United Nations Development Programme

GLOBAL ENVIRONMENT FACILITY

Date: 14 October 1999

To: Mr. Kenneth King
Assistant CEO

Attention: Program Coordination

From: Rafael Asenjo
GEF Executive Coordinator

Subject: **Submission of Medium Size Project Brief for GEF contribution of $748,600: Introduction of Viable Electric and Hybrid-Electric Bus Technology in Egypt – Phase I(a)**

Enclosed is a project brief for Egypt entitled: **Introduction of Viable Electric and Hybrid-Electric Bus Technology in Egypt – Phase I(a)** submitted to UNDP by the Ministry of State for Environmental Affairs. Please note that the project has been endorsed by the GEF national operational focal point in Egypt.

In accordance with the operational guidance for the preparation and approval of medium-sized projects, we are submitting this to the GEF Secretariat for action by the Chief Executive Office (CEO). We understand that the Secretariat will recommend to the CEO that the project be submitted to the Council for approval, that it be returned for revision or that it not be developed further.

We are simultaneously circulating copies to UNEP/GEF, World Bank/GEF, STAP and the UNFCCC Secretariat for comments to the GEF Secretariat. We expect to receive these comments within 15 working days. Therefore, we look forward to receiving the CEO's decision on or before 19 November 1999 but understand that the project will not be formally approved, even if the CEO has endorsed it, until the Council has reviewed it (within the following 15-day period, namely by 10 December 1999.

Thank you and best regards.

cc: Ahmed Djoghlaf, UNEP
Lars Vidaeus, World Bank
Madhav Gadgil, STAP
Rohit Khanna, UNEP/GEF
Mark Griffith, UNEP/STAP
Mr. Tahar Hadj-Sadok/Ms. Martha Perdomo, UNFCCC

MEDIUM-SIZED PROJECT BRIEF

PROJECT SUMMARY

Project Identifiers	
1. Project Name: *Introduction of Viable Electric and Hybrid-Electric Bus Technology in Egypt – Phase I (a)*	2. GEF Implementing Agency: *UNDP*
3. Country or countries in which the project is being implemented: *Egypt*	4. Country eligibility: *Egypt ratified climate change convention on* 5 December 1994.
5. GEF focal areas(s): *Sustainable Transport*	6. Operational program/short-term measure: *OP 11 Promoting the Sustainable Transport and Reducing Incremental Cost.*
7. Project linkage to national priorities, action plans, and programs: *The Government of Egypt established a twenty-year strategy designed to usher Egypt into the 21st Century. The plan, created in 1997 and known as "Vision 2017", moves the country towards an export-oriented economy operating under the rules of the free market, and sets the path leading to a long term and sustained development. With human development being the underlying factor for the success of the strategy, the objectives of the proposed project are at the core of this plan. National projects that are able to provide a multitude of benefits and can contribute to these objectives will most certainly help to achieve the success of Vision 2017. Specifically, enhancement of the quality of life through the reduction of pollution, improvement to the efficiency of the mass transport system, creation of sustainable jobs, and enhancement of security are at the top of the national agenda.*	
8. GEF national operational focal point and date of country endorsement:	
Project Objectives and Activities	
9. Project rationale and objectives: *Immediate Objectives:* 1) Demonstration of Electric and Hybrid Electric Bus technology in historic sites and protectorates 2) Sustainable manufacturing, operational, and maintenance infrastructure to support growing market *Development Objective:* Increased utilization of electric and hybrid electric buses to replace diesel buses in historic sites, protectorates, and newly designed cities in Egypt	*Indicators:* 1) Marked decrease in CO2 emissions resulting from deployment 2) Increased investment in, and demand for, electric and hybrid electric buses 3) Existence of local bus manufacturers and service operators 4) Socioeconomic impact and job creation
10. Project outcomes 1. Demonstration with two electric buses of the technology benefits at the Giza Plateau 2. Completion of alternate bus routes in two areas in Greater Cairo 3. Assessment of long term environmental impact (local and global) after program replication 4. Assessment of socioeconomic impact and job creation after program replication 5. Awareness by stakeholders (small and medium	*Indicators:* 1. Two buses delivered and demonstrated at Giza Plateau 2. Tests conducted at various sites with fully instrumented buses 3. Simulations demonstrating performance and applicability of buses in two areas in Greater Cairo 4. Seminar conducted in Cairo for transfer of technology and awareness

businesses and government entities), academia, and transport authorities. 6. Development of comprehensive operational plan for 24 bus pilot project in Giza and Greater Cairo, and creation of proposal for funding of pilot project Phase I (b)	5. Final report summarizing studies and proposal for Phase I (b) pilot project
11. Project activities to achieve outcomes (including cost in $ for each activity): 1. Identifying and Designing Potential Bus Service Routes ($65,000) 2. Training, Maintenance and Operation ($45,000) 3. Testing of Electric Bus in Various Routes (includes cost of two buses) ($869,030) 4. Computer Simulation of Various Bus Configurations and Routes ($50,000) 5. Economic, Environmental, and Societal Impact Studies ($100,000) 6. Developing Detailed Plan and Proposal for Phase I (b) ($35,000)	*Indicators:* 1. Successful demonstration and testing of two buses in Giza 2. Design of potential operational routes for Phase I (b) 3. In-country awareness of the benefits and potential of switching to the electric and hybrid electric bus technology 4. Potential for creation of jobs though domestic production of new bus technology and operational businesses
12. Estimated budget (in US $ currency): PDF: - GEF: 748,600 Co-financing: in-kind: 550,000 (Southern Coalition for Advanced Transportation) in-cash: 415,430 (Government of Egypt – Social Fund for Development and EEAA) TOTAL: 1,714,030	
13. Information on project proposer: *The Ministry of State for Environmental Affairs is the proposer for this project.*	
14. Information on proposed executing agency (if different from above): *The Phase I (a) project will be implemented by the Egyptian Environmental Affairs Agency, and project management and execution will be carried out by the Social Fund for Development through the Southern Coalition for Advanced Transportation.*	
15. Date of initial submission of project concept: *No project concept was submitted.*	
Information on Institution Submitting Project Brief	
16. Project Identification number:	
17. Implementing Agency contact person:	
18. Project linkage to Implementing Agency program(s): This project conforms with the Country Cooperation Framework and is in line with other climate change activities being implemented by The UNDP country office in Egypt.	

1.0 Summery: Project Objectives & Description

1.1 Technology Background

Electric, hybrid-electric, and fuel cell vehicle technologies have received marked attention in the past six to eight years. The logical progression of these technologies is based on the fact that fundamentally all three involve an electric drive train that provides the propulsion for the vehicle. A pure electric bus is "zero-emission" by nature of the fact that it burns no fossil fuels on board, and derives its electric energy from battery storage devices. Battery options include lead-acid, nickel-cadmium, nickel-metal-hydride, and lithium-ion, with other more exotic and less commercially viable types being researched for future applications. While the limited range of electric buses may be perceived as a problem, these types of buses are in fact the easiest to implement in existing transport systems because they do not require a new fueling infrastructure. Batteries are charged off-board and are placed in the buses in a swap-out operation in approximately 10 minutes. Recycling of batteries is not a major issue because currently lead-acid batteries are recycled as part of the normal system for automotive batteries. Cost may be viewed as being high up front, however, with higher volume, leasing options, and operational life cycle accounting, electric vehicles will eventually have a lower cost per km traveled.

The next level of progression is to hybrid-electric buses. The hybrid refers to an auxiliary power unit (APU) which is placed on the bus to generate electricity. The APU could take on any form ranging from compressed natural gas or diesel turbine, to small gasoline internal combustion engine, or any combination. The primary purpose of the APU is to extend the range of an electric bus, and in some instances, provide load balancing. While hybrid-electric buses are not classified as "zero-emission", they do qualify under "ultra-low emission". To go from electric to hybrid-electric is literally the addition of an APU engine and plugging a wire to the bus power system. The drive train does not change.

A fuel cell bus is similar in concept to the hybrid-electric, in that the fuel cell is mounted in the bus and plugged into the power system. The difference is that batteries could be eliminated completely when using a fuel cell. The advantage of the fuel cell / electric bus (without on-board reformer) is that it is zero-emission since electricity is generated by combining hydrogen stored on-board in a tank with oxygen from the air. A reformer based fuel cell bus is similar to a hybrid-electric in that some form of fuel, such as methanol, is utilized to extract the hydrogen. The disadvantage, today, is that the fuel cell cost is on the order of $20,000 per kWatt, it requires hydrogen which has to be generated off-board and transferred to the bus tank (new infrastructure) and is still in the research and pre-commercialization stage. Undoubtedly fuel cells will become commercially viable in the next 4 to 6 years. Based on that, this proposal recommends the introduction of the electric, hybrid-electric, and fuel cell technologies in a natural progression. This would enable funds to be utilized more effectively, and it would insure that a critical mass is created by having a large fleet of buses to truly study the operational and maintenance aspects of the technologies in Egypt. A one-bus project may not provide the necessary visibility needed to secure the public acceptance, and the introduction of a new technology pre-maturely may have a long-term negative impact if it exhibits any signs of failure.

The direction taken by the automotive industry is to introduce hybrid-electric vehicles/buses in the short term (i.e. 5-10 years), but this direction will move to pure electric transportation as battery technology further develops. Fuel cell and direct injection diesel hybrid vehicles make more sense in the next ten years due to the limitations of battery technology. However, all indications are that with the expanded use of portable telephones, computers, and other electronic devices, battery technologies such as lithium ion, nickel metal hydride, among others, will be commercially viable in large scale. This would offer electric powered vehicles and buses the extended range with reduced weight, which are current limitations of lead acid technologies.

It should be pointed out that for shuttle services in congested areas, electric buses offer a sound solution. Replacement of the batteries in a 5-10 km circular route is easily achieved once or twice per day. This system is the preferred choice for most of the national parks in the US.

1.2 Objectives

The overall objective of the project is to introduce to Egypt a viable electric, hybrid-electric, and eventually fuel cell bus technology program, that would have significant benefits and sustainability in various segments of the country. The project will contribute to the long-term cost reduction of low emission bus systems, to the enhancement of Egypt's technological competitiveness, and to job creation. This will be applied to antiquity sites starting with the Giza plateau as well as the Cairo public ground transport sector. Contributing to a long-term cost reduction will enable the technology to reach commercially viable levels in a much shorter time, thereby ensuring that electric, hybrid-electric, and fuel cell powered buses play a major role in the urban mass transit of Cairo and other UNDP/WHO identified "megacities" around the globe.

The proposed project consists of a multi-year, multi-phase plan introduced by a US-Egyptian public-private partnership that will have a marked impact on global abatement of greenhouse gases, reducing the pollution in Egypt and meeting some of the objectives of Egypt's Vision 2017, in addition to serving as an example to other megacities worldwide. With this multi-phase plan and growth sequence, the project would be in line with GEF Operational Program number 11 on Sustainable Transport as well as GEF Operational Program number 7 "Reducing the Long-term Cost of Greenhouse Gas Emitting Technologies" of the GEF Operational Strategy. Through a study funded by GEF titled "Zero or Low Emission Fuel Cell Buses for Cairo", it was concluded that Egypt is adequately positioned in terms of technological know-how, human capacity, and national priorities to be a viable option for a project to contribute to the objectives stated here. With the experience, track record, and commitment of the proposing team members, there is no doubt that the immediate and long-term objectives will be met successfully.

