agrarian Reform Programs		
1. Agrarian Reform Estates Development Financing Program	This program aims to support Samahang Nayons, Area Marketing Cooperatives and other land reform beneficiaries to acquire and operate post-harvest facilities.	LBP
2. Land Settlement Project, Package II	The program is designed to rehabilitate and improve existing settlements. It aims to formulate an integrated program of action for the amelioration of the living conditions of settler families in Quirino, Nueva Vizcaya and Southern Leyte.	DAR

NFAC - National Food and Agricultural Council
NGA - National Grains Authority
PHILSUCOM - Philippine Sugarcane Commission
PCA - Philippine Coconut Authority
BAI - Bureau of Animal Industry
LDC - Livestock Development Council
BFAR - Bureau of Fisheries and Aquatic Resources
PCC - Philippine Cotton Cooperative
DAR - Department of Agrarian Reform

nonrenewable energy in rice production and processing. Improved irrigation and methods of water pumping are a continuing priority. However, there have been increased crop losses recently due to nonuse of powered irrigation, as farmers have not wanted to pay the increased cost of gasoline.

National Grains Authority (NGA) officials stated to the DHR team that, by international standards, about 60 percent of the rice crop is often of lower quality due to inadequate drying. In addition to increasing the number of farmers using dryers, the NGA has instructed their research and development units to attempt to eliminate, wherever possible, the need for fossil fuel in drying and other operations for rice and corn. NGA officials stated that they did not see rural electrification as providing any major help in solving their energy needs in field operations.

- CORN -- Increasing corn production for human consumption is a major emphasis at this time due to a large domestic production deficit, and the resulting importation of about 120,000 metric tons per year. Moreover, the key limiting factor to increasing animal production in the Philippines is the lack of feed grains. Production is targeted to increase by 20 to 25 percent over the next six years. This increased production is meant to reduce the need for imported corn and to increase the availability of corn as an animal feed.

  In the drier areas of the Philippines, corn can be rotated with rice during the dry season, as it requires much less water, even though still needing irrigation. This strategy is being supported by the Ministry of Agriculture and is expected to spread. Also, better post-harvest drying methods are being encouraged because losses are sometimes as high as 80 to 90 percent due to poor drying and infestation during storage. Methods where P/V is applicable are discussed in chapter 5.

- OTHER CROPS -- There are several crops for which P/V does not seem a likely power source in actual production. However, P/V could be utilized in support facilities and at central building complexes on large farms. Sugarcane, bananas, pineapple, and casava are crops in this category. Banana and pineapple production should grow slightly for the export market. Sugarcane and casava may experience more rapid growth in feedstocks for alcohol fuel production. If the Philippine government develops a large alcohol program, then production of these crops will rise dramatically. As yet, however, there is no indication of what increased production is likely to occur.

There are a number of other crops in the Philippines that are either not experiencing increases in production or are not, at this time, likely candidates for P/V system applications in production operations. Among these are coffee, rubber, cocoa, coconut, tobacco, wheat, and cotton.

- **LIVESTOCK PRODUCTION -- Poultry, pork, beef, and dairy are all priority production areas. Government policies support a number of programs aimed at improving production efficiency and increasing the size of operations. This is especially true with poultry and pork operations where the private sector is extremely active in establishing larger and more efficient operations. However, at this time, the number of P/V applications in livestock production seems limited.**

3.4 Fisheries

The fishing industry in the Philippines employs approximately 795,000 fishermen and has been contributing about five percent annually to the GNP. Objectives of the government policy are:

- attain and maintain self-sufficiency in fish;
- optimize the use of fish and other aquatic resources, and reduce wastage;
- promote import substitution and increase the exportation of traditional and nontraditional fish and fishery products; and
- achieve and maintain the optimum productive condition of the country's fishery resources.

The strategies for the exploitation of fishery resources are to:

- increase yields of existing production units in capture fisheries and aquaculture, and selectively expand production units;
- improve the fish marketing and distribution systems to minimize gaps between production and consumption on the local and regional levels, and to retain the quality of fresh fish and fishery products that reach consumers;
- develop processed products from indigenous fishery resources traditionally exported in raw or semi-processed forms;

These goals are from the "Integrated Fisheries Development Plan", Bureau of Fisheries and Aquatic Resources, 1980.

- develop fishery resource-based cottage inductries and other ancillary industries;

- develop local markets for import substitutes, and traditional and nontraditional foreign markets, for fish and fishery products;

- protect the fishery resources from illegal practices of over-exploitation and pollution by both domestic and foreign vessels; and

- promote the use of appropriate technologies for the exploitation and use of the resources.

The highest projected growth rate in fisheries is 10.8 percent for inland fisheries. This estimate is of importance, as the DHR team identified inland fisheries as the most likely part of the fisheries sector for P/V applications. Electricity is presently used (mainly for water pumping and aeration) in hatching operations and in fish ponds to allow for increasing the stocking density. The Bureau of Fisheries and Aquatic Resources has an ongoing inland fisheries and aquaculture development program.

The incremental production in inland fisheries is expected to come from the increased production of existing and additional freshwater and brackish water fish ponds (both government leased and privately owned), fish pond estates in suitable areas, and lake fisheries (including fish pen and cage culture). The major activities designed to realize the targeted incremental production and development of this specific project are fingerling production and dispersal, extension services, research, fish pond development surveys, and training for the private sector.

3.5 Forestry

The major effort in forestry in the Philippines is directed at reforestation, and at managing and protecting the existing forest resources, rather than increasing harvests. Forest resources came under increasingly heavy pressure during the 1970s, and government policy is mainly directed at assuring a long-term production base.

Of particular interest to the energy sector is the development of Ipil-Ipil plantations.[6] The Forest Products Research and Industries Development Commission is involved with the Ministry of Natural Resources regarding wood production research and field production strategies. Initial planting has already occurred. The National Electrification Administration is managing the overall effort of generating electricity using wood-fired plants. Two pilot plants have been initiated: one 500 kw plant and another two to five MW plant. The intended users of this power are rural electrical cooperatives.

[6] Leucaena - Promising Forage and Tree Crops for the Tropics, National Academy of Sciences, Washington, D.C., 1977.

4.0 FINANCING OF ENERGY, AGRICULTURE AND DEVELOPMENT PROJECTS

4.1 Overview of the Philippines Banking/Investment System

The financial system of the Philippines is a network of bank and non-bank financial institutions. The banking sector is composed of the commercial banks, thrift banks including savings and mortgage banks, rural banks, development banks and the savings and loan associations. The non-bank sector includes investment houses, insurance and finance companies, pension and trust funds and pawnshops. The Central Bank of the Philippines regulates the operation of bank and non-bank financial institutions. The banking sector accepts deposits, grants loans, invests in equities, re-discounts papers and acts as trustee. In actual practice, however, each financial institution specializes in certain types of credit service. Complementing the financial system are specialized banks comprising of the Development Bank of the Philippines, the Land Bank, and the Philippine Amanah Bank as well as government non-bank financial institutions like the Social Security System, the Government Service Insurance System, the Agricultural Credit Administration and the National Investment and Development Corporation.

Of the financial institutions mentioned above, six are primarily concerned with investment in energy, agriculture and development projects. These six financial institutions are:

- Commercial Banks which are active in small loans to small and medium industries. These loans are short-term and have high interest rates.

- Savings and Mortgage Banks that grant loans in a similar fashion to commercial banks but cannot engage in foreign exchange trading, nor open letters of credit.

- Rural Banks which are privately owned like commercial and savings banks but receive financial and technical assistance and incentives from the government. Rura' banks primarily provide short-term working capital loans to farmers.

- Land Bank of the Philippines which is owned by the government and is charged with the responsibility of financing the transfers of land from landlords to tenant-farmers as well as redirecting land-owner resources to industry or other productive endeavors.

- Development Banks which usually provide short to long-term financing for productive enterprises on a secured basis. These loans are given to both industry and agriculture. These banks are government owned.

- Non-Bank Financial Institutions which extend financial services to the commercial and industrial sectors of the economy. Financing is short- to long-term in nature.

A more detailed description of the above institutions can be found in Appendix D.

4.2 Attitudes of Financial Institutions Towards Photovoltaics

Interviews with a number of private and government financial institutions representatives were held to assess the attitudes of the financial community towards photovoltaic systems. As a whole there was a general sense of enthusiasm and willingness of high officials to consider photovoltaics systems for loans. At the project staff level,[1/] however, there was a general sense of skepticism as to photovoltaics' applicability in Philippines agriculture. This skepticism appeared to be influenced by the following factors:

- High initial capital cost of photovoltaic systems

- Awareness by project staff that only small photovoltaic systems are currently economical

- Lack of information by project staff on photovoltaics' limitations and advantages

- A belief that photovoltaics will not, in the near future, be able to supply large quantities of power at a low cost

1/ Those technical/economic analysts responsible for evaluating and recommending projects for loans.

- A belief that other energy sources, such as biogas, should be financed before photovoltaics.

Although project staff remained skeptical after being interviewed, there appeared to be a consensus that they would consider photovoltaics as one energy alternative in a project and would finance photovoltaic projects if they proved to be economically and financially viable.

4.3 Availability of Long-Term Investment Funds

In the Philippines, investment funds can be categorized into medium- and long-term loans (2 to 5 years for medium-term loans and 5 to 15 years for long-term loans) and short-term loans (less than 2 year loan periods). Due to high inflation rates and rapidly changing interest rates most of the capital loaned by commercial and savings banks tend to be short-term in nature. Capital loaned by the development banks, both private and government owned, rural banks, and the Land of Bank of the Philippines tend to be in the form of medium and long-term loans. Of these long-term lending institutions, only the private and government development banks, and non-bank financial institutions as a rule issue long-term loans for fixed assets in excess of ₱50,000. Rural banks typically issue small working capital loans while the Land of Bank of the Philippines finances primarily land transfers from owners to tenants.

Capital for long-term loans by the development banks is usually borrowed from either the central banks of donor countries, bilateral aid agencies such as the United States Agency for International Development, multilateral aid agencies such as the World Bank and Asia Development Bank, or export financing banks such as the U.S. Export-Import Bank. As Table 4.1 illustrates, the Development Bank of the Philippines total long-term Foreign Borrowings amounted to over $992 million in 1979. Of this total, loans directly from the United States or agencies financed by the United States totaled $337 million or nearby one third of total foreign borrowings.

Table 4.1 Long-Term Foreign Borrowings from USAID, World Bank, Export-Import Bank, U.S. Commodity Credit Corporation, and Asia Development Bank for the Development Bank of the Philippines

Foreign Borrowings	
Total Long-Term Foreign Borrowings	$992,279,653
U.S. AID 4½% US$ loan, due 1968-1988	4,860,869
U.S. AID 3½% US$ loan, due 1974-1994	3,460,000
Export-Import Bank of the US, 6% US$ loan due 1974-1984	54,965,158
U.S. Commodity Credit Corporation, 8% to 10% US$ credit, due 1975-1981	105,938,000
IBRD, through Philippine Government 7¼%, due 1979-1992	48,000,000
IBRD, through Philippine Government, 8% due 1978-1992	20,000,000
IBRD, through Philippine Government 7½%, due 1981-1995	50,000,000
IBRD, through Philippine Government 8½%, due 1980-1993	50,000,000
TOTAL U.S. BORROWING	$337,224,027

Table 4.2 illustrates the relative size of total loans and investments outstanding of the major Philippine financial institutions. Commercial banks accounts for 72% or over ₱59 billion of outstanding capital in the Philippines as of June, 1978.* The next largest category in terms of loans outstanding are the development banks with 17% or over ₱14 billion in investments. All remaining institutions total 10% of the outstanding loans and investments or 9.1 billion. Of loans made by commercial and savings banks in March of 1976, 69% or over ₱9 billion was for short-term, working capital loans and only 1% or ₱126 million of all loans were long term. In contrast, nearly all of the capital lent or outstanding by the development banks was in the form of medium and long-term loans for fixed assets.

Of the available long-term capital of ₱6085.2 billion in 1977, ₱731.5 million (approximately $100 million) or 12% was loaned for agricultural, fisheries or forestry projects. The development banks accounted for 91% or ₱663.9 million ($90 million) of these funds with the Development Bank of the Philippines (DBP) issuing more than 95% of the loans granted by this group (Table 4.3).

In examining the DBP's 1979 lending program, ₱424.4 million or 29% of the total ₱1.47 billion loaned in 1979 was granted to the domestic agricultural sector and ₱277 million was loaned to foreign agricultural projects**. The majority of agricultural loans were for land preparation/

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* Exchange rate is 7.41 pesos to 1 U.S. dollar.

** Foreign agricultural projects are those investments undertaken by the DBP in other countries.

TABLE 4.2

TOTAL LOANS AND INVESTMENTS OUTSTANDING BY INSTITUTIONS (June, 1978)

Institution	Amount (Million)	Percent Distribution
Commercial Banks	59,281.5	72.0
Rural Banks	5,660.1	7.0
Development Banks	14,390.5	17.0
Savings Banks	2,702.9	3.0
Private Non-Bank Financial Institutions	170.2	0
Government Non-Bank Financial Institutions	621.3	0
Total	82,870.3	100

Source: Philippine Yearbook-1979, Republic of the Philippines National Economic Development Authority, October, 1979.

TABLE 4.3

Loans Granted by Development Banks By Industry (1977) (Million Pesos)

Institution	Agriculture, Fisheries and Forestry	Mining and Quarrying	Manufacturing	Contract Construction	Real Estate	Public Utilities	Service	Government
Development Banks[1]	663.9	735.2	831.5	11.7	123.6	350.2	224.0	79.6
Government Non-Bank Financial Institutions[2]	40.1				579.3	20.9		
Private Non-Bank Financial Institutions[3]	27.5				172.3	9.7		
Total	731.5				875.2	380.8		

1) Includes private development banks

2) Loans granted also include ₱893 million for consumption and ₱40 million for industry.

3) Loans granted include ₱46 million for commerce, ₱305.3 million for industry and ₱141 million for consumption.

Source: Philippine Yearbook-1979, Republic of the Philippines, NEDA, October, 1979.

project site improvements, and the purchase, installation and repair of machinery and equipment (Table 4.4).***

4.4 Availability of Long-Term Investment Funds for Photovoltaics Systems in Agriculture

For the most part, photovoltaic systems, due to their high initial capital cost, will require long-term capital financing. The previous section estimated the amount of available, long-term investment capital in the Philippines in 1977 to be approximately ₱6085.2 billion of which ₱731.5 million was allocated to agriculture (both foreign and domestic). In 1979, the DBP loaned ₱424.4 million ($60 million) for domestic and ₱277 million ($31 million) for foreign agricultural projects. In contrast, the long-term loans given to cooperatives for rural electrification in 1979 amounted to ₱917 million ($125 million). These figures indicate that the amount of long-term capital is small and would not be available to finance large purchases of photovoltaic systems. It is clear that long-term financing photovoltaic systems in agriculture would fall under the lending program of the DBP due to the institution's major contribution to the long-term capital market in the Philippines. Commercial and savings banks, although the largest source of capital in the Philippines, would be interested primarily in short-term working capital loans for low-risk, familiar, technologies. This preference tends to work against photovoltaic systems. The amount of long-term capital available for agricultural projects appears to have been less than $60 million in 1979. How much this figure will increase in the next five years would depend on the development priorities of the Philippines and the ability of the nation to borrow long-term capital abroad. Assuming that agricultural lending

*** Note that the best data available on entire banking system's long-term capital loans is dated 1977. Data on the DBP's lending is more recent, dating to 1979. Both sets of data are used in this section and dates are given when appropriate.

TABLE 4.4

DISTRIBUTION OF DBP AGRICULTURAL LOANS BY PURPOSES*

Purpose	Loans (₱)	Percent Distribution
Land preparation/project site improvements	228,212,788	33
Purchases of stocks/planting materials	49,291,351	7
Purchase of work animals	30,636,389	4
Purchase of irrigation pumps	3,303,117	0
Purchase of fertilizers	20,624,834	3
Operating and revolving capital	31,589,992	5
Purchase of delivery and transport equipment	16,539,058	2
Purchase, installation and repair of machinery and equipment	221,061,464	32
Purchase and repair of fishing vessels, boats and equipment	29,086,464	4
Others	71,046,819	10
Total	₱701,392,245	100

*Includes foreign loans.

Source: 1980 DBP Annual Report.

increases 10% per year for the next five years, there will be only $100 million of long-term capital available for domestic agriculture in 1985.

Although energy projects do have a priority in the DBP's lending program and will likely be as important in the next five years as they are today, the likelihood that long-term loans will be given by the DBP for photovoltaics remains small for a number of non-financial reasons including:

- Lack of information on photovoltaics by potential applicants for loans.
- High initial capital costs for photovoltaic systems requiring very large loans for relatively small systems in terms of power output.
- Competition with other energy sources such as biogas and biomass, alcohol, mini-hydroelectric, etc., which are relatively low-cost and familiar to the Filipinos.

It is DHR's opinion for the above reasons, that the total amount of long-term capital that would be available for photovoltaic systems would be very small. Therefore, innovative financing schemes by either photovoltaic manufacturers or U.S. and Philippine financial institutions may be needed to promote American photovoltaic systems in the Philippines.

4.5 Loan Terms for Long-Term Investments

To provide some indication of the terms that photovoltaic systems will encounter in receiving long-term loans, this section presents a sample of the loan terms for long-term loans currently being given to applicants by long-term financing institutions. Three types of financial institutions were considered: The Development Bank of the Philippines, the Private Development Corporation of the Philippines (a private, non-bank financial institution) and the Industrial Guarantee and Loan Fund (a government, non-bank, financial institution) (see Table 4.5).

TABLE 4.5

LONG-TERM, LOAN TERMS FOR SELECTED FINANCIAL INSTITUTIONS

Terms	DBP	PDCP	IGLF	Rural Electrification
Interest Rate	12%-14%	12%-14%	12%	2% Power Generation Co-ops 3% NPC Connected Co-ops
Debt-Equity Ratio	85:15	N/A	80:20 (90:10 for depressed areas)	
Collateral Loan Values	90% on Titled Real Estate; 80% on Chattel	N/A	Guarantees on Non-Collateral Loan Portion	
Maturity/Repayment	10 Years-Fixed Assets	4-15 Years	3 Years-Working Capital 10 Years-Fixed Assets	25 Years with a 5 Year Grace Period
Loan Range	₱100,000-₱1,000,000*	₱50,000-₱1,000,000	₱50,000-₱500,000	

*Loans above and below these amounts are available.

N/A = not available
DBP = Development Bank of the Philippines
PDCP = Private Development Corporation of the Philippines
IGLF = Industrial Guarantee and Loan Fund

Interest rates for long-term loans ranged between 12%-14% for all three institutions. These interest rates are substantially lower than those offered by the commercial and savings bank sectors (20%-22%), but are substantially higher than rural electrification loans (2%-3%). Maturity time for loans is short---a maximum of 15 years on fixed assets compared to 25 years for rural electrification loans.*

4.6 Conclusion

The Philippines has an extensive financial network composed of both private and government owned financial institutions. The majority of investment funds are controlled by the privately owned commercial and savings bank sectors. These funds are available as short-term working capital loans primarily invested in industry, consumption, commerce, real estate and public utilities. Long-term investment capital amounts to ₱6085.2 billion ($832 million). In 1977, of this amount ₱731.5 million ($100 million) was loaned to the agricultural sector. The Development Bank of the Philippines is the major source of long-term capital for agriculture. DHR estimates that only a small part of this capital will be available for financing photovoltaic systems. This lack of capital may be a significant barrier to the marketing of photovoltaic systems.

Considering that private venture capital in the Philippines tends to be short-term and loans have high interest rates, there appears to be few alternatives to the development banks as a source of low interest, long-term loans.

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* Note that another potential barrier to the financing of P/V systems is related to the method used in estimating the costs/benefits of P/V and alternatives. These methods are discussed in Section 6.2, The Need for Economic and Financial Analysis.

American photovoltaic manufacturers or distributors will have to either focus part of their marketing efforts on convincing these institutions that photovoltaics are economically and financially viable and worthy of long-term loans, or introduce innovative financial schemes to promote the sales of photovoltaic systems.

5.0 POTENTIAL PHOTOVOLTAIC APPLICATIONS IN PHILIPPINE AGRICULTURE

The major portion of data gathering activities in the Philippines were dedicated to the identification and characterization of potential P/V applications in agriculture. Those applications that were identified as possible candidates for P/V power systems were evaluated by:

- Level of production/importance of crop in the Philiipine agriculture;
- Type of operation and its ability to use a P/V power source;
- Extent of use of operation in the Philippines;
- Extent of current level of mechanization of the operation;
- Size of the power required (less than 15KW capacity).

This evaluation process identified a variety of applications such as: irrigation of rice, corn and sugarcane; piggeries; rice hulling; corn shelling and grinding; and fish refrigeration that represent high P/V use potential in the Philippines. The specific agricultural operations identified are described in later sections of this chapter and include:

- Irrigation
- Rice Drying
- Rice Hulling
- Corn Milling
- Continuous Cropping of Rice
- Ice Plant for Fish Preservation
- Fish and Shrimp Hatcheries
- Maintenance Facilities for Large Farms
- Forestry Stations
- Salt Ponds
- Miscellaneous Battery Charging Applications

The list of applications characterized covers a wide range of power requirements (20W to 12KW capacity), diverse load profiles and varying operating environments.

They also represent a potentially large market for P/V systems if cost and other barriers are overcome. It is very likely that many other allied applications would fall within the operating characteristics described in this chapter.

5.1 Irrigation

Currently, there are 3 million hectares (ha) of rice in cultivation of which 1.3 million hectares are irrigated by developed water resources. Current government policy calls for irrigating the remaining 1.7 million hectares at the rate of 100,000 hectares per year.[1] Other crops requiring irrigation are:

- Vegetables -- These are mainly quarter to half acre plots farmed by tenant or owner farmers. The vegetable plots are irrigated manually and require about one to two man-hours per day. Due to the subsistance nature of this group of farmers, it is unlikely that they would be a possible P/V system user.

- Commercial Crops (sugarcane, pineapple, etc.) -- Generally, these are irrigated by means of high volume and/or high pressure irrigation systems. They often use 6-10 inch pumps driven by 50-150hp diesel or electric motors. Thus, it is unlikely that in the near-term photovoltaic pumping systems could replace these large pumps.

- High Value Cash Crops in the Upland Areas -- These require less water per hectare than rice, but a higher pumping head (up to about 50m to 60m) is needed. Photovoltaic powered pumps could be appropriate for irrigating these crops.

Farmers participating in large irrigation schemes use small pumps for pumping water from the irrigation channels to the fields. Irrigation water is also supplied by pumps from ground water. The most common pumps size in use is the 4" diameter and smaller discharge, and typical pumping heads range from

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[1] Estuar, Dr. Fiorello, Administrator, National Irrigation Administration. The majority of the irrigation schemes (80%) are and will be gravity fed, while 10% will employ large pumps of the order of 100-500hp, irrigating 100-300ha. These irrigation schemes are undertaken by the National Irrigation Administration. The remaining 10% are small irrigation pumping schemes (less than 100ha), falling under the jurisdiction of the Farm Systems Development Corporation.

5m to 50m, with the average around 15m[2]. Although the average rice field size is 2ha, most small pump installations (about 45%) service about 6-8 ha, which suggests that some pumps are used by groups of farmers.[3]

In recent years, due to the ever increasing cost of gasoline and diesel fuels, many farmers have drastically reduced the use of small pump irrigation. This has resulted in lowered crop productivity and financial distress for the farmers. Thus, a cost-effective source of power independent of conventional fuels would be looked upon favorably by not only the farmers but also the rural and development banks who have recently been faced with high default rates on working capital loans to farmers.

