PROPOSAL FOR REVIEW	**February 8, 1996**
Project Title:	**Sri Lanka: Energy Services Delivery (ESD) Project**
GEF Focal Area:	Climate Change
Country Eligibility:	Sri Lanka ratified the FCCC on November 3, 1993 IDA Eligible (1994 GNP/capita of $631)
Total Project Costs:	$53.8 million
GEF Financing:	$7.3 million
Government and Private Sector Counterpart Financing of GEF Component:	$11.0 million
Cofinancing/ Parallel Financing:	IDA $35.5 million
Associated Project:	Sri Lanka: Energy Services Delivery (ESD) Project
GEF Implementing Agency:	World Bank
Executing Agency:	Ministry of Finance and Ceylon Electricity Board (CEB)
Local Counterpart Agencies:	
Estimated Starting Date (Effectiveness):	May 1997
Project Duration:	5 years
GEF Preparation Costs:	$200,000 (Block B Grant)

SECTORAL CONTEXT

Sectoral Policies

1. GOSL development policy places high priority on energy and electricity development. Hydropower is the only indigenous energy resource used for power generation on a large-scale. About half of Sri Lanka's available hydropower potential has been developed. The growing need to import petroleum products contributes to a significant trade deficit. The GOSL energy strategy, endorsed by the National Environmental Action Plan (NEAP, June 1994), is to support socio-economic development and meet basic human needs by (a) optimally developing energy resources in a least economic cost and environmentally sound manner; (b) developing and managing forest and non-forest wood fuel resources; (c) improving institutional capacity to develop and manage the energy sector; (d) promoting efficiency pricing of energy; (e) energy conservation; and (f) diversifying energy sources and reducing dependence on imported energy sources.

2. To implement this strategy in the power sector and to satisfy a projected 8% per annum increase in electricity demand, the GOSL has taken steps to: (a) encourage private sector investment in generation, (including renewable energy and diesels) by agreeing to purchase power from private sector developers, entering into power purchase contracts, awarding mini-hydro sites to private developers, and removing import duties on diesels greater than 500 kW capacity; (b) promote energy efficiency improvements by moving toward market-based electricity tariffs and initiating demand-side management (DSM) measures to reduce growth in electricity use; and (c) initiate related legal, regulatory and policy changes.

3. As part of its environmental strategy, Sri Lanka has ratified the Framework Convention on Climate Change. In particular, Sri Lanka recognizes the global significance of the greenhouse gas emissions from power generation based on fossil fuels. A recent report, *Climate Change in Asia: Sri Lanka*, prepared by the Sri Lankan Ministry of Environmental and Parliamentary Affairs has identified renewable energy and energy efficiency as key elements in Sri Lanka's greenhouse gas mitigation strategy.

Grid Electrification

4. The GOSL has a declared policy objective of universal access to electricity by 2000, while only 1.5 million customers are presently connected to the grid. About 70% of Sri Lanka's households outside Colombo and the Western Province lack access to grid electricity. The 1991 Rural Electrification Master Plan estimates that it would be economically feasible to connect only 60% of villages (and 42% of rural households) by the year 2000. The Ceylon Electricity Board (CEB), under the Ministry of Irrigation, Power and Energy, (MOIPE) is the sole organization responsible for electricity generation and HV transmission on the central grid. It owns and operates an installed capacity of 1409 MW (1137 MW hydro and 272 MW thermal), and also distributes to 1.3 million customers. Around Colombo and the southwest coast, the Lanka Electricity Company (LECO) distributes to 0.2 million customers. CEB planning studies indicate that 800 MW of new capacity would be needed by 2003, requiring $1.5 billion of investment over the next decade. CEB power generation plans include a large run-of-river hydropower project, rehabilitation of thermal plants, new diesel plants, as well as a private build-own-operate 300 MW coal-fired plant. With lead times of six years for large power plants and variable amounts of hydropower available depending on rainfall, short-term energy deficits of 1 to 11% per year are expected.

5. Meeting the rural electricity demand using traditional grid-based approaches has become increasingly expensive. The current capital cost for distribution investments averages $650/customer. CEB expects unit rural electrification costs to increase as lines are extended to dispersed populations. Escalation in grid costs has slowed the pace of grid extension. The large pent-up rural demand for electricity in Sri Lanka is evident from the 300,000 off-grid households who are currently using automotive batteries, recharged from grid supplies, as a power source for lights, radios and TVs. This pent-up demand has spurred GOSL and private sector interest in cost-effective alternatives. As part of this process, the CEB has created DSM and Pre-Electrification Units. The MOIPE has recently created a National Committee to prepare a National Energy Policy.

Ongoing efforts to encourage renewable energy

6. Sri Lanka possesses ample renewable energy resources with significant economic potential, including solar energy, large and small hydro, wind and biomass. To date, except for large hydro, these resources have hardly been exploited. A World Bank-assisted study confirmed the economic and financial viability of rehabilitating at least 100 small (under 2 MW) **grid-connected mini-hydro** schemes on tea estates. The CEB recently began accepting power from its first privately developed 150 kW plant and two other private mini-hydro units (60 kW and 1.2 MW) are close to completion. Studies of Sri Lanka's **wind power** potential show that economically exploitable wind resources could support at least 200 MW of capacity. However, no grid-connected wind farms have been developed to date. Key advantages of such small power projects are the relatively short lead times for construction and project start-up and a growing private investor interest as well as minimal environmental impacts. An assessment of the Hambantota District has demonstrated that the area has potentially exploitable wind resources. The CEB has received IDA Project Preparation Facility (PPF) support to complete a feasibility study and to prepare a bid package for a pilot wind farm.

7. Pilot off-grid **solar photovoltaic (PV)** and **village hydro** systems have been supported by the GOSL, bilateral programs, the private sector and NGOs. These demonstrate the technical viability and social acceptability of small-scale off-grid renewable energy technologies to deliver basic electricity

services. Since 1982, about 5000 solar home systems have been installed at an all-inclusive cost of $300-700/household. This initial market activity has produced a nascent local PV supply industry and support infrastructure. Village hydro systems (3 to 35 kW), at an average all-inclusive cost of $275/household, serve about 20 isolated villages in hilly areas with high rainfall. These units have been installed and managed by village cooperatives, with assistance from donor-supported Integrated Rural Development Projects, NGOs and the National Development (formerly Janasaviya) Trust Fund. However, the scale of the PV and village hydro projects is too small for vendors to realize the benefits of economies of scale in manufacture, sales and servicing. The lack of long-term financing and the unfamiliarity of the financial community has impeded greater use of these economic alternatives to grid-based rural electrification. Two pilot solar PV and village hydro projects are currently financed by an IDA PPF to demonstrate commercial viability of the subprojects.

Barriers to renewable energy development

8. The availability of renewable energy resources -- solar, hydro and wind -- offers a significant technical potential for small renewable energy power projects in Sri Lanka. The initial developments of the solar PV and micro-hydro markets indicate that consumers are willing to pay for these services. The current expenditures of off-grid households on kerosene for lighting and car batteries for power also confirm the high priority that consumers attach to energy services.

9. Barriers which constrain the market-based development of off-grid renewable energy resources in Sri Lanka include the:

(a) **High first cost** of renewable energy projects and a **lack of adequate term (10 year) financing**;

(b) **Lack of familiarity** of the private sector and the financial community with renewable energy projects; and

(c) **High transaction costs, perceived commercial risks, and lack of consumer awareness,** resulting in an underdeveloped local marketing, distribution, and servicing infrastructure.

Demand-Side Management

10. **Government Action**: A number of studies and audits conducted to date show that Demand Side Management (DSM) could significantly improve energy efficiency in each of the major customer sectors. In recognition of this potential, the MOIPE and the CEB have already taken steps to mitigate electricity demand growth. These include: (a) preparation of an outline DSM Strategy, with the assistance of the Asian Development Bank; (b) a Cabinet Memorandum, setting out the framework for energy conservation and policy, as well as legal and fiscal changes required; (c) creation of an Energy Conservation Fund; (d) introduction of an Integrated Resource Planning Process; (e) establishment of a DSM Unit in the CEB; (f) a pilot project to test Compact Fluorescent Lights in the residential sector; (g) completion of preliminary energy audits in the commercial and industrial sectors; and (h) completion of a rural/urban residential electricity consumption assessment to provide a database for designing cost-effective DSM programs.

