



UNDP Project Document

Government of The Islamic Republic of Mauritania

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Adrar Solar Initiative and Decentralized Electrification in the Northern Coastline of Mauritania through Hybrid (Wind/Diesel) Systems

Brief Description

The primary objective of the project is to address the country's rural energy service delivery needs by increasing electricity access to the rural and low-income settlements in the Adrar desert area and the northern coastline. A secondary objective is to institutionalize the use of renewable energy technologies for productive end-uses in rural areas as a substitute for fossil fuel-based energy sources (paraffin, diesel and LPG). The activities proposed in the project are designed to: (i) remove barriers to the wide-scale utilization of renewable energy; (ii) meet the basic energy needs of community based organizations; (iii) encourage productive uses of energy for income-generating activities (iv) increase community applications of electricity such as water pumping, water desalination and ice-making; and (v) reinforce public-private partnerships in promoting RETs. This project will assist with the initiation of the intended renewable energy program of the Government of Mauritania and will encourage the development of the private sector industry in the provision of renewable energy in the country.

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Acronyms and Abbreviations

ADER	National Rural Electrification Agency
AFD	French Development Agency
AfDB	African Development Bank
AO&M	Administration, Operations & Maintenance
APAUS	Agency to Promote Universal Access to Basic Services
ARM	Multi-sectoral Regulatory Agency
CBO	Community-Based Organization
FERD	Fund for Decentralized Electrification
GHG	Greenhouse Gas
GEF	Global Environment Facility
GEF-SGP	Global Environment Facility – Small Grants Programme
GOCO	Government-Owned/Contractor-Operated)
GOM	Government of Mauritania
JICA	Japanese International Cooperation Agency
kW	Kilowatt
kWh	Kilowatt-hour
LPG	Liquefied Petroleum Gas
MFI	Micro Finance Institutions
MHE	Ministry of Water Resources and Energy
NGO	Non-Governmental Organization
O&M	Operations & Maintenance
PDF-B	Preparation Development Facility – Block B
PMU	Project Management Unit
PNBA	Arguin Sandbank National Park
PSC	Project Steering Committee
PV	Photovoltaic
RET	Renewable Energy Technology
RFP	Request for Proposals
SCS	Solar Community System
SHS	Solar Home System
SNIM	National Industrial and Mining Company
SOMELEC	Mauritanian Electricity Company
UNDP	United Nations Development Programme
Wp	Peak Watts

Exchange rate:

1 US \$ = 270 ouguiya (March 2005)

SECTION I: ELABORATION OF THE NARRATIVE

PART I: Situation Analysis

Context and global significance

1.1. The majority of the Mauritanian population has no access to electricity. While 30% of households in urban centers such as Nouakchott, Nouadhibou and Ross have electricity service, the electrification rate for rural households is under 1%. The rural poor must rely on candles, car batteries and kerosene lamp for lighting and cooking, limiting the potential for socio-economic development.

1.2. Car batteries are used for radio, black and white TV and cell phone charging. Refrigeration is powered by butane gas in some shops, but due to the hazards and cost, most households don't have refrigeration. A limited number of diesel generators exist in rural areas, but most small entrepreneurs cannot afford either the initial investment or the associated O&M costs due to the high cost and unreliable availability of fuel, lube oil, and spare parts.

1.3. Without access to refrigeration, farmers are not able to store meat and vegetables, and fishermen cannot store their catch. As a result, agricultural and fisheries produce often goes to waste or must be quickly sold regardless of market conditions, causing economic losses for farmers and fishermen. Another problem in a desert country like Mauritania is the availability of clean (non-brackish) water for human consumption, animal needs and irrigation. Energy is needed to power water pumps in the desert to bring underground water to the surface and desalination equipment along to coast to purify brackish water.

1.4. With the increasing cost of fossil fuel energy and the difficulties in shipping diesel fuel from coastal port to inland destination, the government of Mauritania is sensitive to the importance of renewable energy technologies (RETs) to provide sustainable energy resources to isolated rural populations. Mauritania is well suited for using wind and solar energy resources for power generation. Its coastline, especially the northern coastline, enjoys some of the best winds on the entire African continent, while the desert regions are well-adapted for using solar energy technology.

1.5. To address demand for energy while alleviating pressure on the dwindling traditional energy resources, the Government of Mauritania (GOM) began promoting LPG as a substitute for fuelwood in the 1980s. The national program of LPG promotion was supported by foreign donors, principally the EU. Despite a noticeable increase in LPG consumption in urban areas (a threefold increase between 1987 and 1997), the program fell short of meeting its quantitative goals. The dissemination of improved stoves, which began in 1992, has been relatively more successful. However, the overall implementation of the household energy strategy adopted by the GOM in 1991 was hindered by the lack of an effective institutional and organizational framework and well-targeted supporting investments.

1.6. Starting in 1995, the GOM began exploring alternative energy sources, largely through the GEF/UNDP-supported "Decentralized wind electric power for social and economic development (Alizés électrique)" project (MAU/93/G32/A/1G/99). This project was reasonably successful and has resulted in increased local awareness of the importance of RETs. Ownership of the technology was high, and the installation and maintenance of equipment by local firms

was more successful than anticipated. Beneficiary communities were very satisfied and demand blossomed with the success of these initial demonstration projects.

1.7. A post-implementation evaluation conducted in 1996-97 by an international firm¹ revealed that despite the extremely low levels of income in rural Mauritania, the involvement of beneficiary communities in the project and their willingness to pay for the services that they valued had enabled the project to more than meet its operational expenditures. The evaluation report emphasized the need to consolidate the achievements of the program and to take advantage of the wealth of knowledge that was accumulated. The success of the Alizés project in demonstrating the impact that community-based productive uses of electricity could have on the welfare of villagers helped convince the government that it was timely and necessary to promote renewable energies in a more systematic manner and with a longer-term perspective.

1.8. The previous “Alizé Program” established that given the pressing needs for electricity in Mauritanian villages, there was a need for more penetration and new targeted applications of solar power technology together with hybrid (wind-diesel) systems in order to spark a self-sustaining rural economy. The current project sets out to remove critical institutional and market barriers still impeding a large-scale market penetration of RETs by: (i) strengthening the operational capacity of ADER (the Rural Electrification Agency) which emerged out of the success of the first Alizé Program in the mid to late 90s; (ii) using the policy space offered by the recently created multi-sectorial “Universal Access Agency – Water-Energy and Telecommunications” as an operational conduit to link renewable energy technology with integrated rural development programs; and (iii) promoting further private sector participation as the driver behind the RET scale-up efforts in Mauritania, particularly for the hybrid systems component along the coastal line where a management structure utilizing a government owned/contractor operated approach for operations and maintenance is recommended. The government understood that consolidating and building up on the Multi-sectorial Universal Access Agency’s experience in pro-poor service delivery in rural areas would increase the chances of mainstreaming RETs in local development initiatives. Similarly, there was consensus in and outside the Ministry of Energy that if ADER is going to live up to its mandate as a self-standing rural electrification structure, it needs to be at the helm of a challenging RET scale-up project nationwide which serves a dual purpose. First, to deliver the intended running power services in the scattered rural areas. Second, to allow ADER’s own significant capacity strengthening through learning by doing with the required level of technical assistance and outside help in ways that fill the policy void perceived to have increased with the focus on privatization of the nation’s Public Electric Utility.

1.9. Collaboration with the World Bank on this projected started in the second quarter of FY 2003 during PDF-B/Concept preparation in Nouakchott and the surrounding areas. Both the Bank Field Office in Nouakchott and the UNDP-Mauritania Field Office agreed that the investment needs in the sector and the efforts under way with the government’s renewed focus on decentralization and basic infrastructure service delivery with private participation were steps in the right direction. While the Bank has been using the PRSP as its preferred entry point in the rural space to address running power/productive end uses service delivery of RE to alleviate poverty and create more income generating opportunities, UNDP-GEF took advantage of its strong field presence – in Mauritania -- to engage ADER and APAUS in the consolidation of

¹ Evaluation Report BURGEAP and IRAM; by Vincent Butin and Gilles Goldstein, 1996-1997.

past successful UNDP-GEF experiences in country. The basic idea was to scale-up RE systems deployment with a broader spectrum of players and pave the way for irreversible policy reforms based on the realities of a changing institutional and operational landscape. To date, much progress appears to have been accomplished on both fronts and the regular exchange of information between the Bank and UNDP-GEF has been mutually fruitful and productive.

1.10. With respect to the specific WB activities, Component 1 of the PRSP in the making also includes a number of measures to consolidate reforms in the energy sector and to expand access to energy services. As a result of the intensive dialogue between the Bank and the GIRM, efforts are on the way to bring much needed clarity in the institutional arrangements and, there is now a stronger sense in the country that the provision of energy services in rural and peri-urban areas calls for a spectrum of innovative service delivery and financing mechanisms, involving the active participation of local communities, NGOs, and the private sector. The UNDP-GEF Task team and the Bank will continue to collaborate and seek to strengthen the synergies in their interventions. Lately, the AfDB's announced September 2005 preparation mission for the components it will co-finance with UNDP-GEF has been welcomed by all players.

Barrier analysis

1.11. The following barriers are making it more difficult for the public and private sector participants in the energy sector to increase the share of renewable energy technology in the energy mix for Mauritania's rural electrification programs.

(i) Information and perception barriers:

- At the country level, there is insufficient knowledge about available technologies and technological developments among government agencies and private sector companies. Information might be available at the level of research institutions and donor-sponsored projects, but it is not centralized or easily accessible. Exchange of information between different stakeholders regarding financial and technical data, experiences gained with different technologies, financing mechanisms and organizational/institutional delivery set-ups is not formalized. As a result, the ADER, other government agencies and bilateral/multilateral donors are still searching for the most appropriate service delivery model based on existing best practices.

(ii) Financial barriers:

- Bank financing is difficult to secure for RET-based rural energy projects. The fragmentation of the rural energy marketplace in Mauritania, the absence of a sustainable project development model and the perception of low rates of return discourage financial institutions from committing themselves to finance rural electrification projects. Financial institutions lack information about the technologies, their transaction costs, risk management and contract enforcement issues and hence are not in a position to assess potential profit opportunities. This information barrier inhibits financial institutions from entering the renewable energy market, which in turn inhibits the growth of a commercially viable renewable energy sector in the country.
- The dearth of consumer credit schemes makes it difficult for end-users to pay the fully allocated cost of rural electrification projects, requiring some subsidies or leasing arrangements. There also needs to be a longer-term vision on how these financial instruments

(subsidies, favorable credit) will be continued after a project finishes or how they can be scaled down over time. In summary, a program approach needs to be taken as compared to a project approach that introduces severe financial barriers.

- The undercapitalization of local energy service firms restricts the ability of the private sector to fully engage in developing and executing RET-based rural electrification projects. Private sector companies in the renewable energy sector have difficulties raising sufficient credit to finance their operations and/or expand their businesses, and if credit is to be found, it is often very expensive.

(iii) Technology barriers:

- Inappropriate applications of technology can also be a barrier, whether the technology is too complex to maintain or too expensive to operate. Research on PV panels continues to focus on improved energy efficiency with its associated cost, whereas most of the poorer users and countries would benefit more from research into improvements in component quality and robustness and manufacturing efficiency that leads to lower overall costs. The balance between component quality and price is delicate and when components are considered too expensive, users may choose not to use them.

(iv) Institutional/organizational barriers:

- Fragmented institutional responsibilities and overlapping jurisdictions can create some inefficiency among agencies and result in a lack of integrated planning by various stakeholders, including government, research organizations, academic institutions, CBOs and the private sector.
- Another organizational/institutional barrier is the weak linkage between the public and private sectors and a general weakness in both sectors in terms of technical capacity, experience and organizational expertise to deal with renewable energy efforts. A concerted effort between the public and private sectors to overcome these institutional weaknesses is often absent, leaving the renewable energy market in a state of limbo.

1.12. Information and perception barriers will be addressed through the publicity and sensitization campaigns surrounding this UNDP-GEF/AfDB co-financed operation. Focusing on only 7 villages on the northern shoreline will help maximize impact, increase the chances of success and make available more time and resources to target project interventions. Financial barriers are addressed in this project by enhancing both financial and economic viability of RETs through enhanced productive end-uses such as water pumping, desalination, ice-making etc.. Technology barriers will be removed through ADER's improved design and operational capacity putting to good use the technical assistance for the sector. Finally, institutional/organizational barriers will be removed through the partnership between ADER and APAUS as spelled out by the MOU (Memorandum of Understanding) between both institutions with a clear outline of the specific collaborative arrangements as a pre-condition for GEF grant disbursement.

Institutional, sectoral and policy context

1.13. The government has attempted to liberalize the power sector by privatizing the SOMELEC, the national utility company. Even though a full international tender was launched the bidding process was unsuccessful due to a number of factors, including concerns about privatizing a company viewed as a strategic asset. Reportedly, the offer made to the government was far below the government's reservation price. As a result, the power sector in Mauritania

continues to be dominated by a national state enterprise, which is struggling to keep up with the demand from urban areas for reliable and affordable electricity. SOMELEC provides electricity service to 20 cities and towns representing a total population of 974,000 people, equivalent to 83% of the urban population. In 2002, SOMELEC had 64,400 customers, which represents a 29% penetration rate for households. Extension of the national grid is being pursued in the South, along the Senegal River, where a number of mid-sized cities are located and where economic activity shows promise. However, this focus on urban areas means that little is done to address the energy needs of rural areas.

1.14. The government's ownership and preparedness for the current project is best illustrated by the recent efforts to establish dedicated rural electrification institutions. In 2001, as part of a restructuring/reform of the entire energy sector, the ADER (Rural Electrification Agency) was created by way of government decree (No. 2001-065 of June 18, 2001). The ADER is a Public entity with administrative, operational and financial autonomy. ADER is intended to operate on a commercial basis with a public mandate to promote the design, evaluation and field implementation of rural electrification projects with a focus on poverty reduction and socio-economic development. The ADER is the executing agency for a number of donor-funded projects to improve rural access to electricity through a variety of technologies, including diesel generators, solar photovoltaic (PV) systems and wind turbines. The ARM, Mauritania's multi-sectoral Regulatory Agency, is responsible for overseeing the ADER and monitoring its activities.

1.15. The ADER's primary responsibilities are the following:

- defining and overseeing a decentralized electrification program for rural areas;
- developing investment proposals for rural electrification projects;
- overseeing the deployment of rural electrification projects;
- managing the Fund for Decentralized Electrification (FERD);
- managing rural electrification equipment;
- identifying and assisting nascent private operators capable of taking on the responsibilities of operating and maintaining rural electrification equipment;
- technical pilot projects; and,
- training for rural electrification stakeholders.

1.16. The government also established the APAUS (Agency to Promote Access to Universal Services) to play a complementary role to the ADER's. The APAUS focuses on innovative public-private sector partnerships to increase rural access to core services such as water, sanitation and electricity. The role of the APAUS is to create the right conditions for mobilize the private sector in these projects, in order to: (i) increase private sector capabilities in managing, operating and maintaining rural electrification infrastructure an/or equipment under a concessioning or licensing system, and (ii) reduce the overall cost of rural electrification projects through innovative public-private partnership arrangements. Once these innovative programs are launched and refined, they can be institutionalized through the regular execution agencies such as the ADER in the case of rural electrification projects.

1.17. The creation of both institutions indicates the government's strong concern with the energy situation in Mauritania, especially for rural populations that are regrouped in small settlements dispersed over wide areas as a result of the desert land conditions. Mauritania now needs to institutionalize the various rural electrification/poverty reduction schemes that have

been implemented on a pilot basis, while ensuring greater private sector participation in the formulation, design, construction and management of these projects.

Stakeholder analysis

1.18. Relevant institutional actors include: ADER, SOMELEC, the nation's Power Utility, Ministry of Oil and Energy, Electricity Directorate, ARM (responsible for privatization of services and oversight of the process of international tendering); and APAUS (responsible for promoting multi-sectoral rural development projects integrating electricity, telephony & water). Other stakeholder groups include: villagers, local authorities, community groups, private sector companies, academics, donors and NGOs.

1.19. The spreadsheet in Annex IV to this Brief is a compilation of the information concerning the coastal villages, their access to water and electricity, their main economic resources and their needs. This information helped determine the system type and sizing, as well as the set of productive uses to be offered in each village.

1.20. With respect to the villages in the ADRAR and Inchiri regions, they are often spread over a large land area as the people try to band together to support each other yet maintain some degree of separation typical of their nomadic heritage. Thus a typical desert village as in Mauritania consists of very simple dwellings, low community organization, and the absence of a village center. On the other hand, the Adrar region has several old and famous settlements that were crossroads for Saharan caravans, where dwellings are closer together and community life and economic activity are more concentrated. Because of the low population density and low income level, most desert dwellings rely on traditional hydrocarbon fuels despite the detrimental impact on health and the environment. People in the desert communities visited are reported to have a short life expectancy, and the field assessments ascertained their low literacy rate, and little access to modern conveniences, such as electricity, that can improve their quality of life. As a result, these desert regions have an extremely high potential for solar energy and for reduction of CO₂ emissions.

Baseline analysis

1.21. Current efforts to increase rural energy supplies rely on fossil fuel technology, in particular diesel generators. This is particularly true for infrastructure projects designed to provide electricity to the larger rural villages via mini-grid designs. For more isolated communities, villagers will often purchase small diesel-powered pumps to bring underground water to the surface for human consumption, for husbandry activities and/or for irrigation. All of these technologies cause CO₂ emissions due to the reliance on diesel fuel, paraffin oil or LPG gas.

1.22. The impact of energy systems based on traditional fuels is significant:

- a diesel generator is estimated to produce 750 tons of CO₂ emissions annually on average for each kW of output power;
- each household produces up to 10 kg of CO₂ emissions based on the paraffin it consumes on a monthly basis for lighting;

- green cover is harvested on an unsustainable basis to meet the fuelwood needs of rural populations, a problem that is particularly acute in desert areas.

1.23. There are some on-going efforts by the ADER and other agencies to deploy RET-based equipment for rural electrification projects. The ADER has installed 3,900 solar home systems (SHS) out of a proposed 4,450 kits planned in May 2003. Based on photovoltaic (PV) technology, these SHS provide low levels of power that serve to meet the most basic household needs (lighting, TV, etc.) in a cost-effective way. The SHS units are split between a 50 Wp model (representing 20% of total units leased) and a 20 Wp model (80%). The systems are provided to villagers on a lease-to-own plan based on 2-year leases. (A similar program sponsored by APAUS relies on 5-year leases). This program demonstrates an interest on the part of villagers for renewable technology if it can deliver electricity on a reliable basis and at a cost that is commensurate with local household incomes.

1.24. Supply, installation and maintenance of SHS equipment is currently provided on a turnkey basis by private firms under contract with the ADER. Recent experience has shown the challenges of this approach: the foreign firms selected to supply and install the SHS equipment relied on local contractors to maintain the equipment. The ADER was not able to deal directly with the local contractors to improve maintenance services. To remedy this problem, the ADER is proposing that future maintenance contracts be signed directly with local firms to improve accountability and performance. These local contractors need technical assistance and training to adequately perform the maintenance tasks on SHS systems as well as on the more elaborate Solar Community Systems (SCS) that are being proposed.

1.25. Regarding mini-grids, the ADER, the APAUS and the SOMELEC are planning to deploy and launch 17 mini-grids in 2005 using diesel generators. Another 20 mini-grid systems are planned beyond 2005. While the government is making an effort to improve rural electrification access, it is doing so without incorporating RET-based equipment as part of the technical solution, adding to the environmental problems while condemning the country to substantial imports of diesel fuel. In addition to the above need for strengthening the capacities of the key actors, it is clear that without the intended GEF activities, further market penetration efforts by the government alone would not be accompanied by new applications such as solar pumping systems, solar cooling and refrigeration in beneficiary villages. Unlike basic lighting applications, the above productive end-uses require systematic barrier removal activities which GEF is supporting. For example, specific criteria need to be met for solar community systems (SCS-300), solar water pumping systems (SPS) and solar refrigeration systems (SRS). Furthermore, the investigation of the real O&M costs for small, medium, and large solar-based refrigeration Units taking into account all the conjunctive use of refrigeration and pumping to solve the seasonal character of demand suggests that the baseline activities from government are rather limited by way of solar PV promotion.

1.26. With respect to the specific hybrid systems deployments envisaged, it is striking that the ADER, APAUS and SOMELEC did not include hybrid systems in the planned SOMELEC rural electrification program despite the awareness raised and acceptability suggested by the previous Alizé Program. The ADER (and the APAUS) are making efforts to involve private sector companies in the operations, maintenance and revenue collection activities tied to these mini-grids, PV-based or hybrid systems in a couple of villages illustrating the pay-offs of the previous project. However, these efforts are progressing slowly, due to the scarcity of management

experience, technical expertise and financial resources among Mauritanian energy service firms that are interested in management contracts to operate the mini-grid systems.

1.27. While the above documented baseline efforts are not without merits, it is clear that these scattered efforts without a systematic scale-up prospect in a coherent policy environment lend themselves to limited private sector involvement and the chances for autonomous replication and mainstreaming in further national programs are sensibly limited. Three elements need to be introduced into these programs: (i) greater use of renewable energy technology as part of the power production mix; (ii) greater private sector participation in the supply and maintenance of SHS equipment, to ensure that the most efficient distribution and repair networks are in place to address the needs of villagers on a more cost-effective basis (and requiring fewer subsidies), and (iii) greater community applications (SCS) of PV/hybrid-system products for productive uses, whether water pumping (SPS), refrigeration (SRS) and/or desalination through.

PART II: Strategy

Project rationale and policy conformity

2.1. This program seeks to develop a sustainable mechanism for facilitating the introduction and use of renewable energy technologies to provide electricity to isolated, rural communities that currently have no modern sources of energy. By removing the barriers that currently inhibit the adoption of these technologies, the project will allow communities to enjoy a reliable and cost-effective source of energy. The project's global objective is to reduce Mauritania's energy-related CO₂ emissions by substituting fossil fuels (petrol/diesel, paraffin, and LPG) with wind and solar energy in the provision of basic energy services for rural households and community-based services (refrigeration, water pumps, desalination, etc.).

2.2. The end-user field surveys conducted during the PDF phase identified how access to power could improve the quality of life and increase the socio-economic development of rural populations in the following ways:

- (i) improve the community's service delivery capability for basic services such as potable water pumping and desalination;
- (ii) provide water pumping for irrigation purposes on a continuous and more reliable basis that with small self-managed pumps;
- (iii) improve the quality of social services such as health centers and schools;
- (iv) improve indoor air quality and reduce smoke and soot-related health problems by eliminating the use of paraffin and candles at home;
- (v) provide communal refrigeration and/or ice-making capability to help preserve agricultural produce and meat/milk in the Adrar region together with fish in the coastal area, allowing villagers to preserve food surpluses and ship products to urban markets;
- (vi) stimulate new income-generating activities from small shops, micro-enterprise and local crafts (e.g., wood shop, metal shop, tailor, artisan workshops);
- (vii) encourage the development of private sector services for the sale and maintenance of RET-based systems such as PV kits and wind turbines.

2.3. Annex I contains extensive and detailed information on the contribution of renewable energy/electricity services to a range of rural development needs, including water sanitation, food security/preservation, education, health care, job creation, and socio-economic development. Annex I also contains information on survey results concerning specific productive end-use applications from Nouakchott to Nouadhibou (Hybrid Applications), and survey results from the in the Adrar and Inchiri Region. A more complete presentation of the results from the Socio-Economic Analysis conducted during the PDF-B phase is included in Annex IV.

Rationale for Prepaid Metering

2.4. Prepayment of electricity was discussed extensively with potential users and community leaders during the preparatory assistance phase. While villagers were receptive to the concept of prepayment, the cost is significant at US\$150/meter. Given that the uncollectible revenue is under 5% for existing rural electricity customers, prepaid meters are not a necessity for the financial viability of the project. However, prepaid meters can enhance cash flow for the operator, thus increasing the attractiveness of mini-grids to private sector companies willing to operate the systems under a management contract.

Prepaid Metering for Hybrid Wind/Diesel Systems

2.5. The rate of uncollectible revenue for the few electrified villages along Mauritania's northern and southern coasts is very low, typically under 5%. The experience with electricity service suggests that rural customers regularly remit payment for electricity services, as compared to peri-urban communities where the anonymity of urban life may encourage more end-users to ignore their electricity bills. In this context, prepaid meters would marginally improve revenue collection, but they could prevent a worsening of bad debt as more customers are provided with electricity service.

2.6. More importantly, since the hybrid systems rely on diesel generators to produce electricity as back-up to wind power, the operating cash flow requirements to pay for the diesel fuel costs (and other operating expenses) can represent a heavy burden for an operator, whether public and private. Prepaid meters can reasonably be recommended for community and business users to help operators collect revenue in anticipation of fuel charges and other expenses, thus allowing them to improve their cash flow situation. This argument is quite important, especially since it is the intention of the project to encourage private Mauritanian operators to bid for management contracts to operate the hybrid-based mini-grids.

