GLOBAL ENVIRONMENT FACILITY

11315-IN

India

Alternate Energy Project

Project Document
November 1992

THE WORLD BANK

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Report No. 11315-IN

GLOBAL ENVIRONMENT FACILITY

MEMORANDUM AND RECOMMENDATION

OF THE DIRECTOR

INDIA COUNTRY DEPARTMENT

OF THE

INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT

TO THE

REGIONAL VICE PRESIDENT

ON A PROPOSED GRANT

FROM THE GLOBAL ENVIRONMENT TRUST FUND

IN AN AMOUNT EQUIVALENT TO SDR 18.5 MILLION (US$26.0 MILLION)

TO INDIA

FOR AN

ALTERNATE ENERGY PROJECT

NOVEMBER 30, 1992

Energy Operations Division
India Country Department
South Asia Region

INDIA

ALTERNATE ENERGY PROJECT

GRANT AND PROJECT SUMMARY

Recipient: Indian Renewable Energy Development Agency Limited (IREDA)

Cofinancier: International Development Association (IDA)
Swiss Development Cooperation (SDC)
Danish International Development Agency (DANIDA)

Amount: GET SDR 18.5 million (US$26.0 million equivalent)

Terms: Grant

Objectives: To finance components under the proposed Renewable Resources Development project that would demonstrate commercialization of wind energy and solar photovoltaics (PV) by strengthening IREDA's capacity to promote private investments in the sector.

Relending Terms: IREDA will relend grant proceeds to its clients at an interest rate of 15% per annum for windfarm systems, repayable in 6 years with 1 year grace; and 10% per annum for solar PV applications, repayable in 8 years with 2 years grace. These rates and terms will be adjusted from time to time to reflect variations in IREDA's overall cost of funds and will be brought closer to commercial market rates as the technologies gain wider acceptance in the market.

Financing Plan: Renewable Resources Development Project

(US$ million equivalent)

	IBRD	IDA	GEF	Bilateral	Investor	IREDA	IDBI	Total
Small Hydro		70			24			94
Windfarms		15	13	50	31	16		125
Solar PV		30	10	2	13			55
Papermill	75				67		28	170
TA			3	2		1		6
Total	75	115	26	54	135	17	28	450

Economic Rate Of Return: Not applicable

Staff Appraisal Report: Renewable Resources Development Project No. 11240-IN

INDIA
Alternate Energy Project

1. Background. Part of the government's strategy in meeting the rapidly growing demand for energy supply in India is to promote the development and utilization of renewable sources. India's renewable energy program, is one of the largest among developing countries with the aim of supplementing conventional energy supplies and meeting decentralized energy needs of the rural sector. The program is administered through the Ministry of Non-Conventional Energy Sources (MNES) and involves the demonstration of renewable energy systems around the country financed largely through government subsidies. In recent years, the government has stepped up efforts to commercialize the deployment and use of the more mature renewable energy systems through private channels. Recognizing the limitation of the traditional lending approach of commercial banks and financial institutions, the government created the Indian Renewable Energy Development Agency (IREDA) in 1987 to provide financing and encourage private entrepreneurs to undertake investments in the sector. A major role of IREDA is to wean the technologies away from heavy government grant subsidies and supply interventions, by providing both energy consumers and producers affordable credit that initially feature concessional terms but which progressively approache commercial market rates as the technology gains wider acceptance. By financing new ventures in alternate energy, IREDA helps create performance track records for the technologies, facilitating their transition from novelty to mainstream status. Since its inception, IREDA has managed a loan portfolio of about 200 small-scale alternative energy projects while at the same time maintaining a healthy balance sheet and generating modest profits. Demand for IREDA financing now exceeds IREDA's resources; to service this growing demand, IREDA's financial, manpower and operational capacity would have to be further expanded. A key component of the project is the institutional development of IREDA aimed at enhancing the Agency's effectiveness in carrying out its dual role as a technology promotions and financing entity.

2. The proposed GEF project, together with the small hydro component of the associated proposed Bank-financed Renewable Resources Development project, supports creation of commercial markets for alternative energy technologies by strengthening IREDA's role in fostering private sector participation. This would be the first Bank operation in the non-conventional energy sector in India. The project has emerged from the joint UNDP/World Bank Energy Sector Management Assistance Program (ESMAP) review of the government's program on non-conventional energy sources in 1988. This review concluded that grid-interfaced power generation from irrigation-based mini-hydro and windfarm systems, among others, offer near-term opportunities for commercialization. It also reported a potential role for solar PV systems for selected applications. Follow-up pre-investment studies in 1991 and 1992 concluded that wind energy although not least-cost compared to conventional coal-based grid alternatives can become economically competitive when the environmental cost of the fossil-based generation they would replace is considered. On the other hand solar PV lighting and selected applications are economically viable in non-electrified areas but consumer awareness to the benefits of PV systems have to be developed through more efficient marketing and financing schemes. Subsidies for kerosene and electricity reduce the relative financial attractiveness of some but not all PV products.

3. Because of the country's heavy dependence on coal for electric power and on wood and crop residues for household energy needs, environmental problems are associated with India's energy production. These include land degradation, water and air pollution, and the depletion of biomass and soil capacity. But India has made notable environmental policy efforts. It is one of the few countries whose constitutions embrace the principle of environmental protection. Environmental management has been the subject of extensive legislation and has been an underlying principle in the national development plans for the last two decades. Environment departments have been established in 15 of the country's 22 states, but more improvements in policy and program administration are still needed. Most recently, the Bank has supported efforts by the government to promote the development of renewable energy. This is part of a wider program of energy and environmental assistance that includes the government's preparation of an Environmental Action Plan.

4. The proposal to fund solar photovoltaic and windfarms is based on their reduced reliance on depletable fossil fuel and thus their beneficial effects for the environment. The growing local awareness of the hazards of noxious emissions and the potential destruction of India's forest reserves has given rise to strong environmental concerns in India. To expand the role of renewable energy systems in improving environmental quality, the government has requested for GEF funding for priority non-conventional energy activities. These activities, because they are either not least-cost in standard economic terms or still in the process of posting performance track record in the commercial market are thus unlikely to attract commercial or other funding. GEF financing would act as catalyst for attracting financing sources.

5. Rationale for GEF Funding. In developing the project scope, key GEF considerations were taken into account -- sustainability, readiness, implementability, replicability, project economics, and reducing global warming. The windfarm component is characterized by a high degree of readiness and implementability, but it is not least cost when compared to conventional grid alternatives; its economic rate of return of 10% is less than the desired rate of at least 12%. The proposed GEF grant would help reduce the project cost comparable to that of conventional alternatives and would be equivalent to displacing carbon dioxide emissions at a cost of about US$30 per ton. The demand for windfarm stimulated by the project is expected to bring down equipment production and installation costs in India by about 15% in the medium term.

6. The solar photovoltaic component has a high potential for replicability and for contributing to the reduction of global warming, but it requires building up basic marketing infrastructure. GEF financing, together with the additional financing it would attract, would create the necessary confidence among PV suppliers to invest in essential infrastructure required to support the sustainable use of PV in the field. Depending on their application, solar PV systems can be economically and financially viable. However, there are inherent difficulties associated with moving a technology from a heavily subsidized setting into a market-oriented environment and in making PV systems readily accessible and financially attractive to consumers.

GEF support would stimulate a commercial market which could reach 10 MW by year 2000 which in turn would help bring down the cost of PV production. Correspondingly, the cost of displacing carbon dioxide emissions through solar PV could drop from an initial level of $84 to as low as $29 per ton. To the extent that the project would result in the re-alignment of other government-administered solar PV programs towards the proposed market-based approach, a significantly higher scale of commercial sales would be achieved.

7. Since an objective of the project is to catalyze significant PV sales so as to induce higher-volume PV production, potential sales to alternative market segments were assessed under the pre-investment study. The study concluded that given the current cost of PV lanterns, it would be very difficult to finance the systems based on the kerosene payments of the poorer rural households due to their very low kerosene consumption (Annex III, attachment 3.4). If GEF funds were used to pay for the cost differential between PV and kerosene use, the project can only support 0.7 to 0.9 MWp of systems, not enough to stimulate mass production. On the other hand, using GEF funds to provide concessional financing to PV users, would enable the project to support 2.5 to 3.0 MWp out of an estimated 20 MWp potential demand among unelectrified, middle income rural households who can afford to pay under the financing scheme. This strategy would help develop a self-supporting market niche which PV producers can tap even after completion of the project. Through the PV promotions campaign, awareness of quality of lighting offered by PV lamps would increase consumers' willingness to pay beyond their current payments for kerosene. During the mid-term project review, the cost and demand situation would be reassessed and if, by then, the cost differential between PV and kerosene has narrowed, and willingness to pay increased, the financing schemes would be redesigned to focus on lower income households.

8. Project Objectives. The project would promote commercialization of wind energy and solar photovoltaics by strengthening IREDA's capacity to promote and finance private investments in the sector. It would demonstrate the most efficient wind-power and photovoltaic technologies now available for grid-integrated and decentralized power supply on a scale that creates opportunities for local joint venture manufacturing. The project would stimulate penetration of the household lighting market through prudent subsidization of PV alternatives. It would pioneer financing and market delivery mechanisms based largely on private sector intermediaries to overcome non-market barriers. And it would catalyze the development of a mass market for these technologies in India and in other countries through large-scale demonstration, increased consumer confidence, and enhanced willingness-to-pay.