1.3 Description

The proposed project consists of three phases. The first phase, which consists of two stages (Phases I (a) and I (b)), will focus on bringing to Egypt 24 US made electric and hybrid-electric shuttle buses and operating them in Giza and downtown Cairo. The main objective of this phase is to demonstrate the technology and its benefits in various configurations and applications, and at various sites. Furthermore, studies will be conducted to create the detailed plans for the technology transfer to investigate the long-term environmental and economic impact of all three phases of the program. This pilot program will involve placing fourteen zero-emission electric buses to service tourists visiting the Giza Plateau and Sakara, and ten buses comprised of six electric and four hybrid-electric buses connecting the airport to Tahreer Square. The hybrids, which will encompass advanced compressed natural gas, diesel, and gasoline turbine technologies, will be placed in routes requiring extended range. Various aspects of operational logistics and maintenance issues will be investigated.

Phase I (a) is the proposal for which support is sought through the current document This first stage of phase I, described in detail in this proposal, encompasses six tasks aimed at addressing specific operational technology questions, testing a bus in various sites in Egypt, conducting economic, environmental, and societal studies, providing training to managers, engineers, and technicians, and developing the scope and proposal for stage (b) of Phase I. Two electric buses will be used to perform the six tasks in Egypt outlined here. The follow-on stage, Phase I (b), will involve the completion of the pilot project demonstration whereby the remaining 22 buses with various hybrid configurations will be brought to Egypt and placed at various sites. By the end of Phase I, a technology transfer and commercialization plan will exist, based on real demonstration bus routes, for production of viable electric and hybrid-electric buses in Egypt. This will enable the expansion of the bus routes and the addition of new routes in other historic sites, in Greater Cairo, and in other major cities such as Alexandria.

In Phase II, US made electric and hybrid electric drive systems will be integrated into Egyptian made buses with a local manufacturer. This is an interim step to introduce local manufacturing into the process, thus enhancing the economic benefits and reducing the overall cost of the buses. Several buses will be produced and placed in service at historic sites and at various downtown city locations. In addition, export of the buses will be initiated into neighboring countries. A more comprehensive study on the economic feasibility of full manufacturing of the entire drive system, and future economic impact will be performed.

In the third phase of the program, the complete bus and electric drivetrains will be completely manufactured in Egypt The US and Egyptian private sector will establish a manufacturing facility in Egypt to produce the components of the electric drive system for integration in Egyptian built buses and for worldwide export. Motors, controllers, battery management systems, and other critical components will be produced through this new venture. Again, a limited number of buses will be produced and placed in service at various sites throughout the country, for performing shakedown testing. During the three phases of the project, the development and commercialization of fuel cell technology will be monitored to assess its feasibility and viability of implementation in the electric buses.

Upon implementation of the third phase of the program, Egypt will be a major producer and exporter of advanced electric and hybrid electric vehicles for the worldwide market, and more important, will set the trend as a leader in clean transportation and be able to compete in the growing and competitive market for automotive component supplies.

Egypt already has the necessary technology and manufacturing infrastructure for the production of high quality buses. All buses ranging from six-meter transport mini-buses to deluxe twelve-meter buses are manufactured locally. The engine and driveline components are imported from international companies such as General Motors, Ford, Scania, Mitsubishi, and Renault, among others. The proposed Phase II would utilize this existing bus production know-how by incorporating electric and hybrid-electric drivelines. This would reduce the cost of the buses significantly. For example, a US built diesel mini-bus with minimum options sells for approximately $135,000. The equivalent bus in Egypt sells for around $36,000 due to the lower cost of labor and lower demands on quality and safety. Therefore, simply replacing the non-driveline portions of the bus with domestic products could reduce the cost by nearly $100,000.

Phase III offers an additional potential for cost reduction. Egypt does not currently have the capability of manufacturing internal combustion engines. However, there are several manufacturers of lead-acid batteries and industrial electric motors, which form the basic components of an electric vehicle driveline. Other key components, such as power electronics, chargers, and DC to DC converters, are basic electronics units that can be replicated. Studies conducted by the Department of Energy in the US have shown that a complete electric driveline is technically easier and less costly to manufacture than a traditional gasoline engine driveline, once economies of scale have been achieved. With Egypt's high tariffs on imported goods, the net cost of the electric driveline could be much lower when produced in Egypt compared to gasoline engines which will always be imported due to their complexities.

It is further believed that this can be replicated in other megacities worldwide. Most developing countries enjoy the same low cost advantages of mass transport buses as Egypt, and in most cases, possess equal if not better electronics manufacturing capability. Therefore, there is no reason to believe that complete electric and hybrid-electric buses could not be manufactured cost-effectively in most megacities around the world.

1.4 Potential global benefits and replication benefits

A complete analysis of CO2 reductions is presented in Appendix A. This analysis takes into account the source emissions based on the type of power generation stations available in Egypt. The end result is that an electric bus replacing a "clean" diesel bus of equivalent capacity will lead to a reduction of 1,533 tons of CO2 over a 12-year period. With the "future facilities" market estimate of 1000 buses to be placed throughout Egypt in the historic sites and protectorates, this will result in a total CO2 reduction of 1.53 megatons. The resulting Unit Abatement Cost is therefore $0.49/ton of Carbon. The following data represents the contribution of transportation to the world's total emissions:[1]

- Total natural CO2 emissions (i.e. oceans, vegetation, soil, biomass) in 1996 are estimated at 770 Gt/yr while anthropogenic emissions (i.e. power stations, residential, industry, biomass, transportation) accounted for only 28 Gt/yr.
- Worldwide passenger car and commercial vehicle traffic contribute 0.5% to total CO2 emissions.
- Methane emissions from road traffic are so marginal that their contribution to the greenhouse effect can be disregarded.
- Heavy-duty vehicle traffic contributes 1.6% to the total anthropogenic emissions of nitrous oxide.
- Road traffic contributes only about 1% of non-methane hydrocarbon emissions.

With respect to replication, the pilot project (Phase I) is designed to transfer the technology to Egypt, and addresses specific technical issues with operation, infrastructure, and manufacturing. The Social Fund for Development (SFD), one of the funding and implementing agencies for the project, is chartered to enhance job creation and sustainable development in Egypt. Therefore, as part of the implementation plan for Phase I (a), SFD is targeting various groups as beneficiaries that would insure the eventual continuation and replication of this program. The beneficiaries and targeted entities of the proposed project include:

- The citizens of Egypt who will benefit in the long run from the reduction of pollution in congested areas and in the metropolitan cities.
- Beneficiaries of the demonstration project and training including transport authorities of the major Egyptian metropolitan cities.
- Beneficiaries of the availability of clean bus services resulting from the pilot project including the Ministry of Culture and Governorates that have jurisdiction over historic sites or protectorates.
- Long-term target groups include domestic bus manufacturers, as well as small and medium businesses seeking to gain from the technology transfer to become component suppliers as well as operators of clean bus service systems.

These target groups will serve as suppliers and buyers of the proposed bus technology. It is crucial that the demonstration proposed in Phases I (a) and (b) is

[1] Lenz, Hanz Peter and Cozzarini, Christian, *Emissions and Air Quality*, ISBN 0-7680-0248-6, 1999

executed in its entirety because it will clearly address issues such as revenue generation from service, operation and maintenance costs, and technology limitations. These are essential for the replication of the project. The SFD will play a major role in the implementation of Phases II and III by providing credit loans to small and medium businesses for the production and operation of the buses.

1.5 "System-boundary" issues

To address the "system-boundary" issues, a comparison must be made in emission and fuel consumption of diesel versus electric powered buses. A complete emission reduction analysis, including source emissions, is outlined in Appendix A. The quality of emissions resulting from diesel-powered buses is a function of several factors:

1. The drive cycle – city driving with stop and go versus highway driving
2. Age of the vehicles
3. Emission control such as catalytic converters and fuel injection
4. Frequency of preventive maintenance (changing of spark plugs, etc.)

In developing countries, the congestion causes significant stop and go driving, the average vehicles are generally old, no advanced emission controls exist, and preventive maintenance is not as frequent as needed. Therefore, vehicles and buses in developing countries are significantly more polluting than in developed countries. In the case of electric buses this difference goes away since the emissions are eliminated at the vehicle level. It should be noted that the analysis performed in Appendix A is based on diesel bus emissions test data obtained from dynamometer testing of new US buses. This makes the calculation of CO2 reduction conservative since Egyptian diesel buses will in general be significantly more polluting than US buses.

The impact on emissions and fuel consumption in generating the electricity at the power plant level needs to be evaluated. First and most important, due to inefficiencies of internal combustion engines, an electric bus requires in general about one-half of the energy per mile of a conventional bus. This translates to half the fuel and CO2 emissions even if the electricity came from fossil-fueled power plants. Furthermore, electric buses permit regenerative braking, therefore recovering kinetic energy by recharging the battery during deceleration rather than wasting the energy in heating the brakes. In the urban driving cycle, almost half of the mechanical energy for propelling a bus is otherwise squandered in this kinetic energy loss.

As developing countries are becoming more dependent on electronic machinery and equipment (an "electric economy"), the quality of the electric power is challenged. To avoid burnouts and maintain the quality of the electricity supply, power plants now keep vast surpluses of generator power on hand to meet peak demands. Excess capacity comes with a cost. The focus is on reducing surplus capacity by leveling the demand for electricity over the day. Electric buses are charged at night when vast surpluses of electric generating capacity are idle and unproductive. The charging requirements for electric buses and other modes of transportation would utilize this capacity and thereby increase installed capacity usage and render the electric system more efficient. Furthermore, this would reduce the overall cost of electricity because the overhead would be spread over a larger production of energy.

Finally, Egypt is already progressing towards natural gas fueled power plants as well as hybrid-photovoltaic and wind turbine generating plants. This is ultimately creating a much cleaner power generation infrastructure that in the total system, in conjunction with zero-emission buses and cars, will lead to lower CO2 and hydrocarbon emissions.

1.6 Incremental cost analysis

The desired market transformation of diesel powered buses in historic sites and protectorates in Egypt is associated with a cost that is unrecoverable to both the Egyptian public and private sector. This project aims to bring about this market transformation through the removal of barriers that prevent it from happening in the 'business-as-usual' scenario. Through this barrier removal process, the GEF project is providing and promoting an alternative that would in the long run result in a win-win situation. This will be done by bringing down the cost of electric and hybrid electric buses, which is made up of the technology component, as well as added costs such as training and operation. The sustainable introduction of economically viable renewable energy technologies will result in the global benefit of significant reductions in GHG emissions, as well as national benefits of decreased fuel consumption and dependency.

As is shown in the Incremental Cost Matrix below, a substantive baseline (in cash as well as in kind) is provided by the government in line with its sustainable development objectives, and serves to keep with the GEF principles of Incremental Cost.

INCREMENTAL COST MATRIX

	Baseline	Alternative	Increment (Alternative-Baseline)
Global environmental impact	Unjustified high level of CO_2 emissions	Use of clean technology of electric and hybrid electric buses	Decrease in CO2 emissions due to switch of technology (estimated at 1,500 tons of CO2 per bus over 12 years)
Domestic impact	- Growth of tourism in Egypt at historic sites has a negative environmental component - Protectorates are gaining touristic access and require transportation systems	-Supply of and demand for clean buses rendering the schemes environmentally sustainable - Availability of technical know-how for supply, operation, and maintenance of clean bus systems	- Decrease in level of growth of fuel consumption - Increase in production and export of new technology buses - Improvement of quality of life and creation of jobs - Environmental protection of antiquities and protectorates
Costs (US$)	Baseline	Alternative	Incremental Cost

Identifying and Designing Potential Bus Service Routes	40,000	25,000	65,000
Training, Maintenance and Operation	0	45,000	45,000
Testing of Electric Bus in Various Routes (includes cost of two buses)	280,430	588,600	869,030
Computer Simulation of Various Bus Configurations and Routes	30,000	20,000	50,000
Economic, Environmental, and Societal Impact Studies	50,000	50,000	100,000
Developing Detailed Plan and Proposal for Phase I (b)	15,000	20,000	35,000
Total	*415,430*	*748,600*	*1,164,030*

The total budget for Phase I (a) as detailed in Section 9.0 is $1,714,030, with $550,000 in in-kind cost sharing by SCAT (see section 8.2 for a description of SCAT background and role). The cost sharing is a leveraging of an on-going project that resulted in an integrated drive system that is directly applicable to this pilot project. The budget, not including in-kind contributions, is $1,164,030. Of that, $515,600 is for the two buses, additional components, shipping, and charging equipment. If two diesel buses of equivalent capacity were purchased in Egypt, their total cost would be $72,000. Hence the incremental cost for the hardware is $443,600.

