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UTILISATION OF SOLAR AND WIND ENERGY FOR RURAL WATER SUPPLY IN ETHIOPIA

APPRAISAL REPORT

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LIST of ABBREVIATIONS and ACRONYMS

AC	Alternating Current
AMWS	Annual Mean Wind Speed
AWF	African Water Facility
ETB	Ethiopian Birr (Ethiopian Currency)
EEPCO	Ethiopian Electric Power Corporation
DC	Direct Current
FPIU	Federal Project Implementation Unit of RWSSP
GOE	Government of Ethiopia
ICB	International Competitive Bidding
MDG	Millennium Development Goals
MoFED	Ministry of Finance and Economic Development
MoWR	Ministry of Water resource
NCB	National Competitive Bidding
PCU	Project coordination unit of RWSSP
PV	Photovoltaic
REBWSS	Renewable Energy Based Water Supply Schemes
RPIU	Regional Project Implementation Unit of RWSSP
RWB	Regional Water Bureau
RWSSP	Rural Water Supply and Sanitation Program, financed by ADB and other donors
RWSSD	Rural Water Supply and Sanitation Department
SO_2	Sulphur Dioxide
SWERA	Solar and Wind Energy Assessment
UAP	Universal Access Program for water supply and sanitation services
Woreda	The smallest administrative Unit in Ethiopia
Wp	Watts Peak
WSDP	Water Supply Development Program
WWD	Woreda Water Desk
WWCOM	Woreda Water committee
UNEP	United Nations Environmental programme

CURRENCY

Local Currency	:	Ethiopian Birr (ETB)
1 Euro (€)	:	10.634 ETB (ADB exchange rate November 2008)

MEASURES

km	=	kilometers
kW	=	kilowatts
MW	=	Megawatt**s**
m^3	=	cubic meter
m/s	=	Meters per Second
m^4	=	measure of pumping capacity (Product of volume in m^3 and head in m)

LOGICAL FRAMEWORK ANALYSIS

HIERARCHY of OBJECTIVES	EXPECTED RESULTS	REACH BENEFICIARIES	PERFORMANCE INDICATORS	INDICATIVE TARGETS and TIMEFRAME	ASSUMPTIONS/ RISKS >MITIGATON MEASURES
GOAL : Wide spread use of wind and solar technologies for rural water supply in Ethiopia.	**IMPACT:** • An increased and sustained supply of water at lower financial, economic, environmental and social costs than with fossil fuel powered pumping systems. • Improved quality of life due to availability of adequate water supply in rural areas supplied with solar or wind powered pumping systems	• Populations in areas not supplied from the electric grid, representing 83% of inhabitants • Water related institutions in the country	**Indicators**: 1. National targets for WSS to rural areas off the electric grid 2. Improvements in quality of life statistics related to water. **Source**: National statistics and reports **Periodicity**: Annual review	1. National UAP target of 98% access to WSS 2. Quality of life statistics comparable with those of middle income countries	• Lack of funds to meet the incremental capital costs of solar or wind technologies > appropriate policies and funding mechanisms will be put in place • Availability of technical expertise, and adequate numbers of private sector suppliers of equipment, spare parts and maintenance services > a pro-active approach to support the private sector through appropriate procurement strategies.
PURPOSE/OBJECTIVES: Promote and pilot the use of solar and wind energy for water pumping in rural areas of Ethiopia	**OUTCOMES:** • Increased demand for solar/wind technologies from end-users and stakeholders • Solar/wind pumping tech systematically considered as options in design of water pumping systems and implemented when viable • Local privates sector provides supply of equipment and after sales services including spare parts	• End-users, water service providers • Design engineers, consultants involved in water project designs • Local manufacturers of windmills, appurtenant works; retailers, local mechanics	**Indicators**: 1. Trend in the number of schemes with solar/wind tech. for pumping specified 2. Number of suppliers and technicians supporting the technologies **Source**: Baseline data collected during assessment, National statistics and water sector reports **Periodicity**: Annual review	1. Solar or wind energy utilised in all viable locations in response to expressed demand, by end of project 2. Suppliers and technicians available in all regions within 5 years	
ACTIVITIES: • Undertake assessment of existing conditions, opportunities and constraints • Prepare implementation strategy • Sensitisation and capacity building of National / Regional PIUs, Woredas and communities • Identification of sites and selection of water pumping technologies • Engineering design and preparation of bidding documents • Supply and installation of solar/wind pumping systems • Monitor implementation and generate lessons learned and success factors • Prepare a framework for integration into the UAP • Creation of awareness and demand for solar/wind **Inputs:** AWF: € 1,991,880 GOE: € 173,800	**OUTPUTS:** • Pilot implementation strategy in accordance with the UAP • Solar/wind water pumping infrastructure functioning in selected locations benefitting 130,000 people • Improved capacity at government, community, and private sector levels in the planning, design, operation and maintenance of solar and wind powered water supply systems • The private sector actively supporting solar/wind for water pumping • Appropriate policies to facilitate the widespread use of solar and wind energy adopted. • Framework for long term implementation under UAP developed • Increased awareness amongst government, end users and other sectors of society on the benefits of solar and wind technologies	• Beneficiary men and women • Communities in candidate locations • PIUs at Federal and Regional level and Woreda Water Staff • Private enterprises • Policy makers, donors • Sector experts, designers • Government, end users	**Indicators**: 1. Pilot implementation strategy prepared and validated 2. Number of operational schemes 3. Number of trained persons involved in the continuation of the program 4. Number of private enterprises involved in the project 5. Revision of policies to facilitate adoption 6. Long term implementation framework adopted 7. Forums established for information exchange **Source**: Progress reports from PIU, and AWF supervision reports. **Periodicity**: Quarterly and end of project	1. Strategy validated by month 14 2. Up to 30 wind and 40 solar schemes operational by the end of implementation 3. 20 PIU and 80 Woreda staff trained 4. 4 supply and installation, 1 consulting firm involved 5. All recommended policy changes made 6. Framework adopted by end of project 7. Forums for information exchange in place	• Availability of UAP funds for the basic works > Use of UAP funds will be detailed in the procurement plan prepared before the project is deemed Grant Effective • Lack of government commitment and capacity > MOWR to assign qualified staff to serve on the PIUs, and provide adequate financial resources • Slow pace of implementation under RWSSP which delegates responsibilities to Regional or Woreda level > key tasks such as procurement of equipment will be centralised at national level

EXECUTIVE SUMMARY

1. Despite concerted efforts by the Government of Ethiopia (GOE) to increase water supply in the country, over half of the rural population still lack access to water. To improve access, the use of solar and wind energy for water pumping is an attractive option in the rural areas since over 83% of the population has no access to the electric grid to power mechanised pumps. However, there are no projects currently under implementation which comprehensively addresses the use of renewable energy for water supply. As a result, the GOE approached the AWF to finance a pilot project on the utilisation of solar and wind energy, in order to draw lessons on how to scale up the use of these renewable energies in the country.

2. The purpose of this project is therefore to promote and pilot the use of solar and wind energy for water pumping in rural areas of Ethiopia, and so initiate development of a long term investment in these technologies under the Government's Universal Access Programme (UAP) where they are appropriate and the most suitable. This will help ensure an increased and sustained supply of water at lower financial, economic, environmental and social costs than with fossil fuel powered pumping systems. The short term outputs directly arising from the project activities include the following:

- Appropriate policies adopted to facilitate the widespread adoption of solar and wind technologies.
- Water sector specialists systematically include solar and wind among those technology options to be considered, and that by using life-cycle costing these options will be fairly evaluated;
- Approximately 70 water supply schemes utilizing solar and wind are effectively functioning and supplying clean potable water to 130,000 people in the project areas.
- Improved capacity at community level to operate and maintain solar or wind powered water supply systems, and at National, Regional and District levels to implement future schemes.
- Increased involvement of private sector in providing equipment and services.
- Framework for long term implementation under the UAP developed.
- Awareness created amongst government, end users and other sectors of society on the benefits of solar/wind technologies, thereby triggering an increased demand

3. Project activities will be undertaken in four components or phases: (i) Assessment and Preparation; (ii) Design and Implementation of Pilot Works - Stage I; (iii) Design and Implementation of Pilot Works - Stage II; and (iv) Development of Framework for Incorporation of Solar/Wind into the UAP. The inception phase will enable the Recipient to refine the overall approach to encourage ownership and local innovation. Two phases of implementation have been proposed to further refine approaches, promote capacity building, and stimulate the private sector. The framework will help ensure the replication of best practices, which will facilitate the increased use of solar and wind technologies. Implementation of the project will be conducted over a period of 36 months after Grant Signature.

4. The estimated cost of the project is €2,165,680 of which 70.6% is in foreign currency. The bulk of the costs is for the solar and wind pumping equipment, which amounts to €1,320,000. Consultancy services amount to €658,6130. The remainder is for GOE project management costs. A provision of 10% of the project's base cost has been considered to cover contingency. The AWF will finance 92.0% of the project costs, covering the consultancy services, and the foreign or local cost of the equipment to be procured. However, since the project is integrated with the UAP, the GOE is expected to finance the base costs for source development and associated facilitative aspects such as community mobilization and hygiene education, under its Rural Water Supply and Sanitation Programme (RWSSP).

5. The Ministry of Water Resources (MOWR) will be the Grant Recipient and Executing Agency. The project will be undertaken in conformity with the existing implementation arrangements of the Rural Water Supply and Sanitation Programme (RWSSP) of the UAP. The Programme Coordination Unit (PCU) established within the MOWR will coordinate all the Project activities. The Federal and Regional Programme Implementation Units (PIU), established for the implementation of UAP RWSSP, will also take on their same roles and responsibilities for the project. Throughout the implementation, the Woreda Water Desks (WWD) and the Woreda Water Committee (WWC) will play a key role. A Consulting Firm will be recruited to undertake the assessment, design, procurement, implementation, monitoring and training activities, and to ensure the transfer of knowledge in solar and wind technology.

6. Procurement for the project will generally be in accordance with the UAP-RWSSP, with modifications as necessary to expedite procurement due to the limited time of the pilot project (mainly consisting of packaging procurement of solar/wind equipment at Federal/Regional levels). Procurement of Consulting Services will be undertaken using international short-listing procedures. Contracts for procurement of goods, which mainly consist of supply and installation of equipment for solar PV pumping systems valued in aggregate at €660,000, and equipment for wind pumping systems valued at €660,000, will be awarded through International Competitive Bidding (ICB). Disbursement will be through the Special Accounts method, with disbursement made by the Bank in three tranches.