5.1.1 Irrigation Load Profiles

Crop irrigation load profiles depend on rainfall. There are four distinct climatic zones in the Philippines.[4] They are:

- First type: Two pronounced seasons; one dry from November to April, the other wet during the rest of the year. All the regions on the western part of the Islands of Luzon, Mindoro, Negros and Palawan are of this type.

- Second type: No dry season; with a very pronounced maximum rain period from November to January. In this class fall Catanduanes, Sorsogon, the eastern part of Albay, the eastern part of Leyte and a large portion of eastern Mindanao.

- Third type: Seasons not very pronounced; relatively dry from November to April and wet drying the rest of the year. The maximum rain periods are not very pronounced with the short dry season lasting only from one to three months. Regions with this type of climate are the western part of Cagayan (Luzon), Isabela, Nueva Vizcaya, the eastern portion of the

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[2]NIA, unpublished data on small pump characteristics.

[3]These refer to pumps installed through NIA financing. Privately purchased pumps may supply the needs of individual farmers.

[4]For more information see: Kintanar, R.L., Annual Climatological Review, 1974. Philippine Atmosphere, Geophysical and Astronomical Services Administration (PAGASA), March 5, 1980.

Mountain Province, southern Quezon, Masbate, Romblon, northeast Panay, eastern Negros, central and southern Cebu, part of northern Mindanao, and most of eastern Palawan.

- Fourth type: Rainfall more or less evenly distributed throughout the year. The regions affected by this type are the Batanes Province, northeastern Luzon, the southwestern part of the Camarines Norte, the western parts of Camarines Sur and Albay, Bondoc Peninsula, eastern Mindoro, Marinduque, western Leyte, northern Cebu, Bohol and most of central, eastern and southern Mindanao.

Typical growing seasons for various crops within each of the growing seasons can be found in the Philippines Agriculture Factbook and Buyers Guide.[5]

Table 5.1 shows typical irrigation water requirements for rice and corn cultivation in Laguna, which is located in central Luzon, a major rice growing area in the Philippines. Only double cropping of rice and corn are presented in this table.

5.1.2 Extent of Mechanically Powered Pumping

Small pumps, powered by diesel and gasoline engines, are purchased directly by the farmers. Financing is through agencies such as NIA, FSDC, the development or rural banks, or self-financed.

Table 5.2 shows data on Philippine pump sales as recorded by AMMDA[6] as well as pumps installed using NIA financing. A majority of the pumps sold are 4" pumps with a 10m to 20m total dynamic head (TDH). They are coupled to a 5-10hp gasoline or diesel engine depending on the TDH requirements. Table 5.3 shows the distribution of pumps by size. AMMDA estimates that demand for irrigation pumps of all sizes should average about 3500 units/year for the next five years.

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[5] Second Edition, Copyright 1979, published by Philippine Almanac Printers, Inc.

[6] Agricultural Machinery Manufacturers and Dealers Association.

Table 5.1

IRRIGATION WATER REQUIREMENTS FOR SELECTED CROP GROWTH REGIME IN LAGUNA

(in mm/month)

Crop Regimen	Rice Double Crop[1] - 1 HA				Rice Double Crop and Corn One Crop[2] - 1 HA			
Water Required mm/month	Evapo-transpiration	Effective Rainfall	Seepage and Percolation	Gross Irrigation Water Requirements	Evapo-transpiration	Seepage and Percolation	Effective Rainfall	Gross Water Requirements
Month								
January	66	22	56	166	66	56	22	166
February[3]	-	-	-	-	112	-	20	153
March[3]	-	-	-	-	150	-	27	205
April[3]	-	-	-	-	174	-	30	240
May[3]	-	-	-	-	75	-	51	40
June	156	128	112	233	156	-	128	233
July	138	128	112	204	138	112	128	204
August	135	144	112	172	135	112	144	172
September	61	69	56	80	61	112	69	80
October	132	147	112	161	132	112	147	161
November	109	151	112	117	109	112	151	117
December	110	96	112	211	110	112	96	211

Notes

1. Rice first crop from June to September, Second crop from October to January
2. The above rice crop season plus corn from February to May
3. Rice is not grown from February to May

Assumptions

a. Evapotranspiration equals pan evaporation for rice (M.M Aqua, et al. Water Use Patterns in Different Scales of Pumped Irrigation Systems - International Rice Research Institute, Typescript).

b. Evapotranspiration for corn is 0.72 times that of rice (0.72 = consumptive coefficient for corn (0.75 - 0.85)/consumptive coefficient for rice (1.0 - 1.2)).

c. Effective rainfall is 100% in dry season and 54% in wet season (Aqua, M.M. et al.).

d. Power requirements calculations assume 15m head, 70% pump efficiency, 80% motor efficiency. See DMA, Inc. Phase I Report, Volume IV Page P-15.

e. Rainfall and pan evaporation data from Weather and Climate Data for Philippine Rice Research, IRRI Research Series, No. 41, November 1979.

f. Irrigation efficiency is 60%.

TABLE 5.2

NUMBER OF PUMPS SOLD AND INSTALLED IN THE PHILIPPINES

	As of June 1975	1976	1977	1978	1979	Jan-Sept 1980	Total Installed As of 1978
Financed via NIA	16,582	1422	1464	1641	N/A	N/A	21,109
AMMDA Sales	N/A	N/A	N/A	4331	4106	1612	40,000[a]

a) DHR estimate

Source: AMMDA, NIA unpublished data.

TABLE 5.3

DHR ESTIMATE OF IRRIGATION PUMP SIZE DISTRIBUTION

Pipe Diameters	Percent Distribution of Sales	Typical Engine Size (HP)	Total Pumps Installed As of 1978
2" x 2"	25	3-5	10,000
3" x 3"	10	3-5	4,000
4" x 4"	50	5-10	20,000
greater than 5" x 5"	15	7-16	6,000

Source: Based on data from AMMDA, NIA and several other miscellaneous sources.

Based on our observation and discussion, we found that farmers in general have over-sized pumping units when compared to their water demand TDH requirements. This is due to current water management practices and to the popularity of certain engine/pump sizes. It is likely that smaller pumps could be used, but the farmers must be convinced that the smaller pump is appropriate before P/V systems could be considered as an alternative power source.

5.2 Rice Drying

In 1979, the Philippines had approximately 10,000 MT/day of mechanical drying capacity.[7] The ownership pattern and average daily capacities per unit were as follows:

National Grains Authority	-- 30% (3.5 MT/day)
Private	-- 20% (15 MT/day)
Industry	-- 50% (6 MT/day)

The majority of the dryers are batch type, with oil fired furnances and gasoline or electrically powered fans. Given the limited national dryer capacity, it is very likely that only 15 to 25 percent of the annual rice harvest (7 million MT in 1979) is mechanically dried. The remainder is sun-dried. Currently, post harvest losses are high due to inadequate drying. With the increasing popularity of rice multi-cropping, the need for mechanical dryers will increase further due to the need for drying during the wet season.

The International Rice Research Institute has developed small capacity batch type dryer configurations which would be compatible with small P/V power systems. Their characteristics are shown in Table 5.4. The most probable P/V powered configuration of the dryer would be one with an electrically

[7] National Grains Authority, "National Drying Situation," unpublished typescript.

TABLE 5.4

IRRI VERTICAL BIN BATCH DRYERS CHARACTERISTICS

	IRRI MODEL I	IRRI MODEL II
Capacity	2MT per 4 to 6 hours	1MT per 5 to 6 hours
Power	3hp electric motor or 5hp gasoline engine	2hp electric motor or 3hp gasoline engine
Fuel Consumption		
Engine	1.5 liters gasoline/hour	0.75 liters gasoline/hour
Burner	2.7 liters kerosene/hour	2.0 liters kerosene/hour, or 3-4 kg rice hulls/hour*

*Model II can use either a kerosene burner or a rice hull furnace. (One ton of paddy provides approximately 200 kg of rice hulls, sufficient for 50 hours of drying (10 tons of rice)).

Source: Agricultural Engineering Department, The International Rice Research Institute, Manila, Philippines.

driven air circulator and a rice hull fueled combustor. The purchaser of one of these units would most likely be a farmer, who in addition to drying his own grain would dry the grain of neighboring farmers for a fee. It could also be purchased by a group of farmers.

Given the intermittent use of the dryer throughout the year, it is most unlikely that a P/V array, fully dedicated to running the dryer fan, could be economical. The most likely configuration would be the use of a dryer along with a farm irrigation system.

5.2.1 Rice Drying Load Profile

Assume a farmer with two hectares under rice, and 2 MT/ha yield, purchases the dryer. He could use the Model II dryer for four days after harvest to dry his grain. If he double-crops in Luzon or Visayas, he would use it for eight days per year. The total electricity consumption would be approximately 35 kwh/harvest, and the power requirements would be about 1.5 kw (capacity).

5.2.2 Extent of Mechanically Powered Drying

Table 5.5 shows the numbers of dryers installed up to 1979. These account for drying only a small portion of the annual rice production. Sales of dryers in 1978 and 1979, amounted to 63 and 73, respectively.[8] Sales in the first three quarters of 1980, totaled 46. AMMDA estimates that future sales of flat type dryers and circulating type dryers to average about 580 and 80 per year for the next five years, respectively. If all rice were to be mechanically dried, the number of dryers required for the 1979 rice crop would be 20,000[9] with a total capacity of 70,000 MT/day. This can be compared with the current capacity of 10,000 MT/day, or the probable capacity in 1985 of about 22,000 MT/day.

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[8] Source: AMMDA

[9] Assumes 3.5 MT/day drying capacity and 100 drying days/year per dryer.

Table 5.5

NUMBER OF RICE DRYERS INSTALLED AS OF 1979

Ownership	Number of Dryers	Capacity MT/day (12-Hour Operation)
National Grain Authority	875	3,083
Private	156	2,059
Industry	919	5,443
TOTAL		10,585

Sou e: National Grain Authority, "National Drying Situation".

5.3 Rice Milling

Over 99 percent of the 1979 milling operations are privately owned and operated. Two major types of milling machines in use in the Philippines are:

- The Steel Huller -- This is the most popular type of machine currently in use. Various sizes are available ranging from 200-300 kg/hour to 600-800 kg/hour models. Power requirements range from 3 hp to 10 hp (electric)[10]. They account for over 95% of rice mills installed, but only 57% of the rice-milling capacity.[11]

- The Cone Type Mills -- These account for less than 5% of the rice mills installed, but mill about 43% of the rice. The average capacity of a mill is about 600 kg/hour and the power requirements range from 10 hp to 40 hp (electric).[11]

Generally, the mills are powered by diesel engines. A recent study[12] found that an average of 11 hp is required to drive steel huller mills, while cone type mills average 42 hp. Cone type mills are generally located near the main throughfares and in towns away from the main source of paddy. In contrast, steel huller mills are found in rural areas near the main source of paddy. This mill type is often household oriented, serving primarily the needs of consumers living within the village.

5.3.1 Rice Milling Load Profile

Rice mills are operated continuously throughout the year. However, the intensity of use varies from month to month, with peaks coinciding with the planting months.

A recent study[12] showed that the steel hullers were utilized an average

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[10] Source: Polygon Agro-Industrial Corporation, Manila, Philippines.

[11] National Grain Authority, "National Milling Situation", unpublished typescript.

[12] "The Technical and Economic Characteristics of Rice Post-production Systems in the Bicol River Basin." The Processing Engineering Dept., Institute of Agricultural Engineering and Technology, University of The Philippines at Los Banos, November, 1978.

of 26% of rated capacity and cone type mills an average of 64% on a monthly basis. Table 5.6 shows the capacity utilization rates by type and capacity for the Bicol River Basin area for rice milling operations.

5.3.2 Extent of Rice Milling

Table 5.7 shows the milling capacity as of 1979. While there has been a significant increase in milling capacity, there is still a milling shortfall that has to be met. AMMDA estimates that the sales of the smaller steel hullers to average about 4,000 units per year for the next five years. Sales of the cone type machines are expected to average about 70 per year. Rubber roll type huller sales are expected to average around 700 per year.[13]

5.4 Corn Grinding

Corn is the second largest single crop produced in the Philippines. The production in 1979 amounted to 3.2 million metric tons, representing an average annual increase of about 5.5% since 1977. The area under corn, however, has been fluctuating around 3.3 million hectares during this time period.[14] Two types of mills predominantly used in the Philippines are:

- Grinders -- capacity range: 100-500 kg/hour; average capacity: 200 kg/hour; typical power requirements: 3 hp electric motor, 5 hp diesel engine, or 6-8 hp gasoline engine.

- Roller Mills -- capacity range: 500-3650 kg/hour; average capacity: 1200 kg/hour; typical power requirements: 15 hp electric motor, 25 hp diesel engine, or 35 hp gasoline engine.

A recent study[15] indicated that on the average a grinder mill processes about 40,000 kg/month of corn. The regional variation in processing load

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[13] These are similar in power requirements to the steel hullers.

[14] Bureau of Agricultural Economics, Summary of Agricultural Production, 1977, 1978, and 1979, unpublished transcript.

[15] Almeda, J.P. and Caddaro, R.A., "Milling Costs and Recovery Rates of Palay and Corn in the Philippines, 1976." Economics Research Report, 1979 series, Number 7, Bureau of Agricultural Economics.

Table 5.6

RICE MILL USAGE PATTERNS

Hours of Usage/Day

Mill Type:	Steel Huller				Cone Type			
Power HP (diesel)	7	10	16	Aver. 11	18	37	61	Aver. 42
Rated Capacity kg/12 hr.day	1300	1300-2500	2500	1500	3550	3550-9500	9500	4000
MONTH								
January	3.1	1.4	2.6	2.2	5.0	5.5	7.0	6.5
February	3.4	1.4	2.6	2.2	5.0	3.4	6.5	5.8
March	3.1	2.9	3.1	8.6	5.0	5.8	10.3	8.9
April	4.6	3.4	5.5	4.6	5.0	9.8	11.5	10.6
May	4.3	2.9	5.3	4.3	5.0	9.8	8.6	8.4
June	2.9	1.4	3.1	2.4	5.8	3.4	6.5	5.8
July	2.6	1.0	2.6	2.2	5.5	5.5	6.5	6.0
August	2.6	1.2	2.2	1.9	5.5	5.5	6.5	6.0
September	4.6	2.4	3.4	3.1	4.1	4.6	6.7	6.2
October	6.2	3.1	6.0	5.0	4.1	9.8	12.0	10.8
November	4.8	3.1	5.3	4.3	4.1	9.8	12.0	10.8
December	3.1	1.7	3.4	2.6	3.5	6.7	9.1	8.2
Monthly Average	3.6	2.2	3.8	3.1	4.8	6.7	8.6	7.7

Source: Calculated from data in Process Engineering Department, op.cit.

Table 5.7

1979 RICE MILLING CAPACITY

Ownership	No. of Mills	Milling Capacity (MT/12 hr. day)
National Grain Authority	66	17,220
Industry	15,396	1,725,236

Source: National Grain Authority, Unpublished Typescript, 1980.

varies from a low of 13,000 kg/month to 142,899 kg/month. Roller mills process about 190,000 kg/month of corn. The regional variation in processing load for roller mills ranges from 33,000 to 450,000 kg/month.

5.4.1 Corn Milling Load Profile

Corn mills operate throughout the year on an as-needed basis. There is some degree of monthly utilization rate variation, but details on the month-to-month variation are unknown. Table 5.8 shows the operation characteristics for each type of mill.

5.4.2 Extent of Use of Corn Milling Equipment

Discussions with agricultural machinery dealers indicate that about 80% of the corn mills are the grinder type. Thus, an estimate of the total number of corn grinders in use in 1979 is about 2700 and the number of roller mills is about 700.[16]

AMMDA expects sales of corn grinders to average around 550 per year for the next five years. The sales of corn roller mills are expected to average about 60 per year for the next five years.

5.5 Continuous Cropping of Rice

Continuous cropping of rice ("rice garden") is a new rice production system currently under investigation by the International Rice Research Institute (IRRI) in Los Banos, Philippines. Presently, it has not been introduced as a general agricultural practice. It has certain energy use characteristics that make it ideally suited for P/V systems use. In this technique, rice is continuously cultivated and harvested, resulting in four harvests per year. IRRI may soon introduce this technique to the farming community in the Philippines

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[16] Assumed 80% of the corn is machine ground; 422,400 kg of corn is ground by one grinder in a year (i.e., 200 kg/hour x 8 hours/day x 22 days/month x 12 months/year); 2,073,600 kg of corn is grounded by one roller mill in a year (1200 kg/hour x 6 hours/day x 24 days/month x 12 months/year); and 80% of the mills are the "grinder" type.

TABLE 5.8

CORN MILLING OPERATING CHARACTERISTICS

	Hours/Day			Corresponding Days/Month		
	Low	Average	High	Low	Average	High
Grinder Mills	3	8	14	16	22	23
Roller Mills	3	6	13	20	24	28

Source: Calculated from data in Almeda, et.al., op. cit.

and other rice growing countries around the world, with the hope that it could provide an effective means in increasing worldwide rice production.

For a typical rice garden of about 1 hectare, the land is divided into 13 rice paddies of approximately 800 m^2, and four seed beds of 25 m^2 each. Each plot is sequentially cultivated, planted, and harvested in a weekly schedule. The principle behind the sequential operation is that by the time the 13th plot is cultivated, the 1st plot is ready for harvest and re-planting. Thus, four crops/year are possible per hectare compared to the current Philippine average of about 1.1 crops/year/hectare.

The advantages of the rice garden technique are:

- Seasonal labor peaks are dispersed into constant year-round labor use that generate employment opportunities throughout the year;
- Risk of insect attack or weather damage is minimized because rice in each plot is in a different stage of growth; and
- The continuous flow of cash from weekly sales allows the farmer to finance the farm operation himself and eliminates the need for financing.

On the other hand, the continuous production system has rather stringent requirements for successful implementation, such as:

- Control over a dependable year-round water supply is essential.
- Rice in all stages of growth in a small area, and the continued use of insecticides, may bring about insect resistance to insecticides quicker than in other less intensive systems.
- A high degree of management ability by the farmer is needed.

Rice farmers may also face resistance from laborers or neighbors if they try to modify their rice farming to use the continuous system.

Typical equipment needed for a successful rice garden operation includes: 6.5 hp tiller, 5-7 hp small thresher, small grain dryer, and an irrigation pump. The latter is needed if a dependable year-round, gravity fed water supply is unavailable.[17]

5.5.1 Rice Garden Load Profiles

The compatability of the rice garden method with P/V power systems is due to the need for a year-round supply of irrigation water which closely matches the solar insolation levels which are greatest during the dry months. Table 5.9 shows the monthly water requirements for a 1 hectare rice garden. Water requirements are the most important parameter defining monthly energy requirements.

5.5.2 Extent of Use of Rice Gardens

Currently, the rice garden method is an experimental technique. It is about to be publicized worldwide by IRRI. If the worldwide rice growing community begins to accept this new technique, then the identification of P/V with rice garden method could result in the opening-up of a large market for P/V powered irrigation systems.

5.6 Ice Plant

The small ice plant is an innovative technology developed by Schultz Industries with the technical assistance of the Technology Utilization Support System (TUSS) of the Technology Resource Center (TRC) in the Philippines. It is one of several improved technologies being promoted by the TRC for commercial utilization. The ice plant answers the need of countryside farmers and fishermen for a reliable source of ice and refrigeration. It is ideal for rural areas and fishing villages too small or too remote to be serviced by large ice plants. In such villages, ice has become a very expensive and scarce commodity.

[17] For more information see:

Morooka, Y., Herdt, R.W. and Haws, L.D., "An Analysis of the Labor-Intensive Continuous Rice Production System at IRRI." The International Rice Research Institute, Research Paper, Series No. 29, May, 1979.

Morooka, Y., Masicat, P., Cordova, V. and Herdt, R.W., "Aliwalas to Rice Garden: A Case Study of the Intensification of Rice Farming in Camerines Sur," Philippines, IRRI Research Paper, Series No. 36, August, 1979.

The Rice Garden Handbook, unpublished typescript.

TABLE 5.9

IRRIGATION WATER REQUIREMENTS FOR CONTINUOUS CROPPING OF RICE*

MONTH	Water Requirements (mm/month)			
	Evapotranspiration	Seepage and Percolation	Effective Rainfall	Gross Water Requirements
January	132	112	44	333
February	156	112	20	413
March	209	112	27	491
April	242	112	30	540
May	208	112	102	363
June	156	112	128	233
July	138	112	144	177
August	135	112	138	181
September	122	112	147	145
October	132	112	127	195
November	109	112	151	117
December	109	112	96	208

*Assumptions used: See Table 5.1.

Additional Assumption

Land area irrigated per day 8600m^2 (11 plots + 120m^2 seed bed) -- 2 plots are under preparation or being harvested on any given week.

Aside from fish and food preservation, the ice plant has other important uses. Its engine can serve as a generator to produce electricity, operate a rice mill or an irrigation pump. The freezing tank can be used as cold storage by simply removing the brine solution. And its condensing fan can dry crops, fish and clothes.

The ice plant has many advantages over ordinary ice plants, such as:

- low cost
- ease-of-operation (requires only two people to run it)
- capacity sufficient for the needs of small communities
- reduced delivery costs.

5.6.1 Ice Plant Profile

The ice plant is compact and self-contained. Running on a two-cylinder diesel engine, it can produce 1.5 tons of block ice a day, with three cycles per 24-hour operation. Maximum processing time is eight hours requiring one cubic meter of fresh potable water per day. The ice plant requires minimum technical skills to operate and needs only two operators.

Due to the 24-hour operating characteristics of the plant, the size of the P/V array required would be large; however, this example is used to demonstrate the cost characteristics of a system at the upper end of the scale of technologies being investigated in this study. Technical Specification of the system is as follows: The main component is an ice maker consisting of an open-type compressor, twin cylinder engine, fly wheel and drive pulley, refrigerant freon - 12, service valves, receiver and oil separator. The technical features of the 1.5 ton ice plant include:

- 18-21 hp diesel engine or 15 hp electric motor
- 2.25 liters/hour of diesel consumption
- Open-type compressor with 7-10 tons refrigerating capacity

5.6.2 Extent of Use of Ice Plant

It is estimated that a plant of this size would be adequate for a fishing village with a daily fish catch of 1.5 MT/day or a village with a population of 15,000.

Currently, there are very many fishing villages too far from large ice plants that have to limit their fish harvest due to lack of preservation facilities. These fishermen, (600,000 in number), account for 50% of the fish harvest.[18] Since the average annual fish harvest of such fishermen is 400 kg/year/fishermen,[19] the quantity of ice required for preservation is 240 million kg/year. Thus, the potential number of ice plants required would be at least 400.

5.7 Prawn and Fish Hatchery

Prawn and fish aquaculture in brackish and fresh water ponds is an industry that is rapidly being developed in the Philippines. Currently there are 302 hatcheries[20] operating in the Philippines, each producing about 10 million fry per year.[21]

Prawn and fish production is to be expanded by increasing stocking densities (from 4000 fry/ha to 50,000 fry/ha) and by increasing the number of ponds (currently 176,000 ha) in use. This production increase is going to require increased hatchery facilities. Since all hatcheries have to be

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[18] Bureau of Fisheries and Aquatic Resources (BFAR)

[19] Calculated from data in Philippine Yearbook, 1979

[20] BFAR

[21] Southeast Asian Fisheries Development Center (SEAFDEC), Iloilo

located adjacent to sources of good quality water, often away from easy access to grid power, they have to use small gasoline generators (5-10hp)[22] for power.