The remaining portion of the budget ($648,430) covers project oversight, bus operation, pilot project demonstration, technical studies and testing, training, environmental impact studies, socioeconomic studies, and travel. GEF is asked to fund less than half of these costs ($305,000) for a total of $748,600 for the entire Phase I (a).

The "polluter-pays" principle is being considered in a broader sense for enhancing the feasibility of replication beyond Phase I. Currently no dedicated transportation system exists within the historic sites and protectorates in Egypt. Tourists are transported directly by their tour buses and the Egyptian government is planning on banning the approach of these large diesel coach buses to the historic sites. The plan is to incorporate a fee structure, which will be studied and partially implemented in Phase I (b).

2.0 Description of Proposed Phase I (a) Activities *(see Appendix B Sample SOW)*

2.1 Activity 1: Identifying and Designing Potential Bus Service Routes ($65,000)

To insure the success of the overall Phase I Pilot Project, it is necessary to select the appropriate bus service routes that can: (a) benefit from a zero or low emission transportation system, (b) exhibit high visibility and recognition to offer the program the proper national and international awareness, and (c) can be managed properly and not face logistical problems that could potentially jeopardize the success of the program. In this task, several sites will be studied and downselected for implementation in Phase I (b). The current preference is to establish only one shuttle service route with 24 buses at one location, as opposed to spreading the buses across two or more locations. This would insure that factors (a), (b), and (c) listed above can be met with great success. However, during Phase I (a), these issues will be studied carefully and discussed with EEAA to determine the most suitable approach for Phase I (b).

Another key factor in selecting the bus service route is the strategy for battery charging and issues of infrastructure. The electric buses proposed to be introduced under this study have a typical range of 80-100 km on a full battery charge. Depending on the requirements for the bus, the charging of the batteries can then be done either overnight when the bus returns to the station, or the entire battery pack can be replaced with a fully charged pack. Charging of a battery pack requires approximately 8 hours for both on-board charging and off-board charging. Swapping out a battery pack can be accomplished in under 15 minutes, therefore a strategy whereby the bus comes into the station for a battery swap-out resembles that of fueling up a regular bus with diesel fuel. The infrastructure required to achieve this includes a garage-type station, generally the area where the buses are maintained, a number of battery chargers, racks for holding the batteries during off-board charging, and a fork lift for performing the battery exchange. These items are included in the plan for Phase I (a), and will be used to determine the best strategy for charging and maximizing the bus fleet performance.

2.1.1 Shuttle Bus Service in Giza and Sakara

It is estimated that every year, over 1.4 million tourists visit the Great Pyramids of Giza, and some fraction of this enormous number also visits the stepped pyramids at Sakara. The Ministry of Culture, in cooperation with the Governorate of Giza, will construct a ring road around the Great Pyramids at the Giza Plateau. The purpose of this road is to direct vehicle traffic consisting of tourism heavy duty diesel buses and other polluting cars and pick-ups away from the fragile historic structures. It is proposed to operate a zero-emission shuttle service inside the ring road to transport tourists from the parking and rest areas spread out along the ring road to the various stops of sightseeing. It is estimated that at peak tourism season, there will be a need for fifty shuttle buses to accommodate the number of visitors to the site.

The portion of this task conducted in Phase I (a) will address the issues related to selecting and creating the shuttle routes in Giza and Sakara. The plan is to place in the Giza Plateau during Phase I (b) a pilot shuttle bus service which can transport tourists throughout the historic site, and connecting to Sakara via the new desert road. The purpose of the pilot project is to study the needs of the visitors specific to this site at various times throughout the year and driving patterns that best optimize the functionality of the service. Furthermore, the performance of the buses as a function of the terrain, weather, maintenance accessibility, and operational logistics will be studied. One of the key issues for assuring the success of the service is to establish the proper battery exchange strategy, and create the appropriate charging and service stations. This will also be a focus of the Phase I (b) pilot project during the first year. In the long run, it is anticipated that tourists will be charged a nominal fee to ride the buses. Whether this fee is part of the entrance fee to the site, or a ticket purchased separately, will also be investigated.

2.1.2 Bus Service in Cairo

Similar to the aforementioned pilot project at the Giza Plateau, a demonstration and study shuttle service could be created in downtown Cairo to address comparable issues that are particular to this situation. Phase I (a) will address the feasibility of incorporating such a pilot route in Phase I (b) that could successfully address the aforementioned factors. Through discussions with officials in the Governorate of Cairo, it is believed that a reasonable route for the pilot project is to provide a shuttle service connecting the airport to Midan El-Tahreer. With a number of buses having options such as air conditioning and APUs running on gasoline, diesel, and CNG, a combination of scenarios could be studied and documented during this stage of the study. It is believed that the service should be eventually implemented in various locations throughout Cairo where zero-emission, low noise, clean mini-buses can provide a better quality of life for the citizens of Greater Cairo. Part of the Phase I (b) pilot study will include a survey of ridership focusing on ticket price versus convenience factors and overall comfort.

2.2 Activity 2: Training, Maintenance and Operation ($45,000)

A significant portion of the phase I pilot project will address proper training of transportation authority managers, as well as maintenance and operation personnel. The project team will have in place a full time staff from the private sector comprised of a program manager, engineers, maintenance technicians, and drivers who will operate and maintain the buses during the pilot project. These individuals will work with their counterparts at every level in the Egyptian government to provide the necessary training, planning support, and operational knowledge transfer. Assisting the project team will be consultants from CARTA (the Chattanooga, Tennessee transport authority) who are experienced with the operation and maintenance of a fleet of electric and hybrid electric buses, as well as the US bus manufacturer, who will provide training in the US for a number of Egyptian Government officials, and in Egypt for other operational personnel. By the end of the Phase I project, the Egyptian government personnel will be capable of operating and maintaining the entire system of buses. Furthermore, the vehicle manuals, including specifications, maintenance procedures, and other related material will be translated to the Arabic language.

Training in Phase I (a) will focus on conducting a short conference/seminar in Egypt with open invitations to government officials, engineers, and university professors. This seminar will describe the technology in detail, and address issues such as current programs worldwide and future trends in transportation. The benefits to the participants are numerous, and feedback from Egyptian experts could be invaluable at this early stage of the program. The follow-on activity in Phase I (b) will address training of Egyptian transport personnel in the US and more extensive in-country training of engineers, technicians, and drivers.

2.3 Activity 3: Testing of Electric Bus in Various Routes ($869,030)

Under this activity, two electric shuttle buses will be shipped to Egypt and used to perform several technical and operational tests. One bus will be fully instrumented with a data acquisition system measuring motor/controller input power, battery state-of-charge and output, bus speed and acceleration, road inclination, etc. This bus will be used to physically test performance in various routes to help optimize the 22 buses that will be implemented in Phase I (b) of the pilot project. For example, at the Giza Plateau, there is need for higher torque due to the large grades, but top speed is not an issue. Furthermore, given that the bus will operate in a small shuttle loop, range is less of an issue. Testing in downtown Cairo will address more specifically speed, acceleration, and range. Much of the data collected in this task will be used to supplement the simulation to be performed in Task 4.

The second electric bus will be used for public awareness and perception studies. For example, passenger related studies such as comfort, acceptable cost of tickets, graphic design issues (e.g. what would be acceptable in the Giza Plateau), as well as official and media related appearances. It is crucial that for these types of applications, the bus is always operational, is presented in its normal appearance, does not have wires exposed (the way the bus described above will appear), and does not interfere with the rigorous testing program.

2.4 Activity 4: Computer Simulation of Various Bus Configurations/Routes ($50,000)

This activity will assist in extrapolating the performance data obtained in Task 2 to properly configure the 22 buses in the Phase I (b) pilot project. The simulation takes into account the route conditions (inclinations, number and types of complete stops, speed limitations, possible charge station locations, etc.) and coupled with data on the bus and all its components, simulates the performance of the given bus as it would perform physically. Based on that, questions such as specific type and number of batteries, type of APU, effect of air conditioning system, and expected range can be answered. This is a critical task in Phase I (a) since proper configuration of the buses in Phase I (b) is crucial for the long term success of the program.

2.5 Activity 5: Economic, Environmental, and Societal Impact Studies ($100,000)

As described in the benefits section that follows, among the long term implications of this project to Egypt are the reduction in CO2 emissions, creation of jobs through technology transfer, and overall improvement to quality of life. The long term goal of the proposed project is to transfer to Egypt the technology for the manufacturing and integration of electric and hybrid electric vehicles. As indicated, during phase I, the feasibility of the technology transfer in preparation for phases II and III will be investigated. Based on the assumptions of large scale local production and implementation of these buses, an economic, environmental, and societal impact study will be performed by the proposing team to assess the complete benefit of this project if it went to phases II and III, including job creation potential. All the factors that affect the current and future cost of the new technology components will be identified. Based on these factors, required interventions for bringing about the desired cost reduction to achieve commercialization of the technology will be investigated. This will include improving life-cycle economics, increased or improved local manufacturing potential, competition, the need for and impact of financial support mechanics for suppliers, increased demand and any other relevant issues. Lastly, issues of importance to the global manufacturer and the impact of these issues on cost should be assessed. The studies will be used to compile a detailed proposal for the follow-on phases and to provide a viable basis for further funding of the program by the Egyptian Government.

2.6 Activity 6: Developing Detailed Plan and Proposal for Phase I (b) ($35,000)

The outcome of Activities 1 to 5 above will provide the basis for defining the Phase I (b) project. In this task the detailed project activities and outputs will be conceptualized and designed in order to achieve the overall objectives of establishing a successful pilot project demonstration and to contributing to the long-term local commercialization and reduction of cost of the technology. The overall project will design, among others, activities addressing a successful demonstration component, policy interventions, institutional and infrastructure requirements, as well as national capacity building needs. Mechanisms will be specified to ensure connection for complementing the Phases I (b), II, and II projects and other worldwide efforts (US, India, Costa Rica, Brazil and Mexico).

3.0 Phase I (a) Output

The output of the Phase I (a) project will be in the form of a final report and proposal for Phase I (b). The report will describe the results of tasks 1-5 outlined above, including technical, logistical, and public perception findings. Furthermore, it will include an Incremental Cost Analysis, potential GHG emissions curtailed, and potential commercialization strategies. The output of Task 6, namely the Phase I (b) proposal, will define the plan for putting in place a successful pilot project demonstration at various sites in Egypt serving multiple purposes. This will also include the plan for participation by various end users and stakeholders such municipal governmental entities, which is key to the success of Phases II and III, participation by local bus and component manufacturers, and participation by US manufacturers and global organizations.

4.0 Eligibility for GEF Funding

The government of Egypt ratified the UN Framework Convention on Climate Change on 5 December 1994.