2.7. For households, the decision to use prepaid meters should be made at the time of the tender, after consultation with potential private sector operators to determine the value of prepaid meters to their business models. Prepaid meters should only be installed if it is determined that the benefit of such an action (in attracting qualified private operators) exceeds the cost of the end-user. The possibility of improved cash collection in anticipation of actual expenditures can reduce the financing barriers that might otherwise discourage an energy service company from operating a hybrid wind/diesel mini-grid.

Prepaid Metering for Solar PV Systems

2.8. Just as in the coastal areas, the rate of uncollectible revenue for Solar Home Systems (SHS) in the Adrar villages is extremely low, typically under 5 %. This is due to several factors:

(i) the high value that villagers and small businesses place on electricity service, (ii) the social pressures at the village level that discourage non-payment, and (iii) the ability of the ADER (or its agents) to repossess the equipment in case of non-payment. Since the end-users end up owning the equipment at the end of the lease-to-buy period, it is in their best interest to meet their payment obligations until the end, lest they lose their initial investment.

2.9. The primary application where prepaid meters would be advisable is for Solar Community Systems (SCS), which are appropriate for schools, health clinics and/or community centers such as libraries. This will ensure that political pressures to maintain basic public services don't force the operator to continue to provide service in situations where the end-user falls behind on his payments. Prepaid meters are not recommended for other Solar PV applications.

Market-Based Pricing and Tariff Structure

Electricity Tariff for Hybrid Systems

2.10. The goal of the project is to ensure financial self-sufficiency of the hybrid wind/diesel system during the operational phase, to ensure that tariffs are set at a level that will cover operational and maintenance costs. The deployment of prepaid meters (see above) should help the operator maintain a positive cash flow with receipts preceding actual expenditures on such major items as personnel costs and diesel fuel purchases.

2.11. The Mauritanian government is currently in the process of establishing a national approach to electricity tariffs. Tariffs for the proposed mini-grids will be subject to this governmental approach. The operational subsidy required to cover any potential shortfall between the national tariff and the actual cost of production will be determined after private sector bids for the mini-grid operation have been submitted and relevant government institutions have established a desired tariff level.

2.12. Economic feasibility analyses conducted during the preparatory assistance phase have estimated the following cost-recovery tariffs (assuming all 12 North Coast villages are eventually electrified) based on estimated capital and O&M costs:

- Recovery of ***operating costs only*** would require an energy tariff of US\$0.192/kWh in the small villages and US\$0.055/kWh in the largest village. A uniform tariff of US\$0.10 in all 12 North Coast villages would provide for full operating cost recovery, with the large and medium villages cross-subsidizing the small ones.
- ***Full cost recovery*** would require an energy tariff of US\$0.46/kWh in the small villages and US\$0.20/kWh in the largest village. A uniform tariff of US\$0.29 in all 12 North Coast villages would provide for full cost recovery, with the large and medium villages cross-subsidizing the small ones.

2.13. With average household consumption estimated around 53 kWh/month, the tariff of US\$0.10 (allowing for recovery of operating costs only) would lead to a monthly electricity bill of US\$5/household. This represents 11% of the average rural monthly income of US\$46/month. It can therefore be realistically assumed that the adoption of a tariff calculated to recover operating costs only can be implemented with minimal requirements for operating subsidies. With the appropriate concession terms, full private sector participation can be a realistic option provided that cost recovery and an acceptable rate of return on equity investment is allowed.

Village Selection Criteria

Selection of Villages for Hybrid Systems

2.14. The hybrid wind/diesel component will focus on supplying productive end-use electricity to the villages of the north coast between Nouakchott and Nouadhibou (see Exhibit 1 for a map of the area). These villages have been selected because of the potential for socio-economic development tied to the provision of electricity, including: (i) the fishing industry and related activities such as boat building can improve productivity and lower costs with access to ice making², electric power tools, etc.; and (ii) commerce and small enterprise are expected to grow along the coast as the first hard surface road linking Nouakchott and Nouadhibou is built. Additional details on the selection of participating villages is provided in Annex II.

2.15. The current proposal calls for providing productive end-use electricity coverage to some 380 households in 7 coastal villages through hybrid systems despite the fact that the feasibility studies have carried out in-depth investigations for up to 13 villages out of the 25 villages initially surveyed. This choice was a tactical decision driven by the need to ensure the full implementation of productive end-uses of electricity with dedicated community end-use equipments and to allow the government to fully gain ownership of the hybrid technology and consolidate the experience/knowledge accumulated through this pioneering initiative into much larger national programs at a later time. This would ideally happen once the basic institutional actors have gone through the learning curve and witnessed the removal of various barriers to sector development. As a result of the funding estimates once the reduced geographical coverage was consensually agreed to, the project concept was reshuffled and strengthened to support the deployment of desalination plants and ice making equipment in all 7 villages at a realistic cost of US\$940,000. The decision to provide ice making capability will allow local populations to improve the economic rate of return from fishing activities by reducing the spoilage that currently accounts for 20-30% of the catch. By enabling the villagers to freeze the fish, they will be able to bypass the middleman and sell it directly to urban markets at a higher price. Secondary economic activities tied to boat building and sail making are also expected to grow. Desalination equipment is considered essential by local populations that must purchase imported fresh water as highly inflated costs or do with brackish water. With the upcoming construction of the Nouakchott-Nouadhibou hard surface road, economic activity is expected to increase in these villages through commerce and light industry (e.g., car/truck repair). However, economic activity and population growth will be constrained without sufficient supplies of fresh water.

² 20% to 30% of fishing production spoils on average due to the lack of ice making capability required to freeze the fish before it is transported to urban markets.



Exhibit 1: Map of Coastal Villages in Mauritania

2.16. The government of Mauritania and ADER agreed that the proposed financing will support the electrification of 7 villages on the North Coast (see Table 1 for the list of potential sites) with the understanding that other government led programs will ensure replication of the scheme based on the expected success. The final list will be determined during the project execution phase from this list. It is proposed that the villages inside the National Park of the Banc d'Arguin (PNBA) be electrified first. Since they are located inside a national park, the use of environmentally sensitive RET-based solutions such as wind power to provide energy to those villages is very appropriate and rather timely. Annex II provides additional information on wind resources of Mauritania's North Coast.

Table 1: List of Villages and Population on Mauritania's North Coast

Village	Nominal Number of Households	Nominal Population	PNBA
Agadir	20	100	X
Arkeiss	20	100	X
Awqueij	20	100	X
Limsid	20	100	
Tiwilit	20	100	
Iwik	40	200	X
R'Gueiba	40	200	X
Ten-Alloul	40	200	X
Tessot	40	200	X
Belawakh	60	300	
Teichott	60	300	X
M'Hejjratt	100	500	
Mamghar	200	1000	X

Selection of Villages for Solar PV Applications

2.17. The project will target 50 villages in a few concentrated areas of Adrar and Inchiri. These two regions were selected because they provide an optimal setting to carry out two government

objectives tied to rural electrification: (i) increase access of rural populations to electricity in order to reduce poverty and increase economic development; and (ii) encourage the regrouping of populations in rural centers to reduce the cost of providing basic services.

2.18. While the original project scope focused on the Adrar region, field work carried out during the preparatory assistance phase strongly recommended the inclusion of the Inchiri region as well. This region was included because of its proximity to the capital city (it is located between Nouakchott and Adrar), its potential for economic development, and the scarcity of infrastructure in most villages. ADER has not yet provided solar panels in this region. Inchiri province (Moughataa) has a very low rural population density with about 20 small villages. Each village has between 10 and 100 households and has a very scattered population, up to sometimes 5 km away from the “center”. The total number of rural households in Inchiri is only about 500 and none are electrified yet (except for a few private initiatives with solar modules or car batteries).

2.19. The Adrar region has a slightly higher population than its neighbors (Inchiri and Tiris Zemour) and is more geographically stable because of the presence of more farmers (see Exhibit 2). There are more than 100 villages with over 10,000 households scattered over the desert land. The existing ADER project has delivered about 1,000 solar home systems for domestic use in 40 Adrar villages, corresponding to approximately 25% penetration rate. Those villages have between 10 and 230 households (average is 85) but the number of installed solar kits varies between 1 and 86 per village (average is 25). Today, the unsatisfied demand recorded by ADER is more than double the present supply in all villages, and the proposed project is viewed with much interest by villagers still waiting for electricity, principally for community and productive end-uses.

2.20. Typical households in the region are rather small; usually one room, sometimes two, plus one additional small kitchen outside. Average families use mainly candles (about 60% of households) and flashlights (about 35%). Other families rely on butane gas, kerosene and car batteries. More than 75% of households spend less than 2,000 ouguiya/month (US\$7.41) for lighting and audiovisual consumption, while a small number (5%) spend more than 3,000 ouguiya/month (US\$11.11). For example, recharging a car battery (to power a TV) costs 200 ouguiya/charge (US\$0.74).

2.21. Given the prohibitive cost of extending the electricity grid to remote rural villages spread over a large geographic area, solar PV technology is an appropriate alternative RET that makes use of the tremendous solar resources in the Sahara Desert. Solar PV technology is also more appropriate for poorer communities that may not be able to afford the prohibitively high cost of diesel fuel after it has been transported hundreds of miles to inland destinations. Productive end-use applications are closely tied to the availability of electricity for community uses such as water pumping for agriculture, communal refrigerators to preserve meat and other produce, and power for community applications such as schools, health clinics and libraries. See Annex I for additional details.

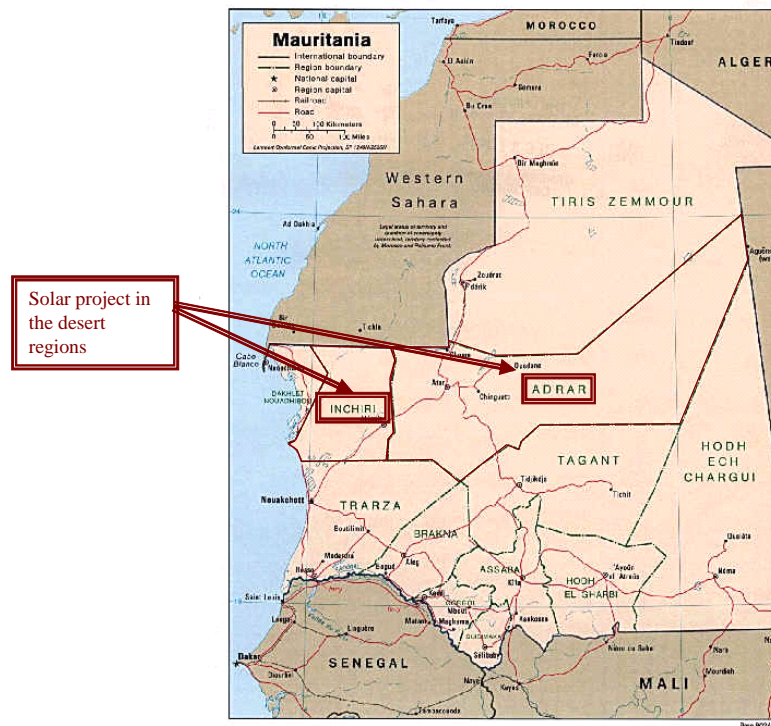


Exhibit 2: Proposed Geographic Areas for Deployment of Solar PV-based system for productive end-uses

Lessons Learned from Past Initiatives

2.22. A review of past RET promotional activities suggest that failures were principally caused by: (i) extremely harsh operating environments; (ii) lack of technical skill and operating experience; (iii) Lack of clear ownership, responsibility and profitability; (iv) lack of support infrastructure, spare parts, etc.; (iv) limited culture of customer service. With regards to the hybrid component specifically, success will depend on selection of the right ownership structure, existence of a solid corporate infrastructure and having the proper incentives built into the operation and regulation of the technical systems that are eventually provided. Determinants of success or failure can be summarized as follows:

- Clear lines of ownership, responsibility and profitability
- Modular systems designed for high levels of reliability and redundancy (assume 50% failure rates on all components over 2-year periods)
- Maintenance of a large spare parts inventories and rapid responsiveness to equipment failures
- Strict control over financial processes, operations and maintenance and particularly preventive maintenance
- A pool of operating reserve funds that must be replenished,
- A pool of investment capital that is grown organically from general operating revenues

2.23. Based on the local Mauritanian experience, there appears to be noticeable differences of approach between the ADER and APAUS management models for the solar kits promotion. The current ADER management approach for solar kits uses a single supplier to sell, install and

maintain the kits, with a local agent to collect the tariff and pass the money to an ADER field agent who sends the money to ADER, who then pays the agents and pays for maintenance services. End users own their solar kits after two years. This approach differs from that being tested at APAUS, which is installing solar kits of sizes identical to ADER in other regions of Mauritania. APAUS selects operators through a bidding process (lowest total subsidy requirement wins the work). The operators are totally responsible to sell, install and maintain the equipment; end users own their solar kits after five years.

2.24. A comparison of total cost and cost to end user between the ADER and APAUS models was made, and costs for the ADER approach are significantly less (see Table 2 below).

Table 2. Cost Comparison - ADER Solar Lighting vs APAUS Solar Lighting (US\$)
(270 ou = US\$1)

	APAUS		ADER	
	20 watt	50 watt	20 watt	50 watt
End User Initial Cost	US\$60.00	US\$67.00	US\$30.00	US\$48.00
End User Monthly Cost	US\$6.00	US\$7.40	US\$4.40	US\$7.80
Total months in Plan	60	60	24	24
End User Total Cost	US\$420.00	US\$511.00	US\$135.60	US\$235.20
Government Subsidy	40%	40%	70%	70%
Total Cost	US\$700.00	US\$851.67	US\$452.00	US\$784.00

2.25. Setting the cost issue aside for the moment based on the presumption that a more aggressive APAUS negotiation and contracting process would have resulted in costs comparable to ADER's, it is useful to compare the two approaches. The current ADER approach has advantages as well as drawbacks compared to the APAUS approach:

- The ADER agent is typically a community leader who can more easily resolve issues.
- The ADER approach provides employment to local people.
- ADER end users own their equipment in only two years; ownership is very important to the villagers.
- The ADER approach requires multiple responsible people in the chain of custody of complaints, maintenance, money collection and customer care. There are many opportunities for errors and omissions.
- The ADER approach does not make use of a private operator. Increased involvement of private enterprise is a goal of the Mauritanian government in many public service sectors, although it is recognized that rural electrification needs the power of strong government involvement for some time.

2.26. In consideration of the importance of these advantages as well as the realities of the current situation, it is recommended that the current ADER management model be retained for implementation of the new PV-based systems for the intended productive end-uses; e.g. pumping, and refrigeration recommended in this project (recognizing however that subsidy levels, monthly payments, and ownership time periods may need adjustment). With the current situation, a workable infrastructure and existing ADER-served customers are already in place in many of the locations in which the intended PV-systems will be deployed. Participatory field surveys carried out during the PDF-B phase suggests that, at this point, it would be confusing and perhaps divisive for new customers to be managed differently than those in the previous

program despite the innovative focus on productive end-uses for which ADER will also have much learning to do.

2.27. To bring to bear lessons learned from past GEF experiences and focusing on private sector led delivery mechanisms with the highest chances of success, the feasibility phase has established that ADER should make the following key improvements: (i) Process streamlining to improve ADER responsiveness to issues such as customer equipment problems and field agent collection and logistics problems; (ii) communication with isolated field personnel, for example providing them with radios to communicate with ADER collection agents; and (iii) training for end users in the care of equipment and proper means of battery maintenance and disposal. Hence, the activities proposed for implementation in the full project are in line with the recommendations of the September 2000 GEF Marrakech workshop “Making a difference in emerging PV Markets: Strategies to promote PV energy generation”, especially with regard to PV service businesses, financing, standardized quality products, creative partnerships, etc. and takes into account the lessons learned by UNDP-GEF, as discussed in its May 2004 publication entitled “Solar Photovoltaics in Africa: Experiences with Financing and Delivery Models”.

2.28. Specific lessons can be drawn from GEF Projects outside Mauritania. The Tanzania “Transformation of the Rural PV market deals mainly with SHS, provisions of subsidies and hardly any productive end-use activities which drive the current Mauritania PV systems deployment in ADRAR and Inchiri regions. Nevertheless, ADER could learn from the models used to provide PV services to rural areas and improve the quality of service in Tanzania, particularly as ADER will be bound to gradually increase private sector participation its solar PV activities in the country. While grants are provided to innovative business ideas for productive end-uses in the Tanzania case, the main challenge of this productive end-use application project in the Mauritanian case is to ascertain that government will afford the current level of initial subsidy to the community-based productive end-use equipment or that other line Ministries – outside the confine of the electricity sector – are prepared to contribute to the initial acquisition of the productive end-use equipment. Engaging the relevant Ministries (Agriculture, Rural Development, Environment and Planning etc...) in such a debate during project preparation and before GEF Council approval would be premature because it is the demonstration effect that will illustrate the merits of the approach to begin with. In this sense, the partnership with the African Development Bank (AfDB) and the active involvement of the Minister of Finance and Economic Affairs is quite useful. Perhaps, it is also an indication of the government’s seriousness about mainstreaming the approach if proven successful.

2.29. The Uganda PV Pilot Project for Rural Electrification is reported to have effectively established a functioning financing mechanism for vendors and users of PV systems, built technical capacity in the public and private sector and deployed PV systems through competitive bidding. Therefore, it provides some credence to the merits of private sector implication and the need to depart from old outright public sector financing and subsidies to PV systems for household use. To the extend that this Mauritania project will solely focus on the identified Productive PV-based end-uses in the selected regions as a first national experience in the very least, using the project to strengthen ADER’s own institutional and operational capacity is a sensible and a realistic option. In the above Ugandan case, total value of private investments in the tune of some US\$2,600,000 suggests that the African private sector which is interested in the PV business can – indeed – venture its own resources under the right set of initial conditions with concrete market incentives. Given the prior experience of ADER and APAUS in the SHS

business line and the presumption that ADER and/APAUS are well placed to continue to do what they have been doing all along, GEF resources will target selected activities which are incremental in nature and for which it is clear that a strong enough foundation is being laid out towards private sector involvement. This is the case in the Management model for the hybrid component which is fully outsourced to the private sector. As suggested by the above Ugandan experience, the seasonality of incomes of the rural customer means that flexible repayment terms with lower rates and longer maturities can elicit the market further. In Mauritania, the current emphasis on community-based enterprises together with the progress recorded in the country's administrative decentralization process suggest that a formal arrangement among the rural communities, ADER and the interested financing institutions could be fruitfully developed if the multi-sectoral nature of the Project and the interest of the Planning Ministries is sustained overtime.

1. The activities proposed are consistent with the recommendations of the September 2000 GEF Marrakech workshop "Making a difference in emerging PV Markets: Strategies to promote PV energy generation", especially with regard to PV service businesses, financing, standardized quality products, creative partnerships, etc., and take into account the lessons learned by UNDP-GEF, as discussed in its May 2004 publication entitled "Solar Photovoltaics in Africa: Experiences with Financing and Delivery Models". The project design also has drawn lessons from UNDP/GEF projects including the Tanzania Transformation of the Rural PV Market project that deals mainly with SHS, in particular regarding the models used to provide PV services to rural areas and improve the quality of service. The Uganda PV Pilot Project for Rural Electrification also has provided several lessons including that the seasonality of incomes of the rural customer requires correspondingly flexible repayment terms with lower rates and longer maturities.

Review of Concession examples in Senegal, Mali and South Africa and Lessons Learned for the Mauritania UNDP-GEF Project:

Senegal: With only 5% rural electricity access rate in 2000, Senegal intends to reach 30% rural access by 2015. To that end, the country was divided into 18 rural concession zones/areas. While the government and donors typically contribute up to 80% subsidy on the investment capital, private firms are expected to contribute a minimum of 20% in owners equity investment. Each concession is a 25 year contract targeting an estimated 5,000 to 10,000 customer base. Key features are that : (i) tariffs are allowed to vary from one concession area to another; (ii) fee-for-service arrangement is adopted; and (iii) the subsidy arrangements are technologically neutral and principally seek to elicit further competition and to create transparency in the sector. As a critical objective is to strengthen the link with the country's PRSP, various end-uses are also targeted including water pumping, fish conservation, low head irrigation for agriculture, shops and commercial businesses, together with community-based applications such as lighting for schools and health centers. Total project financing secured is as follows: World Bank 29.9 US\$ millions; AfDB: 14 US\$ millions; Islaic Development Bank: 9.5 US\$ million.

Mali Project: The privatization of the utility in Mali, EDM SA, has involved a commitment to investment (US\$70 million in electivity services in the first 3 years). Although the company has managed to mobilize a part of its investment obligation, investments targeted at increasing electrification rates have not materialized. When the company has been unable to mobilize all the investment resources required, World Bank reports suggest that EDM SA did clearly

prioritize other needs, including dividend payment, over access rate increase. Through the Household and Universal Rural Access Project (HEURA), a US\$ 53 million program spanning over 5 years and funded by the government of Mali, GEF and IDA (International Development Association) and support from UNDP., the following targets have been set:

- Provision of 40,000 new off-grid electricity connections in the rural and peri-urban areas;
- Provision of electricity services to 135 schools and 100 health centers
- Installation of 500 solar PV systems for community use;
- Installation of 10,000 individual solar home systems

In 2000, the government and its development partners also sponsored a connection fee promotion. The promotion involved requiring users to pay 50% of the connection fee upfront, with the remaining half paid off over the subsequent five to eight months (instead of the traditional EDM, SA scheme, which required new customers to pay 100 % of the fee upfront). In addition to EDM, SA, 2 Private firms are active: SSD (Société de Service Décentralisé) Koutiala and SSD Kayes. These 2 started operation in 2000 and are now working in 22 localities, providing off-grid electricity generated from Diesel and solar PV. They operate on a fee-for-service model, with their smallest systems consisting of a 25 Watt photovoltaic (Wp) solar panel and regulator with 2 lamps and about 5 hours of operation per day for a fee of US\$7.30 per month.

South Africa: Expanding access has been a dominant feature in the policy debate. The government has set national electrification targets and initially the state-owned utility Eskom cross-subsidized the national electrification program with earnings from industry and wealthier households. Since Eskom was corporatized and started paying taxes, the government has funded the capital costs of new connections and the first 50 kilowatt hours (kwh) per month for poor households. The South African government subsidizes both capital connection costs and 50 KWh a month for small consumers. As a result of these hands-on policies, the percentage of the population with access to electricity increased from a third of the population in the early 1990s to about 70 percent today; as many people were connected in 7 years as in the previous 100 years.

Emerging Lessons from private concessions in the off-grid rural electrification market:

A critical policy decision: A common feature of the above experiences is the implementation of a policy to attract new private entrants into rural electrification by providing rural electrification capital subsidies as an incentive **for off-grid supply**. A recent ESMAP report (Power Sector Reform in Africa: Assessing Impact on the Poor People, August 2005) noted that, to date, it is difficult to judge whether these policies are proving successful in attracting investment.

Delivery model: Fee-for-service arrangements for off-grid systems are gradually becoming the dominant delivery scheme into different countries, including Senegal, Mali and South Africa. It is too early to assess their suitability, but so far the World Bank and ESMAP reviews suggest that the record looks promising.

Increasing connection and access rate: A traditional barrier to expanded access has been the requirement by many rural ESCOs/Utilities to pay the connection fees upfront. Utility schemes that provide capital subsidies or financing and repayment via monthly accounts can greatly increase electrification rates. The South African off-grid rural concessions have yet to deliver

the anticipated number of connections. A major issue being the reluctance of governments to depart from the National uniform tariff policy by category of customers and to differentiate tariffs for off-grid supply. Off-grid tariffs, even when supported by government subsidies, can rarely be commercially sustainable if aligned with grid-based tariffs. In all 3 countries above, access to electricity, defined as the number of effective connections, has more than doubled over the past decade.

Performance standards and inter-fuel substitution: Quality and reliability of supply (outages and voltage dips) vary significantly across concession zones but in the rural areas, customers are voiceless about it and seem not to switch to other fuels because these have little effect on cooking patterns in poor households because they tend not to use electricity for cooking in the first place. Despite improvements in the standard of the electricity service in Mali, limited fuels switching has been recorded.

Potential for productive end-use increase: In Mali, off-grid electricity access has created opportunities for new businesses in ice making, soft drink and ice cream sales, battery charging, welding, and bread making. Off-grid solar projects have assisted the development of retail shops, taverns, hairdressing salons, truck parks, and market points where solar street lighting has been installed. Similarly, in South Africa, welding, sewing, telecommunication and retail activities are reported to be directly emerging in rural areas as a result of the rural electrification projects.