9. Project Description. The project would include two components: a windfarm demonstration component and a solar photovoltaic component. The windfarm demonstration component would involve development of about 85 MW of installed capacity of wind generators largely by the private sector. The estimated financing required is Rs 3,320 million (US$125 million); this would include a GEF contribution of at least US$13 million. The solar photovoltaic component involves developing a marketing program for the initial deployment, over five years, of solar photovoltaic systems with a capacity equivalent to

2.5 to 3 MW, for efficient lighting, water pumping, and rural community services. PV products could include solar lanterns, domestic and commercial power systems providing power for lighting and appliances; and community service power systems providing power for lighting, TV, communications, water supply and refrigeration. The financing required for this component is estimated at Rs 1,480 million (US$55 million) and would require a GEF contribution of about US$10 million including US$2 million from the Swiss Government. It is estimated that over 80% of the line of credit for PV systems would be used to finance PV lanterns. The solar PV component represents the initial phase of a larger program designed to sustain up to 10 MWp of solar PV capacity installation by year 2000. Under the project, the pace of market penetration will be closely monitored to determine the appropriate timing of subsequent phases and required additional program funding.

10. In addition, the project includes a technical assistance (TA) package involving a total of US$5 million from GET and SDC to (a) finance expertise, training and equipment in support of IREDA's project lending, marketing, technology improvement and entrepreneurial promotion functions; (b) establishment of comprehensive system of program review at IREDA including preparation work to sustain the pipeline of windfarm and solar PV projects; and (c) support studies on improving the policy environment and introduction of best practices for grid purchases from private small-scale power producers and co-generation systems. A major component of the TA is associated with building up a PV promotions and awareness campaign for rural consumers. A breakdown of costs and the financing plan for the Renewable Resources Development Project are shown in Schedule A. Amounts and methods of procurement and of disbursements, and the disbursement schedule are shown in Schedule B. A timetable of key project processing events and the supervision plan are given in Schedule C. A technical annex is attached and the Staff Appraisal Report for the Renewable Resources Development Project, No. 11240-IN dated November 30, 1992, is being distributed separately.

11. Project Implementation. The project would be implemented by the Indian Renewable Energy Development Agency (IREDA) and pursued in close parallel with the small hydro component of the Bank's Renewable Resources Development project. A credit line supported by funds from GET, IDA and DANIDA would be extended by IREDA under its wind energy loan window to private developers that have entered into wind generation agreements with the state government or state electricity board. IREDA would revolve the funds to generate an additional US$16 million to ensure that at least 85 MW of windfarm capacity is installed.

12. The solar photovoltaic project would involve the establishment of a revolving fund for concessional consumer financing and associated marketing infrastructure support necessary to reach a wider customer base. The revolving fund would be seeded by proceeds from the GET/SDC grant and IDA to refinance purchases of solar PV systems by bulk buyers and consumer financing/leasing firms. IREDA would closely monitor the evolution of the market and prepare for the required program expansion to achieve more significant levels of sales.

13. Proceeds from GET/SDC would be transferred by GOI to IREDA as grants, which IREDA in turn would relend at interest rates of 15% per annum for windfarm investors and at 10% per annum for PV users with repayment periods of 6 to 8 years, respectively. The rate for PV users would be reviewed by IREDA upon completion of a PV market survey in July 1993. Although, the lending rates are currently below market rates, by policy, IREDA's terms are adjusted towards commercial rates as the technology gains wider acceptance. The GET grant, when blended with other fund sources would permit IREDA to offer these relatively concessional terms to its clients. This mechanism for transferring GET concessionality to ultimate energy users is deemed to be more effective than use of product cost subsidies and would permit the grant fund to revolve enabling more consumers to avail of the benefits. Past experience in India on use of grant subsidies for alternate energy devices has not sufficiently promoted product cost reduction and quality improvement and has limited the consumers' choice for products and their accessibility to financing. Use of concessional financing subsidy would be more transparent to users and can be easily measured against prevailing market rates; it is also aligned with IREDA's current approach to bringing the technologies to the marketplace. During the mid-term review of the project, IREDA and the Bank will jointly assess the potential of moving IREDA's interest rates for the sub-projects closer to market rates and on which basis interest rates would be further adjusted.

14. Project Sustainability. An important feature of the windfarm component is the development and implementation of a suitable policy incentive package by the state governments to attract private investment in power facilities and ensure the sustainability of the investments. Existing agreements between private developers and the states on the "wheeling" and sale of wind-based generation reflect a mutually beneficial arrangement and foster more competitive pricing of wind energy. In the longer term, the transfer and eventual indigenization of commercially proven wind technology and a growing partnership between state utilities and the private sector will render windfarm development competitive and commercially sustainable. Similarly, the development of appropriate and affordable applications of solar photovoltaic systems through measures such as the establishment of an effective product delivery and maintenance system and the use of economic incentives to promote competitively priced services should help broaden the market for SPV systems. Strengthening the capability of existing and new institutions, enhancing public and private sector cooperation and providing for "mid-course corrections" during implementation would reinforce the longer-term sustainability of the solar PV project.

15. Environmental Aspects. The proposed project has no significant adverse effects on the environment and is instead expected to result in reduced greenhouse gas emissions by displacing fossil-based energy systems. Under its existing procedure, IREDA requires that projects to be financed have the necessary environmental clearances; its technical staff would review environmental issues related to the windfarm and solar PV sub-projects and would advise borrowers on the preparation of the requisite environmental assessments.

16. Agreed Actions. During negotiations, IREDA agreed to: (a) implement a satisfactory organizational structure and increase its staffing based on a timetable agreed with the Bank; (b) conduct their business in accordance with the agreed Operational Policy Statement (OPS) and to consult with the Bank before any material modification is introduced to it; (c) retain project management consultants to assist in project management; (d) finance sub-projects from proceeds from the Credit and Trust Fund based on the agreed criteria; (e) conduct a mid-term review of the project and to submit findings to the Bank on or before March 31, 1995; and (f) review with the Bank (i) on or before July 1, 1993, the interest rate for its PV loans based on the findings of the PV market survey, and (ii) on or before May 1, 1995 the interest rates for windfarms based on the findings of the mid-term review of the project and adjust them closer to commercial rates as appropriate.

17. The execution of a Subsidiary Loan Agreement between GOI and IREDA for relending of the proceeds of the IDA Credit is a condition of effectiveness.

18. Project Benefits. Main benefits of the project are: (a) demonstration on a commercial scale of renewable resource systems that could lead to their replication in other parts of India and the world; (b) mobilization of private investment in the energy sector; (c) reduced reliance on fossil fuels and thus help improve the environment; and (d) increased availability and improved reliability of power supply to help meet the industrial and decentralized rural energy needs.

19. Risks. There are several areas of project risks. First, there are the risks associated with monitoring numerous work sites; these are being countered by involving the private sector as investors and by setting up a monitoring and evaluation team at IREDA with back-up consultancy support to monitor progress of the works. Second, there are risks that the institutional and energy-pricing environment may prevent the solar PV systems from becoming affordable. These risks will be managed by requiring that adequate commercial arrangements for supply and after-sales service are in place prior to loan approval by IREDA and by firmly establishing, through market surveys, the viability of product demand and acceptability within the context of the users' environment. Third, operation of the new energy systems may not be sustainable if the deployed systems perform poorly and capital and operating costs are higher than expected. These risks will be minimized by limiting the technology choices to those for which performance reliability and costs have been sufficiently established through actual operating experience in India and in other countries.

Attachments

Schedule A

INDIA

RENEWABLE RESOURCES DEVELOPMENT PROJECT

Estimated Costs and Financing Plan
(US$ million)

Estimated Cost:

	Local	Foreign	Total
	(US$ million)		
A. Small Hydro Schemes	16	51	67
B. Non-conventional Energy Systems Component	77	63	140
Windfarms	50	52	102
Solar PV Systems	27	12	39
C. TNPL Bagasse-based Papermill Expansion	66	66	132
Plant Cost	64	66	130
Pre-operating Costs	2	0	2
D. Technical Assistance	1	3	4
TOTAL BASELINE COSTS	160	184	344
Physical Contingencies	16	18	34
Price Contingencies	29	15	44
TOTAL PROJECT COSTS	205	217	422
TNPL Working Capital	2	0	2
Interest During Construction (IDC)	19	7	26
TOTAL FINANCING REQUIRED	226	224	450

Financing Plan:

Source				%
IBRD		75	75	16.6
TNPL	67		67	14.9
IDBI	28		28	6.2
IDA	25	90	115	25.6
GEF	21	5	26	5.8
SDC		4	4	0.9
DANIDA		50	50	11.1
IREDA	17		17	3.8
Developers	68		68	15.1
Total	226	224	450	100.0

Schedule B
Page 1 of 2

INDIA

RENEWABLE RESOURCES DEVELOPMENT PROJECT

Summary of Proposed Procurement Arrangements
(US$ million)

Component	ICB	LCB	Commercial Practices	Others	Total
Small-hydro					
Equipment	25	20	23		68
	(25)	(20)	(23)		(68)
Civil works			15		15
			(2)		(2)
Services			2		2
Sub-total	25	20	40		85
	(25)	(20)	(25)		(70)
Windfarms					
Equipment	15	10	28	50	103
	(15)	(3)	(10)		(28)
Civil works			10		10
Services				4	4
Land				4	4
Sub-total	15	10	38	58	121
	(15)	(3)	(10)		(28)
Solar PV	7		35	10	52
	(7)		(26)	(7)	(40)
TNPL Papermill					
Equipment	75	68			143
	(75)				(75)
Civil works		7			7
Erection		4			4
Engineering		2			2
Others				2	2
Sub-total	75	81		2	158
	(75)				(75)
Technical Assistance					
IREDA	1		3	2	6
	(1)		(2)		(3)
TOTAL	123	111	116	72	422
	(123)	(23)	(63)	(7)	(216)

a/ Contract values include contingencies, taxes, and duties.
Brackets reflect IDA, Bank and GET financed portions.