7. The proposed implementation methodology and arrangements are found to be in accordance with the criteria laid down in AWF's Operational Procedures, and the anticipated efficiency, effectiveness and sustainability of the project are considered to be acceptable. As well, the MOWR of the GOE has shown strong interest in undertaking this project.

8. It is recommended that a grant not exceeding €1,991,880 from the African Water Facility resources be extended to the Ministry of Water Resources of the Government of Ethiopia for the implementation of the project described in this appraisal report. Obligations of the AWF to make the first disbursement of the Grant shall be conditional upon the nomination acceptable to the AWF of the Project Coordinator, opening of a Special Account in a commercial bank in Ethiopia acceptable to the AWF, and preparation of a procurement plan.

1 BACKGROUND

1.1 Project Rational and Links with Sector Priorities

1.1.1 Within the past two decades, the country has addressed a host of policy issues to enhance the development of the water sector. In 1999, Ethiopian *Water Resources Management Policy* was issued. In 2001, the Ethiopian *Water Sector Strategy* was prepared. In 2002, the GOE prepared a *Water Sector Development Program* (WSDP) which provided a detailed inventory of projects to be implemented within the upcoming 15 years, and requires about €6.1 billion to implement. The GOE has also developed a National Sustainable Development Poverty Reduction Programme, which recognized that the WSDP is pivotal to overall socio-economic development of the country.

1.1.2 Despite these efforts, over half the population remained without access to water supply, with national water coverage of 47% in 2006. The gap between urban and rural coverage is large, with coverage of 79% and 41% respectively. This is very significant since nearly 85% of the entire population, or about 69 million people, live in rural areas.

1.1.3 In recognition of the urgent need to provide over 80 million people with water, in 2005 the GOE designed an ambitious seven years *Universal Access Program (UAP)* for Water Supply and Sanitation Services. The program intends to raise water supply coverage to 98% by 2012. The GOE has put in place a decentralised institutional framework to implement the UAP, with each of the nine political administrative regions having their own water bureaux which are completely independent of the federal MoWR in budgetary and administrative terms.

1.1.4 At the rural level, the Government implemented a *Rural Water Supply and Sanitation Programme (RWSSP)* in 2006, under the UAP, with funding from the ADB and other donors. Details of the Programme are described in Annex 5.

1.1.5 Experience with the use of renewable energy technologies for water pumping in Ethiopia is limited. Some NGOs, such as Hope 2020, have implemented demonstration water supply projects using solar power, and there are a few wind energy powered water supply systems scattered throughout the country. There is also a centre for appropriate technology which looks at the use or RET for a variety of needs, including water pumping. As well, there has been some large projects funded by donor partners that promote the use of renewable energy, but these have not specifically addressed water pumping. For example, the World Bank has an ongoing Energy Access Project, which includes a grant from the Global Environment Facility (GEF), but it is focused on the use of renewable technologies for off-grid rural electrification.

1.1.6 Partly as a result of this lack of focused effort to address the use of solar or wind energy for water pumping purposes, their use has not yet taken off in the country. Nonetheless, the GOE remains committed to increase their use for water supply purposes. The option of using solar and wind pumping technologies has been considered within the framework of UAP, and while the RWSSP notes that solar and wind technologies are among those which will be used, there are no specific plans to facilitate their adoption during the project.

1.1.7 In order to help catalyse their widespread use, the Government of Ethiopia approached the AWF to finance a pilot project on the utilisation of solar and wind energy for water supply in rural areas. The Government anticipated drawing lessons on how to scale up the use of these renewable energies under the UAP. The AWF accepted to support the project in 2007 and recruited a consultant to prepare the project. This appraisal report uses the preparation report of the consultant as background material.

1.2 Problem Definition

1.2.1 Many of the UAP's new schemes require mechanised pumps. However, since access to electric services is only about 17% in the country, most rural areas do not have the opportunity to use grid electricity to drive the pumps, and have instead relied on diesel and petrol driven generators to provide power. Diesel/petrol pumps have many drawbacks such as high running and maintenance costs, unreliable supply of fuel, and poor availability of spare parts.

1.2.2 Under appropriate conditions wind and solar based pumping offer several advantages such as low running costs and minimal environmental impact. While the upfront investment on solar or wind energy based water supply schemes is higher than for conventional systems, the financial costs on a life cycle basis are often more favorable since the much lower running costs due to the almost free supply of energy offsets the incremental initial investment cost. Maintenance costs of solar systems are also low, since the photovoltaic cells have been proven to be very reliable in practice. As such the operation and maintenance costs can easily be covered by a community.

1.2.3 The overall impact of and wind based pumping systems is very positive on both the local and global environment. Comparing to a diesel based schemes, the amount of fossil fuels to be displaced by using solar and wind energy impacts the environment positively, with significant reductions in greenhouse gas (as CO_2 equivalent) and acid air emissions (as SO_2 equivalent). Solar or wind systems have little negative impact on the environment. Wind turbines do pose a modest risk to birds and cause noise created due to wind rotors, and care has to be taken that the wind turbines are not be located too close to residential areas or the habitat of endemic rare bird species.

1.2.3 The solar technologies to be piloted will generally consist of a photovoltaic array producing DC voltage, with an inverter to change the output to AC to power a centrifugal, multistage, submersible pump. As a rule of thumb, solar pumping systems should generally be considered for applications of less than 8 to 10 kW peak. The wind technologies consist of either a conventional mechanical wind pumping systems using a small wind turbine installed directly over the well and powering a positive displacement pump, or wind- electric pumping options using a wind turbine to generate AC power to run a submersible centrifugal pump. Wind pumping systems are generally a viable option in areas with average wind speeds above 3 to 4m/s, with mechanical systems preferred at lower wind speeds.

1.2.4 However, the use of solar and wind technologies are not without challenges. Because of their peculiarities, solar and wind systems requires special design considerations that may differ from more conventional systems. Solar-based water pumping system design requires accurate data on such matters as the available resource, the water demand and well characteristics so that they can be designed as precisely as possible with the smallest possible allowance in power due to the expensive capital costs of the photovoltaic cells, which is

currently about €5-7 per watt peak. As well, the intermittent availability of solar energy requires the construction of sizable storage reservoirs. Wind resources availability is also highly variable and often unpredictable. Therefore constructing large reservoirs to store the water pumped during periods of wind availability for later use is necessary.

1.2.5 For solar and wind technologies to gain widespread acceptance by the communities and supporting structures, it is necessary to create the necessary awareness and demonstrate the operation of these systems in real life situation. There is also a need to encourage participation of the local private sector in the supply of equipment, spare parts and after sales services. However, without a critical mass of installed systems, solar or wind technologies will likely suffer from weak supply chains and a lack of private sector capacity for maintenance. Consequently, sustainability would remain low despite their many advantages.

1.2.6 A pilot project is therefore necessary to address these design and support issues, and to plan for future phases of this component of the UAP. The challenge for the pilot project will be to go beyond infrastructure provision to develop capacities and mature the market for these technologies to be sustainable.

1.3 Beneficiaries and Stakeholders

1.3.1 The primary beneficiaries will be those people in the rural communities who would be the direct users of the water scheme. It is estimated that about 130,000 people will benefit from the installation of approximately 40 solar and 30 wind systems (this number will be refined during the inception stage). These people will not only benefit from improved quality of water and improved hygienic condition, but also from the low operations and maintenance costs. Women and children particularly within these communities would be saved from the present ordeal of transporting water from as far as six kms. Women will have direct involvement in the selection, location and management of solar and wind sub-projects through their participation in the water, sanitation and hygiene committees, and will constitute at least 30% of the membership of these committees.

1.3.2 In addition, the beneficiaries of the project will include all the various stakeholders in the water sector in Ethiopia. Planning agencies and designers will be better and more widely informed of choices available for application of these technologies; private sector enterprises will benefit from the supply of solar and wind pumping equipment, spare parts and repair services; and funding agencies will be provided with better information about needs and demands for these services. The capacity building component of the project has a direct benefit to the Federal and Local government institutions, whose capacity would be enhanced through training and strengthening of the institutions.

2 THE PROJECT

2.1 Goal and Impacts

2.1.1 The goal or vision of the project is the widespread use of wind and solar technologies for rural water supply in Ethiopia. Its corresponding impacts are expected to be:

- An increased and sustained supply of water at lower financial, economic, environmental and social costs than with fossil fuel powered pumping systems.

- Improved quality of life due to availability of adequate water supply in rural areas supplied with solar/wind powered pumping systems

2.2 Objective and Outcomes

2.2.1 The project objective is to promote and pilot the use of solar and wind energy for water pumping in rural areas of Ethiopia, and so initiate development of a long term investment in these technologies under the Universal Access Programme (UAP) where they are appropriate and the most suitable. The outcomes expected from the project are:

- Increased demand for solar/wind technologies from end-users and other stakeholders
- Water sector specialists systematically include solar and wind technological options among those to be considered in projects where conditions allow, and that by using life-cycle costing these options will be fairly evaluated;
- Local private sector will be motivated, and have adequate capacity, to support the supply and after sales service of solar and wind pumping equipment, including supply of spare parts and maintenance.

2.3 Activities

2.3.1 The activities to be undertaken in the course of this project implementation basically consist of testing of technical, institutional and other logistical arrangements in order to quickly scale-up use of these technologies throughout the country where appropriate. Most of the activities will be done as part of the ongoing operations of the RWSSP, leaving the project to focus on only specific activities related to the adoption and use of solar and wind technologies. The project activities will be undertaken in four components or phases:

A: Assessment and Preparation

B: Design and Implementation of Pilot Works - Stage I

C: Design and Implementation of Pilot Works - Stage II

D: Development of Framework for Incorporation of Solar/Wind into the UAP

Component A: Assessment and Preparation

2.3.2 The project commences with a brief inception phase to allow an opportunity for detailed assessment and preparation of pilot project implementation strategies. The purpose of this phase is to ensure local ownership; encourage partners to brainstorm on how to integrate into UAP-RWSSP so as to positively impact on sustainability; and to make use of data from the assessment to refine the implementation strategy. It will be implemented in a participatory manner in order to ensure broad support of all stakeholders. At the end of the inception phase of the project the pilot implementation strategy shall be presented at a Federal workshop and validated.

