PROPOSAL FOR REVIEW

Project Title:	**Indonesia: Solar Home System (SHS) Project**
GEF Focal Area:	Climate Change
Country Eligibility:	Convention Ratified August 23, 1994
Total Project Costs:	US $ 75 million
GEF Financing:	US $ 24.3 million
Government and Private Sector Counterpart Financing:	US $ 27.5 million
Cofinancing/Parallel Financing:	IBRD US $ 20 - 25 million
GEF Implementing Agency:	World Bank
Executing Agency:	Agency for the Assessment and Application of Technology (BPPT), and Government of Indonesia's multi-agency Rural Electrification Steering Committee
Estimated Approval Date:	September 1996
Project Duration:	5 years
GEF Preparation Costs:	No GEF PDF
Government Endorsement:	Received 7 July, 1995

SECTORAL CONTEXT

1. **Background** In Indonesia today, out of an the estimated population of 186 million, over 110 million -- about 24 million households -- remain literally and figuratively speaking "in the dark", without access to electricity, and many with little or no hope of getting such access in the foreseeable future. The vast majority of this population segment (nearly 80%) reside in rural areas. For meeting their very basic needs, lighting, these rural households have little choice today but to make do with vastly inferior and yet typically more expensive and polluting energy sources other than electricity, such as candles, flashlights, and most commonly kerosene fuelled wick lamps, hurricane lanterns and petromax lamps. By depriving rural households of any real choice in efficient and sustainable energy forms, the welfare and quality of life of the rural population is greatly diminished; since they have diminished access -- quality and quantity -- to many highly valued end-use services, and are often forced to pay more than necessary for inferior services.

2. In Indonesia, the cost of supplying electricity to rural households that have access to grid supply from the national power utility (PLN) is high. PLN owns and operates over 5,000 diesel plants scattered throughout Indonesia -- about 2,000 MW of diesel generating capacity -- as a primary means to supply power for rural electrification (RE). Apart from the high cost of sustaining diesel operations in remote areas, the cost is high because much of the diesel plant is under-utilized, with capacity factors averaging less than 30%. In addition, even in the case of the RE loads supplied by regional grids, diesel is the marginal fuel at most times of system operations.

3. Under the present policy of nationally uniform electricity tariffs, the total cost of PLN supply for many RE loads is well in excess of the tariffs to such consumers. PLN's "avoided costs" are estimated, on average, to be about Rp. 140/Kwh (about USc 6.6/kWh) for the Java-Bali grid, about Rp. 196/kWh (USc 9.3/kWh) for the seven regional grids outside Java, and as high as Rp. 250/kWh (USc 11.7/kWh), for PLN's large number of diesel-based isolated units and mini-grids. In contrast, PLN's average revenue from the typical rural consumer is only Rp 137/kWh (USc 6.45/kWh). Thus, diesel-based rural electrification implies a significant subsidy burden on PLN.

4. The Government of Indonesia (GOI) has recently begun to assess the suitability of various supply options for meeting the energy needs of the remaining unelectrified villages and households in a least-cost and economic sequence. One element of this assessment is the recently completed Rural Electrification (RE) Master Plan, which analyzed only grid-based electricity supply. One of the main implications of the RE Master Plan is that there are about ten million households -- consisting of the isolated rural households for whom it will never be economic to provide grid-based supply, and of the households for whom the least cost supply option is grid extension, but who will not receive grid-based supply during the project duration and even beyond. These households comprise the economic potential for decentralized supply options that are cheaper and environmentally superior to the conventional alternative of diesel-based mini-grids.

5. **Renewable Energy** The Government attaches high priority to cost effective renewable-based energy supply as a means of ensuring high and environmentally sustainable rates of economic growth. Increased penetration of renewable based generation will have a significant and positive impact on the environment by reducing local pollutants such as SO_2 as well as pollutants of global concern such as emissions of green house gases (GHG). To the extent that this development displaces kerosene consumption and diesel generation, it reduces the negative environmental impacts of transport, waste disposal and burning of these fossil fuels.

6. Beginning in 1987, the Government of Indonesia (GOI) has sponsored a series of pilot **solar photo-voltaic** (PV) demonstration programs. The most recent initiative -- "Banpres" (Presidential Aid) -- is directly linked to the President of Indonesia. The combined total of these demonstration efforts has resulted in the installation of about 16,000 PV units in rural households. These Government programs have helped to demonstrate the potential of solar PV technology for meeting some of the electricity end-use needs that many rural households perceive to be most important. An evaluation of this experience indicates that customers are generally satisfied with the performance of their solar home system (SHS) and there is no evidence of systemic problems or high premature failure rates for critical components such as batteries, panels, and controllers.

7. These early and various Government-agency sponsored programs were primarily geared to technology demonstration; as such, they did not focus on cost recovery or building a base for future product or market development, nor did they offer a means to mainstream private sector delivery and sustainability. Specifically, in Indonesia, the Government/public agency led model is best characterized as a procurement system, not as a commercial market, with the SHS units typically distributed in small lots to homes widely dispersed all over Indonesia. Such a distribution mechanism has proved to be incompatible with the development of cost effective and sustainable private dealer chains, given the limited scale and geographic fragmentation.

8. It is the GOI's goal to ensure that modern forms of energy become accessible to all rural households in a phased, least-cost manner. In recognition of the role that solar PV can play in meeting the energy needs of rural households, the Government of Indonesia has formulated the outlines of a plan to install solar PV systems with a total capacity of 50 MW_p. However, there still remains a need to develop a detailed solar PV strategy and its implementation plan.

9. The GOI recognizes that a number of different delivery and financing approaches are required in Indonesia, based on the incomes, energy requirements, and geographic location of the target population. Broadly speaking, the Government's solar PV strategy for rural electrification has two prongs: (i) Government-based programs targeted at the higher-cost remote areas and for the poorer segments of the population, and (ii) commercially-based private sector led programs for the relatively closer-in and more affluent segments of the population.

10. For example, as part of the first prong, the Government, in association with AusAID, is currently formulating a plan to install about 36,000 solar PV systems in the remote islands of Indonesia. It is recognized that a commercial approach is not appropriate for the target population; though the details of the payment schemes have not yet been finalized, it is likely that there will be a small downpayment, a long repayment period of 7-10 years, low monthly payments, and interest rate subsidies. At the same time, recognizing the heavy and recurrent subsidy burden inevitably associated with such public agency programs, the Government is also keen to promote alternate delivery and financing approaches that are commercially sustainable, private sector based, and that offer the prospect of achieving high levels of penetration at a much faster pace than is feasible with the Government-based approach. In short, the GOI recognizes that Government-based programs will be complementary to the commercially-based programs.

11. **Barriers to Solar PV Market Development** An indirect benefit of the Government programs has been the emergence of a nascent SHS market. However, the present market conditions can be characterized as a "high price low volume" equilibrium, while an expansion of the market requires a move to a self-sustaining "low price high volume" equilibrium. Three inter-locking factors together form a barrier to increased SHS sales:

(i) **Lack of established high-volume supplier-dealer chains.** At present, there are only a limited number of supplier-dealer chains, and they operate at low volumes in limited geographical regions within and outside Java. Most of the potential customers are not being offered an opportunity to buy a SHS;

(ii) **High prices.** At present, the annual volume of SHS direct household sales is low, and the prices are high; at the same time, the dealers are unable to reduce their prices, given the small scale of their operations;

(iii) **Lack of credit.** At present, the bulk of the potential customers, both within and outside Java, are unable to secure the credit they need to buy the SHS. Even if banks were to extend credit for SHS, under current Indonesian banking practices, they would expect repayment over 1-2 years maximum, which would be an insufficient amortization period for the majority of potential customers.

