PROJECT BRIEF

1. IDENTIFIERS:

PROJECT NUMBER	
PROJECT NAME	**China: Demonstration for Fuel-Cell Bus Commercialization, Phase II-Part I**
DURATION	5 years, divided into two implementation segments of 1 year (Part I) and 4 years (Part II) duration
IMPLEMENTING AGENCY	United Nations Development Program
EXECUTING AGENCY	Ministry of Science & Technology (MOST)
REQUESTING COUNTRY	China
ELIGIBILITY	China ratified the UNFCCC on 5 January 1993
GEF FOCAL AREA	Climate Change
GEF OPERATIONAL PROGRAM	Sustainable Transport (Operational Program 11)

2. SUMMARY:

This project will help catalyze the cost-reduction of fuel-cell buses (FCBs) for public transit applications in Chinese cities by supporting significant parallel demonstrations of FCBs and their fueling infrastructures in Beijing and Shanghai. In collaboration with the Chinese national government, the municipal governments of Beijing and Shanghai, and the private sector, the GEF and UNDP will assist the public transit companies of Beijing and Shanghai to obtain 6 FCBs each and to operate these over a combined total of 1.6 million km. The knowledge and experience gained through this project will enable the technology suppliers to identify cost reduction opportunities and the host public transit operators to gain valuable experience needed to adopt larger fleets of FCBs in the future. Additionally, some activities will help build capacity relating to FCBs, including strengthening policy and planning capabilities of the public transit companies; enhancing scientific, technical, and industrial capacity for commercializing FCBs; and increasing the understanding of FCBs among government, investment, media, and other key actors. Finally, a series of activities will also focus on defining a detailed strategy for large-scale FCB implementation in China, which is planned as a follow-on to this initial project.

3. COSTS AND FINANCING (US$ MILLION):

GEF:	**Implementation Part I**	**5.815**
	Implementation Part II	5.767
	GEF Subtotal	11.582
CO-FINANCING	**Implementation Part I**	
	UNDP project funding	0.194
	Ministry of Science & Technology	4.922
	Municipal government of Beijing	1.854
	Municipal government of Shanghai	2.040
	Private sector	1.105
CO-FINANCING	**Implementation Part II**	
	UNDP project funding	0.193
	Ministry of Science & Technology	4.881
	Municipal government of Beijing	2.152
	Municipal government of Shanghai	2.343
	Private sector	1.095

1 BACKGROUND AND CONTEXT

1.1 Fuel-cell bus technology

Fuel cells are identified by GEF in the description of its Operational Programs (OP7 and OP11) as a promising future least-cost technology for GHG emissions reductions. In the case of transport vehicles, fuel-cell vehicles have the prospect for zero tailpipe emissions of both criteria pollutants (CO, NO_x, HCs, etc.) and greenhouse gas emissions, and very low net lifecycle emissions of these pollutants (including those associated with the production and delivery of the fuel for the fuel cell). Also, industry and independent cost projections indicate that fuel-cell vehicles will be cost-competitive by late in the first decade of 2000, once mass production is established.[1]

GEF assistance is needed to ensure that fuel-cell buses (FCBs) are commercialized for developing country markets, where bus markets are large. Buses are an especially attractive commercial application for fuel cells because cost and volume constraints are less severe than with cars, and the supply of hydrogen (the preferred fuel for fuel-cell vehicles) is facilitated by the centralized refueling that characterizes bus fleet operations. However, while buses present an easier commercial target than cars, fuel-cell engine manufacturers are most aggressively pursuing automotive markets, because bus markets in the OECD countries (the perceived initial markets for fuel-cell vehicles) are relatively small. Daimler/Chrysler, Ford, Honda, Nissan, and Mazda have all produced prototype fuel-cell cars and plan to start mass production in the 2005-2007 timeframe.

Most fuel-cell engine companies appear interested in buses only to the extent that they provide a stepping stone to fuel-cell automobiles—the basic fuel-cell engine would be similar in cars and buses. Small fleets of FCBs have been operating in passenger revenue service for nearly two years in demonstration projects in Chicago and Vancouver. An additional demonstration project that will place 25 FCBs on the roads in California has recently been launched.[2] GEF support for FCB demonstration efforts would help significantly catalyze the commercialization of FCBs for developing countries.