5.7.1 Prawn and Fish Hatchery Load Profile

Typical equipment required in a hatchery is shown in Table 5.10. It also shows the equipment usage profile. This system is adequate for the production of about 10 million fry per year.

5.7.2 Extent of Use of Prawn and Fish Hatcheries

As mentioned previously, there are currently 302 hatcheries in operation. SEAFDEC operates 15 at present and expects to triple the number within the next few years. Data on rates of increase of the number of hatcheries is not available. However, an approximate estimate of the potential number of fish hatcheries required is 1,700[23], supplying ponds producing a total of 2,000 kg/ha/year of fish. This can be compared to the production in 1977 of 657 kg/ha/year. Of course, larger hatcheries producing well over 10 million fry/year are possible, and in fact, one such operation requiring about 60KW of power was being contemplated by a private industry group.

5.8 Support Facilities for Large Commercial Farms

Many large commercial farms (sugarcane, coconut, coffee, pineapple, etc.) have facilities to store equipment, and to perform minor preventive maintenance activities. These facilities also provide housing for a number of permanent employees.

Equipment required for a facility would include lights, water pump, transceiver, and possibly a refrigerator. Power requirements for this

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[22] BFAR

[23] Assuming 5 fish/kg at harvest, 50,000 fry/ha stocking density; 50% mortality, 170,000 ha of fish ponds, two harvests/year and 10 million fry/hatchery/year.

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TABLE 5.10

EQUIPMENT AND USAGE PROFILE FOR A PRAWN/FISH HATCHERY

Equipment	Power Required	Usage Profile
Water Pump	100 W electric motor	4-8 hours/day -- pumps 4-8 M^3/day with a 5-8 M head
Aerators	0.7 KW electric compressor	24 hours/day
Lights	Five 40 W fluorescent lights	5 hours/day

Source: Pudadero, B.V., Jr., SEAFDEC

facility would be compatible with the P/V systems being considered in this study. A similar facility would be required for the 70 forestry stations in the Philippines. These stations are set-up and maintained by the Bureau of Forest Development and are used for forestry management.

5.8.1 <u>Support Facilities Load Profile</u>

Table 5.11 gives the type of equipment required and the load profile for small support facilities. Power for such facilities could be provided by small gasoline generators of about 1.5KW.

5.8.2 <u>Extent of Use of Support Facilities</u>

A recent estimate of the number of large farms in the Philippines is not available. The 1971 census of agriculture showed that there were about 4300 farms over 50 hectares in size in the commercial farm class. The average size of the farms were:

- sugarcane - 175 ha
- coconut - 150 ha
- other - 355 ha (fruit, coffee, abaca, cattle, etc.)

Since 1971, there have been substantial increases in the land cultivated with the above commercial crops. The Bureau of Agricultural Economics experts contended that it is unlikely that the proportion of large farms in these crops would have have changed. Based on this assumption, the number of farms over 50 ha in these crops are shown in Table 5.12. Discussions with a variety of persons appeared to indicate that a large majority of these farms would not have easy access to grid power.

Additionally, the current energy devleopment plans call for planting 200,000 ha of new land in sugarcane for alcohol production. If a maintenance facility is required for every 200 ha, then potentially an additional market for 1000 small generators would emerge.

TABLE 5.11

EQUIPMENT AND USAGE PROFILE FOR SUPPORT FACILITIES

Equipment	Power Required	Usage Profile
Lights	100 W (Forestry Station) 600 W (Maintenance Facility)	5 hours/day
Water Pump	0.7 KW electric motor (higher power motor may be required, depending on pumping head)	½ hour/day (Forestry Station) 2 hours/day (Maintenance Facility)
Transceiver	60 W	0.5 hours/day
Refrigerator (optional)	400 W	4 hours/day running time

TABLE 5.12

ESTIMATED NUMBER OF FARMS OVER 50 HA IN AREA IN 1980

Crop	Number of Farms
Sugar cane	2100
Coconut	2000
Other	1400
Total	5500

Source: Estimated from data in 1971 Census of Agriculture and the 1979 Philippine Agriculture Factbook and Buyers Guide.

Other remote locations where such small power generation units would be required include forestry stations (70).[24]

Thus, the demand for such small units has an upper bound of about 6,500 units.

5.9 Fish Ponds

Fish pond development is the most outstanding inland fishery operation in the Philippines. They are developed from mangrove swamps, estuarine areas, tidal flats, and shallow coastal areas, and are used mainly for the rearing of bangus (milkfish) and shrimp, in brackish water.

The average size of a fish pond operation is 20 ha. Currently, fish ponds operate at low stocking densities of less than 10,000 fry/ha (compared to 200,000 fry/ha in Taiwan), and use natural algae for feed. There is a growing trend, and a government policy[25] for increasing the yield and output from fish pond operations. Currently, over 95% of the ponds depend on tidal water exchange for water transfer. However, with increased fish stocking densities, water pumping will be essential since a water exchange rate of 20% will be required (20,000 gal/hr/ha -- 75 m^3/hr/ha).

5.9.1 Fish Pond Load Profile

Pumps are operated throughout the year. Pumping takes place between 0400 and 0900 hours for about 5 hours. Frequency of operation is 2-3 times a week. During the hotter months (March to June in the Iloilo area) an additional 2-3 hours of pumping is required at about 1500 hours.

Type of pumps required for fish pond water exchange are low head (2-3 m), high volume pumps. The water exchange requirements can be satisfied by the following pump configurations for a 20 ha fish farm.

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[24] The 8500 fish farms are also a possibility, however, they are smaller (20 ha) and thus may not always required such a facility.

[25] Bureau of Fisheries and Aquatic Resources.

- Six inch axial flow pump coupled to a 5 hp gasoline engine, delivering 2500 liters per minute (660 gpm) at a 3 m head. Number of pumps required is four (IRRI design).
- Four inch centrifugal pump coupled to a 10 hp diesel engine, delivering 2500 liters per minute (660 gpm) at a 10 m head. Number of pumps required is four.

The type of pump commonly used is the centrifugal pump. Table 5.13 shows the usage profile for the pumps.

5.9.2 Extent of Use of Fish Ponds

In 1977, there were 8524 fish farms operating on 176,000 ha[26]. These farms, and any additional farms that may result from the Five Year Development Plan, would form the upper-bound of the potential market.

5.10 Salt Manufacture

Salt manufacture through the crystallation of sea water, is an important industry in the Philippines. The quantity of salt produced annually amounts to about 200,000 MT[27], produced on about 200-250 salt farms.[28]

The process employed in salt manufacturing is rather simple: sea water is pumped into retention tanks and as its salt concentration increases, through evaporation the liquor is transferred to smaller tanks. The latter transfers are by gravity. Finally, the highly concentrated liquor is transferred to brick-lined crystallation tanks. Pumping is sometimes required at this stage, depending on the salt pond design. When all the water has evaporated, the salt is manually scraped off the bricks and stored in a silo or sacks.

Salt is manufactured only during the dry season, which in Iloilo, a major salt producing region, is January to May. During the wet season, the salt ponds are used to cultivate backish water, such as bangus (milkfish) or prawns. An average size of a salt manufacturing facility is about 10 ha. Currently no pumping is required for fish cultivation.

[26] Bureau of Fisheries and Aquatic Resources.

[27] Philippine Yearbook, 1979.

[28] DHR estimate based on average production per farm of about 600-800 MT/ha.

TABLE 5.13

POWER REQUIRED AND USAGE PROFILE FOR FISH POND OPERATION (20 HA)

Equipment	Power	Usage Profile
Four 6" axial flow pumps	5 hp gasoline	5 hours/day (0400-0900 hours), 3 days/week, 52 weeks/year
OR		AND
Four 4" centrifugal pumps	10 hp diesel	2 hours/day (1500-1700 hours), 3 days/week during March to June

Source: DHR site visits

However, as mentioned previously, if stocking densities are to be increased, mechanical pumping will be required.

5.10.1 Salt Pond Load Profile

A typical pumping unit required for salt manufacturing is a 6" low head, high volume centrifugal pump coupled to a 10 to 15 hp diesel engine. This is used to pump sea water into the first concentrating tank. Depending on the pond layout, one or two 3" pumps coupled to 6-8 hp diesel engines can be also used. These pumps are required for pumping the concentrated liquor into the crystallization tanks. The small pumps would not be used during the wet season for fish cultivation. Table 5.14 gives the power requirements and load profiles for a typical salt/fish operation.

5.10.2 Extent of Use of Salt Manufacturing

The average production of salt in the Philippines is about 80-100 MT/ha/year. Since total production of salt in 1977 was about 200,000 MT, the area required for salt production is about 2000-2500 ha. Since each salt farm is approximately 10 ha in size, the number of salt farms is about 200-250. At present, there is no estimate of the expected increase in the number of salt farms in the next few years. Thus, 250 salt farms could be used as the upper-bound on the number of salt farms that potentially could use P/V power.

5.11 Miscellaneous Small Power Applications

There are many small power applications in the Philippines where photovoltaics could prove to be an ideal power source. These include:

- Fisheries stock gathering -- Most hatcheries must collect young fry or specimen from the wild or ocean and then transfer them to the hatchery. During the collection process, which is done in remote locations, power is required for pumping small amounts of water or for aeration. Currently these fractional horsepower pumps are powered using small gasoline engines or batteries. Problems with the current power sources are: noisy gasoline engines disturb fish collection; and batteries have to be taken into town for charging, resulting in significant damage to the batteries due to mishandling.

- Communication -- Most large farms and fish pond operations require power to operate a transceiver. Currrently these are battery powered, with the inherent problems associated with battery charging.

TABLE 5.14

POWER REQUIRED AND USAGE PROFILE FOR SALT/FISH PRODUCTION

Equipment	Power Required	Fuel Consumed	Usage Profile January - May (salt)	Usage Profile June - December (fish)
6" pump	10-15 hp	10 liters/day	5 hours/day	5 hours/day
Two 3" pumps	6-8 hp	10 liters/3 days for two pumps	1 hour/day	---

Source: Iloilo salt farm site visits.

- Battery charging in logging sites -- At present considerable inconvenience is caused to logging operations in forests due to discharged batteries. Loggers have to use small gasoline generators for battery charging. Some are even experimenting with small wind powered battery chargers.

- Agricultural extension use -- Agricultural extension agents have a need for a power source to operate their slide projectors used in farmer education.[29] Currently, the need is met through small gasoline generators. Small battery powered slide projectors would easily provide the same service. There are three possible alternatives for charging these batteries, each with their own advantages and disadvantages. They are:

  -- Using grid power for charging batteries. A cheap alternative, but the extension agents do not always have access to grid power.

  -- Using the alternator in the vehicle for battery charging. A feasible alternative if the vehicle alternator is increased in size. However, extension agents do not always drive long enough to adequately charge the batteries.

  -- A P/V battery charger. The small array could be attached to the vehicle roof and could be a convenient source of power for charging the batteries.

There are other battery charging applications in the agricultural sector, but the above application provides an overview of the variety of existing applications.

5.11.1 Battery Charging Load Profile

The battery charging power requirements depend on the power requirements of the equipment and the intensity of use. Table 5.15 gives power requirements and intensity of use estimates for the above applications.

5.11.2 Extent of Use of Battery Chargers

An accurate estimate of the extent of potential market is difficult to make. However, an indication of market size can be gauged from the following facts:

- There are 302 fish hatcheries currently operating in the Philippines.

[29] The World Bank is financing the purchase of 200 projectors and gasoline generators for use by the extension agents.

TABLE 5.15

POWER REQUIRED AND USAGE PROFILE FOR BATTERY CHARGING APPLICATIONS

Usage	Equipment	Power Required	Useage Profile
1. Fisheries Stock Gathering	Small Pump	20W	8 hours/week, year round
2. Logging Site Battery Charging	Automobile batteries	140W	2 hours/day
3. Communication Equipment	Transceiver	100W	1 hour/day
4. Agricultural Extension	Slide Projector	400W	5 hours/week

- There are about 150-200 logging sites in the Philippines.

- There are about 15,000 large farms and fish ponds operating in the Philippines.

- The cadre of extension agents in the Philippines numbers 10,000, and the Bureau of Agricultural Extension hope to provide one slide projector per five extension agents.

Thus, the upper bound for P/V battery charging application market is about 17,500.

5.12 Marginal Applications

There are several other applications which would be technically feasible under certain special circumstances. They include:

- Piggeries -- An average sized commercial piggery in the Philippines has about 50 sows. Equipment used includes a 3 hp hammermill, 3 hp mixer, 1 hp water pump, and 1 KW of fluourescent lights. Since this equipment is used throughout the year, it is suitable for a P/V generator. However, the P/V generator would have to compete with a biogas electricity generator; thus, it is unlikely that P/V would prove to be cost-competitive.

- Abaca Strippers -- There are about 12,000 small, 1.5 hp gasoline engine driven strippers in use in the Philippines. They are used throughout the year and would be ideal for use with a small 1 KW P/V generator. However, the machines have to be moved from field to field in many instances and due to portability problems of P/V generators, they would not be suitable.

- Rice Threshers -- Small rice threshers, driven by 2-3 hp gasoline motors, are commonly used in the Philippines. However, the need to move them from field to field makes it unsuitable for use with a P/V generator.

These applications would be feasible if the equipment does not have to be moved frequently or moved a great distance. In the case of the piggery, P/V use would be possible if biogas electricity was inappropriate.

5.13 Summary

The following table summarizes the characteristics of applications adaptable to the use of P/V power systems.

CHARACTERISTICS OF APPLICATIONS ADAPTABLE TO THE USE OF P/V POWER SYSTEMS

Application	Power Required * Capacity(KW)	Power Required * Peak(KW)	Energy Required KWH/Year	DNR Estimate of the Current Extent of Use (Number of Units)	Total Power (KWp)
Hatchery-Fish Stock Gathering Pump	0.02	0.01	10	300	3
Radio Communication	0.1	0.03	100	15,000	450
Battery Charger-Logging Operations	0.14	0.08	110	200	16
Agriculture Extension Audio-Visual Equipment	0.4	0.07	100	2,000	140
Prawn & Fish Hatchery	0.9	5.1	6,720	300	1,530
Forestry Station	1.2	0.7	910	70	50
Commercial Farm Maintenance Yard	1.2	1.8	2,330	5,500	9,900
Rice Garden - 1HA**	1.9	2.0	2,620	Experimental	-
Corn Grinder	2.3	1.0-6.7	1,330-8,880	2,700	10,200
Rice Mill (small)	3.1	2.4	3,230	14,700	32,280
Rice Mill (average)	4.4	2.1	2,780	4,000	8,400
Rice Mill (large)	7.2	6.3	8,300	4,000	25,200
Irrigation for Rice Double Cropping (2HA to 6HA plots)	4.0-6.0	3.3-10.0	2,150-7,050	20,000-40,000	133,600
Irrigation for Rice Doubling Cropping + Single Crop Corn (2HA to 6HA plots)	4.0-6.0	3.3-10.0	3,190-10,170		
Fish Pond 10HA	5.0	7.4	10,640	2,500	18,500
Fish and Salt Ponds 10HA	5.0	7.0	9,480	250	1,750
Fish Pond 20HA	10.0	14.8	21,280	3,700	54,760
Small Ice Plant	11.0	73.0	96,360	400	29,200
Corn Roller Mill	11.2	6.0-37.0	8,030-48,720	700	14,000
Total Power Required					340,000

* - depending on hours of daily usage peak power requirements may be less than or greater than capacity power requirements.

** - HA - Hectare

6.0 MARKET ASSESSMENT

6.1 Introduction

The market size estimates for photovoltaics in the Philippines are based on the hypothesis that a market will start developing when P/V systems are cost-competitive, on a life-cycle basis, when compared to the least cost, practical alternative. At this point the market share of P/V will be close to zero as the conventional systems have the advantages of existing supply and repair systems, tradition, less initial capital investment and greater end-use flexibility. As the cost advantage of P/V over conventional systems grows so will its market share. Once the cost equality point for P/V is passed, their rate of penetration will be determined by other factors such as: equipment turnaround rates, awareness, availability of finance, marketing strategies, availability of distribution, installation, and maintenance facilities and other market related factors. Another assumption made in estimating the market is that P/V systems will first penetrate into areas where users are already using mechanically or electrically powered equipment. For example, P/V systems will be more acceptable to a farmer using a gasoline engine driven pump than one who irrigates the field manually.

In Section 6.2, the methodology used in the market size estimation analysis is described briefly. Section 6.3 discusses the necessity of conducting an economic cost/benefit as well as financial cost/benefit analysis. Section 6.4 summarizes the market and institutional factors that constitute incentives and barriers to P/V use. In Section 6.5, a series of cost-competitive analyses are described. It identifies the year in which various P/V applications become equal in cost (on a life-cycle basis) to the least expensive conventional power system. Finally, in

Section 6.6, an annual potential market size estimate is obtained for 1982 through 1990.

6.2 Market Size Estimation Methodology

Market size estimates are developed in two stages. In Stage 1, the life-cycle cost of P/V systems is compared to its nearest conventional power system for a variety of applications. For example, for applications requiring a power capacity of about 1 KW or less, the competitor is assumed to be gasoline driven generators. For larger systems, the competitor is diesel driven generators. The life-cycle costs of P/V systems and the competing conventional systems are calculated on an annual system purchase basis, from 1980 to 1990. Since the P/V array and balance of system costs are steadily decreasing and conventional system and fuel costs are increasing, at some point in time the costs become equal. That is to say, when costs become equal, a P/V system installed in that year costs as much as a conventional system installed in the same year, as measured on a life-cycle basis. Thus, the analysis enables one to determine the year when P/V systems first become competitive with the competing conventional systems. In the next stage, the upper bound on the P/V market (defined by the extent of use of various applications) is modified by the equipment turnaround rates, financing availability and other factors to obtain an estimate of the possible annual sales of P/V systems in the Philippines. Due to the inherent uncertainties prevalent in such predictions, we provide three market size estimates: "most likely", "increased activity" and "optimistic", and their definitions are described later.

6.2.1 Cost Analysis

The cost analyses are based on accepted life-cycle costing principles. Both a financial and an economic life-cycle cost analysis are conducted due to the reasons explained in Section 6.3.

To reflect inherent uncertainties prevalent in predicting future trends, several scenarios are considered:

- Financial analysis using a real fuel cost escalation of 16% per year for gasoline and 10% per year for diesel. This corresponds to historical escalation rates from 1975 to 1980.[1] For each case, two loan rates of 21% and 14% are used. The former corresponds to the current commercial bank rate and the latter to the development bank loan rate.

- Financial analysis using a real fuel cost escalation of 3% per year for gasoline and diesel and a loan rate of 14%.

- Economic analysis using a real discount rate of 12% and a real fuel cost escalation rate of 3% per year. These rates were recommended for use by Dr. Mohan Munasinghe, Energy Economist, The World Bank, Washington, D.C.

The methodology used for the analyses and the input data assumption are described in Appendex E.

6.2.2 Market Size Estimation

P/V market size estimation methodologies that use current and projected gasoline and diesel generator sales as an indicator of possible P/V sales can be misleading. For example, in the Philippines most large diesel driven generators are used to provide back-up power in the case of grid power failure. Furthermore, in many agricultural applications, gasoline and diesel engines are directly coupled to equipment, without the need for an electricity generator. Thus, in this study, generator sales are not an adequate indicator since they do not take into account a large segment of the feasible agricultural sector market.

Our "bottom-up" approach begins by estimating the upper-bound of the potential market. The upper-bound is defined as the peak power required for the total number of cost competitive, practical applications. The upper-bound is modified by the new equipment installation rate to obtain an estimate of

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[1] This assumption implies that the extraordinary fuel cost escalation from 1975 to 1980 will continue. At 10% and 16% real fuel cost escalation, a barrel costing $40 in 1980 will cost in 1990 (in constant dollars) $104 and $176 respectively.

the applications that may be installed in a particular year. The modified potential market is then further reduced to reflect other constraints to achieving the potential market. These include awareness, financing, institutional barriers, and other market related factors.

6.3 Need for Financial and Economic Cost/Benefit Analysis

Long-term financing of photovoltaic systems is likely to be handled through the government financial system. Most long-term financing in agriculture is directed through the development banks, which are in turn partially financed through multi-lateral donor agencies, such as the Asian Development Bank and the World Bank and bilateral agreements between the Philippines and donor countries. These banks function not only as lending agencies but also as agents of government policy objectives. This dual function creates the need within the development banks to evaluate loans in terms of their economic benefits to the nation as well as their benefits to the potential applicant. The World Bank has been instrumental in developing a methodology for the evaluation of economic benefits to the nation from investment projects. Most development banks financed by the World Bank have been encouraged to adopt this economic analysis of projects as a part of their lending evaluations in addition to the more traditional, business-oriented, financial analysis.[2]

Interviews with the Development Bank of the Philippines' planners indicated that the bank will, in the future, adopt the economic analysis of projects as part of their evaluation of loans. Once this practice has been instituted, loans will be given according to the following criteria:

- Loans would be given if projects pass both and economic and financial analysis.

[2] For details on the World Bank economic analysis methodology see: Lyn Squire and Herman G. Van Der Tak, Economic Analysis of Projects, the Johns Hopkins University Press, 1975.

- If a project passes an economic analysis and not a financial analysis, it would be more likely to receive funding than if it passes a financial analysis and fails an economic analysis.

- Finally, if a project fails both an economic analysis and financial analysis it will not receive funding.

Considering that most long-term agricultural financing in the Philippines is presently directed through the Development Bank of the Philippines, American photovoltaic firms wishing to sell in the future to the government or to government-financed projects may have to justify on economic grounds the viability of these systems. DHR, in considering potential photovoltaic applications, has included in its evaluation of photovoltaic systems both an economic and a financial analysis. The purpose of using both types of economic evaluation is to provide photovoltaic manufacturers with an idea of the economics under which these systems will be financed by the Development Bank of the Philippines.

Briefly, an economic analysis is defined here as an attempt to value the contribution to the country's basic socioeconomic objectives made by a project. In practice, an economic analysis involves the use of prices for goods and services that are free from distortions in the marketplace and reflect the real, economic value of the good. For example, price of gasoline at the National Philippine Oil Corporation refinery outlet is ($1.18 per gallon, including wholesale markup). Taxes and duties have raised this price to ($2.42 per gallon) and have distorted the market for gasoline.[3] In an economic analysis, the price of $1.18 per gallon would be used in the evaluation of the costs/benefits of a gasoline engine. This approach differs from a financial analysis that would use the higher price inclusive of taxes

[3] The prices are as of August 15, 1980. The corresponding diesel prices are as follows: Refinery Outlet: $1.18 per gallon (including wholesale markup); Retail: $1.43 per gallon.

and duties. To a businessman, the latter approach is much more valuable than the former. However, to a development planner the economic analysis would be relatively more important. DHR's analysis is not intended to be a primer on economic analysis of projects. It is directed at illustrating the potential changes that could occur in the market for photovoltaics as a result of using a different methodology for economic evaluation. In general, it can be said that <u>the economic analysis of projects will tend to delay introduction of photovoltaic systems into the marketplace</u>. Further details will be provided on the factors that influence the economic analysis of photovoltaics in the next section.