12. What this means in practical terms is that the barriers blocking rapid, sustainable expansion of SHS in rural Indonesia are not amenable to simple, single-problem solutions. Rather, a multi-pronged strategy is required. For instance, by itself, without a reduction in the selling price, making credit available and stretching out the maturity/term of such credit will not eliminate the barriers that presently restrict market development. Without price reductions, affordable levels of downpayment and monthly installments would require installment terms of 6 to 8+ years duration, given current interest rates. However, the maximum loan duration feasible under a sustainable private sector approach, given conditions would be in the 3 to 4 year range. Amortizing the cost of an SHS over 3 to 4 years, without a price reduction, would result in monthly payments that exceed the capacity of most target households.

13. In light of this, for a sustainable delivery approach led by the private sector, it would be necessary to design an installment payment mechanism that addresses rural households' cash constraints and the banking system's upper limit of a 3 to 4 year amortization period. An analysis of the data from market surveys indicates that for target rural households, an affordable down payment would range from $80-125, and that monthly installment payments should be close to potential customers' present monthly expenditures on energy (about $8-10). For these consumer cash flow limits to be compatible with the 3 - 4 year amortization period, it would be necessary to bring down the final price to the household by a "first cost buy down".

SHS DEVELOPMENT STRATEGY

14. **Pilot effort** The SHS project is a pilot effort to catalyze private sector-based markets for SHS, where they are consistent with a least cost rural electrification strategy. The project focuses on a few selected target markets that have high potential for quick penetration. The proposed project scale (para 19), has been determined taking into account several key factors, including: (i) the desirability to establish competitive pressures on the dealers -- actual or by comparison -- which requires that at least two SHS dealers operate in each market; (ii) the minimum scale needed for each dealer in order to capture supply and service chain economies in operations, delivery and after-sales service; and (iii) make it sufficiently profitable for each participating dealer to lower prices and aggressively expand operations, so that the market as whole can move to a higher volume-lower price equilibrium.

15. **Long term view** In the long term, the SHS project is seen as one of a series of linked projects, phased over a period of time; each seeking to build upon the lessons learnt from the predecessor project.

while broadening the regional market and technology focus to new areas, and at the same time also seeking to further enhance the efficiency and reduce the costs of existing delivery and financing mechanisms. The cost reductions achieved and efficient delivery mechanisms developed under the first SHS project would form the foundations of all successor projects.

PROJECT OBJECTIVES

16. **Global objective** The global environmental objective of the SHS project is to mitigate emissions of CO_2 in Indonesia. At present, a significant portion of Indonesia's rural population satisfy their energy needs by fossil fuels in various ways, such as kerosene for lighting or diesel-based power generation, which lead to the emission of CO_2. The penetration of SHS would reduce CO_2 emissions by displacing the use of the fossil fuels. It is anticipated that about 2 million tons of CO_2 emissions will be mitigated as a result of the SHS project (Annex 4).

17. In addition to this global objective, the SHS project's goals are to:

(i) catalyze the rapid penetration of solar PV systems within the framework of a least cost rural electrification strategy;

(ii) facilitate participation by the private sector -- including cooperatives and NGOs -- in advancing renewable energy commercialization through the creation of a sustainable "market conforming" framework;

(iii) promote environmentally sound energy resource development in Indonesia and to reduce the energy sector's dependence on fossil fuels; and

(iv) strengthen Indonesia's institutional capacity to sustain solar PV development.

PROJECT DESCRIPTION

18. The SHS project consists of two major components: (i) investment (including project implementation support), which forms the bulk of the project, and (ii) capacity building. The project will also support detailed monitoring and evaluation activities during project implementation.

19. The **investment component** consists of the sale and installation of about 200,000 (10 Mwp) SHS units. It is expected that purchasers of PV units will include households, commercial establishments (such as shops), and local communities (for community buildings such as meeting halls, etc.). The geographical scope of the SHS project will not exceed four selected regional markets -- West Java, Lampung, South Sulawesi, and North Sumatera [1] -- where, under the least cost grid reticulation plan for rural electrification (the "RE Master Plan"), grid supply by the national power utility (PLN) is not expected over the next decade, or where it will be uneconomic for PLN to provide such service. The sale and

1/ Recently completed detailed field surveys to assess the demand for SHS in these provinces, with the specific purpose of assessing the extent of the market that can be served in the near-term by private dealers at commercial terms, show that there is a large market for commercial SHS sales in North Sumatera, South Sulawesi, West Java, and Lampung.

installation of these SHS units will be executed by private dealers, who will take the responsibility for procurement, sales, installation and maintenance of SHS.

20. **Capacity building component** The SHS project would: (i) assist GOI's Rural Electrification Steering Committee to develop a strategy and corresponding action plan for meeting the modern energy needs of the segments of the rural population for which solar PV systems represent the least-cost strategy; and (ii) strengthen the institutional capacity of the Indonesian Agency for the Assessment and Application of Technology (BPPT) in supporting solar PV projects. The Government of Indonesia has given BPPT a strong charter and mandate to increase penetration of solar PV systems in Indonesia, on a large scale and quickly. The assistance provided by the SHS project would be in areas, such as qualification testing facilities, technical design services, and best practices identification, that would strengthen BPPT's ability to assist the private sector in designing and delivering high quality solar PV products. Together, these two aspects of capacity building would facilitate the design and establishment of a longer term program for solar PV penetration in Indonesia that is consistent with a least cost and sustainable rural electrification strategy.

21. The SHS project would address the barriers to SHS market development by providing the dealers an integrated package of support, comprising three elements:

(i) **Term credit at market rates** Loans from commercial banks to supplier-dealers for up to about five years at commercial market rates of interest. Supplier-dealers would apply for the loan to a commercial bank which meets Bank of Indonesia guidelines. In deciding whether to make loans to the supplier-dealers, the commercial banks would apply their standard loan appraisal procedures. The commercial bank loans would be refinanced through Government of Indonesia on-lending arrangements under an IBRD credit.

(ii) **First cost buydown** First cost buydown in the range of $75-90 per SHS sold and installed on Java, and $ 100-125 off Java. The amount of the first cost buydown has been calculated to bring the final price to households to a level at which the unpaid balance to the dealer can be amortized over no more than 3 to 4 years, with monthly payments that are affordable. The buydown would be provided to dealers only after the SHS sales have taken place and been verified, in order to reward actual sales performance and to ensure that scarce GEF grant funds are not immobilized with poor performing dealers. The first cost buydown would be financed by GEF grant funds.

(iii) **Support facilities** Promotional, business development and technical support to reduce information constraints, encourage competition and facilitate supplier-dealers in their development of bankable investment proposals. This support would be financed by GEF grant funds.