1.2 Barriers to commercial introduction of fuel-cell buses in China

By comparison to most developing countries, China has relatively strong research and development (R&D) activities in fuel cell science and technology relevant to FCBs. Additional discussion on this is presented later. While there is a strong R&D base relating to FCBs, there are a number of major barriers to commercializing FCBs in China. This project will address these barriers:

- Because FCBs are not yet commercially established, their costs are too high to be competitive with diesel buses, the conventional alternative in China and most other countries;
- There is no FCB operating experience nor technical and institutional capacity relating to commercial operation, maintenance, or manufacturing of FCBs in China;
- There is a lack of awareness and acceptance of FCB technology among key actors, including policy makers and potential investors, and among the general public; and,
- The policy and planning capacity in the public transport sector in China is weak, resulting in less-than-optimal management, infrastructure, and operating conditions for maximizing the likelihood of sustainable introduction of FCBs.

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[1] For example, see UNDP/GEF, 2000, *Commercialization of Fuel Cell Buses: Potential Roles for the GEF*, workshop proceedings, UNDP, 27-28 April; R. Hosier and E.D. Larson, 2000, *GEF Participation in Fuel Cell Bus Commercialization*, UNDP/GEF, New York, February; .F.R. Kalhammer, P.R. Prokopius, V.P. Roan, G.E. Voecks, 1998, *Status and Prospects of Fuel Cells as Automobile Engines*, a report of the Fuel Cell Technical Advisory Panel prepared for the California Air Resources Board, Sacramento, California, July; F.D. Lomax, Jr., B.D. James, G.N. Baum, and C.E. Thomas, 1998, *Detailed Manufacturing Cost Estimates for Polymer Electrolyte Membrane (PEM) Fuel Cells for Light Duty Vehicles*, prepared for the Ford Motor Company under prime contract to the US Dept. of Energy (Office of Transportation Technologies) by Direct Technologies, Inc., Arlington, VA, August.

[2] The "California Fuel Cell Partnership" involves a collaboration of Ford, Honda, DaimlerChrysler, Volkswagen, ARCO, Shell, Texaco, Ballard, State of California, and the US DOE. It aims to demonstrate 25 fuel cell buses (and a similar number of automobiles) in California before 2004. See http://www.drivingthefuture.org/.

1.3 Economic reform and urban public transportation in China

The evolution of the urban transport sector has mirrored the development of the economy as a whole in China.[3]

The planned economy period, 1949-1978, was characterized by highly centralized planning, with little power given to the municipal level. Urban transport was characterized by a lack of local initiative and heavy central government intervention at the enterprise level, resulting in inefficient operations and only modest growth in services during this period.

The planned-commodity economy began with the introduction of the open door policy in 1978 and lasted until 1993. Participation of the private and cooperative sectors increased dramatically during this period: state-owned enterprises (SOEs) accounted for 78% of production in 1978 and 34% in 1994.[4] (At its September 1997 meeting, the Party Congress said it planned to ultimately retain full ownership of only 3000 of its 370,000 SOEs.) For urban transport, the policy was "unified planning and unified management". SOEs continued to play a dominant role, but with much less government intervention at the enterprise level. Importantly, municipal governments were granted greater autonomy in policy, planning, and implementation. Government policy in the mid-1980s stipulated that public transport should be the principal mode of urban transport:[5] SOEs were still considered the mainstay service providers, but movement away from "sole ownership" operating enterprises toward operation by "multiple economic elements" (including collective and individual-owned enterprises) was encouraged.

The socialist market economy was launched in 1993 with the directive of the Communist Party's Central Committee "Decision on the Establishment of a Socialist Market Economy System, 1993." This directive further separated government from enterprises and streamlined government administration and SOEs. Governments at all levels began reform efforts. In 1994, the Ministry of Construction issued "Directives on the Franchising of Urban Bus and Trolleybus Services" to strengthen SOEs in the provision of urban bus services while inducing competition, for example by introducing competitive bidding for bus route concessions. Primary responsibility for policy, planning, and implementation of urban public transport services today rests with the municipal or provincial levels of the Ministry of Urban Construction,[5] since public transport is considered a social service, along with water supply, waste management, roads, bridges, residential gas and heat supply, etc.