2.3.3 ***Assessment:*** An assessment of the existing conditions, opportunities and constraints affecting utilisation of solar and wind power for water pumping shall be undertaken. It shall include:

- Assemble data and information allowing the mapping of technical potential, and identify any gaps in availability of solar and wind data.

- Undertake an inventory of WSS systems (existing or planned) which do or could benefit from wind and solar pumping technologies.
- Collect and review socio-economic baseline data available from the RWSSP and other sources.
- Examine the existing institutional arrangements for implementation of the pilot project.
- Identify policy, socio-cultural and any other constraints to wide acceptance and use of the technologies.
- Examine other similar projects/programmes in countries which have successfully adopted the use of solar/wind for water pumping (with a focus on African countries such as Namibia), as well other ongoing or completed renewable energy technology projects in Ethiopia, and distil lessons learned and best practices regarding promotion of solar/wind to generate a mapping of success factors.
- Collect and analyse data on supply chains and local Operation and Maintenance (O&M) capability with respect to use of solar/wind technologies.
- Collect and analyse data on existing market and suppliers to identify any bottlenecks such as import procedures, import licence requirements, duties and taxes, market information; commercial knowledge of local traders etc.
- Assess the opportunities and threats surrounding the use of solar/wind energy technologies for pumping, particularly the constraints/impediments to wider adoption.
- Identify most suitable areas for pilot installation of solar or wind technologies.
- Analyse and identify issues for detailed study during pilot implementation.

2.3.4 ***Preparation:*** An approach for implementation of the pilot project which is fully integrated with the UAP shall be prepared, building on what is described in this appraisal report. This will later be modified based on the experience of this pilot project to form a basis for the long term strategy and implementation framework (see 2.3.13). It shall include:

- Establish joint implementation and co-funding mechanisms. Develop opportunities for integration of AWF funded solar and wind technology component into planned development of water points under the UAP. This would involve obtaining approval at national/regional levels to include solar or wind as one of the technology options, followed by commitments to fund source development and other aspects such as community mobilisation, training and hygiene promotion under the UAP, with AWF picking-up only the solar/wind pumping component.
- Put in place mechanisms to ensure that solar and wind is incorporated into the process for the selection of the most appropriate technology for water pumping at a specific site.
- Incorporate mechanisms for undertaking social and environmental assessments at the scheme level, along with mitigation and management measures.
- Prepare a strategy to promote the involvement of the private sector in supply, installation, maintenance and provision of spare parts. This should build on existing experience in the country and be integrated with similar activities under the UAP. Innovative PPP arrangements should be assessed. Business models on how local SME can provide renewable energy equipment and services should be developed.

- Prepare a procurement strategy and plan (building on what is elaborated in Section 3.3), aimed at encouraging growth of the market, participation of the local private sector and the involvement of beneficiaries in contracting services.
- Explore options for additional funding. Some donors may wish to contribute directly to the AWF funded project through a co-financing arrangement, enabling the project to incorporate solar/wind in a larger number of sites.
- Incorporate success factors and best practices from similar projects/programmes in other countries which have successfully adopted the use of solar/wind for water pumping, as well as from other renewable energy technology projects in the country.
- Develop a monitoring system to evaluate the incorporation of solar/wind technology in design and implementation processes under the UAP; the technical performance of the equipment in the field; its acceptance and use by the communities; and market responses. Identify issues to be addressed, and data to be collected and analysed during implementation, as well as responsibilities for these tasks. A platform for information and knowledge sharing should be developed.

2.3.5 ***Sensitisation:*** The project will work through the existing UAP structures at the Federal, Regional, Woreda and Community levels to sensitise and mobilize various categories of stakeholders for implementation of the pilot project, as follows:

- Convene an Introductory Workshop of Stakeholders to introduce the project to UAP structures, other government departments with interest in WSS, donors, NGOs, private consultants, suppliers and technicians, etc.
- Undertake more intensive workshops for PIUs at Federal and Regional levels to thoroughly familiarize them with the project, and select candidates for detailed training and capacity building;
- Delegate PIUs to mobilize teams at Woreda level for familiarization, and select trainees for detailed training;

Component B: Design and Implementation - Stage 1

2.3.6 ***Capacity building:*** Prior to commencement of works, the capacity of Government and community will be strengthened:

- Establish and strengthen the project implementation units: Provide training for Federal and Regional PIUs to plan and implement solar/wind schemes. PIU staff training will be provided by the Consultant in Addis Ababa and in the Regions, with the option for some selected staff to visit other African countries where solar/wind use is advanced and well integrated into national programmes (such as Namibia). The initial round of training will cover aspects associated with overall project planning and management, and set the stage for on-the-job training during design and implementation stages.
- Strengthen the capacity of local government: Training at Woreda level will be for staff of Water Bureaux (WWB) and water supply departments (WWD) responsible for planning and implementation at scheme level. The Consultant and staff of PIU will provide training at Woreda levels during implementation, on issues specific to use of wind and solar energy in water pumping.

- Strengthen community capacity: Training will be provided by the PIUs and Woredas to communities on solar and wind pumping systems. It will involve mobilisation of communities in selected areas and identification of leaders for detailed induction prior to commencement of works. The project will undertake community level activities alongside those being done as part of the RWSSP, with the project focused only on providing support and training specifically related to solar and wind pumping systems.

2.3.7 ***Design:*** Undertake the project engineering design activities. The pilot works will be implemented in up to 80 selected locations (depending on funds available), consisting of approximately 40 schemes based on solar pumping and 30 on wind pumping. Due to the limited funds available, it is anticipated that 3 to 4 regions will be targeted under this project.

- Identify potential sites for solar/wind tech. This could include (i) favourable sites for solar or wind where water supply development activities are being planned under the UAP; and (ii) existing sites where solar/wind can be retrofitted to replace diesel powered generators. Since the RWSSP is being implemented nation-wide, there should be ample opportunities to select a representative number of sites in all regions for demonstration of solar or wind technologies.
- Select the most appropriate technology, using standard approaches under the UAP with an emphasis on life-cycle costing. The standard processes under the RWSSP will be followed in ensuring community participation in technology selection.
- Design the solar/wind components for selected systems which will incorporate these technologies. The project has been prepared using the UAP access standards of 15 l/cap/day, but it is flexible to adjust to use other access standards in all its designs, such as the 20 l/cap/day originally noted in the RWSSP.
- Prepare tender documents for supply and installation of solar/wind equipment, including specifications, invitation to bid and contract documents.

2.3.8 ***Implementation:*** Implementation will be in harmony with the approaches under the UAP. Specific AWF supported project tasks will consist of:

- Finalize and issue tender documents for the supply and installation of solar/wind equipment. Evaluate bids received and award contract.
- Supervise installation of solar/wind equipment, up to commissioning of works.
- Continue to strengthen government capacity through participation in all activities undertaken by the Consultant
- Strengthen community capacity in operation and maintenance of solar/wind tech: Woreda staff will provide training to community leaders and communities during implementation and afterward.

2.3.9 ***Monitoring:*** As a result of feedback obtained from the detailed monitoring of performance, and actual usage by the communities, there will be improved knowledge about critical success factors for the application of solar wind technologies to water pumping in Ethiopia. These will be incorporated into Framework for Implementation of the long-term programme.

2.3.10 ***Review:*** A mid-term review will be conducted at the end of the first phase of implementation. Lessons learned will be used to refine the implementation strategy for the second phase of the pilot works.

Component C: Design and Implementation - Stage 2

2.3.11 Most of the activities noted in Stage 1 of the implementation will be repeated here. The intention is threefold: i) to allow a refinement of the strategy; (ii) to increase the capacity of PIU and Woreda to design and supervise the implementation of solar and wind pumping systems; and (iii) to increase the opportunities for the private sector to get involved, through a second series of tenders. Based on costs of stage 1, accurate estimates of the number of additional solar and wind systems which can be funded will be made, enabling the project to install the maximum possible number of systems and disburse all available funds.

2.3.12 Capacity building activities will be similar to that of Stage 1 for new regions, Woredas and communities which will have solar and wind systems for the first time. Should implementation be repeated in a same region or Woreda, the need for refresher training will be determined as part of the monitoring feedback from regional PIU and Woreda level staff.

Component D: Develop a framework for incorporation of solar/wind into the UAP

2.3.13 Based on the results and lessons learned during implementation, a framework for implementation of the long term programme will be developed. This may include:

- ***Policy development and reforms*** to facilitate increased use of solar and wind technologies. This may include a policy statement on how to fund the incremental capital costs of solar or wind equipment under the UAP. Some options include sourcing grant funding from donors (such as the GEF), making use of carbon trade financing mechanisms, repayment by beneficiaries over the first few years inline with the benefits they will receive due to not having to pay for fuel or electricity costs of pumping, or acceptance by the government to pick up the additional costs.
- ***Tools for design and implementation:*** code of practice and manuals; standard designs and procurement documents; model investment plan for various sizes of systems; models for financial and economic analysis; standard forms for applications for funding; operations and maintenance procedures; solar/wind data gathering and knowledge management systems.
- ***Private sector support options:*** Business planning templates aimed at assisting private sector players to identify possible roles in supporting the supply of equipment and services; mechanisms to allow private public participation in one of the various forms of build own operate and transfer (BOOT) arrangements for wind and solar pump operated water sources; use of procurement procedures to foster strategic partnerships between oversees and centralized suppliers and locally based retailers and technicians; strategy to strengthen the spare parts supply chain for solar and wind equipment.
- ***Communication Strategy*** for the sub-sector in collaboration with the Ministry responsible for renewable energy, including preparation of communication materials such as brochures, manuals and general media messages, along with guidelines.
- ***Awareness and demand creation:*** Through the implementation of the communication strategy and the sharing of experiences among stakeholders, awareness on the benefits

of solar and wind energy water pumping systems will be increased. This will lead to an interest in use of these technologies, thus stimulating demand.

2.4 Outputs

2.4.1 The corresponding short term measurable outputs directly arising from the project activities include but are not limited to the following:

- ***Appropriate policies adopted*** to facilitate the widespread adoption of solar and wind technologies. Particularly, a policy on meeting the incremental capital costs associated with the use of solar and wind equipment will be put in place.