22. This package of support to the dealers will provide two significant benefits to the customers who purchase SHS units. First, the dealers will be an effective channel linking commercial banks and rural customers, who will gain access to credit at market rates without having to undertake formal credit application and approval steps. Those customers interested in purchasing a system on an installment plan basis will make a down payment -- typically in the range of $80-100 -- and thereafter will make monthly payments to the dealer, typically for durations of 3-4 years. Second, the bulk of the GEF grant would flow to the consumers in the form of lower prices, as the dealers shift from a "high price low volume" equilibrium to a "low price high volume" equilibrium.

23. **Consumer protection** The SHS consumers will be protected in a number of ways. Apart from ensuring that the SHS units meet rigorous technical standards, the dealers will also be required to offer a no-questions-asked money-back option, valid for a short period of time after the initial sale. Second, the dealers will also be required to provide industry-standard warranties on all systems that they install. Further, during the course of the project implementation, the project support unit (PSU) will provide potential SHS customers information about the technical, financial, and operational aspects of the SHS. While the SHS project will not set prices, consumers will be provided with expected price ranges, including details about downpayments, monthly payments, etc. The PSU will provide all actual SHS customers with the means to communicate with it; on its own initiative, the PSU will contact a number of actual customers, on a random sample basis, to determine the extent of their satisfaction with SHS, and to resolve any problems. It is expected that some of these contacts will be undertaken by local community organizations and NGOs (see para 27).

24. **Technical specifications** It is expected that each SHS would consist of one or more photovoltaic (PV) modules with an output of at least 50 Wp nominal, a car-type 12 volt DC lead-acid battery, and related electronic and electrical components and mounting hardware. All SHS units supported by the project will have to meet rigorous technical specifications, which have already been developed by BPPT in cooperation with solar PV dealers, and have been widely circulated. The technical performance of the Indonesian non-panel (Balance-of-Systems) components is already high; for example, the locally made batteries available in Indonesia have an average life in this application of about three years, which is longer than that reported in many other developing countries. Further, there are some indications that the very initiation of the SHS project will itself lead to improvements in the technical components; one of the established battery manufacturers in Indonesia has stated that they would be interested in setting up a production line for specialized deep-discharge batteries particularly suitable for solar PV applications, once they can foresee demand on the scale implied by the SHS project.

IMPLEMENTATION ARRANGEMENTS

25. The sale and installation of SHS units will be undertaken by independent private dealers. In order to reduce the risk of low participation rates and poor implementation performance, intensive efforts have been made during project preparation (and will continue to be made) to pre-identify by the time of appraisal six to ten dealers who are interested and capable of participating in the project. Initial proposals to participate in the SHS project have already been received from seven dealers. It is possible, that one or two dealers may be added after project appraisal, in the event that some good new dealers with sound business plans surface later, or some of the pre-identified dealers are unable to continue their participation in the project.

26. **Selection criteria** In order to be considered for participation in the SHS project, dealers must meet a set of minimum criteria: (i) the company must be Indonesia based; (ii) its current operations must include SHS sales or the marketing of other products in rural areas; and (iii) its past performance and current operations must demonstrate adequate technical, financial and business capability. In addition to these basic criteria, in order to be selected for participation in the SHS project, an enterprise would have to meet the following conditions:

(i) **Additionality** The enterprise must demonstrate that it would increase SHS sales in the selected area well beyond an estimated "baseline level" which would be achieved without the project's support. It is anticipated that the availability of project support would encourage supplier dealers to mount ambitious market development efforts.

(ii) **Technical standards** The enterprise must prove that the SHS it would sell would meet the detailed technical specifications.

(iii) **Financial viability** The enterprise has to develop a business plan which would demonstrate the investment's profitability and include adequate arrangements for hire-purchase based SHS purchases by households, and technical support to ensure high quality of the system and after sales service.

(iv) **Commercial acceptability** The enterprise's credit application must be acceptable to a commercial bank participating in the program. As the World Bank's credit would be channeled through a commercial bank, which would bear the commercial risk, the commercial bank's approval of the loan would be necessary.

27. **Disbursement** GEF funds would be disbursed to participating dealers only after confirmation that the sales and installations had been made and all the conditions met. The confirmation process would be based upon independent field based verifications of the sales, installations and compliance with the technical and other conditions. It is expected each dealer's initial sales and installations would be verified; subsequent confirmations would be on a routine basis subject to *ex post* verifications conducted on randomly selected samples of installed units. The *ex post* verifications would be undertaken by NGO teams, who would be trained for this purpose.

ENVIRONMENT AND RESETTLEMENT

28. The solar PV technology to be disseminated through the SHS project has no emissions of gases such as CO_2 or SO_2, and is environmentally superior to the available alternative forms of energy, which are based on fossil fuels. Since the SHS systems will be installed on existing structures (homes, shops, community buildings, etc.), the SHS project is not expected to pose any resettlement problems. The SHS project is classified as a "B" project, and an environmental analysis is being prepared.

RATIONALE FOR BANK INVOLVEMENT

29. The World Bank is committed to supporting renewable energy development in Indonesia, as stated in the Indonesia Country Assistance Strategy (CAS) that was presented to the Bank's Board in February 1995. The proposed project design and implementation strategy typify the defining characteristics of the transition that is underway in the assistance strategy for Indonesia: (i) achieving poverty reduction through increased funding for regional development, and a shift towards smaller and regionally oriented projects targeted at reducing urban-rural disparities in the quality of life; and (ii) striking the appropriate balance between public and private roles in energy distribution.

30. The Bank continues to actively support implementation of an efficient and sustainable Rural Electrification (RE) program, initiated in the Rural Electrification I project and now through the successor Rural Electrification II project; primarily by financing extension of the various regional grids, and related institutional capacity building. Solar home systems are one of the key elements of the overall least cost RE strategy in Indonesia, and they complement the least cost grid extension program for RE. The SHS project will provide a means to continue the Bank's dialogue with the Government of Indonesia and to influence the implementation of a sustainable and environmentally sound RE development program, while encouraging private sector participation and the creation of commercial markets for alternative energy.

and continue the process of improving the policy and institutional environment. all matters of high priority on the Bank's agenda.

RATIONALE FOR GEF FINANCING

31. The SHS project is eligible for GEF support and is consistent with the renewable energy market penetration aims embraced by the draft GEF Operational Strategy. The SHS project is expected to help lower the unit costs of solar PV technologies in Indonesia, given the downward sloping technology cost learning curve. In addition, the SHS project is expected to set a new lower global benchmark price for SHS, thereby stimulating further penetration and global environmental benefits from abatement of GHG emissions in other countries as well.

32. Indonesia has ratified the FCCC on August 23, 1994, so that it is eligible to receive GEF funds under this convention. In order to help fulfill its FCCC national commitments, Indonesia has initiated two greenhouse gas mitigation strategy studies. The Asia Least-Cost Greenhouse Abatement Strategy (ALGAS) project, financed by UNDP/GEF, examines Indonesia's GHG emission reduction options in an Asia regional context. Indonesia is also a participant in the second round of study activities financed under the U.S. Country Studies Program. Although both studies are still in early stages of preparation, the relevance of photovoltaics as a greenhouse emissions abatement option for Indonesia is clear. The country is characterized by a large, growing and dispersed rural population, a substantial fraction of whom are not electrified but who presently consume fossil fuel-based energy for lighting and radio and TV services. As a zero greenhouse gas emitting technology, the Solar Home Systems can meet these basic energy demands while substituting for higher polluting kerosene, diesel and grid-based options.