Disbursements

Category	Amount (US$)	Percentage Financing
(1) Equipment, materials and supervisory services	208,000,000	100% of foreign exchange expenditures and 100% of local expenditures (ex-factory cost of manuractured in India) for equipment and materials; 80% of local expenditures for other items procured locally
(2) Consultants' service and training	3,000,000	100% of expenditures
(3) Unallocated	5,000,000	
TOTAL	216,000,000	

Estimated Disbursements (in US$ Million)

	Bank Group Fiscal Year						
	93	94	95	96	97	98	99
Annual	23	55	51	47	24	10	6
Cumulative	23	78	129	176	200	210	216
Cumulative%	11	36	60	81	93	97	100

Schedule C
Page 1 of 2

INDIA

RENEWABLE RESOURCES DEVELOPMENT PROJECT

Timetable of Key Project Processing Events

(a)	Time taken to prepare the project:	16 months
(b)	Prepared by:	MNES, IREDA, TNPL and Bank
(c)	First Bank mission:	June 1991
(d)	Appraisal mission departure:	June 1992
(e)	Negotiations:	November 1992
(f)	Planned date of effectiveness:	February 1993
(g)	List of relevant PCRs and PPARs:	

Credit/Loan No.	Project	PCR Date	PCR No.
Ln. 2050-IN	Tamil Nadu Newsprint Project	December 1986	6517

INDIA
RENEWABLE RESOURCES DEVELOPMENT PROJECT

Supervision Plan

IREDA Line of Credit for Energy Schemes

The staff input indicated in the table below is in addition to the supervision being carried out by IREDA. It is also in addition to the regular supervision needs for the review of progress reports, procurement actions, financial statements and audit reports, and associated correspondence. About 20 staffweeks will be required to establish appropriate procedures for monitoring the program during its initial years; thereafter, an average of 15 staffweeks would be needed to supervise the project. In addition, co-financiers would provide staff/consultants to conduct field evaluation. These will generally be combined with the supervision of other Bank-financed projects under execution.

Bank Staff Inputs for Project Supervision

Approximate Dates	Activity	Anticipated Skill Requirements	Input in staff weeks
12/92-12/93	*Review of IREDA lending policies, guidelines to borrowers, procedures for appraisal, monitoring & control of projects *Review power purchase/wheeling facilities *Review technical guidelines, model bidding documents, clearances procedures, quality assurance control requirements *Review TA proposals	Management Engg/consultants Environmental	3 6 2
2/93	Supervision Mission * Review PV market surveys * Review loan applications and appraisals * Review activities by SNAs * Review engineering design * Review procurement and costs * Visit design offices and review project management arrangements * Site Visits * Review IREDA's accounts	Economist Finance Engineer PV consultant	2 2 3 3
10/93	Supervision Mission * Review project implementation * Review loan applications * Review of procurement process * Review project pipeline * Site Visits * Review IREDA's finances	Engineer Economist Finance Tech. Consultant	2 2 2 4
3/94 & 10/94	Supervision Missions	Engineers Econ/Finance	8 4
3/95	Supervision Mission - Mid Term Review * Review project implementation in terms of project objectives * Review IREDA's institutional and financial capability * Review consultants' reports and action plan * Review project pipeline * Review project financing arrangements	Economist Finance Engineer Tech. Consultant	3 3 6 6

Technical Annex

INDIA **Annex I**

RENEWABLE RESOURCES DEVLOPMENT PROJECT
(GEF- ALTERNATE ENERGY PROJECT)

Summary of Alternative Investment Opportunities Investigated

Out of several project proposals in the alternate energy sector in India presented for GEF funding, four projects, namely, windfarm, solar thermal power plant, solar PV, and compact fluorescent lamps (CFLs) demonstration, were initially assessed to have the highest potential for meeting the GEF-STAP criteria. The table below gives a summary of the result of the evaluation done by a Bank-GEF mission in 1991, updated to 1992 costs. Results show that modest levels of GEF support for windfarm and solar PV projects would sufficiently buy-down the investments costs and allow these technologies to compete with conventional energy sources thus permitting relatively lower cost of carbon displacement. Details of the analysis are presented in the report entitled India: Non-Conventional Energy Projects for GEF Funding, dated December 20, 1991.

		Private Sector Wind Farm	Solar Thermal Power Plant	Solar PV	CFL Demonstration
Capacity Installed (MW)		70	30	2.7 MW (in 5 yr) 13.9 MW (in 10 yr)	15
Capital Cost - Millions US$ - Rs. Crores		 83.5 217.0	 78 204	 38.6 100.4	 4 11
GEF Grant Contribution (Millions US$)		13	46	14	3
Foreign Exchange Required (Millions US$)		42.3	41	11.5	2
EIRR Real (%)	Without GEF	5-10	4	1.5 - 3.3	106
	With GEF	12	12	14.0 - 14.6	~~
FIRR Real (%)	Without GEF	6-23	-2	1.2 - 5.3	
	With GEF	10 to 41	5	7.6 - 13.3	
Cost of Carbon Displaced (US$/ton of Carbon)		27	125	29	77

Notes: Range of IRR values for PV represent changes in the mix of PV products supplied. The cost of carbon displaced by PV is based on the 13.9 MW of PV sales that could be catalyzed by the GEF contribution. By the year 2000, approximately 10 MWp of PV could be installed. The cost of carbon displaced by the PV systems by the year 2000, assuming that the project starts in 1993, is about US$33/tonne of carbon displaced. The range of FIRR for the wind project reflects how available tax credits are utilized by the private wind farm developers. The wind farm IRR estimates are based on displacing captive diesel generators.

INDIA
RENEWABLE RESOURCES DEVELOPMENT PROJECT
(GEF ALTERNATE ENERGY PROJECT)

WINDFARM DEVELOPMENT COMPONENT

The project would finance loans by IREDA for development of grid-interfaced windfarms schemes in States where there are proven good wind resources and established policy framework for private sector participation. Up to an aggregate capacity of 85MW of wind generators are expected to be financed under the project. The windfarm sizes and locations would be based on the proposals submitted by the developers who would own and operate the machines, subject to mutual agreement with the State Electricity Board (SEB). The developer would be responsible for conducting the necessary feasibility studies which would confirm that the grid to which windpower will be fed is adequate for safe and reliable operation of the windfarm.

Only those projects which would be able to demonstrate technical and financial soundness and which have secured the appropriate license and/or satisfactory power transfer agreement and environmental clearance would be considered. In order to avail of GET financing, IREDA's sub-loan appraisal for the first two windfarm schemes shall be subject to prior review and approval by the Bank. Thereafter, sub-loans involving a total project cost equivalent to US$5 million or above shall be subject to the Bank's prior review.

Project Cost Summary

	85 MW WINDFARMS COMPONENT					
	(Rs Millions)			(US$ Millions)		
Turbine-Generator	856	1339	2195	32.9	51.5	84.4
Electrical Works	167		167	6.4		6.4
Civil Works	197		197	7.6		7.6
Land	85		85	3.3		3.3
Total Baseline Costs	1305	1339	2644	50.2	51.5	101.7
Physical Contingencies	131	134	264	5.0	5.2	10.2
Price Contingencies	203	78	281	6.5	2.5	9.0
Total Project Costs	1639	1551	3189	61.7	59.2	121
Interest during Const.	104	26	130	3.5	0.9	4.4
Total Financing Required	1743	1577	3319	65.2	60.1	125.3

INDIA

RENEWABLE RESOURCES DEVELOPMENT PROJECT

List of Proposals for Windfarm Projects

Status	Name of Promoter	Capacity	Proposed Location
UNDER CONSIDERATION BY IREDA			
	1. M/s Seyadu Beedi Co.	1 x 250 KW	Tamil Nadu
	2. M/s Aquasub Engineering	1 x 250 KW	Muppandal, T.N.
	3. M/s Aquapump Industries	1 x 250 KW	Muppandal, T.N.
	4. M/s Shree Akilandeshwari Mills	1 x 250 KW	Kayathar, T.N.
	5. M/s Autolec Industries Ltd.	1 x 250 KW	Kayathar, T.N.
	6. M/s Tamil Nadu Newsprint and Papers Ltd.	80 x 250 KW	Tamil Nadu
	7. M/s Dalmia Cements	16 x 250 KW	Tamil Nadu
	8. M/s Sri Kaliswari Fire Works	1 x 250 KW	Tamil Nadu
		25500 KW	
SITE ALLOTTED BY STATE	1. M/s Golden Agricultural & Poultry Development	500 KW	Tamil Nadu
	2. M/s Rajapalayam Mills	500 KW	Tamil Nadu
	3. M/s Ramco Industries	500 KW	Tamil Nadu
	4. M/s Golden Hills Estate Ltd.	250 KW	Tamil Nadu
	5. M/s Visaldeshi Mills Ltd.	250 KW	Tamil Nadu
	6. M/s Sri Coimbatore Poineer Fertillsers	250 KW	Tamil Nadu
	7. M/s Sri Kateswari Fire Works	250 KW	Tamil Nadu
	8. M/s Bombay Burmah Trading Corp.	1000 KW	Tamil Nadu
	9. M/s Vijayshree Cotton Mills	250 KW	Tamil Nadu
	10. M/s Vijayshree Spinning Mills	250 KW	Tamil Nadu
	11. M/s Soudararaja Mills	250 KW	Tamil Nadu
	12. M/s Sree Karpagambal Mills	500 KW	Tamil Nadu
	13. M/s Vanniyapaumel & Sons	250 KW	Tamil Nadu
	14. M/s Tuticorin Spinning Mills	500 KW	Tamil Nadu
	15. M/s Gulf Olefines (P) Ltd.	250 KW	Tamil Nadu
	16. M/s India Cements	4000 KW	Tamil Nadu
	17. M/s NEPC-MIGON	250 KW	Tamil Nadu
	18. M/s NEPC-AGRO	250 KW	Tamil Nadu
		8250 KW	
SITE STILL TO BE ALLOTTED BY STATE	1. M/s Singareni Steel Pvt Ltd.	2500 KW	Tamil Nadu
	2. M/s Madras Cements	4000 KW	Tamil Nadu
		6500 KW	

