PROJECT BRIEF

1. IDENTIFIERS

PROJECT NUMBER:	
PROJECT NAME:	**Fuel-Cell Bus Development in India, Phase II-Part 1**
DURATION:	5 Years, divided into two implementation segments of 1 year (Part I) and 4 years (Part II) duration
IMPLEMENTING AGENCY:	United Nations Development Programme
EXECUTING AGENCY:	Ministry of Non-Conventional Energy Sources (MNES); Delhi Transport Corporation (DTC)
REQUESTING COUNTRY:	India
ELIGIBILITY:	India ratified the FCCC on 1 November 1993
GEF FOCAL AREA:	Climate Change
GEF PROGRAMMING FRAMEWORK:	Sustainable Transport, Operational Programme No. 11

2. SUMMARY

This project proposes a five-year demonstration program of operating and testing eight fuel-cell buses (FCBs) for public transport in Delhi. The major objective is to introduce this zero emission and highly efficient bus technology in India for reducing local air pollution and global GHG emissions. It will assist the Indian transport sector to gain capability of manufacturing, operating, and servicing FCBs under local conditions. It will also help create an initial volume demand and provide useful feedback of operating experience for the FCB developers/manufacturers to further improve the bus design and reduce the bus cost. The project is consistent with the terms of GEF Operational Program 11 and the overall GEF strategy on FCB.

3. COSTS AND FINANCING (MILLION US $)

GEF:	**Implementation Part I**	**5.983**
	PDF B	0.297
	Implementation Part II	5.867
	GEF Subtotal	**12.147**
CO-FINANCING:	**Implementation Part I**	
	India Government	5.010
	Private	0.831
	Implementation Part II	
	India Government	9.145
	Government (DTC)	0.020
	Private	1.386
	Co-financing Subtotal	16.392
	Total Implementation Part I	**11.824**
	Total Implementation Part II	**16.417**
	PDF B	**0.297**
	Total Project Cost	**28.538**

4. ASSOCIATED FINANCING (MILLION US $) none

5. OPERATIONAL FOCAL POINT ENDORSEMENT

Name: Ms. Rita Acharaya Title: Deputy Secretary
Organization: Department of Economic Affairs Date: August 17, 2000

6. IA CONTACT

Dr. Pradeep Monga, UNDP, New Delhi; and,
Dr. Richard Hosier, UNDP, New York

Ramon Prudencio C. de Mesa
M:\RAMON\Work Programs\WP03-2001\India Fuel Cell Bus\PROJECT BRIEF.doc
April 5, 2001 8:26 PM

LIST OF ACRONYMS/ABBREVIATIONS

BHEL	Bharat Heavy Electrical Limited
CNG	Compressed natural gas
DTC	Delhi Transport Corporation
FCB	Fuel-cell bus
GHG	Green house gas
MNES	Ministry of Non-Conventional Energy Sources
MRTS	Mass Rapid Transport System
NPD	National Project Director
PEM	Proton exchange membrane

I. Background and Context

Relevance of Fuel-Cell Buses in Urban Transport In India

1. With rapidly growing population and continued urbanization in India, the number of vehicles is increasing at 10% per annum, causing serious pollution problems and accounting for more than 60% of the total air emissions in major cities. India is one of the world's largest bus producers and users. The current annual production is in the range of 33,000 buses with 4% annual growth. Most of the buses are diesel buses manufactured and assembled locally in India and account for 76% of the total passenger transport volume in India. Thus, promoting the use of clean bus technology is a very effective method to reduce the urban pollution while meeting the population's transport needs.

2. The use of public buses in India is widespread. However, its share of total urban transport has been falling, mainly due to the rising reliance and spurt in private vehicles. With the advent of globalization and the implementation of economic liberalization policy by the India Government in the nineties, the private vehicle industry continues to have phenomenal growth leading to further increase of the urban pollution and traffic congestion.

3. The realization of the impacts of private transport on health and other social factors (e.g., time loss, incidence of accidents, etc.) has once again demanded quality public transport. The current government policies toward this goal are to introduce "cleaner" buses and electric trolley system.

4. FCBs could potentially offer an ultimate solution to the urban transport problem in India. The drive trains used have no efficiency penalty at low speed part load driving while diesel engines have. Their efficiency in urban traffic can be almost twice as high as that of diesel buses. They have no emissions of toxic substances and carbon dioxide. With the compressed hydrogen gas tanks, they can achieve a driving range of 400 km - more than the urban bus daily transport distance. They can be refueled in their home depots to remove the need for a dispersed re-fuelling infrastructure. They offer the benefits of electric propulsion without the need for overhead power cables.

Overcoming Barriers for Large-scale Deployment of Fuel-Cell Buses

5. Fuel-cell bus (FCB) demonstration projects in Chicago and Vancouver, each involving three buses in actual revenue services, have successfully concluded their two-year operation recently. In these projects, the technical feasibility of building, operating, and fuelling hydrogen FCBs has been demonstrated. Several new demonstration projects have just started to be operational or are in the planning stage in California and Europe. Analysis carried out during the PDF-B project leading to the proposed demonstration project indicates that FCBs have the potential in the next decade to become cost-competitive with diesel buses on a lifecycle basis even with the additional costs of hydrogen production, transport, storage, compression, and dispensing. One of the main reasons is that public buses run very long hours every day and the maintenance cost is the single largest cost item of bus operation. The

saving on the maintenance cost and reduction on the backup buses required as a result of the higher reliability of FCBs is more than enough to compensate for the hydrogen cost. The challenge now is to achieve the cost target, particularly in developing countries, to reach large-scale deployment.

6. There are several major barriers to the large-scale deployment of FCBs:

- The cost gap between current prototype hydrogen FCBs (more than US$ 1 million/bus) and conventional diesel buses (US$ 250,000/bus), all manufactured to North American standards, is still considerable. Most of this difference is attributable to the higher costs of the drive train, which is still not made in automated production;
- A similar gap exists in the engine durability. The fuel-cell stacks, which are the heart of the FCB engines, at present have a life of only 4,000 hours versus 30,000 hours for diesel engines before a major overhaul is required;
- To date, there are an insufficient number of FCBs operating around the world to allow for a thorough debugging of the drive train and for feedback to the developers to improve their design and to achieve their cost and durability goals;
- There is insufficient experience of operating, fuelling, maintaining, and repairing hydrogen FCBs; and,
- There is limited public awareness and support for this new technology.

7. What is needed to break down these barriers is an initial market of sufficient size for the developers/manufactures to continue further investments for development and scaling-up of production. Industry projections indicate that the FCB cost and reliability goals will be reached at a cumulative production level of approximately 2,000 buses. The proposed demonstration project will contribute to build up this initial market demand and providing Indian authorities with sufficient experience to be able to make informed decisions about future deployment of the technology.

THE NEED FOR FCBS IN DELHI

8. Due to traffic congestion and narrow roads, the public buses in India do not require fast acceleration. Thus, they are smaller in both length (10-11 m vs. 12 m) and engine capacity (105-130 hp vs. 275 hp) than full size buses commonly used in US and Europe. These buses lack modern emission controls. The measured particulate emission from buses in Delhi is 560 micrograms per normal cubic meter, which is far higher than the Euro II emission standards of 200 micrograms per normal cubic meter.

9. Delhi has been selected as the city for the FCB demonstration project because it is the most polluted city and also has the largest size bus fleet among all major cities in India. The key steps taken to mitigate vehicular pollution in Delhi include the following:
   - The sulfur content of diesel supplied in Delhi was reduced to 0.5% wt in 1996, 0.25% wt in 1997, and 0.05% wt in 2000;
   - Stringent standards on particulate matter in diesel vehicles have been enforced;

- Diesel and gasoline fuel quality, with respect to environment related parameters, has been modified under the Environment (Protection) Act during April 1996. Supply of only unleaded petrol for all vehicles was started from September 1998 in Delhi. This program has been expanded to other major urban cities;
- Catalytic converters for motor vehicles have been made mandatory since April 1995 in four metro cities and in 45 cities from September 1, 1998. Subsidies for catalytic converters and CNG conversions are being made available;
- The entire city bus fleet is to be converted to CNG by the end of March 2001 as per the Supreme Court direction. 31 CNG retail outlets/filling stations (2 mother stations, 8 on-line stations, and 21 daughter stations) have already been operational;
- Alternate fuels (LPG/Propane) for automobiles have been allowed since an amendment was made in the Motor Vehicles Act to legally permit the use of LPG as automobile fuel;
- Commercial vehicles more than 20-year old have been prohibited from plying with effect from October, 1998 followed by phase out of 17 -20 years old commercial vehicles from November 1998 and 15 - 17 years old vehicles from December 1998. A ban on use of buses more than 8 years old except those using clean fuels has been enforced since April 2000. Registration of new private vehicles is permitted only if they are compliant to the EURO I norms (effective from June 1999) and EURO II compliant (effective from April 2000) in New Delhi;
- The promotion of comprehensive vehicle inspection and certification;
- The Mass Rapid Transport System (MRTS) has been launched and its early and time bound completion is continuously monitored. The first section of MRTS, i.e. the Shahdara - Tees Hazari section, will be completed by 2002;
- Electric trolley-bus networks in the city streets and within the dedicated corridors are being designed and proposed; and,
- Serious efforts are being made to improve traffic management in Delhi. For example, extreme left lane on the roads in Delhi has been earmarked exclusively for the use of heavy transport vehicles. Restrictions have been imposed on goods vehicles operation during day time peak traffic hours in Delhi since August 1999. The private sector is allowed to operate public transport buses to discourage the use of individual private motor vehicles. Traffic decongestion is provided through construction of flyovers, overpasses, and bypasses in addition to streamlining traffic management through proper signals, road signs, and road markings.

The use of FCBs is an additional avenue pursued by the government to mitigate urban transport pollution in Delhi.

10. The daily pollutants emitted by urban transport in Delhi are:

Particulates:	10 tonnes
Sulfur dioxide :	9 tonnes
Nitrogen oxide:	126 tonnes
Hydrocarbons:	250 tonnes
Carbon monoxide:	651 tonnes

Due to litigation by citizens in Delhi for these exorbitant emissions, the Supreme Court of India has recently directed the public bus company in Delhi, Delhi Transport Corporation (DTC), to convert all their diesel buses into CNG (compressed natural gas) buses and retire buses of more than 8 years old as mentioned earlier. However, CNG buses are only a short-term solution because they are basically modified diesel engines. They cannot completely get rid of the air pollutants and have high maintenance cost. More importantly, CNG engines have 30% lower efficiency than diesel engines and this diminishes their value in terms of CO_2 emission reduction. Thus, only FCBs offer a long-term ultimate solution to the air pollution and GHG emissions.

11. DTC is currently operating 40% of the total bus fleets in Delhi. Its own bus fleet consists of 2,000 buses and is purchasing 500 buses annually as part of the normal fleet renewal. As DTC is pursuing vigorously to contain the pollution, it has expressed great interest to host the FCB demonstration project and is potentially a major user of commercial FCBs. Due to the great similarity between CNG and hydrogen re-fueling facilities, DTC's operating experiences and knowledge to be accumulated in the current conversion to CNG buses will facilitate further conversion to FCBs in the future.

12. The India Government's policy framework for the 9th Plan identifies major challenges to energy and environmental management as the rapid growth of vehicle population, the inadequacy of road infrastructure, and rapid growth in vehicular emissions and related pollution. It calls for emphasis on the provision of public modes of transport and introduction of mass rapid transit system in the metro cities. The improvement of the technology used in public transport and the need to increase tariffs in order to provide better quality and cleaner public transport services remain key issues. In this context, FCBs offer an efficient and clean alternative to attract private car passengers for using public transport.

FURTHER EXPANSION POTENTIAL OF FUEL-CELL BUSES IN INDIA

13. There are several other major urban areas in India to follow Delhi's lead. This potential is reflected by the size of the bus fleet of 600,000 in the national and out of which, 130,000 are public buses. Public transport continues to dominate in mega cities where the modal split in favor of public transport is as high as 82% in Mumbai, 76% in Calcutta, 70% in Chennai, and 62% in Delhi. Unlike many developing countries, India has a large-scale, modern, well-equipped and competitive bus industry. There are two major bus manufacturers: TELCO and Ashok Leyland. Each company has an annual capacity production capacity meeting the total bus production of the country with either self-made or imported engines. There are also many bus-body building companies, such as Sutlej Motors, TVS, and Autorola. Thus, India has the capability to embrace the FCB technology.

14. As various State Road Transport Corporations in India cannot afford expensive buses, the Indian bus industry continues to supply them high floor buses with a center aisle and no air-conditioning. However the bus industry has the capability to produce and is producing high technology luxury buses with imported or self-made engines. These buses are primarily for the tourist market.

15. The Ministry of Non-Conventional Energy Sources (MNES) has been supporting fuel cell technology developments, such as the phosphoric acid fuel cell development at BHEL for power generation and PEM fuel cell development at SPIC for hybrid fuel cell/battery vehicles. The immediate beneficiaries of the proposed FCB demonstration project will be the population of Delhi and later on the population of other Indian cities. It will also benefit the private industry by creation of new markets and employment based on the deployment of this new technology. Finally, it will further benefit the global community by the reduction in global CO_2 emissions.