Project goal, objective, outcomes and outputs/activities

2.30. The Goal of the Project is to reduce Mauritania's energy-related CO2 emissions by substituting wind and solar power for fossil fuel (kerosene and diesel) to provide basic productive electricity services to rural populations and community users. The specific objective is to improve people's livelihoods by promoting the utilization of renewable energy (wind/solar) to provide basic electricity services to the rural areas in Mauritania, thus reducing the countries' dependency fossil fuels (kerosene/diesel).

2.31. The project consists of three components. Each of these components includes a number of specific outputs and a series of activities planned to achieve them. By implementing these two components, the project will contribute towards the achievement of the objectives stated above. The project's three components are:

- i. **Deployment of solar kits in the Adrar and Inchiri regions for productive end-uses and community-based applications:** Support the installation of PV-based power systems intended to pump water for cultivation in oases; solar refrigeration Systems for food storage; and Solar Community Systems for schools, health centers together with youth/community centers. This component will specifically focus on: a) Potable water pumping; b) refrigeration for ice and livestock/meat conservation; c) water pumping for low head agriculture; d) running/RE power to supply local industries; e) refrigeration to preserve milk and further develop income generating activities from livestock farming; f) refrigeration for agriculture produce preservation; together with g) refrigeration for food trading and ice production. In addition, this component will also include targeted technical assistance and capacity building activities to support the Executing Agency and

- the relevant local actors in all relevant barrier removal activities which are not core activities of ADER in the first place.
- ii. **Deployment of hybrid (wind-diesel) mini-grid systems in coastal villages** serving 380 households, based on modular 30 kW wind turbines and backed up with diesel generators to provide productive end use electricity and targeted community-based applications. This includes necessary technical assistance – in connection with the envisaged productive end-uses -- to strengthen the operational and management capacities of the ADER and other key sectoral actors including the private sector firms selected for project implementation together with community-based organizations. This component will focus on: a) Potable water pumping and desalination; b) refrigeration/ice production for fish conservation; c) refrigeration for livestock/meat conservation; d) water pumping for low head agriculture; e) running/RE power to supply local industries; e) refrigeration to preserve milk and further develop income generating activities from livestock farming; together with f) refrigeration for agriculture produce preservation.
 - iii. **Project Management and Implementation Support.** This component will focus on the following key management activities: (i) Project planning, budgeting and budgetary control; including regular disbursements activities in accordance with established UNDP procedures and accounting/financial reporting; (ii) M&E system and RE Project tracking data-base; (iii) construction of a RE training center and launching of the targeted training program; and, (iv) the national coordination activities required to integrate RE issues in Rural Electrification Plans.

Component 1: Deployment of Solar Kits in Adrar and Inchiri Regions for Productive End-Uses and Community-based Applications

2.32. The purpose of this component is to remove barriers to the provision of productive electricity to remote desert villages. The project will provide solar kits for productive end-uses such as water-pumping and refrigeration, and community uses (schools and health centers). The management structure for the program will build on the successes and lessons of the existing ADER program along with the lessons from other PV-based systems in Africa. The project will develop new financial mechanisms for delivery of the intended productive end-use solar kits and provide technical assistance to promote community-level dedicated application/productive end-uses.

Technical Specification and System Cost Proposal for Adrar & Inchiri Regions (Solar PV)

2.33. The project will provide 3 standard solar technology products for different productive end-uses:

1. **Solar Water Pumping Systems (SPS)** for cultivation in oases: replacement of small gasoline/diesel pumps by solar pumps (500 Wp to 900 Wp) appropriately sized to reach shallow groundwater resources (1-30 m in depth);
2. **Solar Refrigeration Systems (SRS)** for food storage: 2,200 Wp with diesel backup generator set (to avoid over sizing) and one 1 m³ of chilling room.
3. **Solar Community Systems (SCS)** for public/community uses: 300 Wp for schools, health centers, and youth/community centers;

Solar Water Pumping Systems (SPS 500 – 700 - 900)

2.34. Mauritania already has a prior solar pumping experience, in particular with the Regional Solar Programme (61 pumps in RSP I) and the “Eau de l’Espoir” project (37 pumps), but all of the above projects have focused in the south and eastern part of the country before the creation of ADER. Adrar has a huge potential for small size solar pumping for irrigation. Typical plots of land cultivated by individuals, families or cooperatives are small and groundwater level is often lower than 30m in Adrar.

2.35. For the proposed demonstration project in the ADRA and Inchiri regions, 3 water pumping technology for 3 common total heads (HMT) will be promoted. Therefore, three ranges of solar generator power are proposed: SPS 500 for 10 m; SPS 700 for 20 m; SPS 900 for 30 m. Daily water flow (Q) will range from 30 m³ to 20 m³. Of course, larger systems are also feasible and can meet higher needs (ie. higher hydraulic energy $E_h = HMT \times Q$), but the most needed are small pumps, and it is appropriate to start with reasonable sizes for a demonstration project.

Typology	HMT (m)	Q (m ³ /d)	E _h (m ⁴ /d)	P (Wp)
SPS 500	10	30	300	400-600
SPS 700	20	25	500	600-800
SPS 900	30	20	600	800-1000

2.36. Usually, sizing of the solar pumps takes into account the volume required (m³/day), the total manometric head (m³) and the daily average solar irradiation to calculate the solar power required (Wp). In this case, the sizing has been simplified since the study leads to three standard systems chosen to fit local demand in the oasis assuming a daily irradiation of 6 kWh/m²/day. Each pumping station will include the following parts:

- Immersed water pump.
- Open-air storage tank (30-50 m³) locally made in concrete at the floor level are acceptable for this project although they present a large area for evaporation. If the tank is closed, PV modules can be fixed on top of them.
- Protective devices against theft will include modules and electronics branding, elevation of PV modules (on top of water tank), anti-theft devices (breakable bolts), and welded frames.
- Hybrid pumping systems will also be considered to overcome the frequent problem of non availability of water due to a lack of solar radiation or an unusual need for more water. Diesel genset will not be provided but a switching box should be included to allow the operator to use or rent a spare genset.
- Another concern is the high evaporation rate due to open air irrigation channels and tanks; water saving actions like cheap flexible tubes from the tank to the plot of land, and “drip or micro irrigation” systems should be promoted and included in the project.
- Special attention should also be given to the water quality as the immersed pumps are much more vulnerable than the surface pumps. Additional well casing or housing with gravel will retain sand.

2.37. To assure quality and sustainability of the complete system, all components (electro pump, inverter, solar module, cables and accessories) will have to be tested mechanically, electrically and environmentally by internationally approved testing laboratory. A detailed study will be needed in each selected location to accurately size the solar pump as a function of the borehole characteristics: hydraulic characteristics of the borehole/well, seasonal variations in water level, measurement of several water source parameters, assessment of water availability,

drawdown or drop in water level after pumping, daily water needs, monthly irradiation, min./max. temperatures, etc.

2.38. To promote community use of solar technology with a view toward encouraging productive uses of electricity, the project will principally fund productive end-use community applications such as water pumping, refrigeration for food (especially meat and vegetables in the Adrar region) and public lighting. (see Table 3).

Solar Refrigeration Systems (SRS)

2.39. Evaluation reports and local interviews all point to the need for refrigeration in rural areas to reduce the food wasting due to the hot desert climate. It would be appropriate, if economically feasible, to demonstrate the feasibility of solar refrigeration for 2 different applications, both with backup diesel genset to avoid over sizing of the battery and the module array. (Note: After economic analysis, See Section 4, it was determined that the 20 m³ cold store unit needs further study before a demonstration is undertaken. This study recommends demonstration of only the 1 m³ chest freezer at this time).

- A **chest freezer** of about 1 m³ at -20°C will allow the storage for 6-8 months of 100-150 kg of fresh meat at village level. Assuming a daily load of 50 kg of meat at 30°C, an ambient temperature of 40°C, the electrical power for the compressor, evaporator, fans would be about 600 W, run for max. 14 hours and consume 8400 kWh/day. Considering an irradiation on the module plane of 6 kWh/m²/day and a global efficiency of 70%, the total power needed is around 2,2 kWp of solar modules. With a small diesel/gasoline genset of 1 or 2 kW (but running for 12 to 14h), the minimum battery capacity would be 300 Ah in 48V (= 14,25 kWh), corresponding to one day autonomy.
- The volume needed for vegetable storage in a village is much larger but, as there is no experience with large solar refrigeration in Mauritania, it is suggested to demonstrate a medium size **cold store** of about 20 m³. In such volume, about 1 ton of vegetables can be preserved at 4°C, at a farming cooperative level. Assuming a daily load of 250 kg of vegetables at 30°C, an ambient temperature of 40°C, the electrical power for the compressor, evaporator, fans would be about 1350 W, would run for max. 14 hours and would consume 18,800 kWh/day. Considering an irradiation on the module plane of 6 kWh/m²/day and a global efficiency of 70%, the total power needed to keep the 4°C in the room is around 5 kWp of solar modules. With a small diesel/gasoline genset of 2 kW (but running for 12 to 14h), the minimum battery capacity would be 675 Ah in 48V (= 32,5 kWh), corresponding to one day autonomy. Larger diesel genset will have the advantage to charge the battery faster.

For both systems, special attention should be given to the thermal design of the building to lower as much as possible the room temperature during day time and the thermal losses of the system.

2.40. In addition to the small common solar lighting systems (20 and 50 Wp) that can be used for both domestic and any public infrastructures, a 300Wp solar system should be offered that would supply enough energy for one of the following applications : (i) Medical Unit: refrigeration for vaccines in health centre with lighting and CB radio; (ii) Community Unit (including schools): television and telecommunications set for the public center including a large TV(>19"), DVD/video player, parabolic dish, receiver, CB radio or satellite telephony unit, desktop computer with printer and internet connection; all appliances in 220V AC through an inverter.

Table 3: Proposed Number of Solar Kits To be Financed by Project

Solar Kit Type	Number of Villages	Number of Kits	Cost per Unit*	Total Cost
300 W Solar Community Systems (SCS)	50	100	US\$9,500	US\$950,000
500-900 W Solar Water Pumping Systems (SPS)	28	84	US\$9,210	US\$773,640
2,200 W Solar Refrigeration Systems (SRS)	16	16	US\$39,250	US\$628,000
Total	94	200		US\$2,351,640

* Note cost per unit includes on-going maintenance

Output 1.1 – RFP preparation for equipment supply, installation and maintenance

2.41. ADER launches and manages RFP for private sector supply, installation, and maintenance. Bid specifications must be very explicit as to duties and responsibilities, and the recruitment process must be transparent and well run. The bidding process should be broken into two or more lots (possibly by geography) to allow more firms to participate, promote market competition, and strengthen more local private sector capacity. Contracts should be signed with both foreign suppliers and local installation and maintenance firms that include significant and enforceable financial penalties for non-performance.

Activities:

- Setup RFP and draft bid specifications for equipment supply, installation and maintenance
- Public launch of RFP and international competitive bidding
- Evaluate bids and select lot winners
- Draft and negotiate contracts
- Provide technical assistance to support the preparation and launch of the RFP.

Output 1.2 – Supply and installation of solar kits (Turnkey procurement and installation/construction)

2.42. Selected private firms will supply and install solar kits systems as per the contracts. ADER will oversee successful execution of these contracts by inspecting equipment quality, ensuring timely installation, and overseeing establishment of maintenance mechanisms.

Activities:

- Supply and installation of solar kits by firms
- ADER oversight of contract fulfillment
- Establishment of private sector field capacity for fulfillment of maintenance contracts.

Output 1.3 – Promotion of productive end-uses for community-based solar applications

2.43. Investigations conducted during the preparatory assistance phase established that adequate pilot testing of household solar kits (20 W and 50 W) has already been achieved through the existing ADER program. The proposed project will focus on pilot testing and promoting productive end uses such as solar pumping and refrigeration systems, as well as the prepayment technology proposed for the 300 Wp community systems.

2.44. A demonstration project will be initiated to promote water pumping technology for 3 common total heads. A detailed study will be conducted in each of four selected locations to accurately size the solar pump as a function of the borehole characteristics: (i) hydraulic characteristics of the borehole/well, seasonal variations in water level; (ii) measurement of several water source parameters; (iii) assessment of water availability, drawdown or drop in water level after pumping and (iv) daily water needs, monthly irradiation, minimum/maximum temperatures, etc.

2.45. To demonstrate the feasibility of solar cooling, the proposed project will pilot installation of a 1 m³ chest cooler at -20°C that will allow the storage of 100-150 kg of fresh meat at village level for 6-8 months. Special monitoring and evaluation activities will be established to learn rapid lessons on the pilot efforts to be fed back into ongoing project implementation.

2.46. The deployment of solar PV systems for community applications (water pumping, food preservation, public lighting, education, health, etc.) creates a need to provide capacity building assistance to the local community organizations and/or administrative structures that will be responsible for owning and managing this infrastructure. NGOs and/or Community-Based Organizations will be solicited to provide assistance to local communities in organizing the proposed services.

Activities:

- Detailed study of potential pumping sites
- Detailed design for solar refrigeration (technical, management, and financial aspects)
- Evaluate success of prepayment systems for communal uses and modify as necessary
- Special monitoring activities to learn lessons and feed into ongoing project implementation.
- Technical assistance to piloting of productive solar technologies.
- Capacity building for local community organizations and/or administrative structures in organizing the targeted community services.

Output 1.4 – Technical assistance, capacity building and institutional strengthening for the ADER in supporting PV-based productive end-uses

2.47. Prior to this project, ADER had never been closely associated with PV-based productive end-use applications on a large-scale despite its relatively good record with Solar Home Systems (SHS) for most social applications at the household/residential level. The shift from a household paradigm to a resolute productive end-use scheme intended to characterize the RE business-line at ADER requires sizable internal adjustments and an institutional re-alignment in addition to the specific technical expertise needed to implement the RE solutions retained. Because of a need to assess almost all productive end-use applications of RE in a framework of least cost energy planning for each specific dedicated end-uses/each specific rural environment circumstance and the dilemmas/trade-offs involved, significant training and TA will be required for ADER. ADER is a “Rural Electrification Agency” with a legally binding institutional mandate to promote rural electrification rather than renewable energy solutions and the nuance is important. For example, the north coast region has one of the best wind resources of any populated region in the world. At the scale of these villages in the ADAR region, wind generated electricity can be produced for a fraction of the cost of the solar PV-based solutions retained for this project.

Wind-PV hybrids sometimes make sense for very small systems and/or where the solar resource is well matched to the load and/or the wind resource. More specifically, solar becomes really economic if the principal loads are in the middle of the day when the insolation is greatest, or when the solar resource complements the wind resource on seasonal basis (windy in winter, sunny in summer). In the Mauritanian villages, neither is the case. The village loads peak during the early evening hours (as does the wind typically) and the windy season is the summer. Substituting PV panels for some of the wind turbine capacity would do little except increase the system capital cost. Such trade-off analysis to really lay out a solid operational and institutional foundation for the intended PV-based productive end-use services appear to be beyond the current technical capacity of ADER and this project has set out to fill the gaps identified.

2.48. During the preparatory assistance phase, a detailed organizational assessment of ADER was conducted and a proposal was developed for the longer-term re-alignment of ADER's mandate with a pro-active renewable institutional and operational culture. This proposed restructuring would include the creation of two new departments dedicated to the RE business and a clarification of responsibilities to ensure the separation of project development and exploitation functions along with the separate management of investment and exploitation budgets. ADER plans to take a gradual approach.

2.49. The proposed project will support this organizational strengthening by financing the acquisition of certain essential equipment, the training of key ADER staff and providing ongoing operational support (see Annex I). Training will be required for the following new functions being proposed at ADER: (i) legal/contract management, (ii) RE project management (including project databases), and (iii) RE network operations (as a technical management function to oversee RE private operators).

Activities:

- Provide essential vehicles for ADER RE operational functions
- Provide electrical measurement equipment (counters, voltmeters, wind measurement equipment, GPS systems, etc.) intended to facilitate the supervision/technical backstopping of ADER's RE project portfolio
- Provide portable computers and software for RE project backstopping
- Training of essential ADER staff in RE contract management, project management and RE network operations
- Provide RE operational support to ADER's organizational restructuring
- International exchanges with neighboring countries (Morocco, Mali, etc.) given that CDER (Renewable Energy Development Center) in Morocco has offered to assist with the skills upgrade of ADER.

Output 1.5 – Knowledge transfer and capacity building for the private sector in PV-based systems

2.50. Conduct a detailed evaluation of the existing capacities of energy service companies working on, and interested in working on, PV-based energy projects. Establish a database using questionnaire data. Conduct detailed needs assessment on these firms' needs for training and capacity building related to PV-based systems.

2.51. Develop a variety of learning activities (on-the-job training, short and long courses, workshops and seminars) related to PV-based systems for various target groups on financing for small-scale renewable energy systems; the correct sizing, installation, operation, repair and maintenance. The courses will cover all technologies promoted through this project including PV systems, wind-diesel mini-grids and other relevant topics tailored to the needs of the following groups: NGOs, micro-finance institutions (MFI); banking staff; technicians and sales people; engineers; and vendors. Work with technical training institutes (ADER, SOMELEC, SNIM, national universities) to develop an appropriate curriculum for the training of PV technicians, including training in standards, international best practice, and codes of practice/conduct.

2.52. Provide business planning and development services through one-on-one meetings with business to develop business plans, marketing plans, and promotional opportunities, making reference, as appropriate, to the resources and opportunities available for support. Assist local RE wholesalers and importers to develop stronger linkages with international companies. Carry out training on RE business "best" practice, including service warranties and maintenance contracting.

2.53. Work with local private companies and professionals to explore the idea of establishing a business association for renewable energy sector professionals. Such an association could lead to greater sharing of information and knowledge, establishment of professional standards, transfer of capacities, and the establishment of new partnerships and joint-ventures.

Activities:

- Identify requirements for training, technical support and technology transfer, and develop national training and certification program (in collaboration with the engineering departments of Mauritanian universities)
- Organize workshops, roundtables and sensitization/mobilization programs to reach out to private stakeholders (equipment suppliers, maintenance companies, operators, engineering firms, etc.)
- Develop and execute a plan to provide technical training and technology transfer to private sector companies
- Create a support center for operators
- Establish a trade association for RE sector professionals.

Component 2: Deployment of Hybrid (Wind-Diesel) Mini-Grid Systems in Coastal Villages

2.54. The immediate objectives of this component are to remove barriers to the provision of decentralized electricity service to coastal villages. The project will provide for the construction of hybrid (wind-diesel) generation facilities and low-voltage village mini-grids that will both provide household electricity and be used to power communal ice-making and water desalination activities.

Technical Specification and System Cost Proposal for Coastal Area (Hybrid Wind-Diesel Systems)

2.55. The proposed project will reduce barriers related to the supply and installation of hybrid (wind-diesel) mini-grids in villages of the north coast. The systems will be modular and

expandable to allow for significant load growth. Components will be standardized to facilitate procurement and maintenance and the systems will be designed for robustness to withstand the harsh operating conditions of the area. The modular system design will be based on 30 kW wind turbines and backed up with diesel generators. See Annex V for a detailed system architecture. Electricity will be generated between 12-24 hours per day, depending on the needs of the specific village.

2.56. Given indicative levels of funding from the Government of Mauritania and the AfDB, deployment of hybrid wind-diesel system is proposed in 7 villages at a total capital cost of US\$5.6 million (see Table 4). A financial summary of the proposal is presented in Annex VIII (including, for illustration purposes, the cost for electrifying all 12 North Coast villages should the government eventually secure other sources of funding).

Table 4: Estimated Capital Cost to Electrify 7 Villages

System Components	Number or Unit Cost
Number of households	380
Number of 30 kW wind turbines	19
Power system cost	US\$ 4,176,000
Desalination equipment cost	US\$ 420,000
Ice making equipment cost	US\$ 520,000
Distribution grid, end-user connections and miscellaneous costs	US\$512,000
Total capital cost	US\$ 5,628,000

Output 2.1 – RFP preparation and contract negotiations for construction phase

2.57. ADER will launch and manage an RFP for private sector supply and installation of hybrid mini-grids. Bid specifications must be very explicit as to duties and responsibilities, and the recruitment process must be transparent and well run. See Annex VI for sample bid specifications.

Activities:

- Setup RFP and draft bid specifications (for supply and installation of equipment together with all required consulting services). Specify selection criteria for private firms.
- Bids submitted should include detailed feasibility studies which finalize proposed design of proposed mini-grid system for each site based on the basic architecture developed during preparatory phase (see Annex V). To the extent possible, operational support and training will be bundled with the supplier contracts to ensure successful project implementation.
- Evaluate bids and select winners
- Draft and negotiate contracts (significant and enforceable financial penalties for non-performance)
- ADER would establish performance incentives and a bonus structure based, for instance, on number of new connections or availability of spare parts.

- Oversee contract fulfillment and financial management
- Provide technical support to RFP process.

Output 2.2 – Supply and Installation of Hybrid Mini-Grids

2.58. Selected private firms will supply and install 7 hybrid mini-grids as per the contracts. ADER will oversee successful execution of these contracts by inspecting equipment quality and ensuring timely installation.

Activities:

- Site preparation
- Supply of wind turbine, diesel generator, and miscellaneous equipment
- Build-out of distribution grid and connections to pre-subscribed end-users
- Installation and commissioning of mini-grids
- Performance measurement and load-balancing
- ADER oversight of contract fulfillment.

Output 2.3 – RFP preparation and contract negotiations for operational/system management phase

2.59. ADER launches and manages RFP for private administration, operation and management of mini-grids. Bid specifications must be very explicit as to duties and responsibilities, and the recruitment process must be transparent and well run. See Annex VI for sample bid specifications.

Activities:

- Setup RFP and draft bid specifications for administration, operation and maintenance of hybrid mini-grids. Specify selection criteria for private firms.
- Bids will propose a contract structure to provide administration, operation and maintenance (AO&M) of the mini-grid. The contractor's goal is to encourage customer service, load growth and economic development, and the contract structure bid should encourage this result.
- Evaluate bids and select winners
- Draft and negotiate contracts (significant and enforceable financial penalties for non-performance)
- ADER would establish performance incentives and a bonus structure based, for instance, on number of new connections or availability of spare parts.
- Oversee contract fulfillment and financial management.

Output 2.4 – Technical assistance to ADER and operators for hybrid component

2.60. A wind-diesel hybrid system is considerably more complex than a simple diesel generating plant, and it requires significantly more operational and technical support. Because of the additional complexity, the system should deliver significant fuel savings over a diesel-only system. In other words, a high percentage of the village load should be met with renewable energy. Based on the capacity assessment of ADER carried out during PDF-B, it was agreed that

the system designers should target a minimum of 80% fuel savings over a diesel-only system, even if such a system does not yield the lowest cost energy. This will make a substantial contribution toward the environmental goals of the project by increasing the chances of achieving the intended high renewable fraction set forth. Hence, the proposed TA is incremental.

2.61. It is recommended that the equipment supplier provide a full-time field engineer to be assigned to ADER to assist ADER and the private operator(s) for the first year (possibly first 18 months) of the project. This would facilitate technology transfer, provide technical assistance for the inevitable unforeseen problems, and ensure project success and sustainability. Additional technical training should also be provided to ADER to help support its mission, including: (i) providing technical assistance to the private operators, (ii) performing heavy maintenance and also emergency repairs when the private operator is unable to deliver, and (iii) managing a stock of spares.

Training Activities:

- Training activities for the ADER:
 - System design and specification
 - System engineering and optimization (especially wind component and wind-diesel coupling)
 - Heavy maintenance and emergency repairs on mini-grids
 - Prepayment meter operation
 - Recycling of batteries
- Training activities for the hybrid mini-grid operator(s):
 - On-going regular maintenance
 - Spare parts management
 - Wind/diesel load balancing
 - Capacity/demand management
 - Network growth/customer additions.

Output 2.5 – Promotion of Hybrid-based Productive End-Uses for Coastal Fishing Communities

2.62. A key objective of this component is to encourage productive end-uses for the electricity produced. This will include water desalination and ice-making facilities, as well as the development and intensification of income-generating activities. With ice-making facilities, fishermen should be able to increase the storage of their catches, improve transport to markets, and receive better prices. With widespread electricity, productive economic and social activities can begin to flourish. The project will establish local project development committees to help communities identify, establish and manage such productive uses. These committees may be part of existing cooperatives where they exist and function well. NGOs will be solicited to provide technical assistance to cooperatives and other community-based organizations in the field to ensure the successful development of value-added services.