INDIA
RENEWABLE RESOURCES DEVELOPMENT PROJECT
GEF ALTERNATE ENERGY PROJECT

Historical Performance of Sample Wind Farms
(January 1986 to May 1991)

Wind Farm	Rated Capacity (kW)	Energy Output		Output kWh/kW	Capacity Factor
		From:	To:		
Tamil Nadu					
Kayathar IA	1,350	07-Apr-88	31-May-91	1223	14%
Kayathar IB	400	12-Jun-89	31-Mar-90	1579	18%
Kayathar IB	1,200	31-Mar-90	31-May-91	1966	22%
Kayathar II	6,000	25-Jan-90	31-May-91	1603	18%
Tuticorin I	550	18-Jan-86	31-May-91	1271	15%
Tuticorin II	55	09-Sep-86	20-Nov-86	1045	12%
Tuticorin II	330	21-Nov-86	12-Jan-89	786	9%
Tuticorin II	550	12-Jan-89	31-May-91	1791	20%
Muppandal	4,000	31-Mar-90	31-May-91	2588	30%
Maharashtra					
Deogad I	550	23-May-86	31-May-91	800	9%
Deogard	550	15-Oct-88	31-May-91	574	7%
Gujarat					
Lamba (Harshad)	10,000	30-Apr-90	31-May-91	987	11%
Okha	550	08-Mar-86	31-May-91	1248	14%
Okha-Madhi	1,800	18-Feb-89	31-May-91	646	7%
Mandvi I	1,100	16-Jan-86	31-May-91	1439	16%
Mandvi II	500	29-Aug-89	31-May-91	918	10%
Tirumala	550	15-Jun-89	31-May-91	738	8%
Kheda	500	18-Feb-90	31-May-91	1061	12%

INDIA
RENEWABLE RESOURCES DEVELOPMENT PROJECT
GEF ALTERNATE ENERGY PROJECT
Estimated Performance of Wind Farms at Several Sites in India

Site	Output kWh/kW/year	Capacity Factor
Tamil Nadu		
Andipatti	1259	14%
Kayathar	1459	17%
Meenakshipuram	1104	13%
Muppandal	2245	26%
Poolavadi	1588	18%
Puliyamkulum	1205	14%
Sembagarapadam	1613	18%
Sultanpet	1164	13%
Tuticorin	979	11%
Orissa		
Chandipur	1110	13%
Chatrapur	738	8%
Gopalpur	653	7%
Kaipada 1	559	6%
Marine Drive	371	4%
Paradwip	1090	12%
Puri	939	11%
Gujarat		
Okha	1180	13%
Harshad	1405	16%
Maharashtra		
Deogad	706	8%
Malwan	442	5%
Vijayadurg	1129	13%

Assumptions: Estimated performance based on a stall regulated machine with a cut-in speed of 4 m/s, cut-out at 28 m/s, rated at 250 kW at 15 m/s with a hub height of 30 m. Wind speed was assumed to have a Rayleigh distribution. A wind farm array efficiency of 90% and a technical availability of the machines and the grid of 95% was also assumed. Wind speed data from: Mani, Anna, "Wind Energy Resource Survey for India - 1," Allied Publishers, New Delhi, 1990.

INDIA
RENEWABLE RESOURCES DEVELOPMENT PROJECT

GEF ALTERNATE ENERGY PROJECT

Estimated Unit Cost of Windfarm Capacity

Cost/kW Installed (1992 Rs.)	Local Costs Cost Per kW	Foreign Costs Cost Per kW	Total Costs Cost Per kW	Foreign Cost
Wind Turbine Generator	10,026	15,724	25,750	61%
Electrical Works	1,964	0	1,964	0%
Civil Works	2,308	0	2,308	0%
Land	989	0	989	0%
Total Cost per kW	15,288	15,724	31,012	51%

Cost/kW Installed (1992 US$)	Local Cost Cost per kW	Foreign Costs Cost per kW	Total Costs Cost per kW
Wind Turbine Generator	385	604	990
Electrical Works	75	0	75
Civil Works	88	0	88
Land	38	0	38
Total Cost per kW	588	604	1,192

INDIA

RENEWABLE RESOURCES DEVELOPMENT PROJECT

IREDA WINDFARM DEVELOPMENT COMPONENT

ECONOMIC ANALYSIS

(In Rs Million)

FISCAL YEAR	CAPITAL COSTS LOCAL	FOREX	TOTAL	OPERATING COSTS	TOTAL COSTS	BENEFITS GENERATED	WHEELED	SAVINGS	NET BENEFITS
						GWh	GWh		
1993	343	441	784		784				-784
1994	800	1028	1828		1828				-1828
1995				52	52	71	69	193	140
1996				52	52	141	139	385	333
1997				52	52	141	139	385	333
1998				52	52	141	139	385	333
1999				52	52	141	139	385	333
2000				52	52	141	139	385	333
:				:	:	:	:	:	:
:				:	:	:	:	:	:
:				:	:	:	:	:	:
:				:	:	:	:	:	:
:				:	:	:	:	:	:
2015				52	52	141	139	385	333

EIRR: 10 %

Assumptions:

Capacity:	85 MW
Economic Life:	20 years
O & M Costs:	2 %
Wheeling Fee	2 % of Generation
SCF:	0.8
Diesel cost:	Rs 2.78/kWh

INDIA
RENEWABLE RESOURCES DEVELOPMENT PROJECT
(GEF - ALTERNATE ENERGY PROJECT)

THE SOLAR PV MARKET DEVELOPMENT COMPONENT

A. Project Objectives

The objective of the PV Market Development Project is to stimulate the marketing of PV products on a commercial basis and thus encourage the establishment of sustainable product supply, delivery, after-sales service, and financing mechanisms. This project is expected and create a favorable environment for the PV industry to grow and to generate the impetus for establishment of profitable business enterprises. The project would support the deployment of commercial PV systems for lighting, water supply, and other service applications in the household, commercial, agricultural and light industrial sectors in electricity-deficit areas of India. These services are currently provided through kerosene lanterns; primary and secondary batteries; petrol, kerosene and diesel generators, or weak grids. It is expected that the project would lead to investments in 2.5 to 3 MW of PV systems over five years, and catalyze investments in about 14 MW of PV systems over ten years.

B. Project Description

The project would finance the establishment of a marketing and financing program that would support the delivery of PV systems. The project would stimulate the development of production, marketing, financing, sales and service channels necessary for the commercial development of the PV industry. The project includes the following two main components:

Revolving credit fund that will provide refinancing to financial intermediaries (such as leasing companies, finance companies) to enable them to on-lend this money to purchasers of PV systems; and to large volume purchasers of PV equipment (companies, non-governmental agencies (NGOs), cooperatives etc.).

Technical assistance for launching a promotional campaign to increase consumer awareness and willingness to pay for PV systems would be provided. In addition, TA to support improvements in product quality, marketing and after sales services for products financed by the revolving fund would be made available.

Use of GEF funds. The value of the GEF support is in making PV affordable to consumers and in assisting in demand creation and infrastructure building. It is expected that GEF funds will be utilized to reduce interest charges instead of subsidizing capital costs. This approach is favored because most rural customers can afford to pay a small amount every month for the PV system, rather than a large lump sum investment, as is the current practice in India. Experience with PV projects in Sri Lanka, Indonesia, and the Dominican Republic show that the concessional credit approach is viable and acceptable to consumers. Previous PV projects in India had heavily subsidized the capital costs (consumers paid only one third the cost), but over the course of about eight years this strategy had neither led to a commercial market expansion, nor cost reductions.

Evidence from India and other countries have shown that inadequate awareness of the value of PV, poor product quality and unresponsive service to be impediments to the success of PV projects. A cost-effective supporting infrastructure requires a substantial number of PV systems in the service territory. Therefore GEF funds will be used to establish a good supporting infrastructure, ensure high product quality, and launch an awareness and demand creation campaign.

Potential for increasing PV module manufacturing capacity. While the GEF funds could lead to added investments in PV product assembly plants, significant investments in new PV module manufacturing capacity is not expected. At present, due to increased interest and demand for PV worldwide, a large expansion in international manufacturing capacity is expected with about 150 MW/year of new production capacity to be added by 1995.[1] Current worldwide manufacturing capacity is about 75 MW/year (PV demand in 1992 is forecast at 64-68 MW). The relatively small increased demand leveraged by the GEF support is unlikely to be an major incentive to add more PV module manufacturering capacity. There is however, a possibility that this project could induce a shift of manufacturing capacity to India.

C. Detailed Features

Revolving Credit Fund. The revolving fund will be set up at IREDA to finance the purchase of PV systems on credit. The revolving fund will provide re-financing to financial intermediaries, or large volume purchasers of PV systems in the form of a credit line or loan that will be accessed only as sales of PV systems occur. It is expected that initially financing would be made available at below market rates. However, the rates set would cover revolving fund administrative costs. Congruent with IREDA's practices, as the PV market matures, and buyer confidence increases, lending rates could progressively converge towards commercial rates.