11. **Commercial Building Energy Efficiency**: Energy consumption in the Sri Lanka commercial building sector is growing at 10% per annum, primarily due to new construction. A World Bank-sponsored DSM Potential Study for the Commercial Building Sector (CBS) concluded that DSM/energy efficiency measures could reduce energy consumption by approximately 40% in new buildings and 20% in existing commercial buildings. However, insufficient data on energy use, unfamiliarity with new energy

saving approaches among the local engineering, architectural and entrepreneurial communities, and distorted incentives for efficient building design limit the chance to achieve these savings. The Study recommended developing an Energy Efficiency Building Code (EEBC), coupled with training and design assistance, as a first step toward improving efficiency in the commercial building sector. The EEBC would serve as a guideline/target for raising energy efficiency levels in new buildings by recommending technically sound, economically viable efficiency measures. Training and design tools would be required to enable building professionals to incorporate the technical recommendations of the EEBC into building design and construction. The study further recommended additional design assistance and incentive mechanisms to encourage the construction of more efficient buildings. The GOSL is preparing a Commercial Building Energy Efficiency Plan with support from a GEF Project Development and Preparation Facility.

12. **Need for capacity building**: As the primary generator and distributor of power, the CEB is best positioned to develop a DSM Action Plan that sets priorities with respect to system requirements (e.g. peak clipping versus energy conservation), sectors (e.g. residential, commercial and industrial), and end-uses/technologies (e.g. lighting, AC, motors). The CEB is preparing a DSM Action Plan with support from an IDA PPF. To implement such a Plan, the CEB must strengthen its capabilities regarding load research, DSM program design, implementation and evaluation.

PROJECT OBJECTIVES

13. **Global objective**: The global environmental objective of the ESD project is to mitigate carbon emissions in Sri Lanka. At present, a significant portion of Sri Lanka's rural population uses fossil fuels in various ways, such as kerosene for lighting, which lead to carbon emissions The penetration of solar home systems would reduce carbon emissions by displacing the use of the fossil fuels. In addition, the generation of electricity from renewable energy facilities -- hydro and wind -- and reduction in demand for electricity due to DSM would displace fossil fuels.

14. In addition to this global objective, the national objectives of the ESD project are to:

(a) encourage the participation of the private sector, NGOs, and cooperatives in the provision of grid and off-grid energy services, using environmentally sound renewable energy technologies;
(b) reduce demand for electricity through DSM; and
(c) strengthen the public and private institutional capacity of to deliver energy services through renewable energy and DSM.

PROJECT DESCRIPTION

15. The project would finance (i) investments in selected renewable energy resources by the private sector and CEB, and (ii) capacity-building for renewable energy development and DSM. The project has three components:

(a) **The ESD Credit Line Component** would provide medium and long-term financing to private sector firms, NGOs, and cooperatives for solar PV, village micro-hydro schemes, rehabilitation of grid-connected tea estate mini-hydro sites, and other renewable energy investments. The developers of mini-hydro power plant rehabilitation sub-projects, where power is expected to be sold to the grid, are likely to be private power developers and/or tea estate management companies; the solar PV and micro-hydro sub-projects are expected to be developed by private investors, NGOs, or village cooperatives.

(b) **Pilot Grid-Connected Wind Farm Component** would finance a CEB-executed grid-connected pilot wind farm project of approximately 3 MW. This pilot project is expected to demonstrate the technical potential as well as the long-run economic potential for wind power in Sri Lanka. The pilot is expected to lead to long-term private sector development of wind power.

(c) **Capacity Building Component** would support commercial building sector energy efficiency initiatives, strengthen the capacity of the CEB to refine and implement a DSM action plan, prepare a National Renewable Energy Strategy, strengthen the capacity of the CEB to facilitate small private power investments and pre-electrification through a newly formed Pre-Electrification Unit, and provide pipeline development, institutional support and training, as well as equipment and materials, to the ESD Credit Line and participating banks. Funding for independent monitoring and auditing of the ESD Credit Line would also be included.

16. The UNDP has prepared a Project entitled Renewable Energy and Energy Efficiency Capacity Building for funding by GEF and UNDP's IPF. The project was prepared as part of a joint mission involving a UNDP consultant and the ESD pre-appraisal mission. This Capacity Building Project is designed to complement the ESD Project by providing detailed assessments of renewable resources; strengthening technological capabilities; training energy managers; and providing public information for renewable energy promotion. The UNDP project is meant to facilitate the implementation of the ESD Project and to further strengthen the foundation for an expanded future role for renewable energy and energy efficiency in Sri Lanka. UNDP and IDA will continue to cooperate closely in the finalization and implementation of these two Projects.

PROJECT IMPLEMENTATION

17. The **ESD Credit Line**: Operating guidelines, subproject eligibility criteria, and lending terms and conditions for the Credit Line would be similar to those used in the ongoing Private Finance Development Project (PFDP) (Cr. 2484-CE). Eligibility criteria are being defined to allow development finance institutions, commercial banks, merchant banks, leasing companies, and NGOs to be Participating Credit Institutions (PCIs). Private sector developers and tea estate management companies are the likely beneficiaries for mini-hydro power plant rehabilitation projects, which would sell power to the grid, based on an avoided-cost tariff. Private investors, NGOs or village cooperatives would be the beneficiaries for the solar photovoltaic and village hydro subprojects. Beneficiaries would be responsible for subproject preparation, loan application, subproject implementation, and loan repayments. The PCIs would be responsible for loan appraisal which would follow IDA environmental and procurement guidelines. An ESD Credit Line Administrative Unit (AU) would be created to: (i) process applications for both GEF and IDA funds; (ii) administer technical assistance in subproject appraisal to the Participating Credit Institutions (PCIs); and (iii) carry out solar home system consumer protection activities. An independent organization would be selected for monitoring and auditing of the ESD Credit Line. Table 1 gives an indicative breakdown for ESD Credit Line subprojects.

Table 1: ESD Credit Line - Indicative Subproject Breakdown

Project Type	Number of Units Installed Over Life of Project	Average Unit Capacity	Total Installed Capacity by Project Type
Solar Home System*	30,000	40 W_p	1.2 MW_p
Village Hydro	20	12 kW	0.24 MW
Grid Connected Hydro	21	1000 kW	21 MW

* A Solar Home System provides sufficient energy to operate up to four energy efficient light bulbs and a black-and-white TV for about four hours a day.

18. The primary role of the CEB would be to create the enabling environment for facilitating private implementation of grid-connected and off-grid subprojects. This includes a standard Small Power Purchase Agreement and Agreed Tariff and CEB grid-interconnection standards and certification procedures. The CEB's Pre-Electrification Unit would provide technical and planning support with respect to off-grid subprojects.

19. **Pilot Wind Farm**: The Pilot Wind Farm would be executed by the CEB on a turnkey basis. Procurement would be subject to standard IDA procurement procedures. The CEB would be responsible for monitoring, operation, and maintenance of the facility. The Pilot would be located in the Hambantota District. This region has sufficient wind resources to support up to 200 MW of commercial-scale wind farms. The Pilot Wind Farm entails no relocation of local population and is located well outside of the Bundala and Yala wildlife reserves. No resettlement should be necessary for follow-on commercial wind farm projects in the area. The CEB is conducting a full feasibility study for the Pilot Wind Farm, to be completed by ESD Project appraisal. The size of the Pilot Wind Farm will be sufficient to give CEB practical operational experience and to demonstrate the commercial viability of wind power in Sri Lanka. The expected size is 3 MW, subject to confirmation in the feasibility study.

20. **Capacity Building**: Capacity building to the CEB's DSM Unit would consist of: (a) consulting services for design, implementation and evaluation of targeted DSM initiatives; (b) technical training in DSM technology applications; (c) equipment and related systems for customer tracking, statistical analysis and energy audits; and (d) training and equipment to establish a DSM load research program. Capacity building would also be provided within a public/private sector collaborative framework to reduce energy consumption in the commercial building sector through: (a) development of an Energy Efficiency Building Code (EEBC); (b) training and design tools to facilitate the incorporation of energy efficiency into building design and operation; and (c) design assistance/incentive mechanisms (e.g. design competitions) to encourage the design and construction of efficient buildings. This effort would require international and local expertise to advise and train the various stakeholders (government agencies, building associations, owners and developers) involved in the process. Additional assistance would be provided to monitor the resulting energy savings from the commercial building sector and CEB DSM initiatives. These efforts, which support public sector and design professionals, complement the proposed UNDP energy efficiency activities which focus on energy managers and architecture/engineering students.