Activities:

- Where existing desalination equipment exists, work with relevant organizations to ensure coordination and technical integration with mini-grid

- Setup and train local project development committees to establish and manage desalination and ice-making facilities
- Mobilize villagers, NGOs and CBOs to assess existing and potential economic activities, including microenterprises, commerce, farming, craftsmanship, etc., in association with the Ministry of Rural Development, Water Resources and the Environment.
- Provide training and assistance to villagers and community groups to stimulate the socio-economic development of villages.
- Using project development committees, establish services for helping people to develop new income-generating activities using electricity.

Output 2.6 Knowledge transfer and capacity building for the private sector in hybrid systems

2.63. Similar to Output 1.5, a detailed evaluation will be carried out to determine the existing capacities of energy service companies working on, and interested in working on, hybrid-based energy projects. A database will be established using the questionnaire data, and a detailed needs assessment on these firms' needs for training and capacity building will be conducted.

2.64. Develop a variety of learning activities (on-the-job training, short and long courses, workshops and seminars) related to hybrid systems will be developed for various target groups on financing for small-scale renewable energy systems; the correct sizing, installation, operation, repair and maintenance. The courses will cover all technologies promoted through this project including PV systems, wind-diesel mini-grids and other relevant topics tailored to the needs of the following groups: NGOs, micro-finance institutions (MFI); banking staff; technicians and sales people; engineers; and vendors. Work with technical training institutes (ADER, SOMELEC, SNIM, national universities) to develop an appropriate curriculum for the training of technicians, including training in standards, international best practice, and codes of practice/conduct (see also Output 1.5 for similar work related to PV-based systems).

2.65. Provide business planning and development services through one-on-one meetings with business to develop business plans, marketing plans, and promotional opportunities, making reference, as appropriate, to the resources and opportunities available for support. Assist local RE wholesalers and importers to develop stronger linkages with international companies. Carry out training on RE business "best" practice, including service warranties and maintenance contracting (see also Output 1.5 for similar work related to PV-based systems).

2.66. Work with local private companies and professionals to explore the idea of establishing a business association for renewable energy sector professionals. Such an association could lead to greater sharing of information and knowledge, establishment of professional standards, transfer of capacities, and the establishment of new partnerships and joint-ventures (see also Output 1.5 for similar work related to PV-based systems).

Activities:

- Identify requirements for training, technical support and technology transfer, and develop national training and certification program (in collaboration with the engineering departments of Mauritanian universities)

- Organize workshops, roundtables and sensitization/mobilization programs to reach out to private stakeholders (equipment suppliers, maintenance companies, operators, engineering firms, etc.)
- Develop and execute a plan to provide technical training and technology transfer to private sector companies
- Create a support center for operators
- Establish a trade association for RE sector professionals.

Component 3 – Project Management and Implementation Support

2.67. The main implementing agency for the project will be ADER. A Project Coordination/Management Unit (PCU/PMU) to be established within ADER will be responsible for day-to-day project execution, supervision and backstopping as needed. The structure of the financial management function within the PCU will be determined by the size and nature of the project's transactions. It is foreseen that unlike most other projects in Mauritania, most of the project funding will be towards a relatively small number of large transactions as the African Development Bank's funding for the investment components is expected to be executed by ADER although following separate AfDB rules of procurements. For daily management of the project's UNDP-GEF financial transactions and in order to ensure compliance with established UNDP/NEX-DEX financial management procedures, the PCU will have a Financial Manager recruited on a competitive basis. His specific duties will be documented in the project's Financial Management Manual and he will be supervised by the Project National Coordinator/Manager. This distinction from the usual ADER financial transactions will facilitate reporting and will ensure that the current financial department of ADER is not overwhelmed by the resources and tasks of the joint AfDB-UNDP/GEF project.

2.68. Over the 4 years of the project, operational support will be provided to ADER to assist with key project management functions. This technical assistance will focus on strengthening the ADER's ability to prepare RFP and bid specifications, evaluate bids, monitor performance quality, enforce contracts, ensure accountable financial management, and provide adequate reporting to GEF and other donors. The roles of the project management consultant were specified in the description of components 1 and 2 and justified on the basis of the relative complexity of the Project, the underlying weaknesses of ADER and the need to ensure that the experience will result in a full mainstreaming of the RE sector in Mauritania. Under the ADER's Executing Agency function, the following key management activities will take place: (i) Project planning, budgeting and budgetary control; including regular disbursements activities in accordance with established UNDP procedures and accounting/financial reporting; (ii) M&E system and RE Project tracking data-base; (iii) construction of a RE training center and launching of the targeted training program; together with (iv) the national coordination activities required to integrate RE issues in Rural Electrification Plans.

Output 3.1 - Overall Project Management Support (both PV & Hybrid systems)

2.69. Over the project duration, operational support will be provided to ADER to assist with key project management functions in connection with its RE project portfolio. This technical assistance will focus on strengthening the ADER's ability to prepare RFP and bid specifications, evaluate bids, monitor performance quality, enforce contracts, ensure accountable financial management, and provide adequate reporting to GEF and other donors. While the above skills

are sensibly required for all energy projects in general, the specific requirements and complexities in connection with RE projects justify some cost sharing with catalytic GEF resources. The support provided by the project management consultant will provide ADER with exposure to best practices, thereby assist ADER with building its capacity to fully assume these, or similar, roles at the project's end. The roles of the project management consultant are specified below.

Activities:

- Support to daily project management
- Act as liaison between the ADER and the project Steering Committee
- Clarify donor expectations to ADER staff and assist with quality control
- Assist with drafting of bid specifications, managing RFPs, evaluating bids and negotiating contracts
- Oversee procurement and financial management
- Conduct consultations with key stakeholders, including local authorities
- Implement monitoring and evaluation system and provide regular reporting

Output 3.2 - M&E system and RE Project tracking database (both PV & Hybrid systems)

2.70. The project will be monitored and evaluated according to standard UNDP rules for nationally executed projects. Annual reviews will be held and two independent external evaluations will be carried out – one at mid-term and another project completion. Additional indicators have been established to track impacts of particular interest to the GEF, including CO2 emissions reduction and increased PV market activity. See section 7 for details.

Activities:

- Setup project M&E system (establish processes, management structure, roles & responsibilities, issue escalation and decision-making approaches) per details in section 7.
- Implement monitoring and evaluation tools and templates (project plan, action register, etc.)
- Establish indicators and baseline data to monitor operator performance and network/service metrics
- Launch database for tracking project implementation and performance
- Monitor environmental impacts

Output 3.3 - Establishment and Operation of ADER's Renewable Energy Training Center.

2.71. To build local capacity to support renewable energy activities, ADER will establish and operate a Renewable Energy Training Center that will be fully supported by the government of Mauritania.

Activities:

- Establish training center development plan, including defining a clear mission statement, organization structure, budget, staffing needs and yearly goals for a center focused on training related to renewable energy.
- RFP for the development of an appropriate RE curriculum targeted at the continued on the job-training of ADER Project personal or the private sector as needed;

- Recruit and train staff for training center, making use of local and regional experts to the greatest extent possible;
- Establish a rotational training program for all targeted RE practitioners ;
- Operate the training center, and report on achievements on a yearly basis.

Output 3.4 - Integration of RE issues in Decentralized Rural Electrification Plans

2.72. There is presently no clear national strategy or policy which drives either the development of renewable energy beyond the simple promotion of rural electrification in Mauritania. The subcomponent is designed to assist the government of Mauritania in strengthening its institutional and policy framework to develop: (i) a rural electrification strategy based of the country's tremendous RE resources, and (ii) a clear policy on the role of renewable energy in supporting the country's rural electrification strategy in a context of integrated rural development.

Activities:

- Workshops with key institutional partners (ADER, ARM, Ministry of Oil and Energy, APAUS, etc.) and dissemination of project information to promote institutional coordination
- Develop a RE rural electrification policy and strategy for Mauritania
- Develop a policy on the role of renewable energy in support of the rural electrification strategy and rural development activities
- Develop an inventory or portfolio of potential bankable RE mini-grid projects around the country

Project indicators, risks and assumptions

2.73. The impact of the proposed initiative in terms of emission reductions is of immediate interest for GEF, as this is their main mandate. Associated impacts such as market developments for PV operations and increasing income generating activities are considered important as well as both contribute to the sustainability of the proposed initiative and hence the (continued) reduction of emissions of CO₂.

2.74. To properly and practically monitor these impacts it will be necessary that baselines be established prior to introducing and disseminating the PV based technologies. Further, it will be necessary to identify a number of (easily) measurable indicators that can be used for the monitoring of the impacts. The impact monitoring (see Table 5) should be done on an annual basis by the project implementation team and the data collected and analyzed should serve as a management tool for the team to steer and/or re-direct the project's implementation. It is proposed that the following indicators (including the indicated means of verification) be used:

Table 5: Proposed Indicators for Impact Monitoring

Impact to be monitored	Indicators to be used	Means of verification
CO ₂ emission reduction	- Liters of paraffin and diesel reduced - Number of operational PV systems	- End-user surveys - Dealer surveys
Increased PV market activities	-Number of PV business in combination with the turn over/profit of each business	- Market surveys - Dealer surveys
Increased income generating activities in the project target area	- Number of income generating activities emerged in combination with the turnover / profit of these activities / businesses - It is anticipated that in 2 years 1% and in 5 years 3% from the households supplied with PV systems will be involved in income generating activities	- End-user surveys

2.75. The following risks identified during the PDF-B phase require careful monitoring during the project execution process:

Institutional Risks

2.76. This project is being undertaken in the context of ongoing power sector restructuring. While much progress has been made, risks exist due to ambiguities in institutional responsibility and questions of institutional weaknesses. The absence of a clearly stated rural electrification policy can also result in a lack of coherence and synergies among the different initiatives sponsored by the government, ADER, other agencies, and multilateral/bilateral donors. These are being mitigated by the technical assistance offered with this project and the MOU between ADER and APAUS.

Financial Risks

2.77. Project beneficiaries have a limited ability to pay. There is a risk that users will not be able to afford the costs of mini-grid electricity or solar kits. In the solar kit component, these risks are minimized by increasing the lease period to 10 year concession to keep monthly payments at their current level. Final tariffs for the mini-grid component should be established with an awareness of users constrained ability to pay. For both the hybrid and solar PV components, the financial risks are being mitigated by allowing some cross-subsidy among small and large villages and by structuring the management contracts in ways that capture existing economies of scale at all levels of power plant management and maintenance. It is also being assumed that with the scope of economic activity along the coastal line once a hard surface/paved road is built between Nouakchott and Nouadhibou, the recommended upper tariff ranges will not force the government and the private contractors to tap the limited resources of the government rural electrification funds beyond what is already being committed through the forgoing of the initial investment costs on social/equity and development grounds. Actual field surveys of willingness to pay of customers suggest that it is realistic to expect full financial sustainability throughout project lifetime under the proposed set of initial GEF catalytic conditions.

Technical Risks

2.78. Successful implementation of the project requires an increase in the technical capacity of ADER staff and adequate capacity within the private sector. This risk is being addressed by the strong emphasis on capacity building, operational support, and establishment of a training center.

Limited market development

Market Risks - Due to the very young private sector in Mauritania, there is a risk that the private sector will not continue to participate in RE based rural electrification. The project seeks to address this risk by actively engaging the private sector, providing firms with training in technical and management issues, and recruiting the private sector to supply, operate, and maintain the proposed systems. An important aspect is the level of connections required for the viability of the hybrid component. To the extent that the government has full ownership of the project and is prepared to support it and other similar activities per the prescription of the World Bank and IMF back PRSP exercise in Mauritania, the risk in connection with the above can be classified as moderate. The quality of the concession contract will mitigate the above risk by specifying options to boost initial connection rates.

Maintenance

2.79. Selected installation/maintenance firms will establish field offices or local service agents in rural areas that are responsive to local maintenance needs. These firms will be encouraged to use local infrastructure wherever it exists (and strengthen it everywhere) during fulfillment of maintenance contracts. The maintenance contract period must match the length of the lease term (four years in the case of a Solar Home System). Rather than pay for the maintenance contract all at once at the beginning of the contract, ADER is considering paying the maintenance fee over the four-year period, to give itself more leverage in case of non-performance by the maintenance firm. The maintenance contract can shift to a fee-for-service model paid by the end-user at the end of the lease period, since the ADER will have transferred ownership of the equipment to the end-user at the end of the lease period.

Risk monitoring

2.80. In addition to the above listed activities to mitigate the identified risks, there will be permanent monitoring of risks and activities to mitigate these risks by the project management team. Instead of following a cast-in-stone project plan, the project management team will adhere to flexible programming to ensure that pitfalls in the program design, planning and implementation are immediately dealt with in the most appropriate manner.

Expected global, national and local benefits

2.81. GEF resources are being sought to cover selected incremental activities based of AfDB, government and UNDP-Mauritania base investment funding. The requested funding will also cover the cost of community involvement and sensitization to ensure project sustainability as was demonstrated by the ALIZE Programme from which critical lessons have been applied. The government, ADER, the local private sector and the beneficiary rural communities were brought together during the project preparation activities to apply the lessons from the previous GEF intervention at a larger scale and with measures and concrete activities to face the new challenges of increasing population pressure on the shoreline, encroachment of the international biosphere reserve of the ARGUIN park. Furthermore, the technical assistance envisaged for ADER during baseline project implementation will create and establish the local capacities to

deal with UNFCCC funding mechanisms including the CDM. If successful, the project will set an example for replicability in the other Sahelian countries in the region which have similar poor natural resources but abundant solar and wind potential. UNDP-Mauritania intends to use the project to illustrate its efforts towards achieving the MDGs and the government expects to showcase its long-term vision in establishing APAUS, a Universal Access Agency dedicated to rural poverty alleviation.

Country ownership: country eligibility and country drivenness

2.82. Mauritania ratified the UNFCCC on January 24, 1994.

2.83. By way of a government decree (No. 2001-065 of June 18th, 2001), the ADER was created as a commercial entity with a public mandate to promote, supervise and raise financing for rural electrification in the country. In establishing ADER as a private commercial venture, governed by commercial law rather than as an Office, the government's intention for ADER's managerial efficiency, cost recovery and financial/economic performance standards were clear. A long term perspective was therefore taken by the country with the creation of ADER and APAUS.

2.84. The project is fully supported by the government per the attached letter of the government GEF operational focal point together with the cash co-financing from government (over US\$2 million). The proposed activities are focused on integrated rural development, which is at the core of the Mauritanian current UNDAF. Hence the sizable support of all government agencies including the Minister of Energy during project preparation.

Sustainability

2.85. Sustainability is built-in by design through the technical, financial and ownership structuring adopted for all project components. An important safeguard is ADER's supervision role as an experienced entity which will have the required technical assistance and training to meet the project's objectives. The targeted levels of community involvement and private-public partnerships will further strengthen overall project sustainability. The hybrid power system supplier should place one of its own field engineers in Mauritania for the first two years of operation to ensure successful system operation and thorough training of project stakeholders (ADER, University of Nouakchott Renewable Energy Center, private company power system operator, etc.) The cost of such an in-country placement should be budgeted at around US\$250'000. Having a knowledgeable engineer in-country for an extended period of time will help ensure that early operation demonstrates the technical viability of the systems and builds confidence in the technology. Also the presence of this field engineer will help ensure that local training in operations and maintenance procedures occurs at more than a superficial level and is absorbed sufficiently to allow local entities to keep the systems operational over many years.

Sustainability of Hybrid systems

2.86. By bundling village electrification with seawater desalination and icemaking, which are also critical needs in the coastal villages, the economic viability of the hybrid power systems has been enhanced. Observations to be drawn from the financial modeling results summarized in Annex IX are:

- The smallest villages (20 households) would use one 30 kW wind turbine, while the medium (40 households), medium-large (60 households), and large (100 households) villages would use two, three, and five turbines respectively.
- The ice-making load is nearly twice that of all other loads combined. It is the deferrable nature of the ice-making load that allows the systems to achieve very high renewable fractions, helping to keep the cost of energy down.
- The installed cost of the wind turbines represents approximately half the total capital cost of the project.
- The levelized cost of energy drops rapidly with increasing village size. It is expensive to deliver 24/7 utility grade power to very small communities. (The cost would be even higher without the ice-making load.)
- All systems use substantial battery banks. However, use of a high quality battery should provide a battery lifetime of at least 10 years. (Achieving this battery lifetime, however, depends on the system not being continually expanded every few years. It is not desirable to mix batteries of different ages.)
- Full cost recovery would require an energy tariff of US\$0.46/kWh in the small villages and US\$0.20/kWh in the largest village. A uniform tariff of US\$0.29 in all villages would provide for full cost recovery, with the large and medium villages subsidizing the small ones.
- Recovery of only operating costs would require an energy tariff of US\$0.192/kWh in the small villages and US\$0.055/kWh in the largest village. A uniform tariff of US\$0.10 in all villages would provide for full operating cost recovery, with the large and medium villages subsidizing the small ones.
- The proposed systems yield very high (87-95%) renewable fractions and thus very high fuel savings. Diesel run time is limited to about 20% of the year in the small systems and only 11% of the year in the large systems).

2.87. Taking US\$0.29/kWh as the average cost of energy in the villages, using the assumed power consumption of the desalination and ice making processes, the energy cost equivalents for potable water³ and ice⁴ yield US\$0.83 (225 ouguiyas) per 200 liters water and US\$2.44 (658 ouguiyas) per 50 kg ice respectively. In both cases, these costs are well below what the villagers currently pay for these commodities delivered to the village. This sensibly suggests that even when factoring the capital and operating costs of the productive end-use equipment, potable water and ice produced locally will be less expensive (and most likely higher quality) than that imported from Nouakchott or elsewhere. These productive-end uses and the income generated will drive project sustainability for the hybrid systems. Moreover, If all twelve unelectrified villages on the North coast receive wind-diesel power systems, it is estimated that the average cost to supply electric energy will be approximately US\$0.30/kWh. At an estimated average household demand of about 53 kWh/month, this equates to a monthly expenditure of US\$16. This is not an insignificant expense for a rural Mauritanian household, but it appears to be within its means, especially considering that a family might pay US\$8-10 per month for candles alone.

³ Water cost of energy equivalent (US\$0.29/kWh) x (1.2 kW)/(2000 l/day) x (24 hr/day) = US\$0.83 (225 ouguiyas) per 200 liters water

⁴ Ice cost of energy equivalent (US\$0.29/kWh) x (7 kW)/(1000 kg/day) x (24 hr/day) = US\$2.44 (658 ouguiyas) per 50 kg ice

2.88. Ultimately, the success of the coastal wind/diesel program will depend on selection of the right ownership structure, existence of a solid corporate infrastructure and having the proper incentives built into the operation and regulation of the technical systems that are eventually provided. The technical assistance that accompanies the project will see to it that the following measures are taken:

- Clear lines of ownership, responsibility and profitability –
- Modular systems designed for high levels of reliability and redundancy (assume 50% failure rates on all components over 2-year periods).
- Maintenance of a large spare parts inventory and rapid responsiveness to equipment failures.
- Strict control over financial processes, operations and maintenance and particularly preventative maintenance.
- A pool of operating reserve funds that must be replenished.
- A pool of investment capital that is grown organically from general operating revenues.

Sustainability of Solar PV Systems

2.89. In the table shown in Annex X, total costs have been estimated for each of the Solar Systems recommended in this project. Margins have been included to allow the selection of high quality components that should guarantee a sustainable service far beyond the project duration. Those estimated costs include: (i) equipment supply costs (capital, transport and installation), (ii) O&M costs for alternative delivery models including a private service provider, a local operator or by ADER itself, and finally (iii) other costs linked with the project support, prior and after the implementation. These managerial and follow-up costs are based on the current experience of ADER.

- For Individual and Collective Systems (SIS and SCS), the project duration is 10 years corresponding to proposed concession terms, the guarantee and the collection period surety required to attract private actors for these type systems. Total system cost per Wp is fairly high for SIS 20 system (> US\$40/Wp) but less for SIS 50 (US\$26/Wp). For the SCS 300, the total cost includes the inverter, prepayment meter, and main electrical appliances.
- For solar pumping systems (SPS), the concession contract is also foreseen to be 10 years or more. Watt peak (Wp) costs of solar pumping systems are appreciably lower (US\$14 to US\$18/ Wp). The calculation does not include external pipes, reservoir, well or borehole construction or improvement, etc. but their costs are marginal compared to the estimated costs.
- For the 2 refrigeration units (SRS), the heavy initial investment costs (all imported products) are mainly due to PV modules (35-45%), the cold room and refrigeration unit (20-25%) and the battery + inverter (10-15%). A 1 m3 freezing chamber unit for meat storage will cost about US\$50'000 and the 20 m3 cold store unit for vegetables will cost US\$90'000 to US\$100'000. The basic calculation for the tariff assumes a payment period of 2 years but additional simulation has been done for 5 years. It should be noted that if the solar generator is removed, the investment cost is reduced by 30-40%, but O&M and fuel costs of the substituted diesel genset will be high and difficult to be supported by a local cooperative or private operators.

2.90. In all cases, the equipment supply will cost between 70 and 80% of the “project cost”, provided that the management structure is optimized and scale effect can be obtained with a large number of systems in a limited area. Based on the estimated costs and for sustainability purposes, it is relevant to investigate the potential contribution from end-users or operators for the new electrical services and the economic performance/viability of each system. The table in Annex X also presents the total “Receipt” needed to cover the estimated costs in 4 different cases. Financing will come from the village contribution over the reimbursement period and from a global subsidy that covers the initial investment and other regular costs such as project promotion, supervision, management, technical and financial assistance.

- A. The first case considers the real tariff that should be implemented if there is no subsidy and financial support to the project. An initial contribution (down payment) of 10% of the equipment delivered (not installed) has been considered for the calculation of the 24 installments. As expected, all tariffs are far beyond the capability to pay of rural villagers, in particular for the refrigeration application. Under a 10 year concession contract, the affordability of the energy service will be greatly improved.
- B. The second case establishes a tariff that covers all the O&M expenses. This sets up the minimum threshold that should guarantee a sustainable activity.
- C. The last is the tariff recommended as the best compromise between the willingness to cover the O&M costs and the capacity to pay of the end-user or community structure or private operator.
 - For the **SCS 300** system, the down payment has been reduced to 7% of the equipment value and the monthly instalment has been levelled off at 10'000 ouguiyas⁵. The limited resources from the community infrastructures like school and health centres explain why the subsidy level should be the highest for this application. Nevertheless, higher contribution can be expected in cases of more commercial activities such as restaurants, cinemas, music halls, etc.
 - For **SPS pumping systems**, the monthly installments have been estimated based on current expenses of some cooperatives consuming a similar daily volume of water. They will pay much less⁶ every month compared to what they are paying now with a gasoline genset, but for a limited period of 2 years, after which they will pay the O&M costs on their own. Subsidy levels are between 69 and 70% only and O&M costs are covered despite a down payment of less than 10%.
 - The economics are much more difficult for the refrigeration units (**SRS**), due to a very high investment cost and a relative low added value on the preserved food. Calculations are presented separately for both applications:

2.91. The description of the chest freezer in the Technology Solutions section has shown that 1 m3 can accommodate every day 50 kg of meat or fish, i.e. 1500 kg/month. As one family consumes an average 1-2 kg/day, the freezer unit will store meat for about 30-40 families. The fresh meat is locally sold at about 1'000 ouguiyas/kg (camel) to 1'200 ouguiyas/kg (goat, mutton) making a turnover of about 1'500'000 ouguiyas per month with the freezer. The margin for the butcher is not large and he usually manages to avoid wasted meat. If we assume 20%

⁵ This contribution has been approved by a director of a high school in Tawaz. Additional financial support can be expected also from parents.

⁶ In El Kweiba village, 8 litres of gasoline for 25 m3 every day correspond to a fuel expense of 45-50'000 ouguiyas per month. The equivalent recommended tariff is 25'000 ouguiyas.

losses on the meat without refrigeration, the savings will be $1'500 \text{ kg} \times 20\% = 300 \text{ kg}$, i.e. 300'000 ouguiyas/month. Monthly installments should be at minimum 100'000 ouguiyas/month to cover O&M costs. The recommended tariff is 150'000 ouguiyas/month with an initial down payment of 300'000 ouguiyas. The subsidy level is 71% and can be reduced only if the recovery period is extended⁷. For example, calculation shows that over 60 months the subsidy level is 69% if the monthly instalment is 100'000 ouguiyas and 53% if it is 150'000 ouguiyas. A more accurate estimation of the capacity to pay of the local butcher or cooperative is essential for the feasibility of the refrigeration.