The rapid rate of economic reform has been accompanied by accelerated urbanization in China, which is adding to the challenges facing the urban public transportation sector. The average annual rate of population growth in urban areas in China during the 1990s (2.9%/yr, 1990-1998) was over 7 times the rate seen in rural areas. Today, slightly over 30% of Chinese live in cities.[6] Walking and bicycling still account for the majority of passenger trips in cities, but as urban populations and the economy grow, the demand for public transport services is growing as well, at an estimated rate of 4% per year. Buses today account for an estimated 75% of urban public- transport passenger volume, with trolleybuses accounting for an additional 10%.

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[3] Wu Yong, Wang Jianqing, and Yao Zukang, 1996, "Theme Paper 3: Municipal Transport Management: A Domestic View," *China's Urban Transport Development Strategy: Proceedings of a Symposium in Beijing*, November 8-10, 1995, The World Bank (Discussion Paper No. 352), Washington, D.C., pp. 153-181.

[4] World Bank, 1999, *Transport in China: An Evaluation of World Bank Assistance*, Report 18865, Operations Evaluation Department, Sector and Thematic Evaluations Group, The World Bank, Washington, DC, Jan. 11.

[5] Wang Jinxia, Zhang Kuifu, and Qiao Junshan, 1996, "Theme Paper 7: The Reform and Development of China's Urban Public Transportation Enterprises," *China's Urban Transport Development Strategy: Proceedings of a Symposium in Beijing*, November 8-10, 1995, The World Bank (Discussion Paper No. 352), Washington, D.C., pp. 311-337.

[6] In 1981, about 20% of the population lived in urban areas distributed across 225 cities (20 of which had a population over 1 million). By 1998, the urban fraction had risen to more than 30% distributed across 668 cities (37 with more than 1 million residents).

Meeting the demand for public transport services in environmentally, economically, and socially sustainable ways presents major challenges for Chinese cities for several reasons:

1. The capacity for planning and management of urban transport is generally weak in Chinese cities,[7] which has resulted in declining bus ridership at the very time that increases in urban public transport services are needed. Declining ridership is attributed to 1) generally low levels of service and technologies, e.g., the average distance to first breakdown of a new bus is 3000 km [5], 2) poor management at bus companies, 3) government policies that appear to give the development of bus services priority, e.g., through subsidization, but do not address a broader set of issues that are bottlenecks to expanding public transport services, e.g., roadway congestion that limits bus speeds, and 4) long-standing government subsidization of fares that has sapped bus companies of incentives and capacity for innovation.
2. As salaries rise with ongoing economic growth, the cost of providing labor-intensive public transport services is also rising.[8] Without improvements in labor productivity, the increasing salaries that are accompanying economic reform will lead to higher and higher costs for public transport services.
3. Increased motorization based on personal vehicles (cars and motorcycles) is on the rise in China's cities, contributing to increased congestion of roadways that is forcing average bus speeds down. The increase in motor vehicles on the road has resulted in large part from the 1994 national directive on "The Development Policy for the Automobile Industry," which encouraged domestic car production and private ownership of cars. The total number of civilian vehicles on the road increased from 8.2 million in 1993 to 13.2 million in 1998, representing an average growth rate of 10% per year. [9]
4. Air pollution in cities is worsening as vehicle populations rise, as discussed in the next section.

1.4 Air pollution and transportation in major cities of China

Air pollution is a major problem in most of the major cities in China today. The case of Beijing is illustrative. In a major 1992 study by the World Heath Organization[10] of air pollution levels in urban areas, Beijing was ranked as the second most polluted mega-city in the world. Since that time, the vehicle population of the city has more than doubled reaching 1.4 million in 1999. (Shanghai, the other host city proposed here for an FCB demonstration, ranked 19th.) The major sources contributing to pollution in Beijing today are coal combustion and vehicle exhaust emissions. During the non-heating season (when coal combustion emissions are lower), the vehicle contributions to CO, HC, and NO_x in Beijing in 1999 were 92%, 98%, and 85%, respectively. (During the heating season, these numbers were 76%, 94%, and 68%, respectively.) CO levels routinely exceed nationally specified limits, as do ozone concentrations. While the majority of fine particulates - which are among the most health-damaging pollutants in urban China today - arise from the combustion of coal, emissions from coal burning will decline in the future (e.g., coal burning is now completely banned inside Beijing). Given this trend and assuming "business-as-usual" in the transportation sector, diesel vehicles will account for an increasing share of particulate emissions over time. Buses will be a major contributor. The poor environmental performance of vehicles in China compared to OECD vehicles is a major contributing factor, along with poor traffic management, which contributes to congestion and slow average speeds on the roadways.