21. Capacity building to support the ESD Credit Line would focus on strengthening the capacity to prepare off-grid subprojects. This capacity building would consist primarily of assistance to project developers with preparation of feasibility studies, business plans, and bank loan documentation. Project preparation grants would be available to any project developer on a reimbursement basis up to specified Rs. limits calculated to cover approximately 90% of the cost of preparation for a PV subproject and 95% of the preparation cost of a village hydro subproject. Reimbursement would be available upon approval of a complete feasibility study/business plan/bank loan application package.

22. Capacity building also is needed to broaden the availability of expertise in off-grid project preparation. To this end, funds would be provided to the CEB's Pre-Electrification Unit to retain local consultants with expertise in technical, financial, institutional, or business development related to renewable energy projects. Consultants would: (i) develop and conduct training courses for CEB staff as well as private sector and NGO personnel; and (ii) assist CEB staff in feasibility study preparation and other services related to off-grid project support.

ENVIRONMENTAL ASPECTS

23. The proposed project would have net positive effects on the environment. The off-grid electrification sub-projects would reduce use of kerosene and lead-acid automotive batteries, thus benefiting the environment. No significant negative impacts are envisaged from the run-of-river village-hydro projects, as demonstrated by the 20 existing village hydro projects. Because of their small size and

the fact that civil works are already in place, the grid-connected tea estate mini-hydro sub-projects are not likely to cause significant environmental damage or require resettlement. Power generated by renewables or saved through DSM would result in corresponding reductions in emissions from the burning of fossil fuels, thus benefiting the local and global environment. The PCIs would ensure that GOSL and IDA-mandated environmental clearances are obtained, as necessary. The project has been assigned a "B" environmental classification, and the requisite Environmental Analysis is being prepared.

RATIONALE FOR BANK INVOLVEMENT

24. The proposed ESD Project supports IDA's objective to enhance private sector participation in Sri Lanka's energy sector as well as the IDA/GEF objective to support environmentally-sustainable development. The proposed project complements the NEAP energy policy reform agenda and, in particular, would implement the renewable energy subproject recommendation. The project is also compatible with the proposed Environmental Action 1 (EA1) Project for which the GOSL is seeking IDA support. ESD Project support to small-scale private power investments would complement the proposed Private Sector Infrastructure Development (PSID) Project, which is intended to encourage private sector investment in large infrastructure projects. The goal of improved efficiency in the power sector would be supported by development of both the least-cost grid-connected and off-grid renewable energy resources as well as investments in energy efficient DSM technologies. The pilot wind farm would provide Sri Lanka its first experience with grid-connected wind power, allowing the CEB to address grid integration issues and prepare for private sector replication. IDA assistance is crucial as a source of long term capital, presently unavailable for private implementation of the types of investments under consideration. IDA support can also reduce the perceived commercial risk of solar PV, mini-hydro, micro-hydro and wind and, thereby, leverage additional equity and debt financing from commercial sources.

RATIONALE FOR GEF FINANCING

25. GEF grant funds will play a crucial role in the ESD project. First, in conjunction with IDA funds, GEF funds will be used to mitigate the key barriers to the realization of the full potential in Sri Lanka of solar PV and village hydro systems. At present, these technologies are constrained by high initial capital costs, high transaction costs, perceived commercial risks, and lack of consumer awareness (para. 9). The GEF funds would be used to buy down a part of the initial capital costs, with the bulk of the costs to be borne by the private sector; in addition, GEF funds would finance technical assistance. The expanded market created by the GEF/IDA-supported ESD Project will assist in eliminating critical barriers to the market-based development of solar PV and village hydro systems. The renewable energy systems targeted for GEF support are consistent with **GEF Climate Change Program 2, Promoting the Adoption of Renewable Energy by Removing Barriers and Reducing Implementation Costs.**

26. Second, the GEF funds will be used to support DSM activities, which are also constrained in Sri Lanka by lack of in-country experience (paras 10 through 12). The use of GEF funds to build capacity and encourage incorporation of energy efficiency in the commercial building sector, assist the CEB to implement and evaluate its DSM action plan, and train the private sector in energy efficient technology applications is expected to demonstrate the benefits of DSM activities to both the CEB and the private sector, and, subsequently, to lead them to undertake such activities on their own. These activities are consistent with **GEF Climate Change Program 1, Removing Barriers to Energy Conservation and Energy Efficiency.**

PARTICIPATION AND SUSTAINABILITY

27. **Participation**: The primary stakeholders in the ESD Project are the CEB and the MOIPE. These agencies have been and continue to be involved in project preparation activities. The Urban Development Authority and NGOs, such as the Sri Lanka Energy Managers Association have assisted with preparation

of the DSM Capacity Building component. Members of the Sri Lanka Energy Forum, representing private sector and NGO stakeholders, have actively participated in preparation activities such as standards development. Additionally, private sector organizations, such as tea estate management companies, and NGOs, such as Lanka Jathika Sarvodaya Shramadana Sangamaya, have been involved in project preparation, and are expected to undertake a number of the solar PV and micro-hydro sub-projects to be supported by the ESD project.

28. **Sustainability**: Rehabilitation of grid connected tea estate **mini-hydro** subprojects, would not receive any GEF grants. Sustainability of this subcomponent under the ESD Credit Line would be ensured by creation of an enabling regulatory environment, strengthened institutions, and providing appropriate incentives for stakeholders. The project would provide a favorable regulatory environment including a standardized power purchase agreement, tariff, and interconnect specifications for small private power producers. The project would also strengthen the planning capacity of the CEB, support the growth of a commercial infrastructure, strengthen the capabilities of the banking sector in lending to alternative energy projects, and use local institutions to deliver energy services. The stakeholders' financial participation and the establishment and enforcement of standards would also contribute to the long term sustainability of the sub-projects.

29. **Solar PV, Village Hydro and Wind Farm**: There are two aspects to the sustainability of these GEF-supported projects: (a) technical sustainability, i.e., the continued smooth functioning of the installed equipment, and (b) financial sustainability after the GEF grant ends. Pilot projects, expected to become operational by Spring 1996 will help demonstrate the affordability of commercial off-grid solar home system, and village hydro services.

30. Technical sustainability of the solar PV component, will be ensured by: (i) requiring that the equipment meets rigorous technical specifications, (ii) spot-checking installed systems, (iii) requiring the project sponsors to develop credible after-sales service as well as overall consumer protection plans as a condition of participation, and (iv) providing consumers convenient means for lodging complaints about poor service, with a provision that such complaints would jeopardize the sponsors' participation in the ESD project. Financial sustainability will be based on cost reductions achieved over the course of the project, arising from economies of scale and learning curve cost reductions mainly in the delivery and financing mechanisms, i.e., in transaction costs and perceived risks associated with the creation by the private sector of a rural sales and service network. In addition, some cost reductions are envisioned in locally manufactured components, such as charge/discharge controllers. While there may be some increase in prices after the GEF grant ends, it is expected that future prices will be significantly lower than the relatively high current prices.

31. Sri Lanka already has excellent experience in the operation of village hydro systems. The lessons of this experience will be applied to the operations supported by the ESD project, and the project sponsors will be required to develop credible servicing plans based on this experience. As with solar PV, it is expected that there will be some cost reductions achieved over the course of the project, arising from economies of scale and learning curve cost reductions, so that future projects would be more economical. For the pilot wind farm, the technical sustainability will be the responsibility of the CEB with the help of technical assistance provided by IDA. It is expected that the success of the wind farm pilot would encourage local manufacture of some components (i.e. towers, electronics, etc.) bringing installed system prices closer to the lower prices already prevailing in southern parts of India and thus leading to economic sustainability.

32. **Demand-Side Management**: The sustainability of these activities will be achieved through demonstration of their financial benefits. The commercial building energy efficiency component is an essential first initiative for this sector that will provide a basis for future GOSL initiatives. The design assistance tools (which include the EEBC) prepared under this project would be used for educating the

building community. To heighten awareness and demonstrate the benefits of energy efficiency, and encourage compliance with the EEBC, a demonstration aspect is included in the ESD project, such as a design competition for new buildings. Initially the EEBC would be a voluntary code of practice, to reduce the difficulties of putting the code in place. Over time, key elements of the code could be made mandatory. Agreements that target encouraging construction of efficient buildings will be sought with the GOSL during preparation and implementation of the project.