- ***Strategy for implementation of solar and wind energy pilot works developed*** under the UAP, with the full approval of national, regional and district levels of government, and the endorsement of donors.

- ***Pilot works implemented:*** At the end of the project, there will be approximately 80 water supply schemes effectively functioning utilizing solar and wind energy and supplying clean potable water to nearly 130,000 people in the project areas.

- ***Improved capacity at community level*** to operate and maintain solar or wind powered water supply systems, ***and at National, Regional and District levels*** to implement future schemes.

- ***Increased involvement of private sector:*** New business opportunities will open up for solar and wind equipment and parts vendors, designers, manufacturers and installation and maintenance technicians. Knowledge and experience of consultants, technicians and artisans in the design, installation and maintenance of solar and wind based water supply systems would be enhanced.

- ***Framework for long term implementation under the UAP developed***, which will facilitate and increase the use of solar and wind water pumping systems.

- ***Awareness created*** amongst government, end users and other sectors of society, with stakeholders more aware of the benefits of solar and wind based water supply systems thereby triggering a replication in the use of these renewable energy technologies.

2.5 Risks and Assumptions

2.5.1 The main project risk relates to the availability of UAP funds for the basic works (source development and 'software' aspects). The project costs assume that the AWF will only meet the costs related to the use of solar or wind technologies. If the AWF has to meet all costs such as drilling, the number of demonstration sites will be greatly reduced. The use of UAP funds will be detailed in the procurement plan which shall be prepared before the project is deemed Grant Effective. Plans to involve other partners and seek co-financing will be stepped up should there be a shortage of RWSSP funds.

2.5.2 There is a risk of lack of government commitment and capacity at national, regional and district levels. The MOWR must assign qualified staff to serve on the PIUs, provide

adequate financial resources, and process all procurement, financial and reporting transactions in a timely manner so as to avoid delays.

2.5.3 The pace of implementation of the project may be slower than planned if it is implemented fully in accordance with the RWSSP arrangements, which delegates most responsibilities to regional or district (Woreda) level. To mitigate this risk, key tasks such as procurement of equipment will be centralised at national level (with two tenders each for solar and wind equipment), with supervision and certification of works at regional/district level as under the RWSSP.

2.5.4 The main post-project risk is the lack of financing to meet the incremental capital costs of solar or wind technologies. To mitigate this, the project will examine a range of funding options, and under the framework for long-term implementation, ensure that appropriate policies and funding mechanisms will be put in place. Other post-project risks relate to the availability of professional and technical expertise in the country, and adequate numbers of private sector suppliers of equipment, spare parts and maintenance services. These risks will be mitigated by an aggressive approach to support the private sector through appropriate procurement strategies.

2.6 Costs and Financing

2.6.1 The estimated cost of the project is €2,165,680 of which €1,4529,220 (70.6%) is in foreign exchange and the remaining €636,460 is in local currency equivalent. A breakdown of the costs by project Component is summarized in Table 2.1, and by Category of Expenditure in Table 2.2, with details shown in Annex 3. The bulk of the costs is for the solar and wind pumping equipment, which amounts to €1,320,000. Consultancy services, consisting of staff remuneration, and reimbursable and miscellaneous expenses, amount to €658,130. The remainder is for GOE project management costs. A provision of 10% of the project's base cost has been included to cover contingency.

2.6.2 The cost estimate for the solar and wind pumping systems must be noted as being preliminary since one outcome of this pilot should be to come up with firm unit costs for solar and wind energy pumping systems for Ethiopia. No budget for works has been allocated since it is assumed that the MOWR under the UAP will pick up the costs of all source development (drilling etc.). Similarly, costs for project management and coordination include just the additional costs of PIU staff assigned to work with the project, and it assumes that they will use their own vehicles and other equipment and supplies.

2.6.2 The proposed financing plan is presented in Table 2.2, with details shown in Annex 3. The AWF will finance 92.0% of the project costs (estimated as €1,991,880), covering the consultancy services, and the foreign or local cost of the equipment to be procured. The Government of Ethiopia will allocate 8.0% mainly as in-kind contributions for the Project Coordination and Implementation Units (estimated as €173,800). In addition, GOE will cover all taxes and duties. The government will also fund source development and other aspects such as community mobilisation and hygiene promotion on those boreholes falling under the AWF project, thus leaving the AWF to fund only the solar/wind pumping component (these GOE costs are not noted in Table 2.2 since they are part of the RWSSP and outside the scope of the project).

Table 2.1: Project Cost Estimates by Component and Foreign/Local Totals (Euros)

Component	Total Cost	AWF		GoE
		Foreign Costs	Local Costs	Local Costs
A: Assessment and Preparation	260,871	70,374	150,997	39,500
B: Pilot Works Stage 1	857,393	659,913	141,052	56,429
C: Pilot Works Stage 2	656,429	600,000	0	56,429
D: Framework for UAP	194,107	59,913	128,552	5,643
Total Base Cost	**1,968,800**	**1,390,200**	**420,600**	**158,000**
Contingency 10%	196880	139020	42060	15800
Total Project Cost	2,165,680	1,529,220	462,660	173,800
Percentage		70.6%	21.4%	8.0%
Total Foreign/Local		**1,529,220**	**636,460**	
Percentage Foreign/Local		70.6%	29.4%	

Table 2.2: Project Cost by Category of Expenditure and Sources of Financing (Euros)

Category of Expenditure	Total Cost	AWF		GOE	
		Foreign Costs	Local Costs	Local Costs	Local In-Kind
Goods					
Solar Pumping Systems	600,000	600,000			
Wind Pumping Systems	600,000	600,000			
Total Goods	1,200,000	1,200,000		0	0
Consultancy Services	598,300	190,200	408,100	0	0
Project Management	170,500	0	12,500	2,000	156,000
Total Base Cost	1,968,800	1,390,200	420,600	2,000	156,000
Contingency 10%	196,880	139,020	42,060	200	15,600
Total Project Cost	**2,165,680**	**1,529,220**	**462,660**	**2,200**	**171,600**
Total Contributions		**1,991,880**		**173,800**	
Percentage Contribution		92.0%		8.0%	

3 PROJECT IMPLEMENTATION

3.1 Implementation Arrangements

3.1.1 The Ministry of Water Resources (MOWR) will be the Grant Recipient and Executing Agency. The project will be undertaken in conformity with the existing implementation arrangements of the Rural Water Supply and Sanitation Programme (RWSSP) of the UAP. Project implementation will be decentralised using existing institutional structures at the Federal, Regional and local/community levels. Details regarding the exact roles and responsibilities of the various institutional structures will be one output of the inception phase. An overview of current arrangements planned for the project is noted below:

- The Programme Coordination Unit (PCU) established within the MOWR will coordinate all the Project activities. The Head of the Rural Water Supply and Sanitation Department will serve as Project Coordinator.

- The Federal and Regional Programme Implementation Units (PIU), established for the implementation of UAP RWSSP, will also take on their same roles and responsibilities for the project. It is expected that each PIU will assign two or more regular professional staff to work alongside the Consultant, and that assigned staff will spend on average one quarter of their time on project activities during the duration of the project. These professionals are expected to learn from the project and act as key technical resource persons to provide ongoing support after completion.
- Throughout the implementation, the Woreda Water Desks (WWD) and the Woreda Water Committee (WWC) will play a key role. The WWD and WWC are already implementing Woreda level community water supply projects, under the RWSSP, including shallow boreholes fitted with pumps which could benefit from solar or wind power.
- The existing Programme Steering Committee will play the same role for the project.

3.1.2 A Consulting Firm will be recruited to undertake the study, design, procurement, implementation, monitoring and training activities, and to ensure the transfer of knowledge in solar and wind technology. The Consulting Firm will be a well qualified and experienced reputable company with specific expertise in rural water supply and renewable energy for water pumping purposes, and must have considerable expertise in undertaking similar projects/programmes in other countries. The Firm will provide a team of local professionals to work with all Federal and Regional PIUs and Woredas who will be impacted by the project activities.

3.1.3 The Consulting Firm shall report to the PCU and shall at all times during the continuity of services ensure the presence of a Resident Project Manager acceptable to the PCU. The Consulting Firm shall also involve the professional and technical staff of the Federal and regional PIUs and Woredas in the work to be performed by the Consultant's staff, in order to provide the opportunity for on-the-job training to ensure maximum transfer of skills.

3.1.4 The project will make use of existing RWSSP implementation documents. This will be supplemented by the pilot implementation strategy to be prepared as one output of the inception phase of the project.

3.2 Implementation Schedule

3.2.1 Implementation of the project will be conducted over a period of 36 months after Grant Signature. The proposed implementation schedule is presented in Annex 2. In the first year a Consulting Firm will be selected, who will begin by undertaking an inception phase leading to the development of an implementation strategy. This will be followed by the implementation of the pilot works in two stages, consisting of design of an initial group of schemes and supply and installation of solar and wind pumping equipment, followed by an assessment of the process and refinement of procedures for the second stage. A mid-term review will be conducted to evaluate the progress in project implementation, timed to coincide with the completion of the first phase of implementation. The project will wind up with the development of a framework for long term integration into the UAP.

3.3 Procurement Arrangements

3.3.1 All procurement of goods, works and acquisition of consultancy services financed by AWF shall be in accordance with the AWF's Operational Procedures, the Bank's Rules and Procedures for Procurement of Goods and Works, or as appropriate, Rules and Procedures for the Use of Consultants. The Procurement arrangements are summarized in Table 3.2.