2.92. As discussed earlier, the typical waste during the vegetable production peak is around 25%. A 20 m³ cold room will allow daily loading of 250 kg of fresh vegetables and a total volume of about 1 ton. One ton at the standard market price (120 ouguiyas/kg) will generate 120'000 ouguiyas compared to 200'000 ouguiyas during the off season. The remaining question is how long the vegetables should be stored? It seems more economical to store them for a short time even if the selling prices are not high enough. Indeed, if one ton of foodstuffs is stored for 3 months, the turnover could be 200'000 ouguiyas in the off-season but the reimbursement by the cooperative will be much higher (3 x 200'000 ouguiyas/month as a minimum). On the other hand if the one ton is stored for less than a week, the turnover would be 4 x 120.000 ouguiyas, covering largely the cost of the reimbursement, and therefore the cost of the O&M. In addition, the down payment has been lowered to 3% but still 500'000 ouguiyas that represents a lot of money for a local cooperative.

2.93. Another simulation has been done for a 5 year recovery period: the subsidy level drops from 78% (2 yrs) to 60% (5 yrs) if the 200'000 ouguiyas/month is maintained and 79% if the installment is reduced to 100'000 ouguiyas/month. The last option is definitely more attractive but won't cover the O&M costs. A 150'000 ouguiyas/month over 5 years could be a good compromise bringing the subsidy down to 68%. But considering the additional fact that the demand for refrigeration is only for 3 to 6 months a year, it is difficult to solve the problem of a monthly payment for no customer benefit during the rest of the year, except if solar power is used for other purposes like water pumping. To mitigate some of the drawbacks and project risks, the several measures recalled earlier (see paragraph 2.40) will be implemented during project execution:

2.94. In addition, the following points will be considered as the management scheme for the new systems being formulated:

- Many users (50%) want to reduce the reimbursement period to less than 2 years. More flexibility in the scheme should be considered.
- Global subsidies should ideally be lowered to help private sector toward a more sustainable and profitable business.
- Larger **SCS systems for community** can be proposed with the same organisation scheme as for SIS lighting systems. Both schools and health centres want also to own the system at the village level. For example, the Director of the high school in Tawaz (90 pupils) can pay 5'000 to 10'000 ouguiyas/month for 2 years for school electrification. Contribution from parents associations are also possible.

⁷ The private operator (individual or cooperative) will pay his share of the expenses during 5 years (60 months) instead of 2. To fit with the longer recovery period, maintenance contract should also be extended to 5 years but it should not include the renewal of the battery as the stationary batteries last for more than 8 years, like most of the electronic devices. The lifetime of the refrigeration unit is unknown but probably greater than 5 years.

- For **solar pumping systems (SPS)**, **farming cooperatives** are extremely interested in purchasing solar equipment if there are attractive incentives. Some past experiences have shown that even with 50% subsidy, the water price could still be acceptable in many villages for their business.
- For **refrigeration units (SRS)**, the heavy initial investment can definitely not be supported by the local economic operators. High subsidy and longer recovery period are needed to cover the total cost of the refrigeration unit. The previous economic calculation has shown that the refrigeration can hardly be promoted (and paid for itself) for low value foodstuffs such as vegetables because the monthly benefit from the sales are too low. On the contrary, meat and fish have a higher specific value and the local cooperative or butcher can pursue or improve its economic activity with an acceptable tariff and a recovery period as short as 2 years.

2.95. Prepayment for the Community System (SCS-300) will be implemented since use will likely be more intermittent and the recommended tariff is comparatively high.

2.96. For the SRS Water Pumping System, it is possible that prepayment could work for specific situations of highly varying needs during the year for water for irrigation, as an example. In most cases however, the need seemed to be either fairly constant or excess fresh water was marketed to nearby users. Of course, simply storing excess water for later use is common and easily accomplished.

2.97. For the SRS Refrigeration system, prepayment for the electricity does not work because the refrigeration is needed at all times for health reasons. Prepayment will occur at the vendor level when financial arrangements are made for use of the refrigerator. In summary, the selective use of pre-payment technology for the SCS-300 community use will contribute to further sustainability of the solar component.

Replicability

2.98. Replication of the proposed Hybrid component of the project is illustrated by the fact that only 7 villages are being covered out of more than 13 immediate candidates for which all required feasibility studies have already been carried out by the PDF-B resources leading to the current project. As explained earlier, 25 villages were surveyed per Annex IV during preparation of the hybrid component. In reference to Exhibit 1 in this document, there are 19 additional villages with similar or equally good wind regimes which fully qualify for the same productive end-use applications of hybrid systems. Owing to the good wind resource endowments towards the South of Nouadhibou and the river Senegal together with the remaining 19 villages (to which one should add the earlier balance from the 25 villages surveyed), it seems sensible to suggest that a minimum of 37 standing villages are prepared to embark on a similar productive end-use experience based on hybrid (wind/diesel) technology. It is quite interesting that, like with the Nouakchott Nouadhibou highway's positive impact for the current project, there is also the "Highway of Hope" (Autoroute de l'Espoir) from Rosso to Kaedi (see Exhibit 1) that will most likely drive significant economic activities along the roads once productive end-use power is delivered.

⁸ $25 + 19 - 5 = 39$ villages that are good candidates for the scheme once the success of the scheme has been demonstrated.

2.99. The identified 19 candidate villages outside the coastal zone are: (i) the villages located between Boghé and Kaédi (Abdallah Diéri; Abdallah Walo; Haéré Golera; Haéré M'Bare; Bababé; Niabina; Wolum Neré; Wolum Hatar; Dioké; Rindiaawe; Thialgou; Neré Walo; Bagodine) together with; (ii) the villages located Rosso and Boghé (Tekane; Dar Salam; Guidakhar; Weli noté; Thiamben; Machra Sidi).

2.100. With an even much easier illustration, the Solar PV activities are similarly highly replicable but it was important for UNDP-Mauritania and UNDP-GEF to have provided the required impetus to ensure that the lessons learned from local and international experience are put to good use with limited outside assistance in an innovative experience focusing of productive end-uses of RE in desert/harsh environment.

2.101. Based on the above, the key question to ascertain whether the replication potential stands some realistic chances of materializing is whether the government will have the capacity and will be prepared to keep up with the level of subsidization required in the current project. The answer is that Mauritania is expected to become an oil producer in 2006 and has started to prepare for the challenges of managing potentially significant oil revenues. The authorities intend to adopt sound principles for oil revenue management and tracking (various frameworks, such as the one proposed in the Extractive Industry Transparency Initiative, are under consideration). Per documented IMF official reports, the authorities plan to budget all the forthcoming oil-revenue and to use it in accordance with the priorities that will be set up in the 2006-10 Poverty Reduction Strategy Paper, to be submitted to Parliament by end-2005. At the heart of this PRSP is the World Bank Energy team work towards expanding access to electricity and running power in the isolated rural areas. Hence, the current project with the active involvement of the Ministry of Finance and the expected co-financing from the AfDB has a unique opportunity to trigger a sweeping replication of RE systems for productive end-uses in Mauritania with the initial catalytic support of GEF.

PART III: Management and Implementation Arrangements

Management Arrangements

3.1 Management of the new off grid power supplies to the coastal villages offers an opportunity to strengthen the institutional and operational capability of ADER through adoption of a private contractor approach. The north coast villages are suited for implementation of this approach because there will be inherent efficiencies that facilitate management and reduce operating and maintenance costs. For example, although access to some villages is somewhat difficult, the villages are relatively few in number, in the same area of the country, and can be served comparatively easily by operating, maintenance and money collection personnel. Perhaps more importantly, most villages have strong cooperatives which can perform important functions such as sales and distribution of prepay services, collection of money at the household and village level, and interface with the private contractor for operating and maintenance services.

3.2. Experience with other rural electrification projects suggests that a **public-private partnership** between local communities and private operators can provide an effective model which involves: (i) **local community participation** to ensure maximum involvement by end-users in determining service level requirements, promoting productive uses of electricity, and ensuring prompt payment of bills; (ii) **private sector participation** to bring in management expertise and technical know-how, and to provide better accountability to the local community.

2. 3.3. For Component 1 and 2, the Hybrid/Solar PV component, the ownership and management structure for the program will follow a straight forward BOO scheme building on the successes and lessons of the existing APAUS/ADER program along with the lessons from other PV-based systems in Africa taking into account concession experiences in Mali, Senegal and South Africa.

3. ADER monitors performance and enforces contracts. ADER will remain the operator of last resort in case of failure by the AO&M to perform. ADER would require an independent annual review of its own oversight and contractor operations, including customer satisfaction surveys.

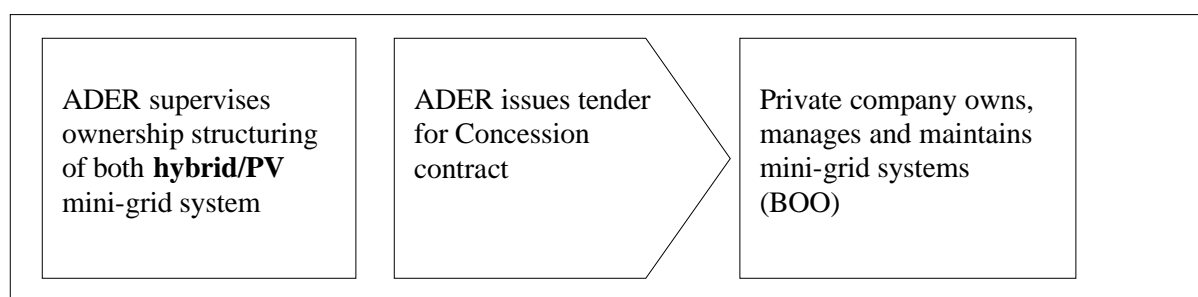


FIGURE 1. PROPOSED OWNERSHIP AND MANAGEMENT FOR SOLAR PV/HYBRID MINI-GRID SYSTEMS

4. The basic elements are:

- The Mauritanian government (through ADER) supervises the ownership structuring, tender processing and bids evaluation for the intended concessions.

- An ADER developed Request for Proposals seeks Mauritanian company bids on various delivery models/ownership structures including the entire scope of operations, maintenance and money collection (using prepayment technology) for all wind/diesel locations and PV system deployments. This organization will also participate in, under the supplying contractor's supervision, the construction, commissioning and testing of the units.
- Bidders propose 1) a one time sign up fee that they would require of all end users, 2) a one time government subsidy for the term of the contract (10 years minimum), and 3) a tariff schedule. Maintenance requirements, initial stock of spare parts, and customer care expectations are predefined by ADER.
- ADER establishes performance standards and incentives, such as equipment availability, that would allow the contractor to win annual bonuses for good performance. The nature and potential amount of these annual bonuses are defined before proposals are solicited.
- ADER requires an independent annual review of its own oversight and contractor operations, including customer satisfaction surveys. (Customer satisfaction would carry significant weight in the rate of return the contractor makes.)
- With this approach, the winning contractor receives payment via: sign-up fees, one time up front government payment, customer tariff, and performance bonuses.

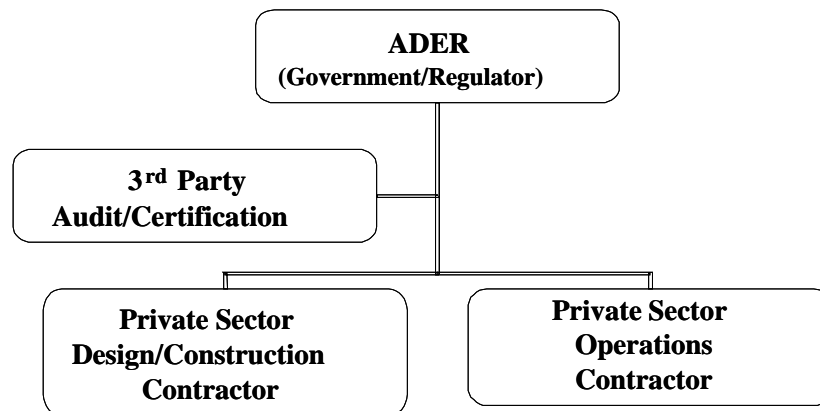


FIGURE 2. Proposed Execution Arrangements for Solar PV/Hybrid Mini-Grid Systems

3.8. For the contractual arrangements in connection with the PV/Hybrid-systems, rather than paying subsidies to PV/wind turbines and diesel genset dealers, fees will be paid to concessionaires to provide service. The business model adopted means that: (i) the most affordable payment schemes will help reach a larger client base; (ii) clients do not have to invest in systems but only pay for services by operators; (iii) clients do not have to worry about after sales systems maintenance which is centrally provided by operator; and, (iv) product standardization and quality assurance is easier as operators can obtain economies of scale in procurement and in the delivery of services.

Implementation Arrangements

3.9. The project will be executed in accordance with UNDP-Mauritania's national execution modalities (NEX) and applicable DEX modalities for international consultancies for which foreign currency payment of fees is expected. DEX modalities will also cover selected activities where backstopping from the Dakar UNDP-GEF Regional Coordination Office adds value to the project implementation while strengthening the delivery capacity of UNDP-Mauritania. Within

the proposed arrangement, the proceeds of the GEF grant will be disbursed through the UNDP Country Office and the Execution Agency will be the ADER. UNDP-Mauritania will work with the Dakar UNDP-GEF Regional Coordination, together with ADER, to carry out all required acquisitions and ensure timely delivery of project outputs and outcomes. UNDP-Mauritania will also provide administrative and financial oversight of the execution.

3.10. A Steering Committee will be formed to provide oversight of the UNDP-GEF project and to promote operational coordination among different government agencies and donors working in the sector. Membership in the Steering Committee should include: PNUD-Mauritania, PNUD-FEM, AfDB, ADER, Electricity Directorate, APAUS and ARM.

3.11. A Consultative Group of sectoral specialists will also be formed and consulted by the Steering Committee on specific issues. This group should include: the University's Renewable Energy Development Center, professional trade associations, wind/solar suppliers, energy consultants and technical bureaus. A series of consultative workshops will be organized to promote information sharing between these groups.

3.12. In order to accord proper acknowledgement to GEF for providing funding, a GEF logo should appear on all relevant GEF project publications, including among others, project hardware and vehicles purchased with GEF funds. Any citation on publications regarding projects funded by GEF should also accord proper acknowledgment to GEF. The UNDP logo should be more prominent -- and separated from the GEF logo if possible, as UN visibility is important for security purposes.

PART IV: Monitoring and Evaluation Plan and Budget

4.1. Project monitoring and evaluation will be conducted in accordance with established UNDP and GEF procedures and will be provided by the project team and the UNDP Country Office (UNDP-CO) with support from UNDP/GEF. The Logical Framework Matrix in Annex B of the Executive Summary provides *performance* and *impact* indicators for project implementation along with their corresponding *means of verification*. These will form the basis on which the project's Monitoring and Evaluation system will be built.

4.2 The following sections outline the principle components of the Monitoring and Evaluation Plan and indicative cost estimates related to M&E activities. The project's Monitoring and Evaluation Plan will be presented and finalized at the Project's Inception Report following a collective fine-tuning of indicators, means of verification, and the full definition of project staff M&E responsibilities.

Monitoring and Reporting

Project Inception Phase

4.3 A Project Inception Workshop will be conducted with the full project team, relevant government counterparts, co-financing partners, the UNDP-CO and representation from the UNDP-GEF Regional Coordinating Unit, as well as UNDP-GEF (HQs) as appropriate.

4.4 A fundamental objective of this Inception Workshop will be to assist the project team to understand and take ownership of the project's goals and objectives, as well as finalize preparation of the project's first annual work plan on the basis of the project's logframe matrix. This will include reviewing the logframe (indicators, means of verification, assumptions), imparting additional detail as needed, and on the basis of this exercise finalize the Annual Work Plan (AWP) with precise and measurable performance indicators, and in a manner consistent with the expected outcomes for the project.

4.5 Additionally, the purpose and objective of the Inception Workshop (IW) will be to: (i) introduce project staff with the UNDP-GEF *expanded team* which will support the project during its implementation, namely the CO and responsible Regional Coordinating Unit staff; (ii) detail the roles, support services and complementary responsibilities of UNDP-CO and RCU staff vis à vis the project team; (iii) provide a detailed overview of UNDP-GEF reporting and monitoring and evaluation (M&E) requirements, with particular emphasis on the Annual Project Implementation Reviews (PIRs) and related documentation, the Annual Project Report (APR), Tripartite Review Meetings, as well as mid-term and final evaluations. Equally, the IW will provide an opportunity to inform the project team on UNDP project related budgetary planning, budget reviews, and mandatory budget rephasings.

4.6 The IW will also provide an opportunity for all parties to understand their roles, functions, and responsibilities within the project's decision-making structures, including reporting and communication lines, and conflict resolution mechanisms. The Terms of Reference for project staff and decision-making structures will be discussed again, as needed, in order to clarify for all, each party's responsibilities during the project's implementation phase.

Monitoring responsibilities and events

4.7 A detailed schedule of project reviews meetings will be developed by the project management, in consultation with project implementation partners and stakeholder representatives and incorporated in the Project Inception Report. Such a schedule will include: (i) tentative time frames for Tripartite Reviews, Steering Committee Meetings, (or relevant advisory and/or coordination mechanisms) and (ii) project related Monitoring and Evaluation activities.

4.8 *Day to day monitoring of implementation progress* will be the responsibility of the Project Coordinator, Director or CTA (depending on the established project structure) based on the project's Annual Work Plan and its indicators. The Project Team will inform the UNDP-CO of any delays or difficulties faced during implementation so that the appropriate support or corrective measures can be adopted in a timely and remedial fashion.

4.9 The Project Coordinator and the Project GEF Technical Advisor will fine-tune the progress and performance/impact indicators of the project in consultation with the full project team at the Inception Workshop with support from UNDP-CO and assisted by the UNDP-GEF Regional Coordinating Unit. Specific targets for the first year implementation progress indicators together with their means of verification will be developed at this Workshop. These will be used to assess whether implementation is proceeding at the intended pace and in the right direction and will form part of the Annual Work Plan. The local implementing agencies will also take part in the Inception Workshop in which a common vision of overall project goals will be established. Targets and indicators for subsequent years would be defined annually as part of the internal evaluation and planning processes undertaken by the project team.

4.10 Measurement of impact indicators related to global benefits will occur according to the schedules defined in the Inception Workshop and tentatively outlined in the indicative Impact Measurement Template at the end of this Annex. The measurement, of these will be undertaken through subcontracts or retainers with relevant institutions (e.g. vegetation cover via analysis of satellite imagery, or populations of key species through inventories) or through specific studies that are to form part of the projects activities (e.g. measurement carbon benefits from improved efficiency of ovens or through surveys for capacity building efforts) or periodic sampling such as with sedimentation.

4.11 *Periodic monitoring of implementation progress* will be undertaken by the UNDP-CO through quarterly meetings with the project proponent, or more frequently as deemed necessary. This will allow parties to take stock and to troubleshoot any problems pertaining to the project in a timely fashion to ensure smooth implementation of project activities.

4.12 UNDP Country Offices and UNDP-GEF RCUs as appropriate, will conduct yearly visits to projects that have field sites, or more often based on an agreed upon scheduled to be detailed in the project's Inception Report / Annual Work Plan to assess first hand project progress. Any other member of the Steering Committee can also accompany, as decided by the SC. A Field Visit Report will be prepared by the CO and circulated no less than one month after the visit to the project team, all SC members, and UNDP-GEF.

4.13 *Annual Monitoring* will occur through the ***Tripartite Review (TPR)***. This is the highest policy-level meeting of the parties directly involved in the implementation of a project. The project will be subject to Tripartite Review (TPR) at least once every year. The first such meeting will be held within the first twelve months of the start of full implementation. The project proponent will prepare an Annual Project Report (APR) and submit it to UNDP-CO and the UNDP-GEF regional office at least two weeks prior to the TPR for review and comments.

4.14 The APR will be used as one of the basic documents for discussions in the TPR meeting. The project proponent will present the APR to the TPR, highlighting policy issues and recommendations for the decision of the TPR participants. The project proponent also informs the participants of any agreement reached by stakeholders during the APR preparation on how to resolve operational issues. Separate reviews of each project component may also be conducted if necessary.

Terminal Tripartite Review (TTR)

4.15 The terminal tripartite review is held in the last month of project operations. The project proponent is responsible for preparing the Terminal Report and submitting it to UNDP-CO and LAC-GEF's Regional Coordinating Unit. It shall be prepared in draft at least two months in advance of the TTR in order to allow review, and will serve as the basis for discussions in the TTR. The terminal tripartite review considers the implementation of the project as a whole, paying particular attention to whether the project has achieved its stated objectives and contributed to the broader environmental objective. It decides whether any actions are still necessary, particularly in relation to sustainability of project results, and acts as a vehicle through which lessons learnt can be captured to feed into other projects under implementation of formulation.

4.16 The TPR has the authority to suspend disbursement if project performance benchmarks are not met. Benchmarks are provided in Annex B of the Executive Summary and will be developed at the Inception Workshop, based on delivery rates, and qualitative assessments of achievements of outputs.

Project Monitoring Reporting

4.17 The Project Coordinator in conjunction with the UNDP-GEF extended team will be responsible for the preparation and submission of the following reports that form part of the monitoring process. Items (a) through (f) are mandatory and strictly related to monitoring, while (g) through (h) have a broader function and the frequency and nature is project specific to be defined throughout implementation.

(a) Inception Report (IR)

4.18 A Project Inception Report will be prepared immediately following the Inception Workshop. It will include a detailed First Year/ Annual Work Plan divided in quarterly time-frames detailing the activities and progress indicators that will guide implementation during the first year of the project. This Work Plan would include the dates of specific field visits, support missions from the UNDP-CO or the Regional Coordinating Unit (RCU) or consultants, as well as time-frames for meetings of the project's decision making structures. The Report will also include the detailed project budget for the first full year of implementation, prepared on the basis of the Annual Work Plan, and including any monitoring and evaluation requirements to effectively measure project performance during the targeted 12 months time-frame.

4.19 The Inception Report will include a more detailed narrative on the institutional roles, responsibilities, coordinating actions and feedback mechanisms of project related partners. In addition, a section will be included on progress to date on project establishment and start-up activities and an update of any changed external conditions that may effect project implementation.

4.20 When finalized the report will be circulated to project counterparts who will be given a period of one calendar month in which to respond with comments or queries. Prior to this circulation of the IR, the UNDP Country Office and UNDP-GEF's Regional Coordinating Unit will review the document.

(b) Annual Project Report (APR)

4.21 The APR is a UNDP requirement and part of UNDP's Country Office central oversight, monitoring and project management. It is a self -assessment report by project management to the CO and provides input to the country office reporting process and the ROAR, as well as forming a key input to the Tripartite Project Review. An APR will be prepared on an annual basis prior to the Tripartite Project Review, to reflect progress achieved in meeting the project's Annual Work Plan and assess performance of the project in contributing to intended outcomes through outputs and partnership work.

4.22 The format of the APR is flexible but should include the following:

§ An analysis of project performance over the reporting period, including outputs produced and, where possible, information on the status of the outcome

- § The constraints experienced in the progress towards results and the reasons for these
- § The three (at most) major constraints to achievement of results
- § AWP, CAE and other expenditure reports (ERP generated)
- § Lessons learned
- § Clear recommendations for future orientation in addressing key problems in lack of progress

(c) *Project Implementation Review (PIR)*

4.23 The PIR is an annual monitoring process mandated by the GEF. It has become an essential management and monitoring tool for project managers and offers the main vehicle for extracting lessons from ongoing projects. Once the project has been under implementation for a year, a Project Implementation Report must be completed by the CO together with the project. The PIR can be prepared any time during the year (July-June) and ideally prior to the TPR. The PIR should then be discussed in the TPR so that the result would be a PIR that has been agreed upon by the project, the executing agency, UNDP CO and the concerned RC.

4.24 The individual PIRs are collected, reviewed and analysed by the RCs prior to sending them to the focal area clusters at the UNDP/GEF headquarters. The focal area clusters supported by the UNDP/GEF M&E Unit analyse the PIRs by focal area, theme and region for common issues/results and lessons. The TAs and PTAs play a key role in this consolidating analysis.

4.25 The focal area PIRs are then discussed in the GEF Interagency Focal Area Task Forces in or around November each year and consolidated reports by focal area are collated by the GEF Independent M&E Unit based on the Task Force findings.

4.26 The GEF M&E Unit provides the scope and content of the PIR. In light of the similarities of both APR and PIR, UNDP/GEF has prepared a harmonized format for reference.

(d) *Quarterly Progress Reports*

4.27 Short reports outlining main updates in project progress will be provided quarterly to the local UNDP Country Office and the UNDP-GEF regional office by the project team. See format attached.

(e) *Periodic Thematic Reports*

4.28 As and when called for by UNDP, UNDP-GEF or the Implementing Partner, the project team will prepare Specific Thematic Reports, focusing on specific issues or areas of activity. The request for a Thematic Report will be provided to the project team in written form by UNDP and will clearly state the issue or activities that need to be reported on. These reports can be used as a form of lessons learnt exercise, specific oversight in key areas, or as troubleshooting exercises to evaluate and overcome obstacles and difficulties encountered. UNDP is requested to minimize its requests for Thematic Reports, and when such are necessary will allow reasonable timeframes for their preparation by the project team.