16. The total global incremental cost of commercializing hydrogen FCBs to the point being commercially competitive with diesel buses built to North American standards has been estimated at about US$ 970 million. Conversion of the major bus fleets in India, 25,000 strong, to run on hydrogen, would avoid 0.5 million tons of CO_2 emissions per year.

II. Rationale and Objectives

India in the Context of the GEF Strategy on FCBs

17. At the GEF Council Meeting in November 2000, the GEF held discussions led jointly by the GEF Secretariat and UNDP on a "GEF Strategy to Develop Fuel-cell Buses (FCB) for the Developing World". This meeting summarized the outputs of a series of workshops sponsored under the UNEP Medium-Sized Project "Fuel Cell Bus and Distributed Power Generation Market Prospects and Intervention Strategy Options". These workshops – which included participants from private industry, public sector transit agencies in both developed and developing countries, and members of the GEF Secretariat and Implementing Agencies – shaped the GEF FCB Strategy for the development of FCBs in GEF recipient countries, consistent with the objectives of Operational Program (OP) 11, Sustainable Transport.

18. The Council decision that "…GEF should develop the five fuel cell bus projects currently in its pipeline…" is consistent with the strategy that was presented to the Council. This strategy proposed GEF support for preparatory, demonstration, and commercialization stages. This project, which has met all of the quality criteria developed as part of the GEF strategy development process, represents a demonstration phase project. In particular, in terms of **climate change impact**, the proposal shows a system-wide reduction in GHG emissions. As far as **replication potential** is concerned, India contains more than 600,000 buses currently in operation, most of which run on diesel. In the context of the other **plans for rationalization of the urban transport system**, this project brief describes the large number of both technological and non-technological activities being pursued by India to improve its transport system and reduce transport-related pollution. The **cost-sharing** is significant, with over half of the resources for the total project being drawn from other sources. The **indicators** are well-developed (see Annex B). Finally, India represents a major **geographic sub-region** in the world bus market, and it is not covered by any of the other projects in the overall GEF-sponsored FCB program. The results of the project will be carefully monitored prior to pursuing any future commercialization phase proposal.

19. Given that the India project is as part of the larger GEF FCB portfolio of projects, this project will benefit from the planned coordination between all GEF FCB projects. Three key coordination approaches are planned: (i) to maximize lessons learned and the sharing of knowledge between the FCB projects, a series of workshops will be organized by the UNDP-GEF that will bring together key stakeholders from the India project with those from other FCB projects; (ii) the FCB Private Sector Advisory Group is intended to provide guidance and support to all of the GEF FCB projects, including India; (iii) a GEF FCB website will be developed and maintained by UNDP, and will host information on progress, lessons learned, and research associated with all FCB projects.

PROJECT OBJECTIVES

20. The **development objective** of the project is to reduce GHG emissions through the introduction of a new energy source and propulsion technology for urban buses. Together with similar initiatives in other countries, it is intended to provide a major push to accelerate development of the clean FCB technology in the mega-cities of developing countries.

21. The **immediate objective** of the project is to demonstrate the operational viability of fuel-cell drives in urban buses, together with the requisite re-fueling infrastructure, under Indian conditions. It will begin the process of commercialization and adaptation of the FCBs in Indian markets.

THE OVERALL FUEL-CELL BUS PROGRAMME IN INDIA

22. As described in the "GEF Strategy to Develop Fuel-cell Buses (FCB) for the Developing World", the overall program consists of four stages. Stage I, which is the PDF study leading to the proposed demonstration project has been successfully completed.

23. Stage II is the proposed demonstration project described in this document. To allow for lessons learned from earlier projects to inform later projects, this Stage has been further broken down into two implementation segments of 1 year (Part I) and 4 years (Part II) duration.

24. In Stage III, the Commercialization Stage, the demonstration project will be extended. It will be pursued only if the Stage II demonstration provides positive results. As an example, 20 more FCBs could be purchased at the end of the demonstration project to increase the fleet size from 8 to 28 buses. As the hydrogen facility is already oversized, purchasing another electrolyzer module to double the hydrogen production capacity should be sufficient to meet the need of the expanded fleet. The cost of the FCBs to be purchased in Stage II is more than 10 times of that of diesel buses. By the time the additional 20 buses are purchased (2007), the FCB cost is expected to drop to be 2-3 times of the diesel bus cost. As the cost difference is still too large for the project to proceed on commercial basis, the India Government will seek finance from various sources to fund the incremental cost. This expanded demonstration will operate for 2-3 years.

25. By 2009 or 2010, when Stage III is completed, Stage IV will begin. Stage IV involves the initial commercialization of the FCB's. By this time, the FCB's are expected to cost between 10 and 30% more than the diesel buses. At that time, a tax credit or soft loan provided by the government should be able to entice the local bus manufactures to launch commercial production. It would also allow DTC and other city bus authorities to convert diesel buses or CNG buses on a depot-by-depot basis (on the average 70-100 buses per depot) without government's financial aid. The incentive for the bus manufactures could also be provided by the increase of diesel fuel cost, tighter air emission standard, tax on air-pollution emissions or carbon emission, or a tax credit for the operation of new, more efficient buses.

RATIONALE FOR THE SIZE, DURATION, AND LOCATION OF THE STAGE II PROJECT

26. The size, duration and location of the Stage II project are dictated by the need to ensure statistically valid results:

- 1 million vehicle-km is the minimum cumulative volume of operation needed to ensure that all likely failures in service are encountered, their causes understood and remedied, and opportunities to reduce costs and increase reliability and durability are identified. Diesel buses in the DTC run an average of 56,750 km per year per bus. In the proposed demonstration project, the FCBs are assumed to run at a lower driving distance at 34,050-39,725 km per year per bus. It is prudent to do so with a new drive train technology and the need to familiarize operators and maintenance personnel with it.
- Achieving 1 million vehicle-km therefore requires 25-30 vehicle-years of operation. Fulfilling this in 1 year with 25-30 buses would be extravagantly expensive in project costs. Also, one year of operation is insufficient experience to identify all potential faults.
- Spreading the experience over more than 4 years would be impractical for a demonstration project because the feedback from operations would be too late to influence the design and improvement of the technology.
- A minimum sample size of 8 buses is needed to ensure the statistical validity of the experimental results and is adopted for this demonstration project. The 8 buses are to be purchased in two batches of 3 and 5 buses, respectively. The test duration is three and half years for the first 3 buses and two and half years for the next 5 buses. As the FCB technology is advancing rapidly, the staged purchase of buses will allow testing of more advanced bus models.
- The 8 buses need to be in the hands of one city bus operator in order to ensure consistency of measurements and results. Delhi contains more than enough opportunities to test the buses in different conditions: different city routes and road conditions, continuous operation or stop-and-go, and premium and regular customer segments. Dispersing these buses to more than one city bus operator will both compromise the integrity of the test program and duplicate the investments in fuelling infrastructure and training.

III. PROJECT ACTIVITIES AND EXPECTED RESULTS

MAJOR OUTPUTS

27. The major outputs of Stage II project are described below. Part I will primarily generate Outputs 1 and 2, and Part II will generate Outputs 3 to 5.

PART I

Output 1: The performance, operability, reliability, and safety of FCBs and hydrogen facility (production, compression, storage, and dispensing) are verified.

28. The demonstration project will purchase the 8 FCBs all in one procurement process but the buses will be delivered in two batches as shown in Table 1.

Table 1 -
Fuel-cell Bus Delivery and Operation Plan (Part I and II)

	Number of Buses	Test Duration, year	Bus Availability, (%)	Hours* Driven/Bus	km** Driven
Part I - 1st Delivery	3	3.5	60	12,264	388,616
Part II - 2nd Delivery	5	2.5	70	10,220	539,744
Total	8			22,484	928,359

* two shifts a day (16 h) driving
**169 km/d/bus under full day (16 h) service

29. These 8 buses will be put into regular revenue service to gain real-time test data and experience. In regular service, each bus runs on the average 16 hours and 169 km a day, every day of the year. The first and second batches of buses will be operational in 2003 and 2004 and their estimated availabilities according to this time frame are 60% and 70%, respectively.

30. A system optimization study conducted as part of the PDF-B for the proposed project shows that the best system to supply hydrogen for a full-scale commercial deployment of FCBs in India is a central natural gas reforming plant with the product hydrogen delivered to the bus depots by a gas pipeline. This system was selected among six different cases based on the energy supply and other local conditions in India and several selection criteria, such as the cost of CO_2 reduction, amount of CO_2 reduced, cost of bus driving, capital required, ability to stage investment, energy availability, etc.

31. For the demonstration project, it is not practical to construct a central natural gas reforming plant. Thus, a packaged electrolyzer unit, including high pressure hydrogen gas storage cylinders, hydrogen compressors, and dispensers, will be purchased and installed at the host bus depot to meet the hydrogen requirement. The central reforming plant and hydrogen pipeline are all proven technologies and thus it is not essential to demonstrate them in this project.

Output 2: Local operation/maintenance capability of FCBs and hydrogen facility is built up

32. As current bus maintenance crews are familiar only with diesel bus maintenance, the maintenance crew for the demonstration project will be sent to the bus supplier to observe and participate in the bus integration, manufacturing, and assembly so that they can gain an in-depth understanding of the bus structure and engine function. After the buses are delivered to the bus depot and start to operate, the technical specialists from the bus manufacture and the engine/chassis supplier will train the maintenance crew on the job until the crew accumulate enough practical experience and knowledge to conduct the maintenance all by themselves. The intent is to gradually build up the expertise to maintain the FCBs over the longer term. As the DTC will be charged with the undertaking, they are expecting to use project funds to hire new crew members who then become the core of the maintenance crews for FCBs, as FCB activities grow. They will be expected to train additional maintenance staff and build up the local cadre of technicians able to maintain FCBs, and the staff will be part of existing DTC operations.

33. As FCBs are basically electric buses, they require operations and maintenance support that are different from that required by diesel buses. In response, the maintenance crew for the FCB project will be hired from outside with adequate background skill and education to embrace the new technology. As the number of FCBs increases in India in the future, their level of responsibility (and pay-scales) will increase with progress toward commercialization.

34. India has many refineries, petrochemical complexes, fertilizer plants, and chlori-alkali plants, which produce large quantities of hydrogen by either natural gas reforming or electrolysis processes. Thus, it already has the local operating and maintenance capability of hydrogen production facilities. However, this project is still budgeted to obtain technical support from the hydrogen facility supplier for training and facility installation, startup, and operation. This is to guarantee a continuous full supply of hydrogen for the FCBs during the entire project operation. Therefore, the commitment for this project is to electrolyze only for the demonstration stage, and thereafter to undertake reforming of natural gas.

35. According to B.C. Transit's experience in the Vancouver demonstration project, each bus operator required only two hours training before they could operate the FCBs and knew how to respond to the road emergency situation. Thus, the build-up of local capability to operate FCBs is not an insurmountable obstacle.

PART II

Output 3: Local bus suppliers have the FCB manufacturing capability

36. Most FCB developers realize that the only effective way to market their products in India is to have the buses manufactured and assembled locally, even for the demonstration project. However, to get the local bus manufactures involved for the demonstration project imposes certain risks. As a compromise, the first three buses are expected to be imported in their entirety, while the next five buses will be assembled locally using some Indian components. This allows the local manufacturing capability to build up after certain familiarity with the technology has been achieved.

Output 4: Public accepts the use of FCBs

37. According to the demonstration project experience in Chicago and Vancouver, FCBs can respond to load and speed changes faster than diesel buses and are quieter with less vibration. Most of the passengers who used the service either could not tell the difference from diesel buses or actually felt the FCBs performed better. However, in Delhi, the bus performance is expected to be a key issue for leaving a good impression to the passengers and general public in the proposed project. The key issue would be how to operate the buses reliably and safely under the tough driving conditions (extreme weather conditions, both good and bad roads, and heavy traffic) in India.

38. To address the issue above, the project will devote a special effort in preparing the bus specification to ensure the buses purchased can handle the tough driving condition in Delhi. The project will also work closely with the bus and hydrogen facility suppliers to structure a sound maintenance and safety program, such as the establishment of a preventive maintenance schedule and an extensive review of the hydrogen monitoring/detection/alarm system.

39. Once the buses run well in the regular revenue services, the remaining work to gain public acceptance is relatively straightforward. The project will basically try to establish a good public relation in terms of news release and holding public awareness workshops for the FCB technology.

Output 5: FCB technology can be sustained in India after the demonstration project

40. All previous outputs are actually pre-requisites to achieve this output. But to ensure this output can be fully attainable, the proposed project needs to and will engage the following activities:

- Generate a master plan and schedule for the follow-on activities or projects beyond the demonstration project to finally lead to a full-scale commercial deployment in India; this will be based on the technology readiness determined from the demonstration project and projected performance improvement and cost reduction from the suppliers. The master plan mentioned above will include a realistic assessment of the buildup rate and schedule for the number of buses and hydrogen infrastructure required to lead to commercial deployment.