6.4 Summary of Incentives and Barriers to P/V Use in Agriculture

The purpose of this section is to summarize DHR's perceptions as to the major non-economic incentives and constraints to P/V use in Philippines agriculture. The Philippines offers a mixed bag of incentives and disincentives for the use of photovoltaics in agriculture. On one hand, the government offers a number of financial incentives designed to spur the introduction and use of non-conventional energy technologies (including P/V) into Philippine society, while on the other hand, there are a variety of business and financial practices that will act as constraints on the development of a P/V market. For American P/V manufacturers, these constraints center on: 1) the lack of long-term capital in the agricultural sector that could be used to finance P/V products; 2) the possibility of foreign competition particularly from German, Japanese and French P/V manufacturers; 3) potential service/maintenance problems for BOS components that require skilled labor or storage of high value parts; 4) existing credit arrangements between dealers/wholesalers/manufacturers; and finally 5) the degree of awareness and lack of information on behalf of end-users and skepticism by planners and policy makers about P/V.

A summary of current Philippine business/financial practices is provided in Table 6.1 with DHR's perception of the relative degree of constraint/incentive for each of the practices identified. Further detail on each constraint/incentive can be found within the text.

In developing a market for photovoltaics in the Philippines, the constraints, particularly the lack of long-term capital, will outweigh the incentives given for photovoltaic use. The high initial capital costs for photovoltaic systems coupled with the shortage of long-term loans would prevent many consumers who would be interested in P/V systems from purchasing these systems. DHR feels that the present inadequacy of long-term capital in the Philippines is the single most important impediment to the development of the P/V market.

6.5 Cost Analyses

The financial and economic cost analyses are based on methods, assumptions and data currently being used by the Filipino financial community in assessing the feasibility of agriculture sector capital investments. The input to the analyses are described in detail in Appendix E. Also described in the same appendix is the power required and energy usage profile for the applications described in the previous chapter.

Table 6.2 shows the results of the financial analyses real fuel escalation rates of 16% (gasoline) and 10% (diesel) in two cases: commercial bank loan rates of 21% and development bank loan rate of 14%. The table indicates the peak array size necessary to supply the energy required for various applications, the first year in which the P/V system becomes equal in cost with its closest competitor, and the life-cycle cost per Kwh in the first year of cost-competitiveness (in nominal dollars). For example, in scenario 1, 0.8 KW (capacity) standard case requires 1.77 KWp array and

TABLE 6.1

CHARACTERIZATION OF BUSINESS ENVIRONMENT/FINANCIAL BARRIERS, CONSTRAINTS AND INCENTIVES TO PHOTOVOLTAICS

Area	Present Status	Degree of Constraints/Incentives Towards Photovoltaics
1.0 BUSINESS ENVIRONMENT		No effect
1.1 Dealer/Importer/Manufacturer Relationship	• Dealers often act as exclusive agents for products.	No effect
	• Sales are on indent basis.	Moderate disadvantage
	• Credit terms range up to 60 days for small equipment--installment payment terms for large items (25% deposit, two-year monthly installments).	
1.2 Service/Maintenance	• Dealers do not usually stock high value parts.	Moderate disadvantage
	• Maintenance of small systems left to purchaser--large systems serviced by dealer.	Small disadvantage
	• Warranty terms are one and two years normally.	Small disadvantage
	• Manufacturer/dealers selling to government or government-financed projects must be accredited.	Moderate disadvantage
	• Current shortage of skilled workers.	Small disadvantage
1.3 Product Pricing	• End-users are highly price sensitive to first cost	Large disadvantage
	• Low dealer margins on some types of electrical generating equipment.	Small disadvantage
	• P/V installation costs can be fully deductible in year incurred.	Large advantage
1.4 Foreign Competition	• U.S. leads in motor generator set field.	Small advantage

TABLE 6.1 (cont'd.)

Area	Present Status	Degree of Constraints/Incentives Towards Photovoltaics
	• Strong competition by Europeans and Japanese in alternators and motor market.	Moderate disadvantage
	• Australian, French, German and Japanese are interested or are currently developing P/V market.	Moderate disadvantage
	• Local P/V industry may develop in near future.	Small disadvantage
1.5 Investment Climate	• P/V designated pioneer industry.	Large advantage
	• Government offers a number of financial incentives to manufacturers to site plants in the Philippines.	Large advantage
1.6 Standards and Regulations	• Generally, all U.S. standards are acceptable.	Small advantage
1.7 Tariffs and Taxes	• P/V exempted from all taxes.	Moderate advantage
	• BOS systems would have import duties and taxes levied.	Moderate disadvantage
2.0 FINANCIAL PRACTICES		
2.1 Role and Responsibilities of Financial Institutions	• Government-run financial system would provide long-term financing for energy projects -- may evaluate projects on economic basis.	No effect
	• Privately-owned financial system provides short-term working capital (seed, fuel fertility, etc.)--would evaluate projects on financial basis.	No effect
2.2 Attitudes to P/V	• Skepticism at project staff level.	Moderate disadvantage
	• Enthusiasm at program staff level.	Small advantage
2.3 Long-Term Investment Capital	• Long-term loans are primarily from government development banks.	Moderate disadvantage

TABLE 6.1 (cont'd.)

Area	Present Status	Degree of Constraints/Incentives Towards Photovoltaics
	● Total long-term capital available for agriculture is small.	Large disadvantage
	● Priority for renewable energy projects in government-run financial institutions' lending programs.	Small advantage
	● Competition of P/V for loans against biogas and biomass projects.	Moderate disadvantage
2.4 Loan Terms for Long-Term Loans	● Interest rates between 12%-14%.	No effect
	● High debt-equity ratio.	Small advantage
	● 10 to 15 year maturity.	No effect
	● Loans range from ₱50,000 to ₱1,000,000 or more.	No effect
3.0 AWARENESS AND INTEREST IN P/V		
3.1 Public Sector	● Lack of information on P/V by government decision-makers.	Small disadvantage
	● Wait-and-see attitude towards P/V by energy officials.	Moderate disadvantage
	● Skepticism by planners that P/V could compete with biogas and biomass.	Moderate disadvantage
3.2 Private Sector	● Active and enthusiastic entrepreneurial interest in P/V by Filipino businessmen.	Small advantage
	● Lack of information on P/V applications by small businessmen.	Small disadvantage
	● Interest by private businessmen in establishing contacts with P/V manufacturers in the U.S.	Small advantage

Table 6.2

FINANCIAL ANALYSIS USING REAL FUEL ESCALATION

RATES OF 16% (GASOLINE) AND 10% (DIESEL)*

		FIRST YEAR OF COST COMPETITIVENESS		LIFE CYCLE COST, $/KWH (NOMINAL $), IN FIRST YEAR OF COST COMPETITIVENESS	
APPLICATION	ARRAY SIZE (KWp)	21% Loan Rate	14% Loan Rate	21% Loan Rate	14% Loan Rate
1) Standard Case: 0.3 KW (capacity)	0.66	1980(-)[1]	1980(-)	>1.00[2]	>0.77
2) Standard Case: 0.8 KW (capacity)	1.77	1980(-)	1980(-)	>1.00	>0.77
3) Standard Case: 2 KW (capacity)	4.43	1985	1983	0.74	0.59
4) Standard Case: 4 KW (capacity)	8.84	1984	1982	0.75	0.58
5) Standard Case: 10 KW (capacity)	22.11	1985	1984	0.74	0.59
6) Standard Case: 20 KW (capacity)	44.22	1986	1985	0.71	0.58
7) Fish Stock Gathering Pump	0.01	1980(-)	1980(-)	>1.00	>0.77
8) Transceiver	0.03	1980(-)	1980(-)	>1.00	>0.77
9) Agricultural Extension/Slide Projector	0.07	1980(-)	1980(-)	>1.00	>0.77
10) Logging Site/Battery Charged	0.08	1980(-)	1980(-)	>1.00	>0.77
11) Forestry Station	0.69	1980(-)	1980(-)	>1.00	>0.77
12) Maintenance Yard	1.76	1980(-)	1980(-)	>1.00	>0.77
13) Prawn/Fish Hatchery	5.09	1980(-)	1980(-)	>1.00	>0.77
14) Corn Grinder, Low Use	1.01	1983	1982	0.75	0.58
15) Small Rice Mill	2.44	1983	1982	0.75	0.58
16) Rice Garden, 1 HA	2.04	1984	1983	0.78	0.60
17) Medium Rice Mill	2.11	1984	1983	0.75	0.59
18) Corn Grinder, Average Use	3.68	1984	1982	0.75	0.58
19) Salt and Fish Farms, 10 HA	7.04	1984	1982	0.74	0.57
20) Fish Ponds, 10 HA	7.42	1984	1982	0.71	0.55
21) Fish Ponds, 20 HA	14.83	1984	1983	0.71	0.55
22) Rice, Double Crop plus Single Crop Corn, 1 HA	1.67	1985	1984	0.97	0.76
23) Rice, Double Crop, plus Single Crop Corn, 2 HA	3.34	1985	1983	0.97	0.76
24) Corn Roller Mill, Low Use	6.08	1985	1984	0.74	0.59
25) Large Rice Mill	6.29	1985	1984	0.74	0.59
26) Corn Grinder, High Use	6.72	1985	1983	0.74	0.59
27) Rice, Double Crop, plus Single Crop Corn, 6 HA	10.03	1985	1984	0.97	0.76
28) Corn Roller Mill, Average Use	14.60	1985	1984	0.74	0.59
29) Corn Roller Mill, High Use	36.90	1986	1985	0.71	0.58
30) Small Ice Plant	72.98	1986	1985	0.71	0.58
31) Rice, Double Crop, 1 HA	1.67	1987	1986	1.39	1.05
32) Rice, Double Crop, 2 HA	3.34	1987	1985	1.39	1.09
33) Rice, Double Crop, 6 HA	10.03	1987	1986	1.39	1.05

1/ "1980(-)" indicates cost competitiveness earlier than 1980.

2/ <: Indicates break-even cost less than cost indicated.
>: Indicates break-even cost greater than cost indicated.

*See Appendix E for use profiles and other assumptions.

NOTE: Standard case assumes 8 hours/day, 365 days/year operation.

if installed in 1980, would be cheaper than its competitor, a gasoline generator. Similarly, the 10 KW (capacity) standard case requires 22.11 KWp array and would be cost-competitive with a diesel generator only on a system installed in or after 1985.

In general, only small peak power applications are currently cost-competitive in either scenario. Most applications become cost-competitive only around 1984-85. All applications become cost-competitive before 1987, using the P/V system costs assumed in Appendix E. The effect of the lower loan rate can be clearly seen in Table 6.2. In almost all cases which become cost-competitive after 1980, the lower loan rate enables P/V to become cost-competitive a year or two earlier.

The effect of the variation in peak power requirements and application type on the first year of cost-competitiveness can be clearly seen in Figures 6.1 and 6.2.

Table 6.3 shows similar results for the economic and financial analyses using a three percent real fuel cost escalation rate. Comparison of the results shows how economic cost/benefit analysis tends to make P/V systems less favorable. This is mainly due to reduced cost of fuel caused by the removal of all fuel taxes and duties. In general, cost competitiveness occurs in a significant number of applications in 1988 and later. The corresponding financial analysis is much more favorable and significant number of applications become cost-competitive in and around 1985-86. Thus, P/V systems fall into the category of investments which are financially, but not economically viable. According to DBP policies, financing of P/V systems is uncertain. Financing would be possible and encouraged if, as required by Presidental Decree, DBP has to give additional incentives to renewable energy systems. Figures 6.3 and 6.4 show very clearly the relationship between peak power requirements and first year cost competitiveness for various agricultural applications.

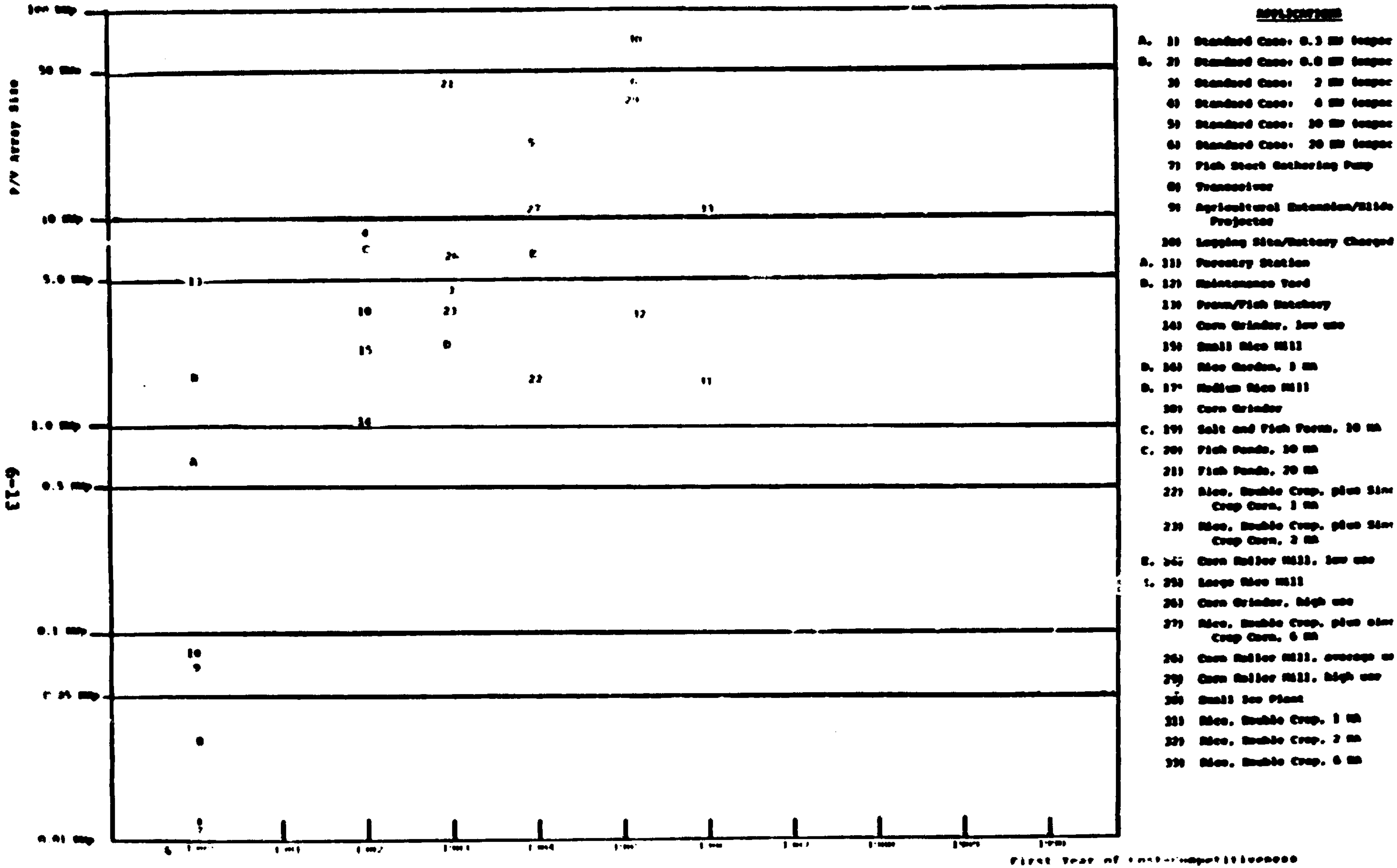

FIGURE 6.1: ARRAY SIZE VS. FIRST YEAR OF COST COMPETITIVENESS FOR VARIOUS AGRICULTURAL APPLICATIONS - FINANCIAL ANALYSIS (14% LOAN RATE)

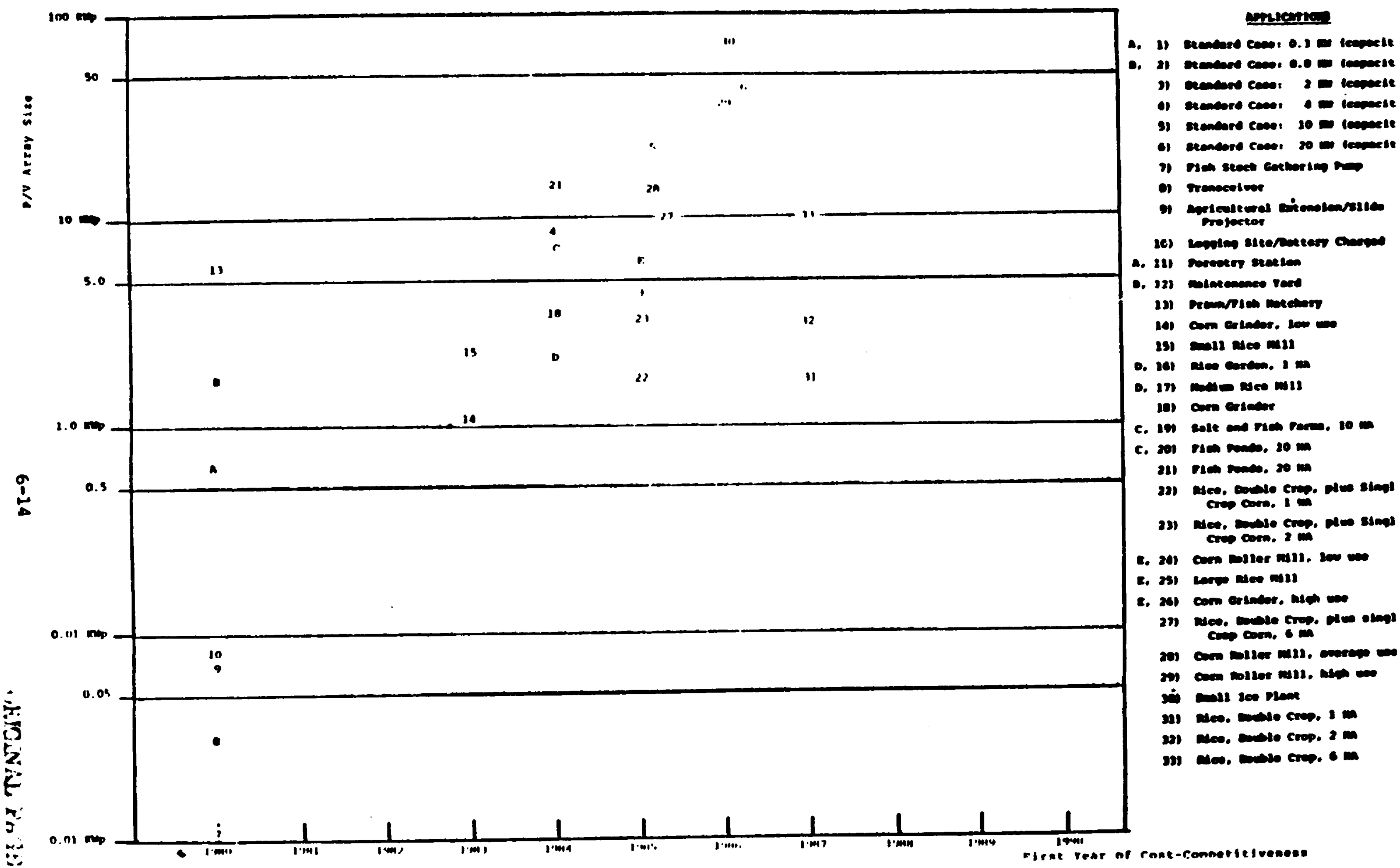

FIGURE 6.2: ARRAY SIZE VS. FIRST YEAR OF COST-COMPETITIVENESS FOR VARIOUS AGRICULTURAL APPLICATIONS - FINANCIAL ANALYSIS (21% LOAN RATE)

Table 6.3

FINANCIAL AND ECONOMIC ANALYSIS USING 3% REAL FUEL COST ESCALATION RATE*

APPLICATION	ARRAY SIZE (KWp)	FIRST YEAR OF COST COMPETITIVENESS: ECONOMIC ANALYSIS	FIRST YEAR OF COST COMPETITIVENESS: FINANCIAL ANALYSIS	LIFE CYCLE COST, $/KWH, IN FIRST YEAR OF COST COMPETITIVENESS: ECONOMIC ANALYSIS (CONSTANT 1980 $)	LIFE CYCLE COST, $/KWH, IN FIRST YEAR OF COST COMPETITIVENESS: FINANCIAL ANALYSIS (NOMINAL $) (14% INTEREST)
1) Standard Case: 0.3 KW	0.66	1981	1980	0.85	0.77
2) Standard Case: 0.8 KW	1.77	1984	1980	0.49	0.77
3) Standard Case: 2 KW	4.43	1990	1985	0.23	0.58
4) Standard Case: 4 KW	8.84	1990	1985	0.23	0.58
5) Standard Case: 10 KW	22.11	1990(+)[2]	1986	<0.23[3]	0.56
6) Standard Case: 20 KW	43.92	1990(+)	1989	<0.23	0.61
7) Fish Stock Gathering Pump	0.01	1980(-)[1]	1980	>1.08[3]	0.77
8) Transceiver	0.03	1980(-)	1980	>1.08	0.77
9) Agricultural Extension/Slide Projector	0.07	1981	1980	0.85	0.77
10) Logging Site	0.08	1981	1980	0.97	0.77
11) Corn Grinder, Low Use	1.01	1985	1983	0.43	0.59
12) Foresting Station	0.69	1986	1981	0.36	0.69
13) Maintenance Yard	1.76	1986	1981	0.36	0.69
14) Rice, Double Crop Plus Single Crop Corn, 1 HA	1.67	1988	1986	0.39	0.73
15) Rice Garden, 1 HA	2.04	1988	1984	0.31	0.60
16) Medium Rice Mill	2.11	1988	1985	0.30	0.58
17) Small Rice Mill	2.44	1988	1984	0.30	0.59
18) Prawn, Fish Hatchery	5.09	1988	1981	0.30	0.69
19) Rice, Double Crop, 1 HA	1.67	1989	1988	0.50	1.12
20) Corn Grinder, Avg. Use	3.68	1989	1984	0.27	0.59
21) Rice, Double Crop, Plus Single Crop Corn, 2 HA	3.34	1990	1985	0.30	0.76
22) Rice, Double Crop, 2 HA	3.34	1990	1988	0.44	1.12
23) Corn Roller Mill, Low Use	6.08	1990(+)	1987	0.23	0.58
24) Large Rice Mill	6.29	1990(+)	1986	<0.23	0.56
25) Corn Grinder, High Use	6.72	1990	1985	<0.23	0.58
26) Salt and Fish Farm, 10 HA	7.04	1990	1984	0.23	0.58
27) Fish Ponds, 10 HA	7.42	1990	1984	0.22	0.56
28) Rice, Double Crop, Plus Single Crop Corn, 6 HA	10.03	1990(+)	1986	<0.30	0.73
29) Rice, Double Crop, 6 HA	10.03	1990	1989	0.44	1.14
30) Corn Roller Mill, Avg. Use	14.60	1990(+)	1987	<0.23	0.58
31) Fish Ponds, 20 HA	14.83	1990(+)	1985	<0.22	0.55
32) Corn Roller Mill, High Use	36.90	1990(+)	1989	<0.23	0.61
33) Small Ice Plant	72.98	1990(+)	1988	<0.23	0.60

[1] 1980(-): Indicates cost competitiveness earlier than 1980.

[2] 1990(+): Indicates cost competitiveness at a date beyond 1990.

[3] <: Indicates break-even cost less than cost indicated.
>: Indicates break-even cost greater than cost indicated.