LESSONS LEARNED AND TECHNICAL REVIEW

33. **Lessons Learned**: The proposed Project includes innovative renewable energy and DSM components for which no relevant OED or Project Completion Reports are available. Experience in these new areas is limited to the Wind Farm and PV sub-components of the India Renewable Resources Development (RRD) Project (Ln 3544-IN/ Cr. 2449-IN), the GEF-supported DSM component of the Thailand MEA Distribution and Efficiency Project (Ln 3446-TH), the GEF-supported DSM stand-alone Mexico Electric Power End-Use Efficiency Project, the Second Rural Electrification Project in Indonesia (Ln. 3845-IND) and the Jamaica Demand-Side Management projects. All five operations are in early stages of implementation. However, the India RRD Project does offer relevant experience. The Wind Farm sub-component of the RRD Project has been particularly successful. The Project has financed 20 MW of capacity, and this demonstration has spawned commercial development of an additional 340 MW. The ESD Project seeks to replicate this demonstration effect in Sri Lanka. The PV sub-component of the RRD Project, however, has moved more slowly due to (1) competing, highly subsidized government PV programs and (2) an on-lending interest rate which did not reflect declining market conditions. The absence of subsidized PV programs in Sri Lanka, and the market orientation of the ESD Credit Line will address these concerns.

34. Previous IDA-assisted power projects in Sri Lanka have experienced serious implementation problems resulting largely from CEB procurement delays and shortage of experienced staff. The proposed Project addresses these concerns by limiting CEB's participation in the ESD Credit Line to creating an enabling environment, planning and technical assistance. CEB would execute the pilot wind farm component through a turnkey contract. The June 1994 OED review of Bank Rural Electrification experience in Asia stresses the need for the rigorous economic and financial analysis of projects and an increased attention to cost recovery. Appraisal procedures of the participating credit institutions will require economic and financial analysis of subprojects (the SAR will include analyses of representative subprojects). The private sector focus of the Credit Line ensures that cost recovery will be a high priority in all subprojects.

35. The Bank has two working examples of private sector development funds, one in Pakistan (Ln.2982-PAK) and one in Jamaica (Ln.3502-JM) which yield useful lessons for the ESD project. The former has focused on large-scale investments (possibly due to the large size of the Hub River subproject), and the latter is very new with no track record. Lessons from the Pakistan Private Sector Energy Development Fund (PSEDF) project applicable to the proposed project are: **First**, a serious Government policy commitment to create conditions conducive to private sector investment is necessary. The GOSL policy commitment to private sector investment is evidenced by its ongoing privatization program, which currently involves privatization of the country's tea estates. **Second**, significant private sector equity participation is important at the initiation of the project. The equity investors should also be prepared to be involved fully in the promotion and management of investments under the ESD Credit Line and to be committed to its success. Equity requirements for ESD subprojects are expected to be in the 30% range, however specific subproject requirements will be established by each participating credit institution. **Third**, in addition to a favorable policy environment, the regulatory and institutional systems must be oriented toward successful project operation. Issues being addressed in this area include standard purchase, tariff, and interconnect agreements, land tenure and water rights for the tea estate mini-hydro sites, and coordination of pre-grid electrification projects with CEB's ongoing rural electrification activities.

36. **Technical Review**: Technical review comments by Mr. Samuel Baldwin, of the U.S. National Renewable Energy Laboratory are attached as Annex 2. This Project Brief incorporates Mr. Baldwin's comments in the three focal areas of commercial buildings, wind farm, and household energy systems. In particular, regarding **commercial buildings**, we agree that building energy codes should serve as a model of best practice and training tool, but mandatory compliance may be counterproductive. The code developed under the Project would initially be voluntary, avoiding the shortcomings of a mandatory code highlighted by the reviewer. The practicality of making elements of the code mandatory will be reviewed in light of international experience before any steps are taken in that direction. While the details are under development, the project will support incentive programs such as design competitions as recommended by the reviewer. While the Project specifically addresses capacity building for Sri Lankan building professionals, mechanisms to encourage efficiency in foreign designed and financed buildings will be explored further during final preparation and project implementation (options in this regard have been discussed with the UDA and Board of Investment). Regarding the **wind farm**, the reviewer correctly noted an error in the incremental cost calculation which has been corrected in this version of the Project Brief. The base case is now taken as a gas turbine operating in a peaking mode, and the incremental cost has been adjusted accordingly (see Annex 1 for details). In the area of **household energy systems**, the scale of solar home system support has been increased from 20,000 to 30,000 units in conformance with the reviewer's comments and the consensus of the review meeting. Additional technical review comments in all areas have been incorporated where appropriate in the Project Brief.

PERFORMANCE MONITORING AND EVALUATION

37. The performance of the Renewable Energy Fund will be monitored based on specific targets established during preparation. These targets will be tied to: i) <u>additionality</u>, or the number of alternative energy systems financed by the Project compared to what would have been deployed in the absence of financing from the ESD Credit Line; ii) <u>mainstreaming</u> of alternative energy investments, measured by such factors as increasing equity participation by local financial institutions. and price reductions (comparison of pre- and post-project prices); and iii) estimates of fossil fuel displacement and associated carbon emissions reduction, based on the sampling strategy described in the GEF Monitoring and Evaluation Guidelines. Performance of the DSM capacity building will be monitored based on a time bound schedule for commercial building sector energy efficiency component and DSM Action Plan implementation. The Administrative Unit will have responsibility for monitoring Project performance. An independent Sri Lankan-based organization would be selected for auditing use of both the GEF and IDA funds.

DETERMINATION OF INCREMENTAL COST

38. **Solar PV**: Off-grid households currently use kerosene for lighting, and automotive batteries for operating televisions and radios. The automotive batteries are carried to a grid charging station for recharging. Therefore, household expenditures for kerosene and automotive batteries form the **baseline** for the incremental cost calculation. As shown in Annex 1, the present value of the target rural household's baseline expenditures on kerosene and battery charging is approximately $650. The **GEF alternative** is solar home systems; at current costs, on a lifecycle basis, solar home systems are more expensive than the baseline arrangements. As shown in Annex 1, the SHS lifecycle cost is approximately $750. Thus, the **incremental costs** of the GEF alternative are about $ 100 per unit, or a total of $ 3 million for 30,000 units. In addition, technical assistance is needed for development of credit-worthy solar home system subprojects. Since this activity would not have been undertaken without the ESD Project, the baseline for this TA is essentially zero. The GEF incremental cost is the full cost of subproject development: $70,000.

39. **Village Hydro**: As with solar PV, the target households currently use kerosene for lighting, and automotive batteries for operating TVs and radios, though the energy consumption of these households is less than that of the target households for solar PV systems. Therefore, household expenditures for kerosene and automotive batteries form the **baseline** for the incremental cost calculation. As shown in Annex 1, the present value of the target rural household's baseline expenditures on kerosene and battery charging is $27,000 for 120 households. The **GEF alternative** is a village hydro system that serves about 120 households. At current costs, on a lifecycle basis, a village hydro system is more expensive than the baseline arrangements. As shown in Annex 1, the village hydro lifecycle cost is $33,000. Thus, the **incremental costs** of the GEF alternative are about $ 6,000 per system, or a total of $ 120,000 for 20 systems. In addition, technical assistance is needed for development of credit-worthy village hydro subprojects. Since this activity would not have been undertaken without the ESD Project, the baseline for this TA is essentially zero. The GEF **incremental cost** is the full cost of subproject development: $180,000.

40. **Pilot Wind Farm**: The **baseline** in this case is a gas turbine, the marginal (peaking) generation unit on the CEB grid. The combined capacity and energy cost of gas turbine operation is $0.065 per kWh, resulting in a lifecycle cost of $2.98 million for the 6 GWh per year displaced by the Pilot Wind Farm. The **GEF alternative** is a wind farm, which on a lifecycle basis, costs $ 3.86 million (see Annex 1). Thus, the **incremental costs** of the GEF alternative are about $ 880,000 for the Pilot Wind Farm.

41. **Pre-Electrification Unit (PEU) Capacity Building and National Renewable Energy Strategy Development**: In the absence of the ESD Project, the PEU could be expected to make modest increases in staffing and equipment, and to make some use of consultants to assist with its activities. As shown in Annex 1, the **baseline** for the PEU growth is approximately $155,000. The **GEF alternative** includes greater increases in PEU staffing and equipment, provision of training for CEB and private sector staff, and the preparation of a National Renewable Energy Strategy at an estimated cost of $1.46 million. Thus the **incremental cost** of the GEF alternative is $1.3 million.