Table 3.2: Procurement Arrangements (all amounts in Euro)

Description	ICB and LIB	International Shortlist	Shopping	Non-AWF Funded[2]	Total
GOODS					
Solar PV Pumping Systems	660,000 (660,000) [1]				660,000 (660,000)
Wind Pumping Systems	660,000 (660,000)				660,000 (660,000)
Office Equipment			13,750 (13,750)		13,750 (13,750)
CONSULTANT SERVICES		658,130 (658,130)[1]			658,130 (658,130)
PROJECT MANAGEMENT				173,800 (0)	173,800 (0)
TOTAL	**1,320,000 (1,320,000)**	**658,130 (658,130)**	**13,750 (13,750)**	**173,800 (0)**	**2,165,680 (1,991,880)** [1]

1) Figures in brackets are amounts financed by the AWF.
2) Consisting of in-kind contributions by the GOE for Project Implementation Unit and Steering Committee Meetings

3.3.2 Procurement for the project will generally be in accordance with the UAP-RWSSP with modifications as necessary to expedite procurement due to the limited time of the pilot project (mainly consisting of packaging procurement of solar/wind equip at Federal/Regional levels, see 3.3.5). For procurements using procedures other than International Competitive Bidding (ICB) and Limited International Bidding (LIB), the procurement rules and documents designed for the RWSSP shall be used. During the appraisal of the RWSSP, the national procurement rules and procedures were reviewed and found to be adequate, and it was deemed that there are no fundamental conflicts with the Bank's procurement rules and procedures. Bank Group Standard Bidding Documents will be used for all ICB and LIB contracts. For NCB and other procurement, national procurement documents prepared for the programme will be used.

3.3.3 A procurement plan will be prepared by the MOWR before grant effectiveness, outlining how procurement activities will be undertaken. This will be updated and refined as part of the inception phase, covering in more detail the modalities for procurement of the solar and wind water pumping equipment. The PIUs will undertake all procurement. The procurement plan will detail the procurement to be undertaken at Federal and Regional levels, and the division of responsibilities between NPIU/RPIUs. While the PIUs have the capacity, experience and expertise to manage the procurement of consulting services and equipment, they lack specific expertise in solar and wind. Consequently, the PIUs will draw upon the support of the Consultant in preparing tender documents for the Supply and Installation of Solar/Wind Equipment, and evaluation of bids.

3.3.4 ***Consultancy Services:*** Procurement of Consulting Services valued in aggregate at €658,130 will be undertaken through competition among an international short-list of consulting firms with expertise in solar and wind systems, rural water supply and renewable energy. The quality and cost based selection (QCBS) procedure shall be applied.

3.3.5 ***Goods:*** Contracts for procurement of goods, which mainly consist of supply and installation of equipment for solar PV pumping systems valued in aggregate at €660,000, and equipment for wind pumping systems valued at €660,000, will be undertaken separately for each of the two pilot implementation stages through International Competitive Bidding (ICB) for the first stage, and Limited International Bidding (LIB) for the second stage. Proposals for packaging of the contracts for the solar and wind equipment to ensure efficiency, yet take into account the decentralised nature of implementation at Regional levels under the RWSSP, will be detailed in the updated procurement plan to be prepared during the inception phase. It is anticipated that procurement of solar/wind equipment will be consolidated into two solar and two wind related tenders at Federal level, with contracts awarded at Regional level and supervision/certification of works at Regional/Woreda levels. Special attention shall be given to the need to build up local private sector capacity to supply, install and maintain the solar and wind equipment throughout the country. Arrangements shall be incorporated into the procurement contract to ensure availability of spare parts at Regional level, as well as for the training of government and community personnel on installation and maintenance of solar and wind systems. Office Equipment, valued at €13,700 will be procured under Shopping procedures, given the small value involved and the availability of appropriate suppliers in Ethiopia.

3.3.6 All procurement activities which are carried out through ICB, LIB, and International Shortlisting valued at more than €100,000, will require the AWF's prior review at all stages of the process. This is expected to include the Consultancy Services as well as the Supply of most of the Solar/Wind Equipment. Therefore, the following procurement documents shall be prepared and submitted for prior review and "no objection" by the AWF (with responsibility as noted in brackets): (i) Procurement Plan (FPIU); (ii) Specific Procurement Notice for Consultancy Services and for Solar/Wind Energy Equipment for UNDP Development Business and the Local Press (FPIU); (iii) Shortlist of qualified and experienced Consulting Firms (FPIU); (iv) Requests for Proposals from Consulting Firms, including detailed Terms of Reference (FPIU); (v) Tender documents for Supply and Installation of Solar/Wind Energy Equipment (FPIU); (vi) Report on Evaluation of Consultants' proposals, and on the Supply and Installation of Equipment, including recommendations for Contract Award (FPIU, RPIU); and (vii) Outcomes of contract negotiations and draft contract agreement (FPIU, RPIU).

3.4 Disbursement Arrangements and Expenditure Schedule

3.4.1 The grant amounts covering the AWF funded portion of the project (as noted in Section 2.6) will be disbursed using the Special Account method of disbursement, in line with the provisions of the Disbursement Handbook of the Bank. The AWF funds will be channelled through the PCU, which will open a Special Account denominated in Euro in a bank acceptable to the AWF.

3.4.2 The proceeds of the Grant shall be disbursed by the Bank in three instalments or tranches, with estimated amounts as shown in Table 3.3. The first tranche will be disbursed when the conditions for Grant Effectiveness are met, estimated to be within three months of

grant signature. The second and third tranches will be disbursed upon draw down of the Special Account, with anticipated disbursement of the second tranche at completion of the inception phase, and the third tranche after the first stage of the pilot works.

3.4.3 Obligations of the AWF to make the first disbursement of the Grant shall be conditional upon the opening of a Special Account, the nomination acceptable to the AWF of the Project Coordinator, and preparation of a procurement plan. Supporting documentation for replenishment of the Special Account before the second and third disbursements will be a summary statement of expenditure and an updated work program and cost estimate for the remainder of the project. All detailed documents related to utilization of AWF funds will be held by the PCU for subsequent verification and confirmation by the external auditors (see Section 3.5).

Table 3.3: AWF Expenditure and Disbursement Schedule (amounts in Euros)

Category of Expenditures	Tranche 1	Tranche 2	Tranche 3	Total
Goods	0	673,750	660,000	1, 333,750
Services	243,508	207,311	207,311	658,130
Total	**243,508**	**881,061**	**867,311**	**1,991,880**
	12 %	44 %	44 %	

3.5 Accounting and Audit Arrangements

3.5.1 The Grant Agreement will provide details about the specific accounting arrangements and requirements for the opening of a Special Account, from which all eligible payments will be made. The administration of the Special Account shall be performed by the PCU, in accordance with the procedures used under the UAP-RWSSP.

3.5.2 The AWF requires that a statement of expenditure and supporting documents review be performed and certified by an independent auditor at predetermined intervals to ensure that funds have been utilized in line with the grant agreement. The AWF will recruit and retain an auditor for this purpose, and the cost of the audit shall be paid from the AWF administrative budget, not from this Grant.

3.6 Monitoring and Reporting Arrangements

3.6.1 The ongoing monitoring of the projects will be done by the Federal and Regional Project Implementation Units, following the standard procedures under the RWSSP. As well, the Steering Committee shall review progress during its regular meetings. The project will incorporate specific procedures and indicators within the RWSSP's monitoring system to evaluate the selection and use of solar/wind technology under the UAP; the technical performance of the equipment in the field; its acceptance and use by the communities; and market responses. The Logical Framework matrix included in this Appraisal Report shall serve as a basis for the result based assessment of the outputs of the project during implementation and after completion.

3.6.2 The AWF's supervision of the project will include regular communication and correspondence with the FPIU/RPIU, as well as review of the Quarterly Progress Reports and other documents. AWF will consider at any time, as the need may arise, to undertake a field supervision mission.

3.6.2 The PCU shall submit to the AWF the documents noted in Table 3.4. The project completion report shall include details on project activities and a comprehensive expenditure report on the utilization of the Grant. All documents shall be transmitted to the AWF by email, with hard copies to follow.

Table 3.4: AWF Reporting Requirement

Documents to be Submitted to the AWF	**Prepared By**	**Reporting Schedule**	**AWF Action**
1. Inception Report	Consultant	Upon completion of PCU review, month 14	Review and comment
2. Procurement Documents as noted in Section 3.3	FPIU/RPIU/ Consultant	As noted in Section 3.4	Review and "no objection"
3. Mid-Term Review Report	PCU	Upon completion of review, month 25	Review and comment
4. Project Completion Report	PCU	By end of month 36	Review and acceptance
5. Quarterly Progress Report (with report on expenditures)	PCU	Months 8, 11, 14, 17, 20, 23, 26, 29, 32	Review and comment
6. Consultant Monthly Reports	Consultant	Upon presentation to FPIU	For information
7. Minutes of Steering Committee Meetings	PCU	Within 7 days of meeting	Review and comment
8. Minutes of any other project meeting	PCU/FPIU/ RPIUs	Within 7 days of meeting	For information
9. Reports on Federal or Regional Workshops	PCU/FPIU/ RPIUs	Within 14 days of workshop	Review and comment

4 EFFECTIVENESS, EFFICIENCY AND SUSTAINABILITY

4.1 The ***effectiveness*** of this project is related to the likelihood of achieving the expected outputs and outcomes as given in the LFA, which the appraisal team deems reasonable and achievable. The ***efficiency*** of the project is related to the overall performance of the project coordination and implementation units. In this regard, the PCU and the national and regional PIUs have been in place for over two years, and have gained the apparent capacity to implement the project as planned. However, they lack expertise in solar and wind energy. Consequently, the Consultant, in the role of TA, will provide critical inputs regarding solar and wind technologies, and build the capacity of the implementation units in the use of these technologies. The Woreda level water entities will ensure collective decision making at the community level and good supervision of implementation. The Steering Committee will provide the requisite policy direction to ensure that the project is fully integrated with the UAP-RWSSP. In conclusion, the overall assessment made by the Appraisal Team concludes that the project is likely to be implemented with the necessary effectiveness and efficiency required by AWF.

4.2 The project has many aspects which will help ensure the ***sustainable use*** of solar and wind energy technologies for water pumping purposes: the financial and economic returns which normally accrue from use of solar and wind are very favourable, and hence this will promote acceptance by government and donor partners; the communities will be able to afford the water tariffs required for operation and maintenance since solar and wind powered systems have very low running costs; the policy review to define options and implement modalities for funding the incremental capital costs of solar and wind technologies will alleviate this risk to long term acceptance; a component for training and capacity building at national, regional and district levels is part of the project, including involvement of staff in the Consultants activities to ensure transfer of skills; communities will be trained to operate solar and wind pumping schemes and to undertake minor maintenance; the anticipated partnership of an international Consulting Firm with a locally registered consultant will help build local knowledge and capacity; the procurement of equipment in two stages helps build the network of private sector suppliers by offering increased opportunities for more companies to get involved; the awareness creation activities will stimulate a demand for solar and wind energy at all levels; and the important end of project activity to develop a framework for integration of solar and wind technologies into the UAP will help ensure that these technologies become mainstreamed into Ethiopia's efforts to supply water to all.