The trends in vehicle populations and air pollution in most of the other major cities of China are similar to those in Beijing. Without major efforts to reduce air pollution from vehicles, the environmental future of China's cities is bleak. A particularly sobering statistic, in this case for Guangzhou, comes out of a study of vehicle air pollution in China in the mid-1990s.[11] As of the early 1990s, the number of vehicles in Guangzhou was one-tenth that in Tokyo or Los Angeles, yet the total tonnage of tailpipe emissions from vehicles in Guangzhou was comparable to

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[7] Li Xiaojiang and Yu Li, "Theme Paper 11: Land Use and Transport Planning in China," *China's Urban Transport Development Strategy: Proceedings of a Symposium in Beijing*, November 8-10, 1995, The World Bank (Discussion Paper No. 352), Washington, D.C., pp. 413-457.
[8] In 1994, the cost breakdown from a survey of 118 public transit enterprises in China found the following contributions to the cost of services: salaries 30.5%, fuel 26.4%, management 17.6%, maintenance 17.0%, and depreciation 8.5% (from reference cited in footnote 5).
[9] National Bureau of Statistics, *1999 China Statistical Yearbook*, China Statistics Press, Beijing, 1999.
[10] World Health Organization and United Nations Environment Program, 1992,*Urban Air Pollution in Megacities of the World*, Blackwell Reference, Oxford, UK.
[11] He, Kebin, *et al.*, 1996, "The Status and Trend of Vehicle Pollution in China," *Environmental Science*, No. 4.

emissions in those cities. In this context, the 15% per annum growth rate in the vehicle population of Guangzhou in the 1990s is alarming.

Respiratory illness, to which air pollution is a contributor, is the 4th-largest killer in urban areas of China, accounting for 14% of all deaths in urban areas in 1998. While correlating vehicle air pollution with the cost of illness and death is difficult, some such efforts have been made. For example, one study in 1996 estimated the health cost of air pollution in 20 large and medium-sized cities in China.[12] The increase in respiratory disease attributed to air pollution resulted in the direct loss of around 500 million yuan and some 2 million working days. Another study in Chongqing concluded that the development of children's lung function is imperiled by air pollution in typically polluted areas.[13] While an exact correlation cannot be determined, there is little question that pollution from vehicles exacts a high cost, both in human health and economic terms.

In order to address the increasingly serious air pollution problems in China's cities, Vice-Premier of the State Council, Li Lanqing, recently announced plans to launch the "Air Purification Engineering," or Clean Air Program, starting in 2001 and aimed at reducing air pollution in cities from the two largest sources: motor vehicles and industrial coal boilers. The program will be led by the Ministry of Science and Technology (MOST) together with 13 other ministries and commissions at the national level. The principal vehicle-related elements of the program will include expanding use of LPG and CNG vehicles, adopting electronic injection and tailpipe-emission reduction technologies, and developing and applying electric vehicles (including fuel-cell vehicles). The program will strive to demonstrably improve air quality over the next 3 to 5 years in 12 selected model cities, including Beijing, Shanghai, Tianjin, Chongquing, Hainan, and others. Substantial national and local financial resources will be committed to this program during the period of the 10th 5-Year Plan (2001-2005).

One component of the Clean Air Program will emphasize the development of multi-person public transport systems, especially buses. In 1998, there were a total of 184,352 public transit buses in China, or about 1 bus for every 2000 urban residents.[14] Passenger travel demand (person-trips) is growing about 4% per year, and the bus population must grow at least as fast as this to meet this demand.