42. **DSM Capacity Building**: The **baseline** in this case is IDA-assisted CEB DSM program design, implementation and evaluation, with an estimated budget of $ 2.5 million. The **GEF alternative** includes additional capacity building for energy efficiency in the commercial building sector through: (a) development of an EEBC; (b) training and design tools for the private sector to facilitate the incorporation of energy efficiency into building design and operation; and (c) design assistance/incentive mechanisms (e.g. design competitions) to encourage the design and construction of efficient buildings. The GEF alternative also includes assistance to monitor the energy savings from the commercial building sector and CEB DSM initiatives. The total cost of the combined efforts is estimated to be $ 4 million over the five year duration of the ESD Project. Thus, the **incremental cost** of the GEF alternative is $1.5 million.

43. **ESD Credit Line Administrative Unit**: Given the early developmental stage of the solar home system and village hydro market, experience is lacking in the PCIs for subproject appraisal. TA in the form of training to PCI loan officers is needed to build appropriate capacity. This TA would be administered by the Administrative Unit. The Administrative Unit also will need funds to process and report on GEF funds administration. The **baseline** in this case would be zero, since no off-grid subprojects of the anticipated scope would be forthcoming in the absence of the ESD Project. The **incremental cost** is the full cost of technical assistance and administrative fees: $ 210,000.

44. Together, the overall GEF incremental cost is approximately $ 7.26 million.

PROJECT FINANCING AND BUDGET

45. The total funding required for the project is $53.8 million. A tentative financing plan is presented in Table 2.

Table 2: Project Financing Plan ($US Million)

Component	IDA	GEF	Private Sector	CEB/ GOSL	Total
1. Renewable Energy Fund					
Estate Hydro	23.9	0	6.3	0.1	30.3
Village Hydro	0.3	0.12	0.1	0.1	0.62
PV	6.0	3.0	3.0	0	12.0
Business Development	0	0.25	0.2	0	0.45
Administrative Unit Fee	0.9	0.21	0	0	1.11
Subtotal	***31.1***	***3.58***	***9.6***	***0.2***	***44.5***
2. Wind Farm	***2.4***	***0.88***	***0***	***0.5***	***3.8***
3. Capacity Building					
CEB Pre-Electrification Unit	0	1.3	0	0.2	1.5
DSM	2	1.5	0	0.5	4.0
Subtotal	***2***	***2.8***	***0***	***0.7***	***5.5***
Total	**35.5**	**7.26**	**9.6**	**1.4**	**53.8**

ISSUES, ACTIONS AND RISKS

46. **Conditionalities**: The following actions or agreements will be required as conditions for IDA/GEF assistance: (a) the GOSL would establish the standardized small power purchase tariff and non-negotiable Power Purchase Agreement, as well as grid interconnection specifications. Technical assistance is being provided during project preparation in order to facilitate the speedy conclusion of this process; (b) GOSL would agree to ESD Credit Line operating guidelines, sub-project selection criteria and lending terms and conditions that are in accordance with financial sector policies acceptable to IDA/GEF; and (c) GOSL would agree to implement a building code (EEBC), acceptable to the Bank, for the commercial building sector.

47. **Risks**: The project the risk of insufficient technical capacity in the public and private sectors to carry out the project. This is addressed in project design through the selection of proven technologies and implementation modes, as well as with provisions for technical assistance. The technology risk of substandard equipment and practices has been addressed by the collaboration of the CEB and industry in preparation of specifications for off-grid systems. The institutional risk of ineffective project execution is addressed through use of existing public and private institutions whose capabilities will be strengthened under the project. Possible financial risks include private investors' reluctance to participate on the proposed scale for the grid-connected ESD Credit Line subprojects. This is addressed by establishing legally binding small power purchase agreements and tariffs. The loan repayment risk for the ESD Credit Line off-grid investments would be addressed through involvement of NGOs and other organizations with considerable experience in rural resource mobilization and community programs. Finally, the risk that ESD Credit Line funds may be diverted to unauthorized investments would be addressed through monitoring and auditing by an independent institution.

Sri Lanka: Energy Services Delivery (ESD) Project

Incremental Costs and Global Environmental Benefits

Baseline

1. **Solar home systems and micro-hydro:** In Sri Lanka today, about 300,000 isolated rural households use kerosene lamps for lighting and automobile batteries 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 service is not available to them now, nor is it likely to be available to them in the medium term. Thus, the baseline course of action is that these households will continue to rely on fossil fuels for their energy needs.

2. **Wind Farm:** The CEB operates a central grid that includes both hydro and thermal facilities, and the expansion plan also includes both types of facilities. Since gas turbine power plants are the facilities at the margin, and the wind farm would displace generation from these plants, the baseline course of action is greater reliance on fossil fuels for power generation.

3. **Demand-side management:** Demand-side management initiatives lead to lower levels of electricity consumption than would occur in their absence. The baseline for this component is the DSM component that would have been implemented without the GEF-ESD project.

Global Environmental Objective

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

GEF Alternative

5. Under the ESD project, the GEF alternative to the baseline scenario is: (i) the sale and installation of 30,000 solar home systems in selected markets in Sri Lanka over a period of five years; (ii) the electrification of 20 villages by village hydro schemes; (iii) the construction of a 3 MW pilot wind farm; and (iv) capacity building for energy efficiency in the commercial building sector through development of an energy efficiency building code and associated training, design tools and incentives, and for enhanced monitoring of DSM impacts. Additional capacity building and program support (such as dissemination of technical, financial, and operational information to customers and dealers), which would contribute to the removal of market and institutional barriers to the adoption of solar home systems and village hydro, is included in the GEF alternative.

Additional Domestic Benefits

6. Apart from progress towards least-cost provision of electricity to rural consumers, the solar home system and micro hydro initiatives will reduce the exposure of household members to the smoke, pollution and dangers of fire/burns associated with kerosene lighting systems. The wind farm component will introduce Sri Lanka to an additional electricity generating resource option which is environmentally friendly. The demand-side management initiatives will lead to reduced building operating costs.

Costs

7. **Solar home systems:** Through the Solar Home Systems project component, households currently using a combination of kerosene for lighting and diesel-based battery charging for other activities such as powering a black-and-white TV will be targeted for the installation of solar home systems in 30Wp, 40Wp and 50Wp configurations. The level of service provided by a solar home system increases from the 30Wp system to the 50Wp system. Based on survey data and secondary information about prices, the monthly economic expenditures of the target households on kerosene and battery charging range from $5.40 to $7.94, depending on level of service. Correspondingly, the present values of the target household's baseline expenditures on kerosene and battery charging (for 15 years at a discount rate of 10%) range from $503 to $739 (Table 1), again depending on level of service.

8. Based on prevailing prices, the present value cost of solar home systems in Sri Lanka are $594 (30Wp), $781 (40Wp) and $857 (50Wp). The costs represent the per system cost of the GEF Alternative. The incremental cost of the GEF Alternative is the difference between the cost of providing service with solar home system and kerosene/batteries. These costs are $91 (30Wp), $90 (40Wp) and $118 (50Wp), for a weighted average of $100.

Table 1: Solar Home System Component Lifetime Cost Comparison

	30 Wp	40 Wp	50 Wp
Solar Home System Costs	$594	$781	$857
Kerosene & Battery	$503	$691	$739
Incremental Cost	$91	$90	$118

9. In addition to the cost differential between solar home system and kerosene/battery service, GEF incremental costs arise from: (i) the need to increase potential customer familiarity with solar home system, to assist dealers, and to maintain links with actual customers under this solar home system component, (ii) institutional capacity strengthening, and (iii) monitoring and evaluation. The GEF incremental costs for these activities are included in the costs of the Administrative Unit.

10. **Village hydro:** The Village Hydro project component will provide electricity to households currently using 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, dry cell batteries and battery charging are $2.42. Correspondingly, the present value of the target household's baseline expenditures on kerosene, dry cell batteries and battery charging (for 15 years at a discount rate of 10%) is $290, or $27,000 for 120 households.

11. Based on prevailing prices for a typical 12 kW village hydro system, the estimated present value lifetime cost in Sri Lanka is about $33,000 - the cost of the GEF Alternative. Because a village hydro system will provide electricity to approximately 120 households, the incremental cost of the GEF Alternative is the difference between the baseline expenditure for 120 households and the cost of the village hydro system - $6,000 per installation or $120,000 for 20 sites.

12. **Wind Farm:** The wind farm component will provide electricity directly to the CEB grid. Gas turbine generating plants are the projected marginal generators, and would therefore represent the baseline generating plant. The present value lifetime cost (discounted at 10% for 15 years) of providing energy with gas turbine generation is approximately $2,980,000, assuming a combined energy and capacity avoided of $0.065 per kWh.[1] The GEF Alternative is a wind farm with a lifetime cost of $3,860,000. Therefore, the incremental cost of the GEF alternative is approximately $880,000.