5 CONCLUSIONS AND RECOMMENDATIONS

Conclusions

5.1 The GOE is undertaking a number of encouraging steps to meet and exceed the Millennium Development Goals related to water. These include the development and adaptation of Universal Access Program aimed at attaining a rural water supply access level of about 98% by 2012. This project will be an important component of RWSS Programme within the UAP. It will complement and reinforce the overall endeavour by supporting the search for broader choices in achieving the goals of the UAP, through piloting and promoting the use of solar and wind sources of energy for water pumping purposes. The demonstration pilot works will increase the access to essential water supply facilities to an estimated 160,000 rural people, and will enable a better understanding of their application within the Ethiopian context. The project will also facilitate their sustained use by providing a long term framework for integration into the UAP.

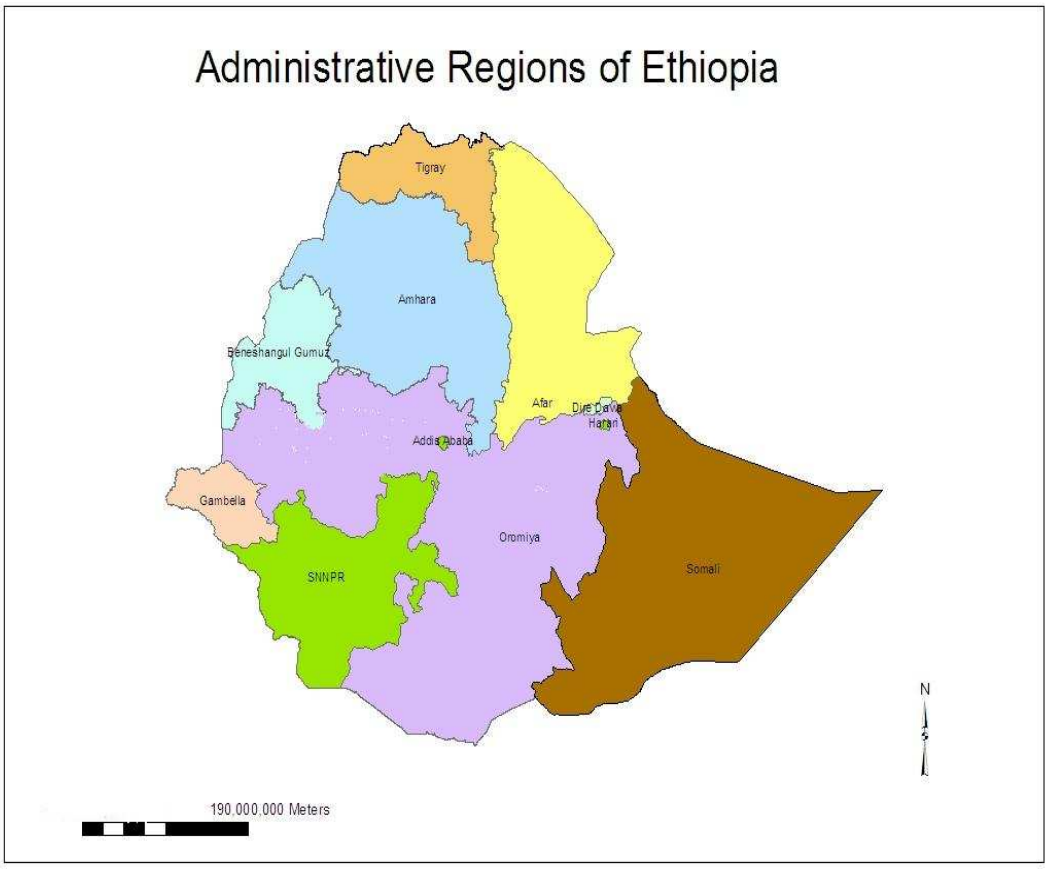
5.2 The proposed implementation methodology and arrangements are found to be in accordance with the criteria laid down in AWF's Operational Procedures, and the anticipated efficiency, effectiveness and sustainability of the project are considered to be acceptable. As well, the MOWR of the GOE has shown strong interest in undertaking this project.

Recommendations and Conditions

5.3 It is recommended that a grant not exceeding €1,991,880 from the African Water Facility resources be extended to the Ministry of Water Resources of the Government of Ethiopia for the implementation of the project described in this appraisal report.

5.4 Obligations of the AWF to make the first disbursement of the Grant shall be conditional upon the nomination acceptable to the AWF of the Project Coordinator, opening of a Special Account in a commercial bank in Ethiopia acceptable to the AWF, and preparation of a procurement plan.

ANNEX 1: MAP OF ETHIOPIA



ANNEX 2: IMPLEMENTATION SCHEDULE

Activity	Time in Months																																				
	S	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Grant Processing and Disbursements																																					
Signature to Grant Effectiveness	x	x	x	x																																	
Disbursements to Special Account					x											x											x										
Procurement of Consultancy Services																																					
Expressions of Interest, Short-listing, RFP					x	x	x																														
Submission of Bids by Consultants								x	x																												
Evaluation, Negotiation, Award of Contract										x																											
Consultant Mobilisation											x																										
Assessment and Preparation																																					
Assessment												x	x																								
Development of Implementation Strategy													x	x																							
Sensitisation National/Regional Workshops													x	x																							
Inception Report and Validation															x																						
Implementation of Pilot Works																																					
Capacity Building of National/Regional PIU																x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	
Design, Preparation of Bidding Documents																x	x										x	x									
Advertising and Submission of Bids																		x	x	x									x	x	x						
Evaluation, Negotiation, Award of Contracts																					x											x					
Supply and Installation of Equipment																						x	x	x									x	x	x		
Monitoring and Evaluation																									x										x	x	
Mid-Term Review																										x											
Framework for Integration into UAP																																				x	x

ANNEX 3: COST ESTIMATE

(Amounts in Euro)

Description	Unit	Quantity	Unit Cost	Total	Foreign Costs AWF	Local Costs AWF	Local Costs GoE	Local Costs In-Kind
CONSULTANCY CONTRACT								
Remuneration								
Project Coordinator	m/m	24	3,000	**72,000**		72,000		
Solar PV Expert	m/m	8	8,000	**64,000**	64,000			
Wind Energy Expert	m/m	8	8,000	**64,000**	64,000			
Electro-Mechanical Engineer	m/m	24	3,000	**72,000**		72,000		
Supervisory Engineer	m/m	48	2,000	**96,000**		96,000		
Secretarial/Administrative	m/m	24	1,500	**36,000**		36,000		
Sub-total Remuneration				**404,000**	**128,000**	**276,000**	**0**	**0**
Reimbursable Expenses								
Allowance Foreign Consultants	Days	360	70	**25,200**	25,200			
Allowance Local Consultants	Days	2880	20	**57,600**		57,600		
International Air Travel	No.	6	2,000	**12,000**	12,000			
Transportation allowance (2 vehicles x 24 months)	Months	48	1,000	**48,000**		48,000		
Documentation	Item		500	**500**		500		
Communications	Item		1,000	**1,000**		1,000		
Sub-total Reimbursable Expenses				**144,300**	**37,200**	**107,100**	**0**	**0**
MISCELLANEOUS EXPENSES								
Education tours	No.	5	5,000	**25,000**	25,000			
National/Regional Workshops	No.	5	5,000	**25,000**		25,000		
Total Miscellaneous				**50,000**	**25,000**	**25,000**	**0**	**0**
TOTAL CONSULTANCY CONTRACT				**598,300**	**190,200**	**408,100**	**0**	**0**
Percent of Total					31.8%	68.2%	0.0%	0.0%
Percent Contribution					100.0%		0.0%	
PROJECT MANAGEMENT								
Management and Coordination								
PIU National/Regional (10 staff quarter time)	Months	120	800	**96,000**				96,000
PIU Allowances and Transportation	Months	120	500	**60,000**				60,000
Steering Committee Meetings	No.	4	500	**2,000**			2,000	0
Total Management				**158,000**			**2,000**	**156,000**
Office Equipment								
Personal Computers	Item	5	1,500	**7,500**		7,500		
Office Furniture	Item	5	1,000	**5,000**		5,000		
Total Office Equipment				**12,500**	**0**	**12,500**	**0**	**0**
TOTAL PROJECT MANAGEMENT				**170,500**	**0**	**12,500**	**2,000**	**156,000**
SOLAR/WIND EQUIPMENT								
PV Pumping Systems	No.	40	15,000	**600,000**	600,000			
Wind Pumping Systems	No.	30	20,000	**600,000**	600,000			
TOTAL SOLAR/WIND EQUIPMENT				**1,200,000**	**1,200,000**	**0**	**0**	**0**
TOTAL				**1,968,800**	**1,390,200**	**420,600**	**2,000**	**156,000**
CONTINGENCY 10%				**196,880**	139,020	42,060	200	15,600
GRAND TOTAL				**2,165,680**	**1,529,220**	**462,660**	**2,200**	**171,600**
Percent of Grand Total					70.6%	21.4%	0.1%	7.9%
CONTRIBUTIONS					1,991,880		173,800	
Percent Contribution					92.0%		8.0%	

Technical Description and Cost Estimates

The technical description and associated cost estimates for solar and wind pumping systems, as prepared by the consultant recruited by the AWF in 2007 to prepare the project, are presented below. The cost estimate for the solar and wind pumping systems must be noted as being preliminary since one outcome of this pilot should be to come up with firm unit costs for solar and wind energy pumping systems for Ethiopia.

Solar Pumping Systems

1) Assumptions

Solar pumping system viability is dependant upon careful design with accurate site and demand data. Solar pumping systems are more suitable for low head and small scale water demand. For the purpose of estimating the costs, the following assumptions are considered.

a) Average daily solar radiation energy is estimated at 4Kwh/m^2
b) Daily per capita water demand is assumed to be 15 liters
c) The population range to be served by solar pumping would be 500 to 2500.
d) Pumping head is assumed to be with in the range of 20 to 100 meters
e) Water demand is estimated to be with in the range of 8m^3 to 40m^3
f) Total pumping requirement is assumed not to exceed 800m^4 /day
g) The maximum power of the Photovoltaic array is 1200 (WP)
h) The system will be designed with Photovoltaic array producing DC voltage. An inverter will be used to change the output to AC. An AC, centrifugal, multistage, submersible pump will be used.
i) Water reservoirs (concrete or water tanks) for one day autonomy will be constructed. The reservoir capacity will be 8m^3 per 1000 people

2) Cost estimation:

Based upon the aforementioned assumptions, the possible configuration of solar pumping systems and related costs for each category of population will be as shown in table A3.1 below.