1.5 Development and innovation in public transportation in Beijing and Shanghai

Since 1990, the development of public transportation systems has been accelerating in Beijing. The number of buses in the city increased from 4720, in 1990, to 8853 in 1999 - a rate of growth exceeding 6.5% per year. At the same time, taxis, trolleys, and clean fuel vehicles have also been developed to a certain extent. Some details are shown in Table 1.

Table 1 Development of the public bus and taxi transport in Beijing*

	1990	***1995***	***1999***
Total buses	4720	4821	8853
heavy-to-medium duty	3777	3927	6875
light duty	429	369	1432
Trolley buses	514	525	546
Clean fuel buses	0	-----	1900
Taxis	------	-----	about 60000

*Source: Beijing General company of the public traffic

[12] Anonymous, 1996, "Economic Analysis on Human Health Damage Induced by Air Pollution," *Fujian Environmental Science*, No. 12.
[13] Anonymous, 1996, "Effects of Atmospheric Pollution on Lung Function of Children in Chongqing," *Chongqing Environmental Science*, No. 12.
[14] For comparison, Brazil has about 1 bus for every 800 urban residents.

Of the Beijing fleet of 8850 buses, 4310 use diesel fuel, 2640 run on gasoline, 1600 run on LPG, and 300 run on CNG. The city also has 546 electric trolley buses. In order to keep up with economic development and to improve air quality Beijing will build 1000 CNG buses using USA technology in year 2000 and 12 CNG fuel stations. To improve the public traffic and air quality before 2008 (when China hopes to host the Olympics), the Beijing government is also planning to build an above-ground light rail system and expand the underground system.

The traffic of Shanghai is the most developed in China. Both the average number of public traffic cars per person and the road density are highest in the nation. In 1999, Shanghai had a fleet of some 17,000 buses, 10,200 of which were diesel fueled and 6,800 of which were gasoline fueled. The city also has 520 electric trolley buses, 450 of which are currently operated. Some details are given in Table 2.

Table 2 Public traffic status and forecast of Shanghai.*

	1998	*1999*	*2010*
Number of buses Large-to-medium duty	15,400	17,000 15,300	20,000
Trolley buses, total Trolley buses, operating		520 450	
Taxis	40,000	42,000	42,000-46,800
Mini-engine motor		50,000	
Bicycles		700,000	

*Source: provided by Shanghai General company of the public traffic

To accommodate economic development and improve public transit, the Shanghai government started a clean-fuel transport plan. Up to 1999, 14,000 taxis had been refit to use LPG, and 25,000 taxis and 42,000 taxis will be refit in 2000 and 2005, respectively. In the mean time, the Shanghai local government will refit large buses to use CNG. Some 3000 large buses will be refit and 3 CNG fuel stations will be built this year (2000). In addition, the Shanghai government plans to build 10 light railways, expand the underground system, and maintain a bus fleet of about 20000 units.

Shanghai has begun to actively promote the development of fuel-cell vehicles. With the strong support of the Mayor (and catalyzed by an initiative of the W. Alton Jones Foundation), the Shanghai municipal government has included fuel-cell technology in its Tenth Five-Year Plan, and is now working to finalize a long-term fuel-cell vehicle development program. The government will encourage and coordinate different companies to carry out the program, and identify one or more organizations to take the lead in implementation. On its part, the municipal government will formulate preferential policies to support the commercialization of fuel-cell vehicles.

As part of this program, Shanghai is planning to build or assemble a demonstration FCB for exhibition at the November 2001 APEC summit in Shanghai. Shanghai believes that this will help to demonstrate the city's commitment to environmental protection. To assist with this effort, a number of private enterprises and investors, including the Suzhou Electrical & Machinery Co., Ltd., Beijing Fuyuan Century Fuel Cell Company, and the Pudong Development Group of Shanghai are working to establish a shareholding company to develop FCBs.

Shanghai is also one of five Chinese cities participating in a sustainable transportation project (sponsored by the W. Alton Jones Foundation). The purpose of this project is to help each city identify the bottlenecks in its urban transportation system and develop appropriate solutions. Local experts will examine a variety of strategies including integrated walk, bicycle and public transit systems; clean fuel vehicles; and public/private financing alternatives. Following visits by city mayors and technical experts to a number of model urban transportation systems, including Curitiba, each city will develop an implementation plan for the establishment of a Green Zone in which to demonstrate an integrated urban transportation system.