13. **DSM capacity building:** As indicated above, in the absence of the GEF alternative, DSM capacity building component would include IDA assistance to the CEB for load research and consulting services to develop and implement utility driven DSM initiatives. The cost of this initiative is estimated to be $2.5 million. The GEF alternative includes funding for developing an Energy Efficiency Building Code (EEBC), private sector training and incentives to incorporate energy efficiency and EEBC provisions into new buildings, and enhanced monitoring of the impact of DSM initiatives. The cost of the GEF alternative project component is approximately $4 million, for an associated incremental cost of $1.5 million.

14. **CEB Pre-electrification Unit:** The project will support the development of CEB's Pre-electrification Unit which will have responsibility for renewable energy. It is expected that the total cost of this activity will be $1.46 million. It is estimated that CEB would have spent about $155,000 in the absence of the project. Hence the GEF incremental costs are $1.3 million.

15. **ESD Credit Line Administrative Unit:** Given the early developmental stage of the solar PV and village hydro market, experience is lacking in the Participating Credit Institutions (PCIs) for subproject appraisal. Capacity building in the form of training to PCI loan officers is needed to build appropriate capacity. Capacity building is also needed to assist PV and village hydro developers in preparation of bankable subprojects. This capacity building would be administered by the ESD Credit Line Administrative Unit. The Administrative Unit also will need funds to process and report on GEF funds administration. The estimated costs for these activities are $250,000 for project developer assistance and $210,000 for GEF funds administration and PCI capacity building. The baseline in this case would be zero, since no off-grid subprojects of the anticipated scope would be forthcoming in the absence of the ESD Project. The incremental cost is the full cost of technical assistance and administrative fees: $460,000.

16. Together, the overall GEF incremental cost is approximately $7.26 million.

Global Environmental Benefits

17. There are no carbon emissions associated with the GEF alternative, so that there will be a total replacement of the fossil fuel use that would have taken place under the baseline scenario. The overall avoided emissions are about 140,000 tons of carbon for the solar home system, village hydro and wind farm components (Table 2). While the DSM and PEU capacity building components, as well as Administrative Unit support, will lead to a reduction in carbon emissions, since these activities include no direct investment, estimates of avoided emissions have not been included in the

---

1 Avoided energy and capacity cost based on "Published Small Power Purchase Tariff for Sri Lanka," Robert Vernstrom, (Study commissioned by the World Bank in support of ESD Project preparation), December 1995.

project total. Similarly, the project estimates do not include programmatic impacts arising from accelerated market penetration of renewable energy technologies in Sri Lanka.

Table 2: Incremental Costs and Global Benefits of GEF-supported Technologies

Technology	Incremental Costs	Global Benefits (tons carbon-equivalent)
Wind Farm	$880,000	106,000
Solar PV	$3,000,000	31,500
Village Hydro	$120,000	2,000
Demand-Side Management	$1,500,000	*
Pre-electrification Unit	$1,300,000	*
Administrative Unit	$460,000	*
Total	$7,260,000	139,500

* Capacity building in support of direct investments, as well as programmatic benefits (not estimated)

Sri Lanka: Energy Services Delivery Project - Solar Home Systems Component

Incremental Costs **System** **50 Watts**

Discount Rate	10%	Exchange Rate	52

Solar		
Levelized Monthly Cost		$9.21
Net Present Value		$857
Kerosene /Battery		
Levelized Monthly Cost		
Lighting	$3.16	
Battery Charge	$4.78	
Total		$7.94
Net Present Value		$739
Solar Life Cycle Incremental Cost		$118

50 Watt Solar Home Systems : Sri Lanka

Discount Rate	10%
Exchange Rate	52

	Cost and Life Assumptions				Life Cycle Costs		
	Cost		Life		Unit	Number	Cost
	Rupees	US $	Years	Months			
First Cost	32,300	621	15	180	621	1	621.15
Panels		300	20	240	0.00	1	0.00
Battery		63	3	36	127.09	1	127.09
Controller		60	7	84	44.76	1	44.76
Wiring, Switches& Outlets		35	15	180	0.00	0	0.00
Support Structure		20	15	180	0.00	1	0.00
Other Accessories		10	15	180	0.00	1	0.00
Bulbs		1	1	12	3.55	6	21.28
Fixture		9	10	120	3.20	6	19.18
Present Value -- Replacement							212.32
Present Value							833.47
Levelized Monthly							**$8.96**
O&M -- Water, etc.							**$0.25**
Present Value O&M							**$23.26**
Solar Levelized Monthly Costs							**$9.21**

Note: The first cost is the full cost of the initial purchase, and it is not discounted.

The other costs are replacement costs; no credit is taken for salvage value at end of life

Sri Lanka: Energy Services Delivery Project - Solar Home Systems Component

Kerosene and Battery Levelized Costs - 50 Watt Solar Home Systems

Discount rate	10.00%		
Lighting			
Kerosene Monthly Use (liters)	10		
Kerosene Cost $/liter	0.23		
Monthly Kerosene Cost			$2.30
Petromax Cost $	$20.00		
Petromax Life	5 years		
Petromax Levelized Cost	$0.42		
Mantle Monthly	$0.08		
Petromax Monthly			$0.50
Wick lantern Cost	$2.00		
Wick Lantern Life	3 years		
Number of Wick Lanterns	3		
Wick Lantern Levelized Cost	$0.19		
Wicks used monthly	$0.16		
Wick Lantern Monthly			$0.35
Total Monthly Lighting Costs			**$3.16**
Battery Costs			
Charges Per Year	40		
Cost per charge	$0.77	(observed cost in Sri Lanka)	
Monthly Charging Cost			$2.56
Battery Cost	$48.08		
Lifetime years	2	(lower than solar - deep discharges)	
Battery levelized Cost			$2.22
Total Monthly Battery Costs			**$4.78**
TOTAL LEVELIZED MONTHLY COSTS			**$ 7.94**

40 Watt Solar Home Systems : Sri Lanka

Discount Rate 10%

Exchange Rate 52

	Cost and Life Assumptions				Life Cycle Costs		
	Cost		Life				
	Rupees	US $	Years	Months	Unit	Number	Cost
First Cost	28,820	554	15	180	554	1	554.23
Panels		250	20	240	0.00	1	0.00
Battery		63	3	36	127.09	1	127.09
Controller		58	7	84	43.04	1	43.04
Wiring, Switches& Outlets		35	15	180	0.00	0	0.00
Support Structure		20	15	180	0.00	1	0.00
Other Accessories		10	15	180	0.00	1	0.00
Bulbs		1	1	12	3.55	5	17.73
Fixture		9	10	120	3.20	5	15.98
Present Value -- Replacement							203.85
Present Value							758.08
Levelized Monthly							**$8.15**
O&M -- Water, etc.							**$0.25**
Present Value O&M							**$23.26**
Solar Levelized Monthly Costs							**$8.40**

Note: The first cost is the full cost of the initial purchase, and it is not discounted.

The other costs are replacement costs; no credit is taken for salvage value at end of life

Sri Lanka: Energy Services Delivery Project - Solar Home Systems Component

Kerosene and Battery Levelized Costs - 40 Watt Solar Home Systems

Discount rate	10.00%		
Lighting			
Kerosene Monthly Use (liters)	10		
Kerosene Cost $/liter	0.23		
Monthly Kerosene Cost			$2.30
Petromax Cost $	$20.00		
Petromax Life	5 years		
Petromax Levelized Cost	$0.42		
Mantle Monthly	$0.08		
Petromax Monthly			$0.50
Wick lantern Cost	$2.00		
Wick Lantern Life	3 years		
Number of Wick Lanterns	3		
Wick Lantern Levelized Cost	$0.19		
Wicks used monthly	$0.16		
Wick Lantern Monthly			$0.35
Total Lighting Monthly			$3.16
Battery Costs			
Charges Per Year	32		
Cost per charge	$0.77	(observed cost in Sri Lanka)	
Monthly Charging Cost			$2.05
Battery Cost	$48.08		
Lifetime years	2	(lower than solar - deep discharges)	
Battery levelized Cost			$2.22
Total Battery Monthly			$4.27
TOTAL LEVELIZED MONTHLY COSTS			$ 7.43