(f) *Project Terminal Report*

4.29 During the last three months of the project the project team will prepare the Project Terminal Report. This comprehensive report will summarize all activities, achievements and

outputs of the Project, lessons learnt, objectives met, or not achieved, structures and systems implemented, etc. and will be the definitive statement of the Project's activities during its lifetime. It will also lay out recommendations for any further steps that may need to be taken to ensure sustainability and replicability of the Project's activities.

(g) *Technical Reports*

4.30 Technical Reports are detailed documents covering specific areas of analysis or scientific specializations within the overall project. As part of the Inception Report, the project team will prepare a draft Reports List, detailing the technical reports that are expected to be prepared on key areas of activity during the course of the Project, and tentative due dates. Where necessary this Reports List will be revised and updated, and included in subsequent APRs. Technical Reports may also be prepared by external consultants and should be comprehensive, specialized analyses of clearly defined areas of research within the framework of the project and its sites. These technical reports will represent, as appropriate, the project's substantive contribution to specific areas, and will be used in efforts to disseminate relevant information and best practices at local, national and international levels.

(h) *Project Publications*

4.31 Project Publications will form a key method of crystallizing and disseminating the results and achievements of the Project. These publications may be scientific or informational texts on the activities and achievements of the Project, in the form of journal articles, multimedia publications, etc. These publications can be based on Technical Reports, depending upon the relevance, scientific worth, etc. of these Reports, or may be summaries or compilations of a series of Technical Reports and other research. The project team will determine if any of the Technical Reports merit formal publication, and will also (in consultation with UNDP, the government and other relevant stakeholder groups) plan and produce these Publications in a consistent and recognizable format. Project resources will need to be defined and allocated for these activities as appropriate and in a manner commensurate with the project's budget.

Independent Evaluation

4.32 The project will be subjected to at least two independent external evaluations as follows:-

(i) *Mid-term Evaluation*

4.33 An independent Mid-Term Evaluation will be undertaken at the end of the second year of implementation. The Mid-Term Evaluation will determine progress being made towards the achievement of outcomes and will identify course correction if needed. It will focus on the effectiveness, efficiency and timeliness of project implementation; will highlight issues requiring decisions and actions; and will present initial lessons learned about project design, implementation and management. Findings of this review will be incorporated as recommendations for enhanced implementation during the final half of the project's term. The organization, terms of reference and timing of the mid-term evaluation will be decided after consultation between the parties to the project document. The Terms of Reference for this Mid-term evaluation will be prepared by the UNDP CO based on guidance from the Regional Coordinating Unit and UNDP-GEF.

(ii) *Final Evaluation*

4.34 An independent Final Evaluation will take place three months prior to the terminal tripartite review meeting, and will focus on the same issues as the mid-term evaluation. The final evaluation will also look at impact and sustainability of results, including the contribution to capacity development and the achievement of global environmental goals. The Final Evaluation should also provide recommendations for follow-up activities. The Terms of Reference for this evaluation will be prepared by the UNDP CO based on guidance from the Regional Coordinating Unit and UNDP-GEF.

4.35 The Government will provide the Resident Representative with certified periodic financial statements, and with an annual audit of the financial statements relating to the status of UNDP (including GEF) funds according to the established procedures set out in the Programming and Finance manuals. The Audit will be conducted by the legally recognized auditor of the Government, or by a commercial auditor engaged by the Government.

Learning and Knowledge Sharing

4.36 Results from the project will be disseminated within and beyond the project intervention zone through a number of existing information sharing networks and forums. In addition:

- The project will participate, as relevant and appropriate, in UNDP/GEF sponsored networks, organized for Senior Personnel working on projects that share common characteristics. UNDP/GEF shall establish a number of networks, such as Integrated Ecosystem Management, eco-tourism, co-management, etc, that will largely function on the basis of an electronic platform.
- The project will identify and participate, as relevant and appropriate, in scientific, policy-based and/or any other networks, which may be of benefit to project implementation though lessons learned.

4.37 The project will identify, analyze, and share lessons learned that might be beneficial in the design and implementation of similar future projects. Identify and analyzing lessons learned is an on- going process, and the need to communicate such lessons as one of the project's central contributions is a requirement to be delivered not less frequently than once every 12 months. UNDP/GEF shall provide a format and assist the project team in categorizing, documenting and reporting on lessons learned. To this end a percentage of project resources will need to be allocated for these activities.

4.38 For each of the six components, a monitoring plan will be prepared during the project's inception phase. A Project Planning Matrix has been developed and is part of the submission (Annex B of the Executive Summary). Appropriate and specific performance benchmarks will be established to effectively monitor project progress and to make crucial management decisions. An annual reporting cycle will be established for this project that will provide progress reports.

Monitoring and Evaluation Budget

4.39 The M&E activities will be funded through GEF and UNDP contributions (\$200,000 and \$150,000, respectively). Based on the rural nature of the project, an M&E budget of GEF funding (less than 3% total project funding) was considered appropriate. The additional \$50,000 under activity 3.2, coming from the government, will be used to establish the tracking database.

4.40 The baseline methodologies and monitoring and evaluation plans as they are being used as part of the Clean Development Mechanism project development cycle could be used to further fine-tune the impact monitoring scheme indicated above.

Monitoring Environmental Impacts

4.41 Waste generated due to the use of PV systems consists of two elements: discarded PV panels and balance of system components, such as batteries, regulators, lights, etc.

4.42 *Discarded PV panels* - Silicon is the basic material for the production of most solar panels. Since silicon is not toxic, there is minimal pollution risk. PV cell materials other than silicon, such as cadmium-telluride or other toxic materials may cause a pollution risk. During normal operation there is no leaking and even if the panel is broken, there is only limited risk to humans from toxic materials. The aluminum used in frames does not cause an environmental hazard, but frames are fairly easy to remove and recycling of aluminum is a well established industry, although not in Mauritania.

4.43 *Balance of system components* - Of the balance of system components, batteries pose the highest potential for pollution since they contain lead and sulphuric acid, or other toxic materials. There are more discarded batteries than solar panels since batteries have to be replaced several times during the lifetime of the panels. The environmental impact of mainly the batteries will be closely monitored under the proposed initiative and measures for collection and recycling will be included in the operation and maintenance procedures that will be designed and implemented under the program.

PART V: Legal Context and Pre-requisites

5.1. This Project Document shall be the instrument referred to as such in Article I of the Standard Basic Assistance Agreement between the Government of Mauritania and the United Nations Development Programme, signed by the parties. The host country implementing agency shall, for the purpose of the Standard Basic Assistance Agreement, refer to the government co-operating agency described in that Agreement.

5.2. The UNDP Resident Representative in Nouakchott is authorized to effect in writing the following types of revision to this Project Document, provided that he/she has verified the agreement thereto by the UNDP-GEF Unit and is assured that the other signatories to the Project Document have no objection to the proposed changes:

- a) Revision of, or addition to, any of the annexes to the Project Document;
- b) Revisions which do not involve significant changes in the immediate objectives, outputs or activities of the project, but are caused by the rearrangement of the inputs already agreed to or by cost increases due to inflation;

- c) Mandatory annual revisions which re-phase the delivery of agreed project inputs or increased expert or other costs due to inflation or take into account agency expenditure flexibility; and
- d) Inclusion of additional annexes and attachments only as set out here in this Project Document

Pre-requisites

5.3. All GEF grant disbursements will be contingent upon the evidence to UNDP-GEF/UNDP-Mauritania of the following:

- (a) AfDB co-financing approval;
- (b) Submission of signed MOU between ADER and APAUS with a satisfactory matrix of collaboration; and,
- (c) Designation of all Project Steering Committee Members and appointment of national project Coordinator within ADER.
- (d) By GEF CEO Endorsement, submission of the outline of project concession delivery model for both components spelling out: **(a)** the key contract parameters and specifying a term of 10 years or more; and; **(b)** for the hybrid component specifically indicating the alternative provisions to ensure optimal connection rate at project inception.

SECTION II: STRATEGIC RESULTS FRAMEWORK AND GEF INCREMENT

PART I : Incremental Cost Analysis

Refer to Annex A of the Executive Summary.

PART II : Logical Framework Analysis

Refer to Annex B of the Executive Summary.

SECTION III : TOTAL BUDGET AND WORKPLAN

Overall Project Component Financing								
Project name	Components	GEF	AfDB	Government of Mauritania		UNDP- Nouakchott	Others	Total
		(Cash, US\$)	(Cash, US\$)	(In-kind)	(Cash, US\$)	(Cash, US\$)	(Cash, US\$)	(Cash, US\$)
Solar Adrar PV Systems and Hybrid Systems in the Northern Coastline	I. Solar PV Systems	1,240,000	1,000,000	0	990,000	0	362,000	3,592,000
	II. Hybrid Systems	1,170,000	3,000,000	0	1,300,000	0	1,679,000	7,149,000
	III. Overall Program Management Support	290,000	0	250,000	400,000	300,000	0	1,240,000
	Total	2,700,000	4,000,000	250,000	2,690,000	300,000	2,041,000	11,981,000

Component	Sub-Component	GEF	AfDB	Government of Mauritania		UNDP- Nouakchott	Others	Total
		(Cash, US\$)	(Cash, US\$)	(In-kind)	(Cash, US\$)	(Cash, US\$)	(Cash, US\$)	(Cash, US\$)
I. Deployments of Solar Kits in Adrar and Inchiri Regions	1.1 RFP for equipment supply, installation and maintenance	140,000						140,000
	1.2 Supply and installation of Solar kits		1,000,000		990,000		362,000	2,352,000
	1.3 Promotion of productive end-uses for community-based solar applications	450,000						450,000
	1.4 Technical assistance, Capacity building and institutional strengthening for the ADER in supporting PV-based Productive end-uses	400,000						400,000
	1.5 Knowledge transfer and capacity building for the private sector in PV-based systems	250,000						250,000
	Sub-Total	1,240,000	1,000,000	0	990,000	0	362,000	3,592,000

Component	Sub-Component	GEF	AfDB	Government of Mauritania		UNDP-Nouakchott	Others	Total
		(Cash, US\$)	(Cash, US\$)	(In-kind)	(Cash, US\$)	(Cash, US\$)	(Cash, US\$)	(Cash, US\$)
II. Deployments of Hybrid Mini-Grid Systems in Coastal villages	2.1 RFP and contract negotiations for construction	170,000						170,000
	2.2 Supply and Deployment of 7 Hybrid Mini-Grids		3,000,000		949,000		1,679,000	5,628,000
	2.3 RFP and contract negotiations for operational/System management phase	150,000						150,000
	2.4 Technical assistance to ADER and operators for hybrid component	250,000			251,000			501,000
	2.5 Promotion of Hybrid-based Productive End-Uses for	350,000			100,000			450,000
	2.6. Knowledge transfer and capacity building for the Private sector in Hybrid systems	250,000						250,000
	Sub-Total	1,170,000	3,000,000	0	1,300,000	0	1,679,000	7,149,000

Component	Sub-Component	GEF	AfDB	Government of Mauritania		UNDP- Nouakchott	Others	Total
		(Cash, US\$)	(Cash, US\$)	(In-kind)	(Cash, US\$)	(Cash, US\$)	(Cash, US\$)	(Cash, US\$)
III. Project Management	3.1. Overall Project Management Support (both PV & Hybrid systems)	0		50,000	200,000	150,000		400,000
	3.2. M&E system and RE Project tracking database (both PV & Hybrid systems)	200,000		50,000		150,000		400,000
	3.3. Construction and Operation of ADER's Renewable Energy Training Center			150,000	200,000			350,000
	3.4. Integration of RE issues in Rural Electrification Plans	90,000						90,000
	Sub-Total	290,000	0	250,000	400,000	300,000	0	1,240,000

SECTION IV : ADDITIONAL INFORMATION

PART I : Other agreements



LETTRE D'ENDOSSEMENT

En ma qualité de Point Focal Opérationnel du Fonds pour l'Environnement Mondial (FEM), j'endorsse par la présente le Projet ci-joint d'électrification par le solaire photovoltaïque de la région de l'Adrar et par systèmes hybrides (éolien - diesel) les villages du littoral nord mauritanien.

Le projet en question est conforme à la politique nationale en matière d'électrification rurale et d'encouragement des énergies propres et renouvelables (éolienne et solaire). Il bénéficie à 20 villages dans les wilayas de l'Adrar et de l'Inchiri et 25 villages du Littoral.

La Mauritanie considère que le présent projet contribue dans ses efforts pour protéger l'environnement mondial tout en atteignant ses objectifs nationaux de développement durable.

EL HADRAMI OULD BAHNEINE



République Islamique de Mauritanie

Honneur - Fraternité - Justice

Ministère des Affaires Economiques
et du Développement

N° 0065 / M.A.E.D.W.

الجمهورية الإسلامية الموريتانية

شرف - إخاء - عدالة

وزارة الشؤون الاقتصادية
والتنمية

Nouakchott: le 3 JUIN 2005
انواكشوط في:

Le Ministre

الوزير

A Monsieur Omar Kabbaj,
Président de la Banque Africaine
de Développement
Tunis

Objet: Projet d'électrification par système hybride et solaire

Monsieur le Président,

J'ai l'honneur de vous informer que notre Gouvernement compte réaliser un projet d'électrification par système hybride (éolien-diesel) dans la zone du littoral et par le solaire photovoltaïque dans les régions de l'Adrar et de l'Inchiri. Le coût global de cet important projet, dont bénéficiera une vingtaine de localités sur le littoral ainsi que 1 500 foyers dans les régions de l'Adrar, et l'Inchiri, s'élève à 12 millions de SUS.

Comme indiqué dans le document de requête ci-joint, le Gouvernement participera au financement du projet à hauteur de 2 359 000 USD et le Fonds pour le l'Environnement Mondial (FEM) apportera une contribution de 3.366.000 USD.

Compte tenu de l'intérêt exprimé par votre honorable Institution à l'égard de ce projet, lors de la réunion de travail tenue le 24 février 2005 avec les autorités mauritanienne compétentes et les Coordinateur Régional du FEM, je vous saurais gré des dispositions que vous voudriez bien prendre en vue de diligenter l'instruction de la présente requête par vos services compétents pour assurer une contribution de la BAD à son financement à hauteur de 4 millions USD.

Comptant sur votre aimable coopération, je vous prie de croire, Monsieur le Président, en l'assurance de ma haute considération.

Sidi Ould Bidi



Programme des Nations Unies pour le développement



TELECOPIE de la part de:

PNUD/NOUAKCHOTT/MAURITANIE

A: Mr .Mathieu Koumoin
Coordonnateur Régional Changements
Climatiques et Energie
PNUD/GEF
Dakar-Sénégal

mathieu.koumoin@undp.org

N° du message : **000048**

Nature :

Poste :

DE : Cécile Molinier
Représentante Résidente

Date : **08 JUN 2005**

Nombre de pages (page de garde comprise)

(01)

Monsieur le Coordonnateur,

Objet : Projet d'électrification par le solaire photovoltaïque de la région de l'Adrar et par systèmes hybrides (éolien-diesel) des villages du littoral nord mauritanien

J ai le plaisir de vous confirmer que le bureau PNUD- Mauritanie contribuera au projet cité en objet avec un montant de 300 000 \$US reparté sur quatre annuités de 75000\$US.

Meilleures Salutations.

Ministère de l'Énergie et de l'Électricité
Direction Générale de l'Énergie
Département de l'Énergie Rurale

ADER

[14 2]



الوكالة الوطنية لتنمية الكهرباء الريفية
ووكالة تنمية الكهرباء الريفية
وتمرك

[14 JUN 2005]

Le Directeur Général

Monsieur Mathieu C. KOUMOIN
Coordonnateur Régional pour les
changements Climatiques et l'Energie
PNUD / FEM DAKAR

Objet : Projet d'électrification par le solaire photovoltaïque de la région de l'Adrar, et par systèmes hybrides (éolien –Diesel) des villages du littoral Mauritanien

J'ai l'honneur de vous faire parvenir ci jointe une copie de la lettre N° 00658 / MAED en date du 13 juin 2005 adressée au Président de la Banque Africaine de Développement BAD et relative d'une part à l'engagement du Gouvernement de participer au financement du projet à hauteur de 2 359 000 \$ US et d'autre part à la contribution de la BAD

Veuillez agréer Monsieur le Coordonnateur l'expression de ma considération distinguée.

El Kory Ould H'Meity

Ampliatiions:

Représentant Résident PNUD / Nouakchott



PART II: Stakeholder Involvement Plan

6.1. During the preparatory assistance phase, the consultants held numerous meetings and discussion with a wide range of stakeholders, including ministries, government agencies, donors, academic institutions, and members of the private sector. At the village level, meetings were held not only with village leaders, but with dozens of villagers who participated in discussions by expressing their needs, preferences and concerns; and learning about the proposed project modalities. Meetings were also held with key government institutions to validate findings and recommendations flowing from the PDF-B phase and to strengthen government ownership of the project. This participatory approach will be continued during project execution.

6.2. The project will schedule a number of workshops at the start of the project, as well as at critical points during its implementation, to ensure: (i) close coordination with private sector companies representing suppliers, engineering firms, maintenance companies and technical bureaus, and (ii) continued collaboration between ADER and private operators to refine and sustain the concession model for rural mini-grid operations.

6.3. The project will also contain a sensitization and mobilization campaign to promote the full participation of local communities and end-users via ADER, NGOs and CBOs to ensure that: (i) project objectives are clearly communicated to the beneficiaries, (ii) the productive end-uses of electricity are clearly identified and communicated for each economic category (fishermen, livestock herders, growers, etc.) and community groups (schools, health clinic, salination), and (iii) a consistent plan for involving villagers and community groups in promoting socio-economic development is well received.

6.4. The project will reach out to various government Ministries and the stakeholders above including the specific 7 rural communities off the 13 good candidates for which detailed feasibility reports were carried out. The government suggested that the final selection of the coastal villages be made in collaboration with the African Development which has planned its preparation/field pre-appraisal mission in Mauritania during the month of September 2005. As a result, only upstream consultations with government agencies, private actors and the necessary interactions with the villagers has taken place in order not to set unduly high expectations from a number of good candidate villages that may (or may) not make it to the final list in this round of hybrid systems for productive end-uses. Prior to GEF Council Endorsement and in collaboration with the African Development, a comprehensive stakeholder consultation plan will be prepared and executed to the extent possible in preparation for the signing of the joint MOU between the ADER and APAUS.

ANNEXES

Annex I. Surveyed Productive End-Use Applications for Hybrid Systems and Solar PV in Mauritania

The end-user field surveys conducted during the PDF phase identified how access to power could improve the quality of life and increase the socio-economic development of rural populations in the following ways:

- (i) improve the community's service delivery capability for basic services such as potable water pumping and desalination;
- (ii) provide water pumping for irrigation purposes on a continuous and more reliable basis than with small self-managed pumps;
- (iii) improve the quality of social services such as health centers and schools;
- (iv) improve indoor air quality and reduce smoke and soot-related health problems by eliminating the use of paraffin and candles at home;
- (v) provide communal refrigeration and/or ice-making capability to help preserve agricultural produce and meat/milk in the Adrar region together with fish in the coastal area, allowing villagers to preserve food surpluses and ship products to urban markets;
- (vi) stimulate new income-generating activities from small shops, micro-enterprise and local crafts (e.g., wood shop, metal shop, tailor, artisan workshops);
- (vii) encourage the development of private sector services for the sale and maintenance of RET-based systems such as PV kits and wind turbines.

Table IA below summarizes the contribution of renewable energy/electricity services to a range of rural development needs, including water sanitation, food security/preservation, education, health care, job creation, and socio-economic development. A more complete presentation of the results from the Socio-Economic Analysis conducted during the PDF-B phase is included in Annex IV.

Table IA: *Contribution of Electricity to a Range of Rural Economic Activities*

Rural Development Needs	Contribution of Electricity
1. Water and sanitation	<ul style="list-style-type: none"> Electricity can help meet the critical need for water by enabling pumping of ground water in the desert and desalination of seawater on the coast.
2. Food security and nutrition	<ul style="list-style-type: none"> Agricultural productivity can be increased through water pumping and irrigation. Storage of vaccines for livestock. Cold storage of meat and vegetable production.
3. Education and early childhood development	<ul style="list-style-type: none"> Electricity availability at home and schools enables access to educational media. Good quality lighting enables home-based study. Lighting in schools allows evening classes and study, and helps retain teachers, especially if their accommodation has electricity. Availability of electricity services free children's and especially,

Rural Development Needs	Contribution of Electricity
	girls' time from helping with survival activities such as fetching water and collecting firewood.
4. Access to essential health care	<ul style="list-style-type: none"> • Electricity for refrigeration allows vaccination and medicine storage for prevention and treatment of diseases and infections. • Enables access to health education media through information and communication technology. • Cleaner energy technologies are expected to reduce energy-related health problems/diseases. • Electricity in health centers enables night availability, helps to retain qualified staff and allows equipment use.
5. Employment creation and entrepreneurship development	<ul style="list-style-type: none"> • Electricity enhances income-generating activities such as small local tourism, knitting and sewing industry. • Existing local shops can now extend their operating hours beyond the daylight period. • Stimulation of private sector activity related to supply and maintenance of renewables and solar kits.

Survey Results from Nouakchott to Nouadhibou (Specific Hybrid Applications)

For the coastal fishing villages, the electricity needs are primarily driven by the proximity to the Atlantic Ocean. Socio-economic development in these villages is constrained by two main factors: (i) the preponderance of brackish water, which limits the ability of the villages to expand and forces the villagers to dedicate precious financial resources to obtaining fresh water⁹; and (ii) the inability to freeze fish, so that villagers can transport the fish to urban markets (typically Nouakchott) and sell their catch for a higher price than what is being offered by middlemen in the fishing villages. As a result, the primary productive end-uses of electricity are tied to these main applications: (i) desalination of water for drinking and sanitary purposes via reverse osmosis, and (ii) production of ice for the preservation and transportation of fish.

Other productive applications of electricity were identified during the field surveys. Boat building is an important industry, but productivity is low as boats must be built with hand tools. With access to electric tools, it is estimated that boat builders could increase production from one to two boats every 10 months. The potential productivity gains also exist in sail making and the production of fishing nets. As an example, it now takes the women in the village three days to make a sail. With access to an electric sewing machine, the rate of production could be increased. Most of the villages are organized with a cooperative; some are better organized than others. The cooperative often has a car to transport their fish to sell in the city and bring back what's needed for the community: nets, ice, water, gasoline. The cooperatives also often manage a shop in the village. In most cases, the PNBA has loaned inside PNBA villages associations some money to invest in a car. Hence there is an established market for the intended productive end-use services within which the villages are active participants and what is being pursued – through the current project -- is to elicit and further develop such a market locally based on

⁹ For villages that rely on water that is trucked in, prices range from 1,000 to 2,000 ouguiyas (US\$3.70-US\$7.40) for 200 liters, 40 to 50 times more than the price of piped water in the cities.

productive end-uses of clean/renewable electricity rather than being completely dependent upon the current commercial exchanges with Nouakchott.

Specific productive end-use applications of Hybrid (wind-Diesel)-based systems in the Coastal Villages

Potable water pumping and desalination

Water supply is a crucial issue in all the villages. Drinking water supply infrastructures do not exist everywhere yet. The project activities in the coastal villages will focus on specific needs of electricity for water pumping, and desalinization or treatment that can help to supply drinking water, as well as local economic activities such as agriculture or livestock.

As part of the project implementation, each village to be electrified will receive a seawater reverse osmosis desalination system sized to meet the entire village need for potable water. The advantages of the RO process are well known¹⁰: (i) the processing system is simple; the only complicating factor is finding or producing a clean supply of feedwater to minimize the need for frequent cleaning of the membrane; and (ii) systems may be assembled from prepackaged modules to produce a supply of product water ranging from a few liters per day to 750'000 l/day for brackish water, and to 400'000 l/day for seawater; the modular system allows for high mobility, making RO plants ideal for emergency water supply use. The system would be located near to or on the beach and would require two wells, one located at the unit from which to draw fresh saltwater, the other some distance away in which to discharge concentrated brine. A survey of small RO desalination units suggests that the steady state electric load is approximately 1 kW per 1'000 liter/day of freshwater production capacity.

Several diesel powered RO desalination systems have been installed by a Spanish government aid program in villages along the north coast. During project preparation, it was agreed that it would not be cost-effective to try to integrate these units with the wind-diesel hybrid systems proposed in this intervention. It is being proposed to install smaller units that will run continuously and that will share a common feed water supply with the ice making system. Nevertheless, it is fair to say that the Spanish systems operating independently will make a worthwhile contribution to the region. In the first phase of this project, it is likely that only about half of the north coast villages will receive wind-diesel systems. There will therefore remain many villages without on-site potable water production. Having the additional production capacity of the Spanish desalination units will help to ensure that there is enough potable water produced in the region. Though water may still have to be transported from one village to another, not as much will have to be transported all the way from Nouakchott or other distant wells.