- Develop jointly with the Indian Government an incentive program for the FCB manufactures and hydrogen facility suppliers to venture into commercial production and marketing in India; direct incentives could be import duty exemption, tax credit for the products, or a soft loan guarantee and indirect incentives such as adding user tax to the diesel fuel cost, tightening the air emission limits, or imposing tax on air emission or carbon emission.; the impact of the incentive program on the acceleration rate of the commercial deployment will be examined under the demo phase.
- Mobilize the technical/scientific societies and regulatory agencies in India to develop necessary codes and standards for a safe use of hydrogen
- Intensify research in India to engage more in fuel-cell vehicle development as to generate a talent pool to support commercial deployment; the project will award several research grants annually to the leading local research and development institutions for selected topics judged useful for capacity building purposes. The specific types of research that will be conducted will be identified during the preparation of the Project Document.

PROJECT ACTIVITIES

41. The proposed project activities will be carried out with five major task components, conducted under two parts. Part I deals mainly with the purchase of FCB (Output 1) and the hydrogen facility set-up (Output 2), although the buses are delivered in two installments. Part II deals with the operation of the FCB fleet and the hydrogen facility, data analysis and project management, and the development and implementation of the sustainability program. A logical framework matrix is shown in Annex A, which links the project output with the major activities described below.

PART I

Task 1: <u>FCB Purchase</u>

Task 1.1: <u>Prepare Bus Specifications</u>

42. In this task, a technical specification for the FCB will be finalized as the basis for the bus purchase. It will reflect the tough driving conditions in Delhi and DTC’s service requirements. It will also specify the shop inspection and testing requirements, warranty and technical support to be provided, spare parts to be furnished, and required delivery schedule. This specification preparation will take advantage of DTC’s current specification for the diesel and CNG buses, particularly that for the bus body.

Task 1.2: <u>Issue Tender and Award Contract for the FCBs</u>

43. In this task, a bid package for the buses will be issued to potential suppliers, the bids received will be reviewed and evaluated, and then a contract will be negotiated with and awarded to a selected supplier. The bid package will include the technical specification described above, the payment method and schedule, contractual requirements, and the stipulation of local content for the second five buses, as discussed under Output 3.

Task 2: Hydrogen Facility Purchase and Installation

Task 2.1: Engineering and Site Design

44. In this task, the project team will prepare a technical specification for the packaged hydrogen facility as the basis for the purchase of this facility, conduct design for the site improvement civil work, design the hydrogen facility foundation and grounding system, design the utility supply and connection system, such as the electric supply line, transformer, switch gears, motor control centers, water supply line, and drainage line, design the required bus depot modifications to adapt the use of FCBs, including safety monitoring, hydrogen detection/alarm system, and fire protection system , engineering drawings and specifications, such as site layout, piping and instruments diagrams, and electric connection diagrams, will be developed for installation of the hydrogen facility and prepare technical specifications for the equipment required in the utility support system.

Task 2.2: Permitting

45. In this task, the necessary documents for obtaining permits to construct and operate the hydrogen facility and FCBs will be prepared and submitted to the relevant agencies. As this project involves the use of hydrogen and the technology involved is new in India, the permitting process could be lengthy and difficult. The project will prepare the permitting documents and approach the permitting agencies, particularly the fire marshal, as early as possible.

Task 2.3: Major Equipment/Facility Purchase

46. In this task, the hydrogen facility and major equipment required for the utility support system will be procured, fabricated, and delivered in a similar fashion as described above for the FCBs (see Tasks 1.2 and 1.3).

Task 2.4: Utility Hookup and Site Construction

47. In this task, a construction subcontract bid package will be prepared and issued to potential bidders, the bids received will be reviewed and evaluated, and a contract will be negotiated with and awarded to a selected subcontractor.

PART II

Task 1: FCB Purchase (continued)

Task 1.3: Fabrication and Delivery of the First 3 Buses

48. In this task, the selected bus supplier will fabricate and deliver the buses. Prior to the fabrication, the supplier will submit detailed engineering drawings to the project for review, comments, and approval.

49. At various stages of the fabrication, the project will send technical specialists to check the quality of the key system components and witness any performance tests conducted by the supplier on those components. This shop inspection is to ensure the buses are being manufactured according to the specification and to expedite the schedule if necessary.

Task 1.4: Fabrication and Delivery of the Next 5 Buses

50. The scope of work for this task is similar to that under Task 1.3, except that it may require greater effort on design and manufacturing integration between the drive train and the bus glider, given the requirement for increased local content. The issue of design and manufacturing integration will be addressed in greater detail during the development of the Project Document.

Task 2: Hydrogen Facility Purchase and Installation (continued)

Task 2.4: Utility Hookup and Site Construction (continued)

51. In this task, the subcontractor will install the hydrogen facility and make the utility hookup according to the engineering drawings and specifications developed in Task 2.1.

Task 2.5: Mechanical Shakedown and Facility Startup

52. After the hydrogen facility and the utility support system are installed, DTC, with the assistance from the hydrogen facility supplier and the international/national consultants who provide the engineering, will check the completion of the construction and start up the facility.

Task 3: Bus/H2 Facility Operation and Maintenance

Task 3.1: Operation and Maintenance of the First 3 Buses

53. As mentioned previously (Output 1), the first 3 FCBs will be operated for three and half years. The training required for the bus operators and maintenance crew and how it is to be provided have also been discussed previously under Output 2.

Task 3.2: Operation and Maintenance of the Next 5 Buses

54. The activity under this task is the same as that described for Task 3.1.

Task 3.3: Operation and Maintenance of Hydrogen Facility

55. The hydrogen facility will not be installed in two stages to coincide with the bus purchase. It will be built once to satisfy the hydrogen consumption of all the 8 buses. This is because it can provide significant cost saving due to the economy of scale. The hydrogen facility will be designed for unattended operation. Thus, the operator training required prior to the startup and during the startup is expected to be minimum and will concentrate more on the troubleshooting in case problems develop during the hydrogen production.

Task 4: Test Data Analysis and Project Management

Task 4.1: Prepare Test Plan

56. In this task, a comprehensive test plan will be developed in terms of the specific tests to be conducted, frequency and duration of the tests, data acquisition methods and responsibility, and data analysis methods and responsibility. For the FCB operation and performance, the following parameters will be verified as a minimum:
    - Fuel economy & its decay rate;
    - Acceleration capability/load response time;
    - Capability to operate under hot weather in New Delhi;
    - Capability to operate with frequent stop and go in congested traffic in New Delhi;
    - Startup time;
    - Emissions; and,
    - Noise/vibration level.

57. For the hydrogen facility operation and performance, the following parameters will be verified as a minimum:
    - System efficiency at various load points;
    - Electrolyzer performance decay rate;
    - Startup/shutdown time;
    - H2 purity/quality measurements;
    - Dispensing time;
    - Noise/vibration level (electrolyzer/H2 compressor);
    - Unattended operation capability; and,
    - Effectiveness of the safety system.

58. For the reliability/availability of the FCBs and hydrogen facility, the following parameters will be verified as a minimum:
    - Maintenance labor requirements;
    - Maintenance material requirement;
    - Mean time between failures;
    - Downtime;
    - Stack life;
    - Overall availability;
    - Failure modes and their causes;
    - Repair times and;
    - Required spare parts inventory.

Task 4.2: Data Acquisition and Analysis

59. In this task, the test data will be collected, stored, and analyzed.

Task 4.3: Project Management and Reporting

60. In this task, the project team will submit monthly reports to the steering committee and generate topical reports for the bus and H2 facility test, operating, and maintenance results

and the work conducted under the sustainability program. A quarterly project review meeting will also be held to monitor the project progress. Details of the project monitoring and evaluation are described in Section 7.

Task 5: <u>Sustainability Program</u>

Task 5.1: <u>Develop Master Plan/Intervention Measures</u>

61. A master plan and schedule will be generated for the follow-on activities or projects beyond the demonstration project to finally lead to a full-scale commercial deployment in India. These will be based on the technology readiness determined from the demonstration project and projected performance improvement and cost reduction from the suppliers. The master plan mentioned above will include a realistic assessment of the buildup rate and schedule for the number of buses and hydrogen infrastructure required to lead to commercial deployment.

62. An incentive program for the FCB manufactures and hydrogen facility suppliers will be developed jointly with the Indian Government to venture into commercial production and marketing in India. Direct incentives could include import duty exemption, tax credit for the products, or a soft loan guarantee and indirect incentives such as adding user tax to the diesel fuel cost, tightening the air emission limits, or imposing tax on air emission or carbon emission. The impact of the incentive program on the acceleration rate of the commercial deployment will be examined under the demonstration phase.

Task 5.2: <u>Build Up Codes/Standards and Local Capability</u>

63. This activity will seek to mobilize the technical/scientific societies and regulatory agencies in India to develop necessary codes and standards for a safe use of hydrogen. Research in India will be increased to more fully engage in fuel-cell vehicle development and to generate a talent pool to support commercial deployment. The project will award several research grants annually to the leading local research and development institutions for selected topics judged useful for capacity building purposes. The specific types of research that will be conducted will be identified during the preparation of the Project Document.

Task 5.3: <u>Disseminate Information</u>

64. The project team will host a public awareness workshop and a technology conference every year after the FCBs become operational and generate enough data and experience. To ensure that the GEF's contribution to the project is sufficiently recognized, all marketing and communications will recognize GEF support for the project, which will include GEF's logo(s) on the actual FCBs.

IV. RISKS AND SUSTAINABILITY

65. This project has been designed to be consistent with the paper entitled *"Toward a GEF Strategy to Develop Fuel-Cell Buses for the Developing World"* that was presented, discussed and approved at the November, 2000 GEF Council Meeting. As such, its risks correspond to the major risks identified in that document. In particular, three external risks identified in that programmatic logical framework merit mentioning here. These risks involve the response of fuel-cell and bus manufacturers to the bid issued in a manner that conforms to normal commercial procurement. This risk will be closely monitored and the experiences gained from the implementation of the procurements in the other FCB projects (Brazil, Mexico, Egypt, and China) will also be brought to bear. A second external risk has to do with how much the private sector, local transport authorities, and industry in Annex II countries will continue to invest in FCBs. This risk will also be closely monitored as part of the overall GEF programmatic framework on FCBs.

66. A third external risk highlighted in the programmatic log-frame has particular relevance to the Indian case. This risk has to do with the assumption that the costs of fuel-cell technology will decline to a point where FCBs will become less expensive over their life-cycle compared to diesel buses. This is especially problematic in India, where the basic diesel bus commonly used for public transport costs as little as US$30,000. This low cost reflects not only the low labor costs but also the low standards and short lifetimes (8 years) required for public buses in India. In other countries, as income and concern for urban environmental quality have risen, so have both the quality and the cost of the "baseline" diesel buses. In middle-income countries, the buses commonly used for urban transport can cost as much as $200,000. In Europe and North America, these costs run as high as $300,000. This risk may pose concerns for the potential long-term viability of FCBs in India. However, two considerations mitigate this risk. First, as is the case in other countries, the environmental and service requirements of public sector buses in India has already begun to increase, leading to the production of more expensive buses. In response to recent Supreme Court rulings on air quality, the DTC has begun purchasing CNG buses, which sell at a significant premium over the lower-quality diesel buses used. In addition, in order to provide higher quality service especially for physically disabled residents, DTC has also begun purchasing a limited number of low-floor, air-conditioned buses that sell for over $100,000 each. Thus, the drive to improve quality--and with it, the rising cost experienced in other countries--has also begun. Targeting FCBs at these higher quality market segments will improve the chances for successful commercialization of FCB's in India. Second, as one of the goals of this demonstration project is to increase the capability of India industry to produce FCB's, the cost comparison should not be between a low-cost Indian diesel bus and an FCB produced in OECD countries. Rather, the appropriate comparison for monitoring the costs which serve as a key to commercialization is between a high quality Indian diesel bus and a high quality, Indian FCB. Nevertheless, the costs relating to this risk will be closely monitored as they hold the key to long-term sustainability.

67. In addition to these risks external to the project, this project has been designed to mitigate two major risks inherent in working with any new bus technology.

68. **Risk #1:** ***The FCBs fall short of expectation on reliability*** **-** The P3 buses in the Chicago and Vancouver projects and also the P4 buses, which just started the revenue service for the transit authority at Palm Desert and Oakland, California, are all experimental buses and thus have short life. The FCBs in the Chicago and Vancouver demonstration projects have achieved only 30% availability. The P5 buses, which could be purchased among other bus manufactures for this demonstration project, are Xcellsis' first batch of commercial units and are expected to have significant improvements on the availability and stack life. One of the major objectives of this demonstration project is to verify these improvements.

69. **Risk #2:** ***Improper bus operation and maintenance*** **-** FCBs are basically electric vehicles and many of the engine components, such as the fuel-cell stacks and inverters, are high technology equipment. If they are not properly operated and maintained due to the lack of skilled labor, both the performance and safety of the buses could be jeopardized. The negative image created could then cause this technology to wither.

70. Due to this concern, the operator and maintenance crew training is of paramount importance and special effort will be taken as described under Output 2. DTC is a public company and thus limited by the salary scale they can offer to attract the skilled labor needed. The solution to this problem is to contract out the skilled services during the demonstration project and gradually build the skills at DTC.