Sri Lanka: Energy Services Delivery Project - Solar Home Systems Component

Incremental Costs **System** **40 Watts**

Discount Rate	10.00%	Exchange Rate	52

Solar		
Levelized Monthly Cost		$8.40
Net Present Value		$781
Kerosene /Battery		
Levelized Monthly Cost		
Lighting	$3.16	
Battery Charge	$4.27	
Total		$7.43
Net Present Value		$691
Solar Life Cycle Incremental Cost		$90

Sri Lanka: Energy Services Delivery Project - Solar Home Systems Component

Incremental Costs **System** **30 Watts**

Discount Rate	10.00%	Exchange Rate	52
Solar			
Levelized Monthly Cost			$6.38
Net Present Value			**$594**
Kerosene /Battery			
Levelized Monthly Cost			
Lighting		$2.47	
Battery Charge		$2.93	
Total			$5.40
Net Present Value			**$503**
Solar Life Cycle Incremental Cost			**$91**

30 Watt Solar Home Systems : Sri Lanka

Discount Rate 10%

Exchange Rate 52

	Cost and Life Assumptions				Life Cycle Costs		
	Cost		Life		Unit	Number	Cost
	Rupees	US $	Years	Months			
First Cost	22,650	436	15	180	436	1	435.58
Panels		220	20	240	0.00	1	0.00
Battery		43	3	36	86.66	1	86.66
Controller		29	7	84	21.52	1	21.52
Wiring, Switches& Outlets		25	15	180	0.00	0	0.00
Support Structure		15	15	180	0.00	1	0.00
Other Accessories		10	15	180	0.00	1	0.00
8W bulb		1	1	12	3.55	4	14.18
8W Fixture		9	10	120	3.20	4	12.79
Present Value -- Replacement							135.15
Present Value							570.72
Levelized Monthly							**$6.13**
O&M -- Water, etc.							**$0.25**
Present Value O&M							**$23.26**
Solar Levelized Monthly Costs							**$6.38**

Note: The first cost is the full cost of the initial purchase, and it is not discounted.

The other costs are replacement costs; no credit is taken for salvage value at end of life

Kerosene and Battery Levelized Costs - 30 Watt Solar Home Systems

Discount rate 10.00%

Lighting			
Kerosene Monthly Use (liters)	7		
Kerosene Cost $/liter	0.23		
Monthly Kerosene Cost			**$1.61**
Petromax Cost $	$20.00		
Petromax Life	5	years	
Petromax Levelized Cost	$0.42		
Mantle Monthly	$0.08		
Petromax Monthly			**$0.50**
Wick lantern Cost	$2.00		
Wick Lantern Life	3	years	
Number of Wick Lanterns	3		
Wick Lantern Levelized Cost	$0.19		
Wicks used monthly	$0.16		
Wick Lantern Monthly			**$0.35**
Total Lighting Monthly			**$2.47**
Battery Costs			
Charges Per Year	24		
Cost per charge	$0.77	(observed cost in Sri Lanka)	
Monthly Charging Cost			**$1.54**
Battery Cost	$43.27		
Lifetime years	3	(lower than solar - deep discharges)	
Battery levelized Cost			**$1.40**
Total Battery Monthly			**$2.93**
TOTAL LEVELIZED MONTHLY COST			**$ 5.40**

Sri Lanka: Energy Services Delivery Project
Village Hydro Component

Incremental Cost		12 Kw Typical System	
Number of Customers	120		
Discount Rate	10.00%	Exchange	52

Vllage Hydro		
Levelized Monthly Cost		**$354**
Net Present Value		**$32,969**
Kerosene /Battery		
Levelized Monthly Cost		
Lighting	$180	
Battery Charge	$109	
Total		**$290**
Net Present Value		**$26,976**
Village Hydro Life Cycle Incremental Cost		**$5,993**

Sri Lanka: Energy Services Delivery Project
Village Hydro Component

Number of Customers		**120**	**12 kW Typical System**
Installed System Cost		**Economic Costs**	
	Item	Total Rs	Rs/kW
	Civil	379,223	31602
	Penstock	268,307	22359
	Electro-Mechanical	494,817	41235
	Distribution	177,885	14824
	Consultants	274,466	22872
	Contingencies	-	-
	Working Capital	-	-
Initial System Price (Rs)		1,594,698	132,891
Initial Hydro Cost $		**$30,667**	**$2,556**
Replacement/O&M		**$2,302**	
Total Hydro Life Cycle Costs		**$32,969**	

Sri Lanka: Energy Services Delivery Project
Village Hydro Component

Discount 10% Exchange Rate 52

	Cost and Life Assumptions				Life Cycle Costs		
	Cost		Life		Unit	Number	Cost
	Rupees	US $	Years	Months			
First Cost	1,594,698	30,667	15	180	30,667	1	30,667
O&M	33,200	638	1	12	1,101.10	1	1,101
Insurance	5,205	100	1	12	369.15	1	369
Land Lease	-	-	1	12	0.00	1	0
Major Overhaul	-	-	10	120	0.00	0	0
Bulbs	21,600	415	3	36	831.89	1	832

Operating Costs - NPV	2,302
Lifecycle Cost - NPV	32,969
Village Hydro Levelized Monthly Cost	**354**

Note: The first cost is the full cost of the initial purchase, and it is not discounted.

Sri Lanka: Energy Services Delivery Project

Kerosene and Battery Levelized Costs - Village Hydro

			Per Customer	Per Village	
Discount rate	10.00%				
Number of Customers	120				
Lighting					
Kerosene Monthly Use (liters)	5				
Kerosene Cost $/liter	0.23				
Monthly Kerosene Cost			$ 1.15	$ 138	
Petromax Cost $	$0.00				
Petromax Life	5	years			
Petromax Levelized Cost	$0.00				
Mantle Monthly	$0.00				
Petromax Monthly			$ -	$ -	
Wick lantern Cost	$2.00				
Wick Lantern Life	3	years			
Number of Wick Lanterns	3				
Wick Lantern Levelized Cost	$0.19				
Wicks used monthly	$0.16				
Wick Lantern Monthly			$ 0.35	$ 42	
Total Lighting Monthly			$ 1.50	$ 180	
Dry Cell Batteries					
Dry Cell Battery Price	0.23				
Batteries Used Monthly	0				
Dry Cell Battery Monthly			$ -	$ -	
Battery Costs					
Charges Per Year	8				
Cost per charge	0.77				(observed cost in Sri Lanka)
Monthly Charging Cost			$ 0.51	$ 62	
Battery Cost	$8.65				
Lifetime (years)	2				(lower than solar - deep discharges)
Battery Levelized Cost			$ 0.40	$ 48	
Total Battery Monthly			$ 0.91	$ 109	
TOTAL LEVELIZED MONTHLY COST			$ 2.42	$ 290	

Sri Lanka Energy Services Delivery Project
Pilot Wind Farm Component
Incremental Cost

Exchange Rate		52	Rs/$
Discount Rate		10%	
Wind Farm Energy Generation			
Wind Plant Load Factor		23%	
Annual Energy Produced		2,015	kWh/kW
25 Year Present Value Energy		45,974,187	kWh
Baseline Cost -- Gas Turbine Generation			
Avoided Capacity Cost*		0.3	Rs/kWh
Avoided Energy Cost*		3.07	Rs/kWh
Avoided Cost	$	0.065	$/kWh
Present Value Energy & Capacity Displaced by Wind Farm	**$**	**2,979,481**	
Wind Farm Cost	**$**	**3,862,562**	
Incremental Cost	**$**	**883,081**	

* Source: "Published Small Power Purchase Tariff for Sri Lanka," Robert Vernstrom, (Study commissioned by World Bank in support of ESD Project preparation), December 1995

windfarm

Sri Lanka Energy Services Delivery Project
Windfarm Component

Windfarm Cost Components	3 MW Cost Breakdown Estimate	3 MW Plant Foreign Cost Total	Local Costs (GOSL)	Total Costs
Turbines	$ 3,005,923	$ 3,005,923		$ 3,005,923
Installation & Startup	$ 153,756	$ 38,439	$ 115,317	$ 153,756
Civil Works	$ 153,756		$ 153,756	$ 153,756
Electrical Work	$ 175,721	$ 70,288	$ 105,432	$ 175,721
Spare Parts	$ 54,913	$ 54,913		$ 54,913
Grid Interconnect	$ 219,651	$ 65,895	$ 153,756	$ 219,651
Proj. Mgmt	$ 98,843	$ 79,074	$ 19,769	$ 98,843
Total	$ 3,862,562	$ 3,314,533	$ 548,029	$ 3,862,562

National Renewable Energy Laboratory

MEMO:

TO: Loretta Schaeffer
Program Manager, ASTAE
MC10-443
1818 H Street, N.W.
World Bank
Washington, DC 20433
fax: 202-522-3573

FROM: Sam Baldwin
Technical Director, International Programs
National Renewable Energy Laboratory
409 12th St. SW, #710
Washington, DC 20024-2125
tel: 202-651-7542
fax: 202-651-7502/7501
eml: baldwins@tcplink.nrel.gov

RE: Technical review of the Sri Lanka Energy Services Delivery Project

DATE: February 6, 1996

The proposed Sri Lanka Energy Services Delivery Project has clearly received careful attention from the staff developing the proposal. The following comments are intended to strengthen the proposal and assist in moving it forward. The four principal areas focussed on here are the Commercial Buildings, Wind Farm, and PV program elements.