33. The project has high priority in Indonesia, given that the access of rural Indonesian households to modern forms of energy less than commensurate with Indonesia's overall level of economic development. The Government of Indonesia has a long history of commitment to the SHS project. Initially, in 1993, the Government submitted a proposal entitled "Integration of Renewable Energy Systems Within a Least-cost Rural Electrification Strategy," which formally conveyed the Government's request for IBRD financing, including a GEF grant component, for increasing the penetration of renewable energy systems. More recently, a letter from the Vice Chairman of the Indonesian Planning Agency (BAPPENAS) to the Bank has reaffirmed the high priority the Government accords to rapidly increasing the contribution of cost effective renewable resources in meeting the growing energy end-use needs in Indonesia, especially in rural areas: and in light of such priority, the importance of the proposed Bank/GEF-financed SHS project (Annex 2).

PARTICIPATION AND SUSTAINABILITY

34. **Participation** Within the Government of Indonesia, the primary stakeholders in the SHS project are: the Agency for the Assessment and Application of Technology (BPPT), the Directorate-General of Electricity and Energy Development (DGEED), the Planning Agency (BAPPENAS), and the Ministries of Finance and Cooperatives. These agencies have been and continue to be involved to varying degrees in project preparation. In particular, BPPT has played a very active role, and has been involved in activities such as conducting market surveys, developing technical specifications, publicizing the SHS project within Indonesia, and providing office facilities for project preparation work. The SHS project would strengthen BBPT's institutional capabilities.

35. **Within the private sector, the primary stakeholders include the Indonesian Solar Energy** Association and individual solar PV systems dealers and suppliers. A number of presentations related to the SHS project have been made to the Solar Energy Association as well as to individual dealers, and their comments have been incorporated into project design and the technical specifications.

36. Site visits and discussions have been held with a limited number of households that have already installed SHS, whether as part of a Government program or buying it privately. In addition, about 1,000 households were contacted as part of the market surveys. These contacts have confirmed that there is a potential market for SHS in selected parts of rural Indonesian households, which ensures that lack of demand will not impede sustainability.

37. **Sustainability** The project's strategy of focusing on a number of selected regions that have high market potential is expected to lead to cost reductions as suppliers begin to capture economies of scale, particularly in establishing sales-and-service chains and in assembly of balance-of-system components. It is expected that the dealers will pass on the bulk of the first cost buydown to their customers, so that SHS prices at the project starting date (Fall 1996) would be lower than the current (Fall 1995) prices. Additional price reductions are expected to occur as a result of unit cost reductions, particularly in the markets where there has been very limited penetration of SHS and current prices are high. In the post-project phase, when the GEF first cost buydown would end, based on reductions in unit costs, it is expected that the dealers will be able to maintain prices that are essentially similar, in real terms, to the prices prevailing at the beginning of the project, without sacrificing profitability. Furthermore, in the project regions/markets, it is expected that other key barriers to market development, besides price, such as weak SHS dealers, unavailability of term credit from financial markets, limited customer awareness, would all have been lowered substantially or even eliminated. Thus, it is expected that the dealers will be commercially viable in the selected markets at the end of the project, and those markets will be sustainable in the post-project phase without GEF intervention.

LESSONS LEARNED AND TECHNICAL REVIEW

38. Given the Bank's limited involvement in solar PV projects, there are no relevant Bank reports on past projects. Ongoing experience is limited to the IBRD/GEF-supported solar PV component of the India Renewable Energy Development Project (Ln. 3544-IN/Cr. 2449-IN). One key lesson learned from the India project is that timely project implementation is facilitated by: (i) pipeline development, i.e., pre-identification and preparation of sub-projects, and (ii) early development and dissemination of technical specifications. Further, the participating dealers can operate more efficiently if they have easy access to commercial banks, and the processing procedures for the disbursement of funds are simple and straightforward. These lessons have been incorporated in the project design.

39. To complement the limited in-house experience with PV projects, the experience of solar PV projects in other countries, particularly the Dominican Republic and Mexico (as suggested by the GEF independent technical reviewer), has also been reviewed with a view of improving the design of the SHS project. This review shows that in the Dominican Republic, a commercial approach has been successful in delivering SHS to rural households, but the overall scale has been restricted by the limited availability of credit, both to the SHS suppliers as well as the households. In Mexico, nearly 90% of the households are served by grid supply, and the SHS are being supplied on a subsidy basis to the remaining households for whom grid supply is uneconomic, and most of whom cannot afford to pay for the systems. Experience in other countries also points to the ability of the private sector to deliver SHS to rural households, the need for credit, and the benefits of some government involvement. For example, the

Kenyan private sector has successfully made cash sales of about 25.000 SHS on a purely commercial basis, but after a few years, in the absence of credit, the sales have slowed significantly, and further, in the absence of technical standards or other forms of support from government agencies, it is reported that about 25% of the systems are no longer functioning. This experience supports the design of the SHS project, which focuses on the private sector, addresses the barriers faced by the private sector, but includes government involvement to ensure adequate technical standards and support.

40. **Technical review** The project was reviewed in June 1995 by an independent external expert selected from the STAP roster, who is knowledgeable on global markets for solar PV systems. His comments are supportive of the project design and implementation strategy which he also notes will set the stage for larger programs worldwide (see Annex 3). His main comments were that: (i) the SHS project should build on the experience of other countries, (ii) the scale of 120,000 SHS units may be too small, and (iii) the guidelines on what characterizes success should be established early on. These comments have been incorporated in the revised project brief.

PROJECT FINANCING AND BUDGET

41. **Total Cost and Financing Plan** The total cost of the project is about $ 75 million, of which the investment component is about $ 73 million (including project implementation support), the capacity building component amounts to about $2.5 million, and monitoring and evaluation activities amount to about $0.3 million. A preliminary financing plan, disaggregated by component and source of financing -- IBRD, GEF, GOI and private sector -- is presented in Annex 1. The total GEF grant requested is $24.3 million, which corresponds to the proposed project's incremental costs.

42. **Phasing** Whereas a commitment for the total GEF grant amount of $ 24.3 million would be made now, in view of the innovative nature of this project and the proposed commercial scale, it is proposed that project implementation be phased, in order to afford national stakeholders and the GEF family of Implementing Agencies an opportunity to assess the success of the implementation mechanism. The first phase would consist of the sale and installation of 120,000 SHS units in the targeted rural markets over the project duration. This is the minimum economic scale estimated to be sufficient to provide private dealers with the incentives to commit themselves to extend their rural PV delivery network, and to take the risks associated with developing the infrastructure to install and maintain SHS units on a large scale, assume commercial debt obligations vis-a-vis a commercial bank, and extend installment credit to dispersed rural clients. Project support costs, capacity building activities, and monitoring and evaluation would also be included in the first phase of the project. The cost of the proposed first phase is estimated at $47 million, of which $15.75 million would be GEF grant funding.

43. An independent technical review panel would assess project performance against an agreed set of indicators and report back to the GEF Chief Executive Officer with its recommendation(s) about releasing the second phase of the GEF grant support (see para 56). This review would be timed such that private sector confidence and project implementation continuity would not be jeopardized, in the case of satisfactory performance. The second phase of the GEF grant funding would support the sale and installation of the balance of the planned SHS target for the project, or 80,000 SHS units. Continuation of project support and monitoring activities would also be included in the proposed second phase. The cost of the proposed second phase is estimated at $38 million, of which $8.55 million would be GEF grant funding.