71. The overall FCB program is designed to sustain the technology in India after the GEF support. In summary, this demonstration project will build capacity within the FCB and related industries by enhancing technical knowledge and skills, and by strengthening institutional capacity. Research in will be increased to more fully engage in fuel-cell vehicle development and to generate a talent pool to support commercial deployment and to sustain FCB technology in India. The project will award several research grants annually to leading local research and development institutions for capacity building purposes. Public awareness activities are developed to increase acceptance of this technology.

V. STAKEHOLDER PARTICIPATION AND IMPLEMENTATION ARRANGEMENTS

STAKEHOLDER PARTICIPATION

72. The project has been conceived and designed (in the PDF phase) with the involvement of a wide range of institutions, all of which are expected to participate in the implementation phase, as discussed in the next section. There have also been extensive consultations with potential equipment suppliers to evaluate their interests and capabilities in participating in Stage II and beyond. The Steering Committee for the project will be chaired by MNES, and the other major stakeholders, listed below, will be given an opportunity to participate. The final composition of the Steering Committee will be determined during project document finalization, however, it will include stakeholders with direct responsibilities for the transport sector.

73. The following institutions will be involved in implementation of the project, were also involved or consulted during the PDF phase:
    - The executing agency is the MNES, which will be responsible for disseminating the experience resulting from the project into the other States of India;
    - The national local implementing agency is the DTC;
    - MNES and DTC are expected to provide national financial participation;
    - Bharat Heavy Electrical Limited (BHEL), who managed the PDF-B activity, will provide technical inputs to DTC;
    - A Technical Advisory Committee, consisting of BHEL, SPIC, TERI, AF Ferguson, IIT and others, will provide the technical backstopping;
    - The participation of organizations dealing with petroleum products and research on alternate fuels, such as Indian Oil Corporation and Gas Authority of India Limited, will be involved;
    - Other important stakeholders include the Ministry of Industry, Department of Transport, ARSTU (Association of State Road Transportation), ARAI (Automotive Research Association of India), and Pollution Control Boards; and,
    - In addition to the above agencies, DTC will ensure input of the bus-riding public through the use of focus groups or rider ship surveys for those of its customers riding the routes to which the FCBs are assigned.

IMPLEMENTATION ARRANGEMENTS

74. The project will be organized and executed as follows:
    - A National Project Director (NPD) will be appointed by the MNES with the consultation with UNDP for the supervision of the project. The NPD will be responsible for the review, monitoring, and clearance of the work plan, which forms the basis for project execution. The Steering Committee will establish a subcommittee to finalize the selection of the project team as per the Terms of References (TOR);
    - Day-to-day co-ordination will be the responsibility of the Project Manager, contracted through this project. To this end, the NPD will facilitate the close coordination among the various line ministries, state governments, nodal departments, private sector, and the participating institutions;
    - A Project Management Cell (PMC) will be set up in DTC to carry out day to day working of the project. The Project Manager will head the PMC. He will be assisted by the technical and operational staff and will maintain close interaction with the institutions associated with the line ministries. He will also facilitate the work of the collaborating institutions and consultants. He will report to the NPD and the Steering Committee for policy directions, work plan and budget approvals; and
    - The Project Manager will also undertake coordination of all the activities under the respective ministries, which would include contracting/sub-contracting of activities to various institutions, preparation of TORs for consultants, and organization of training events, and workshops.

75. The project will be implemented according to the schedule shown in Figure 1. The project is expected to start in the 4th quarter of Year 1 (currently assumed to be 2001) and complete by the 3rd quarter of Year 6 with a total duration of 5 years. For all buses, the bus specification

preparation, issuing of tender, evaluation of the bids received, and negotiation/award of the contract (Tasks 1.1 and 1.2) will be completed by the end of Year 1. Based on the feedback from the leading FCB developers, fifteen months are allowed for the bus supplier to fabricate and deliver the buses to DTC. The next 5 buses will be delivered one year after the first 3 buses.

76. For the hydrogen facility, the contract award to the supplier will also be in place by the end of Year 2. Twelve months are required for the supplier to fabricate and deliver the packaged H2 unit to DTC, including the sea and land shipping time. It will be installed, commissioned, and ready to produce and supply hydrogen by when the FCBs arrive.

77. To support the hydrogen production schedule above, the H2 facility supplier will generate and provide the project team certified engineering drawings of their unit in the first 1-2 month of their contract. Based on these drawings, the project will start the site work design and engineering of the utility support for the H2 facility. Major equipment required will be purchased and the construction subcontractor will be selected and brought on board. The site construction will start before the 4th quarter of Year 2 so that the whole H2 facility will be ready for startup when the FCBs arrive.

78. The first 3 buses and hydrogen facility will be operational in the 2nd quarter of Year 3 and the next 5 buses in the 2nd quarter of Year 4. As indicated previously, the bus drivers will be trained shortly before the buses are put into revenue service. The bus maintenance crew will be trained during the bus manufacturing stage and on-the-job, when the buses start revenue service.

79. Task 5.1 (Master Plan for the Next Phase of activities) will start about one year prior to the project completion while Task 5.2 (build codes/standards/local capability will start at the very beginning of the project. Task 5.3 (information dissemination) will occur periodically after the project starts to accumulate enough data and experience from the testing program.

Figure 1 - Project Schedule

	Part I		Part II			
TASK NO. & DESCRIPTION	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
1. Fuel-cell Bus Purchase						
1.1 Finalize Bus Specifications	---					
1.2 Tender/Award Contract for all Buses	--					
1.3 Fabrication and Delivery of 1st 3 Buses		----------	--			
1.4 Fabrication and Delivery of 2nd 5 Buses			----------	--		
2. H2 Facility Purchase/Installation						
2.1 Engineering and Site Design	---	-------				
2.2 Permitting	--	---				
2.3 Major Equipment/Facility Purchase	--	----------				
2.4 Utility Hookup and Site Construction		--	--			
2.5 Mechanical Shakedown/Facility Startup			---			
3. Bus/H2 Facility Operation/Maintenance						
3.1 Operation and Maint. of 1st 3 Buses			-------	----------	----------	-------
3.2 Operation and Maint. of 2nd 5 Buses				--------	----------	-------
3.3 Operation and Maint. of H2 Facility			-------	----------	----------	-------
4. Test Program/Project Management						
4.1 Prepare Test Plan	-	---				
4.2 Data Acquisition and Analysis			-------	----------	----------	-------
4.3 Project Management and Reporting	---	----------	----------	----------	----------	-------
5. Sustainability Program						
5.1 Develop Master Plan/Incentive Program					-	-------
5.2 Codes/Standards/Local Capability	---	----------	----------	----------	----------	-------
5.3 Disseminate Information				--	--	--

VI. INCREMENTAL COSTS AND PROJECT FINANCING

80. The incremental costs required for the proposed project are shown in Table 2. Bases for the incremental cost estimate are given in the incremental cost analysis shown in Annex A. The project component financing is shown in Table 3 (Part I) and Table 4 (Part II). The baseline case is the current diesel bus operation in Delhi. Both the global and local emissions correspond to the amount released during the test period, i.e. 3 buses for 3.5 years and 5 buses for 2.5 years.

Table 2 - Incremental Cost Matrix for Part I and II

	Baseline	GEF Project	Increment
Global CO2 Emission, tonnes			
From Buses	723	---	(723)
From Hydrogen Production	---	666	666
Total	723	666	(57)
Local Emissions, tonnes			
SO2	1.7	0.2	(1.7)
NOx	19.5	0.4	(19.5)
CO	6.4	0.4	(6.4)
HC	2.4	0.4	(2.4)
Particulates	1.9	---	(1.9)
Part I Cost, US$ millon	0.320	11.824	11.505
Part II Cost, US$ millon	1.224	16.417	15.193
Cost, US$ million	1.544	28.241	26.697

Table 3 - Component Financing – Part I

	Cost, US$				
		Co-Funding			
Component	GEF	DTC	Equip. Supplier	India Govern't	Total
Bus Purchase	4,671,000		831,375	3,495,080	8,997,455
H2 Facility Purchase/Install	1,246,500			1,282,500	2,529,000
Operation & Maintenance					
Project Management/Testing	22,400			123,201	145,601
Sustainability Program	10,600			109,518	120,118
Project Monitoring/Evaluation	32,000				32,000
Contingency					
Total	5,982,500		831,375	5,010,299	11,824,174

Table 4 - Component Financing – Part II

	Cost, US$				
		Co-Funding			
Component	GEF	DTC	Equip. Supplier	India Govern't	Total
Bus Purchase	5,410,000		1,385,624	4,349,199	11,144,823
H2 Facility Purchase/Install					
Operation & Maintenance	150,000	20,000		2,569,084	2,739,084
Project Management/Testing	89,600			536,124	625,724
Sustainability Program	89,400			690,113	779,513
Project Monitoring/Evaluation	128,000				128,000
Contingency				1,000,000	1,000,000
Total	5,867,000	20,000	1,385,624	9,144,521	16,417,145

81. The diesel bus CO_2 emission is calculated based on typical diesel fuel composition in India, average bus daily driving distance of 169 km, and fuel economy of 3.76 km/liter. It also has taken into account that fuel oil production from crude in a refinery typically has 90% conversion efficiency. The diesel bus emissions of air pollutants are calculated based on: 1.2 g/km SO_2, 13.73 g/km NOx, 4.5 g/km CO, 16.8 g/km HC, and 0.8 g/km particulates.

82. The FCBs used have zero emissions for CO_2 and air pollutants. The CO_2 emission from the power consumption for hydrogen production (electrolyzer) is based on the power produced in a natural gas fired combined cycle plant located across the street from the bus depot which hosts the demonstration project. The combined cycle plant has 50% generation efficiency, with 4 ppmv sulfur in the natural gas feed and 9 ppmv NOx, 10 ppmv CO, and 10 ppmv HC in the flue gas.

83. The small amount of CO_2 emission reduction shown in Table 2 is not indicative of the potential total GHG emissions benefit of FCBs in India. Shown in Table 5 is the CO_2 reduction when DTC's entire fleet of public buses is converted to FCBs. The diesel bus CO_2 emission is calculated on the same basis as described above. The FCB case is based on the optimum system selected in the PDF-B activity: central hydrogen plant by natural gas reforming with H2 produced delivered to bus garages by a gas pipeline. The CO_2 emissions from various power consumptions are based the current grid mix, which consists of 73% fossil power generated from coal at 31.2% efficiency and 27% hydro/nuclear power. Overall, the use of FCBs in Delhi can provide close to 40,000 tonnes of global CO_2 reduction annually.

Table 5 - Estimated Future CO_2 Emission Reduction (Sustainable Phase)

CO2 Emission, tonnes/year	Diesel Buses	Fuel Cell Buses	Increment
From Bus Operation	96,857	---	(96,857)
From Natural Gas Used in H2 Production	---	54,707	54,707
From Power Consumed for Hydrogen Fueling	---	2,343	2,343
Total	96,857	57,050	(39,807)

( ) denotes reduction

84. The GEF project cost is substantially more than the baseline cost, mainly because the FCBs to be purchased would be the initial introduction of commercial product without the benefit of volume production. Details of these costs are provided in Annex B.

85. Based on the incremental cost table provided in Table 2, the GEF fund requested is only about 44% of the total increment cost. The India government will provide most of the remaining funding requirement of $14.154 million in cash and in-kind. In the budget allocation, the GEF funds are used mainly for the purchase of the buses, H2 facility, and international consultant services. The Indian Government's funds are used mainly for domestic expenses, such as the use of local subcontractor for the H2 facility installation, the cost of bus operators and maintenance crew, and the pursuit of the intervention measures.

VII. MONITORING, EVALUATION AND DISSEMINATION

86. The steering committee will be responsible for the project monitoring and evaluation. At project start-up, the project team will submit to the steering committee a work plan, showing a detailed scope of work, the project schedule, major milestones, staffing requirements, and the projected budget expenditure. During the project execution, the project manager will submit a progress report to the steering committee on a monthly basis, showing the work accomplished, major findings and results, actual budget expenditure vs. planned, problems encountered, and corrective measures taken.

87. The project team will also submit topical reports to the steering committee for review and comments on a quarterly basis. The reports would summarize the work conducted under the sustainability program and the test results of the bus and H2 facility operation and maintenance.

88. A quarterly project review meeting will be held between the project team and steering committee to review the progress, discuss key issues, and plan for future key events. In case it is necessary, the steering committee may redirect the project's schedule, budget, or scope of work.

89. A mid-term project evaluation meeting will be held with participation of the GEF and UNDP/GEF advisers. This meeting will take place after the first 3 buses have gained one-year operation and testing. It will review the project progress and results.