Fish conservation and ice making

One of the main economic activities of the coastal villages is fishing. This activity will benefit greatly from assistance with fish preservation. Some fish, such as "mulet" are fished in the

¹⁰ Excerpted from "Source Book of Alternative Technologies for Freshwater Augmentation in Latin America and the Caribbean", International Environmental Technology Centre, UNEP.

summer (july/august), the hottest season, and preservation is of great concern as it is difficult to transport and store ice, on the land as well as on the boat. Some fishermen even have to reduce their fishing time if they don't want to waste their catch. For the villages that are located closer to the cities, the problem is less critical as they can easily reach the city to sell their fish. Some alternatives such as fish drying are used but during the hottest season, the weather is very humid, so the fish cannot dry well and they spoil. The fishermen try to bring ice on their boat to be able to fish longer.

As part of the project implementation, each village to be electrified will receive a containerized seawater flake ice making system sized to meet the entire village need for ice for fish preservation. Seawater ice will be suitable for fish preservation but not for most other potential uses. Making freshwater ice would greatly increase the required capacity of the desalination system.

For small-scale icemakers, we estimate the steady state electrical load to be 7 kW per MT/day production capacity. The ice-making load is by far the largest load component; indeed, it is almost twice the household load and the desalination load combined. Because it is a deferrable load (the load can be scheduled by the system rather than being dictated by the end user), it is best to oversize the ice making system to be able to take full advantage of frequent periods of excess wind energy, thereby minimizing the amount of diesel generated energy needed for ice production. Thus, for modeling purposes, it was assumed that the icemaker has a capacity of twice the average village requirement, and that it will run with a duty cycle of around 50%.

Livestock/meat conservation and ice making

Another important economic activity concerns livestock, especially in the south coast villages. The conservation of meat is a real concern for the breeders. The requirements are almost the same as for the fishing activities: community refrigeration systems and icing.

Low head irrigation for agriculture

Agriculture is an economic activity in the villages close to the river Senegal. Irrigation is not the major problem, as they get the overflow from the river, but preservation of harvested crops is a real issue. Like the other economic activities, due to the lack of preservation, the people are dependant on the price offered by the buyer at the time.

Power to supply local industries

The main industries already existing in the villages are boat making and sail making. Most of the products related to those industries are made by hand, with no electric tools. The boat making activity could be done with some electrical equipment as the cooperative already has some tools, but erratic electricity supply is their main concern. If a village has a source of power such as a diesel, they are able to make 2 boats every ten months versus only one every ten months without electricity. Electricity will bring an added value to these villages that are going to be able to make more profit from their activities. For the sail making activities, some step-up of production could be realized with electricity. Today, the women of one village can make one sail every three

days. With electricity, some other industries could come in the villages, especially in the villages that are closer to the city of Nouakchott. Some fishing industries, such as net making could become a new source of income for the villages.

Handicraft activities

In the bulk of the villages surveyed, women cooperatives are involved in handicraft activity such as mat making. Lighting could bring them some better conditions of work, and some specific tools could be used to increase their production. The leather work is also a major activity in the villages where livestock is a resources. In most of the cases, the women tan the skins but don't wrap them as it needs to be done with electrical facilities. So the skins are sold in the cities where the major value add is given. Bringing electricity into those villages could help the locals to develop some new leather industries.

Other productive end-use activities based on availability of running power from hybrid systems

Some of the villages, especially the ones in the PNBA have some economic activities centered around tourists. Some places have tourist camps that would need to be electrified for lighting the tents, for a refrigerator and for hot shower facilities. Some new activities such as hair dressing or tire repairs could also become new source of income with the advent of electricity. Along the paved road between Nouakchott and Nouakchott and Tiguent, specific activities are developing quickly as small shops, restaurants, tea stalls, "country inns" (motels), and garages become more commonplace.

Ice making and community refrigeration systems are solutions proposed for the coastal villages. In the villages where the local cooperatives are already well organized, the management of the infrastructure will not be a problem. The recommended mix of renewable and fossil fuel technology for these villages is a hybrid wind/diesel power in 30 kilowatt modules to provide power for individual residences, microenterprises and community needs. Depending on the size of the village, as many as five 30 kilowatt units will be needed.

Survey Results in the Adrar and Inchiri Region

The main energy needs can be grouped in three main categories: domestic need, public need, and business and trade need. The main domestic needs are for lighting and audiovisual. Some more prosperous families may also use electricity for refrigeration. Identified public needs include lighting (for evening lessons for adults, emergency medical interventions, library); audiovisual (for community activities like TV, video, movies, library, board games, etc.); small refrigeration units for veterinary/ health centers; and CB radio and communication.

Specific productive end-use applications of PV-based systems in the ADRAR and Inchiri regions

Pumping of potable drinking water

Water supply is a crucial issue in these regions and the water resources are extremely variable from one village to another and from one season to another, in terms of availability, depth, flow rates, and specific capacity. Drinking water supply infrastructure does not exist everywhere yet. In the majority of Adrar villages, farmers use small pumps (2-4 kW) supplied by diesel or gasoline (2-6 liters/day) to take water from underground (1 to 25m) and to fill reservoirs (< 30 m³) or directly to irrigate fields (10 to 60 m³/day). Inchiri faces a real shortage of fresh water and water is transported by tanks on trucks. The proposed project will help meet the critical need for drinking and irrigation water by providing solar electricity for water pumping. Other specific productive end-uses for the PV-based service delivery in Adrar and Inchiri are presented below.

Livestock farming (refrigeration)

One important economic activity, in particular in the Inchiri region, is linked to livestock farming. The main concern of the breeders is to preserve meat and milk longer. For example, camel milk must be discarded after only 2 or 3 hours at ambient temperature, but can be kept for 24 hours or more in a refrigerator. If the basic food is meat in a rural household (ideally 2 kg/family/day), meat consumption is erratic and is dependant on the needs of other neighbors. The local “butcher” will cut the animal’s throat only if he is sure that all the meat will be sold. One camel is about 250 – 350 kg of meat and cost about 150’000 ouguiyas. Goats and sheep (about 30 kg) are easier to manage. In cold season, people claim that they can keep the meat for 3 to 4 days without refrigeration. Excess meat is sometimes dried but waste and losses are frequent especially in the hot season. Many villages already have local cooperatives for milk or for breeders. These are ideal organizations for centralization of the intended refrigeration activities.

Agriculture (Water Pumping for Low head irrigation) to supplement refrigeration for agricultural produce preservation

Many villages already have local cooperatives with women or farmers to organise the cultivation of vegetables, but water supply, transportation and commercialisation are not collectively managed. Farmers usually use small motopumps for the water supply. Adrar is also a major location for the production of dates in large palm oases. About half of the Adrar vegetable production is from Aoujeft Moughataa, 40% from Atar and 10% from Chinghetti and Ouadane. Pluvial farming has also been experimented with in dry regions which have been victims of groundwater shortage (such as Yagref in Adrar), but irregularity of the rainy season doesn’t allow people to have a reproducible and profitable business.

Some villages around Aoujeft (like Tougad) and Atar (like Tawaz) have several hundred small moto-pumps running every day for cultivation. Due to the harsh environment and use, those low cost pumps last no longer than 6 months and most need to be replaced because they are unrepairable. Moreover, the high flow rate of such pumps is not appropriate to the local fragile

groundwater capacity. Users have to run the pump for ½ hour and then wait another 2 hours before groundwater level is high enough to restart the pump. Operating and maintenance costs are very high. These farm locations can produce an enormous amount of vegetables during 3 months (May-July). For Tawaz alone, annual production (by 400 families) fluctuates between 2'000 and 5'000 tons per year, depending on unpredictable parameters (e.g.rain, locusts). Considering the poor network of roads in the country and the lack of commercialisation management, partial storage of the production is a crucial issue. Huge margins can be expected if vegetables can be sold during the off-season (September – April).

The field survey investigation during the PDF-B exercise concluded that a major challenge for the intended PV-based refrigeration systems could potentially be the seasonal use (3-6 months per year) of the systems. The problem of refrigeration is its seasonal use (3-6 months per year). For example, three cold rooms in Atar (100 m³ each or 300 m³) are connected to the local power grid and run for less than 6 months. However there is a potential complementary use of electrical power for irrigation (during 6 to 9 months between September and April) and for refrigeration (May to September).

Such complementary productive end-uses can be illustrated by the situation in Louebda (Inchiri), where a cooperative with 13 women is producing about 30 kg of vegetables per week per woman. Each woman delivers to the genset operator 20 litres of fuel per week and receives in exchange about 1 m³ of water. It costs each of them 4,000 ouguiyas for the fuel, including transportation. They sell the crop on the market at Akjoujt at about 120 ouguiyas/kg (market prices might fall down to 20-30 ouguiyas/kg at the production peak and up to 200-300 ouguiyas in the off-season). But the common waste for the cooperative is about 100 kg per week (> 25%). A small size refrigeration unit would help the women generate profits, instead of a loss or a breakeven situation.

Food trading (refrigeration for food, fish, meat or vegetables) & Ice Production

Both regions (Adrar and Inchiri) are facing shortages of some food and are importing from other areas either fish, meat or vegetables. This activity is usually done by individuals or small traders and small refrigeration units are highly welcome to improve their business and increase their incomes. Ice production will also be useful for fish and meat transportation.

The purpose of this component is to remove barriers to the provision of PV-based service delivery for all of the above productive end-uses based on the survey results. The management structure for the program will build on the successes and lessons of the existing ADER program together with some key elements from international best practices.

Annex II. Village Selection Criteria

Selection of Villages for Hybrid Systems

The hybrid wind/diesel component will focus on supplying productive end-use electricity to the villages of the north coast between Nouakchott and Nouadhibou (see Exhibit 1 for a map of the area). These villages have been selected because of the potential for socio-economic development tied to the provision of electricity, including: (i) the fishing industry and related activities such as boat building can improve productivity and lower costs with access to ice making¹¹, electric power tools, etc.; and (ii) commerce and small enterprise are expected to grow along the coast as the first hard surface road linking Nouakchott and Nouadhibou is built.

The original project concept supported by the PDF-B proposal suggested that the hybrid mini-grid solution would cover 15-20/25 villages on the North Coast representing an estimated population base of 8,000 households or more. As presented in Annex IV, a total of 25 villages were surveyed on the coast; i.e. 9 villages classified in the North Coast inside the PNBA¹², 4 villages in the North Coast outside the PNBA, 5 villages on the South Coast (non-seaside villages); and, 7 villages on the South Coast classified as seaside villages per the summary table in Annex IV. Had the project sponsors decided to cover the entire set of 25 villages surveyed during PDF-B, total project target population for the hybrid component would have been sensibly close to the original PDF-B estimate using an approximate number of households per village in the range of 200 to 300 or more in a few instances.

For these coastal villages, it was quite clear that the budgetary resources suggested by both the government and UNDP-GEF at project planning/design stage and prior to the recent involvement of the AfDB for implementing the recommended solutions would be inadequate to respond to all of the needs identified during the field surveys and addressed in the underlying feasibility report. Nevertheless, it was agreed with the relevant local actors that, by necessity, this innovative project has to be limited in scope to be manageable and to ensure operational effectiveness. Given that the underlying weaknesses of the Executing Agency designated by Government (ADER) is bound to take some time to be corrected as in most institutional strengthening efforts, it was sensible to take into account the absorption capacity of all key stakeholders in calibrating the resources for the hybrid component and the overall project budget.

The question became whether to:

- a) spread the resources thin to obtain coverage as wide as possible, thus running the risk of declining performance, eventual failure of systems and sustained public skepticism; or
- b) limit coverage with an aggressive approach toward reliability, quality of service, and system financial solvency that generates investment funds for new resources in other

¹¹ 20% to 30% of fishing production spoils on average due to the lack of ice making capability required to freeze the fish before it is transported to urban markets.

¹² The PNBA has been operating since 1980 and has the mission to protect the biodiversity of the region, through conserving the traditions and good management of the resources. But Park management also wants to offer the people the right to live in the same conditions as other people in the country. In order to be successful in this mission, they have a 5 year plan of development, wherein one of the goals of the park is to have an egalitarian system of development between the villages. In addition an ecotourism project is going to be implemented, creating cultural centers in most of the villages.

villages. This approach carries with it the hope of sustainable energy supply, economic growth and public confidence with a significant likelihood of mainstreaming the intended applications of productive end-uses of renewable energy.

The current proposal calls for providing productive end-use electricity coverage to some 380 households in 7 coastal villages through hybrid systems despite the fact that the feasibility studies have carried out in-depth investigations for up to 13 villages out of the 25 villages initially surveyed. The decrease from 13 to 7 villages was a tactical decision driven by the need to ensure the full implementation of productive end-uses of electricity with dedicated community end-use equipments and to allow the government to fully gain ownership of the hybrid technology and consolidate the experience/knowledge accumulated through this pioneering initiative into much larger national programs at a later time. This would ideally happen once the basic institutional actors have gone through the learning curve and witnessed the removal of various barriers to sector development. As a result of the funding estimates once the reduced geographical coverage was consensually agreed to, the project concept was reshuffled and strengthened to support the deployment of desalination plants and ice making equipment in all 7 villages at a realistic cost of US\$940,000. The decision to provide ice making capability will allow local populations to improve the economic rate of return from fishing activities by reducing the spoilage that currently accounts for 20-30% of the catch. By enabling the villagers to freeze the fish, they will be able to bypass the middleman and sell it directly to urban markets at a higher price. Secondary economic activities tied to boat building and sail making are also expected to grow. Desalination equipment is considered essential by local populations that must purchase imported fresh water as highly inflated costs or do with brackish water. With the upcoming construction of the Nouakchott-Nouadhibou hard surface road, economic activity is expected to increase in these villages through commerce and light industry (e.g., car/truck repair). However, economic activity and population growth will be constrained without sufficient supplies of fresh water.

The government of Mauritania and ADER agreed that the proposed financing will support the electrification of 7 villages on the North Coast (see Table 2 for the list of potential sites) with the understanding that other government led programs will ensure replication of the scheme based on the expected success. The final list will be determined during the project execution phase from this list. It is proposed that the villages inside the National Park of the Banc d'Arguin (PNBA) be electrified first. Since they are located inside a national park, the use of environmentally sensitive RET-based solutions such as wind power to provide energy to those villages is very appropriate and rather timely.

Based on a study conducted by a Canadian firm in January 2003, the monthly average wind speed varies approximately linearly between a minimum of 6.1 m/s in December and a maximum of 10.4 m/s in June (see Exhibit IIA).

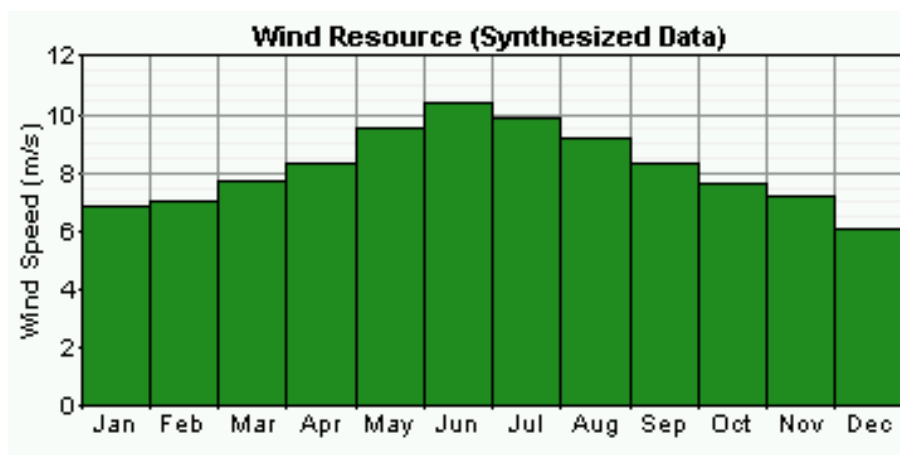


Exhibit IIA: Wind Resources on Mauritania's North Coast

Selection of Villages for Solar PV Applications

The project will target 50 villages in a few concentrated areas of Adrar and Inchiri. These two regions were selected because they provide an optimal setting to carry out two government objectives tied to rural electrification: (i) increase access of rural populations to electricity in order to reduce poverty and increase economic development; and (ii) encourage the regrouping of populations in rural centers to reduce the cost of providing basic services.

While the original project scope focused on the Adrar region, field work carried out during the preparatory assistance phase strongly recommended the inclusion of the Inchiri region as well. This region was included because of its proximity to the capital city (it is located between Nouakchott and Adrar), its potential for economic development, and the scarcity of infrastructure in most villages. ADER has not yet provided solar panels in this region. Inchiri province (Moughataa) has a very low rural population density with about 20 small villages. Each village has between 10 and 100 households and has a very scattered population, up to sometimes 5 km away from the “center”. The total number of rural households in Inchiri is only about 500 and none are electrified yet (except for a few private initiatives with solar modules or car batteries).

The Adrar region has a slightly higher population than its neighbors (Inchiri and Tiris Zemour) and is more geographically stable because of the presence of more farmers (see Exhibit 2). There are more than 100 villages with over 10,000 households scattered over the desert land. The existing ADER project has delivered about 1,000 solar home systems for domestic use in 40 Adrar villages, corresponding to approximately 25% penetration rate. Those villages have between 10 and 230 households (average is 85) but the number of installed solar kits varies between 1 and 86 per village (average is 25). Today, the unsatisfied demand recorded by ADER is more than double the present supply in all villages, and the proposed project is viewed with much interest by villagers still waiting for electricity, principally for community and productive end-uses.

Typical households in the region are rather small; usually one room, sometimes two, plus one additional small kitchen outside. Average families use mainly candles (about 60% of

households) and flashlights (about 35%). Other families rely on butane gas, kerosene and car batteries. More than 75% of households spend less than 2,000 ouguiya/month (US\$7.41) for lighting and audiovisual consumption, while a small number (5%) spend more than 3,000 ouguiya/month (US\$11.11). For example, recharging a car battery (to power a TV) costs 200 ouguiya/charge (US\$0.74).

Given the prohibitive cost of extending the electricity grid to remote rural villages spread over a large geographic area, solar PV technology is an appropriate alternative RET that makes use of the tremendous solar resources in the Sahara Desert. Solar PV technology is also more appropriate for poorer communities that may not be able to afford the prohibitively high cost of diesel fuel after it has been transported hundreds of miles to inland destinations. Productive end-use applications are closely tied to the availability of electricity for community uses such as water pumping for agriculture, communal refrigerators to preserve meat and other produce, and power for community applications such as schools, health clinics and libraries.

Based on the socio-economical surveys done previously by ADER in those villages and data collected during the PDF-B phase, the principal family enterprise in Inchiri is breeding of animals. On average, 15% are employed in cities (Nouakchott and Akjoujt) and another 15% are shopkeepers and traders along the main road. Several villages have a small bakery and sometimes butchers and farmers, but economic activities are still very low in most villages. Dwellings vary widely from one village to another; some villages are 90% small “solid buildings” and some are 90% flimsy houses (shanty, tent, grass hut). Almost all have primary schools and mosques. A few have small health centres. For their energy consumption, average families use mainly candles (about 60% of households) and flashlights (about 35%). Others use gas, kerosene, solar, and car batteries. It is noted that more than 75% of households spend less than 2'000 ouguiyas/month for lighting and audiovisual consumption, and very few (5%) spend more than 3'000 ouguiyas/month. Very few shops have gas refrigerators¹³ for meat and drinks along the main road, but when they do have refrigeration, the temperature is far above 10°C and meat can only be stored 2 or 3 days.

Several villages see their population increase greatly in winter time (Guetna holidays). The largest village in the province is Benichabe, which is characterised by water pumping and storage to supply the province capital (Akjoujt) with fresh water and bottled mineral water. Only 10% of the 100 households in this village benefit from the electricity generated by the diesel powered pumping station. Except for the centre of the village (50%) that is rather concentrated, the other households are widely scattered as in all other villages in Inchiri.

¹³ Gas refrigeration for small shops : about 1 GPL gas bottle (12 kg) / 7-10 days at 2'000 – 2'500 ouguiyas = about 8000 ouguiyas/month.

ANNEX III: List of Candidate Villages for Solar Kit Components

#	Wilaya (Region)	Moughataa	Commune	Village
1	Adrar	Atar	Atar	Amarya II
2	Adrar	Atar	Atar	Voum Chour
3	Adrar	Atar	Atar	R'Keina
4	Adrar	Atar	Atar	Terwen Ziret
5	Adrar	Atar	Tawaz	Tedh
6	Adrar	Atar	Tawaz	Tezegrez
7	Adrar	Atar	Tawaz	Lemaidher
8	Adrar	Atar	Tawaz	M'Heimine
9	Adrar	Atar	Tawaz	N'Watil
10	Adrar	Atar	Tawaz	T'Weizeguet Rag
11	Adrar	Atar	Tawaz	Taryouvet
12	Adrar	Atar	Tawaz	Amdeir Sghir
13	Adrar	Atar	Ain Ehel Taya	Hamdoun
14	Adrar	Atar	Ain Ehel Taya	Eweinet Dhmeine
15	Adrar	Atar	Ain Ehel Taya	Teyzenet
16	Adrar	Atar	Ain Ehel Taya	Kediwar
17	Adrar	Atar	Ain Ehel Taya	Jalla
18	Adrar	Atar	Choum	El Hadra
19	Adrar	Aoujeft	Aoujeft	Ijechane
20	Adrar	Aoujeft	Madene	Rag Varoune
21	Adrar	Aoujeft	N'Teirguent	El Bhgua
22	Adrar	Aoujeft	N'Teirguent	El Maoussae
23	Adrar	Aoujeft	N'Teirguent	Eitmarene
24	Adrar	Aoujeft	Medah	Tekamerte
25	Adrar	Aoujeft	Medah	Erchatt
26	Adrar	Aoujeft	Medah	Tenemrourett
27	Adrar	Aoujeft	Medah	Jedida Medah
28	Adrar	Aoujeft	Medah	Azweigua
29	Adrar	Chinghuiti	Chinguiti	Abeir
30	Adrar	Chinghuiti	Chinguiti	El Berbara
31	Adrar	Chinghuiti	Chinguiti	Leaweina
32	Adrar	Chinghuiti	Chinguiti	Graret Legtar
33	Adrar	Chinghuiti	El Ain Savra	J'Wali Maham
34	Adrar	Chinghuiti	El Ain Savra	N'beika
35	Adrar	Chinghuiti	El Ain Savra	Lebheir
36	Adrar	Chinghuiti	El Ain Savra	Ereidh
37	Adrar	Ouadane	Ouadane	Tenewcherett
38	Adrar	Ouadane	Ouadane	R'Gueiwia
39	Adrar	Ouadane	Ouadane	Enewj
40	Inchiri	Akjoujt	Akjoujt	Aghesremett
41	Inchiri	Akjoujt	Akjoujt	Tabrenkout
42	Inchiri	Akjoujt	Akjoujt	Loueibda
43	Inchiri	Akjoujt	Akjoujt	Khayata
44	Inchiri	Akjoujt	Benichab	Benichab
45	Inchiri	Akjoujt	Benichab	El Asma
46	Inchiri	Akjoujt	Benichab	Lebeidhatt

#	Wilaya (Region)	Moughataa	Commune	Village
47	Inchiri	Akjoujt	Benichab	El Mechroue
48	Inchiri	Akjoujt	Benichab	Berjeimatt
49	Inchiri	Akjoujt	Benichab	El Guareh
50	Inchiri	Akjoujt	Benichab	Demane