COMMERCIAL BUILDINGS: Improving the energy performance of commercial buildings is a very large but barely tapped opportunity. In the United States, residential and commercial buildings account for about two-thirds of all electricity use, with commercial buildings consuming 40% and residential buildings 60% of this. Thus, commercial buildings in the U.S. account for about one-fourth of all electricity use. Detailed monitoring of buildings in the United States and other OECD countries has shown that energy use can cost-effectively be cut in half using commercially available energy efficiency and passive renewable design features and equipment. Typical energy reductions of 65% of lighting, 65% of cooling, and 44% of heating are observed, at an increased cost ranging from 2-15% of the building capital cost with a wide variation ranging from net cost savings to significant cost increases depending on the quality of the design. Similar cost-effective savings of 50% of electricity use can be expected in developing countries with proper building design and use of efficient equipment.

To realize such savings, however, requires incorporating efficient and passive solar design features into the building from the very beginning. Many architects lack training in these energy-conscious design features. Even those architects that do have appropriate training are often unable to incorporate these design features as there are few good computer design tools; without design tools the design process is very labor-intensive for which the architects low operating margins make it unprofitable to attempt to develop a good design, regardless of the cost-effective savings over the lifetime of the building for the owner.

Several policies have been used to redress this difficulty and capture the roughly 50% energy savings at little additional construction cost that are possible through good design; this is a very high leverage intervention One key policy, of course, is training--which is necessary but not sufficient to ensure good design because the low design margins for the architect may prevent them from spending the time necessary to incorporate these features.

Building energy codes have been widely used to improve performance. As a model for best practice and as a tool for training, building energy codes can be very useful, including as a mechanism to bring stakeholders into the code development process. As a mandatory code, however, building energy codes are difficult to enforce, tend to become technically stagnant, are often complex and rigid, and generally provide for a minimum performance rather than for best design practice. In some places where mandatory building energy codes have been implemented, a small consulting industry has sprung up to assist builders through the permitting process at the minimum performance level. As formulated in the proposal, however, building energy codes are a useful first step in improving overall building energy performance.

Alternatively, design competitions may be a useful mechanism for improving building energy performance, providing a carrot rather than the stick of mandatory codes. Design competitions typically provide a financial reward roughly equivalent to or greater than the increased cost of efficient and passive design for roughly the best 30-50% of building designs submitted. Useful supporting activities include training, the provision of effective building design tools, and model best practice building designs. By using design competitions rather than mandatory codes, there is a financial advantage to the company investing in good design, competition is spurred, enforcement difficulties are lessened, there is little risk of becoming technologically stagnant, the design process remains fully flexible, and performance/cost can be continuously improved over time. There is significant leverage in this through providing incremental costs to the design process, spurring competition, and leveraging all of the downstream construction investment. Mechanisms to fund such design competitions in the longer term might include a small building permitting fee on all construction, which would be largely reimbursed to those winning the competition, thus having little net cost to the construction industry. Such approaches might be considered in future project activity, following training and the development of model building energy codes.

In the case of Sri Lanka, two groups of Architect/Engineers must be addressed: local A&E firms primarily doing low-rise construction; and international A&E firms such as those based in Hong Kong and Singapore that focus on high-rise buildings.

In summary, this project could be a model for a very significant program in commercial building design with global potential for replication. It is potentially a highly cost effective activity. Project design and implementation can be readily adjusted to include the above considerations.

WIND FARM: The Sri Lanka Energy Services Development project proposes a 3 MW wind farm. Key issues that need to be addressed in later stages of project design include the following:

- Is 3 MW a sufficient scale given the large transaction cost and high O&M costs for such a small project? The answer is probably "yes", but further examination of this issue may be useful in the next stage of project design.
- Can some additional details be provided during the next phase of project development concerning the process for replication this project and realizing much larger wind power use? What lessons from the India program can be usefully applied here?
- Can additional details also be provided during the next phase concerning the structure of the power purchase agreements? Experience elsewhere has shown that the power purchase process can very strongly influence independent power development. For example, fixed purchase prices will generate no bids if set too low, but will generate a flood of bids if set too high, and there is often not a very good a priori mechanism for determining what the contract price should be. In response, some U.S. utilities have moved towards competitive bidding within green set-asides for environmentally-friendly technologies (this process is actually on hold at the present due to a Federal Energy Regulatory Commission decision last spring). This mechanism thus provides a competitive framework for optimising renewable energy bids, prices, etc.
- The capacity credit calculation for the wind farm appears to assume that the diesel engine will only operate at the same capacity factor as the wind farm. This should be adjusted to reflect actual operating capacity factors

for similar sized diesel engines in Sri Lanka, followed by downsizing of the diesel capacity investment to the level needed to match that of a wind farm operating at the wind capacity factor.

Wind energy represents a very significant opportunity globally for being cost competitive with fossil fuels in generating electricity. Although the scale of the wind farm proposed here will not have a significant impact on global wind turbine manufacturing, it is a necessary first step towards developing in-country experience with and support for longer term larger-scale wind power development in Sri Lanka. Although transaction and O&M costs will be relatively high in this pilot project due to its small scale, this activity can leverage additional investment leading to cost competitive use of windpower. The proposed project design and implementation are well thought through and rely on the private sector.

HOUSEHOLD ENERGY SYSTEMS: The proposal calls for extending a credit line to support the installation of 20,000 household PV lighting systems. Several issues are of interest and might be usefully explored during the next phase of project development, including:

- Is the scale sufficiently large that a critical mass of business infrastructure--sales, support, etc. can be created to drive down prices and maintain a long term market? Why was this scale chosen given the 5000 systems already installed, and the potential market of some 300,000 using auto batteries that was cited?
- What various finance mechanisms are expected? How will revenue be collected from these systems?
- Is it appropriate to focus solely on market credit lines, or should some support be provided directly for creation of business infrastructure through such mechanisms as training, incubators, facilitating access to private lines of capital, etc.?
- Can mechanisms be designed in to measure the pre- and post-project prices of PV systems and show the market impact of this package?
- Can appropriate mechanisms be designed in to effectively monitor sales activities, financing mechanisms, and other details so that useful lessons can be extracted for global interests? Will alternative financing mechanisms be tried?
- Can import duties and tariffs on PV systems and components be reduced--as was apparently done for large-scale diesel engines--so as to make them more affordable in rural areas?

With a total capacity of 0.8 MW of PV to be supported over 5 years, this project will have little impact on global manufacturing, which now totals roughly 80 MW/year globally. The cost effectiveness of these household systems within Sri Lanka, however, could be substantially improved by this project's impact on transaction costs and business infrastructure. The lessons drawn from this activity could also have significance globally in project design and implementation. These will be important issues to focus on during the next stages of project development.

HYDROPOWER: Two hydropower projects--grid connected and village minigrid--will be examined under this proposal. Project details to this point seem appropriate, well focussed, and appropriately costed.

More broadly, I look forward to learning more about the potential markets in Sri Lanka, private sector risks, and related issues that can strongly affect project performance during future stages of project design.

I also provided brief review comments for the complementary UNDP/GEF Sri Lanka proposal. The two proposals are well integrated and complementary and should provide a stronger package than either project by itself.

I look forward to further information on this project as it continues through the preparation process. It has received considerable attention from Bank staff and can be a useful contribution both to Sri Lanka and to the larger global pursuit of sustainable energy systems.

Please let me know if I can be of further assistance,

Sincerely,

Samuel F. Baldwin

National Renewable Energy Laboratory • 409 12th St. SW #710 • Washington, DC 20024-2125 • (202) 651-7500
NREL is a national laboratory of the U.S. Department of Energy operated by Midwest Research Institute