90. The monitoring and evaluation plan for the project will be based on pre-agreed benchmarks, to be developed by the project team, consistent with the project objectives and procurement specifications. A proposed set of benchmarks is listed below:

- Preparation of a detailed work-plan, showing the milestones and benchmarks;
- Preparation of a comprehensive test plan for the buses and hydrogen plant in terms of the specific tests to be conducted, frequency and duration of the tests, data acquisition methods and responsibility, and data analysis methods and responsibility;
- Timely execution of specification, solicitation and procurement activities in the first year;
- Delivery and commissioning of buses, fuelling system, spares, software, etc in the second and third years;
- Quarterly reports on the FCB operation and performance, including fuel economy and its decay rate, acceleration capability/load response time, capability to operate under hot weather in New Delhi, capability to operate with frequent stop and go in congested traffic in New Delhi, startup time, and emissions;
- Quarterly reports on the hydrogen facility operation and performance, including system efficiency at various load points, electrolyzer performance decay rate, startup/shutdown time, H2 purity/quality measurements, dispensing time, noise/vibration level (electrolyzer/H2 compressor), unattended operation capability, and effectiveness of the safety system;

- Quarterly reports on the reliability/availability of the FCBs and hydrogen facility, including maintenance labor requirements, maintenance material requirement, mean time between failures, stack life, overall availability, failure modes and their cause, and required spare parts inventory;
- Quarterly reports on proposed engineering modifications and the communication of these to vendors, plus confirmation of actions taken;
- Quarterly reports on operator and maintenance personnel training and achievement;
- Annual review of progress towards cost, reliability and durability targets; and
- Annual records of communication activities: participation in international meetings, information dissemination within India.

91. Effective technology transfer will be key to the success of this project and the achievement of the programmatic goals. One of UNDP's roles, therefore, will be to monitor the issue of intellectual property rights – to the maximum extent possible – as it applies to the fuel-cell technology used in this project.

92. The indicators listed in Annex B (logical framework matrix) will be further refined and specified during the formulation of the project document.

LIST OF ANNEXES

Annex A.	**Incremental Cost**
Annex B.	**Logical Framework Matrix**
Annex C.	**STAP Roster Technical Review**
Annex C1.	**Response to STAP**
Annex D.	**Letter(s) of Endorsements**
Annex E .	**Project Categorization**

Annex A
Incremental Cost Analysis

Broad Development Goal

The broad development goal being pursued by the Government of India, MNES, and DTC is the provision of public transport services to its urban inhabitants. The incremental cost matrix is presented as Table 2 in the body of the proposal.

Baseline

Under the baseline situation, the DTC would provide urban bus transport services to its population through the continued reliance on diesel or CNG-powered buses. The baseline to this project is the provision of urban bus service through diesel-fueled buses. There are some 2,000 buses currently in operation by DTC.

Diesel buses are a major contributor to urban air pollution. Under the baseline, 3 buses would be operated for 3.5 years at 60% availability, and 5 buses operated for 2.5 years at 70% availability. The diesel bus CO_2 emission is calculated based on DTC's diesel fuel composition, average bus daily driving distance of 169 km and fuel economy of 0.266 l/km. It also has taken into account that fuel oil production from crude in a refinery typically has 90% conversion efficiency. The diesel bus emissions of air pollutants are calculated based on: 1.2 g/km SO_2; 13 gm/km NOx, 18 g/km CO, 2.9 g/km HC and 0.8 g/km particulates. Over the life of the project, the baseline estimate of distance driven will be 0.928 million km, which will result in the emission of 723 tonnes of CO_2.

Global Environmental Objectives

The global environmental objective is the reduction of greenhouse gas (GHG) emissions from the urban transport sector in India. Over the immediate term of the project, this will involve the demonstration and testing of FCBs fueled by electrolytic hydrogen. Over the longer term, this project will lead to an increased production in fuel-cell propelled buses, and the eventual reduction in their costs to the point where they will become commercially competitive with conventional, diesel buses. This project has been prepared to be consistent with GEF Operational Program 11 "Promoting Sustainable Transport".

GEF Project Activities

This project is designed to develop and operate a demonstration fleet of eight FCBs in Delhi, India. These buses will be procured once but delivered in two batches (the first of three and the second of five buses). They will be designed to operate commercially under Indian conditions and will provide the MNES and DTC with detailed operating experience of around 1,000,000 vehicle-km. This operating information will be used as feedback both to the bus suppliers and DTC so that future FCB activities can successfully build upon the initial activities of this project.

In order for the long-term programmatic goal of this project to be achieved, FCBs must be produced for use in other contexts. According to industry projections, after a total of 2,000 FCBs have been produced, the costs should fall to where FCBs will be roughly competitive on a lifecycle basis with modern, clean diesel buses.

Global Environmental Benefits

The deployment of FCBs in India can lead to significant reduction in carbon emissions from the transport sector. As the technology is further developed and deployed, these significant global benefits will continue to multiply as FCBs are deployed around the world.

The eight diesel buses operating in the baseline of 1 million vehicle km are expected to emit approximately 723 tonnes of CO_2. The FCBs, as explained elsewhere, will emit nothing at the tailpipe level, but the production of the electricity which will be used to produce hydrogen via electrolysis will result in the emission of 666 tonnes of CO_2. The net CO_2 benefits from this demonstration project are therefore equal to 57 tonnes.

Beyond the demonstration stage, the potential exists to move toward a zero net CO_2 system. As the project moves closer to commercialization, other efforts, such as the sequestration of the CO_2 following the steam reforming process become economically viable. As shown in the text (paragraph 11), Delhi Transport Company operates a fleet of 2,000 buses. If all of these were converted to run on fuel-cells, the carbon dioxide emission reduction would be 40,000 tonnes per year (paragraph 84). If the entire population of major fleet buses in India (25,000, para 16) were converted to run on fuel-cells with similar fuel-supply characteristics, the overall CO_2 emission-reduction would amount to 500,000 tonnes of CO_2 per year.

Costs

The costs of the baseline course of action are measured by the costs of operating conventional diesel buses for one million vehicle-kilometers. These are estimated at US$1.54m over the five-year project lifespan. The costs of the proposed project activities are estimated at US$28.24m, of which about US$26.70m are considered incremental (see Table 2 in main body of this brief). These incremental costs are shared between the GEF, Indian sources, and the private sector providers of the technology (see Section VI in main body of this brief).

System Boundary

Although the boundary for this immediate project is the Indian urban transport sector, because of the nature of the fuel-supply system, it encompasses the electricity sector. The project will support and draw upon resources from the global automotive industry. It should also provide important feedback for public transport agencies in other parts of the developing world. One of UNDP-GEF's roles is to ensure that the information gathered and experience gained can be shared across national and commercial boundaries. In that context, this project is important internationally for the experience to be gained and shared.

Additional Benefits

The project will demonstrate significant additional local benefits in terms of reduced emissions of pollutants dangerous to human health and habitat. In particular, the project will reduce the emission of NO_x, SO_x, CO, HC, and particulates, as detailed in the incremental cost matrix. As detailed in the text, there are also significant benefits to the global community, the automotive industry, and the technology providers.

Cost Estimate Details

Table A-1 gives a detailed incremental cost analysis for Part I of the proposed FCB demonstration project. Table A-2 proves the analysis for Part II of the project, and Table A-3 gives the detailed analysis for the entire project (Part I and II combined). The basis for each of the cost items in the above tables is described in the following section.

Table A-1 - Detailed Project Cost Estimate for Part I

Item	Cost, US$					
		Fuel Cell Bus Demonstration Project				
	Baseline (Diesel Buses)	GEF	Co-Funding DTC	Co-Funding Equip. Supplier	Co-Funding India Govern't	Total
Bus Purchase						
Buses with Tech. Support	32,813	4,590,000		831,375		5,421,375
Bus Specification/Procure		81,000			25,400	106,400
Import Duties					3,469,680	3,469,680
Subtotal	32,813	4,671,000		831,375	3,495,080	8,997,455
H2 Facility Purchase/Install						
H2 Facility		1,100,000				1,100,000
Spare Parts		27,500				27,500
H2 Facility Shipping Cost		10,000				10,000
Import Duties					902,000	902,000
Bus Depot Adaptation					39,000	39,000
Site Prep/Utility Hookup					201,500	201,500
H2 Facility Installation					91,000	91,000
Engineering/Permitting/ Procurement/Startup		109,000			49,000	158,000
Subtotal		1,246,500			1,282,500	2,529,000
Operation & Maintenance						
Bus Operator Training						
Bus Maint. Crew Training						
Technical Support						
by Bus Supplier						
by H2 Facility Supplier						
Diesel Fuel	15,204					
Electricity						
Water						
Bus Depot Depreciation	4,941					
Bus O&M Materials	53,296					
H2 Facility O&M Materials						
Bus Operation Labor	202,500					
Bus/H2 Facility Maint. Labor	10,826					
Subtotal	286,766					
Project Management/Testing						
Project Management		22,400			123,201	145,601
Testing & Reporting						
Subtotal		22,400			123,201	145,601
Sustainability Program						
Master Plan/Incentives						
Codes/Standards &						
Local Capability		10,600			109,518	120,118
Information Dissemination						
Subtotal		10,600			109,518	120,118
Project Monitoring/Evaluation		32,000				32,000
Contingency						
Total	319,579	5,982,500		831,375	5,010,299	11,824,174

Table A-2 - Detailed Project Cost Estimate for Part II

Item	Cost, US$					
		Fuel Cell Bus Demonstration Project				
	Baseline (Diesel Buses)		Co-Funding			
		GEF	DTC	Equip. Supplier	India Govern't	Total
Bus Purchase						
Buses with Tech. Support	39,063	5,410,000		1,385,624		6,795,624
Bus Specification/Procure						
Import Duties					4,349,199	4,349,199
Subtotal	39,063	5,410,000		1,385,624	4,349,199	11,144,823
H2 Facility Purchase/Install						
H2 Facility						
Spare Parts						
H2 Facility Shipping Cost						
Import Duties						
Bus Depot Adaptation						
Site Prep/Utility Hookup						
H2 Facility Installation						
Engineering/Permitting/ Procurement/Startup						
Subtotal						
Operation & Maintenance						
Bus Operator Training					12,131	12,131
Bus Maint. Crew Training					182,300	182,300
Technical Support						
by Bus Supplier						in bus cost
by H2 Facility Supplier		150,000				150,000
Diesel Fuel	69,545					
Electricity					742,330	742,330
Water					1,744	1,744
Bus Depot Depreciation	19,762				41,171	41,171
Bus O&M Materials	219,105				112,082	112,082
H2 Facility O&M Materials					2,500	2,500
Bus Operation Labor	832,500		20,000		1,015,000	1,035,000
Bus/H2 Facility Maint. Labor	44,506				459,826	459,826
Subtotal	1,185,418	150,000	20,000		2,569,084	2,739,084
Project Management/Testing						
Project Management		89,600			492,806	582,406
Testing & Reporting					43,319	43,319
Subtotal		89,600			536,124	625,724
Sustainability Program						
Master Plan/Incentives		29,000			27,452	56,452
Codes/Standards & Local Capability		42,400			438,071	480,471
Information Dissemination		18,000			224,589	242,589
Subtotal		89,400			690,113	779,513
Project Monitoring/Evaluation		128,000				128,000
Contingency					1,000,000	1,000,000
Total	1,224,481	5,867,000	20,000	1,385,624	9,144,521	16,417,145

Table A-3 - Detailed Project Cost Estimate for Total Project (Part I and II)

Item	Cost, US$					
		Fuel Cell Bus Demonstration Project				
	Baseline (Diesel Buses)	GEF	Co-Funding: DTC	Co-Funding: Equip. Supplier	Co-Funding: India Govern't	Total
Bus Purchase						
Buses with Tech. Support	71,875	10,000,000		2,216,999		12,216,999
Bus Specification/Procure		81,000			25,400	106,400
Import Duties					7,818,879	7,818,879
Subtotal	71,875	10,081,000		2,216,999	7,844,279	20,142,278
H2 Facility Purchase/Install						
H2 Facility		1,100,000				1,100,000
Spare Parts		27,500				27,500
H2 Facility Shipping Cost		10,000				10,000
Import Duties					902,000	902,000
Bus Depot Adaptation					39,000	39,000
Site Prep/Utility Hookup					201,500	201,500
H2 Facility Installation					91,000	91,000
Engineering/Permitting/ Procurement/Startup		109,000			49,000	158,000
Subtotal		1,246,500			1,282,500	2,529,000
Operation & Maintenance						
Bus Operator Training					12,131	12,131
Bus Maint. Crew Training					182,300	182,300
Technical Support						
by Bus Supplier						in bus cost
by H2 Facility Supplier		150,000				150,000
Diesel Fuel	84,750					
Electricity					742,330	742,330
Water					1,744	1,744
Bus Depot Depreciation	24,703				41,171	41,171
Bus O&M Materials	272,401				112,082	112,082
H2 Facility O&M Materials					2,500	2,500
Bus Operation Labor	1,035,000		20,000		1,015,000	1,035,000
Bus/H2 Facility Maint. Labor	55,331				459,826	459,826
Subtotal	1,472,185	150,000	20,000		2,569,084	2,739,084
Project Management/Testing						
Project Management		112,000			616,007	728,007
Testing & Reporting					43,319	43,319
Subtotal		112,000			659,326	771,326
Sustainability Program						
Master Plan/Incentives		29,000			27,452	56,452
Codes/Standards & Local Capability		53,000			547,589	600,589
Information Dissemination		18,000			224,589	242,589
Subtotal		100,000			799,631	899,631
Project Monitoring/Evaluation		160,000				160,000
Contingency					1,000,000	1,000,000
Total	1,544,060	11,849,500	20,000	2,216,999	14,154,820	28,241,319

Bus Costs

The FCB cost is based on input from Ballard Automotive (sales arm of Xcellsis) for their commercial buses (P5 buses): $1.53 million/bus. It includes warranty, spare parts (for the 2.5-3.5 year operation), and technical support by the bus suppliers. But the current price they charged for the 30 buses in the European FCB demonstration program is $1.25 million/bus (including the cost of membrane replacement). Ballard Automotives indicated that they would charge the same for the proposed Delhi demonstration project. The difference between the cost and price to charge would be the cost share from the FCB supplier.