A range of PV systems will be eligible for financing. They include domestic and commercial lighting and power systems; community services, including lighting, communication, refrigeration, water pumping and others; industrial and agricultural applications including lighting, motive power and others; and any other applications of solar PV where there is a demonstrated demand (see Attachment 3.2). Locally manufactured or imported products will be eligible for financing under the revolving fund so long as they meet the required technical performance criteria and there is a demonstrated demand for the products. While there will be no geographical restriction on the provision of credit, it is recognized that it will be necessary to focus promotional efforts under the technical assistance component, especially in the initial stage. A market study has been commissioned to determine the regional focus.

Applications for a line of credit or a loan would be made to the fund by financial intermediaries or large volume purchasers. Three types of applications may be considered:

-- IREDA provides a line of credit to private sector beneficiaries and public sector enterprises who will be responsible for procurement.

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[1] Photovoltaic Insider's Report, Volume XI No. 10, October 1992.

-- IREDA may act as the procurement agent when many sub-borrowers can be organized together to procure a large number of common items such as solar lanterns or household lighting systems.

-- Financing agencies or leasing companies establish lines of credit for the purchase of PV products. IREDA together with the borrowers may pre-qualify products from selected suppliers to expedite the delivery of goods to their customers and to minimize the transaction costs.

These applications would include the following elements:

-- A description of products to be purchased, including product specifications, product sourcing, and warranties.
-- Details of the arrangements for after sales service during and after the warranty period, including the facilities, equipment, staffing, training requirements.
-- A demonstrated understanding of the market for the proposed products.
-- Estimated purchase volumes, product prices including costs of after sales service, and cashflow required to finance PV system purchases.
-- Environmental management plan, especially the plan for recylcing lead-acid batteries.
-- Financial guarantees as required by IREDA.
-- In the case of a financial intermediary, the following additional information will be required:
  - demonstrated capacity in lending in the proposed market area and recovery rates achieved;
  - proposed regional concentration of lending;
  - proposed on-lending terms and conditions.

IREDA will award credit lines on the basis of financial and technical criteria. The financial criteria will include the strength of the balance sheet of the borrower, and, in the case of financial intermediaries, their lending portfolio, the extent of their experience in the proposed market areas, the adequacy of their recovery rates, and the attractiveness of proposed on-lending terms. The technical criteria will include the quality of the products proposed for sale, proof that there is demand for the products based on market research and testing, warranty terms and conditions, the technical performance of the supplier, adequacy of cost recovery procedures, and the strength of the arrangements for after sales service and environmental management.

IREDA will function as a wholesale lender. Financial intermediaries or large buyers will apply for a credit line or loan. After the credit line or loan is approved, funds will be disbursed on a periodic basis, on receipt of documentation summarizing manufacturers invoices for sales. The financial intermediary or bulk buyer would pay the manufacturer through his distributor, recover the funds from the recipient of the credit through regular installments and repay IREDA. The financial intermediary or large volume buyer will bear the full burden of the risk of non-repayment. The credit flows through the revolving fund are shown in Figure 1.

As part of its management of the credit fund, IREDA will award credit lines or loans, monitor and evaluate lending under the credit lines, sales of PV systems by type and region of the country, performance of equipment, adequacy of

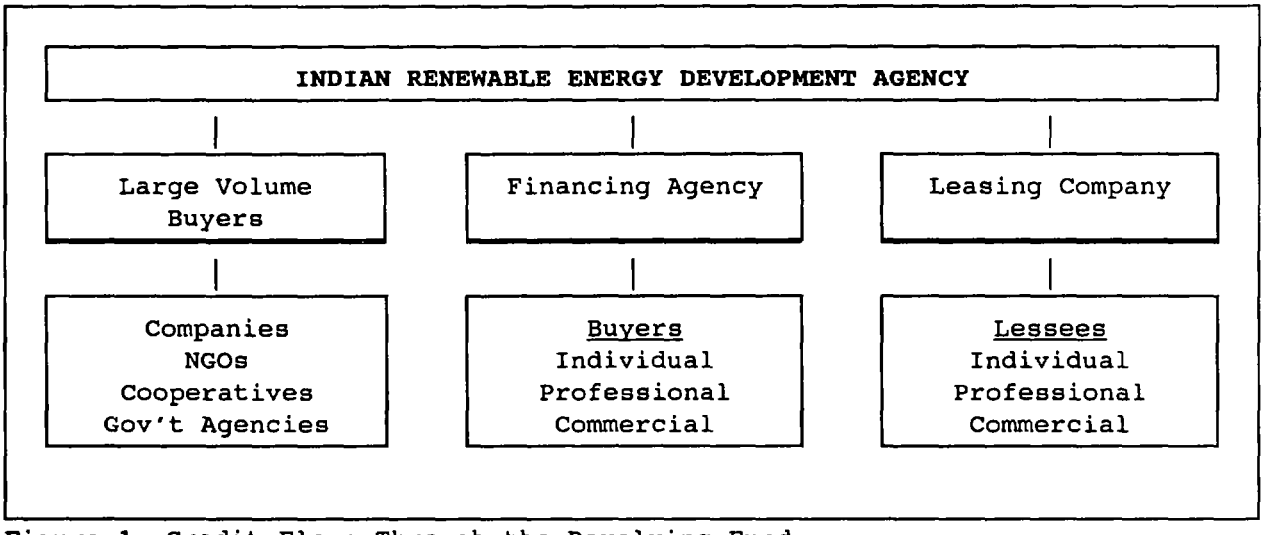

Figure 1 Credit Flows Through the Revolving Fund

after sales service, and performance of financial intermediaries and suppliers. Consultancy services have been obtained to assist IREDA design the management and operation of fund and in preparing sample bidding documents.

Technical Assistance. Funds will be provided to IREDA to launch a promotional and awareness campaign targeted at potential investors in PV systems as well as at financial intermediaries. Consultants have been recruited to assess the market, estimate consumers' willingness to pay, and to design the promotional campaign. The promotional campaign will increasing the awareness among potential buyers about the benefits of PV and thereby increase their willingness to pay for the superior services delivered by the PV power systems. The scope of work for the market study, willingness to pay assessment and for designing the promotional campaign is presented in Attachment 3.3.

The success of the PV market development effort is intimately linked with the acceptability of the PV products by the consumer. Experience has shown that loan repayment is positively correlated with the level of satisfaction that the consumer obtains from the product. Supplying a high quality, reliable product and in establishing a responsive after sales support system is critically important to both the suppliers, as well as IREDA. IREDA will provide technical and marketing experts to buyer organizations in establishing effective marketing and after service networks. Through the buyer organizations, the technical experts could also advice suppliers on improving product quality. Technical assistance will also be provided for loan application evaluation. Attachment 3.5 presents the scope of work. In addition, sample technical specifications are under preparation. These will be made available for a variety of PV products to IREDA borrowers.

In addition, IREDA will monitor the field performance and acceptability of the PV systems and feed this information back to IREDA borrowers and their suppliers (See Paragraph on Monitoring). The provision of product and service quality improvement assistance during the complete sub-loan cycle will lead to better products, greater consumer acceptance, and consequently, better loan performance.

IREDA will also supply procurement assistance to its borrowers (Attachment 3.6 shows the scope of work). IREDA will be responsible for managing all technical assistance activities. In addition IREDA will recruit procurement specialists to ensure that its borrowers adhere to Bank-recommended procurement practices.

D. Project Implementation

Management. The executing agency for the project is the Indian Renewable Development Agency (IREDA). A PV Projects Unit function will be integrated within IREDA. The Unit will be tasked with appraising, negotiating, awarding, supervising, and monitoring all loans and technical support provided through the Revolving Credit Fund. IREDA will be responsible for establishing the detailed lending terms and guidelines, and in developing loan application evaluation procedures. Following its current practice, IREDA would continue to retain consultancy services of technical and marketing experts to assist in the evaluation of loan applications made to the Revolving Credit Fund, as well as providing services Product Quality Improvement Technical Assistance. IREDA will also lead the publicity campaign.

Coordination. The continuing efforts by MNES at developing and introducing appropriate policy incentives for PV at the Center and State levels will benefit this project and assure a competitive environment for private and public investment in PV to prosper. The ongoing MNES efforts in support of the development of high quality components and systems; providing access to manufacturers to the MNES PV testing facilities; and the field evaluation of PV systems will assist this project. Figure 2 shows the organizational relationships of IREDA and MNES. The PV market development component will integrate with and build upon the experience of MNES in planning, coordinating and field evaluation of PV systems. In particular, the PV marketing component will extend and support the MNES-initiated process of commercialization of PV systems by increasing the beneficiary involvement in selecting the products and in the maintenance of these systems.

Monitoring. Monitoring and evaluating the progress of PV loans, the performance and consumer acceptability of the financed PV products, and technical support will be the responsibility of IREDA. In addition to the quarterly reports on the project, IREDA will submit an annual report on the performance of the PV systems financed under this project. The performance evaluation will be based on independent field surveys of the systems and will present information on:

- Types and number of systems planned for, and actually installed; types of services delivered; the regional distribution of the systems; and a description of the installation sites in terms of road access and the nearness to the electric grids.
- Characterization of the borrowers and the PV systems users in terms of their organization, occupation, education, and types of systems purchased, and the reasons for purchasing the systems.
- Adequacy of consumer awareness of the correct operation of the PV systems, and their levels of satisfaction with the services provided.