*See Appendix E for use profiles and other assumptions.

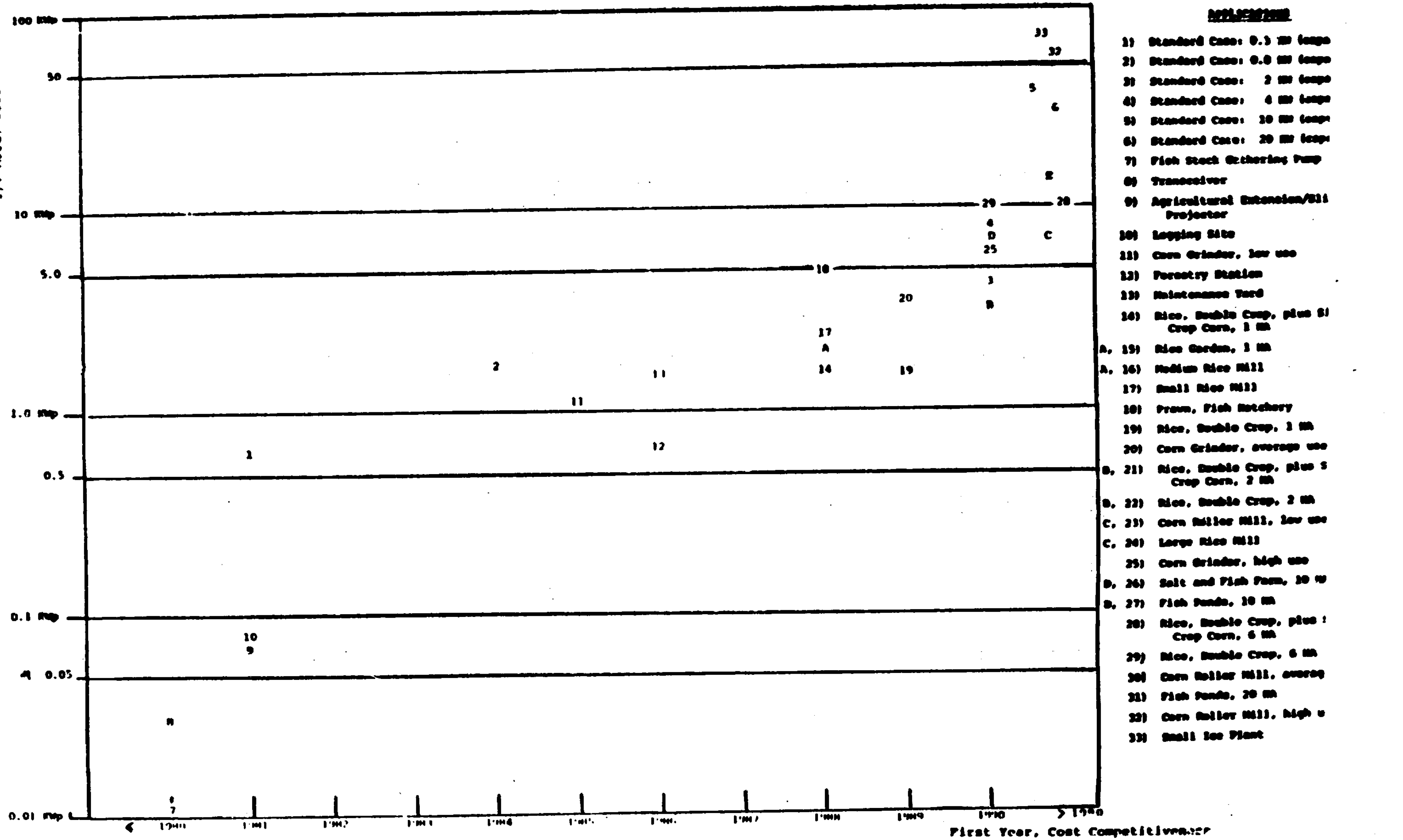

FIGURE 6.3: ARRAY SIZE VS. FIRST YEAR OF COST-COMPETITIVENESS FOR VARIOUS AGRICULTURAL APPLICATIONS - ECONOMIC ANALYSIS (3% REAL FUEL COST ESCALATION RATE)

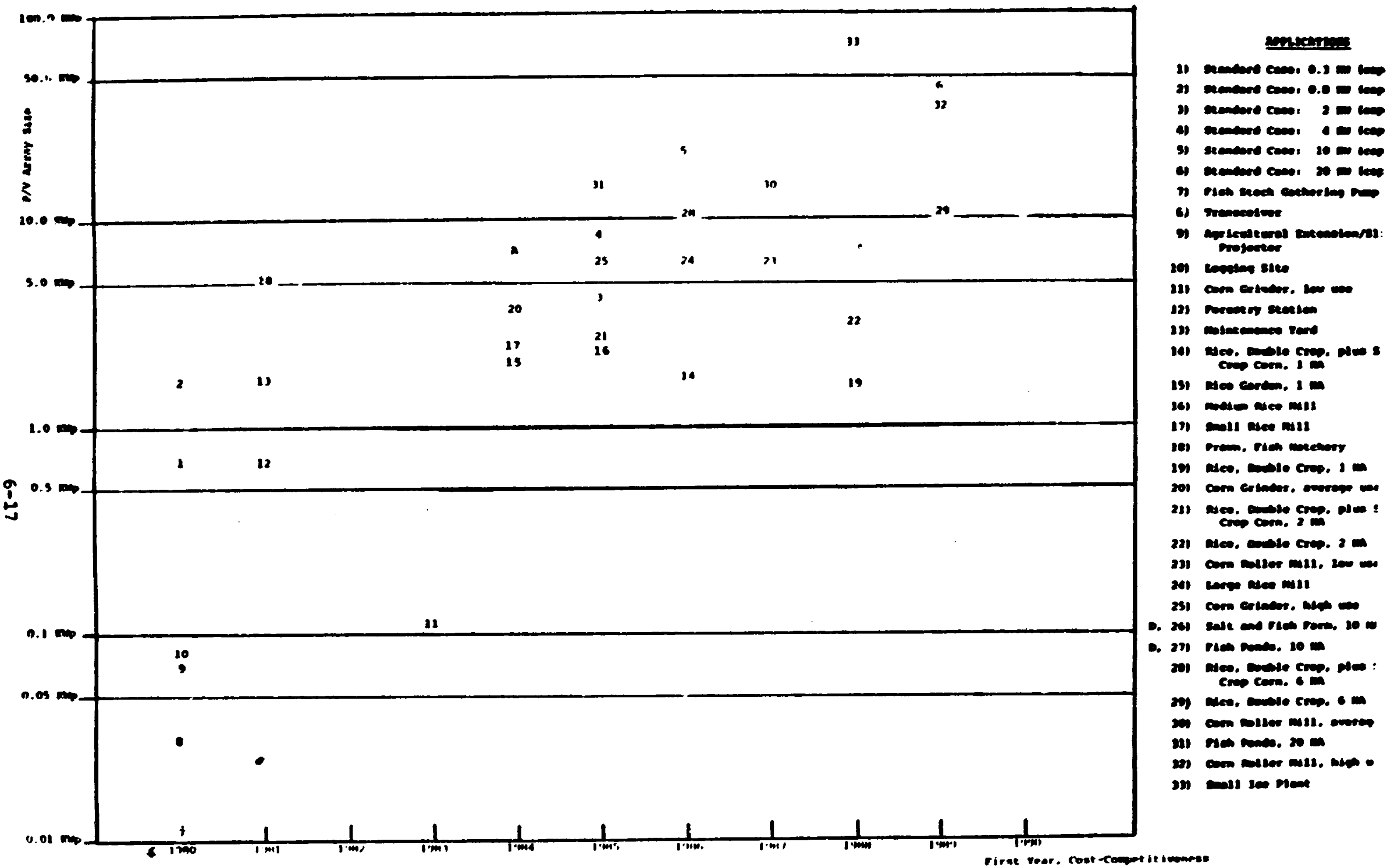

FIGURE 6.4: ARRAY SIZE VS. FIRST YEAR OF COST-COMPETITIVENESS FOR VARIOUS AGRICULTURAL APPLICATIONS - FINANCIAL ANALYSIS (3% REAL FUEL COST ESCALATION RATE)

6.6 Estimation of Market Size

The previous discussions and the summary in Section 6.4 identified the key determinants of P/V market development in the Philippine agriculture sector. They were:

- Awareness -- There is, in general, a lack of awareness among end-users, private and public banking communities, and government decision-makers as to the possibilities for P/V use.
- Cost-Competitiveness -- P/V systems must be cost-competitive with the least cost, practical alternative, on a life-cycle basis before P/V use will be seriously contemplated.
- Financial -- The Philippines is faced with a serious capital constraint. Consequently, only a few institutions currently make long-term loans to the agricultural sector.

6.6.1 Scenario Definition

Our approach to estimating the market size evaluates each of the above criteria and provides three estimates (status quo, increased activity and optimistic); namely, number of cost-competitive applications or finance, based on the tightest constraint.

- "Status Quo" scenario assumes that the current status quo is maintained and fuel costs have a low escalation rate. That is, the barriers and incentives summarized in Section 6.4, continue to be relevant and applicable in the future.
- "Increased Activity" scenario assumes greater government interest, additional government financing, aggressive marketing by P/V companies, considerable end-user interest and awareness, low (3%) real fuel escalation rates, and self-financing by larger operations in addition to the incentives assumed in previous cases.
- "Optimistic" scenario assumes a definite government commitment towards P/V, priority government financing, very strong end-user interest, smaller operations entering the market, the private financial community funding for P/V systems and historical fuel cost escalation rates, in addition to the assumptions described in the previous scenario.

In Section 6.6.2, market estimates based on cost-competitiveness are made assuming no shortage of capital. In Section 6.6.3, market estimates based on capital constraints are made. The set of market size estimates that are more constrained will be used as the DHR's best estimate for P/V use in Philippines agriculture.

6.6.2 Market Estimate Based on Cost-Competitiveness

Table 6.4 shows the upper bound on P/V power requirements based on the financial and economic analysis described in Section 6.4. The power requirements were calculated by multiplying the number of cost-competitive applications by the peak power requirements per unit. It shows the demand for P/V power in MWp if all cost-competitive applications began using P/V systems. While this table indicates an upper-bound, it cannot be used to determine the number of possible P/V conversions in a given year since a total one-time conversion is impractical.

A better indicator is to assume that equipment being installed in a particular year could be considered for P/V conversion. An indication of annual conversion rates may be obtained by examining the actual number of agricultural equipment in use and the expected annual sales as projected by AMMDA. In most cases, equipment installed per year (equipment turn-over plus new installations) amounts to about 10% of the existing stock. For the purposes of estimating a P/V market share, we assume that 10% of equipment installed will use P/V. These assumptions will be imposed on each scenario.

Based on the scenario definitions, the economic analysis market penetration corresponds most closely to the "status quo" case. The financial analysis case with a 14% loan rate and 3% fuel cost escalation corresponds to the "increased activity" scenario. The "optimistic" scenario market

TABLE 6.4

UPPER BOUND ON P/V POWER REQUIREMENTS (MWp)#

Scenario	Financial Analysis						Economic Analysis	
Loan Rate	21%		14%				No Loan	
Fuel Cost Escalation (%) Gas/Diesel (real)	16/10		16/10		3/3		3/3	
Year	Annual	Cumu-lative	Annual	Cumu-lative	Annual	Cumu-lative	Annual	Cumu-lative
Up to 1981	9*	9	9	9	9	9	1	1
1982	-	9	62	71	-	9	-	1
1983	37	46	136	207	1	10	-	1
1984	88	134	31	238	61	71	-	1
1985	103	237	102	340	134	205	1	2
1986	36	273			25	230	7	9
1987	67	340			6	236	-	9
1988					97	333	46	55
1989					7	340	5	60
1990							159	219
after 1990							121	340

#Upper bound is defined as the <u>total</u> P/V power required for all cost-competitive applications in a particular year.

*Rounded to the nearest MWp.

Assumptions: Number of applications possible is as in Chapter 5.

The following equipment size distribution assumptions have been made: Small Rice Mill-50%; Average Rice Mill-25%; Corn Grinder/Roller (low use)-25%; Corn Grinder/Roller (average use)-50%; 10 HA Fish Ponds-29% (Philippine survey data); 20 HA Fish Ponds-43%; Experimental Rice Garden-0%; Rice Double Crop on 2 HA-50% of pumps; Rice Double Crop and Corn on 2 HA-50% of pumps.
(e.g., total number of fish farms = 8500, therefore number of fish farms of 10 HA size is 0.29 x 8500 = 2500.

estimate is equivalent to the financial analysis case with a 21% loan rate. Table 6.5 shows the market penetration for each scenario.

6.6.3 Market Size Estimate Based on Financial Constraints

Based on the level of financing available for capital investments in the agricultural sector,[1] DHR prepared estimates of capital available for P/V system financing between 1981 and 1990. Capital availability estimates are shown in Table 6.6. The estimates reflect the fact that there is a significant "learning" or awareness problem associated with P/V use and until that barrier is broken, no significant amounts of P/V systems will be installed. DHR estimates that it will be at least 1985 before this barrier is minimized.

On the more positive side, it is assumed that most small applications, currently cost-competitive, will be purchased by the more affluent users. These include transceivers, logging operation battery chargers, maintenance yard power supply, forestry stations, and prawn hatcheries. In most cases, the amount of capital required is well within the resources of the users (for example, annual revenue from a prawn hatchery is about $60,000). The small applications used by the more affluent groups amount to about 8.5 MWp of power for the financial analyses cases and about 1 MWp for the economic analysis case. The data in Table 6.6 reflects only financing available from Filipino sources for commercial use of P/V and does not take into account foreign funds supplied for demonstration projects. Estimation of funds available for the latter activities is fraught with even greater uncertainties. Thus, making such estimates would be fruitless. Table 6.7 shows quantity of P/V systems that can be installed for financing levels in Table 6.6. This is based on P/V system costs shown in Table 3 in Appendix E.

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[1] The total 1977 long-term financing in the Philippine agriculture sector was approximately $60 million.

TABLE 6.5

MARKET SIZE ESTIMATIONS BASED ON COST-COMPETITIVENESS CRITERIA (KWp)

	SCENARIO					
	Most Likely		Increase Activity		Optimistic	
Year	Annual	Cumulative	Annual	Cumulative	Annual	Cumulative
1982	10	10	90	90	90	90
1983	10	20	90	180	450	540
1984	10	30	700	880	1,300	1,840
1985	10	40	2,000	2,880	2,200	4,040
1986	90	130	2,000	4,380	2,300	6,340
1987	80	210	1,900	6,780	2,700	9,040
1988	530	740	2,600	9,380	2,700	11,740
1989	520	1,260	2,500	11,880	2,700	14,440
1990	2,000	3,260	2,500	14,380	2,700	17,140

NOTE: 1) Above figures reflect a market share of 10% of cumulative equipment installed up to a given year, less conversion to P/V in previous years.

2) As a comparison, AMMDA estimates that sales of small gasoline engines (average 5 hp) for agricultural uses is expected to be about 30,000 to 40,000 a year till 1985. This is equivalent to above 245 MWp/year (at 7 KWp = 5 hp)[3]. Since the average cost of the engines is about \$400, the total expenditure is above \$14 million/year. The equivalent cost of P/V systems at the 1985 array price is \$2 billion, and the quantity of P/V arrays purchasable for \$14 million amounts to 1.8 MWp at the 1985 price of \$7.78/wp (1980 \$) of arrays.

3) 7KWp = 5 hp * 0.746 KW/hp * 8 hours/day/(4.3 peak sunlight hours/day).

TABLE 6.6

DHR ESTIMATES OF CAPITAL AVAILABLE FOR FINANCING P/V SYSTEMS IN THE AGRICULTURE SECTOR

	Capital Available from Private and Public Filipino Sources (1000's of 1980 $)		
	SCENARIO		
Year	Most Likely	Increased Activity	Optimistic
1981	NS*	NS	NS
1982	20	200	500
1983	40	600	1000
1984	60	1000	1500
1985	120	1600	2100
1986	200	2000	2500
1987	300	2200	3200
1988	500	2500	4700
1989	700	3000	6800
1990	1000	4000	10,000

*NS = not significant

TABLE 6.7

DHR MARKET SIZE ESTIMATES BASED ON FINANCE AVAILABILITY (KWp)

	SCENARIO					
	Most Likely		Increased Activity		Optimistic	
Year	Annual	Cumulative	Annual	Cumulative	Annual	Cumulative
1981	-	-	-	-	-	-
1982	2	2	17	17	43	43
1983	4	6	57	74	96	139
1984	7	13	109	183	164	303
1985	15	28	204	387	268	571
1986	31	59	305	692	382	953
1987	51	110	338	1030	540	1493
1988	95	205	473	1503	890	2383
1989	151	356	647	2150	1466	3849
1990	250	606	1000	3150	2500	6349

6.7 Conclusions

If the present business practices continue, the market for P/V power systems in the Philippines agricultural sector will be small. The most important limiting factor is the limited availability of capital financing for P/V systems. If this constraint could be relaxed, then the cost-effective market becomes larger by several orders of magnitude. Thus, devising innovative financing schemes and promotional campaigns could have a very high pay-off. The market would be mainly small power applications in the pre-1985 period with sales to affluent individuals or corporations. In the post-1985 period, DHR speculates that the market for larger systems would open up with long-term financing provided by the Philippine banking community.

As a comparison of Table 6.5 and 6.7 clearly shows, capital availability would be the most constraining factor determining market size. Thus, the market estimates in Table 6.7 would be representative of what can be expected in terms of P/V system sales in the Philippine agriculture sector.

Additionally, there are many characteristics of the Philippine agricultural and energy sectors that will influence the market for P/V systems. Among the most favorable factors are:

- Stated government policy towards promotion of renewable, and dispersed power sources.
- Financial incentives for the production and use of P/V systems.
- High cost of conventional energy supplies such as gasoline and diesel.
- Entrepreneurial interest in P/V systems.
- Cost-competitiveness of P/V systems when compared to gasoline and diesel power sources in a wide range of agricultural applications.
- Availability of suitable marketing channels for sale of P/V systems in the agricultural sector.
- The shortage of skilled labor for maintaining competing gasoline and diesel powered systems.

However, very significant and serious barriers prevent achieving the technically feasible, cost-competitive market for P/V systems in the agricultural sector. These include: The lack of awareness of the possibilities for P/V systems; high first costs of P/V when compared to competing systems; and, the inadequacy of long term capital for financing P/V systems.

7.0 BUSINESS ENVIRONMENT

7.1 Level of Public Awareness

The DHR team estimated that only about 20 percent of the individuals contacted and interviewed had any substantial knowledge about P/V systems. However, within the agricultural sector and related organizations or agencies contacted by the team, the level of awareness was higher, as almost all organizations or agencies had one or more persons who were aware of what P/V systems were and how they can generally be utilized for power. A higher level of awareness and sophistication about P/V systems was found in several key agencies outside the Ministry of Energy. For example, in the Ministry of Agriculture, the National Grains Authority, and the National Irrigation Administration people had been considering possible applications and had, therefore, educated themselves about P/V systems. However, in most instances where there was such a high level of awareness, the people were professionals who were actively involved in trying to solve energy problems in the agriculture, fisheries, or forestry sectors.

In summary, the DHR team found that although general awareness was low, that in almost all agencies or organizations it was not difficult to find individuals who had some general knowledge of P/V systems.

As a result of extensive meetings with all of the major government agencies related to agriculture (and, therefore having important relationships to the future of P/V systems in the Philippines -- see Appendix A), the DHR team felt that there is certainly a strong interest in P/V systems among these government agencies. Even in those instances where awareness was not high, a simple P/V demonstration or explanation by the DHR team usually resulted in a strong interest to explore P/V possibilities. However, there is not yet a concentrated or strong effort to adopt or utilize P/V systems. Present interest is mainly confined to the demonstration level.

A number of officials were able to identify initial applications where P/V systems could be employed---for example, in agency communication systems or in field extension operations related to research and development activities. Interest in research and testing of various applications; for example, in water pumping, powering fans for dryers, or multiple-use applications. Interest also exists for uses such as charging remote batteries, powering remote communication equipment, or running media equipment.

In moving beyond experimentation and demonstration, people, especially those involved in energy work within agencies, become skeptical as to the appropriateness or match of P/V to their needs. It was repeatedly mentioned to the DHR team that their major concern or reservation was based on the high present market cost of P/V systems. This seems to be the key inhibitor to a more widespread and higher level of interest necessary to move beyond demonstrations. People in the Philippines are taking a wait-and-see attitude toward P/V. An improvement in the relative cost of P/V to competing energy sources will address this inhibiting factor, and create an atmosphere and possibility of increased interest. At that time, it will be possible to address remaining concerns about P/V performance (e.g., reliability and durability) that can only come with user experience in the field.

7.2 Entrepreneurial Interest*

There is currently an active and enthusiastic entrepreneurial interest in photovoltaics by Filipino businessmen. In interviews with both large and small industrialists, there was the attitude that photovoltaics could develop as a viable energy industry in the Philippines. Both a large industrial corporation and a large commercial bank have expressed interest

*To protect the confidentiality of DHR sources, this section presents a general overview of DHR impressions of Philippine entrepreneurial interest in photovoltaics.

in financing economically viable photovoltaic projects, as well as establishing a local photovoltaic industry. Smaller firms, presently involved in selling flat plate solar collectors, have also expressed an interest in establishing contact with American photovoltaic manufacturers with the purposes of either establishing joint manufacturing ventures or marketing of photovoltaic systems.

In general, the level of knowledge and sophistication about potential applications, markets and photovoltaic systems is high in larger firms. In addition, larger firms appeared to be interested in technology transfer arrangements with the United States, while smaller entrepreneurs expressed a willingness to act as dealers for photvoltaic systems. A number of entrepreneurs, both large and small, inquired about the possibility of setting up a regional production facility in the Philippines to service the ASEAN marlet (Singapore, Thailand, Indonesia, Malaysia and the Philippines). These entrepreneurs felt that it may be possible to obtain preferential tariff duties on an ASEAN photovoltaic facility from the ASEAN community. One firm has advertised small photovoltaic systems in Philippine newspapers. These systems were designed to power radios and electric fans and geared to the upper-middle and upper class market. To date this businessmen has not been able to penetrate this market successfully. One problem (often cited by businessmen) is the fact that potential customers are familiar with much larger systems. For example, farmers irrigating their fields commonly use 4"-6" pumps coupled to 5 to 10 hp gasoline or diesel engines. Smaller photovoltaic systems (below 1KW) are viewed with sketpicism by farmers who feel that P/V cannot irrigate as large an area as a gasoline or a diesel pump.

Finally, there have been a number of foreign and American firms that have sold photovoltaic systems to the Philippines Non-Conventional Energy Center and the Philippines Armed Forces for demonstration and testing purposes. Satisfaction with these systems sold to the government and private sectors appeared to be high.

7.3 Overview of Philippine Business Practices in the Electric Generation and Transmission Equipment Areas[1]

The bulk of electric generating and transmission equipment sold in the Philippines flows either directly from manufacturers to end-users or from manufacturers through importer/dealers to end-users. There is also wholesale/retail distribution of small electrical items such as switches and low-voltage wire, but this distribution constitutes a small portion of total market value.