The diesel bus cost in the baseline case is based on a linear depreciation for 3 buses after 3.5 years of use and 5 buses after 2.5 years of use (the same number of buses and years of use as the FCB case). DTC's current purchase price of diesel buses with spare parts is $30,000/bus.

FCB Specification and Procurement

This is estimated based on the activities and labor requirements shown in Table A-2. It is assumed that national consultants will take the lead for this effort, assisted by international consultant for the bus purchase and inspection.

Table A-4 - Cost Estimate of FCB Specification/Procurement

	International Consultants	National Consultants
Prepare Bus Bid Package	80	320
Review Bus Bids & Issue Purchase Order	120	320
Review Engineering Drawings from Bus Supplier	160	320
Shop Inspection of Bus Manufacturing	80	80
Total Man-hours	440	1,040
Unit Labor Cost, US$/MH	150	10
Labor Cost, US$	66,000	10,400
Travel, US$	15,000	15,000
Total Cost, US$	81,000	25,400

Import Duty for the FCBs

The duty is 80% of the cost of engine/chassis imported for the FCB cost. The engine/chassis cost is assumed to be 80% of the total bus cost. India Government will waive this duty as cost contribution to the project.

H2 Facility Cost

This is based on a cost quote from Stuart Energy, the major supplier of packaged electrolyzer unit and hydrogen fueling facility. It includes the electrolyzer, rectifier, water treatment, cooling system, hydrogen compression, hydrogen storage, dispenser, and the control system for the whole facility. From the design basis of this facility shown Table A-5, most of the major components are oversized with very large design margin to accommodate uncertainties expected in a demonstration project. For example, the electrolyzer is sized based on 25 kg/d/bus hydrogen consumption while the predicted consumption is only 16.7 kg/d/bus based on the purchase of full size buses (12 m length with 275 hp engine).

Even though the 8 buses are to be purchased in two batches, the H2 facility will not be built in stages. The hydrogen production capacity (200 kg/d) provided will be sufficient to satisfy the entire fleet of 8 buses from the very beginning.

Table A-5 - Design Basis of Hydrogen Facility

H2 Production/Compression Design Capacity	Refueling Design	H2 Facility Construction and Operation
• 169 km/d bus driving • 0.1 kg/km H2 consumption, assuming full size bus with 275 hp engine • 16.7 kg/d/bus H2 but use 25 kg/d/bus (conservative) • 200 kg/d H2 facility design capacity for 8 buses • 100% spare for H2 compression	• 4h/d bus refueling; 2 dispensing stations • 44 h H2 storage (6 cylinders) provided	• H2 facility to be built in one stage • 24 h/d operation

Spare Parts for the H2 Facility

Stuart Energy estimated this cost to be 2.5% of the facility cost.

H2 Facility Sea/Land Shipping

The hydrogen facility is to be packaged into three standard-size shipping containers. The shipping cost is a quote from a shipping company based on the number of shipping containers and their weights.

Import Duty for the H2 Facility

The imported duty is 80% of the hydrogen facility and their spare parts.

Bus Depot Adaptation for FCBs

This is estimated based on a preliminary engineering of the garage modification required for operating and maintaining the FCBs and hydrogen facility. The modification required includes changing all electric system in the FCB and hydrogen facility area to be hydrogen explosion proof and adding hydrogen sensors in the necessary locations.

Site Preparation and Utility Hookup for the H2 Facility

Based on a site visit of the host bus depot for the demonstration project and preliminary contact with local electricity authority, a preliminary engineering was conducted to determine the site preparation and utility hookup requirements for the hydrogen facility. The cost shown consists of the following:

Site Preparation	$ 3,000
Water Supply and Drainage	$ 3,000
Electric Work	
HV Cables (two 700 m long cables)	$70,000
Ring Main Unit	$15,000
Transformer (750 KVA rating)	$20,000
LT Panel	$30,000
LT Cables	$ 7,000
Structure	$ 7,000
Total	$155,000
Contingency (30%)	$46,500
Total with Contingency	$201,500

The cost above includes only the construction material and labor. The engineering and procurement labor is excluded. The 30% contingency added is to take into account that only a preliminary engineering of the site work and utility hookup has been conducted for the cost estimate.

H2 Facility Installation

This cost consists of the following:

Constructing a Roof/Shelter for the H2 Facility	$20,000
Installing H2 Facility, Including Foundation	$50,000
Total	$70,000
Contingency (30%)	$21,000
Total with Contingency	$91,000

The cost above includes only the construction material and labor. The engineering and procurement labor is excluded. The 30% contingency added is to take into account that only a preliminary engineering of the installation has been conducted for the cost estimate.

Engineering/Permitting/Procurement/Startup

This is estimated based on the activities and labor requirements shown in Table A-6. It is assumed that national consultants will take the lead for this effort, assisted by international consultants for the procurement of the hydrogen facility and the permitting, detailed engineering, and procurement of the support facility. The engineering of the support facility includes:

- Design for the civil work required for the site improvement
- Design of the foundation for the hydrogen facility
- Design of the utility supply and connection (i.e. the water supply/drainage and electric work).

Table A-6 - Cost Estimate of H2 Facility Engineering/ Permitting/Procurement/Startup (Part I)

	International Consultants	National Consultants
Prepare H2 Facility Procurement Package	80	320
Review H2 Facility Bids & Issue Purchase Order	80	320
Review Engineering Drawings from H2 Facility Supplier	80	320
Shop Inspection of H2 Facility Manufacturing	40	160
Coordinate Sea/Land Transport of H2 Facility	20	80
Permitting Documents Preparation	40	160
Coordination/Interface with Permitting Agencies	40	240
Site Preparation Engineering	40	400
Engineering of Supporting Facility	80	1,600
Procurement of Supporting Facility	80	400
Startup of Hydrogen Facility	80	400
Total Man-hours	660	4,400
Unit Labor Cost, US$/MH	150	10
Labor Cost, US$	99,000	44,000
Travel, US$	10,000	5,000
Total Cost, US$	109,000	49,000

Bus Operator Training

According to British Columbia Transit's experience in the Vancouver FCB demonstration project, each bus operator required only two hours training before they could operate the FCBs and knew how to respond to the road emergency situation. The bus operator training cost estimated for this demonstration project includes:

- Salary to cover the two hours training time for each of the 216 bus operators (72 buses at 3 shifts/d) in the host depot; the current bus operator salary in DTC, including benefits, is $750/month.
- $10,000 to cover the training materials, class room cost, and other miscellaneous expenses

The H2 facility is designed for unattended operation. Thus, no operator training is necessary.

Bus Maintenance Crew Training

The FCB maintenance crew is assumed to consist of two engineers, two foremen, and six technicians. They will be sent to the bus company (assuming the buses will be assembled locally with imported engines/chassis) to observe and participate in the bus integration, manufacturing, and assembly so that they can gain an in-depth understanding of the bus structure and engine function. After the buses are delivered to the garage and start to operate, the technical specialists from the bus manufacture and the engine/chassis suppliers will further train the maintenance crew on the job for half year.

The cost shown is to cover the salary of the maintenance crew for their participation in the bus manufacturing and assembly period (15 months). It excludes the on-the-job training cost, of which the crew labor is covered as part of the bus maintenance labor and the trainer labor is covered as part of the technical support from the bus supplier. The monthly salary, including benefits, assumed for the maintenance crew is as following:

Engineers:	$1,000/month
Foremen:	$750/month
Technicians:	$750/month

The cost shown also includes $50,000 to cover the training materials, classroom cost, and other miscellaneous expenses.

Technical Support from H2 Facility Supplier

The cost given is an estimate from Stuart Energy. It includes:

- Assistance for installation of the hydrogen facility
- Assistance for startup/commissioning of the hydrogen facility
- Training of the operation/maintenance personnel
- 3 months transition support for DTC to confidently take over the H2 facility operation/maintenance
- Visit by Stuart's staff every three months to review the facility performance

Diesel Fuel

This cost is based on the same number of diesel buses and operation duration as those of the FCB demonstration project. The current bus fuel economy (air conditioned buses) and diesel fuel purchase price at GCBC are used:

Fuel economy:	3.76 km/liter
Driving distance:	169 km/d
Diesel price:	Rs.15/liter or $0.34/liter

The cost has taken into account the inflation, which is assumed to be 5% annually.

Electricity

The bases used to calculate this cost item are as following:

- The H2 facility power consumption is 550 kW at 200 kg/d hydrogen production capacity (8 buses at 25 kg H2/d/bus). As indicated previously, the 25 kg/d/bus hydrogen consumption is a very conservative estimate. Actual consumption could be less than that and the power consumption could thus be lower accordingly. However, this potential consumption reduction is ignored to provide adequate contingency for this cost item.
- The total kWh power consumption during the bus operation and demonstration period

takes into account the bus availability (and thus their hydrogen consumption), which is assumed to be 60% for the first 3 buses and 70% for the next 5 buses.

- DTC's current electricity cost of $0.0819/kWh is used as the power purchase price.

The cost has taken into account the inflation, which is assumed to be 5% annually.

Water

The bases used to calculate this cost item are as following:

- The H2 facility water consumption is 185 liters/h at 200 kg/d hydrogen production capacity. As indicated previously, actual consumption could be less than that and the water consumption thus could be lower accordingly. However, this potential consumption reduction is ignored to provide adequate contingency for this cost item.
- The total water consumption during the bus operation and demonstration period takes into account the bus availability (and thus their hydrogen consumption), which is assumed to be 60% for the first 3 buses and 70% for the next 5 buses.
- DTC's current water cost of $0.5721/m3 is used as the water purchase price.

The cost has taken into account the inflation, which is assumed to be 5% annually.

Bus Depot Depreciation

The depot space, which needs to be allocated for the demonstration project, is estimated as following:

Bus Parking Area (for 8 buses)	288 m2
H2 Facility Area (plot plan provided by Stuart Energy)	192 m2
Total	480 m2

At $343/m2, the total land value of the space required is $164,640. At 5% annual depreciation for 5 years, the cost contribution from DTC for providing this space is $41,171.

For the baseline case (diesel buses), the land requirement is the same as above except there is no space required for the hydrogen facility. The depreciation is calculated accordingly based on this reduced land requirement.

Bus O&M Materials and Contract Maintenance

For the diesel buses, this cost item is derived from the accumulated distance driven by the buses during the demonstration project and DTC's current cost on per km driven basis for utility and lubricants, tires and tubes, spares and materials, and contracted maintenance. For the FCBs, this cost item is the same as that for the diesel buses except it excludes the utility and lubricants and contracted maintenance.

The costs has taken into account the inflation, which is assumed to be 5% annually.

H2 Facility Operating and Maintenance Materials

The cost shown is an estimate from Stuart Energy.

Bus Operation Labor (Drivers, Conductors, and Inspectors)

For both the diesel and FCBs, this cost item is derived from the accumulated distance driven by the buses during the demonstration project and DTC's current cost on per km driven basis for bus operators.

Bus/H2 Facility Maintenance Labor

For the FCB case, this cost is based on the staffing for the bus maintenance mentioned previously plus one additional engineer for the H2 facility maintenance. The monthly salary for this additional engineer is $1,000.

For the diesel buses, this cost item is derived from the accumulated distance driven by the buses during the demonstration project and DTC's current cost on per km driven basis for maintenance labor. The cost shown is lower than that of the FCB case because:

- The maintenance personnel for the FCBs and H2 facility need to be exceptionally good to embrace the new technologies. They will not be drawn from DTC's current staff but will be hired from outside with substantially higher salary.
- The diesel bus case does not have H2 facility to maintain.

The costs have taken into account the inflation, which is assumed to be 5% annually.

Project Management/Scheduling/Coordination

This cost consists of:

- Salary for the project manager ($2,000/month) and his/her assistant ($1,500/month) for the entire 5 years project duration (including 5% annual inflation) plus office space, utility, supplies, and telecommunication expenses.
- A full time administrative assistant for 5 years at $750/month salary (including 5% annual inflation).
- The expenses for the international consultants and the national consultants to assist the project management and coordination. Details of these expenses are shown in Table A-7.

For funding allocation for the cost above, it is assumed that GEF will cover the expenses of the international consultants and the India Government will provide rest of the cost.