5.0 Implementing Agency Coordination and NGO Participation

EEAA will be the principal national coordinating agency for the proposed bus pilot project. EEAA has agreed to assume the role of overall local coordination between the stakeholders until the completion of Phase I. EEAA will manage the project in close cooperation with the Social Fund for Development. The SFD will form a Steering Committee that will assist with directing the project and insure that it meets the objectives of the stakeholders, including the Ministry of Culture, and the Giza Governorate. Assisting the SFD and participating in the project is the Southern Coalition for Advanced Transportation (SCAT), a non-governmental organization (NGO) aimed at accelerating the growth of electric and hybrid-electric transportation industries worldwide. SCAT has been successful over the past six years in supporting similar governmental projects with research, development, and demonstration projects.

Examples of potential stakeholders include the Greater Cairo Bus Company (GCBC), the Organization for Energy Conservation & Planning, (OECP), New & Renewable Energy Authority and the Egyptian General Petroleum Corporation (EGPC). Under the USAID funded Cairo Air Improvement Project, GCBC and OECP are already cooperating with EEAA on comparing emissions, and engine performance of diesel and natural gas buses operating on identical routes in Cairo.

Each of the above stakeholders will provide competent counterparts to work with the project. As the local coordinating agency, EEAA will also provide a senior officer from the Agency to work with UNDP/GEF team for the execution of the project, particularly as it relates to coordinating the work with other national agencies and the private sector.

6.0 Justification and Project Benefits

6.1 Justification

The Giza Plateau and the city of Cairo are ideally suited project sites for key demonstration activities aimed at speeding up the rate of commercialization of the technology. Cairo is identified as one of 20 megacities worldwide, with a population of over 13 million. Of the 20 megacities identified in the 1992 UNDP/WHO report, 16 were in developing nations. These megacities form a dispersed group of urban centers in the tropical belt, emitting intense greenhouse gases and air pollutants, particularly from the transport sector. In Egypt, 21.568 million tons of CO2 were emitted by the transport sector during the 1995/96 fiscal year. Total national CO2 emissions for the same year were 82.897 million tons of CO2.

Urban air pollution is a major environmental problem, which jeopardizes Egypt's economic development and the health of its citizens. Urban air quality is degraded as a result of industrial emissions, vehicles, construction, and garbage burning. Among the world's largest cities, Cairo has the worst air pollution in terms of suspended particulates and lead, resulting in an estimated 10,000 to 25,000 additional deaths and 90 million to 270 million sick days per year, and an average lowering of Children's IQ by four to five points. In Cairo, particulate matter was estimated to be 349 to 857 micrograms per cubic meter of air, by comparison to 75 in the US. Lead was estimated at 5 to 10 micrograms per cubic meter of air, compared to 1.5 in the US. Recent developments in Egypt, such as phasing out of leaded gasoline, enforcement of Law number 4, and the introduction of CNG in the transport sector, have led to dramatic decreases in lead and particulate concentrations. With respect to transportation in Cairo, more than 3.6 million commuters ride the 3,300 buses and 700 minibuses of the Public Transport Authority daily, and another 800,000 ride the 700 buses of the Cairo Bus Company. A plan for reducing the pollution levels in Egypt and effective abatement of greenhouse gases globally must certainly address the transportation component. Beside the large emissions reduction potential from applying the electric and hybrid-electric bus technology in such a large market, the potential for replicability in similar megacities becomes more feasible. In 1997, the Government of Egypt established a twenty-year strategy designed to usher Egypt into the 21st Century. The plan, known as Vision 2017, moves the country towards an export-oriented economy operating under the rules of the free market, and sets the path leading to a long term and sustained development. Specifically, enhancement of the quality of life through the reduction of pollution, improvement to the efficiency of the mass transport system, creation of sustainable jobs, and enhancement of security are at the top of the national agenda.

One of GEF mandates is to help foster low-GHG emitting technologies, and their applications, especially those that are close to commercial viability. More specifically, GEF Operational Program 7 states that its objective is to reduce GHG emissions "by increasing the market share of low GHG emitting technologies that have not yet become wide spread least cost alternatives...". The proposed Phase I (a) project will help pave the way for setting up a full scale Phase I (b) project to achieve the above objectives.

In summary, therefore, GEF support is justified for the proposed Phase I (a) and (b) work because this technology has the prospect of becoming a least cost option. More important, however, is its potential to substantially reduce carbon dioxide emissions per unit of bus service provided compared to petroleum internal combustion engines.

6.2 Benefits

6.2.1 *Environment*

The Egyptian government has already taken steps towards the reduction of pollution on the industrial level and in the transportation sector. The latter has focused mainly on the shift to compressed natural gas (CNG) usage, which offers a logical step given the country's reserves. The shift to electric vehicles (EVs) and hybrid electric vehicles (HEVs), however, offers substantial reductions in pollution levels far beyond those achieved with open loop CNG systems. Regardless of the fuel used in an HEV, the fuel consumption and pollution levels are lower than the dedicated internal combustion (IC) engine equivalents. Specifically, if 100 diesel buses are replaced by an equal number of hybrid electric buses, the reduction in emission levels utilizing diesel or CNG fuel in the hybrid system are shown in Table I below.

Table I - Comparison of emission levels for three bus configurations

Bus	Emissions (tons per year per 100 buses)				
Type	CO	NOx	THC	SOx	Total
Dedicated diesel	1,067.87	344.47	89.56	17.22	1,519.13
Hybrid electric diesel	3.81	1.05	0.61	N/A	5.46
Hybrid electric CNG	1.71	1.04	0.60	N/A	3.35

The table clearly shows the significant reductions in emission levels for the same type of fuel given its implementation in a hybrid electric bus versus a dedicated IC engine bus. In the case of diesel fuel, 100 buses with dedicated IC engines contribute 1,519 tons of pollutant annually, while a hybrid electric diesel bus contributes less than 6 tons of pollutant per year. It should be noted that a diesel hybrid and CNG hybrid produce pollutants that are at the same magnitude levels. Therefore, the major shift in transportation strategy in developing countries should be to the hybrid electric technology, which can accept various types of fuels with no significant change in technology from one fuel to the next, as opposed to a shift in fuel type.

To explain the technical reasons behind the significant reduction in pollutants for HEVs, one must examine the operational aspects of the vehicles. An HEV consists of an electric drive system which draws its energy from batteries in the form of electric power. Therefore, if the bus is stopped or in a stop-and-go mode due to traffic congestion, energy is not being drawn from the batteries. Therefore, the system is inherently more efficient. The fuel carried on-board, whether diesel, CNG, or gasoline, is burned by a small engine or turbine (referred to as auxiliary power unit - APU) with the sole purpose of generating electricity to charge the batteries. Therefore, this APU does not waste energy in stop-and-go traffic as is the case with dedicated engine vehicles. Second, the fact that this APU operates at one speed only (acceleration and vehicle speed have no effect on the APU output), the fuel is being burned very efficiently, much more so than the fuel in a dedicated IC engine vehicle. Along the same line, since this APU does not power the vehicle mechanically, it need not produce as much power as a dedicated engine, and therefore tends to consume significantly less fuel, and is typically rated at 1/10 the size of the equivalent dedicated engine. Finally, since the APU need not provide power to drive the vehicle, the device can have more stringent emission suppression equipment with literally no effect on the driving performance of the bus. This is obvious when a catalytic converter is placed in a typical vehicle, in which case the power output of the vehicle diminishes.

In summary, it can be stated that a hybrid electric vehicle consumes less fuel than a dedicated engine vehicle burning the same fuel type, therefore emits less pollutants, but also does so more cleanly. The compounded result of these two effects reduces the emissions by a factor of 300. This is in the case of hybrid electric buses. For the case of pure electric buses, the effect is considerably more significant because the bus has zero emissions, and the power required to generate electricity to charge the batteries could be obtained from efficient power plants or even zero emission sources such as photovoltaics, hydropower, and wind.

6.2.2 *National Security*

National security is typically achieved with a combination of two factors, viz. military and economic strategies. Military preparedness is obvious for insuring a strong line of defense against forced aggression. Economic strength, in the form of trade balance and stability of currency, is equally important because it determines the self-sufficiency of the nation and its ability to deal with supply and demand aggressions. Simply stated, if a country lacks a commodity essential for its population such as a basic food source or an energy source, it can always be held hostage by the suppliers of these commodities. This economic form of aggression can be fought with more self sufficiency and less dependence on supplying countries for basic needs of a nation.

The Government of Egypt made a national security decision a few years ago to reduce its consumption of crude oil and take advantage of the available domestic resource of CNG. Egypt's current oil production capacity is 800,000 bbl/day, and consumes approximately half of that domestically, which includes imports from neighboring countries. The crude refining capacity is 546,060 bbl/day, and therefore does not have the capability to export the more expensive refined oil. With the shift to increased use of CNG and less of refined oil, Egypt now has the capability to export more oil, hence improving the trade balance. Egypt's natural gas sector is expanding rapidly, with production expected to double by 2001. Currently, the country's proven gas reserves are estimated at 36 trillion cubic feet (Tcf), up 35% from 1997, and nearly double of proven reserves in 1993.

By shifting to alternative forms of fuel for the transportation sector, and adding flexibility in utilizing these fuels, Egypt can enhance its national security and be able to align its strategies with the shifts in energy powers around the world. Electric and hybrid electric vehicles offer tremendous flexibility at low cost to utilize different forms of fuel, and in the long run, are becoming the choice of transportation modes by developed countries for exactly this reason.

6.2.3 *Antiquities and the Tourism Industry*

A major problem that is facing Egypt today is the deterioration of the antiquities because of the high levels of pollution present. The tourism industry is a major component of the economy, and very few steps are in place to regulate the industry in an effort to preserve the antiquities. A clear example can be seen in Giza, where heavy duty diesel buses are driven up to the foot of the pyramids to drop off the tourists. Not only is the direct emission from the exhaust detrimental to the antiquities, but also the vibrations caused by the heavy buses driving near these fragile structures cause cracking and eventual destruction. A system needs to be implemented whereby historical sites are protected without inconveniencing the tourist or jeopardizing the important tourism industry.

A clear benefit of this proposed program is the creation of zero-emission shuttle bus systems at the historic sites. Starting with Giza and Sakara, a plan exists to convert all the historic sites in Egypt to national parks where preservation and controlled access are the highest priority. A major move is currently underway in the US to achieve this type of national preservation, and a similar planned approach is being presented here for Egypt's historic monuments. This plan has been embraced by the Egyptian government, and it is believed that this proposal can be the first step in its systematic implementation.

Another factor which combines the aforementioned benefits is the increased security which can be achieved in tourist populated historic sites through the introduction of the proposed shuttle system. All visitors to the monuments will be expected to ride the buses from the distant parking spaces and entrances. This offers a logical control point for screening visitors and inspection, if deemed necessary. It is believed that this system will provide tourists with an added feeling of security because of the perceived organization level, and the screening process. The outcome, of course, is an increase in tourism and hence, growth in the economy.

6.2.4 *Improved Maintenance and Cost of Operation*

While the cost of electric buses is currently higher than traditional diesel buses, due to the relatively low volume of production and the new technology, this differential will get smaller over time as the volume increases. However, even with the higher initial cost invested in the purchase of these buses, the savings achieved due to reduced maintenance and operation expenses make the life-cycle cost competitive. Table II summarizes the fuel and maintenance cost comparisons between an electric bus and a diesel bus based on US operational costs. It becomes clear that if the cost of fuel, maintenance, and vehicle overhaul are included in the life cycle analysis, electric buses cost less to own and operate per mile traveled than diesel buses. This table is based on today's costs of electric buses and batteries, and does not account for reductions in prices due to volume. Furthermore, the comparison may vary when addressing operation in Egypt due to the price levels of fuel and electricity that may be different than the US. This detailed analysis, along with a an expanded comparison to address the utilization of CNG as a fuel in dedicated CNG buses and hybrid buses, will be conducted as part of the economic impact study in Phase I (a).