In the case of imported items, importer/dealers most often act as exclusive agents for overseas suppliers and promote the products to end-users. In some cases the importer/dealers will keep stock of items but in most instances, particularly for high-value items, sales are on an indent basis: the importer/dealer makes payment to the overseas supplier and then collects from the customer, or the customer opens a letter of credit, or some other form of payment to the overseas supplier with the overseas supplier reserving a commission for the local importer/dealer. Foreigners cannot own retail operations in the Philippines; but can wholesale their products.

Credit terms are normally up to 60 days for small equipment items while for large items installment payment terms are often arranged which include

[1] Note that a substantial portion of this information has been taken from "Energy Systems Equipment Market Research in the Philippines." Mobius Research, May 1979; and verified through interviews by the DHR project staff.

terms of 25% deposit with the remainder payable in monthly installments over a 2-year period.

Warranty terms normally range between one and two years. For example, in the case of diesel generating sets, typical warranty terms would be two years for standby units and one year for primary power use. Such a warranty would include parts and labor for repairs arising from equipment faults.

Service is a very important factor in sales of equipment in the Philippines, particularly service and spare parts facilities outside the Greater Manila Area. End-users favor dealers who have a plentiful and easily available supply of spare parts in addition to availability of workers capable of undertaking the repairs. For smaller generating systems, service is often left to the end-user or to the myriad of small electrical/mechanical repair shops that exist in the larger towns. Larger systems will be serviced either by the wholesaler or retailer of these systems. It should be noted that a recent Presidential decree has required all firms that sell equipment to the government or to projects financed by the government to maintain a service department and a supply of spare parts that is capable of maintaining all equipment that is sold. Many distributors are currently finding a shortage of skilled mechanics as a consequence of this regulation.

End-users tend to be highly price sensitive and often a price difference of 1% in comparable products will result in the purchase of the cheaper unit. The Japanese have recognized this price sensitivity and have allowed their dealers only a 3% mark-up on the cost of the system in order to capture a larger proportion of the market. The Philippine government does try to encourage the local production of electrical generation equipment by allowing usually a 10% premium on these systems before selecting the cheaper unit.

7.4 Current Generation Equipment Competition

Presently, U.S. suppliers lead in the motor generator set field, which may be an advantage to American photovoltaic manufacturers. The three major suppliers are Caterpillar, GM Detroit Diesel and Cummins. Their long history in the market, good service organizations and extensive availability of spare parts puts them in the lead. The sales of those firms are concentrated in the range of diesel generator sets below 1,000 KW, which constitute the bulk of the market. For diesel sets above 1,000 KW, major suppliers include European firms such as Mirrlees Blackstone, MAN, and Pielstick mainly because these firms are able to arrange financing for end-users. In the very small generator set range, gasoline engines are used. Leading suppliers for that range include Briggs & Stratton, Honda, and Wisconsin. DHR has found that in the agricultural sector, the near term competition is most likely to be gasoline engines rather than gasoline generators, particularly in irrigation/pumping applications.

It is common for alternators and motors to be imported separately and assembled locally for tariff purposes. Leading alternator suppliers include Delco of the U.S., Hawker-Siddley, Brush, and Stanford of the United Kingdom. Leading motor suppliers, in addition to Caterpillar, Detroit Diesel and Cummins, include Ford and Lister, both from the United Kingdom, Hercules of the U.S., Slanzi of Italy and MAN of West Germany. British suppliers have a strong position in the market as a result of their long history of market promotion and frequent visits by their representatives. German motors are known for their quality and reliability. Italian suppliers enter the market by quoting competitive prices and liberal credit terms. The Board of Investment (BOI) has also given permission for two firms, Izuzu Motor Co. and West Germany's MAN to manufacture all ranges of diesel engines in the Philippines.

7.5 Foreign P/V Competition

Australian, French, German and Japanese firms have approached local entrepreneurs as to their interest in photovoltaic systems. The French currently have two small 200 watt demonstration systems located in the Province of Bulacan outside of Manila.* These demonstrations are under the auspices of the United Nations Development Program in cooperation with the Philippine's Non-Conventional Energy Center and the Farm System Development Corporation. The German government has proposed a $4 million photovoltaic system for the Province of Illocos del Norte for electrifying a village. An agreement in principal has been worked out between the German government, the Non-Conventional Energy Center and the Technology Resource Center. The system is expected to be in place by the end of 1981. AEG-Telefunken will supply the photovoltaic system and train Filipino technicians to operate and maintain the system. An Australian firm is selling used American solar panels to a Filipino entrepreneur.

In addition to foreign competitors, American photovoltaic manufacturers may also in the future face local Filipino competition. A large, local, industrial firm and a large commercial bank have expressed interest in investing in American photovoltaic firms and establishing an indigenous photovoltaic industry based on American technology. A number of smaller firms and entrepreneurs also expressed an interest in joint ventures with American firms primarily in the importation of photovoltaic systems. These entrepreneurs have also approached foreign photovoltaic manufacturers with the possibility of local manufacture of photovoltaic systems.

*An additional two P/V pumps were supplied by an American manufacturer.

Of the dealers interviewed, those presently carrying American motor generator sets appeared to be willing to retail American photovoltaic systems. However, to remain competitive in the field nearly all retailers expressed the belief that American firms must offer liberal credit terms and low dealer margins to prevent the Japanese or Europeans from taking over and controlling the market. The advantages of using these dealers as part of a Philippine marketing effort is that they are 1) familiar with the electric generation market, 2) familiar in dealing with American firms, and 3) usually have a trained core of service representatives knowledgeable about electric repair.

7.6 Climate for Investment

The Philippine government has accorded the local manufacture of photovoltaic systems "pioneer industry" status. All projects under this status:

> "...shall be accorded priority by all government-owned or controlled financing institutions such as, but not limited to, the Central Bank of the Philippines, Development Bank of the Philippines, Philippine National Bank and applications for financial assistance submitted for these projects shall be given preferential consideration in the matter of collateral requirements, rediscounting and other requirements in order to facilitate the early establishment of the projects. Furthermore, costs incurred in the establishment and construction of non-conventional energy conversion facilities or equipment duly certified by the Ministry of Energy# may, at the option of the taxpayer, be directly chargeable to expenses and shall be fully deductible as such from gross income in the year wherein such expenses were incurred."*

In addition to the above, there are also a number of incentives regarding Filipino equity, tax exemptions, remittance of profits, etc. that result in

* Source: Investment Opportunities in the Philippines, Board of Investments, September 1980.

Certifying authority is the Center for Non-conventional Energy Development.

an exceptional business climate for investment by foreign firms in the local manufacture of photovoltaics (See Appendix B). In fact, one American photovoltaic manufacturer has filed a letter of intent to establish a local subsidiary that would eventually manufacture both the silicon cells and photovoltaic modules. An additional incentive to locate a photovoltaic manufacturing facility in the Philippines is its membership in ASEAN - a potentially large market that could be developed from the Philippines.

7.7 Standards and Regulations

Generally, all U.S. standards are acceptable in the Philippines. The technical orientation of industry and government in the country is toward the U.S. as a result of the long history of U.S. presence. Local standards are most often based on U.S. standards.

The power supply is 60 hertz, 220-240 volts and 440-480 volts. Transmission is 69 KV (kilovolts), 115 KV, 138 KV, and 240 KV.

Standards most commonly specified in National Power Corporation, National Electrification Administration and for power and transmission projects include the following:

UL - Underwriters' Laboratories Inc. (U.S.)

NEMA - National Electrical Manufacturers Association (U.S.)

REA - Rural Electrification Administration (U.S.)

ASTM - American Society for Testing and Materials (U.S.)

IEC - International Electrotechnical Commission (Europe)

PTS - Philippine Trade Standards

PEC - Philippine Electrical Code

IPCEA - Insulated Power Cable Engineers Association (U.S.)

DIN - German National Standards (West Germany)

JIS - Japan Institute of Standards (Japan)

ANSI - American National Standards Institute

EEI - Edison Electric Institute

7.8 Tariff Rates

Energy equipment and supplies imported into the Philippines are subject to customs duties and sales taxes (see Appendix C). Customs duties are contained in the Tariff and Customs Code of the Philippines. The basis of dutiable value is described in the Code as follows:

> "The dutiable value of an imported article subject to an ad valorem rate of duty shall be based on the home consumption value or price (excluding internal excise taxes) of same, like or similar articles, as bought and sold or offered for sale freely in the usual wholesale quantities in the ordinary course of trade, in the principal markets of the country from where exported on the date of exportation to the Philippines, or where there is none on such date, then on the home consumption value or price nearest to the date of exportation including the value of all containers, coverings and/or packings of any kind and all other costs, charges and expenses incident to placing the article in the condition ready for shipment to the Philippines plus ten (10) percent of such home consumption value or price."

In addition to import duties, energy systems equipment imports are subject to a compensating sales tax as specified in the New Sales Tax Law (NIRC). The rate for energy systems equipment as defined in this study would be 10% calculated on a base of the total landed cost plus a 25% mark-up. The calculation would be as follows:

(Home Consumption Value) + (10% of Home Consumption Value) + (Postage, Commission & Other Charges)

+ (Custom Duty) = Total Landed Cost

(Total Landed Cost) + (25% of Total Landed Cost) x 10% = Sales Tax

It should be noted that photovoltaics as a pioneer industry would be exempted from all taxes under the National Internal Revenue Code, except income tax, on a diminishing percentage. However, it is not clear whether imported photovoltaic systems would be exempt from import duties and sales taxes. It is likely that imported photovoltaic systems would be taxed if a local photovoltaic manufacturing capacity existed and therefore imported systems would be at a price disadvantage.

Balance of system components required for photovoltaic systems would be tariffed. Presently, dealers of power generation equipment import alternators and motors separately from generators to avoid paying the higher tariff for the complete system. In all likelihood, American firms exporting photovoltaic systems to the Philippines will have to ship the balance of system components separately from photovoltaic modules to avoid paying a similar import duty on the complete system.

7.9 Conclusion

Presently, American manufacturers of photovoltaic systems have several advantages in developing the Philippine market. First, there is an established dealer/service/wholesaler network that is extensive and familiar with American products and business practices. Second, photovoltaic systems have been granted a number of tax incentives in order to promote the use of these systems in the Philippines. Third, there are a number of entrepreneurs willing to invest in local production of photovoltaic systems in joint ventures with American firms. Finally, as a pioneer industry photovoltaic systems will be granted priority access to capital from all government-owned or controlled financing institutions.

Potential disadvantages to American development of the Philippine market is the presence by foreign firms currently being established through demonstration projects.

APPENDIX A

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APPENDIX B

DOING BUSINESS IN THE PHILIPPINES

B.1 Introduction

This section examines the distinctive features of doing business in the Philippines. In particular, it focuses upon the incentives that are available and the regulations that one can expect to encounter in producing and/or selling photovoltaics in the Philippines.

Three cases are developed in the course of this discussion, paralleling the three basic types of business involvement for a foreign (non-Filipino owned) firm in the Philippines. The first case looks at a foreign firm producing photovoltaic products outside the Philippines and exporting them to that country. In the second case, the firm both produces and sells photovoltaic goods inside the Philippines. Finally, in the third case, the firm not only produces and sells photovoltaics within the Philippines, but also exports some of the Philippine-produced goods abroad. Incentives and regulations differ for these three scenarios, and these differences are delineated in this examination.

This discussion is not intended to serve as a comprehensive manual on doing business in the Philippines. Rather, its purpose is to outline some of the major incentives and regulations, acting as a springboard from which further inquiries for more detailed information can ensue. Accordingly, additional references on specific topics will be furnished throughout the discussion.

Table 1 provides background information on the Philippines and its economy. More detailed information can be found in the SGV Group's Philippines: An Economic Profile 1979. Having briefly examined the Philippines in general, we now turn to the first case -- a foreign firm exporting photovoltaic products to the Philippines.

TABLE 1

GENERAL PHILIPPINES CHARACTERISTICS

POPULATION:	42.1 million according to the 1975 Census (Average annual growth rate of 2.7% since 1970)
LANGUAGE:	Eighty-seven dialects spoken; chiefly Ilocano, Tagalog and Cebuano. English is also spoken.
CURRENCY:	Peso (₱), U.S. $1 = ₱7.25 (January 1, 1981)
GNP:	₱86.7 billion, or approximately U.S. $12 billion, in 1979 (in 1972 prices) (An average 6.7% real annual growth rate between 1972-1979)
PRINCIPAL INDUSTRIES:	Agriculture, Forestry, Fisheries (accounted for approximately 60% of labor force in 1977)
LABOR FORCE:	Approximately 16.9 million in 1977 (5% growth rate since 1977)
TAXES:	Corporate Income Tax Individual Income Tax Excise Taxes Local Taxes (plus others)
FOREIGN INVESTMENT:	Total net inflow of foreign equity investment, according to National Census and Statistics Office, of ₱1,599.2 million (U.S. $216 million) in 1977 (U.S. a major source of foreign investment).

Sources: SGV & Co., Philippines: An Economic Profile 1979

SGV & Co., Doing Business in the Philippines 1980

Price Waterhouse, Doing Business in the Philippines, March, 1978.

B.2 Case 1 -- Export to the Philippines

In the first case, a foreign firm is exporting photovoltaic products to the Philippines. Here, while the firm may choose to set up an office in the Philippines to coordinate its activity, there is no actual production of goods within the Philippines.

A firm exporting to the Philippines is subject to a variety of regulations. For example, it is prohibited from engaging in retail trade. The Retail Trade Nationalization Act restricts retail trade, either direct or indirect, to those firms wholly owned by Philippine citizens.[1] The firm is permitted to use foreign trademarks in the Philippines, however, such trademarks or tradenames must be registered with the Philippine Patent Office (PPO). This registration is valid for 20 years from the date of issuance so long as the registrant files an affidavit of use with the PPO within one (1) year following the fifth, tenth and fifteenth anniversaries of the registration. However, in order for registration to be granted, the firm's home country must grant similar privileges to Filipinos, i.e., reciprocity.[2]

Methods of payment for imports are also regulated. Philippine imports may be financed by either letters of credit (L/Cs), documents against acceptance (D/A), or open account (C/A) arrangements. The Philippine Central Bank must approve importations maturing beyond 360 days, as such importations are treated as foreign borrowings.[3] Further detail on payment procedures can be found in Price Waterhouse, Doing Business in the Philippines (March, 1978).

In order to comply with Customs and International regulations, a number of documents are required for import of goods. These include:

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[1] SGV & Co., Doing Business in the Philippines 1980, p. 29.

[2] Guerrero & Torres, Primer on Doing Business in the Philippines 1980. p. 27.

[3] Price Waterhouse & Co., Doing Business in the Philippines, March, 1978, p. 43.

- Consular Invoice for shipments over ₱500 in export value;
- Certificate of Origin;
- Commercial Invoice;
- Bill of Lading;
- Inward Cargo Manifest;
- Delivery Permit;
- Central Bank Release Certificate.[4]

In setting up operations in the Philippines, if desired, the firm may establish and register any of the following:

1) Joint Venture Corporation
2) Branch
3) Subsidiary
4) Representative Office

The firm may enter into a joint venture corporation with Philippine residents, contributing equity, subject to Philippine participation regulations. Alternatively, a branch is considered an extension of a foreign enterprise, and is fully controlled by the parent company. All the assets of the firm may be held liable for the operations of the branch. A subsidiary, while normally mostly owned by the parent company, has a juridicial personality separate and distinct from its parent company, with the parent company insulated from subsidiary liabilities. Finally, the firm can establish a representative office, having a maximum of ten personnel of which only two can be expatriates.[5] Tax information of the various forms of operation can be found in SGV & Co., Doing Business in the Philippines 1980.

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[4] SGV & Co., Doing Business in the Philippines 1980, p. 36.

[5] Guerrero & Torres, op. cit., pp. 3-8.

Table 2 provides a summary of the information in the first case.

TABLE 2

Case 1 -- Export to the Philippines
General Information

- Prohibited from engaging in retail trade.
- Permitted to use trademarks and tradenames subject to reciprocity.
- Payment for exports via letters of credit, documents against acceptance, or open account arrangements.
- Importations maturing beyond 360 days must be approved by the Central Bank.
- A variety of documents required for goods to be imported (Consular Invoice on shipments over ₱500, Certificate of Origin, Commercial Invoice, Bill of Lading, Inward Cargo Manifest, Delivery Permit, Central Bank Release Certificate).
- Four types of Philippines business vehicles can be established -- joint venture corporation, branch, subsidiary, representative office.

B.3 Case 2 -- Produce and Sell in the Philippines

In the second case, a foreign firm is producing and selling photovoltaic products in the Philippines. All goods that are manufactured are sold in the Philippines; none of the firm's Philippine production is exported.

Photovoltaics is considered a "pioneer" area in the Philippines, and as a consequence, firms engaged in producing photovoltaic products qualify for special benefits and incentives once registered with the Philippine Board of Investments (BOI). A foreign firm is permitted to possess 100% of capital stock in a Philippine photovoltaics firm, whereas only 30% is generally allowed for firms engaged in non-priority activities. However, it should be noted that "pioneer" enterprises are required to attain Filipino status (60% Filipino ownership) within 30 years unless granted a 10-year extension by the BOI.[6]

[6] Philippine Board of Investments, Questions and Answers on Foreign Investments in the Philippines, June, 1980, pp. 4-5.

Photovoltaic enterprises also qualify for a variety of benefits under the Investment Incentives Act (R.A. 5186) as amended by Presidential Decree No. 1584. Table 3 summarizes the incentives provided to firms; specific provisions of the Act can be found in the BOI's, The Investment and Export Incentives Act. Further, a firm is able to qualify for additional incentives if it locates its production, processing and manufacturing plants in an area designated as less developed. The additional incentives include:

- Tax allowance to the extent of actual investment but not to exceed 30% of taxable income;
- Exemption from General Banking Act collateral requirement on loans against real estate security;
- Exemption from the payment of filing, processing and all other fees of BOI and Security and Exchange Commission if total assets are less than 1 million pesos.[7]

As part of its effort to respond to its need for greater self-sufficiency in energy resources, the Philippines extends additional benefits to those cited above to photovoltaic enterprises as part of its 1980 Energy Priorities Program. Projects registered under the program are accorded priority by all government-owned or controlled financing institutions, such as the Central Bank and the Development Bank, and are given preferential consideration on collateral, rediscounting and other requirements in order to facilitate the early establishment of the projects.[8]

Finally, photovoltaic enterprises, as are all foreign investors and enterprises, are given several basic rights and guarantees to ensure the safety of foreign investments. These include:

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[7] Philippine Board of Investments, Investment Opportunities in the Philippines, pp. 25-26.

[8] Philippine Board of Investments, 1980 Thirteenth Investment Priorities Plan, Sixth Public Utilities Plan and Energy Priorities Program, pp. 13-14.

TABLE 3

Case 2 -- Produce and Sell in the Philippines
Summary of Incentives Under Investment Incentives Act

- Deduction of organizational and preoperational expenses from taxable income.
- Deduction of labor training expenses.
- Accelerated depreciation.
- Carry-over as deduction of net operating losses incurred in any of first 10 years of operation.
- Exemption/reduction and/or deferment of tariff duties and compensating tax on importations of machinery, equipment and spare parts.
- Tax credit equivalent to 100% of the value of compensating tax and customs duties that would have been paid on machinery, etc. had it been imported.
- Tax credit for tax withheld on interest payments on foreign loans.
- Right to employ foreign nationals in supervisory, technical or advisory positions within 5 years from registration.
- Deduction from taxable income of a percentage of undistributed profits.
- Anti-dumping protection (i.e., limit imports that compete unfairly or unnecessarily).
- Protection from Government competition.
- Exemption from all taxes under the National Internal Revenue Code, except income tax on a gradually diminishing percentage.
- Post-operative tariff protection.

Source: Philippine Board of Investments, Investment Opportunities in the Philippines.

- Basic rights and guarantees under the Constitution;
- Right to repatriate investments and remit earnings;
- Right to remit foreign exchange to service foreign loans and obligations arising from technological assistance contracts;
- Freedom from expropriation of property except for public use, national welfare and defense upon payment of just compensation;
- Freedom from requisition of investment, except in event of war or national emergency and only for the duration thereof and with just compensation.

P.4 Case 3 -- Produce in Philippines and Sell in Philippines and/or Abroad

In the third case, a foreign firm is producing photovoltaic products in the Philippines. It may either sell part of its goods in the Philippines and part abroad, or export all of its Philippine production.

In an effort to develop the country's export trade, the Philippines offer benefits and incentives in addition to those delineated in Scenario 2, to photovoltaic enterprises that produce for export. Photovoltaic enterprises that export at least 70% of their total production are allowed an additional 10 years to attain Filipino status, 40 years as opposed to 30 years. Further, these firms are still eligible for a 10-year extension by the BOI. Moreover, if a firm exports 100% of its production, it need not attain Filipino status.[9]

Photovoltaic firms registered with the BOI as a "registered export producer," also qualify for additional benefits under the Investment Incentives Act and the Export Incentives Act (R.A. 6135) as amended by Presidential Decree No. 1646. Incentives afforded firms are summarized in Table 4. Further detail on the incentives to "registered export producers" can be found in BOI, The Investment and Export Incentives Act and Invest-Investment Opportunities in the Philippines.

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[9] SGV & Co., Doing Business in the Philippines 1980, p. 65.

TABLE 4

Case 3 -- Produce in Philippines and Sell in Philippines and Abroad
Summary of Incentives in Addition to those of Scenario 2

- Tax credits on taxes and exemption from duties on supplies used in production of exported goods.
- Additional deduction from taxable income of direct labor cost and local raw materials utilized in manufacture of export products (not to exceed 25% of total export revenues).
- Exemption from sales tax on export products sold to other export producers or export traders.
- Employment of foreign nationals within 5 years from operation or even after said period in exceptional cases.
- Exemption from export and stabilization taxes.
- Additional incentives wherever processing or manufacturing processing or manufacturing plant is located in an area designated by BOI as necessary for proper dispersal of industry or which is deficient in infrastructures.

B.5 Summary

The Philippines, in an attempt to attract foreign investment and further develop its economy, offers a host of incentives and benefits to foreign firms establishing enterprises in the Philippines. Table 5 summarizes benefits for the three cases we have examined. Incentives are provided in many forms, primarily by lowering tax expenses and generating an environment conducive to firm operation.

Photovoltaics, by virtue of its "pioneer" status, qualifies for most of the incentives offered, as long as goods are produced in the Philippines. In addition, supplemental benefits can be received if the firm exports a portion of its Philippine photovoltaics production and if the firm locates its plants in an area designated as less developed. In either case, though, firms are subject to the regulations on registration, Filipino status and other matters that govern doing business in the Philippines.

TABLE 5

Incentives to P/V Firms Doing Business in the Philippines

Incentive	Firm that[1] Exports to Philippines	Firm that Manufactures and Sells in Philippines	Firm that Manufactures in Philippines and Exports some of Product Abroad
Deduction of organizational and pre-operational expenses		X	X
Deduction of labor training expenses		X	X
Accelerated depreciation		X	X
Carryover as deduction of net operating losses		X	X
Exemption/reduction of tariff duties on imports		X	X
Tax credit on value of customs duties		X	X
Tax credit for tax withheld on interest payments on foreign loans		X	X
Right to employ foreign nationals in supervisory, technical or advisory positions within 5 years from registration		X	X
Deduction of a percentage of undistributed profits		X	X
Anti-dumping protection		X	X
Protection from Government competition		X	X
Exemption from all taxes under National Internal Revenue Code, except income tax		X	X
Post-operative tariff protection		X	X
Tax credits on taxes and duties on supplies used in production of exported goods			X
Deduction of direct labor cost and local raw materials used in manufacture of exports			X

(cont'd.)