Table A-7 - Cost Estimate of Project Management and Testing (Part I and II)

	International Consultants	National Consultants
Project Schedule Preparation and Control	40	160
Preparation of Test Program	80	400
Coordinate Tech Support from Bus Supplier	160	640
Coordinate Tech Support from H2 Facility Supplier	80	320
Test Data Collection and Analysis	320	2,400
Total Man-hours	680	3,920
Unit Labor Cost, US$/MH	150	10
Labor Cost, US$	102,000	39,200
Direct Cost		
Travel	10,000	5,000
Office Space		120,000
Utility Consumption		50,000
Office Supplies		80,000
Telecommunication		40,000
Subtotal	10,000	295,000
Total Cost, US$	112,000	334,200

Testing and Reporting

This cost covers the test engineer's labor cost ($1,000/month) for 3.5 years (including 5% annual inflation) plus $5,000 allowance for computer and other miscellaneous equipment/supplies required for data acquisition, analysis, and reporting. It is assumed that the Indian Government will fund the entire activity.

Sustainability Program

A detailed breakdown of the efforts involved and costs required is shown in Table A-8. It is assumed that the Indian Government will hire several national consultants to take the lead for these efforts. They will be supported by international consultants.

Project Monitoring and Evaluation

A detailed breakdown of the costs required is shown in Table A-9.

Contingency

Of all the cost items described above, it is assumed that GEF will fund the items related to offshore equipment/materials and international consultant services while the Indian Government will fund all domestic expenses. As indicated previously, the budget allocated for the offshore supply of the FCBs and H2 facility already has built-in contingency due to either the design margin provided or the conservative cost estimate made. Thus, there is no additional contingency included in the funding requirement from GEF. However, there are still many unforeseeable uncertainties in the project expenses. It is assumed that $1 million will be required as the project contingency and the Indian Government is responsible for providing this contingency fund.

Table A-8 - Cost Estimate of Sustainability Program

	International Consultants	National Consultants
Develop Master Plan/Intervention Measures		
Prepare Master Plan for Post GEF Activities	80	480
Pursue Intervention Measures	80	480
Build Codes/Standards and Local Capability		
Build codes/standards for hydrogen use	160	1,000
Funding for H2/Fuel Cell Research	80	4,800
Establish local suppliers for fuel cell bus parts	80	6,000
Information Dissemination		
Public awareness workshop (once/y for 3 years)	40	2,400
News conference or release	40	480
Host national conferences (once/y for 3 years)	40	2,400
Total Man-hours	600	18,040
Unit Labor Cost, US$/MH	150	10
Labor Cost, US$	90,000	180,400
Other Costs, US$		
Travel	10,000	2,000
Research grants (2 grants/year @ $25,000/grant)		250,000
Conf./workshop expenses ($15,000/event, 6 events)		90,000
Administrative support		6,631
Total Cost, US$	100,000	529,031

Table A-9 - Cost Estimate of Project Monitoring and Evaluation

UNDP/GEF Country Officer for the Program	100,000
Monitoring/Field Travel of Program Office Staff	10,000
Tripartite Reviews	20,000
Mid-Term Evaluation	25,000
Communications and Office Supplies	5,000
Total Cost, US$	160,000

ANNEX B
THE LOGICAL FRAMEWORK MATRIX

	(1) Programme or project summary	(2) Indicators	(3) Means of verification	(4) External Factors (assumptions and risks)
Development objectives	To reduce GHG emission by introducing a new energy source & propulsion technology for urban transport in India	CO_2 emission in India is reduced		
Immediate objectives	a. Reduce global GHG emission b. Mitigate air pollution in India c. Implant fuel cell vehicle technology in India d. Lead India to be regional or world-wide fuel cell bus manufacture to contribute to the nation's economy e. Increase volume demand of fuel cell buses to accelerate commercialization	a. CO_2 emission from public buses in Delhi is reduced by 57 tonnes over the project life b. Air is cleaner in India c. Public accepts; local operation/maintenance capability exists d. Local bus manufactures have production expertise and capability e. Fuel cell bus price drops		
Output 1 Activities	Zero emission, high efficiency, high reliability, operability, and safety of fuel cell buses and H_2 facility are verified 1.1 Engineering & site design of host bus depot (Task 2.1) 1.2 Permitting for building H_2 facility (Task 2.2) 1.3 Major equipment purchase of H_2 facility (Task 2.3) 1.4 Utility hookup and site construction of H_2 facility (Task 2.4) 1.5 Startup of H_2 facility (Task 2.5) 1.6 Prepare test plan (Task 4.1) 1.7 Data acquisition & analysis (Task 4.2) 1.8 Test result reporting & project management (Task 4.3)	Actual record of fuel economy, emissions, safety, load response, and maintenance from the project	Review of the data record	Assumptions: a. Fuel cell buses have high reliability and can provide revenue service on commercial basis b. Delhi bus company can properly operate and maintain fuel cell buses Risks: a. Fuel cell buses are not as reliable as projected b. The buses are not properly operated and maintained Both will cast a bad imagine for this technology and hinder its acceptance and future commercial implementation in India
Output 2 Activities	Local operation/maintenance capability of fuel cell buses is built up 2.1 Operating and maintenance of 1st 3 buses (Task 3.1) 2.2 Operating and maintenance of 2nd 5 buses (Task 3.2) 2.1 Operating and maintenance of the H_2 facility (Task 3.3)	Delhi bus company can operate and maintain fuel cell buses independently; parts can be supplied locally Target operation hours and km driven are accomplished		
Output 3 Activities	Local bus manufactures can supply fuel cell buses 3.1 Prepare bus specification (Task 1.1) 3.2 Tender/award contract for fuel cell buses (Task 1.2) 3.3 Fabrication and delivery of 1st 3 buses by local supplier (Task 1.3) 3.4 Fabrication and delivery of 2nd 5 buses by local supplier (Task 1.4)	Local manufacture integrates assembles fuel cell buses for the project		Assumptions: Local bus manufacture has the capability to integrate and assemble high quality fuel cell buses based on imported chassis or engines Risks: Local bus manufacture fails to supply the buses on schedule and with high quality; this will cause project delay or even cost overrun;

THE LOGICAL FRAMEWORK MATRIX
(continued)

	(1) Programme or project summary	(2) Indicators	(3) Means of verification	(4) External Factors (assumptions and risks)
Output 4 Activities	Public accept the use of fuel cell buses 4.1 Hold information dissemination workshop/conferences	Public are willing to ride fuel cell buses in Delhi; positive results are obtained from the rider ship survey	Survey of Public's opinion and experience of riding fuel cell buses	
Output 5 Activities	Fuel cell bus technology can be sustained in India 5.1 Develop master plan & incentive program 5.2 Codes/standards/local capability buildup	Intervention measures by government are taken; codes/standards for hydrogen established; research institutes pursue fuel cell technology Global evolution of fuel cell bus price		

Annex C - STAP ROSTER TECHNICAL REVIEW

Independent Technical Review
Fuel Cell Bus Development in India
Project Brief of UNDP to GEF

Dr. Pat DeLaquil

Attached is my independent technical review of the Project Brief for "Fuel Cell Bus Development in India."

I appreciate the opportunity to review this project brief, and I believe the project has the potential to become a successful element of the GEF strategy for development of fuel cell buses.

INTRODUCTION

Fuel cell buses (FCBs) fired by hydrogen offer reduced GHG emissions compared to conventional diesel buses, especially for the urban transport sector, if the total system is carefully designed. Although fuel cells are technically proven, they are not yet commercial products for this application. Their performance, reliability and suitability as drives for urban buses needs further demonstration and development. The GEF strategy to promote fuel cell bus commercialization is in support of Operational Program 11, and it involves the development of partnerships between GEF, private industry, and local/national governments in developing countries with large bus markets. The review of this project brief was performed relative to this GEF strategy.

KEY ISSUES

India is one of the largest producers and users of buses for urban transport, and total vehicular emissions account for over 60% of air pollution in major Indian cities. Clean FCBs would be an attractive alternative to the current stock of diesel-fuelled buses if the goals for cost and reliability can be reached. The benefits in the form of reduced local air pollution and reduced greenhouse gas emissions could be significant (CO_2 reductions of over 40,000 tons per year for New Delhi alone.)

The project brief presents a technically sound approach to demonstrating the current pre-commercial FCBs in a developing country setting. The number of buses selected, and the estimates of reliability are reasonable and are designed to accumulate a statistically significant number of vehicle-kilometers. The purchase of FCBs in two parts, that are one year apart, will allow for incremental improvements in fuel cell technology to be incorporated. Also, the project has designed of the FCB procurement so that the first set of three buses will be imported fully assembled to minimize technical risk. The second set of five buses will require the fuel cell drive train suppliers to work with Indian bus manufacturers to integrate the FCBs locally. This approach will necessitate the development of business arrangements that should be beneficial towards promoting the commercialization of FCB technology in India.

This project is one of several under development, and it will contribute to the body of knowledge being accumulated on FCB technology and application. Lessons learned can be shared through workshops. A private sector advisory group can provide guidance to support progress towards commercialization, and a website will facilitate regular communication between the FCB projects. In this way, the project will have a better chance of replication than if it were a single stand-alone project.

FIT TO GEF STRATEGY

The proposed project is consistent with the designated roles for GEF involvement. The funds requested are less than the incremental cost of the project. Key government and private sector institutions will collaborate in the implementation of the project, and the project plans to share knowledge and experience with the other GEF FCB projects.

The GEF Strategy to Develop FCBs identified six predetermined criteria which each projects would need to meet. The evaluation of this project against these criteria is discussed below.

1. Climate change impact for this project is positive, although small, because it uses hydrogen from a small electrolysis plant driven by electricity from a modern gas-fired combined cycle plant near the project. This is a cost-effective approach for this small project. Future climate change benefits would be significantly greater based on the use of hydrogen produced through steam reforming of natural gas.
2. The project is designed to lead to replication through creation of a master plan and schedule for the follow-on activities, development of an incentive programs to encourage the development of local FCB manufactures and hydrogen facility suppliers, development of codes and standards, and support for local research organizations. The last point is an important aspect of capacity building in this field, and it should be further elaborated to ensure proper attention during project execution.
3. According to the proposal, urban transport in Delhi is in entering a period of significant change. Strict environmental rules are being implemented to reduce emissions, old vehicles are being manditorily retired, and the Supreme Court has directed that the entire Delhi bus fleet be converted to compressed natural gas fuel. This is far from an integrated effort to rationalize urban transport, but it does create favorable conditions for the demonstration and further introduction of FCBs.
4. Funding support from non-GEF partners is heavily weighted to the Government of India. Institutional support from the Delhi Transport Corporation is significant and important, and there is advisory participation by potential local supply companies. However, there is no involvement of transit authorities from other major Indian cities. Such involvement would promote increased awareness of the potential of FCBs and could stimulate broader support for the next project phase.
5. The project brief contains an implementation plan that is straightforward and contains the necessary metrics for evaluating the success of the project.
6. This particular project brief does not address geographical diversity of the bus market in India. However, urban bus duties in New Delhi are very similar to those in other major Indian cities (Mumbai, Chennai and Calcutta.) Furthermore, the GEF program has projects planned for several other countries (Brazil, Mexico, Egypt and China) that provide the necessary geographical diversity.

ADEQUACY OF THE PROJECT BRIEF

The project brief is generally well written, but several areas need clarification:

1. Paragraph 18 need to better state how the proposed project meets the specific criteria for FCB projects as defined by the GEF Strategy.
2. Paragraph 40 final bullet should clarify what kinds of R&D activities will be promoted and if the funds allocated in the budget will leverage other R&D funds.
3. Paragraph 50 (Task 1.4) needs further development to recognize that more attention will be required to address the design integration and manufacturing integration issues that will arise when an imported drive train is integrated to a local bus chassis.
4. Paragraph 58 should include a metric to measure repair times.
5. Paragraphs 61 and 62 should elaborate the activities discussed under Output 5 rather than refer back to that section.
6. Paragraph 69 should summarize how this project will help sustain FCB technology in India. E.g. through the technical knowledge and skills gained, the institutional capacity building, the policy development, the public awareness gained, and the business arrangements created that will help lead to commercialization.
7. Paragraph 70 should define the charter and composition of the Steering Committee.
8. Annex B. The Logical Framework Matrix does not include "Means of Verification" for activities related to Outputs 2 and 3. Output 2 should include interviews with operators and maintenance staff. Output 3 could include the degree of integration accomplished, the types of business arrangements made, and the degree of tech transfer accomplished.

Annex C-1 Response to STAP Review

The STAP reviewer indicates that the project has the potential to become a successful element of the GEF strategy for development of fuel cell buses, and that the brief presents a technically sound approach to demonstrating the current pre-commercial FCBs in a developing country setting. While the reviewer notes that the project brief is generally well written, several areas require clarification. These clarifications are described below and have been included in the project brief.

1. Paragraph 18 need to better state how the proposed project meets the specific criteria for FCB projects as defined by the GEF Strategy.