Table: A3.1 Technical Description and Cost Estimates of Solar Pumping Schemes

Type of system	SPS1	SPS2	SPS3	SPS4	SPS5
Population	500	1000	1500	2000	2500
Daily Water Demand (m^3)	7.5	15	22.5	30	37.5
Maximum head (m)	100	50	35	25	20
Array power (Wp)	1200	1200	1200	1200	1200
Equivalent hydraulic load(m^4)	750	750	787.5	750	750
Reservoir capacity	8	8	16	16	16
No of Water points	1	1	1	1	1
	Costs'000 Birr				
A) Design and Supervision	**20**	**20**	**20**	**20**	**20**
B)Civil Works					
Well drilling	161.2	103	84	72	67
Reservoir	23	23	46	46	46
Water Points	12.6	12.6	12.6	12.6	12.6
Subtotal civil works	**204.8**	**146.6**	**150.6**	**138.6**	**133.6**
C) Solar Pumping Systems	177.3	177.3	177.3	177.3	177.3
Grand Total (A+B+C)	**402.1**	**343.9**	**347.9**	**335.9**	**330.9**
Specific Pumping Capacity Cost (Birr/m4)	536.1	458.5	441.8	447.9	441.2
Per capita water supply cost (Birr)	804.2	343.9	231.9	168.0	132.4

No schemes Proposed for year 1	0	0	0	0	0
No of schemes Proposed for year 2&3	0	30	0	0	0
Total Cost of schemes('000 Birr)	**0.0**	**10,317.0**	**0.0**	**0.0**	**0.0**
Total Cost of all schemes(Birr)	**10,317,000.00**				
Total cost of schemes('€)	**871,059.25**				
Total population in schemes	0	30,000	0	0	0
Total population served	30,000				
Average per capita water supply cost(Birr)	343.90				
Average per capita water supply cost(€)	29.04				

Technical Description and Cost estimates of wind pumping Systems

1) Required Data and Information

Wind water pumping can be an attractive option for areas with sufficient wind potential. However, the potential of wind is extremely site specific and variable. An accurate site data collected continuously over a couple of years are essential for designing the water supply system. The most important site data required includes the following.

a) Wind Resource estimate: average wind speed, variability of wind over a day over the seasons and over a year.
b) Water demand: the water demand of the population to be served
c) Well characteristics: the discharge and draw down characteristics
d) The total head: well depth, height of the reservoir and frictional head.

2) Design Considerations

a) Wind water pumping can be designed in at least two options. The conventional wind water pumping systems are mechanical wind pumping systems that are installed directly over the water well and use a positive displacement pump. However, the most recent trend is to use wind electric pumping. Wind electric pumping systems can be used in small wind resources areas often as low as 4m/s and provide a cost effective option to that of diesel and solar pumping alternatives.

b) Mechanical wind water pumping can be the best option when the annual average wind speed is less than 4m/s. These systems require regular maintenance. The seals in pumps fail frequently, leaving the community with unsafe water supply for a long period of time.

c) Recent developments indicate that highly reliable small wind turbines that can operate longer period of time without maintenance have been developed. Such wind turbines have the capability to operate at variable wind. Wind-electric water pumping systems can be fitted with 50 or 60 Hertz induction motors. These motors can operate at variable speed which matches with the power needs of a centrifugal pump and the power availability from wind turbines.

3) Assumptions

In estimating the cost of wind water pumping the following assumptions is made.

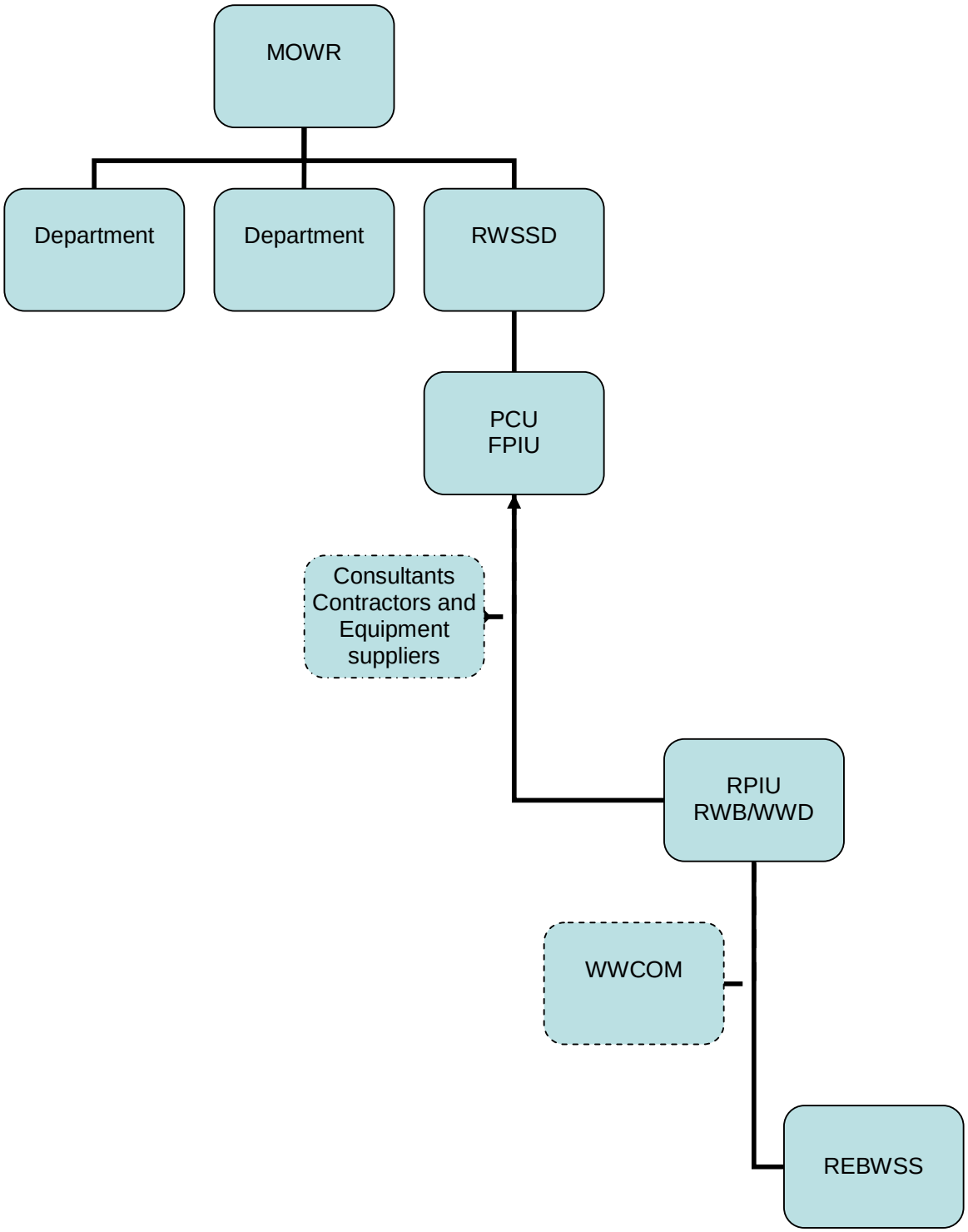
a) Both mechanical wind water pumping and wind- electric pumping options would be tried.
b) The population to be served will be with in the range of 2,000 to 4,000.
c) The daily per capita water demand is estimated to be 15 liters
d) The total pumping head will be in the range of 65- 100 meters.
e) The average wind speed will be 5.5m/s
f) The rotor diameter is 6 meters

4) Cost estimation

Table: A3.2 Cost Estimates of Wind Pumping Systems

Type of system	WPS1	WPS2	WPS3	WPS4	WPS5
Population	2000	2500	3000	3500	4000
Daily Water Demand (m^3)	30	37.5	45	52.5	60
Maximum head (m)	120	100	85	70	65
Array power (Wp)	3600	3750	3825	3675	3900
Equivalent hydraulic load(m^4)	16	24	24	24	32
Reservoir capacity	1	1	2	2	2
No of Water points	1	1	2	2	2
	Costs'000 Birr				
A)Design and Supervision	**22**	**22**	**22**	**22**	**22**
B)Civil works					
Well drilling	193.8	161.2	148.2	128.8	122.6
Reservoirs	46	69	69	92	92
Water Points	12.6	12.6	25.2	25.2	25.2
Sub Total civil works	**260.4**	**250.8**	**258.4**	**262**	**255.8**
C)Wind pumping systems	150	150	150	150	150
Grand total (A+B+C)	**432.4**	**422.8**	**430.4**	**434**	**427.8**
Specific Pumping capacity cost(Birr/m4)	120.1	112.7	112.5	118.1	109.7
Per capita water supply cost(Birr)	216.2	169.1	143.5	124	107.0
No of schemes proposed for year 1	0	0	0	0	0
No of schemes proposed for year2&3	0	4	4	8	10
Total cost of schemes('000 Birr)	0	1691.2	1,721.6	3472	4278
Total cost of all schemes (Birr)	**11,162,800.00**				
Total cost of all schemes (€)	**942469.73**				
Total population in schemes	0	10,000	12,000	28,000	40,000
Total Population served	**90,000**				
Average per capita water supply cost (Birr)	**124.03**				
Average per capita water supply cost (€)	**10.47**				

ANNEX 4: PROJECT ORGANISATION CHART



ANNEX 5: DESCRIPTION OF THE RWSSP

RURAL WATER SUPPLY & SANITATION PROGRAM

1. **PROJECT NUMBER : P-ET-E00-006**
2. **LOCATION : 120 WOREDAS IN ALL 9 REGIONS**
3. **SECTOR : WATER SUPPLY AND SANITATION**
4. **DURATION : 30.0 MONTHS**
5. **ESTIMATED COST : 180,370,000 UAC**
6. **PROJECT PROCESSING SCHEDULE**
   - **Current Status : On-Going**
   - **Appraisal : 22.06.2005**
   - **Presentation to Board : 21.12.2005**

7. PROJECT BACKGROUND :

The Bank Group has developed a Rural Water Supply and Sanitation Initiative (RWSSI or the Initiative) to assist Regional Member Countries achieve the African Water Vision and Millennium Development Goals (MDG) for water supply and sanitation in Africa. Ethiopia is among the five countries selected to start the Initiative as the country meets the requirement of being advanced in the development of sector policies and strategies. Besides having prepared a Water Sector Development Programme and Water Supply and Sanitation Master Plan, the Government of Ethiopia (GOE) has also put in place a decentralized institutional framework that is suitable for scaling-up the implementation of the National Rural Water Supply and Sanitation Programme.