Table II - Comparison of Fuel and Maintenance Costs of Electric and Diesel Buses

Fuel Cost	**Electric Bus**	**Diesel Bus**
kWh per mile	1.2	
Electricity cost/kWh (US$)	$0.050	
Miles per gallon		4.0
Diesel cost per gallon (US$)		$0.650
Fuel Cost/Mile	$0.060	$0.163

Assumptions:

1. Electricity is purchased off-peak. Rate reflects commercial off-peak rate in US
2. Diesel fuel cost does not include any taxes.

Routine Maintenance Costs	**Electric Bus**	**Diesel Bus**
Tires (US$/Mile)	$0.040	$0.040
Other Maintenance Costs (US$/Mile)	$0.120	$0.160
Total Routine Maintenance Costs (US$/Mile)	$0.160	$0.200

Assumptions:

1. In mature application, maintenance cost for EV bus is approximately 50% of diesel bus.
2. For startup demonstration, maintenance costs will be higher; suggest use of 75% of diesel bus
3. Costs do not include mechanic training

Battery/Overhaul Costs	**Electric Bus**	**Diesel Bus**
Battery cost/mile (US$)	$0.1037	
Overhaul cost/mile (US$)		$0.116
Total Battery/Overhaul cost/mile	$0.1037	$0.116

Assumptions:

1. Replace batteries every 3 years at cost of $10,000
2. Overhaul IC Engine and Transmission every 5 years at cost of $20,000
3. Paid as charge/mile at end of each year. Charge is sufficient, with interest, to generate amount needed
4. Annual charge invested @7%
5. Battery charge/year US$3,111 (US$0.1037/Mile)
6. Overhaul charge/year US$3,480 (US$0.116/Mile)

	Electric Bus	**Diesel Bus**
Total Fuel & Maintenance Costs (US$)	*$0.324*	*$0.479*

6.2.5 *Economic Impact and Job Creation*

Perhaps the most significant long term impact of this project on Egypt is on the new jobs created. While the first phase will bring a handful of new jobs because of the new technology and influx of funds, the creation of a new industry in Egypt with focus on export in the world-wide market will bring many more jobs. It is difficult to estimate the exact impact and number of jobs that this new industry will bring to Egypt, and therefore it is proposed that a portion of the funds in phase I will be dedicated to conducting a comprehensive economic study. To give an example of the size of this industry in the next five years, in the US alone, there are currently laws which require the sale of over one million new electric vehicles in the next five years. This translates to $30 billion in new sales, with a technology that has no major players and no defined territories. A look at the world wide potential market, it is clear that companies and countries that take the leading role in staking their share of the market early on will have the ability to dominate the future market. There is no doubt that the opportunity presented here to Egypt will enable the creation of tens of thousands of jobs over the next decade. This is very much in support of the projected need for 550,000 new jobs as outlined in Vision 2017.

6.2.6 *International Competitiveness and Technology Transfer*

Egypt, unlike other countries seeking to become competitive in the global trade market, has to battle the need to find niche areas that will enable its businesses to compete head-to-head with other more established companies and nations. The automotive industry, specifically, and transportation generally, are among the largest business sectors in the world today. In the US, 15 million new vehicles are sold every year. The Big Three, namely, General Motors Corporation, Ford Motor Company, and Chrysler Corporation grossed $180 billion, $150 billion, and $55 billion this past year, respectively. Combined, the automotive sector accounted for one out of every seven jobs in the US. In China, the standard of living of the population is rising, creating the need for 100 million new vehicles over the next decade. This demand for cars and other forms of family transportation has created a $500 billion feeder industry worldwide. Egyptian companies recognized this fact in the past few years, and are beginning to compete on an international scale, but in modest levels. This is mainly due to the existence of well established, stiff competition, with recognition for high quality and responsiveness to customer needs. It is very difficult for Egyptian companies which lack the international exposure, experience, reputation, and financial resources to claim a major stake in this market. What needs to occur is to focus on industries and technologies that are less developed worldwide, where the market will grow over the next decade, and where expertise is still being built everywhere. Only then can Egyptian companies have a fair chance at excelling and growing their market share consistently.

Along with the need for new vehicles, there is an underlying demand by many of the major cities for environmental reform. This is placing a great demand for cleaner vehicles, ones that are based on new technologies. Electric and hybrid electric vehicles are at the forefront of this breed of zero and ultra low emission vehicles. Markets are now emerging everywhere in cities such as Beijing, Shanghai, New Delhi, Bombay, Bangkok, Mexico City, New York, Los Angeles, and others worldwide. It is believed that if Egypt invested today in introducing this technology in its own operational strategy, and made a significant effort in attracting international companies to establish joint ventures to manufacture these products domestically, then there is a strong likelihood that a significant export industry of vehicles and components can be created in the next decade. The technology transfer plan to be executed over the next few years requires the initial seed funding support requested in this proposal. Every indication is that there is a revolutionary change occurring in the automotive industry today, one that may occur once every eighty years. There is no doubt that Egypt can, and will, play a major role in this growing market if it seizes the opportunity today.

7.0 Expected Date of Preparation and Completion

It is anticipated that the current proposal will be approved in October 1999, and project activities will start immediately after. The project duration will be six months. The project schedule is shown in the table below.

PROJECT IMPLEMENTATION PLAN

[illegible]	
ACTIVITIES	**PROJECT-MONTHS**
Completion of project activities	*1 2 3 4 5 6*
1. Identifying and Designing Potential Bus Service Routes	[---------------------------]
2. Training, Maintenance and Operation	[-----]
3. Testing of Electric Bus in Various Routes	[--------------------------------]
4. Computer Simulation of Various Bus Configurations and Routes	[-----------------]
5. Economic, Environmental, and Societal Impact Studies	[--------------]
6. Developing Detailed Plan and Proposal for Phase I (b)	[-------]

8.0 Special Features

8.1 <u>Participation of Social Fund for Development (SFD)</u>

As stated previously, in 1997, the Government of Egypt established a twenty year strategy designed to usher Egypt into the 21st Century. The plan, known as "Vision 2017", moves the country towards an export-oriented economy operating under the rules of the free market, and sets the path leading to a long term and sustained development.

The mission of the Social Fund for Development (SFD) is very much in line with the goals of Vision 2017. With human development being the underlying factor for the success of the strategy, the SFD's activities are at the core of this plan, and are expected to contribute significantly to its success. There are several SFD programs in place already that are designed to offer opportunities for education, health care, employment, increased income, and improvement in the quality of life. National projects that are able to provide a multitude of benefits and can contribute to these objectives will most certainly help to achieve the success of Vision 2017. Specifically, enhancement of the quality of life through the reduction of pollution, improvement to the efficiency of the mass transport system, creation of sustainable jobs, and enhancement of security-are at the top of the national agenda.

The SFD recently signed a Memorandum of Understanding (MOU) with the US Small Business Administration (SBA) to create a mechanism for assisting small enterprises and to bridge the gap between US and Egyptian small businesses. In a paper presented by Dr. Hussein El Gammal, Managing Director of the SFD, at the US-Egypt Presidents' Council in 1997 in Washington DC, it was stated that the development of the private sector is a crucial component of a nation's economy, and that support is required to build enterprises on the basis of technology cooperation and investment finance. It is believed that much of these objectives can be met through the new partnership established by the SFD and US SBA.

The proposed program (Phases I, II, and II) is in line with the mission of the SFD, and as a result, qualifies for financial support to complement funds provided by GEF. Furthermore, technology transfer and the US-Egyptian small business partnerships required for the success of Phases II and III, can be facilitated under the umbrella for the MOU established between the SFD and US SBA.

8.2 Participation by the Southern Coalition for Advanced Transportation

One of the strengths of the proposal which clearly indicates a high probability of success is the participation by the Southern Coalition for Advanced Transportation (SCAT). As a non-profit technology consortium of more than 70 public and private institutions, SCAT provides mechanisms for government, businesses, and academia to pool resources in areas ranging from electric and hybrid electric transportation technology research and demonstration to direct market stimulation. SCAT's mission is to accelerate the advancement of clean and economically viable transportation through:

- Leveraged public and private funds
- Improved components, infrastructure, and manufacturing techniques
- Stronger partnerships among emerging industry players
- Improved public awareness and demand
- Favorable public policy actions at all levels
- Accelerated fleet markets leading to consumer markets
- Enhanced economic development

Since 1993, SCAT has been entrusted with over $60 million in government/industry cost-shared projects. Government agencies participating in SCAT's research, development, and demonstration portfolio include:

- Defense Advanced Research Projects Agency (DARPA)

U.S. Army

- Department of Transportation (DOT)
- Department of the Interior (DOI)
- National Aeronautics and Space Administration (NASA)
- Department of Energy (DOE)

SCAT is expected to contribute significantly to the technical and management aspect of the project by assisting EEAA and SFD. SCAT can help draw upon the successes and failures in this emerging industry to help launch the pilot project in the right direction. Furthermore, their experience with drawing upon the talents of various technology providers adds further benefits.

9.0 Phase I (a) Budget and Funding Sources

PROJECT BUDGET

Component	[illegible]	Other sources	Project total
PDF:			
Personnel :	245,000	193,000	438,000
Training:	45,000	0	45,000
Equipment (Buses and other components):	443,600	687,000[2]	1,130,600
Travel:	15,000	30,000	45,000
Project support (project oversight):	0	55,430	55,430
Project total (PDF + Project costs):	**748,600**	**965,430[2]**	**1,714,030**

1 Other sources are expressed as in-cash and in-kind contribution by EEAA, SFD, and SCAT
2. Includes $550,000 of in-kind SCAT contribution

Contrary to the incremental cost matrix table in section 1.6, the above table does include in-kind contributions to the project by the Southern Coalition for Advanced Transportation (US$550,000). Other Government contributions will be in the form of personnel and space for the buses to be utilized by the project. Additional detail on the breakdown of this budget is provided in Appendix C.

APPENDIX A

Analysis of Reduction in Global CO_2 Emissions

Replacing Diesel Fueled Buses with Electric Buses

This section provides an analysis of the projected reduction in greenhouse gases (GHG), specifically CO_2, based on the introduction of the electric buses funded under this program. The analysis makes the following assumptions:

1. Two electric buses will be introduced in Phase I (a) with a life expectancy of 12 years each.
2. Twenty-two additional electric buses will be introduced in Phase I (b) with a life expectancy of 12 years each.
3. The electric buses produce ***no*** CO_2 at the point of operation, and that all calculations are based on electric power station source emissions.
4. The proposed electric buses would be replacing diesel buses with a 12 year life, where CO_2 emissions are measured at the tail pipe, and where the emission levels increase over the 12 year period due to age and lower performance of the engine.
5. For the purpose of estimating total CO2 emissions over the 12-year life, the buses are assumed to drive 200 km per day, 335 days per year. For the electric shuttle buses, this implies one battery swap per day.

A)- CO_2 emitted by diesel fueled buses

The following data is derived from the paper *Comparative Evaluation of Clean Fuels*: Final Report, OCTA Agreement No. C-89-032, Acurex Environmental Project No. 6590, Stefan Unnasch, et al., Acurex Environmental Corporation.

No in-service operation measured emissions data exist for buses, and much of the data is available from dynamometer tests against various bus cycles. When buses are emission tested against specified cycles on the dynamometer, the air conditioning is not in operation. With regard to the test cycle, the Central Business District (CBD) cycle appears closest (typical 20 mph speeds with stops about one per block). Data averaged over 14 tests, using 8 CBD cycles, 4 arterial cycles and 2 steady state 20-mph tests with low-sulfur diesel fuel, indicate that the CO_2 emission is 2,126 grams/mile (1,329 grams/km). With degradation of performance over 12 years, this number is estimated to double by year 12. For the entire life of a diesel bus, with 200 km range per day, and 335 days per year, the total CO_2 emissions are summarized in Table I. This shows that the buses supplied under Phase I (a) will replace two diesel buses that potentially would emit

3,206 tons of CO_2 over a twelve year period, and the buses supplied under Phases I (a) and (b) will replace twenty-four diesel buses that potentially would emit 38,467 tons of CO_2 over a twelve year period.