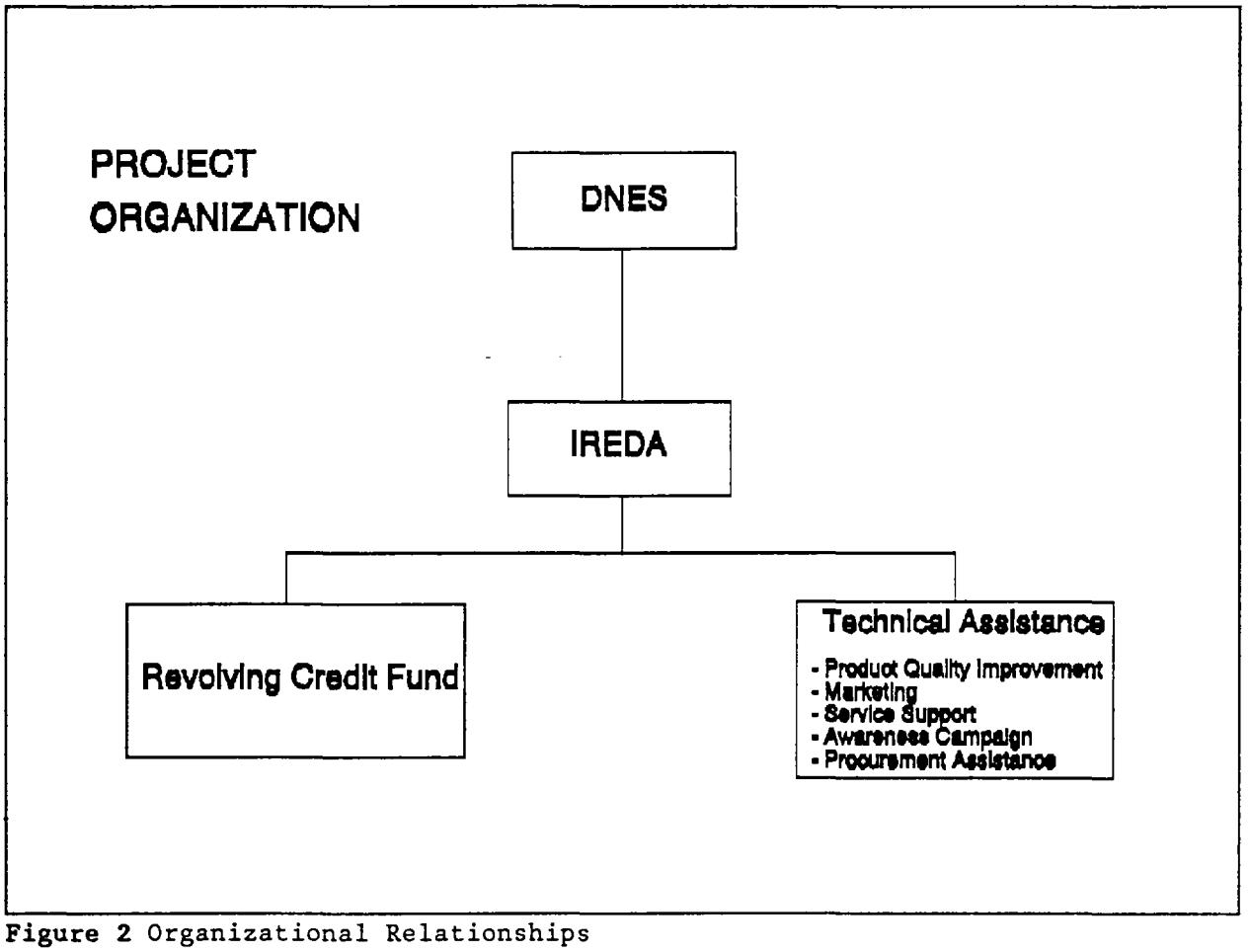

Figure 2 Organizational Relationships

-- Performance and reliability of the PV systems including number of systems in operation, frequency and types of failures of the major components, safety problems, the adequacy and responsiveness of the maintenance services, and the acceptability of the battery recycling efforts.
-- Social, environmental, and economic developmental impact on the users and the community.
-- Assessment of cost recovery procedures, their suitability and their success.
-- Recommendations for improving the technical performance, financial management, and institutional arrangements.

This information will also be reported back to IREDA borrowers and their suppliers so that they can continue to improve the quality of their products and services.

E. Project Impact and Risks

Benefits

Environmental Benefits. The PV systems directly displaces kerosene for lighting applications, petrol-fueled generators for larger commercial lighting and small power applications, and diesel-fueled or grid-based electricity for village electrification and battery charging applications. The amount of fossil fuel displaced by PV is difficult to estimate precisely, but it is estimated that the 2.7 MW of PV will displace 130,000 cubic meters of fossil fuel over a ten-year operating period, and the 14 MW of PV catalyzed by this project will displace 700,000 cubic meters of fossil fuel over a ten-year operating period.[2] As the project serves as a catalyst to accelerate the rate of introduction of PV systems in India, the investments made in the project will result in a far greater displacement of fossil fuels than is evident in the initial 5-to 10-year period.

Over the course of a 10-year period, the 2.7 MWp of PV installed in five years, due to the initial injection of funds by the GEF would displace 100,000 tons of carbon equivalent. Over the course of a 10-year period, the 14 MWp of PV installed in 10 years, due to the catalytic effect the GEF financing would displace 600,000 tons of carbon equivalent. The GEF investment over a 10 year operating period of the 14 MW of PV systems is US$29/ton of carbon displaced.

The GEF investment of US$17 million leverages an additional US$41 million over five years. Over the ten year period, the GEF financing leverages an additional US$206 million. The multiplier effect of the GEF financing in the 5- and 10-year period is 2.4 and 11.1, respectively.[3]

As a replacement for dry cell batteries which contain mercury, solar electric systems are environmentally safer. As a replacement for car batteries for operating small appliances such as TVs, solar electric systems are also far more convenient. Furthermore, as the battery in a solar PV system is not allowed to discharge deeply, the replacement frequency of the battery is less compared to a battery that has to be taken into town for recharging. Thus, the quality of lead needed to be recycled is less.

Other Benefits. Solar PV systems provide a number of other unquantifiable benefits. Light quality and quantity supplied by solar lanterns and lighting systems are far superior to that available from kerosene lanterns. The quality of the solar electric light is also better than that provided by a Petromax lantern. In addition to their global benefits, they also have a number of local benefits. Unlike kerosene burning lanterns they do not emit fumes, CO, or particulate matter. Solar electric systems are also safer to operate than hurricane and Petromax lights.

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[2] PV modules manufactured in the USA, Europe or Japan routinely offer 10 year warranties and have realistic expectations of a 20 year life. One manufacturer, Kyocera of Japan, offers a 12 year warranty.

[3] Multiplier effect is non-GEF investment divided by GEF contribution.

Risks and Uncertainties

The financial risk of the project is low as loans will be made only to qualified buyers and payments made only after products are procured. The project expects to invest about 6% of its funds for technical assistance to reduce project uncertainties. Project uncertainties and mitigation actions are discussed below:

Market Uncertainties. While the potential market is very large there is little substantive evidence as yet to indicate that people are willing to pay the high costs associated with PV systems. A marketing survey which has been commissioned will provide an improved understanding of the products to be marketed, determine who the customers are, and assess their willingness and capability to pay. A preliminary market assessment conducted in four states (Orissa, Rajasthan, Uttar Pradesh and Andhra Pradesh) estimated the potential market to be around 80 MWp as shown below[4]. The potential national market is estimated at about 140 MWp. To validate the preliminary results, the results of the more comprehensive market assessment will be available in about six months.

Preliminary Estimate of the
Potential Domestic and Commercial Market for Small PV Systems
(MWp)

PV Application	Andhra Pradesh	Orissa	Rajasthan	Uttar Pradesh	Four States	All India
Lanterns	2.3	2.4	9.0	38.4	52.1	81.1
2 Light	1.6	1.4	3.6	15.7	22.3	38.2
2 Light + Other Loads	1.1	0.6	0.7	2.9	5.4	13.5
4 Light + Other Loads	0.3	0.2	0.2	0.7	1.2	3.1
TOTAL (MWp)	5.3	4.6	13.5	57.7	81.1	135.9

Source: World Bank Consultants, India: Solar Photovoltaics Market Development Component Pre-Investment Study, Draft report, June 23, 1992.

Investigations performed during the pre-invesment study show that PV systems are financially viable for applications such as two and four light systems plus other small loads for use in commercial establishments, and for small village electrification schemes. Residential applications such as lanterns or small two light systems require the consumer to be willing to pay about three times more than their current expenses for kerosene. It is expected that the greater convenience and better quality light provided by the PV systems will induce these customers to prefer PV over kerosene lighting. Attachment 3.1 provides details of the analyses. The market study will provide more definitive information about consumers willingness to pay for PV systems. Furthermore, the project will conduct an extensive promotional campaign which will increase the awareness among consumers about the benefits of PV, and help increase the demand for the products.

[4] India: Solar Photovoltaics Market Development Component Pre-Investment Study, Draft Report, May 3, 1992.

Cost Recovery. Cost recovery of commercial banks has been very poor in the rural areas. If the PV systems that are financed run into the same problems, the project success could be jeopardized. IREDA will therefore finance sales to individuals in rural areas only through organized groups such as cooperatives and NGO who have a strong presence in the community. Also, IREDA will lend through lending through private financing agencies and leasing companies whose rural cost recovery rates are better.

Product and Service Quality. In the past, PV product quality in the consumer market in India was generally low and had led to consumer dissatisfaction. To overcpme these problems, this project is setting technical specifications for PV products. The project will also offer technical assistance to improve product quality. There has also been limited recognition of the importance of supplying responsive after-sales service for PV systems in India. The project will provide technical assistance for developing service networks and in training technicians. In addition, effectiveness of after sales service arrangements will be an important criteria for evaluating loan applications.

Access to Financing. Financing agencies and banks have not lent to PV product manufacture or sales, or have required stringent financial terms. This has hampered the industry. Credit availability and the awareness campaign directed at financial institutions will lend credibility to the PV industry and its products.