INCREMENTAL COSTS

44. **Baseline** At present, most of the target households for SHS units use a combination of kerosene for lighting and diesel-based battery charging for other activities such as powering a black-and-white TV. Based on survey data and secondary information about prices, the monthly economic expenditures of the target households on kerosene and battery charging are about $9.30 on Java and $10 off-Java. These expenditure patterns reflect the fact that in Indonesia; (i) kerosene consumption levels in Indonesia are higher than in many other countries, and (ii) off-Java, the kerosene and battery costs are higher and their consumption level lower than on Java. Correspondingly, the present value of the target rural household's baseline expenditures on kerosene and battery charging (for 15 years at a discount rate of 10%) is $867 on Java and $930 off-Java.

45. **GEF Alternative** In terms of lighting, the SHS unit would provide more light and a better quality of light than kerosene, without the emissions; in terms of battery power supply, the SHS unit would eliminate the loss of service arising from the need to leave the battery at the service shop for overnight charging. However, on a lifecycle cost basis, under present conditions, the SHS are more expensive than the baseline arrangements, except in the limited regions on Java where some dealers have managed to establish an initial presence. In other words, the costs of SHS units are high in areas of Java where the dealer chains have not yet been established ("new Java areas"), and the costs off-Java are higher than this. At the same time, given the developments that have already taken place in Indonesia, the costs in the new Java areas and the off-Java areas are well below the costs reported in a number of other countries.

46. Based on the prevailing prices, the monthly economic cost of a SHS unit in the new Java areas is $10.10, which implies a present value of $940 for 15 years at a 10% discount rate. For off-Java, the SHS monthly economic cost is $11.38, with a present value of $1,059.

47. When the present value of the GEF alternative is compared with the baseline expenditures of the typical target household, the **incremental costs** are estimated to be about $73 per SHS unit in the new Java areas and about $129 per SHS unit off-Java.[2] For total project sales of 200,000, split about equally between the new Java areas and off-Java, the total incremental cost for the SHS units is about $20 million.

48. A small Project Support Unit (PSU) will be established to provide customers and dealers with the technical, financial and operational information. It is expected that potential customers will use this information, in part, to make informed decisions about the suitability of SHS. The PSU will also be responsible for monitoring project implementation performance. The total cost of these activities are expected to be $4 million. In the baseline scenario, BPPT/GOI would have undertaken some of these activities, at an estimated cost of $1.5 million. Hence, the GEF incremental cost is $2.5 million.

49. The capacity building component includes institutional strengthening of BPPT, as well as a SHS Strategy and Implementation Study. The total costs of these activities are estimated to be $2 million. However, in the baseline scenario, it is expected that BPPT/GOI would have undertaken some similar activities, whose cost is estimated to be $0.5 million. Hence, the GEF incremental cost is $1.5 million.

2/ The incremental costs are negative for the limited regions of Java where solar PV is already the least-cost option.

50. **The costs** of the SHS project monitoring and evaluation activities by the national working group, including the first phase review by the independent panel of experts (para 56), are estimated at $0.3 million. As these activities would not have been undertaken in the baseline scenario, these expenditures are part of the GEF incremental cost.

51. Together, the overall GEF incremental cost is $24.3 million.

ISSUES, ACTIONS AND RISKS

52. **Key policy reforms sought and related conditionalities** Taking into account the findings and recommendations of SHS Strategy Study to be undertaken as part of the capacity building component, the Government of Indonesia will develop a national strategy and corresponding action plan, acceptable to the Bank, related to the future role of SHS in rural electrification on a commercial and non-commercial basis. Discussion on this matter will be initiated with GOI and the various departments/ministries concerned during pre-appraisal.

53. **Risks** There are several risks associated with the project. First, there are technical, implementation and operational risks associated with the solar PV technology utilized by the private sector. In order to minimize this risk, minimum performance standards and specifications for key components of the systems have been established in association with BPPT and the potential participants in the project, to help ensure that customers experience high quality service standards. Second, there is the risk that consumer demand does not materialize at the anticipated scale. This risk has been minimized by concentrating on a few regional markets, well researched by undertaking corresponding market and institutional assessments, by designing the GEF buydown to make the systems affordable, and the project support unit undertaking market awareness and product promotion activities during project implementation. Third, there are risks that the selected dealers will be unable to achieve the level of sales envisaged in the project. These risks related to supply response, are being minimized by selecting the dealers carefully and assisting them in formulating realistic business plans.

54. Finally, there is the project preparation risk that commercial banks will not be willing to take the risk of lending to the SHS dealers. This risk is being minimized by ascertaining that a number of commercial banks are interested, by assisting the dealers in the preparation of bankable plans and by increasing the comfort level of banks by familiarizing them with information about the technology, its performance and market potential.

MONITORING AND EVALUATION

55. During the five year implementation period, local oversight will be provided by the Rural Electrification Steering Committee, headed by the Director-General of Electricity and Energy Development (DGEED). A Working Group, composed of representatives of BPPT, DGEED, the Planning Agency (BAPPENAS), the Ministries of Cooperatives and Finance, and the national power utility (PLN) will be set up to review the SHS project's progress and provide a forum for inter-agency discussion and coordination. Specific performance indicators that the working group will monitor will be agreed during appraisal, and will possibly include system reliability, customer complaints and loan repayment rates. Critical success factors for the project are that: (i) market demand materializes at anticipated levels, (ii)

the project results in satisfied customers that experience high quality service standards, and (iii) end users payback their loans on time.

56. In addition to this national monitoring mechanism, given the pilot nature of the SHS project and its innovative approach to developing a private sector PV market, an independent technical panel (composed of internationally recognized experts in the field and representatives of the GEF Implementing Agencies) will conduct a review of first phase project performance with the stakeholders, in order to assess whether the proposed project modality is functioning effectively, identify adjustments that could be made to improve performance (if any), and recommend to the GEF Chief Executive Officer whether the project's second phase should proceed as planned. The exact scope of the review, its timing, and the performance criteria to be assessed, will be agreed with the Indonesian stakeholders during final preparation and appraisal. It will be critical for private sector confidence and project success that the trigger for initiating and completing this first phase review be selected in such a way that implementation continuity not be jeopardized.

Annex 1

Table 1 INDONESIA: SOLAR HOME SYSTEMS (SHS) PROJECT FINANCING PLAN
(US$ million)

Component	IBRD	GEF			Private Sector (customer down payments, dealer equity, reinvested profits)	BPPT/ GOI	TOTAL
		Phase 1	Phase 2	Total			
Investment							
- Sale and installation of SHS	20 to 25	12.0	8.0	20.0	25	0	65 to 70
- Project Support Services	0	2.0	0.5	2.5	1	0.5	4
Capacity Building - BPPT strengthening - SHS Strategy & Implementation Plan	0	1.5	0	1.5	0	1	2.5
Monitoring and Evaluation		0.25	0.05	0.30	0	0	0
Project Total	**20 to 25**	**15.75**	**8.55**	**24.30**	**26**	**1.5**	**72 to 77**

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Annex 2

Canadian Photovoltaic Industries Association

European Photovoltaic Industries Association

Manufacturers Association of Israel

New Energy Foundation: Solar System Development Association (Japan)

Solar Energy Industries Association (USA)

Solar Energy Industries Association of Australia

June 13, 1995

TO: Surinder Malik
Acting Chief
Industry and Energy Division
Country Department III
East Asia & Pacific Region

RE: Review of GEF Indonesia Renewable Energy Project

Attached are the comments sheets specifically related to the major attachments per your request. This cover memo serves as an overview and findings:

First, over 70 percent of photovoltaics now produced is exported for developing world applications and over 175,000 villages worldwide are being electrified with solar applications.