B)- CO_2 emitted by power plants for electricity generation

Table II summarizes the CO2 emissions of standard fossil fuel power generation plants based on reported US-EPA data for 1998. The data clearly shows that coal burning plants have the worst emissions, and that gas, gas-oil, and gas-diesel are significantly cleaner in that respect.

C)- Egypt's power and electricity system and future plans

Egypt has experienced a very rapid growth rate of electricity demand in the last thirty years. High annual growth rates are mainly attributed to the expansion of large energy intensive industries, the development of extensive rural electrification plants, development of new communities, industrial zones, and touristic areas, and land reclamation projects in desert areas. The peak load is expected to jump from 8,516 MW currently to 11,136 MW in the year 2002 and to 16,500 MW in the year 2007, so that installed capacity has to increase from 13,500 MW currently to 15,100 MW in the year 2000 and 20,550 MW in the year 2007. Accordingly, additional generation capacities of 7,050 MW are required to meet the demand up to the year 2007 in addition to 300 MW wind Farm units.

One of the most important features of the electricity system in Egypt is the steady improvement in thermal efficiency and transmission and distribution losses. Thermal efficiency improved from 25.9 percent in 1983 to 37.9 percent in 1994, and transmission and distribution losses were reduced from 20 percent in 1983 to 16.7 percent in 1994. Total electricity generated thus increased from 24.5 billion kilowatt hours (BkW-hr) in 1983 to 58 BkW-hr in 1997, while total electricity consumption increased from 19.6 to 45.6 BkW-hr in the same period. Industry is still the major consumer of electricity in Egypt with a share of 44 percent, followed by the residential sector whose share is 34 percent. The impact of conservation efforts and electricity price reform are clearly evident in all sectors. The strategy of the energy sector in Egypt is to increase the utilization of natural gas, which reached 80 percent of fossil fuel burning plants in 1996, and is expected to rise to 100 percent in 2000 percent onward.

Electricity demand projections made by the Egyptian Electricity Authority (EEA) for the next 17 years (up to the year 2017) are based on an expected annual GDP growth rate of 5 percent and an income elasticity coefficient of 0.9 to 1.0. The estimates for electricity generation are an increase to 71.2 BkW-hr in the year 2002, 90 BkW-hr in 2007 and 115 BkW-hr in 2012. The implied investments required by this forecast are $2 billion for additional consumption of 2,4[illegible] megawatt (MW), $2.7 billion for additional consumption of 3,411 MW and $3.3 billion for additional consumption of 4,232 MW for the next three Five Year Plans respectively.

In accordance with the government policy which includes a general liberalization of the economy with emphasis on privatization, the electricity sector has set a plan to open the door for private ownership and operation of new electric power generating facilities of up to 20 percent of total installed capacity through international competitive bidding based on BOOT (Build, Own, Operate and Transfer). Private sector investment required for power generation from the year 2001 to year the 2007 is estimated to be about $3.5 billion. As part of the national energy policy, the following are four of the measures pertaining to cost and emissions of power generation:

1. Bring down the average fuel consumption rate in thermal stations.

2. Diversify sources of electric energy, with the object of preserving oil resources, enhancing food security and guaranteeing necessary flexibility.

3. Intensify local manufacture of electric equipment, in order to increase the local component of the electricity sector's investments and create new employment opportunities.

4. Give due attention to replacement and renovation in order to preserve existing assets of the sector, reinforce rural and urban networks to ensure continuous power supply, minimize waste in power generation, linkage, transmission and distribution, leading to rationalized investment spending in this sector.

With regard to wind and other forms of renewable energy, Egypt has been ahead of other countries in the region. The New and Renewable Energy Authority in Egypt recently established a number of wind farms in Hurghada, Ras Ghareb and Zafarana. The aim is to provide almost five per cent of the country's total energy requirements from renewable energy sources by the year 2005. Available solar and thermal as well as wind energy is used to generate power at high ratings, which realized a surplus of 3 billion kW/h in 1998 and is expected to reach 40 billion kW/h in 2017. This surplus is to be exported to the neighboring Arab countries and Europe.

The biggest project to exploit wind energy in Egypt is now being carried out in Zafarana, almost 60 km south of Ain Al Sokhna, where a large-scale wind farm is being established. Once completed, the 60 MW farm will provide the country with almost half of the renewable energy contribution to national energy requirements. Many photovoltaic systems were installed and operated to light part of the New and Renewable Energy Authority site in Zafarana.

A number of smaller wind farms have been successfully operated in other locations in the country. Hurghada's 5 MW wind farm, for example, contributes almost four per cent of the city's total energy. Stations I and II in the Graduates village at al-Rowaisat at Gharb el-Hamam area and al-Dakhla village at Ras al-Hekma were completed, using wind-turbine insulated systems together with diesel generator units. Work is underway to complete on a BOOT basis the first Egyptian thermo-solar power generating station project with linkage to the compound-circuit operation of the traditional gas stations with 150 MW rating in al-kuraimat area. The dual-system plant will be powered by solar energy by day and natural gas at night.

Hydraulic energy stations still constitute 20% of the total power generated in Egypt, with the largest being the Aswan station (345 MW).

D)-Analysis of reduction in CO_2 emissions in Egypt with electric buses

Based on the data presented in sections B) and C) above, it is clear that Egypt's power generation system is among the most efficient and least polluting, and the national policy calls for continued improvement in that direction. For the purpose of computing the anticipated reduction in CO_2 emissions, an average value of 125 grams/kW-hr by the power grid is assumed. This is derived from Table II above noting that most of the power stations in Egypt are in that power range, with gas, gas-diesel, or gas-oil fuel, and noting that a minimum of 20% of the total energy is derived from renewable energy stations. Furthermore, the assumption is that over the next twelve years, this number will be reduced to 90 grams/kW-hr. In support of this assumption, it should be noted that the United Kingdom, which operates a large number of coal burning stations, achieved a reduction from 135 grams/kW-hr in 1990 to 100 grams/kW-hr in 1999. Therefore, these assumptions are quite conservative.

The class of electric buses proposed for this pilot project has an average power consumption of 1.2 kW-hr/mile (0.75 kW-hr/km). Therefore, with the same assumption made in Section A) of 200 km per day and 335 days of operation per year, the expected CO_2 emissions from the power station resulting during charging of the bus batteries is summarized in Table III.

Comparison of the data in Tables I and III reveals that for the two buses acquired during Phase I (a) the total reduction of CO_2 emissions over the twelve year period of operation is 3,065 metric tons. Furthermore, for the twenty-four buses acquired during Phases I (a) and (b) the total reduction of CO_2 emissions over the twelve-year period of operation is 36,772 metric tons.

It is estimated that the "future facilities" market will constitute a minimum of 1000 buses to be placed throughout Egypt in the historic sites and protectorates. This will result in a total CO2 reduction of 1.53 megatons. The resulting Unit Abatement Cost is therefore $0.49/ton of Carbon.

Table I - Emission of CO2 by Diesel Fueled Buses Over 12 Year Operation Period

Data does not take into account cold-start of engine which would significantly increase CO2 emissions

	YEAR				
	1	3	6	9	12
ONE BUS					
CO_2 (metric ton/km)	0.00133	0.00157	0.00193	0.00230	0.00266
Total CO_2 per year (metric ton)	89	105	130	154	178
Cumulative CO_2 (metric ton)	89	291	656	1,093	1,603
TWO BUSES					
Cumulative CO_2 (metric ton)	178	583	1,311	2,186	***3,206***
TWENTY FOUR BUSES					
Cumulative CO_2 (metric ton)	2,137	6,994	15,736	26,227	***38,467***

Table II – Measured 1998 CO2 Emissions from Sample Power Plants (Reported by EPA)

	YEAR				
	1	3	6	9	12
ONE BUS					
Electric energy per bus per year (kW-hr)	54,750	54,750	54,750	54,750	54,750
Power Station CO_2 (kg/kW-hr)	0.1250	0.1186	0.1091	0.0995	0.0900
Total CO_2 per year (metric ton)	7	6	6	5	5
Cumulative CO_2 (metric ton)	7	20	38	55	71
TWO BUSES					
Cumulative CO_2 (metric ton)	14	40	77	111	***141***
TWENTY FOUR BUSES					
Cumulative CO_2 (metric ton)	164	480	923	1,328	***1,695***

Fuel	Technology	Capacity (MW)	CO_2 Emissions (gram/kW-hr)
Coal	Tangential	694	762
Coal-Gas	Tangential	187	692
Coal	Tangential	112	561
Coal	Dry Bottom Turbo-Fired	387	474
Oil-Gas	Dry Bottom Turbo-Fired	306	204
Oil-Gas	Other	495	164
Oil-Gas	Tangential	333	103
Oil-Gas	Dry Bottom Turbo-Fired	110	77
Diesel-Gas	Combined Cycle	147	173
Gas	Dry Bottom Turbo-Fired	156	141
Gas	Dry Bottom Turbo-Fired	27	73

APPENDIX B
Sample Statement of Work for Phase I (a)

Introduction of Viable Electric and Hybrid-Electric Bus Technology in Egypt

Statement of Work

1. General

The overall objective of the project is to introduce to Egypt a viable electric, hybrid-electric, and eventually fuel cell bus technology program, that would have significant benefits and sustainability in various segments of the country. The project will contribute to the long-term cost reduction of low emission bus systems, to the enhancement of Egypt's technological competitiveness, and to job creation. This will be applied to antiquity sites starting with the Giza plateau as well as the Cairo public ground transport sector. Contributing to a long-term cost reduction will enable the technology to reach commercially viable levels in a much shorter time, thereby ensuring that electric, hybrid-electric, and fuel cell powered buses play a major role in the urban mass transit of Cairo and other UNDP/WHO identified "megacities" around the globe.

The proposed project consists of a multi-year, multi-phase plan introduced by a US-Egyptian public-private partnership that will have a marked impact on global abatement of greenhouse gases, reducing the pollution in Egypt and meeting some of the objectives of Egypt's Vision 2017. In addition, it will serve as an example to other megacities worldwide.

2. Scope of Work

The proposed project consists of three phases. The first phase, which consists of two stages (Phases I (a) and I (b)), will focus on bringing to Egypt 24 US made electric and hybrid-electric shuttle buses and operating them in Giza and downtown Cairo. The main objective of this phase is to demonstrate the technology and its benefits in various configurations and applications, and at various sites. Furthermore, studies will be conducted to create the detailed plans for the technology transfer to investigate the long-term environmental and economic impact of all three phases of the program. The following section describes the scope of work for Phase I (a) of the project.

1.1. Contractor shall conduct a survey of the current and planned roads around Giza/Sakara and collect the necessary data to be used in simulation models for bus configuration and detailed route planning.

1.2. Contractor shall develop a detailed simulation model of the bus and potential bus routes for Giza/Sakara.

1.3. Contractor shall develop detailed plans for potential bus route configurations around Giza/Sakara, including location and requirements for charging and maintenance facilities, that would be implemented in Phase I (b) of the project.

1.4. Contractor shall conduct a feasibility study using developed simulation models for other potential bus routes and operational configurations for Downtown Cairo.

2.5. Contractor, at its facility and subcontractor's facilities, shall manufacture, assemble, and test two 22-foot electric shuttle buses. The following equipment shall be provided with each bus platform:

a) (2) NGM-MDF-375 Motors
b) (2) NGM-EV200-266 Controller
c) (2) Lead-Acid Battery Packs
d) (1) A/C system

2.6. Contractor shall fully instrument one 22-foot electric shuttle bus to be used for data collection on bus performance and potential bus routes.