Negative Environmental Impacts. The most common type of battery used is the lead-acid battery. The batteries needed for PV will require recycling about 100 tonnes of lead per MWp of PV every year. India has an effective informal lead recycling program which could handle this volume of lead. However, the PV Project should ensure that adequate facilities are available for the safe recycling of battery lead. Also, for smaller storage requirements, a nickel metal hydride battery is now available. This battery is environmentally safer than the Nickel Cadmium battery. The manufacture of PV also utilizes a number of toxic chemicals. The use of these chemicals as feedstock or for cleaning and etching are carefully controlled and disposed of in modern plants. The MNES must ensure that best available control technology is used at all PV manufacturing plants, and the manufacturers take the necessary precautions in protecting plant workers.

Attachment 3.1

Results and Details of Sample PV Systems Evaluations

The financial and economic viability of PV applications were assessed in relation to currently used technologies, on the basis of complete life cycle costs for providing comparable services. The annual stream of costs associated with the use of a PV technology was compared to the annual stream of costs avoided by replacing currently used technologies.

The design characteristics of PV systems and the estimated costs of their components are given on the basis of both current costs in 1992 and since it is expected that the cost of PV panels will fall over the next five years, their costs in 1996 (year 3 of the five year period of the PV Component of the Renewable Energy Project). The financial and economic analysis is based on the expected capital cost of PV systems in 1996. Since the financial analysis compares PV systems on the basis of their full costs with highly subsidized kerosine and grid electricity to rural customers, it is biased against PV. The economic analysis gives a clearer picture of the true viability of PV systems.

Table 1 shows the economic and financial viability of the applications on the basis of a 12% discount rate. The financial and economic viability is estimated on the basis that the benefits are: (a) due only to the value of alternative fuel displaced, and (b) that the consumer shows an added willingness to pay due to the much higher quality of service available from the PV system compared to their alternatives. Assumptions used in the analyses are presented in Tables 2 to 4.

Table 1
Summary of Economic and Financial NPV of Replacing Conventional Systems with PV Systems
(based on 1996 costs)

Application	Equipment Replaced	Target Market	Economic NPV @ 12 % Discount (Rs 1992)		Financial NPV @ 12% Discount (Rs 1992)	
			replacement cost only (a)	replacement cost plus willingness to pay extra (b)	replacement cost only (a)	replacement cost plus willingness to pay extra (b)
Solar 5 Watt Lantern, Lead Acid Battery	Hurricane Lamp	Domestic	-2070	-407	-3785	-1470
Solar Battery Charging Station, per 5 Watt Lantern	Hurricane Lamp	Domestic	-1610	+585	-2990	+245
Solar 2 Light System	Hurricane Lamp	Domestic, commercial	-2400	+2885	-5280	+1325
Solar 2 Light system plus other loads	Hurricane Lantern plus Battery	Domestic, commercial	-10	+5275	-3525	+3080
Solar 2 Light System	Petromax	Commercial	+2600	viable	+1337	viable
Solar 4 light plus other loads	Gasoline Genset	Commercial	+19445	viable	+52880	viable
Centralized PV Village Electrification, 200 Households	Grid Extension, up to 10 km	Coops, NGO, public sector agencies	-103235	not viable	-3979955	not viable
Centralized PV Village Electrification, 100 Households	Grid Extension, up to 10 km	Coops, NGO, public sector agencies	+435120	viable	+404920	viable
Community Water Pumping @50m head, 30m3/day	Grid Extension, up to 0.5 km	Coops, NGO, public sector agencies	-127540	not viable	-148165	not viable

(a) Benefits are measured as the costs of the kerosene lantern replaced by the PV system.
(b) Benefits are measured as the replacement costs of the kerosene lamp, plus a willingness to pay for additional and better quality light.

Assumptions Used in the PV Systems Analysis

Table 2
System Sizing Assumptions for the PV Applications

Application	PV Size (Wp)	Battery (AhxV)	Lights (5 hrs/day) (# x lumens/ light)	Other loads (wh/day)
5 W Solar Lantern	9	14x6	1x250	-
Battery Charging Station	420	14x6	50x250	-
Two light system	18	40x12	2x250	-
Two lights, other loads	51	100x12	2x250	125
Four lights + other loads	116	200x12	4x250	250
200 HH Village	6800	800x96	400x350 and 25x600	-
100 HH Village	3400	400x96	200x350 and 12x600	-
Water Pump	1000	-	-	30 m3/day @ 50m

Table 3
Cost Assumptions for the PV Applications Evaluations

	Financial Cost (1992 Rs.)		Economic Cost (1992 Rs.)	
Application	1992	1995	1992	1995
5 W Solar Lantern	6000	4700	3600	3200
Battery Charging Station	207 thous.	152 thous.	145 thous.	113 thous.
Two light system	10100	7800	6900	6100
Two lights + other	22500	17500	14500	12300
Four lights + other	47300	37000	30100	25100
200 HH Village	2.9 mill.	2.4 mill.	1.9 mill.	1.7 mill.
100 HH Village	1.50 mill.	1.20 mill.	1.00 mill.	0.85 mill.
Water Pump	370 thous.	280 thous.	290 thous.	230 thous.

Table 4
Key Assumptions for Financial and Economic Analysis of PV Applications

Analysis	Economic	Financial
Discount Rate (%)	12	12
Exchange Rate (RS/US$)	26	26
Standard Conversion Factor	0.8	1.0
PV Panel Cost (1992 Rs/Wp in Yr 3 of Project)	105	150
Kerosene Cost (1992 Rs)	6.3	4.75
Diesel Cost (1992 Rs)	5.6	5.6
Gasoline Cost (1992 Rs)	16.0	5.6
LRMC Power (1992 Rs)	1.8	1.3
Real Escalation Power (%)	2	2

Attachment 3.2

Solar PV Applications Under Consideration

The following are representative PV products that will be eligible for financing under the solar PV Market Development component.

Rural Electrification Applications

A. Solar lanterns.
B. Lighting and other low power applications in houses or commercial establishments.
C. Community service systems (e.g., schools, community centers, health centers etc.).
D. Street or security lighting
E. Village power systems
   1. DC systems
   2. AC systems
   3. AC PV-diesel hybrid systems

Water Supply Applications

F. Water pumping
G. Water purification systems
   1. Filtration plants
   2. Disinfection (UV, ozone)

Other Applications

H. Battery charging stations
I. Ventilation systems and evaporative coolers
J. Crop sprayers
K. Electric fencing
L. Educational kits
M. Vaccine refrigeration

Attachment 3.3
SCOPE OF WORK FOR
SOLAR PV MARKET ASSESSMENT,
WILLING TO PAY ESTIMATION,AND
DESIGN OF PROMOTIONAL CAMPAIGNS

IREDA has recruited consultants to assess the high priority markets for PV systems, determine consumers willingness to pay for such systems, and to design a publicity campaign to encourage potential borrowers and PV users to invest in PV systems and to make them aware of the availability of the revolving fund. The scope of work which will be completed within eight months is detailed below.

The objectives of the market assessment is to profile the market in terms of consumer preferences, market size, and regional opportunities. The consultants will also conduct product and concept testing for selected PV-powered equipment to assess the consumers willingness to pay. Based on this information, the copnsultants will design a promotional campaign: (a) to increase awareness of the availability of the IREDA PV financing and technical assistance services; (b) to increase the familiarity of buyer organizations and financial institutions with PV technologies and increase their willingness to pay for the higher quality services availbe through PV, and (c) to encourage rapid disbursement of the funds. Both private and public sector organizations will be targeted, however, the principal efforts are expected to be directed at private sector organizations. The promotional campaign will focus on financial intermediaries and buyer organizations in specific regions with high market potential. It is anticipated that two states/regions will be targeted annually although alternative strategies may be proposed. The publicity campaign is expected to run for three to five years.

Estimation of the PV Market Potential

The consultant will research existing national and state-level data to determine the regions with the highest potential for PV products over the next ten years. This effort will focus on geographic, demographic, economic, technical, and social factors which bear on PV use such as income level, availability of grid power, availability and cost of alternative fuels and power sources, willingness to pay, solar insolation, etc. Based on data gathered above, identify regions and customer classes with the greatest near-term potential for PV products.

The consultant will estimate the market potential for PV products over the next ten years. The estimate profile the existing market with predictions for market growth. The market potential will be broken down by region, market segment (e.g household, commercial, agricultural, light industrial, cooperative, NGO, private/public sector, etc.) as well as by application.

Conduct Limited Product and Concept Testing

The consultants will conduct limited market testing of specific products and concepts (e.g. PV powered lanterns or lighting/appliance systems). Testing will be conducted in three or more regions and involve sufficient quantity of installations and diversity of potential users to draw meaningful conclusions regarding the product's marketability within the region and country. Elements of the product testing shall include, but not be limited to:

- Profile of test participants
- Identification of potential product user classes
- Identification of product uses
- Assessment of user reaction to product cost versus function
- Willingness/ability to pay for services that the product provides
- Appropriate cost and payment schedule for product
- Preferred financial arrangements for payment
- Problems associated with product
- Ability of product to meet needs/desires of user
- Ability/willingness to conduct minimal system maintenance
- Ability/willingness to understand and abide by system operational constraints
- Preferred servicing arrangements (i.e. service agreement with scheduled visits, on-call servicing, etc.)
- Overall user satisfaction with product

IREDA will assist the consultant in obtaining product samples from Indian and international suppliers for product testing. Where adequate samples cannot be obtained, the consultants will conduct concept testing. The consultant will identify the present constraints to product marketing in terms of consumer needs/desires compared to product quality, reliability, distribution, servicing, pricing, financing, promotion, etc. Recommend actions to be taken by manufacturers and other private and public sector agencies to overcome these constraints. Importantly, the consultant will assess the consumers willingness to pay for PV products and recommend payment strategies that enhace the marketability of PV systems.