Second, the approaches as outlined in the GEF proposal are for the most part being accomplished in other parts of the world quite successfully, including Mexico, the Dominican Republic, India and Southern Africa.

Third, the success of the (RED) project focusses primarily on in-country private sector, financing instruments, and how both drive successful installations and maintenance activities for the life of the renewable energy installations. There are no show stoppers here, just good diligence in project implementation.

Finally, overall the project results are achievable and significant renewable energy utilization and emissions reductions can be attained. I believe it to be a good project with focus, and which will set the stage for larger programs worldwide.

Please advise me if you need further elaboration on any of the comment sheets I have enclosed or please feel free to contact me at any time. Thank you.

These comments were prepared on the RED project, which was later separated into the SHS project and the Renewable Energ_ Small Power (RESP) project.

The stress for the private sector is essential to make the program sustainable.

Some confusions exists regarding the utilization of the different renewables. For instance, small modular biomass may have as much benefit as any other renewables in the Indonesian context and therefore worthy of equal support. Biomass is referred to as a cogeneration technology and could be a distributed modular technology.

Build on other successful programs in solar rural electrification worldwide. The Enersol program in the Dominican Republic has been ongoing for seven years in an ever-profitable manner. Here, a small revolving loan fund helps drive the market for individuals and small business solar users.

The Mexico program has used a cadre of in-country businesses partnered with companies (primarily manufacturers but also system assemblers) from the United States, Japan and Europe to drive village electrification systems primarily for solar but also small wind and microhydro.

A financing approach that concentrates on the key market barrier -- lowering high upfront capital costs so the technology is affordable -- possibly amortizing loan so that monthly payments would fall below monthly fuel costs of conventional energy technologies. Financing needs to go beyond 36 months probably to 48 months.

Environmental safeguards are very necessary for municipal solid waste (MSW) unless it is a uniform waste stream devoid of chemicals and heavy metals (ie batteries), but I have been advised MSW has been eliminated from the project.

Loans using existing market rates make no sense, in that the activity would probably be accomplished already if the traditional loan infrastructure would support decentralized projects. Some kind of interest rate buydown would be required, but the need could be obviated IF loan terms were amortized four years or longer.

Regional focus activities did not include the need for ongoing support in resource assessment (to best understand the best resource availability and under what conditions), technical assistance (to overcome certain technical hurdles in decisionmaking by lenders or use be endusers). An ongoing capability supported by GEF in these areas will provide longterm stability to the program, drive short term momentum, and insure overall program success.

Financial intermediation is approached correctly in that three banks in each of the three regions would be useful. The credit programs should be designed in such a way that the endusers' ease of access to loans is assured; the less centralized the credit program, the more effective it will be. The RED project's delivery channel is dealer financing, under which the private dealers will borrow from commercial banks and pass on credit to individual households. This channel is satisfactory, because the dealers will approach each individual household, and the dealers have a clear incentive to provide households with credit since the households cannot buy the systems without the credit. Further, the dealers should be encouraged to plough back repayments from the initial set of loans as credit to other households, so that an increasing number of households can be served.

The initial scale of the program should function primarily on increasing the economies-of-scale of manufacturing and deployment. These economies-of-scale in production and use will fundamentally lower cost and create a sustainable energy infrastructure for future replication.

The program must also establish the "metrics" of success early on, so as to have guidelines on what characterizes success. Is it the number of systems, it an aggregation approach to financing, is it longetivity of systems and market sustainability or is it a combination of all of these points?

The stand alone systems and utility inter-tied programs should be run in parallel and if there are ways to make them nurture each other, such schemes should be brought up now (since none appear in the text). Both design assistance and maintenance escrows are valid for both programs. In addition, approaches to shift funds from one program to the other, it one gets stalled, might be in order. This was alluded to but should be set out clearly as incentives for the program implementors to keep momentum or face loss of support.

Support of generic information lines or NGO groups that can dispense generalized "rule of thumb" information leaving to the indigenous industry the specialized technology/user information. This activity should be extremely limited to insure maximum support for product in the field.

The role of GEF funds is critical, and appear to me to be best oriented towards addressing key barriers to SHS sales, such as high initial cost, ensuring that the installed systems continue to function over time, and non-promotional activities (lender technical assistance, utility design assistance, etc.) as ways to build infrastructure or capacity building assistance.

GEF may be able to costshare these kinds of activities with other multilateral, bilateral, and philanthropic organizations and agencies.

The 120,000 solar home systems may not be large enough test to significantly lower costs. This partially depends on how many different companies are involved, and to whether GEF wants to encourage standardized designed and compatible components (leads, coloring etc) to insure maximum access to parts and maintainability.

In general, the benefits associated with the renewable technologies have been conservatively estimated. Some of the benefits as shown in the charts for solar PV, small power and the PLN plan, do not take into consideration the speed in which these technologies can be deployed. The real benefit is immediate emissions reductions. Also plant life for all of the renewables is below what is actually seen in the field. While I support conservation estimates, these are still under the general rules of thumb.

Also health benefits, particularly in regard to displacement of residential kerosene use is not included. Respiratory and eye problems associated with in-building combustion is very high. These health savings need to be included even it is token on the charts.

Another failing of the charts regarding comparative emissions reductions from conventional power plants related clearly to the fact that all experience "down times". It appears none of this data is included so the numbers are inordinately high. This effects the comparative economics with renewables since conventional energy output is artificially high -- particularly in relation to the developing world experience.

Indonesia: Solar Home Systems (SHS) Project

Incremental Costs and Global Environmental Benefits

Broad Development Goals

1. Indonesia's basic goals and policies for the development of the energy sector highlight the importance of meeting Indonesia's rapidly growing energy needs in an efficient manner, including through conservation and diversification of primary energy resources, and minimizing the adverse environmental and social impacts of energy use. A key and continuing thrust of the Government's energy strategy is to slow down Indonesia's transition to net oil importer status by diversifying energy supply for domestic consumption towards alternative and economic indigenous resources that have a non-exportable surplus or are non-tradeable, such as renewable energy. Rural electrification (RE) is a key and integral part of the Government's rural development strategy.

Baseline

2. In Indonesia today, a significant number of isolated rural households use kerosene laps for lighting and automobile batteries -- charged at diesel-based generating stations -- for other energy needs, such as watching (black-and-white) TV sets. While these households have the potential resources to pay for grid-based electricity supply, this supply is not available to them now, nor is it likely to be available to them in the medium term. Further, most of these households are not able to buy Solar Home Systems, either because SHS are simply not offered to them for sale, or because of other factors such as high prices, lack of credit, and lack of familiarity. Thus, the baseline course of action is that these households will continue to rely on fossil fuels for their energy needs.