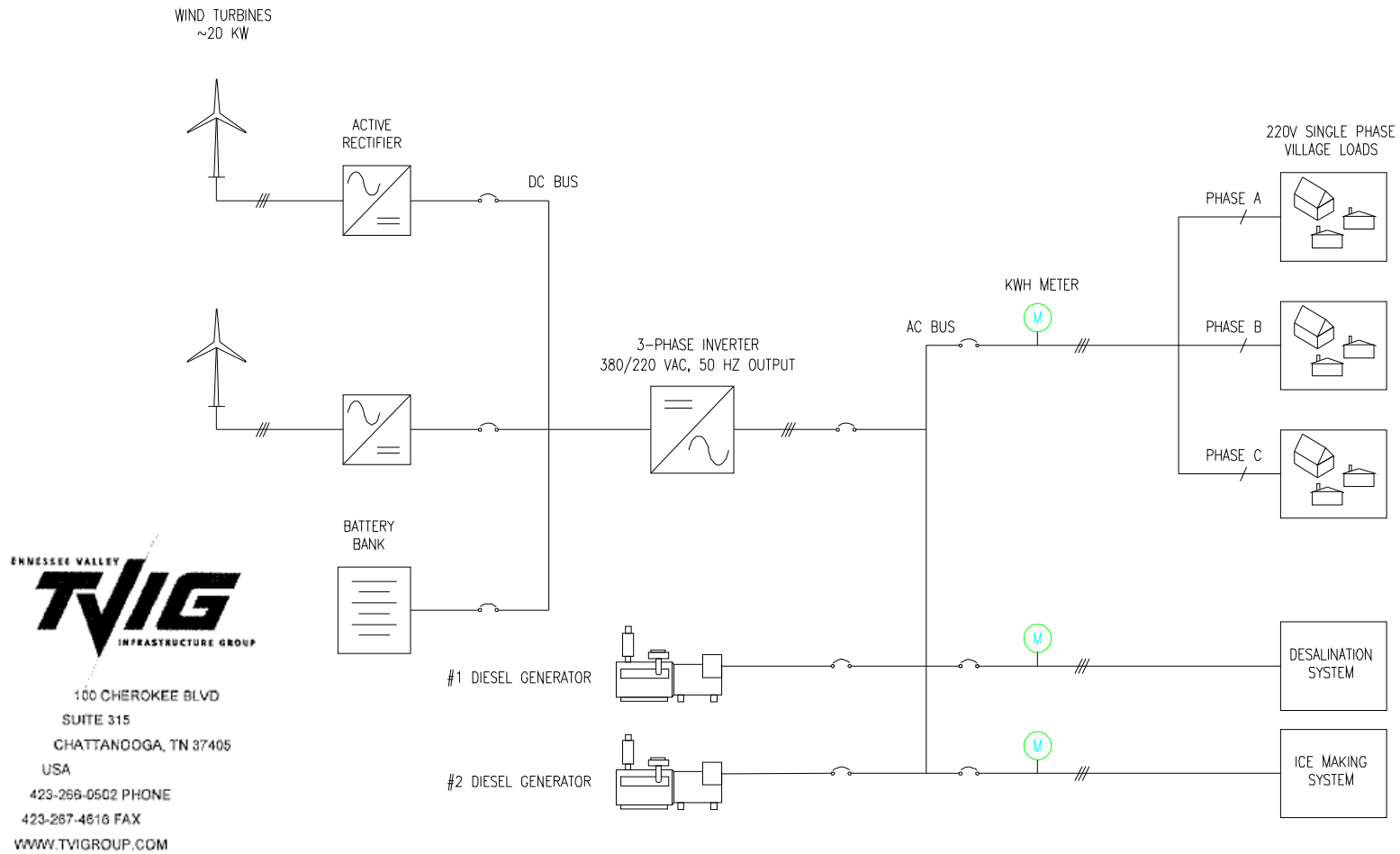
ANNEX IV: Socio-Economic Analysis of Coastal Villages (Hybrid Systems)

Village category	NORTH COAST - INSIDE PNBA									NORTH COAST - OUTSIDE PNBA				SOUTH COAST - NON-SEASIDE VILLAGES				SOUTH COAST – SEASIDE VILLAGES							
Name of the village	Tenalloul	Iwik	Arkeis	Agadir	Tessot	Teichott	R'Queiba	Angeij	Mamghar	El Maïrat	Tiwilit	Limsit	Belawakh	Jder	Kvarda	Twerja	Hassi Boujerna	Tigent	N'Beigna	N'Diogo	N'Boyo	Diaoss	Dar Salam	Zira 2	Biret
Population																									
Nb of inhabitant	160	180	45	80	140	180	170	20	1000									2000							
Nb of families	30	30/75	10	20	20/30	50	40	5	300	100	20	20	60/70	100	90	65	120	500	100	300	70	70	35	130/600	250
Nb of house	100	100	30	50	80	100	90	7																	
Economical resources																									
Fishing	X	X	X	X	X	X	X	X	X	X	X	X	X							X	X	X	X	X	X
Boat making							X																		
Sail Making						X																			
Tourist	X	X	X	X	X	X			X																
Livestock														X	X	X	X	X	X	X			X	X	X
Agriculture																			X	X	X	X	X	X	X
Commerce									X	X	X	X	X	X	X	X	X	X		X				X	X
Other activity													X	X	X	X	X	X					X	X	X
Actual electrical situation																									
No electricity	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X		X	X	X	X	X		
Partial electrificat.									X									X						X	X
Possibility for actual or future other electrification project																									
AFD project																				X					
ADER or Other									X									X						X	X
Future electrical needs																									
Domestic	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Public	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Business and trade	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Local ground water resources																									
Saline	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X			
Brackish														X	X	X	X		X	X			X	X	X

Decentralized Electrification in Mauritania

Village category		NORTH COAST - INSIDE PNBA									NORTH COAST - OUTSIDE PNBA				SOUTH COAST - NON-SEASIDE VILLAGES					SOUTH COAST – SEASIDE VILLAGES							
Name of the village		Tenalloul	Iwik	Arkeis	Agadir	Tessot	Teichott	R'Gueiba	Augeij	Mamghar	El Majirat	Tiwilit	Limsit	Belawakh	Jder	Kvarda	Twerja	Hassi Boujerna	Tigent	N'Beigua	N'Diago	N'Boyo	Diaoss	Dar Salam	Zira 2	Birett	
	Potable																		X								
Possibility for actual or future water supply																											
	Aftout project														X	X	X	X	X								
	Desalination Spanish coop	X	X			X	X	X																			
	Japanese (JICA)									X																	
Systems needed for water supply today																											
	Desalination			X	X				X	X	X	X	X	X	X	X	X	X			X	X	X				
	Purification																			X				X	X	X	
	Pumping																		X	X				X	X	X	

ANNEX V: Proposed Wind-Diesel Hybrid System Architecture for Coastal Villages



ANNEX VI: Sample Bid Specifications For Hybrid Mini-Grid Systems

1. Sample Bid Specification for Supply of Wind Diesel Hybrid Systems for Costal Villages in Mauritania

The attached Report/TOR details the situation and a possible technical approach to providing wind-diesel hybrid systems for costal villages in Northern Mauritania.

Bidders are requested to provide a comprehensive package that will provide energy, water desalination and ice-making capability for the maximum number of villages.

The budget for this project is US\$

The successful bidder's response will:

- Maximize use of renewable energy
- Minimize use of fossil fuels
- Provide the maximum amount of energy and drinking water at the lowest cost to the largest number of end use consumers
- Provide initial customer service connections, including prepayment meters
- Provide an administrative infrastructure for each village unit
- Provide a spare parts inventory and a support structure for maintenance of systems once construction is complete and operation is turned over to a private contractor
- Provide operations and preventive maintenance specifications for the supplied systems
- Provide a warranty for systems operated within the above specifications
- Provide in-country technical support for the systems to support the warranty
- Provide an installation schedule

The successful bidder will design, procure, ship, install, test and commission the equipment.

The successful bidder will train personnel from the selected private sector operations contractor to operate and maintain the systems within the warranty specifications, to connect new customers, to collect revenue through the prepaid metering systems and to give ADER and overview of system design and performance characteristics.

ADER will pay for all taxes, customs duties, port clearances and other fees.

The successful bidder for supply of the physical systems may also bid for the separate operations and maintenance contract, or may partner with another firm to jointly bid for both.

The successful bidder will be able to adequately demonstrate that they have the following experience:

- Developing, operating, and maintaining small power systems in emerging economies
- Building project teams to address unique and challenging energy projects
- Operating, and maintaining desalination and water treatment equipment
- Providing business models and financial solutions for operation of small scale energy systems
- Implementation and use of prepaid metering systems
- Forecasting rural user demand and planning for capacity expansion
- Managing load with wind/diesel hybrid systems
- Operating a power system in a region of very high environmental sensitivity

2. Sample Bid Specification for Administration, Operations and Maintenance of Wind Diesel Hybrid Systems for Coastal Villages in Mauritania

The attached Report details the situation and a possible approach to operations and maintenance of wind-diesel hybrid systems for coastal villages in Northern Mauritania.

Bidders are requested to recommend a comprehensive *two-year* contract structure to provide administration, operation and maintenance (AO&M) of the energy, water desalination and ice-making equipment for the villages. The contractor's goal is to encourage customer service, load growth and economic development, and the contract structure bid should encourage this result.

The contract may be re-negotiated and extended after the first year anniversary of the contract.

The successful bidder's response will:

- Be financially self-supporting through energy and water sales revenue after the first six months of operation. Subsidies may be required from ADER *for fuel only* during the first six months, but bids will be in part evaluated based on the size of the subsidies required. This portion of the bid will be supported by *pro forma* financial projections.
- Provide the maximum amount of energy and drinking water at the lowest cost to the largest number of consumers
- Provide a tariff-setting formula and process that is verifiable by ADER
- Provide a profit for the bidder that is directly proportional to energy supplied to and paid for by end-use consumers
- Provide for monthly operations performance summaries, customer service metrics, financial balance sheets, income and cash flow statements to ADER by the 15th day of each following month
- Minimize use of fossil fuels
- Provide a detailed Customer Service Plan
- Provide a detailed plan for preventive and corrective maintenance
- Provide a detailed plan for minimizing technical and non-technical system losses
- Provide operations bond or other form of surety for two years of operations

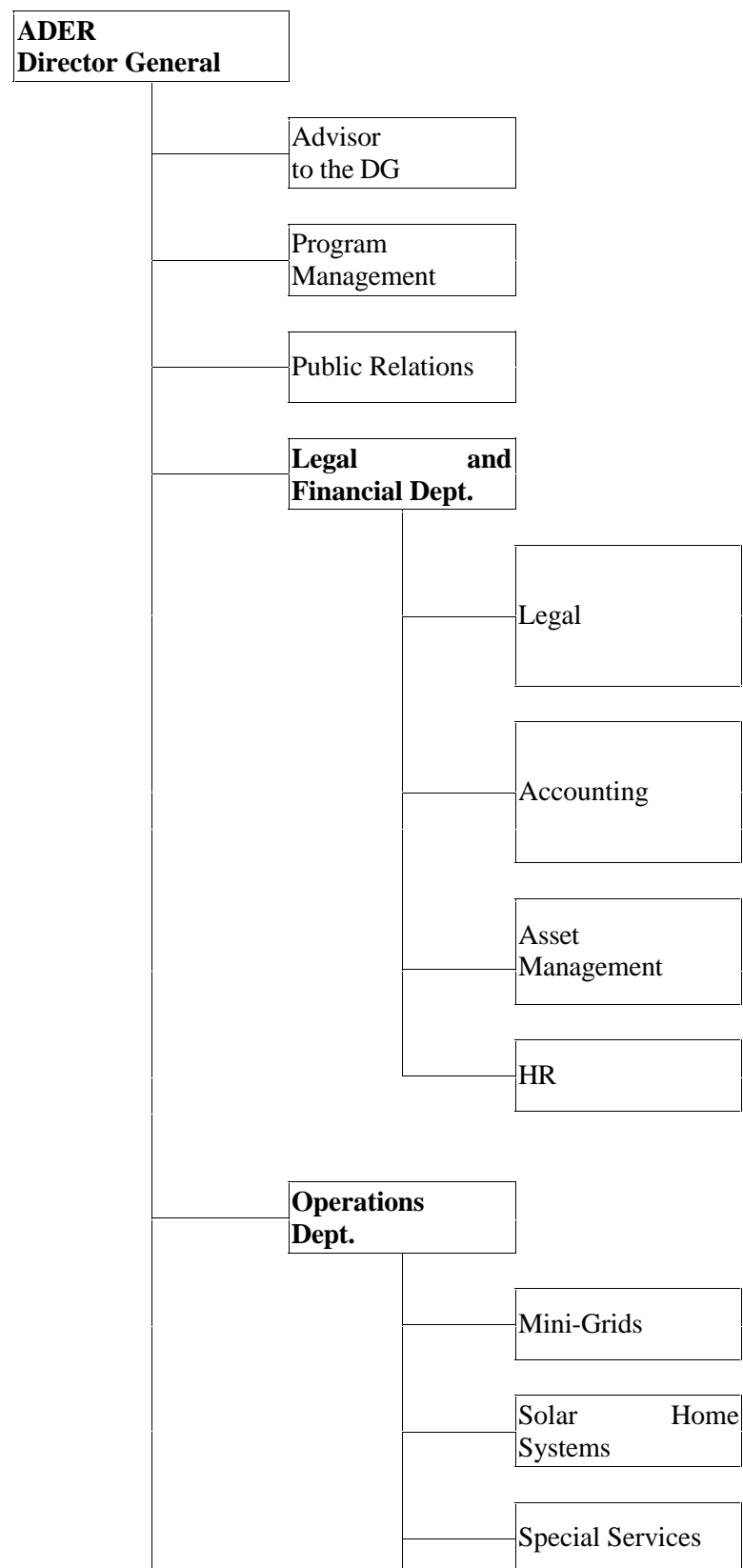
The successful bidder will receive training of its personnel from the system supplier.

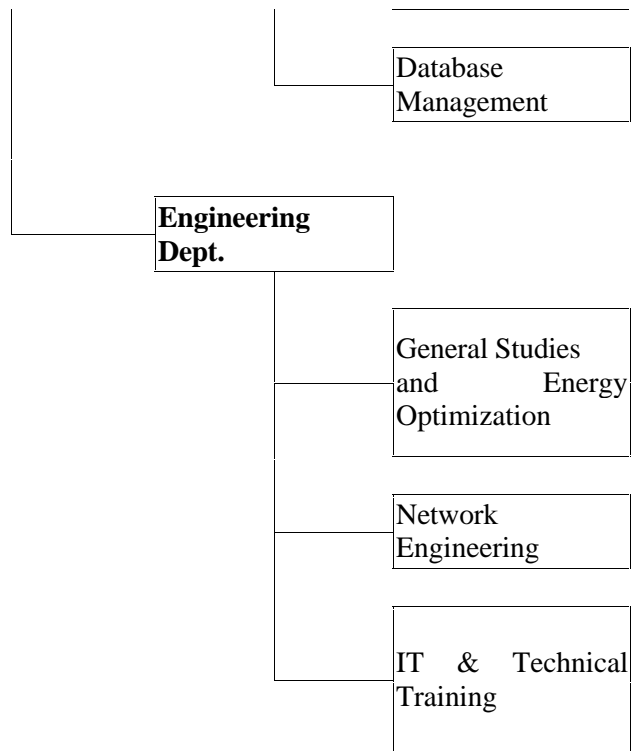
ADER will pay for all capital expansions, warranty fees and for corrective maintenance for catastrophic system failures determined not to be the fault of the AO&M contractor.

The successful bidder for the AO&M contract may also bid for the supply of the physical systems or may partner with another firm to jointly bid for both.

The successful bidder will be able to adequately demonstrate the following experience:

- Developing, operating, and maintaining small power systems in emerging economies
- Building project teams to address unique and challenging energy projects
- Operating, and maintaining desalination and water treatment equipment
- Providing business models and financial solutions for small scale energy systems
- Implementation and use of prepaid metering systems
- Forecasting rural user demand and planning for capacity expansion
- Managing load with wind/diesel hybrid systems
- Operating a power system in a region of very high environmental sensitivity

ANNEX VII: Proposed New Organization Chart for ADER



ANNEX VIII: Cost and Performance Results for Different Village Groupings

	7 Village	11 Village	12 Village
Nominal Number of Households	380	380	480
Number of 30 kW Wind Turbines	19	19	24
Nominal Battery Capacity (kWh)	972	1026	1242
Total Primary Load Served (kWh)	827,349	827,364	1,045,079
Total Ice Making Load Served (kWh)	1,395,130	1,383,536	1,750,240
Total Installed Cost of Power System	US\$ 4,176,140	US\$ 4,971,840	US\$ 5,900,440
Annualized Total Cost	US\$ 537,256	US\$ 686,966	US\$ 802,196
Average Levelized COE (US\$/kWh) (Full Cost Recovery)	US\$ 0.242	US\$ 0.311	US\$ 0.287
Average Annualized O&M + Fuel Cost	US\$ 164,411	US\$ 242,132	US\$ 274,331
Average Levelized COE (US\$/kWh) (Operating Cost Recovery Only)	US\$ 0.074	US\$ 0.110	US\$ 0.098
Total Cost of Desalination Equipment	US\$ 420,000	US\$ 670,000	US\$ 770,000
Total Cost of Ice Making Equipment	US\$ 520,000	US\$ 820,000	US\$ 960,000
Total Distribution Grid, End-User Connections and Miscellaneous Costs	US\$ 512,000	US\$ 646,000	US\$ 763,000
Total Capital Cost	US\$ 5,628,140	US\$ 7,107,840	US\$ 8,393,440
Diesel Fuel Consumed (liters)	60,509	78,325	95,334
CO₂ Reduction (MT/year)	1,845	1,829	2,308

ANNEX IX: Detailed Hybrid Wind/Diesel System Costs By Village

Village	Nominal Number of Households	Number of 30 kW Wind Turbines	Diesel Generator Size (kW)	Inverter Size (kW)	Nominal Battery Capacity (kWh)	Primary Load Served (kWh)	Ice Making Load Served (kWh)	Total Installed Cost (Power System Only)	Levelized COE (US\$/kWh)	Annualized Total Cost	Annualized O&M + Fuel Cost	Renewable Fraction	Diesel Fuel Consumed (liters)	Diesel Run Time (hrs)
Agadir	20	1	10	25	54	43 546	71 022	US\$ 344 860	US\$ 0,463	US\$ 52 988	US\$ 21 984	0,87	6 965	1 757
Arkeiss	20	1	10	25	54	43 546	71 022	US\$ 344 860	US\$ 0,463	US\$ 52 988	US\$ 21 984	0,87	6 965	1 757
Awguej	20	1	10	25	54	43 546	71 022	US\$ 344 860	US\$ 0,463	US\$ 52 988	US\$ 21 984	0,87	6 965	1 757
Limsid	20	1	10	25	54	43 546	71 022	US\$ 344 860	US\$ 0,463	US\$ 52 988	US\$ 21 984	0,87	6 965	1 757
Tiwilit	20	1	10	25	54	43 546	71 022	US\$ 344 860	US\$ 0,463	US\$ 52 988	US\$ 21 984	0,87	6 965	1 757
Iwik	40	2	20	40	108	87 093	146 668	US\$ 491 720	US\$ 0,278	US\$ 65 051	US\$ 21 181	0,94	6 448	1 081
R'Gueiba	40	2	20	40	108	87 093	146 668	US\$ 491 720	US\$ 0,278	US\$ 65 051	US\$ 21 181	0,94	6 448	1 081
Ten-Alloul	40	2	20	40	108	87 093	146 668	US\$ 491 720	US\$ 0,278	US\$ 65 051	US\$ 21 181	0,94	6 448	1 081
Tessot	40	2	20	40	108	87 093	146 668	US\$ 491 720	US\$ 0,278	US\$ 65 051	US\$ 21 181	0,94	6 448	1 081
Belawakh	60	3	30	60	162	130 631	220 877	US\$ 640 330	US\$ 0,230	US\$ 80 911	US\$ 23 744	0,95	8 854	991
Teichott	60	3	30	60	162	130 631	220 877	US\$ 640 330	US\$ 0,230	US\$ 80 911	US\$ 23 744	0,95	8 854	991
M'Heijratt	100	5	50	110	216	217 715	366 704	US\$ 928 600	US\$ 0,197	US\$ 115 230	US\$ 32 199	0,94	17 009	1 145
TOTAL	480	24	NA	NA	1 242	1 045 079	1 750 240	US\$ 5 900 440	NA	US\$ 802 196	US\$ 274 331	NA	95 334	NA

ANNEX X: Detailed Solar Equipment Cost

1 € = 1,30 \$

1 € = 340 UM

1 \$ = 262 UM

1 € = 1,30 \$		SIS		SIS		SCS		SPS		SPS		SPS		SRS		SRS		
1 € = 340 UM		20 Wp		50 Wp		300 Wp		500 Wp		700 Wp		900 Wp		2200 Wp		5000 Wp		
1 \$ = 262 UM																		
Cost Price of Solar Systems (USD- exc.Tax)		260		260		260		260		260		260		260		260		UM/US
Expenses	Equipment supply	Module + support	170,00	330,00	1950,00	3250,00	4550,00	5850,00	13000,00	35%	29900,00	42%						
		Battery	70,00	130,00	1430,00	-	-	-	3250,00	9%	4550,00	6%						
		Battery box	-	-	-	-	-	-	-	-	-	-						
		BCR	50,00	70,00	200,00	-	-	-	460,00	-	910,00	-						
		Prepayment system or meter	-	-	130,00	-	-	-	-	-	-	-						
		Inverter	-	-	1110,00	650,00	910,00	1040,00	1560,00	4%	3250,00	5%						
		Remote data logger	-	-	-	-	-	-	650,00	-	650,00	-						
		Cables	20,00	50,00	200,00	130,00	130,00	130,00	780,00	-	1560,00	-						
		Electrical appliance (Light-pump-refrigerator-TV)	30,00	70,00	2600,00	650,00	780,00	910,00	9100,00	24%	15600,00	22%						
		Electrical accessories (switch, plug, connectors)	50,00	80,00	330,00	330,00	330,00	330,00	1560,00	-	3250,00	-						
		Grounding	-	-	70,00	70,00	70,00	70,00	390,00	-	650,00	-						
		Diesel Genset	-	-	-	-	-	-	1300,00	-	1300,00	-						
		Transport (ex work - on site)	70,00	90,00	130,00	200,00	200,00	200,00	650,00	-	1300,00	-						
		Installation	60,00	80,00	330,00	520,00	520,00	520,00	1300,00	-	1950,00	-						
		Civil engineering	-	-	-	200,00	200,00	200,00	0,00	-	0,00	-						
		Miscellaneous (5-10%)	50,00	90,00	520,00	520,00	520,00	520,00	3250,00	-	6500,00	-						
	O & M (2 yrs)	Battery collection & export (for recycling)	10,00	10,00	130,00	-	-	-	390,00	-	650,00	-						
		O&M - Private company (warranty 2 years)	130,00	160,00	1040,00	1300,00	1560,00	1820,00	7800,00	-	10400,00	-						
		O&M - ADER costs	-	-	-	-	-	-	-	-	-	-						
		Fuel cost	-	-	-	-	-	-	-	-	-	-						
		Money collection - ADER costs	10,00	30,00	130,00	130,00	130,00	130,00	780,00	-	1300,00	-						
	Others	Money collection - local operator costs	10,00	30,00	200,00	260,00	260,00	260,00	1300,00	-	2600,00	-						
		Management & Supervision - ADER costs	10,00	10,00	70,00	130,00	130,00	130,00	520,00	-	780,00	-						
		Training, Promotion, Awareness - ADER costs	50,00	50,00	260,00	330,00	330,00	330,00	2080,00	-	2600,00	-						
		Supervision - TA costs	10,00	10,00	130,00	130,00	130,00	130,00	520,00	-	780,00	-						
		Promotion - awareness - TA costs	30,00	30,00	130,00	130,00	130,00	130,00	1040,00	-	1300,00	-						
Total for Equipment supply		570	69%	990	75%	9000	81%	6520	73%	8210	75%	9770	77%	37250	72%	71370	78%	
Total for O&M (2 years)		160	19%	230	17%	1500	14%	1690	19%	1950	18%	2210	17%	10270	20%	14950	16%	
Total for others		100	12%	100	8%	590	5%	720	8%	720	7%	720	6%	4160	8%	5460	6%	
Total Cost Price (USD)		830,00	\$	1320,00	\$	11090,00	\$	8930,00	\$	10880,00	\$	12700,00	\$	51680,00	\$	91780,00	\$	
Total Cost Price (UM)		215 800	UM	343 200	UM	2 883 400	UM	2 321 800	UM	2 828 800	UM	3 302 000	UM	13 436 800	UM	23 862 800	UM	
Wp cost (USD)		41,50	\$	26,40	\$	36,97	\$	17,86	\$	15,54	\$	14,11	\$	23,49	\$	18,36	\$	

SIGNATURE PAGE

Country: _____

UNDAF Outcome(s)/Indicator(s):

(Link to UNDAF outcome., If no UNDAF, leave blank)

Expected Outcome(s)/Indicator (s):

(CP outcomes linked t the SRF/MYFF goal and service line)

Expected Output(s)/Indicator(s):

(CP outcomes linked t the SRF/MYFF goal and service line)

Implementing partner:

(designated institution/Executing agency)

Other Partners:

Programme Period: _____

Programme Component: _____

Project Title: _____

Project ID: _____

Project Duration: _____

Management Arrangement: _____

Total budget: _____

Allocated resources: _____

• Government _____

• Regular _____

• Other: _____

○ Donor _____

○ Donor _____

○ Donor _____

• In kind contributions _____

Agreed by (Government): _____

Agreed by (Implementing partner/Executing agency): _____

Agreed by (UNDP): _____