Develop Revolving Fund Publicity Campaign

The consultant shall develop a publicity campaign for the proposed IREDA PV financing revolving fund targeted at key financial intermediaries, as well as large-scale borrowers such as NGOs and PV suppliers. The campaign design shall include identification of target audiences in each region, as well as specific strategies and timetables orchestrated to meet the stated objectives while minimizing costs. Specific recommendations for the use of promotional tools such as television, radio, newspapers, magazines, brochures, seminars, workshops, etc., will be included. Mock ups of promotional materials will be provided. Cost estimates for the overall campaign as well as cost breakdown for major components shall be provided.

Design Promotional Campaign for PV Products

The consultant shall design a promotional campaign for the marketing of PV products in India. This campaign shall be a detailed, long-term plan laying out the overall strategy and approach for the marketing effort. It shall include regional and user class specific marketing objectives, approaches, schedules, and costs. The phased introduction of specific products or product classes will be recommended along with the target user. Specific recommendations for the use of promotional tools such as television, radio, newspapers, magazines, brochures, seminars, workshops, etc., will be included. Mock ups of promotional materials will be provided. Recommendations for promotional campaign financing contributions from public and private-sector sources will be included as well as details of public and private sector roles in campaign implementation. A regional focus for the publicity campaign will be recommended along with a rationale.

Attachment 3.4
Impact of Financing Schemes on
Photovoltaic Lantern Sales Leveraged by GEF Funds

An important objective of the project is to use GEF funds to leverage significant amounts of PV sales. This is expected to lead to cost reductions due to improved economies of scale in production. Given the current cost of PV lanterns, it would be extremely difficult to finance the systems based on the kerosene payments of the poorest households due to the very low kerosene consumption of the latter. In India, the use of pressurized kerosene lanterns is rare, even in middle/upper income rural households without electricity. Instead, these households use hurricane lanterns. Low income households use home-made bottle lamps. The cost of operating a hurricane lantern is currently no more than Rs. 30/month at a kerosene cost of Rs. 4.80/liter. Wealthier households may spend more on kerosene, but it is to operate several lanterns in different rooms.

Two financing strategies were considered on the use of GEF funds: (a) to blend the grant with other funds to provide concessional financing (Case I); and (b) to subsidize the capital cost of the PV system so that the customer pays only an amount similar to current expenses for alternatives such as kerosene lighting (Cases II and III):

Case	I	II	III
Mass-produced Lantern Cost (Rs.)	4800	4800	4800
Downpayment	10%	0%	0%
Interest	10%	18%	18%
Payment Period (years)	5	5	5
Monthly payment to recover full commercial costs (Rs/lantern)	109	122	122
Monthly payment collected (Rs)	91	30	50
NPV @ 12% of GEF contribution/lantern ($)	31	159	125
MWp leveraged by GEF $12 million grant	3.5	0.7	0.9

If the GEF grant is used to set the level of consumer payments equivalent to their kerosene lighting expenses (Rs. 30 to 50/month), then the GEF grant can only support 0.7 to 0.9 MWp of PV. Such low volumes will not encourage manufacturers to move into mass production. If on the other hand, credit is subsidized at 10% interest, then GEF the grant will leverage 3.5 MWp of PV (Case I). In this case affordability may be limited to households earning more than Rs. 1800/month (assuming they spend 5% of their monthly income on lighting). As the preinvestment study showed, there are 20 million rural households who meet this income criteria. Even assuming that 90% of these households are already electrified (a conservative estimate as only 26% of rural households were electrified in 1986), there remain at least 2 million households with the capacity to pay Rs. 90/month for a lantern. Two million lanterns require nearly 20 MWp of PV.

The financing strategy demonstrated in Case I is preferred because it will leverage more PV sales. It will also develop a self-supporting market niche which the producers can view as a sustainable market even after the project ends, and not one reliant on subsidy availments. To date producers have catered to the heavily-subsidized government programs; another such scheme is not likely to help "commercialize" the technology. Through the PV promotions campaign, increased awareness of the difference in quality of lighting offered by PV lamps from kerosene bottle lamps would increase the willingness to pay among consumers. But the poorer households may still not be able to afford the system until product cost comes down. During the mid-term project review, the cost and demand situation would be reassessed. If the cost differential between PV and kerosene has narrowed and willingness to pay has increased, the financing schemes can be redesigned to focus on the poorer sector.

Attachment 3.5
Scope of Work
Provision of Technical Assistance for
Quality Assurance, Marketing, Service and Evaluation

(a) PV Product Performance Specification

Advise on methods and techniques for determining the performance requirements necessary for PV systems. These requirements, which may be application-specific, will be based primarily on customer requirements, Indian operating conditions, and safety considerations. Areas included within the scope of services include: component and system specification, packaging/installation requirements; controls; feedback indicators (e.g. charging/discharging); levels of service (e.g. lighting levels and duration); and reliability/cost tradeoff. Suggest modifications to existing equipment, systems, etc. required to meet specifications. Provide training in the areas of interpreting customer surveys and market analysis, preparation of specifications, specification implementation, and product testing. Assist in preliminary preparation of specifications. Estimate the cost of modifications required to meet specifications.

(b) Improving Product Quality and Reliability

Review existing and proposed designs, manufacturing and assembly techniques, installation procedures, and maintenance procedures. Provide recommendations for improvements which will result in enhanced product quality, greater efficiency in manufacture, reduced cost, reduced complexity, improved reliability, and minimal maintenance requirements. Provide training in the areas of designing for product quality, reliability analysis, and the economic/marketing tradeoffs between product costs and product quality/reliability. Perform a benefit/cost analysis of proposed improvements.

(c) Quality Control Procedures

Review current PV product development, production, distribution, installation, and service facilities and techniques. Facilities include manufacturing, assembly, distribution, installation, service, etc. Techniques include fabrication, assembly, packaging, shipping, installation, and service. Analyze current quality control operations and procedures as well as waste minimization and control of toxic or environmentally hazardous discharges. Provide a range of specific recommendations or modifications to the facility and/or technique. Recommendations will be aimed primarily at improving product quality, however, improved environmental controls, increased productivity and reduced product cost will also be considered. Provide training in quality control plan development, implementation, and evaluation. Provide estimates for the benefits versus cost of recommended modifications.

(d) Marketing Structures

Review historic, current, and proposed PV advertising, and promotion efforts, as well as pricing, distribution, financing, sales, and maintenance/service arrangements. Perform market research to identify key elements required for marketing success within the Indian social, business, marketing, financial, environmental, economic, and educational context as well as impediments to effective marketing of PV products. Recommend specific improvements on the PV

industry level for improved marketing of PV products. Also recommend policy/institutional/regulatory changes which will remove obstacles to marketing and sales of PV equipment. Provide training in marketing plan development, implementation, and evaluation, including market research, establishment of pricing and financing plans, promotion, distribution, and servicing.

(e) Establishing Effective After-Sales Service

Review current after-sales service arrangements. Estimate service requirements for PV systems. This may be done by system type (e.g. household lighting, water pumping, street lighting, community center, commercial, agricultural, telecommunications, etc.), by customer type, by region, or other appropriate scheme. Recommend service structures and arrangements which will provide adequate coverage for current and expected installations. Recommendations should be specific and should include, among other things, service network structure, staffing requirements, technician training, field technician placement and affiliation, equipment requirements, factory support arrangements, spare parts requirements, field technician supervision, guarantee/warranty fulfillment, and quality control. Recommend training procedures for technicians, including initial training, review/remedial training, new product training. Review user manuals supplied with product, operations and maintenance (service) manuals and recommend modifications for improvement. Train service organization staff in techniques for designing and establishing effective after-sales service networks as well as consumer education programs for use of PV systems. Estimate cost of service including profit requirements, and recommend payment mechanisms for recouping costs.

Attachment 3.6
Scope of Work
Provision of Procurement Advisory Services and Procurement Assistance

The services to be provided by the procurement organization or consultants include the following:

Establishing acceptable procurement policies, practices, procedures and documentation at IREDA and its clients, as needed. These services include, but are not limited to:

- Review existing procurement practices at IREDA and its borrowers and make recommendations on how these can be restructured to attract local and international bidders, and to ensure that they meet World Bank procurement guidelines.
- Training of procurement specialists in at IREDA and its client organizations in World Bank procurement policies and guidelines for international competitive bidding (ICB), limited international bidding (LIB), local competitive bidding (LCB), and international and local shopping.
- Organize and conduct workshops to familiarize potential IREDA clients with acceptable World Bank procurement practices.
- Prepare sample bid documents for procurement of goods and works for use by IREDA's clients.
- Prepare bid evaluation criteria, guidelines and procedures to ensure that they meet World Bank guidelines.

Assist IREDA in organizing and conducting seminars and training courses for interested suppliers in responding requests for tenders issued in accordance with World Bank procurement guidelines.

For specific procurement, assist IREDA or its clients in the bidding process including selection of appropriate procurement procedure (e.g. ICB, LIB, LCB, shopping), preparation of bidding documents, preparing and issuing the required bid notices, identification and qualifying suppliers, organizing of bidders conferences, evaluation of bids, contract negotiations, preparation of contract documents, quality assurance, monitoring of performance, disbursements, and financial and budgetary supervision.

Assist IREDA and its clients, where appropriate, in pre-qualifying equipment from local and international suppliers to increase the economy and efficiency of procurement process, without compromising competition or constraining the introduction of improved or lower cost products in the future.

Review of current fiscal and customs policies and national PV technology policies governing the procurement of equipment and making recommendations to increase the economic attractiveness of these equipment and improve the availability of quality products.