Global Environmental Objective

3. The baseline course of action will lead to significant emissions of greenhouse gases (CO_2). Thus, the global environmental objective of the SHS project is the mitigation of GHG emissions.

GEF Alternative

4. Under the SHS project, the GEF alternative to the baseline scenario is the installation and sales of 200,000 SHS units in selected markets in Indonesia over a period of five years. The GEF Alternative would also include program support (such as dissemination of technical, financial, and operational information to customers and dealers) and capacity building activities that would contribute to the removal of market and institutional barriers to the adoption of SHS. There are no CO_2 emissions for the SHS units, so that there will be a total replacement of the fossil fuel use that would have taken place under the baseline scenario. It is estimated that the SHS project will lead to an abatement of about 2 million tons of CO_2, at a GEF cost of about $11/ton CO_2 (Table 7).

Additional Domestic Benefits

5. Apart from progress towards least-cost provision of electricity to rural consumers, the SHS will reduce the exposure of household members to the smoke and pollution associated with kerosene lighting systems.

Costs

6. At present, most of the target households for SHS units use a combination of kerosene for lighting and diesel-based battery charging for other activities such as powering a black-and-white TV. Based on survey data and secondary information about prices, the monthly economic expenditures of the target households on kerosene and battery charging are $9.32 on Java and $9.99 off-Java (Tables 3 and 6). These expenditure patterns reflect the fact that in Indonesia: (i) kerosene consumption levels in Indonesia are higher than in many other countries, and (ii) off-Java, the kerosene and battery costs are higher, The costs of kerosene and battery charging are lower on Java than off-Java, primarily due to transportation and logistical differences, and their consumption level lower than on Java. Correspondingly, the present value of the target household's baseline expenditures on kerosene and battery charging (for 15 years at a discount rate of 10%) is $867 on Java and $930 off-Java.

7. The GEF incremental costs arise from: (i) the additional costs, over the baseline expenditures, of the SHS units in the market areas to be developed under the SHS project, including the need to increase potential customer familiarity with SHS, to assist dealers, and to maintain links with actual customers under the SHS project, (ii) institutional capacity strengthening, and (iii) monitoring and evaluation.

8. For the parts of Java where SHS dealers are not yet established ("the new Java areas") the initial cost of an SHS unit is estimated to be Rp 1.4 million ($636), based on the costs of Government procurement programs. For off-Java, the SHS costs are estimated to be Rp 1.65 million ($750), based on the prices of scattered cash sales in Lampung and Sulawesi. These estimates of costs compare favorably with the prices of similar SHS in many other countries.

9. Based on the prevailing prices, the monthly economic cost of a SHS unit in the new Java areas is $10.10, which implies a present value of $940 for 15 years at a 10% discount rate. For off-Java, the SHS monthly economic cost is $11.38, with a present value of $1,059 (Tables 2 and 5).

10. When the present value of the GEF alternative is compared with the baseline expenditures of the the typical target household, the incremental costs are estimated to be about $73 per SHS unit in the new Java areas (Table 1) and about $129 per SHS unit off-Java (Table 4).[1] For total project sales of 200,000, split about equally between the new Java areas and off-Java, the total incremental cost for the SHS units is about $20 million.

11. A small Project Support Unit (PSU) will be established to provide customers and dealers with the technical, financial and operational information. It is expected that potential customers will use this information, in part, to make informed decisions about the suitability of SHS. The total cost of these activities are expected to be $4 million. In the baseline scenario, it is estimated that BPPT/GOI would have undertaken some of these activities, at an estimated cost of $1.5 million. Hence, the GEF incremental cost is $2.5 million.

12. The capacity building component includes institutional strengthening of BPPT, as well as a SHS Strategy and Implementation Study. The total costs of these activities are estimated to be $2 million.

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[1] The incremental costs are negative for the limited regions of Java where solar PV is already the least-cost option.

However, in the baseline scenario, it is expected that BPPT/GOI would have undertaken some similar activities, whose cost is estimated to be $0.5 million. Hence, the GEF incremental cost is $1.5 million.

13. The costs of the SHS project monitoring and evaluation activities by the national working group, including the first phase review by the independent panel of experts, are estimated at $0.3 million. As these activities would not have been undertaken in the baseline scenario, these expenditures are part of the GEF incremental cost.

14. Together, the overall GEF incremental cost is $24.3 million.

Global Environmental Benefits

15. The overall avoided emissions are about 2.1 million tons of CO_2, with a total GEF grant of $24 million, leading to a GEF unit cost of about $11/ton CO_2 (Table 7). The estimates of the emissions avoided include both the emissions avoided as a result of the SHS units directly installed under the SHS project ("project effect") as well as the acceleration of SHS market penetration in Indonesia ("programmatic effect") as a result of the SHS project.

16. The estimation of total emissions avoided starts with an estimate of the unit emissions avoided factor (Table 8). The unit avoided emissions factors are multiplied by the estimated penetration of the technology to arrive at the total emissions avoided.

Table 1

INDONESIA: SOLAR HOME SYSTEMS (SHS) PROJECT
Java: New Areas 1/
Solar and Kerosene/Battery Household Costs

Discount Ra	10.00%	Exchange Rate	2,200

Baseline: Kerosene /Battery Charging		
Levelized Monthly Cost		
Lighting	$3.47	
Battery Charge	$5.85	
Total		$9.32
Net Present Value		**$867.19**
Solar Home Systems		
Levelized Monthly Cost		$10.10
Net Present Value		**$940.25**
Incremental Cost: Per SHS		$73.06

1/: New areas refers to places where SHS are not being sold at present

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Table 2

INDONESIA: SOLAR HOME SYSTEMS (SHS) PROJECT
Java: New Areas [1/]

	Discount Rate		10.00%	Exchange Rate	2,200		
	Cost and Life Assumptions				Life Cycle Costs		
	Cost		Life		Unit	Number	Cost
	Rupiah	US $	Years	Months			
Initial Cost	1,400,000	636	15	180	636	1	636.36
Replacement							
Panels		325	15	180	0.00	1	0.00
Battery		60	3	36	120.16	1	120.16
Regulators		50	7	84	37.30	1	37.30
Generator		95	10	120	35.09	1	35.09
Support Structure		20	10	120	7.39	1	7.39
Other Hardware		20	10	120	7.39	1	7.39
Lamp 4 Watt		15	5	60	14.66	3	43.97
Lamp 6 Watt		15	5	60	14.66	2	29.32
Present Value -- Replacement							280.62
Present Value Without O&M							916.99
Levelized Monthly							$9.85
O&M -- Water, etc.							$0.25
Present Value O&M							$23.26
Solar Monthly							$10.10

Note: The initial cost is the full cost of purchase, and it is not discounted.
The other costs are replacement costs over 15 years.