TABLE 5

(cont'd.)

Incentive	Firm that[1] Exports to Philippines	Firm that Manufactures and Sells in Philippines	Firm that Manufactures in Philippines and Exports some of Product Abroad
Exemption from sales tax on export products sold to other export producers or export traders			X
Employment of foreign nationals within 5 years from operation			X
Exemption from export and stabilization tax			X
Additional incentives depending on location of plants	X		X

[1]Note: Assumed here that firm does not operate Philippine office.

APPENDIX C

TARIFF RATES

Import duties for energy systems equipment and supplies are based on ad valorem with duty rates as follows:

Code	Description	Rate
84.01	Steam and other vapour generating boilers (excluding central heating hot water boilers capable also of producing low pressure steam); super-heated water boilers......................................	10%
84.02	Auxiliary plant for use with boilers (for example, economisers, superheaters, soot removers, gas recoverers and the like...........................	10%
84.06	Internal combustion piston engines:	
	A. Parts of internal combustion piston engines:	
	1. Articles not included in sub-heading A-2 hereof................................	10%
	2. Cylinder liners and sleeves................	50%
	B. Internal combustion engines other than for motor vehicles................................	10%
84.07	Hydraulic engines and motors (including water turbines and water wheels).......................	10%
84.10	Pumps (including motor pumps and turbo pumps) for liquids, whether or not fitted with measuring devices, liquid elevators of bucket, chair, screw, band and similar kinds:	
	A. Articles not included in sub-heading B hereof..	10%
	B. Centrifugal water pumps, single stage, single suction, horizontal shaft type suitable for belt drive or direct coupling (except pumps with shafts common with prime mover), with casings and impellers of cast iron or bronze; piston or plunger type hand pumps.............	30%
84.13	Furnace burners for liquid fuel (atomizers) for pulverised solid fuel or for gas; mechanical strokers, mechanical grates, mechanical ash dischargers and similar appliances.................	10%

Code	Description	Rate
85.01	Electrical goods of the following descriptions: generators, motors, converters (rotary or static), transformers, rectifiers, and rectifying apparatus, inductors:	
	A. Parts and accessories of electric motors and generators:	
	1. Articles not included in subheading A-2 hereof..............................	30%
	2. Stator with windings, machined die casted rotor and completely machined end bells...	50%
	B. Motors over 30 HP, electric generator, high tension transformers (including main and sub-station transformers), loading coils, inductors, converters, rectifiers and battery charges; television yokes and flyback transformers and parts thereof................................	30%
	C. Other..	50%
85.19	Electrical apparatus for making and breaking electrical circuits, for the protection of electrical circuits, or for making connections to or in electric circuits (for example, switches, relays, fuses, lighting arresters, surge suppressors, plugs, lamp-holders, and juction boxes resistors, fixed or variable (including potentiometers), other than heating resistors; printed circuits, switchboards (other than telephone switchboards) and control panels:	
	A. Component parts of magnetic starters and circuit breakers imported with prior authorization of the Board of Investments under a progressive manufacturing program.........................	10%
	B. Other..	50%
85.23	Insulated (including enamelled or anodised) electric wire, cable, bars, strip and the like (including coaxial cable), whether or not fitted with connectors:	
	A. Litz wire (fine copper wire covered with cotton or nylon thread used in radio or TV coils); sub-marine communication cables; lead-covered terminating cables and stalpeth cables.........	30%
	B. Other..	50%

APPENDIX C (CONT'D)

Code	Description	Rate
85.25	Insulators of any material......................	30%
85.26	Insulating fittings for electrical machines, appliances cr equipment, being fittings wholly of insulating material apart from any minor components of metal incorporated during moulding solely for purposes of assembly, but not including insulators falling within heading No. 85.25................	30%
85.27	Electrical conduit tubing and joints therefore, of base metal lined with insulating material......	30%
85.28	Electrical parts of machinery and apparatus, not being goods falling with any of the preceeding headings of this Chapter.........................	50%
90.24	Instruments and apparatus for measuring, checking or automatically controlling the flow, depth, pressure or other variables of liquids or gases, or for automatically controlling temperature, (for example, pressure gauges, thermostats, level gauges, flow meters, heat meters, automatic oven draught regulators), not being articles falling within heading No. 90.14................................	10%
90.25	Instruments and apparatus for physical or chemical analysis (such as polarimeters, gas analysis apparatus); instruments and apparatus for measuring or checking viscosity, porosity, expansion, surface tension or the like (such as viscometers, porosimeters, expansion meters); instruments and apparatus for measuring and checking quantities of heat, light or sound (such as photometers (including exposure meters, calorimeters); microtomes..................	10%
90.26	Gas, liquid and electricity supply or production meters; calibrating meters thereof;	
	A. Articles not included in subheading B hereof...	20%
	B. Totalizing water meters........................	50%
90.28	Electrical measuring, checking analyzing or automatically controlling instruments and apparatus.	20%

APPENDIX D

DESCRIPTION OF FINANCIAL INSTITUTIONS THAT INVEST IN AGRICULTURE

- Commercial Banks

Commercial banks are the more sophisticated members of the banking sector. They accept savings and checking or current accounts and other usual bank services like loans and trust holdings, extend domestic and export letters of credit and trust receipt services. They are also active in the money market and in small loans to small and medium-scale industries. In the Philippines, some banks are even involved in credit card operations and financing through a system of sister companies.

Credits granted by commercial banks consist loans, advances, discounts, overdrafts, domestic bills, customer's liability acceptances and export bills.

Of the ₱52,510.7 million total credits granted by commercial banks in 1977, 72.29 percent or roughly ₱38.0 billion went to private businesses and individuals. Credits granted to local governments as well as semi-government entities reached ₱6,048.8 million or 11.52 percent while another 6.23 percent or ₱3,270.0 million was availed of by the national government.

- Savings and Mortgage Banks

A savings and mortgage bank is any corporation organized primarily for accumulating the small deposits of the public and reinvesting them in bonds, in loans secured by pledge or chattel mortgage certificates, buying and selling them or receiving them in payment of loans. However, a savings bank cannot engage in foreign exchange trading, nor can it open letters of credit. It can grant all kinds of loans extendable by commercial banks, except character loans or overdraft lines which are payable on a medium or long-term basis.

Total resources of savings banks amounted to ₱2,810.4 million as of the end of 1977. Total loans outstanding of savings and mortgage banks on the other hand, amounted to ₱1,954.9 million broken down as follows: agricultural - ₱200 million; commercial - ₱2 million; industrial - ₱22 million; real estate - ₱1,112 million; consumption - ₱195 million; and sundry - ₱424 million. Investments in bonds and other securities meanwhile reached ₱415.3 million. Total loans and investments made by the savings banks reached ₱2,370.2 million in 1977.

- Rural Banks

Rural banks are generally small regional unit banks. In terms of assets and size, they are smaller than either the savings or commercial banks. They perform the same savings and loan services as thrift banks but rural banks specialize in extending small loans to farmers. Some, are also authorized to accept demand deposits or checking accounts. All rural banks are privately owned, but they receive financial and technical assistance and incentives from the government. Their main sources of funds therefore are the deposits of rural savers and the financial assistance of the government.

About ₱977.5 million or 47.3 percent of the total loans granted was made under the supervised credit scheme. The balance of ₱1,088.2 million or 52.7 percent was extended under the non-supervised credit program.

Agricultural loans accounted for 87.1 percent of the total loans granted for the year. Commercial loans represented 8.7 percent, while industrial and other loans constituted 2.7 and 1.5 percent, respectively. Investment in securities on the other hand, reached ₱832.1 million.

The rural banking system aims to accomplish the following goals and objectives: 1) to continue to support the food production program and other developmental projects of the government through active participation in the various special financing programs; 2) to exert more efforts in mobilizing savings and promoting capital formation to be able to provide more and better service to small farmers and producers in the rural areas; 3) to step up participation in the fourth Central Bank-International Bank for Reconstruction and Development (CB-IBRD) rural credit project to meet the increasing demands of agriculture and industries for medium and long-term credit; 4) to cooperate with the government in devising ways and means to reduce the percentage of arrearages of the system to a more manageable level; and 5) to pursue a program of developing managerial skills and personnel capabilities through sustained training programs and seminars, so that rural banks will be in a better position to cope with their day-to-day operational problems.

- Land Bank of the Philippines

The Land Bank is charged with the responsibility of giving financial support to three of the more important aspects of the agrarian reform program namely: 1) the transfer of ownership of agricultural lands covered by the agrarian reform from landlord to tenant-farmers; 2) the effort to help farmer-beneficiaries of land reform increase their productivity and income; and 3) the redirection of land-owner resources to industry or other productive endeavors.

Moreover, the bank in its capacity as administrator of two agricultural guarantee funds (the Land Bank Agricultural Guarantee Fund (LB-AGF) and the Agricultural Guarantee Fund (AGF-R.A. 6390)), extends coverage on certain types of loans granted to farmers by selected lending institutions. Through its guarantee operations, the bank makes it possible for farmers with meager resources to undertake productive activities by encouraging lending institutions to extend credit without being too strict about collateral requirements.

- Development Banks

Except for the Development Bank of the Philippines (DBP), development banks are usually small in size and operate as regional banks. While they rely heavily on local or foreign borrowings through a program of bond issues, they are also authorized to generate deposit funds from the public as their source of funds for the loans and financing services they provide.

Development banks usually provide short-to-long term financing for productive enterprises on a secured basis. Compared with commercial banks which can loan or finance an enterprise without collateral or security for the amount borrowed, development banks and thrift banks are security or collateral oriented.

Foremost among the development banks is the Development Bank of the Philippines. It is entrusted with the responsibilities of providing credit facilities for the rehabilitation, development and expansion of agriculture and industry, the reconstruction of the national economy, and the promotion and establishment of private development banks in provinces and cities.

As of year-end 1977, total resources of the DBP rose to new levels - ₱15.7 billion as against ₱12.7 billion in 1976.

Investments in securities also increased by ₱573 million from ₱2.1 billion to ₱2.6 billion. Of these outstanding investments, ₱2.12 billion or 81 percent are investments in government securities and ₱503 million or 19 percent are private securities. Loan portfolio as of December 31, 1977, likewise increased by ₱1.8 billion or 23 percent from ₱7,870.2 million to ₱9,665.9 million.

The thrust of lending operations of the bank during the period under review continued to be on countryside development as well as on small and medium-scale industry financing. Under the DBP's countryside development program, equal attention is given to agricultural and industrial projects. In agriculture, priority is given to projects geared towards self-sufficiency in food, production of raw materials for local industry needs and diversification of agricultural exports.

- Non-Bank Financial Institutions

The non-bank sector, while extending financial services to the commercial and industrial sectors of the economy, has a different source of funds. Non-banks cannot generate deposit funds from the public, thus they generally resort to stockholder's funds and deposit substitute liabilities to fund lending activities. Deposit substitutes are financial instruments held by the non-banking sector as part of its funds. These include commercial papers such as stocks and bonds, short and long-term debt instruments, and other credit instruments obtained from money market activities. The non-bank sector also borrows funds to finance its services.

Non-bank financial institutions include: the National Investment and Development Corporation (NIDC), Private Development Corporation of the Philippines (PDCP), BANCOM Development Corporation, Non-Stock Savings and Loan Associations, the Government Service Insurance System (GSIS), Social Security System (SSS), Agricultural Credit Administration (ACA), and Mutual Building and Loan Association (MBLA).

The NIDC, PDCP, and BANCOM Development Corporation provide primarily long-term financing for expansion and modernization of productive ventures and for facilitating short-term placements to commercial banks. Stock Savings and Loan Association contributes to home savings and to the growing need for more savings institutions.

- Government Non-Bank Financial Institutions

Loanable funds of government non-bank financial institutions (comprising the GSIS, SSS, ACA and NIDC) released their funds in 1977 for the following purposes: agricultural - ₱40 million; industrial - ₱40 million; consumption - ₱893 million; real estate - ₱579 million; public utility - ₱21 million and other purposes (consisting mostly of notes receivable from financial firms) - ₱2,359.4 million. Combined, these loans aggregated ₱3,932.8 million reflecting an expansion of 49 percent over the level of the preceding year. Accounting for the increase was the ₱1,619.2 million growth in other purpose loans which more than offset the decreases in loans for industrial, consumption, real estate and public utility purposes.

- Agricultural Credit Administration

Created under R.A. 3844, also known as the Agricultural Land Reform Code, the Agricultural Credit Administration (ACA) was specifically designed to help farmers elevate their living standards to make them active factors in the country's economic development. Its activities are therefore, geared at raising the economic well-being of the rural populace by increasing their agricultural production. To achieve this end, it provides the farmers with the necessary technical guidance and credit assistance for the cost of production inputs.

The ACA grants six types of loans, namely: production, facility, commodity, marketing, operating capital and poultry loans. A major portion of the loans granted from 1960 to 1977 were of the production, commodity and marketing types. These three types of loans, constituted an average of 66.7, 6.0 and 21.7 percent respectively, of the total loans granted in 1977 of ₱49.7 million.

- Private Non-Bank Financial Institutions

Private non-bank financial enterprises showed reduced lending operations in 1977 as loans granted totaling ₱1,410 million declined by 28 percent from the previous year's figure of ₱1,969 million. These loans were released by BANCOM, PDCP, MBLA and Non-Stock SLA for various purposes, namely: agricultural - ₱28 million; commercial - ₱46.2 million; real estate - ₱172.3 million; public utility - ₱9.7 million; and others - ₱707.2 million. Except agricultural purpose loans which expanded by more than two times, other types of loans registered decrements ranging from 3 percent to 83 percent as against their respective levels in 1976.

- Investment Houses

Investment houses grant medium to long-term loans for capital expansion purposes. The basic function of investment houses, however, is the underwriting and distribution of securities of other corporations. Commissions and services from this function and earnings from money market activities are their main sources of funds.

Finance companies on the other hand, are authorized to finance consumer durables under installment payment plans. They usually extend short-to-medium term credit to manufacturers and merchants for inventory, receivable financing and transport equipment leasing. Financing companies usually rely on stockholders funds and cash generated from their money market activities to finance their operation.

The Private Development Corporation of the Philippines is a development finance institution which is committed to encourage the emergence and growth of Philippine productive enterprises by providing technical and financial assistance through the purchase of equity investments and expertise.

The BANCOM Development Corporation extends assistance to projects which are viewed to be primary contributors to the acceleration of the country's economic development. Most of these projects are registered with the Board of Investments and are involved in the production of essential products like petroleum, mining, wood, pharmaceutical, paper, sugar and coconut. Like the PDCP, it also engages in money market operations and it has actively engaged in the organization of the Money Market Association of the Philippines.

APPENDIX E

ASSUMPTIONS USED IN THE FINANCIAL AND ECONOMIC ANALYSES

This appendix lists the methodology, data and assumptions used in the financial and economic analyses described in Chapter 8. They reflect actual conditions existing in the Philippines in October/November, 1980. Fuel cost escalations of 31% and 24% for gasoline and diesel, respectively, are the average values experienced between 1975 and 1980. A 3% escalation rate reflects the generally accepted value of worldwide fuel cost escalations.[1] A discount rate of 21% for the financial analyses is equal to the commercial bank loan rate and reflects the project evaluation criteria used by the Development Bank of the Philippines project staff. Sources of other data and assumptions are clearly stated at the bottom of each table.

Method of Calculating Present Value of Life Cycle Costs (PVLCC)

Assume an initial cash flow at time zero followed by cash flows at the end of each year, n, where n=1,2,3 -- N; N being the life in years of the system. The various present values, P, to be calculated are defined below.

1) Fuel -- The cost of fuel during the first year is C_E, its cost escalation rate is E, and the discount rate (or expected after-tax rate of return on investment) is R. The present value of fuel costs is:

$$P_E = C_E \sum_{n=1}^{N} \left(\frac{1+E}{1+R}\right)^n = C_E \cdot PWF(R_E, N) \qquad (1)$$

Where the present worth factor $PWF(R_E, N)$ is just a closed form for the summation of Eq. (1). It is:

$$PWF(R_E, N) = \frac{1-(1+R_E)^{-N}}{R_E} \qquad (2)$$

[1] IBRD estimates

Where:

$$R_E = \frac{R-E}{1+E} \tag{3}$$

2) <u>Maintenance, Property Taxes, and Operating Cost</u> -- The first year cost is C_M; it is assumed to escalate at the average inflation rate I. Its present value is:

$$P_M = C_M \cdot PWF(R_I, N) \tag{4}$$

Where:

$$R_I = \frac{R-I}{1+I} \tag{5}$$

3) <u>Fuel Transportation</u> -- The first year cost is $C_T LQ$ where C_T is the first year cost per distance per quantity of fuel; L is the round trip distance and Q is the quantity needed per year. The cost escalation rate for transportation is T. The present value of fuel transportation is:

$$P_T = C_T LQ \cdot PWF(R_T, N) \tag{6}$$

Where:

$$R_T = \frac{R-T}{1+T} \tag{7}$$

4) <u>Initial Cash Disbursement</u> -- This is the total initial investment, P minus the fraction FP that is borrowed. It is:

$$P_C = (1-F)P \tag{8}$$

5) Repayment of Loan Principal -- We will assume that the loan principal is repaid in N, equal annual installments beginning at the end of the first year. The present value of these cash flows is:

$$P_P = \frac{FP}{N} \cdot PWF(R, N) \qquad (9)$$

6) Interest Payments -- Interest, at an annual rate J, is paid on the remaining principal at the end of each year. The present value of the interest payments is:

$$P_J = \frac{FPJ}{N} \sum_{n=1}^{N} \frac{N+1-n}{(1+R)^n} = \frac{FPJ}{N}\left[\frac{N-PWF(R,N)}{R}\right] \qquad (10)$$

(When R=J, it is not necessary to compute this since one can get P_J more easily from the relation $P_J + P_P = FP$).

7) Depreciation -- This is needed for a country in which depreciation is a tax deductible expense. It can have many forms. For the sum-of-the years-digits method, its present value is:

$$P_D = \frac{2P}{N(N+1)} \sum_{n=1}^{N} \frac{N+1-n}{(1+R)^n} = \frac{2P}{N(N+1)R}\left[N-PWF(R,N)\right] \qquad (11)$$

and P_D = lump sum depreciation for P/V systems in the Philippines.

8) Government Credits -- These can be state or Federal tax credits on renewable energies or the investment tax credit (ITC). They are paid at the end of the first year. Denoting by C_K the total fraction of the investment for which credit is given, the present value of the credits is:

$$P_K = \frac{C_K P + ITC}{1+R} \qquad (12)$$

9) <u>Replacement Costs</u> -- Major items may need replacement in certain years. If the replacement cost today is C_R and the replacement cost escalation rate is I, then the present value of replacements is:

$$P_R = C_R \sum_n \left(\frac{1+I}{1+R} \right)^n \tag{13}$$

Where n is the number of the year in which a replacement is made, for example, n = 5 and 10 years.

10) <u>Salvage Value</u> -- Assuming the salvage value to be a fraction f of the total initial investment P, which includes civil works buildings, etc., the present value is:

$$P_S = P \cdot f \cdot \left(\frac{1+I}{1+R} \right)^N \tag{14}$$

The total present value of the life cycle costs is a suitable sum of these individual present values multiplied by the marginal tax rate t as necessary. It is:

$$PVLCC = P_k + tP_D - P_c - P_p - (1-t)\ (P_E + P_M + P_T + P_J + P_R - P_S) \tag{15}$$

For tax purposes, the replacement costs have been treated as expense items although they should be capitalized and be depreciated separately from the rest of the system. If this appears to be necessary for any of the countries, it can be done. Other changes may also be necessary for certain countries.

The PVLCC, as computed from Eq. (15) and the preceeding equations, must be applied to systems that do approximately the same job. The system with the smallest (least negative) present value would be preferred.

TABLE 1 POWER AND MONTHLY ENERGY REQUIREMENTS FOR AGRICULTURAL APPLICATIONS

Application	Power Required KW(Capacity)	Energy Used (Kwh/Month)											
		JAN.	FEB.	MAR.	APR.	MAY	JUN	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.
1 HA Rice Garden plus Dryers in Laguna	1.9	215	264	112	151	204	195	164	164	142	179	133	219
1 HA Rice Double Crop	1.9	136	0	0	0	0	190	166	141	130	132	96	184
2 HA Rice Double Crop	4	272	0	0	0	0	380	332	282	260	264	192	368
6 HA Rice Double Crop	6	816	0	0	0	0	1,140	996	846	780	792	576	1,104
1 HA Rice Double Crop & Corn	1.9	136	125	168	195	32	190	180	141	130	132	96	186
2 HA Rice Double Crop & Corn	4	272	290	336	390	64	380	332	282	260	264	192	368
6 HA Rice Double Crop & Corn	6	816	750	1,008	1,170	192	1,140	996	846	780	792	576	1,104
Rice "Steel" Mill (Small)	3.1	←					260						→
Rice "Steel" Mill (Average)	4.4	←					232						→
Rice "Steel" Mill (Large)	7.2	←					602						→

TABLE 1 POWER AND MONTHLY ENERGY REQUIREMENTS FOR AGRICULTURAL APPLICATIONS

Application	Power Required KW(Capacity)	Energy Used (Kwh/Month)											
		JAN.	FEB.	MAR.	APR.	MAY	JUN	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.
Forestry Station	1.2	←			76								→
Commercial Farm Maintenance Yard	1.2	←			194								→
Slide Projector for Agri. Ext.	0.4	←			8								→
Hatchery-Fish Stock Gathering	0.02	←			1								→
Battery Charger for Logging Site	0.14	←			9								→
Commercial Farms Communication	0.1	←			1								→
Prawn and Fish Hatchery	0.9	←			560								→
Small Ice Plant	11	←			8,030								→
10 HA Fish Pond	5	760	760	←	1,064		→	←		760			→
30 HA Fish Pond	10	1,520	1,520	←	2,120		→	←		1,520			→
10 HA Salt and Fish Ponds	5	←		[illegible]			→	←		760			→

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TABLE 1 POWER AND MONTHLY ENERGY REQUIREMENTS FOR AGRICULTURAL APPLICATIONS

Application	Power Required KW(Capacity)	Energy Used (Kwh/Month)											
		JAN.	FEB.	MAR.	APR.	MAY	JUN	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.
Corn Grinder Low Usage	2.3						111						
Corn Grinder Average Usage	2.3						405						
Corn Grinder Hig Usage	2.3						740						
Corn Roller Mill Low Usage	11.15						669						
Corn Roller Mill Average Usage	11.15						1,606						
Corn Roller Mill High Usage	11.15						4,080						
Standard Application 8 hr./day	0.3						73						
Every day of the year at full load.	0.8						195						
	2						487						
	4						973						
	10						2,433						
	20						4,866						

TABLE 2

COST ASSUMPTIONS

	Financial Analysis	Economic Analysis
Inflation	13%	-
Discount Rate	21%	12%
Loan Rate		
I. Commercial Bank	21%	-
II. Development Bank	14%	-
Life of Equipment	Equipment Lifetime	Equipment Lifetime
Fuel Escalation Rate		
I. Gasoline, Diesel	31%, 24% (nominal)*	3% (real)
II. Gasoline, Diesel	16.4% (nominal)*	3% (real)
Analysis Lifetime	15 years	15 years
Depreciation		
I. P/V	Lump Sum	-
II. Conventional	Sum-of-Digits	-
Marginal Tax Rate	5%	-
Debt/Equity Rates	0.90	0
Salvage Value	10%	-
Labor Cost	$1/hour	$1/hour

*NOTE: 31% nominal = 16% real
24% nominal = 10% real
16.4% nominal = 3% real

TABLE 3

P/V SYSTEM COST PROFILE

Year	Cost (1980 $) $/Wp
1980	$20.85
1982	11.73
1984	9.14
1986	6.55
1988	5.28
1990	4.40

NOTE: Operation and maintenance labor costs were 0.25 hours per operating day per KWp.