In order to qualify as a demonstration project, this project had to meet all of the quality criteria developed as part of the GEF strategy development process. This project meets the criteria as follows:

- climate change impact - the proposal shows a system-wide reduction in GHG emissions.
- replication potential - India has more than 600,000 buses currently in operation, most of which run on diesel.
- plans for rationalization of the urban transport system - this project brief describes the large number of both technological and non-technological activities being pursued by India to improve its transport system and reduce transport-related pollution.
- cost-sharing - significant, with over half of the resources for the total project being drawn from other sources.
- indicators - well-developed (see Annex B).
- geographic sub-region – India is a major geographic sub-region in the world bus market, and it is not covered by any of the other projects in the overall GEF-sponsored FCB program.

The results of the project will be carefully monitored prior to pursuing any future commercialization phase proposal.

2. Paragraph 40 final bullet should clarify what kinds of R&D activities will be promoted and if the funds allocated in the budget will leverage other R&D funds.

Intensify research in India to engage more in fuel-cell vehicle development as to generate a talent pool to support commercial deployment; the project will award several research grants annually to the leading local research and development institutions for selected topics judged useful for capacity building purposes. The specific types of research that will be conducted will be identified during the preparation of the Project Document.

3. Paragraph 50 (Task 1.4) needs further development to recognize that more attention will be required to address the design integration and manufacturing integration issues that will arise when an imported drive train is integrated to a local bus chassis.

The issue of design and manufacturing integration will be addressed in greater detail during the development of the Project Document.

4. Paragraph 58 should include a metric to measure repair times.

For the reliability/availability of the FCBs and hydrogen facility, downtime has been added as one of the parameters that will be verified as a minimum.

5. Paragraphs 61 and 62 should elaborate the activities discussed under Output 5 rather than refer back to that section.

More detail has been added to paragraphs 61 and 62 (now 61 through 63).

6. Paragraph 69 [now para. 70] should summarize how this project will help sustain FCB technology in India. E.g. through the technical knowledge and skills gained, the institutional capacity building, the policy development, the public awareness gained, and the business arrangements created that will help lead to commercialization.

This demonstration project will build capacity within the FCB and related industries by enhancing technical knowledge and skills, and by strengthening institutional capacity. Research in will be increased to more fully engage in fuel-cell vehicle development and to generate a talent pool to support commercial deployment and to sustain FCB technology in India. The project will award several research grants annually to leading local research and development institutions for capacity building purposes. Public awareness activities are developed to increase acceptance of this technology.

7. Paragraph 70 [now para. 71] should define the charter and composition of the Steering Committee.

Both the charter and composition of the Steering Committee will be determined during the finalization of the Project Document.

8. Annex B. The Logical Framework Matrix does not include “Means of Verification” for activities related to Outputs 2 and 3. Output 2 should include interviews with operators and maintenance staff. Output 3 could include the degree of integration accomplished, the types of business arrangements made, and the degree of tech transfer accomplished.

Means of verification of Outputs 2 and 3 include interviews with operators and staff, degree of integration, and degree of technology transfer.

Annex E
Letters of Endorsement

Rita Acharya
Deputy Secretary(FB)
Tel. NO.3012423

भारत सरकार
वित्त मंत्रालय
आर्थिक कार्य विभाग
Government of India (Bharat Sarkar)
Ministry of Finance (Vitta Mantralaya)
Department of Economic Affairs (Arthik Karya Vibhag)

सत्यमेव जयते

D.O.No.17/14/94-FB VIII

2nd March, 2001

Dear **Dr. Ramana,**

नई दिल्ली/New Delhi

Please refer to letter dated 1.3.2001 from the Ministry of Non-Conventional Energy Sources regarding the UNDP/GEF Project on "Fuel Cell Bus Development in India".

Department of Economic Affairs supports the proposal for inclusion of the project in the ensuing GEF Council Work Programme.

With regards,

Yours sincerely,

RAcharya

(Rita Acharaya)

Dr. Venkata Ramana
Asstt. Resident Representative
UNDP
55, Lodi Estate
New Delhi.

N.P.Singh
Adviser

Fax : ~~011-4361298~~
Telegram : RENEWABLE
Telefax: 4362288

भारत सरकार
अपारम्परिक ऊर्जा स्रोत मंत्रालय
Government of India
MINISTRY OF NON-CONVENTIONAL ENERGY SOURCES
ब्लाक नं 14, केन्द्रीय कार्यालय परिसर, लोदी रोड, नई दिल्ली-110 003
BLOCK NO.14, C.G.O. COMPLEX, LODI ROAD, NEW DELHI - 110 003

सत्यमेव जयते

D. O. No. 102/7/98-NT (Vol.II) Dated 01.03.2001

Dear Shri Kher,

This has reference to my previous D.O. letter of even number dated 18th August, 2000 requesting you to forward the "Project Brief" on UNDP/GEF Project on " Fuel Cell Bus Development in India" to Department of Economic Affairs (DEA), Ministry of Finance and UNDP, New Delhi. The Project Brief has been revised in two Parts, Part-I for one year and Part-II for 4 years, keeping all other components unchanged. Two copies of Final Project Briefs enclosed.

2. As you are aware, the next meeting of Governing Council of Global Environment Facility is likely to be held in the month of May, 2001 and UNDP/GEF, New York has desired that the Project Brief with endorsement from DEA may be sent immediately for its consideration in May meeting. I once again request you to kindly endorse the above-said proposal and send it to Department of Economic Affairs, Ministry of Finance for their final endorsement to UNDP/GEF Ministry of Non-Conventional Energy Sources fully endorse the enclosed proposal. I shall be grateful, if the necessary action in this regard may be taken at the earliest.

With kind regards,

Yours sincerely,

NPSingh

(N.P.Singh)

Shri Rajeev Kher
Joint Secretary
Ministry of Environment & Forest,
Paryavaran Bhawan,
CGO Complex, Lodhi Road,
New Delhi-110003

Copy to :

1. **Mrs. Rita Acharya, Deputy Secretary (FB),** Ministry of Economic Affairs, Ministry of Finance, North Block, New Delhi Fax : 3012477

2. **Dr. P Venkataraman, Asstt.Resident Representative Environment &** GEF, UNDP, 55, Lodhi Estate, New Delhi

Mr. Usha Rao
UNDP

Annex E
Project Categorization

a. Focal Area Categories

Biodiversity		**Climate Change**		**International Waters**	**Ozone Depletion**
Conservation		Energy conservation (prod./distribution)		Transboundary Analysis	Monitoring:
in situ	ex situ	ESCO's	Efficient Designs	Strat. Action Plan Development	ODS phase out (Production)
Sustainable Use		Solar:		Freshwater Basin	ODS Phase Out (Consumption)
Benefit-sharing		Biomass:		Marine Ecosystem	Other:
Agrobiodiversity		Wind:		Wetland Habitat	
Trust fund		Hydro:		Ship-based	
Ecotourism		Geothermal:		Toxic Contaminants	
Inventory		Fuel cells: **X**		GPA Demonstration	
Policy & Legislation		Methane recovery:		Fisheries Protection	
Buffer Zone Dev.		Other:		Global Support:	

b. Categories of General Interest

Investment	Cap.Building/TA **X**	Targeted Research	Land Degrad.
Technology Transf. **X**	Small Islands	Info/Awareness **X**	Private Sector **X**

c. Community &NGO Participation

Involvement type	project design (tech. advise)	implementation (execution)	info/awareness activities	nat./reg./local consultation
Names of Communities and NGOs Involved				

Cover Note

Project Name: Fuel Cell Bus Development in India
Date: 23 March 2001

	Work Program Inclusion	Reference/Note
1. Country Ownership		
• Country Eligibility		• Cover Sheet page 1 (Ratified UNFCCC 1 November 1993)
• Country Drivenness	Clear description of project's fit within: • National reports/communications to Conventions • National or sector development plans	• Pg. 5 *(para.15)* address national priorities • Pg. 2-3 *(para. 8-12)* addresses national plans and specific in-country institutional support.
• Endorsement	• Endorsement by national operational focal point.	• OFP endorsement letter for this project is on file (attached as Annex E)
2. Program & Policy Conformity		
• Program Designation & Conformity	• Describe how project objectives are consistent with Operational Program objectives or operational criteria.	• Pg. 5 *(para. 17)*
• Project Design	Describe: • sector issues, root causes, threats, barriers, etc., affecting global environment. • Project logical framework, including a consistent strategy, goals, objectives, outputs, inputs/activities, measurable performance indicators, risks and assumptions. • Detailed description of goals, objectives, outputs, and related assumptions, risks and performance indicators. • Brief description of proposed project activities, including an explanation how the activities would result in project outputs (in no more than 2 pages). • Global environmental benefits of the project. • Incremental Cost Estimation based on the project logical framework. • Describe project outputs (and related activities and costs) that result in *global* environmental benefits • Describe project outputs (and related activities and costs) that result in joint *global and national* environmental benefits. • Describe project outputs (and related activities and costs) that result in *national* environmental benefits. • Describe the process used to jointly estimate incremental cost with in-country project	• Sector issues are on pg. 1 (*para. 1-4*) and pg. 2 (*para. 8-12*); barriers on pg. 1-2 *(para. 5-7)* • Annex B • Rationale and objectives in Section II (*para. 20-25)*; outputs on pg 8-11 (*para 27-40*); risks in Section IV on pg. 16-17 *(para. 65-71)*; indicators in Annex B. • Activities on pg. 11 to 15 *(para.41 – 64).* • Global benefits on pg.5 *(para.16);* and Table 2 (pg. 21) • Section VI (pg. 20-22); and Annex A detail incremental costs • Pg 5 (*para. 16*) • Annex A describes global and national environmental benefits • Annex A describes global and national environmental benefits • Section VI (pg. 20); and Annex A details incremental costs sharing among

	Work Program Inclusion	Reference/Note
	partner. • Present the incremental cost estimate. If presented as a range, then a brief explanation of challenges and constraints and how these would be addressed by the time of CEO endorsement.	partners. • Chapter V presents cost estimates as well as tables in Annex A.
• Sustainability (including financial sustainability)	• Describe proposed approach to address factors influencing sustainability, within and/or outside the project to deal with these factors.	• Risks and sustainability addressed in Section IV (pg. 16-17) *(para. 65-71)*
• Replicability	• Describe the proposed approach to replication (for e.g., dissemination of lessons, training workshops, information exchange, national and regional forum, etc) (could be within project description).	• Pg. 4 (*para. 13-16*); pg. 10 (*para. 39)*; pg. 13 (*para. 53-55*); pg. 16 (*para. 69).*
• Stakeholder Involvement	• Describe how stakeholders have been involved in project development. • Describe the approach for stakeholder involvement in further project development and implementation.	• Stakeholder involvement in project development is addressed on pg 17 (*para 72*). • Ongoing stakeholder involvement is on pg. 18 (*para. 73*); Implementation arrangements on pg. 18-19 (*para. 74-79).*

• Monitoring & Evaluation	• Describe how the project design has incorporated lessons from similar projects in the past.
	• Describe approach for project M&E system, based on the project logical framework, including the following elements:
	  • Specification of indicators for objectives and outputs, including intermediate benchmarks, and means of measurement.
	  • Outline organizational arrangement for implementing M&E.
	  • Indicative total cost of M&E (maybe reflected in total project cost).
		• Lessons learned from similar projects on pg. 1 (*para. 5)*; pages 6 (*para. 19).*
		• Indicators are addressed in Annex B.
		• Monitoring and evaluation is described on pg. 23-24 *(para.86-92).*
		• Cost of M&E in tables on pg. 29-31.

3. Financing		
• Financing Plan	• Estimate total project cost. • Estimate contribution by financing partners. • Propose type of financing instrument.	• Financing plan including total project cost and co-financing is in pg. 21 table 3 to 4; Tables A1-3 outline contributions of financing partners.
• Implementing Agency Fees	• Propose IA fee.	• The CO fee under a cost recovery structure
• Cost-effectiveness	• Estimate cost effectiveness, if feasible. • Describe alternate project approaches considered and discarded.	• Section VI, pg. 20-22. • Description in Annex A.

	Work Program Inclusion	Reference/Note
4. Institutional Coordination & Support		
IA Coordination and Support • Core commitments & Linkages	Describe how the proposed project is located within the IA's: • Country/regional/global/sector programs. • GEF activities with potential influence on the proposed project (design and implementation).	• This project is part of the global framework to develop fuel-cell buses for the developing world as described in Section II (*para. 17-19).*
• Consultation, Coordination and Collaboration between IAs, and IAs and EAs, if appropriate.	• Describe how the proposed project relates to activities of other IAs (and 4 RDBs) in the country/region. • Describe planned/agreed coordination, collaboration between IAs in project implementation.	
5. Response to Reviews		
Council	Respond to Council Comments at pipeline entry.	GEF held discussions led jointly by the GEF Secretariat and UNDP on a "GEF Strategy to Develop Fuel-cell Buses (FCB) for the Developing World" in Nov. 2000
Convention Secretariat	Respond to comments from Convention Secretariats.	Not provided
GEF Secretariat	Respond to comments from GEFSEC on draft project brief.	Addressed in project brief
Other IAs and 4 RDBs	Respond to comments from other IAs, 4RDBss on project brief.	Addressed in project brief
STAP	Respond to comments by STAP at work program inclusion	
Review by expert from STAP Roster	Respond to review by expert from STAP roster.	Annex C1