1/: New areas refers to places where SHS are not being sold at present

Table 3

INDONESIA: SOLAR HOME SYSTEMS (SHS) PROJECT

Java: New Areas 1/

Kerosene and Battery Levelized Costs

Discount rate **Exchange Rate**

Lighting				
Kerosene Monthly Use (liters)	15			(observed in Indonesia; more than in other countries)
Kerosene Cost $/liter	0.17			
Monthly Kerosene Cost			$2.55	
Petromax Cost $	$20.00			
Petromax Life	5	years		
Petromax Levelized Cost	$0.42			
Mantle Monthly	$0.08			
Petromax Monthly			$0.50	
Wick lantern Cost	$4.00			
Wick Lantern Life	3	years		
Number of Wick Lanterns	2			
Wick Lantern Levelized Cost	$0.26			
Wicks used monthly	$0.16			
Wick Lantern Monthly			$0.42	
Total Lighting Monthly			$3.47	
Battery Costs				
Charges Per Year	48			
Cost per charge	1			(observed cost in Indonesia; similar in Sri Lanka, India)
Monthly Charging Cost			$4.00	
Battery Cost	$40.00			(smaller than solar battery)
Lifetime years	2			(lower than solar - deep discharges)
Battery levelized Cost			$1.85	
Total Battery Monthly			$5.85	
TOTAL MONTHLY		$	9.32	

1/: New areas refers to places where SHS are not being sold at present

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INDONESIA: SOLAR HOME SYSTEMS (SHS) PROJECT
Off-Java
Solar and Kerosene/Battery Household Costs

Discount Rate	10.00%		Exchange Rate	2,200

Baseline: Kerosene /Battery Charging		
Levelized Monthly Cost		
Lighting	$3.56	
Battery Charge	$6.43	
Total		**$9.99**
Net Present Value		**$929.85**
Solar Home Systems		
Levelized Monthly Cost		**$11.38**
Net Present Value		**$1,058.78**
Incremental Cost: Per SHS		**$128.93**

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INDONESIA: SOLAR HOME SYSTEMS (SHS) PROJECT
Off-Java

Discount Rate 10.00% Exchange Rate 2,200

	Cost and Life Assumptions				Life Cycle Costs		
	Cost		Life		Unit	Number	Cost
	Rupiah	US $	Years	Months			
Initial Cost	1,650,000	750	15	180	750	1	750.00
Replacement							
Panels		350	15	180	0.00	1	0.00
Battery		60	3	36	120.16	1	120.16
Regulators		50	7	84	37.30	1	37.30
Generator		95	10	120	35.09	1	35.09
Support Structure		20	10	120	7.39	1	7.39
Other Hardware		20	10	120	7.39	1	7.39
Lamp 4 Watt		16	5	60	15.64	3	46.91
Lamp 6 Watt		16	5	60	15.64	2	31.27
Present Value -- Replacement							285.51
Present Value Without O&M							1,035.51
Levelized Monthly							$11.13
O&M -- Water, etc.							$0.25
Present Value O&M							$23.26
Solar Monthly							**$11.38**

Note: The initial cost is the full cost of purchase, and it is not discounted.
The other costs are replacement costs over 15 years.

INDONESIA: SOLAR HOME SYSTEMS (HS) PROJECT

Off-Java

Kerosene and Battery Levelized Costs

Discount rate	10.00%			
Lighting				
Kerosene Monthly Use (liters)	12			(observed in Indonesia; more than in other countries; less than Java)
Kerosene Cost $/liter	0.22			(more expensive than Java)
Monthly Kerosene Cost			**$2.64**	
Petromax Cost $	$20.00			
Petromax Life	5	years		
Petromax Levelized Cost	$0.42			
Mantle Monthly	$0.08			
Petromax Monthly			**$0.50**	
Wick lantern Cost	$4.00			
Wick Lantern Life	3	years		
Number of Wick Lanterns	2			
Wick Lantern Levelized Cost	$0.26			
Wicks used monthly	$0.16			
Wick Lantern Monthly			**$0.42**	
Total Lighting Monthly			**$3.56**	
Battery Costs				
Charges Per Year	44			(less than in Java)
Cost per charge	1.25			(observed cost in Indonesia; more than in Java)
Monthly Charging Cost			**$4.58**	
Battery Cost	$40.00			(smaller than solar battery)
Lifetime years	2			(lower than solar - deep discharges)
Battery levelized Cost			**$1.85**	
Total Battery Monthly			**$6.43**	
TOTAL MONTHLY			**$ 9.99**	

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Table 7

Indonesia: Solar Home Systems (SHS) Project
Global Environmental Costs and Benefits

GEF Supported Activities: Incremental Costs				
SHS Units Sold	200,000			
Hardware incremental costs			$ million	20.00
Project Support Unit			$ million	2.50
Capacity building			$ million	1.50
Total GEF Costs			$ million	24.00
GEF Supported Activities: Benefits				
Direct Project Benefits				
Unit SHS capacity	50	Wp		
Project Capacity Implemented	10	MWp		
Unit Annual Avoided CO2 Emissions	8.45	'000 tons/MWp		
Unit Lifetime 15 years undiscounted Avoided CO2 Emissions	126.8	'000 tons/MWp		
Total Lifetime 15 years undiscounted Avoided CO2 Emissions			'000 ton	1,268
Programmatic Benefits - Accelerated Market Penetration				
Multiplier Effect - MWp Increase as % of Project MWp's	200%			
Implied MW p Increase	20	MWp		
Timing Effect	5	years accelerated		
Total Effect (approx.)	100	MWp-years		
Total Lifetime 15 years undiscounted Avoided CO2 Emissions			'000 ton	845
Total Project and Programmatic Benefits			'000 ton	2,113
Unit Incremental Costs: Avoided CO_2			$/ton CO2	11.36

Table 8

Indonesia Solar Home Systems (SHS) Project:
AVOIDED CO_2 EMISSION BENEFITS - Unit Factors [a,b]

		SHS (d)
A. Solar Home Systems Technology Characteristics		
Implemented Capacity	MW_p	1
Plant or Capacity Factor [c]		0.13
Plant Life	years	15
Electricity Generation		
Annual Generation	GWH/year	1.2
Life Time Generation	GWH/life	17.6
Unit CO_2 Emission Factor	tons/GWH	0
Annual Emissions	000 tons/year	0
Life Time Emissions	000 tons	0
B. Substitute Technologies		
Avoided Technologies and Unit Emission Factors		
Kerosene Lighting	tons/GWH	10,000
Diesel-based Battery Charging	tons/GWH	1,100
Mix of Substitute Technologies [d]		
Kerosene Lighting		70%
Diesel-based Battery Charging		20%
Substitute Technology CO2 Emissions - weighted average of substitute mix		
Unit Emission Factor (wgt ave)	tons/GWH	7,220
C. Avoided CO2 Emissions	(difference between SHS and substitute technologies)	
Net Avoided Emissions Factor	tons/GWH	7,220
Avoided CO2 Emission Quantities - 000 tons net		
Annual	per MW_p	8.45
Life Time		126.8

(a) See Attachment 1 for background information on renewable and substitute technology factors.

(b) Only direct CO2 emissions are included in this analysis. The global warming potentials of other gases and of CO2 and other gases embedded in the manufacture, transport, etc. of the technologies are not included.

(c) The SHS capacity factor of 0.13 is based on a 50 Watt system that supplies, on average, 170 Watt-hours daily for household use.

(d) Solar home systems (SHS) do not only substitute for existing energy uses. In some cases, SHS also provide additional energy services (or meet previously unmet demand), such as increased television viewing and lighting quality. Therefore, when calculating the avoided emissions for SHS, it is assumed that there are avoided emissions only for the part of the SHS energy that substitutes for current energy use. The kerosene lighting emission factor already includes the adjustment for existing versus new demands.