SOURCE: The 1980, 1982 and 1986 values are from the draft JPL, 1981 Photovoltaic Systems Development Program Summary Document. The others are DHR's estimates.

TABLE 4

FUEL COSTS

	Cost (1980 $/U.S. Gallon)	
	Diesel	Gasoline
Financial Analysis	1.43	2.42
Economic Analysis	1.18	1.18

NOTE: Cost/gallon used in the economics analysis equals the retail cost less all taxes.

SOURCE: Philippines Ministry of Energy.

TABLE 5

SAMPLE SOLAR INSOLATION

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Insolation (Langleys)	360	442	523	588	510	458	410	371	384	374	352	340

SOURCE: Angus, J.F. and Manalo, E.B., "Weather and Climate Data for Philippine Rice Research," IRRI Research Paper Series, No. 41, November, 1979.

Table 6: CONVENTIONAL POWER SYSTEM CHARACTERISTICS

			Fuel Consumption Gallons/Hour			Operation and Maintenance		
Rated Output (kw)	Cost 1980$	First Year Capital Cost Multiplier[1]	100% Load	50% Load	Fuel Type	Labor Hours/ Hrs. of Operation	Parts $/Hours of Operation	Lifetime (hours)
0.3	320	1.0	0.13	0.09	Gas	0.02	0.20	2000
0.4	370	1.1	0.13	0.09	Gas	0.02	0.20	2000
0.8	468	1.2	0.26	0.18	Gas	0.02	0.20	2000
1.2	527	1.2	0.31	0.20	Gas	0.02	0.20	2500
4.0	4000	1.4	0.43	0.25	Diesel	0.03	0.30	3000
6.0	4500	1.4	0.64	0.43	Diesel	0.03	0.30	3000
8.5	6732	1.4	0.80	0.55	Diesel	0.03	0.30	4000
10	7588	1.5	0.93	0.60	Diesel	0.03	0.40	4000
12	7615	1.5	1.20	0.70	Diesel	0.035	0.40	4000
15	7730	1.5	1.50	0.90	Diesel	0.035	0.45	5000
20	8685	1.6	1.65	1.15	Diesel	0.04	0.50	5000

[1] Capital cost multiplier accounts for support facilities such as fuel tank, buildings, etc. needed for the generator.

NOTE: In some applications (e.g. larger irrigation pumps) P/V-powered machines could be unattended whereas diesel or gasoline powered machines would require a full-time operator. In such cases the operator's wages (estimated in the Philippines as $1/hour) are a distinct cost advantage for P/V systems.

SOURCE: Honda, Onan and Kohler Technical Representatives.

APPENDIX F

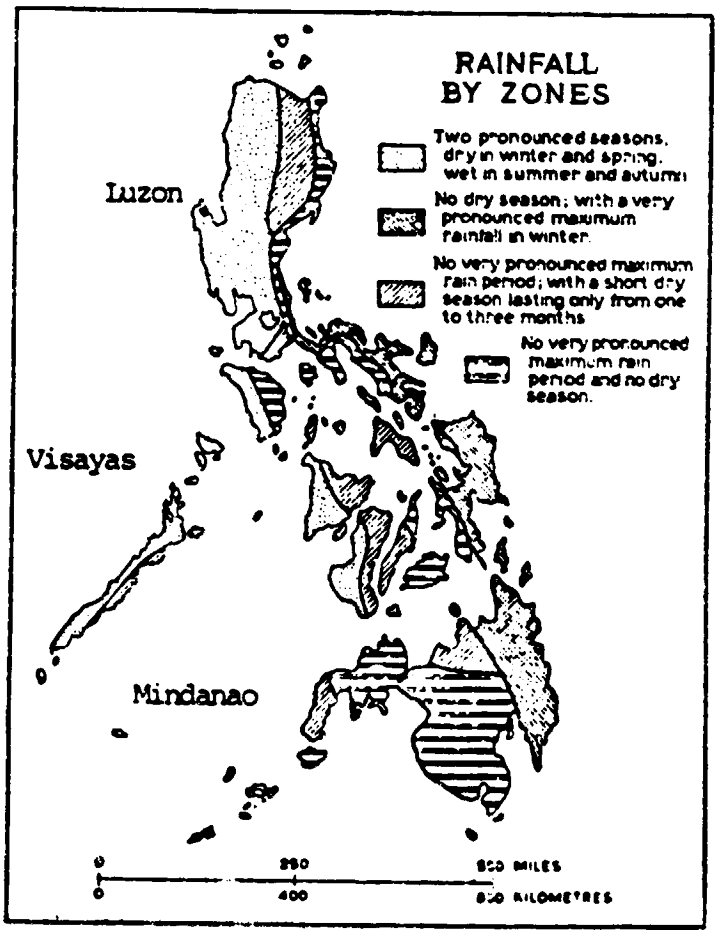
Climate, Agricultural Regions, and Major Domestic and Export Crops of The Philippines

Domestic: rice, maize, wheat, sweet potatoes, fish, cassava

Export: sugar, bananas, pineapple, coconut, coffee tobacco, wood

Sixty percent of the 31 million population of the Philippines depend upon agriculture for their livelihood. Agriculture accounts for 30% of the GDP, more than 50% of employment, and close to 60% of export earnings.

The Philippines is an archipelago, divided into three island groups: Luzon, Visayas and Mindanao. It consists of 7,100 islands, eleven of them comprising in area more than 95% of the total country area. Luzon, in the north, is the largest island. Mindano is the second largest and lies in the south. The other nine islands, the Visayas, constitute 29% of the total country area.



To a large extent the Philippines is a mountainous country with ranges lying close to and parallel with the coastlines. One of the main impediments to increased production of food is bad weather. The country is normally visited by about 20 tropical cyclones (storms and typhoons) annually causing damage to crops and livestock. Four types of climate are characterized by either the length of absence of a dry season, or by the timing of maximum rainfall. The western part has a dry season lasting from December to May. The eastern part has no dry season but a very pronounced rainfall from December to February. The central part of the country has two climates: in the north a short dry season which lasts from 1-3 months; in the south rainfall is fairly well distributed throughout the year but the total amount is less than that in the eastern part of the country. The mean annual rainfall for the entire country is 2,530mm.

Agriculture, fishery and forestry contributed, in 1979, 26% of the gross national product. Almost half of the Philippine's population is agricultural (21,529,000). Sixty-five to seventy percent of this population are rice and/or maize semi-sufficient farmers. Eight million hectares are classified as arable and permanent cropland, providing less than .4 ha. per agricultural caput. Average farm size has been estimated at close to 3½ hectares. Land is perhaps the biggest constraint in Philippine agriculture; next comes water; then comes labor.

Central Luzon is the nation's rice bowl, with the bulk of irrigated land occurring in this section. The northern regions (Ilocos, Cagayan Valley and Central Luzon) and the western Visayas are the most important areas of intensive crop farming. Large tracts of arable land are left fallow in the eastern Visayas and Mindanao. Large-scale operators everywhere are involved in sugar, bananas and pineapple for export, and are increasingly taking over poultry and swine production. Smallholders primarily produce food grains for domestic use and coconut for export.

Livestock: Most of the cattle are raised by small-scale farmers, each with one to several head. Meat consumption is low and native cattle are raised primarily as work animals, second in importance only to the carabao. This water buffalo plows the rice paddies and other land, is a main source of transportation, and an emergency source of cash. Carabaos also account for 2/3 the beef supply. Most animals are maintained by grazing on fallow fields and harvest stubble with a supplementary feeding of rice straw.

The Philippine dairy farming industry is very limited. Presently there are only a few commercial dairy operations.

Poultry production (eggs and meat) has become highly commercialized (65% of the chicken population) in locations near metropolitan areas, and continues to expand. The Philippines is now self-sufficient in poultry, and increased development is being hindered by the high cost of protein feed ingredients which are mostly imported.

Commerical piggeries currently account for 10% of the country's pork production, the balance being in small backyard operations. A few corporations operate large holdings (10,000-15,000ha.) and corporations have set up a few feed-lot fattening businesses to utilize waste from primary enterprises. Total number of cattle at a given time is about 6,000 head.

Forestry: Forest products rank among the country's top four categories in export value. Mahoganies make up the bulk of lumber exports.

Fishing: Although the Philippines lies in a fertile fishing belt, the domestic fishing has remained underdeveloped. Obsolete techniques, inadequate refrigeration and marketing facilities, and lack of investment capital have handicapped the industry so that production does not meet even domestic needs. The annual fish catch in 1977 totaled 1,510,789 MT which was mostly anchovies, mackerels, sea bass, sardines, tuna, bonito and shark.

Small-scale, traditional fishermen in the Philippines use gear not requiring boats, or boats of three tons or less. More than one-third of the fishermen are dependent upon mototized bancas (consuming an average of 1200 liters of gasoline each every year), but almost all fishing gear is totally non-mechanical. (The primary exception to this are the artificial lights used in basnig-fishery where fish are guided into surrounding nets by the light. Ninety percent of the sardines are caught in this method.)

Traditional fishermen fish both inland and ocean waters. There are approximately 600,000 traditional fishermen located in some 10,000 coastal fishing villages throughout the country. They use innumerable techniques such as brush traps, tubular split bamboo traps, bamboo wiers of elaborate design and size, "Kalaskas" boats which have bamboo and rattan root scares-sweepers, dkimming nets, "Sapyan" shoal nets, purse seines, and tiny cover pots for use in the paddy fields.

Fishing villages are generally without wharves, cold storage facilities, ice plants, or fish markets. In fact, fishermen are dependent upon those who market their catch. The relationship between fisherman and buyer is called "suki." While suki has mutually beneficial aspects, fishermen often end up indepted to buyers and boat owners.

By presidential decree in 1972, the country undertook the land reform task of transferring ownership of farmland to about half the country's million landless tenants. By September 1979, the Ministry of Agrarian Reform reported having issued 427,149 Certificates of Land Transfer (CLT) to 308,068 tenants cultivating 525,590 hectares.

(2) Agricultural Development Plans

The long term development goal is that of achieving self-sufficiency in agricultural production. High priority, therefore, is centered upon food production and distribution, fisheries, livestock, and related agricultural activities. The main thrust is the production of cheap but highly nutritious foods that can also generate export earnings. The government has launched the Bakahang Barangay (backyard cattle raising) project and has implemented a Dairy Industry Development Act to attain self-sufficiency in beef by 1985 and cut dairy imports. The Ministry is also making efforts to establish crops traditionally imported, such as soybeans, wheat, and cotton.

The Philippines has reached self-sufficiency in rice, and government efforts are now on increased production of yellow maize, and sorghum. The Philippine Coconut Authority (PCA) has started a program for replanting old areas and planting improved hybrid varieties. A plant for production of soybean products is being constructed which will require 500 tons of soybeans during the first three years of operation, 50% of which is to be locally grown soybeans. Banana hectarage are planned for a 25% increase, land allocated to producers according to past performance.

(3) Income Distribution

Seventy-four percent of farm families in 1971 did not receive enough income to meet the food poverty threshold, as calculated by the Bureau of Census and Statistics using A.S. Abrera's "Philippine Poverty Thresholds" document. Poverty distribution was relatively even across all eleven islands, only falling down to 60% for farm families in Central Luzon. The bulk of those farmers with the lowest incomes were the 40% of the nation's cultivators who have less than two hectares of land.

(4) Credit, Cooperatives, and Extension Services

Credit: Most farm investment is financed by non-institutional means by the farmer---through relatives, landlords, or private moneylenders.

Production credit is granted by rural banks and the Philippine National Bank (the latter is the main source of credit for sugar planters). An agency for small farmer credit, the Agricultural Credit Administration, accounted for only 1% of total production credit in 1971. Marketing credit is provided by the government-owned Philippine National Bank and by private commercial banks.

Institutional credit has been primarily reserved for larger commercial operations.

Participation in cooperatives has been relatively minor, with most activity taking place in communal irrigation works, purchasing cooperatives, or loosely structured organizations owning warehouses and milling equipment. The problem of agricultural marketing in the Philippines is one of distributing products in such a way the farmer gets rewarded for his labor. This applies equally to export products. For this purpose the organization of farmers into marketing cooperatives is being encouraged and even given direct assistance from the government. Farmers are asked to join pre-cooperative groups for training in cooperative principals and practices, then these groups are expected to amalgamate into area marketing co-ops.

The main unit of agricultural extension is the Agricultural Productivity Commission (APC) which was integrated as the Bureau of Agriculture Extension (BAEX) into the Department of Agriculture and Natural Resources in the early '70's. Also, the Department of Agrarian Affairs (DAR) still maintains an extension service in the land reform area which now encompasses much of the country. As of 1973, there was only one extension agent for 1,400 farmers.

(5) Storage Methods

The Palay (unmilled rice) crop is almost entirely solar dried. This takes place both on the farm and after threshing at the mill. Some mechanical driers exist but poor siting and operating costs leave them underutilized. Losses are high from solar drying because the unequal temperature and humidity causes grain cracking, over-drying, and leaves palay subject to rodents, birds and insects.

Palay and rice are stored in sacks, with only a few bulk storage bins and silos available. Sack storage actually minimizes losses from sweating and mold damage, for bulk storage requires a strict control of moisture.

Maize is stored on the farm as whole ears, shelling it only as it is required. Little, if any, drying of shelled maize is practiced on farms. Few mechanical driers exist, and most mills have concrete floors upon which grain is spread for solar drying.

Most farmers do not have storage facilities for coconut. Nuts are sold to desiccated coconut factories. They have to be hauled to a usually distant road where they are collected by the buyer. Cost of transport is high and poor road facilities lead to multiple handling of the copra by a large number of middlemen.

Because of the size and dispersion of individual wholesale markets, viajeros (truck-buyers) buy most vegetable produce either directly from the farmer or from a local assembler. Loosely woven bamboo baskets (an important cottage industry) are customary containers in all sizes for all produce.

An increasing share of the marketing of foodgrains, feedgrains, and pulses has been assumed by the government under the National Grains Authority. Storage facilities are owned primarily by millers as independent warehousing activities have become financially less attractive due to increasing government control of marketing margins.

(6) Agricultural Production

Modern crop production is generally restricted to sugarcane, pineapple and some rice. These two crops use most of the country's fertilizer and cultivation/harvesting large and small machinery.

Most farming is done with human and animal labor. Some farmers may intensively plant, using hybrid seeds, fertilizers and pesticides, but these practices are most likely conducted by hand. The greatest percentage of farming is semi-self-sufficient farming of mixed crops for domestic consumption, and coconuts (often in mixed cultivation) as a cash crop. If crop rotation is practiced, it is that of fallow fields, or a dry crop is planted on the same piece of land following a wet season crop. A lowland rice crop, for instance, may be harvested from November to February, depending upon the variety, and after rice harvest the field may be planted to corn, tobacco, vegetables...or all three.

Sugar cane
7% of the arable land; a production of 2.4 million MT in the '78-'79 season; 2nd in export value with $168.7 million

Sugar cane is the largest user of pesticides, herbicides, and farm machinery in the Philippines. (Quantitative date, however, is lacking.) Mechanization, however, is only on the large farms. Over 90% of farms growing sugar cane are under 50 hectares and have little or no mechanical equipment. The sugar industry uses all kinds of fuel including firewood. In fact, the largest commercial consumption of firewood is the sugar industry.

Most sugar farms are in Central Luzon and the western Visayas. Hand labor is still used even on the mechanized farms. Indeed, the Pakiao labor system is used on nearly 80% of the sugar cane haciendas. This system consists of setting a flat rate per hectare for a given operation (e.g., planting, weeding, or ratooning).

Milling is done commercially with no strict scheduling of delivery so that there is a 10% loss of sugar produce between harvesting and milling because can quality declines rapidly after 48 hours of harvest. Scheduling would necessitate timely land preparation, but farmers with less than 50 hectares can ill afford the purchase of a tractor.

<u>rice</u>
<u>45% of arable land; 6,894.9 thousand MT production</u>

Central Luzon has the greatest amount, and best, land for paddy rice (good paddy land is now priced at 2,000-5,000 per hectare). Under irrigation with HYV seed, and with mechanical equipment or extremely high labor input, double and even triple crops can be grown. Production of this type is capital intensive until harvest (land preparation, irrigation, seed, labor and fertilizer), then labor intensive. Hand tractors save time in tillage and speed up cultivation for high yielding varieties, making an extra crop possible, but costs are high and despite low wage labor costs the financial results are frequently poor unless subsidies are provided. The use of small power-pumps for utilizing both surface and underground water is increasing.

The palay is almost entirely solar dried before milling. Ten percent of the crop is not milled allowing for seed and wastage (including that fed to livestock). Milling is generally done off the farm by mills using either the Kiskisan or Cono milling machines.

<u>Coconut</u>
42% of arable land devoted to this crop;
11,661,000 MT production coconut,
<u>2,600,000 MT production of copra.</u>

Although coconut is the number one export crop of the Philippines, with coconut products for export totaling $740 million in 1979, its cultivation continues to be that of a traditional crop. Trees are hand-planted, grazing stock generally keeps weeds under control, draft animals are occasionally used though mostly for transport, and nuts are processed into copra on the farm.

Large coconut farmers utilize tenants. Tenants provide hand labor and guarding, being paid in cash if they do not participate in copra production or by share of produce and annual crops cultivated under trees if they do. Smallholders, however, make up the bulk (78% under 4 ha.) of coconut growers.

For making copra, the nuts are husked, cut into halves and dried. After the first drying, the nut meat is scooped out of the shell and dried for a second time. This is done in the sun (10%) or in "tapahans". (Tapahans are grills over an open fire with coconut shells and husks used as fuel.)

Good quality copra should be dried for at least three days to a moisture content of not more than 6%. Often this drying process time is speeded up, drying the copra unequally, scorching it, and the resulting copra is dark in color and susceptible to insect attack and mould. Copra kilns are used very infrequently in the Philippines. Inexpensive copra-drying installations used in other countries have not yet been adapted.

maize
40% of arable and permanent land devoted to this crop; 3,167,000 MT production

Maize is grown mostly in the traditional method, even when planted as a sole crop. About 65% of the maize is for human consumption usually in the form of grits; 15% is fed to animals and poultry on the farms; the remainder is manufactured into animal feed or starch and glucose off the farm. Production is centered in Mindanao and Visayas, with the white maize variety comprising 90% of the crop grown. It is grown at all times of the year with double cropping being the most common.

Milling methods are similar to those for palay, most milling done commercially. Absence of adequate feeder roads and high transport costs frequently equal 50% of the farmer's realized value.

Very few mechanical shellers exist, and these are owned by millers or "first buyers" (miller's agents).

Pineapple 550,000 MT production; $56,600,000 export value (canned)
Banana 2,500,000 MT production; $70,700,000 export value
Tobacco 82,344 MT production; $26,300,000 export value

Though pineapple, banana, coffee, and tobacco are considerable export crops for the Philippines, they are generally produced by hand and animal labor except for land preparation (and sometimes spraying and fertilizing) by those farmers owning tractors.

Pineapple production is expected to increase as a third commercial canning plant begins operation. Bananas are now the third major agricultural export, behind coconut products and sugar.

Traditional crop production may be better characterized by breaking farmers into five major groups:

- the indigenous kainginero (shifting cultivator
- the marginal kainginero
- upland rice/maize farmer

upland farmer

- paddy rice farmer
- rainforest shifting cultivator

lowland farmer

The indigenous kainginero is an upland farmer usually exercising squatter's rights and oftentimes migrating as soil depletion or erosion lowers yields. The farmer cleans, by slash and burn, a hectare at a time and subsists on a variety of annual crops. Most of his income is derived from the sale of root crops like cassava, and what upland rice isn't consumed domestically. He may, as well, raise a few pigs or chickens.

The marginal kainginero farms from one to two hectares at a time. This farmer clears land by slash and burn to plant annuals and perennials, often including coffee and fruit trees.

The upland maize/rice farmer relies upon plowed land to plant maize in the dry season and rice in the wet season. He also cultivates in mixed cropping coconuts, bananas, fruit trees and vegetables. Small livestock often are included in the farm husbandry. This farmer has more tools and may even possess a hand tractor or hand thresher.

Many upland farmers engage in off-farm work like rattan gathering, abaca stripping and copra-raking on lowland farms.

Paddy rice farmers of the lowland areas grow at least one crop of rice a year. Few farmers grow only rice and raise other crops in rotation or along with rice. One in three farmers on irrigated paddy cultivates two rice crops. Farmers on irrigated land generally eat 20% of their rice crop, and use 40% to pay for hired labor. Many paddy farmers never receive the full support price of rice because of their inability to adequately dry or clean it. (Twenty percent of palay is hand-milled on the farm by pounding with mortar and pestle.) Most farm units include small livestock and permanent fruit trees.

An example of the shifting cultivator in the rainforest is the Hanunoo of Mindoro. The Hanunoo's cultivation includes the astonishing number of 430 species of intercropped plants. H.C. Conklin, in an FAO report, wrote of their farming thusly:

> "At the sides and against the swidden fences there is found an association dominated by low-climbing or sprawling legumes (asparagus beans, sieva beans, hyacinth beans, string beans, and cowpeas). As one goes out into the center of the swidden, one passes through an association dominated by ripening grain crops, but also including numerous maturing root crops, shrub legumes and tree crops. Poleclimbing yam vines, heart-shaped taro leaves, ground-hugging sweet potato vines, and shrublike manioc stems are the only visible signs of the large store of starch staples which is building up underground, while the grain crops fruit a metre or so above the swidden floor before giving way to the more widely-spaced and less-rapidly maturing tree-crops."

Special Crop: abaca $19,900,000 export value

Last year's production of abaca has been estimated at 620,000 bales of 125 kilos each. This is a banana-like perennial supplying a strong resilient fiber commonly known as Manila hemp. Shading and weeding is

C-3

necessary for this crop (which is both wild and cultivated) until it reaches maturation. Then the stalk is cut and the sheaths are cut into strips to get out the long fiber inside. The fiber strips are then drawn by hand between the edge of a knife blade and a wooden plane. As each drawing makes the fiber cleaner and finer, producing a high grade hemp is largely a matter of hand labor. (Several machines are now in use, though quality is sometimes sacrificed.) Then the fiber is sun-dried and loosely packed into bundles.

PHILIPPINES

Agricultural development needs as they relate to......................	possible p/v applications
Palay almost entirely solar dried, with high losses due to unequal temperature and humidity causing cracking and over-drying	driers
little bulk storage of rice because it requires strict moisture control	ventilating fans
few mechanical driers for maize, maize spread on concrete floors for solar drying	driers
very few mechanical maize shellers exist; large increases of maize production is expected in Mindanao and Cagayan Valley	shellers, mills, driers
Copra kilns are used very infrequently; tapahans often dry copra unequally and scorch it	copra driers
most people won't eat fish that is not fresh; inadequate refrigeration	refrigeration
$1 million in AID fish culture project	pumps, aerators for fish pond aquaculture

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APPENDIX G

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