2.7. Contractor shall ship two 22-foot electric shuttle buses and equipment identified in section 2.4 to Egypt, F.O.B. Alexandria.

2.8. Contractor shall transport two 22-foot electric shuttle buses from Alexandria to Giza.

2.9. Contractor shall provide necessary maintenance and charging equipment required to complete the scope of work for Phase I (a). Equipment provided shall include:

a) Off-Board Battery Charger
b) Fork Lift
c) Mechanics Tools

Adequate facilities shall be provided to Contractor for the storage, maintenance, and operation of the buses and equipment during Phase I (a) and the costs of such facilities shall not be the responsibility of Contractor.

2.10. Contractor shall provide the necessary personnel and conduct testing onsite at Giza/Sakara for one month following the delivery of the buses to characterize the bus performance, to verify the design of proposed bus routes, and to test rider acceptability.

2.11. Contractor shall hold, in Egypt, a 3-day seminar on Electric and Hybrid Electric vehicle Technology and on the introduction of viable EV & HEV Bus technology in Egypt and shall provide invitations to persons from Egyptian Government Agencies, Industry, and Academia.

2.12. Contractor shall conduct studies on the social, economic, and environmental impacts of Electric and Hybrid Electric vehicle technology and provide a report on such studies.

2.13. Contractor shall develop and submit a detailed proposal for Phase I (b) of the Electric and Hybrid-Electric Bus Technology Project.

2.14. Contractor shall produce a final project report on Phase I (a).

3. **Milestones**

3.1. The following shall be Milestones for the EV & HEV Bus Technology Project program:

M1.0	Completion of Detailed Plan for Bus Routes for Giza/Sakara
M2.0	Completion of Feasibility Study on Alternative Bus Routes for Cairo
M3.0	Completion of Simulations of Bus Configurations and Bus Routes
M4.0	Completion of Work Cell #2 for Buses (2)
M5.0	Completion of Buses w/o Drive Train (2)
M6.0	Completion of Drive-trains (2)
M7.0	Completion of Buses (2)
M8.0	Completion of Shipping of Buses and Equipment
M9.0	Completion of EV & HEV Seminar in Egypt
M10.0	Completion of Report on Economic, Social, and Environmental Impact Studies
M11.0	Completion of Detailed Plan/Proposal for Phase I (b)
M12.0	Completion of Final Report on Phase I (a)

4. **Deliverables**

4.1. Contractor shall be responsible for the following deliverables:

1	Detailed Plan on Bus Routes for Giza/Sakara
2	Report on Feasibility of Bus Routes for Cairo
3	Two Electric Buses with equipment as described in Section 2.0
4	Report on Economic, Environmental , and Social Impact Study
5	Proposal for Phase I (b)
6	Final Report for Phase I (a)

5. **Acceptance**

5.1. Social Fund for Development shall be the single responsible party for acceptance of the work and equipment provided by Contractor. Acceptance shall be based on the successful completion of Milestones and Deliverables as outlined in Section 3.0 and 4.0 of this document.

6. Communication

6.1. The EEAA will be the coordinating agency in Egypt for this program, and the Social Fund for Development will be the procuring agency.

6.2. The Social Fund for Development shall be notified in writing on information that affects the scope of work, budget, or schedule as listed in this document. No changes shall be permitted without the Social Fund for Development's written approval.

6.3. Status reports shall be submitted to the Social Fund for Development once every month on the first work day of the month.

6.4. E-mail shall be the preferred method for routine communications.

APPENDIX C

Project Budget Breakdown and Sources of Funds

A. Phase I (a) Budget [1]

Project Manager	$75,000
Engineers, Technicians, etc. for Tasks 1 to 4 [2]	$363,000
Travel	$45,000
Cost of Bus 1 (technical test bus)	$192,500
Second Battery Pack	$15,000
Shipping	$8,800
Charger	$5,500
A/C System	$21,000
Fork lift	$5,500
Spare parts	$25,000
Seminar in Task 2 [2]	$25,000
Cost of studies in Task 5 [2]	$75,000
Project Oversight	$55,430
Subtotal	**$856,300**
Cost of Bus 2	$192,500
First Battery Pack	$15,000
Shipping	$8,800
Second Battery Pack	$15,000
A/C System	$21,000
Subtotal	**$252,300**
TOTAL COST OF PHASE I (a)	**$1,164,030**

(1) This budget covers the funding for the private sector only. EEAA and Governorate of Giza will provide in-kind support in the form of management oversight, personnel, and space for the buses

(2) These items also include the budget for private sector Egyptian experts and engineers/technicians

B. Phase I (a) Funding Sources

GEF/United Nations Development Program	$748,600
Social Fund for Development	$315,430
EEAA (Environment and Tourism Program)	$100,000
TOTAL FROM FUNDING SOURCES	**$1,164,030**
Additional Cost sharing by SCAT (In-kind)	*$550,000*

**Summary of Responses to Technical Assessment
by GEF Core Unit, UNDP Headquarters, New York**

1) GEF eligibility under OP 11

Leveraging Goal

The original proposal and budget presented did not clearly reflect the role of the Southern Coalition for Advanced Transportation (SCAT) in phase I (a). SCAT is a non-governmental organization (NGO) focused on the advancement of electric and hybrid electric technology worldwide. As a non-profit technology consortium of more than 70 public and private institutions, SCAT provides mechanisms for government, businesses, and academia to pool resources in areas ranging from electric and hybrid electric transportation technology research and demonstration to direct market stimulation. SCAT's mission is to accelerate the advancement of clean and economically viable transportation through:

- Leveraged public and private funds
- Improved components, infrastructure, and manufacturing techniques
- Stronger partnerships among emerging industry players
- Improved public awareness and demand
- Favorable public policy actions at all levels
- Accelerated fleet markets leading to consumer markets
- Enhanced economic development

Since 1993, SCAT has been entrusted with over $60 million in government/industry cost-shared projects. Government agencies participating in SCAT's research, development, and demonstration portfolio include:

- Defense Advanced Research Projects Agency (DARPA)
- U.S. Army
- Department of Transportation (DOT)
- Department of the Interior (DOI)
- National Aeronautics and Space Administration (NASA)
- Department of Energy (DOE)

SCAT is expected to contribute significantly to the technical and management aspect of the project by assisting EEAA and SFD. In particular, SCAT is currently assisting DARPA in an ongoing project titled *Fully Integrated EV/HEV Drive System for Enhanced Vehicle Performance and Range*. With funding of approximately $550,000 contributed towards this project by the US government and private sector, it brings tremendous strength in the form of the latest technology and financial resources.

The total project budget, as presented in section 9.0 of the proposal, is $ 1,714,030 with GEF's portion ($748,600) constituting 43.7% of the total project cost.

Incremental Cost Criteria
An incremental cost analysis has been added to the revised proposal. This streamlined analysis, described in more detail in the Technical Comments section below, clearly shows that the proposed funding request to GEF meets this criteria.

Demonstration of Replicability
A replication benefits analysis has been addressed and added to the revised proposal. This is outlined in detail in the Technical Comments section below.

2) *Technical Comments*

First Paragraph – Potential global benefits and replication benefits
The environmental assessment in the proposal focused only on local pollution abatement because this is where the maximum impact is anticipated. It is not practical to assume that this, or any other similar project involving clean transportation, will make any significant contribution to the global reduction in CO2. Specifically, the following data should be kept in mind when addressing the potential global benefits:[1]

- Total natural CO2 emissions (i.e. oceans, vegetation, soil, biomass) in 1996 are estimated at 770 Gt/yr while anthropogenic emissions (i.e. power stations, residential, industry, biomass, transportation) accounted for only 28 Gt/yr.
- Worldwide passenger car and commercial vehicle traffic contribute 0.5% to total CO2 emissions.

  Methane emissions from road traffic are so marginal that their contribution to the greenhouse effect can be disregarded.
- Heavy-duty vehicle traffic contributes 1.6% to the total anthropogenic emissions of nitrous oxide.
- Road traffic contributes only about 1% of non-methane hydrocarbon emissions.

With these statistics in mind, if the CO2 emissions were eliminated completely from all passenger cars and commercial vehicles worldwide, the global reduction of CO2 would be less than 0.5%. Hence the proposal should not be evaluated on this merit but rather for its impact on local reduction of pollution. This is known to have significant impact on health and quality of life in developing countries.

[1] Lenz, Hanz Peter and Cozzarini, Christian, *Emissions and Air Quality*, ISBN 0-7680-0248-6, 1999

With respect to replication, the pilot project (Phase I) is designed to transfer the technology to Egypt, and addresses specific technical issues with operation, infrastructure, and manufacturing. The Social Fund for Development (SFD), one of the funding and implementing agencies for the project, is chartered to enhance job creation and sustainable development in Egypt. Therefore, as part of the implementation plan for Phase I (a), SFD is targeting various groups as beneficiaries that would insure the eventual continuation and replication of this program. The beneficiaries and targeted entities of the proposed project include:

- The citizens of Egypt who will benefit in the long run from the reduction of pollution in congested areas and in the metropolitan cities.
- Beneficiaries of the demonstration project and training including transport authorities of the major Egyptian metropolitan cities.
- Beneficiaries of the availability of clean bus services resulting from the pilot project including the Ministry of Culture and Governorates that have jurisdiction over historic sites or protectorates.
- Long-term target groups include domestic bus manufacturers, as well as small and medium businesses seeking to gain from the technology transfer to become component suppliers as well as operators of clean bus service systems.

These target groups will serve as suppliers and buyers of the proposed bus technology. It is crucial that the demonstration proposed in Phases I (a) and (b) is executed in its entirety because it will clearly address issues such as revenue generation from service, operation and maintenance costs, and technology limitations. These are essential for the replication of the project. The SFD will play a major role in the implementation of Phases II and III by providing credit loans to small and medium businesses for the production and operation of the buses.

Second Paragraph – Assessment of success of phasing process

The proposal describes a three-phase approach whereby Phase I is a pilot project and depends on grant funds, with Phases II and III being the production and commercialization steps. Egypt already has the necessary technology and manufacturing infrastructure for the production of high quality buses. All buses ranging from six-meter transport mini-buses to deluxe twelve-meter buses are manufactured locally. The engine and driveline components are imported from international companies such as General Motors, Ford, Scania, Mitsubishi, and Renault, among others. The proposed Phase II would utilize this existing bus production know-how by incorporating electric and hybrid-electric drivelines. This would reduce the cost of the buses significantly. For example, a US built diesel mini-bus with minimum options sells for approximately $135,000. The equivalent bus in Egypt sells for around $36,000 due to the lower cost of labor and lower demands on quality and safety. Therefore, simply replacing the non-driveline portions of the bus with domestic products could reduce the cost by nearly $100,000.

Phase III offers an additional potential for cost reduction. Egypt does not currently have the capability of manufacturing internal combustion engines. However, there are several manufacturers of lead-acid batteries and industrial electric motors, which form the basic components of an electric vehicle driveline. Other key components, such as power electronics, chargers, and DC to DC converters, are basic electronics units that can be replicated. Studies conducted by the Department of Energy in the US have shown that a complete electric driveline is technically easier and less costly to manufacture than a traditional gasoline engine driveline, once economies of scale have been achieved. With Egypt's high tariffs on imported goods, the net cost of the electric driveline could be much lower when produced in Egypt compared to gasoline engines which will always be imported due to their complexities.

It is further believed that this can be replicated in other megacities worldwide. Most developing countries enjoy the same low cost advantages of mass transport buses as Egypt, and in most cases, possess equal if not better electronics manufacturing capability. Therefore, there is no reason to believe that complete electric and hybrid-electric buses could not be manufactured cost-effectively in most megacities around the world.