Ethiopia is among the poorest countries in the world, ranking 170 out of 177 in the UN Human Development Index, and is the second most populous countries in Africa (population estimated at 71 million). Yet Ethiopia's rural populations are among the least served, with rural water supply and sanitation access at only 24% and 8% respectively.

Following initial consultations with GOE, the Bank fielded a Preparation mission in August 2003 to support the Government's RWSS Programme. Pre-Appraisal and Appraisal missions were subsequently launched in November 2004 and June 2005 respectively.

8. PROJECT RATIONALE :

The Programme has adopted the Demand Responsive Approach (DRA), which provides communities with the opportunity to make informed choices about the types and levels of services they want and can afford, gives them ownership and responsibility for the management, operation and maintenance of the selected option, thus more likely to be sustainable.

Consistent with this approach, the Programme does not dwell on identifying sub-projects up-front but leaves the decision primarily to the communities assisted by local service providers. The Programme focuses on putting in place an institutional and financing mechanisms, with criteria that would allow community requests to be evaluated in a transparent manner, prioritised and funded, while implementation agents will also be procured in a transparent fashion. The Bank's interventions will utilise the existing institutional arrangements and the Implementation Manuals developed for the national programme. Hygiene education will use publicity and training materials developed jointly by the Ministry of Health and UNICEF for scaling up. It will also address the links between water quality and health, pollution of water at source and during transportation and storage, etc. as well as generating demand for sanitation services.

The process will involve reviewing community requests, selecting sub-projects based on agreed criteria as per the operations manuals, designing new services to meet community demands, procuring contractors and implementing the works and handing over to the beneficiary communities. Choices will be based on the effective demand of the communities taking into account their ability to operate and maintain the services and on technical, financial and economic feasibility. These criteria will include:- affordability, adequacy, quality of service, acceptability, ease of O&M, and proximity of service. technology choices will range from

hand dug and drilled wells to small piped and pumping systems. Many regions already have long lists of sub-projects, which have been identified and will be subjected to the same selection criteria as per the implementation manuals.

The Programme design has also taken into account lessons from the Bank's past interventions and those emerging from ongoing projects, as well as the experience of other donors. In particular, the ongoing decentralization programme has compounded the capacity limitations in the regions and Woredas, where project activities are being implemented. It has also contributed to delays in the consolidation and submission of accounts and reporting. Hence a lot of emphasis will be placed on capacity building in the early phase of programme implementation to strengthen capacity at the regional and Woreda level, in areas such as accounting and financial management, procurement, and auditing. The procurement packaging will favour national competition and extensive use of post-review while disbursements will favour the use of Special Accounts. To ensure adherence to the Bank's fiduciary requirements, there will be frequent technical and financial audits.

The Programme takes into account the institutional capacity constraints as well as planned and on-going interventions of other donors. Taking into account the capacity constraints within the local government set-up, programme implementation will also involve NGOs who have sourced their own funding.

Currently, while a number of suppliers of pumps exist in the country, most spares are not always available in the remotely located communities. Through market-based approaches, the Programme will promote standardization of a few models, which will ease the choice of models to stock and support the development of supply chains. Problems of low capacity of contractors will be addressed by training and assisting artisans to organise themselves into small teams of Local Service P roviders to carry out works like well digging, and packaging the procurement of some of the works to attract the bigger contractors.

The programme approach will also help ensure faster implementation. The use of national procurement documents for most of the NCB packages and Post Review procedures for small contract packages, while increased use of disbursement via Special Accounts will minimize procurement and disbursement delays experienced in the past. The move towards the Demand Responsive Approach, with communities involved in making informed choices about the type of schemes and agreeing up front to take responsibility for their operation and maintenance, coupled with the easy access to spare parts at the local level, would help reduce the very high levels of non-functioning schemes, currently estimated at about 33%.

9. PROJECT OBJECTIVE :

To improve access to rural water supply and sanitation services in Ethiopia to reduce poverty and enhance productivity.

10. PROJECT DESCRIPTION

Programme Components include:

A) Water Supply: Provision of new and rehabilitation of existing water supply services and livestock watering troughs where required based on the Demand Responsive Approach. Technology choices for water supply will range from hand dug wells, drilled wells, protected springs, boreholes, gravity schemes, water harvesting, sub-surface dams, small piped systems, and pumping systems (hand pumps, motorized, solar or windmill pumps). Based on an estimate of about 250 persons per water scheme, it is expected that 23,000 new water points will be constructed, and about 1,550 existing ones rehabilitated.

B) Sanitation: Provision of latrine facilities for schools, health centres, communal latrines in crowded settlement area, and demonstration latrines for associations, cooperatives and communities; and conduct of hygiene and health education campaign for 8.4 million people. Sanitation options will be limited to on-site sanitation systems, mostly improved traditional latrines with sanplats and VIP latrines for individual households or communal latrines for institutions and rural growth centres. About 10,000 demonstration latrines in communities and 6,900 public/communal latrines in schools, clinics and rural growth centres will be constructed under the programme.

C) Capacity Building: Beneficiary communities will be sensitised about the Programme, including procedures to apply for assistance (technical and financial), the need to contribute to capital and O&M costs. communities will also be assisted to establish Water Sanitation and Hygiene Committees (WASHCOMS) consisting of at least 3 women out of the 7 members, opening and operating bank accounts, provided training in water management, operation and maintenance; Capacity building at MOWR, MOH, Regional Water Bureaus, Regional Health Bureaus, Woreda Water Desks and Woreda Health Desks for carrying out their responsibilities under the Programme. Woredas will also be assisted to establish Woreda RWSS programmes and WWDs will be provided with and trained in the use of water testing kits for

monitoring water quality as well as dip meters to monitor groundwater levels in their areas at frequencies in line with EPA requirements; Capacity building for Woreda Support Groups (WSG), Local Service Providers (LSP), Community Facilitation Teams (CFT) and Health Extension Workers (HEW), and spare parts suppliers for development of supply chains; Capacity building for artisans to provide training to prepare them for carrying out very small works like well digging, spring development, hand pump installation and maintenance, etc. Artisans will also be provided with basic tools/equipment required for their trade.

D) Programme Support: involves the inputs of the staff of the federal and local government institutions for the implementation of the Programme. These are MOWR, MOH, RWBs, RHBs, WWDs, WHDs and Woreda Administrations. It includes salaries and allowances, office rental, office equipment , setting up of a database, and other logistical support. It includes provision of Technical Assistance in the form of Procurement and Financial Management experts as well as other rural water supply and sanitation experts at MOWR, MOH, RWB and RHBs as required. Programme support also includes the annual technical and financial audits, part of the monitoring and evaluation costs and the cost for the annual review meetings involving all stakeholders. It also includes the cost of a Water Engineer based at the PCU who will provide implementation support to the programme. Programme support includes an allocation of funds for some studies to be undertaken as required during programme implementation. ..

11. PROJECT BENEFITS :

Ethiopia has a population of 71 million, growing at 2.4% per annum, 84.3% or 59.9 million of whom live in rural areas (communities with population of less than 2000 inhabitants). However, only 24% of the rural population has access to adequate water supply only 8% to adequate sanitation. The national Short-Term Programme (STP), which covers the period 2005-2007, will benefit the 8.5 million rural population in Ethiopia without access to adequate water supply and sanitation services. However, through the Bank's financing 1.8 million people will benefit from water supply facilities and 2.0 million people will benefit from the sanitation program.

Other beneficiaries include the federal and local government institutions whose capacity will be enhanced; artisans who will be trained and assisted to establish companies; and the entrepreneurs who will benefit from selling spare parts.

The STP will generate positive impacts that will enhance the livelihood and well-being of the target population. Readily accessible potable and affordable water for domestic use, especially to the rural population has been proven by many studies to have a direct impact on human health and indirectly on labour productivity. Equitable and readily available water will also reduce drudgery of women and children who are usually responsible for collecting water in rural areas. It has been found that the average load carried per trip by an adult is 21 litres and the average trip (two-way) time for fetching water is 6 hours, including 30 minutes of waiting time.

Furthermore, per capita consumption in rural areas will increase from 10 litres/person/day to 20 lit/person/day. Travel times o fetch water is also expected to decrease from 3 hours on average to 1 hour. Hence the burden of fetching water by women and children will be significantly reduced. The provision of water supply and sanitation services will also impact positively on the other MDGs, such as reducing poverty, improving health and access to education, and promoting gender equity.

The economic analysis of the STP, has been prepared under «with» and «without» project scenarios based on estimates of the costs and benefits that would accrue to various sectors as a result of the interventions to improve water and sanitation services in Ethiopia's rural areas. The analysis also takes into account the impact of the project on the health and education sectors, as well as productivity and income effects to rural households. Gains related to fewer deaths are recognised but have not been included in the analysis due to lack of data. The STP posts an Economic Net Present Value (ENPV) of ETB 2.82 billion and Economic Rate of Return (EIRR) at 38%. Being significantly higher than the 10% discount rate, which is the proxy opportunity cost of capital in Ethiopia, these results indicates that the project is economically viable.

The analysis also shows that the benefits are mainly attributable to time savings for households (64% of total estimated benefits) stemming from the convenience of having better access to water and sanitation services. This is followed by direct benefits (22% of total benefits) accruing from incremental water and sanitation services provided. Significant health sector benefits, in the form of health sector cost savings and patient costs saved (11.4%), and education sector cost savings (2.2%) are also derived from the STP. The analysis further indicates that the interventions under the STP are cost effective, with the return on ETB 1 investment estimated at ETB 12. These results are generally consistent with WHO regional and global estimates.