Third Paragraph – Incremental cost analysis

The total budget for Phase I (a) is $1,714,030, with $550,000 in in-kind cost sharing by SCAT. The cost sharing is a leveraging of an on-going project that resulted in an integrated drive system that is directly applicable to this pilot project. The budget, not including in-kind contributions, is $1,164,030. Of that, $515,600 is for the two buses, additional components, shipping, and charging equipment. If two diesel buses of equivalent capacity were purchased in Egypt, their total cost would be $72,000. Hence the incremental cost for the hardware is $443,600.

The remaining portion of the budget ($648,430) covers project oversight, bus operation, pilot project demonstration, technical studies and testing, training, environmental impact studies, socioeconomic studies, and travel. GEF is asked to fund less than half of these costs ($305,000) for a total of $748,600 for the entire Phase I (a).

Fourth Paragraph – "System-boundary" problem

To address the "system-boundary" problem, a comparison must be made in emission and fuel consumption of gasoline versus electric powered buses.

The quality of emissions resulting from diesel-powered buses and gasoline powered cars is a function of several factors:

1. The drive cycle – city driving with stop and go versus highway driving
2. Age of the vehicles
3. Emission control such as catalytic converters and fuel injection
4. Frequency of preventive maintenance (changing of spark plugs, etc.)

In developing countries, the congestion causes significant stop and go driving, the average vehicles are generally old, no advanced emission controls exist, and preventive maintenance is not as frequent as needed. Therefore, vehicles and buses in developing countries are significantly more polluting than in developed countries. In the case of electric buses this difference goes away since the emissions are eliminated at the vehicle level.

The impact on emissions and fuel consumption in generating the electricity at the power plant level needs to be evaluated. First and most important, due to inefficiencies of internal combustion engines, an electric bus requires in general about one-half of the energy per mile of a conventional bus. This translates to half the fuel and CO_2 emissions even if the electricity came from fossil-fueled power plants. Furthermore, electric buses permit regenerative braking, therefore recovering kinetic energy by recharging the battery during deceleration rather than wasting the energy in heating the brakes. In the urban driving cycle, almost half of the mechanical energy for propelling a bus is otherwise squandered in this kinetic energy loss.

As developing countries are becoming more dependent on electronic machinery and equipment (an "electric economy"), the quality of the electric power is challenged. To avoid burnouts and maintain the quality of the electricity supply, power plants now keep vast surpluses of generator power on hand to meet peak demands. Excess capacity comes with a cost. The focus is on reducing surplus capacity by leveling the demand for electricity over the day. Electric buses are charged at night when vast surpluses of electric generating capacity are idle and unproductive. The charging requirements for electric buses and other modes of transportation would utilize this capacity and thereby increase installed capacity usage and render the electric system more efficient. Furthermore, this would reduce the overall cost of electricity because the overhead would be spread over a larger production of energy.

Finally, Egypt is already progressing towards natural gas fueled power plants as well as hybrid-photovoltaic and wind turbine generating plants. This is ultimately creating a much cleaner power generation infrastructure that in the total system, in conjunction with zero-emission buses and cars, will lead to lower CO_2 and hydrocarbon emissions.

<u>Fifth Paragraph – Cost leveraging</u>

As addressed in the first section and in the incremental cost analysis (third paragraph response), there is significant leveraging for the GEF funds. The Egyptian government is contributing $415,430 in cash grants in addition to in-kind.

This proposal did not arise from past USAID support, however, the technology being proposed takes advantage of prior developments by SCAT and its industry partners. The cost sharing by SCAT is comprised of private sector as well as US government support. This is discussed in detail above.

The "polluter-pays" principle is being considered in a broader sense for enhancing the feasibility of replication beyond Phase I. Currently no dedicated transportation system exists within the historic sites in Egypt. Tourists are transported directly by their tour buses and the Egyptian government is planning on banning the approach of these large diesel coach buses to the historic sites. The plan is to incorporate a fee structure, which will be studied and partially implemented in Phase I (b).

Sixth Paragraph – Electric powered battery buses
The direction taken by the automotive industry is to introduce hybrid-electric vehicles/buses in the short term (i.e. 5-10 years), but this direction will move to pure electric transportation as battery technology further develops. Fuel cell and direct injection diesel hybrid vehicles make more sense in the next ten years due to the limitations of battery technology. However, all indications are that with the expanded use of portable telephones, computers, and other electronic devices, battery technologies such as lithium ion, nickel metal hydride, among others, will be commercially viable in large scale. This would offer electric powered vehicles and buses the extended range with reduced weight, which are current limitations of lead acid technologies.

It should be pointed out that for shuttle services in congested areas, electric buses offer a sound solution. Replacement of the batteries in a 5-10 km circular route is easily achieved once or twice per day. This system is the preferred choice for most of the national parks in the US.

3) Confusion with the Fuel-cell Initiative
As described in the proposal, electric, hybrid-electric, and fuel cell buses are all based on the same propulsion technology; namely, electric motors with power electronics. The difference among the three is the energy conversion or storage device. Therefore, the proposed pilot project is not a short-term solution, but rather a necessary step to a long-term sustainable solution. Issues such as drivetrain maintenance, operator training, technology training of engineers, must begin and are common to all three platforms.

Egypt is very well prepared to embark on this pilot project which falls under Operational Program Number 11 Sustainable Transport. The fuel cell initiative, which deals more with the hydrogen infrastructure and the wide application of fuel cell technology, is suited for Operational Program Number 7 Climate Change. The funding of the electric and hybrid electric bus pilot project will enhance the chances of success of the fuel cell program since the technical challenges arising from the vehicle-specific technologies will already be addressed.

With regard to the procurement issues, the proposal was modified to eliminate any reference to specific vendors, and rather, reflects the participation of the NGO SCAT as a team member.

With regard to the schedule, because of SCAT's extensive experience with these types of programs, and because of the leveraging of the ongoing project with the US government, one bus can be made available fairly soon for delivery to Egypt prior to the end of the year. The schedule would require shipment of the bus by November 1, 1999. The remainder of the pilot project would be completed by April 2000.

Arab Republic of Egypt
Ministry of State for Environmental Affairs
The Minister

9 September 1999

Dear Mr. Cain,

With reference to your letter of 5 August outlining the technical assessment by the GEF Core Unit, UNDP Headquarters, New York, please find attached the revised proposal entitled " Introduction of Viable Electric Bus Technology in Egypt". Our technical staff benefited from this assessment and has addressed the comments in the revised proposal. A summary of the responses to the comments, in the order in which they were raised, is also attached separately to assist the technical reviewers in reevaluating the proposal.

There are two aspects of the technical assessment that I would like to highlight. The first relates to GEF funding and the leveraging of additional resources. I am pleased to emphasize the level of commitment, participation and contribution from all organizations involved. In addition to the financial support provided by the Egyptian Government, we are also pleased to have the involvement of the Southern Coalition for Advanced Transportation (SCAT). SCAT is a renown non profit technology consortium of more than 70 public and private organizations. As described in the attached letter of support from the organization's President and CEO Mr. John Wilson , the participation of SCAT in the pilot project provides an additional $ 550.000 of in-kind cost-sharing that is leveraged through an ongoing program funded by the US government and the private sector. This brings tremendous strength in the form of the latest technology and financial resources, as well as in the technical and management aspect to the project.

Mr. Edmund Cain
Resident Representative
UNDP – Cairo

30 Misr Helwan Agricultural Road • Maadi • Cairo
Tel: 3785137 • Fax: 3755438 • email: N_makram@idsc.gov.eg

Arab Republic of Egypt
Ministry of State for Environmental Affairs
The Minister

The second aspect I wanted to address is the schedule of implementation. As indicated in my previous correspondence, the availability of one of the buses in time for the millenium celebration is paramount to launching the pilot project in a high-visibility setting. This is not to say that the entire pilot project study phase I (a) needs to be executed this year, but rather the first bus delivery. All partners in the project, including the Ministry, SFD and SCAT are prepared to assist UNDP/GEF with expediting the process to achieve this worthwhile goal.

I am confident that you will take the necessary prompt action to resubmit this proposal for GEF financing, to enable Egypt to benefit from this forward looking initiative.

Yours sincerely,

Nadia Makram Ebeid

Nadia Makram Ebeid
Minister of State for Environmental Affairs

30 Misr Helwan Agricultural Road • Maadi • Cairo
Tel: 3785137 • Fax: 3755438 • email: N_makram@idsc.gov.eg

SCAT

SOUTHERN COALITION FOR ADVANCED TRANSPORTATION

SUSTAINABLE DEVELOPMENT THROUGH ADVANCED TRANSPORTATION

President and CEO
John W. Wilson, Jr.

P.O. Box 93584
Atlanta, GA 30377-0584
Phone 404-385-0165
Fax 404-385-0168
E-mail MAIL@ADVTRANS.ORG
Web HTTP://WWW.ADVTRANS.ORG

July 8, 1999

H.E. Dr. Nadia Makram Ebeid
Minister of State for Environmental Affairs
Cairo, Egypt

Your Excellency:

I am pleased to provide you with information pertaining to our organization, the Southern Coalition for Advanced Transportation (SCAT), in reference to the proposed pilot project titled "Introduction of Viable Electric and Hybrid Electric Bus Technology in Egypt". We are quite pleased that the Social Fund for Development of the Government of Egypt would entertain such a project and are honored with your kind invitation.

As a non-profit technology consortium of more than 70 public and private institutions, our organization provides mechanisms for businesses, government, and academia to pool resources in areas ranging from electric and hybrid electric transportation technology research and demonstration to direct market stimulation. Our mission is to accelerate the advancement of clean and economically viable transportation through:

- Leveraged public and private funds
- Improved components, infrastructure, and manufacturing techniques
- Stronger partnerships among emerging industry players
- Improved public awareness and demand
- Favorable public policy actions at all levels
- Accelerated fleet markets leading to consumer markets
- Enhanced economic development

Since 1993, SCAT has been entrusted with over $60 million in government/industry cost-shared projects. U.S. Government agencies participating in SCAT's research, development and demonstration portfolio include:

- Defense Advanced Research Projects Agency (DARPA)
- U.S. Army
- Department of Transportation
- Department of the Interior
- National Aeronautics and Space Administration
- Department of Energy

All of these projects are managed by SCAT's professional staff, with oversight from a team of U.S. government program managers at DARPA and the U.S. Department of Transportation. In addition, SCAT's financial records are carefully maintained and publicly reported and an independent audit is conducted every year by the international accounting firm of Deloitte & Touche LLP.

We are certainly very interested in supporting the Egyptian government with the aforementioned proposed pilot project. Our ongoing project with DARPA involving New Generation Motors Corporation (NGM) and Advanced Vehicle Systems, Inc. (titled "Fully Integrated EV/HEV Drive System for Enhanced Vehicle Performance and Range") is a natural precursor to your project. This unique team is both well suited for your proposed project as well as familiar with the importance of succeeding with this first demonstration on the Giza plateau. Our DARPA project has as its objective an advanced integrated drive system offering higher performance and range over traditional EV and HEV drives for medium and heavy duty systems. This system has applications that range from buses to large trucks to heavy military vehicles. The configuration and performance requirements for the two buses as described in the Statement Of Work, as well as the tasks described, are well within the capabilities and experience of the member companies we are proposing for the project. Please note that significant design and development costs for the drive system are being conducted under the DARPA project with cost sharing from the private sector totaling over $300,000 and the U.S. government providing $250,000.

Again I thank you for giving us the opportunity to participate with the Egyptian Government in this exciting program.

Sincerely,

John Wilson
President and CEO