1.6 Energy supply and transportation in China

China is the world's second largest energy consuming country behind the USA in absolute terms,[15] but per-capita energy use is less than one-tenth of that in the USA and less than one-fifth of that in Japan or Western Europe.[16] Total primary commercial energy consumption in China in 1998 amounted to 1,360 million tonnes of standard coal equivalent (SCE[17]). [9] The mix was dominated by coal, which accounted for a 72% share. Oil and natural gas accounted for 20% and 2%, respectively. Total commercial energy consumption grew 4.1% per year from 1990 to 1998, while GDP grew nearly 11% per year (constant RMB).[9]

Among fossil fuels, oil use has grown far faster than coal or natural gas during the 1990s, with consumption growing 6.4% per year from 1990 to 1998, compared to 3.3% per year for coal and 4.1% per year for natural gas.[9] In 1998 China was the 7th largest oil producing country, accounting for nearly10% of non-OPEC oil, but China has been a net importer of oil since 1993. By 1998 imports accounted for 15% of the total 269 million SCE consumed. Oil consumption is projected to nearly double during the next 20 years (3.3% per year growth), while domestic production is expected to be nearly flat.[16] In this case, imported oil will account for nearly 60% of China's oil consumption in 2020, with negative impacts on balance of payments and energy security.

The transport sector, which relies almost entirely on oil today, accounted for nearly 20% of China's oil consumption in 1998.[9] This sector is projected to account for most of the incremental demand for oil over the next 20 years.[16] By 2020, the urban vehicle population is expected to be 13 to 22 times larger than it was in 1995.[18] (Per capita registrations of vehicles in China today are at 3% of the level in the U.S.A.)

In part to help offset oil use, but more importantly because of environmental benefits, China is planning to substantially increase use of natural gas in the coming decades. Between 1996 and 2020, consumption is projected to rise by as much as a factor of 14.[16] Gas supplies to major cities on the east coast are limited today, but will be more widely available in the longer term. Gas use in Beijing was 0.7 billion m^3 in 1999 and is projected to grow to 6 billion m^3 by 2010, or nearly 20% per year. Most of Beijing's current gas is supplied from Shanxi province through a pipeline with 1 billion m^3 per year capacity. A second line with 3 billion m^3 capacity is under construction. Gazprom has announced plans to supply gas to China from Siberia, with Beijing being a likely major beneficiary. Estimates are that 20 billion m^3 per year could be supplied to China from Siberia. Gas prices in Beijing are projected to be 1.4-1.8 RMB/m^3. Shanghai is the intended terminus for a planned 4,200 km pipeline from the northwestern province of Xinjiang,[19] which has China's largest identified natural gas resources. The reserves of natural gas in Xinjiang are more than 200 billion m^3. Engineering and construction of the pipeline will start in 2001 and finish in 2005. The capacity of the pipe will be 20 to 25 billion m^3 per year, more than half of which will be supplied to Shanghai. The expected cost of gas at the Shanghai city gate is about 1.3 RMB/m^3. The East Sea oil field supplies 0.3-0.4 x 10^9 cubic meter of gas per year today to Shanghai. This will rise to 1 x 10^9 cubic meter by 2010, according to experts' estimations. Imported liquefied natural gas (LNG) will be flowing into Guangzhou and other cities in Guangdong Province by 2005.[20] LNG projects are also under discussion for other coastal cities.

In the transport sector, compressed natural gas vehicles (CNG), especially buses, are starting to be introduced in a number of cities as part of air pollution reduction efforts. CNG buses were first introduced in the early 1990s in Sichuan Province, which has large identified reserves of natural gas. CNG buses are now beginning to operate in Beijing, Shanghai, Guangzhou and other major cities.

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[15] BP Amoco, 1999, *Statistical Review of World Energy 1999*, http://www.bpamoco.com/.
[16] Energy Information Administration, 1999, *International Energy Outlook 1999, with Projections to 2020*, DOE/EIA-0484(99), US Department of Energy, Washington, DC, March. (Reference scenario.)
[17] One metric tonne of standard coal equivalent is 29.3 million kilojoules.
[18] The World Bank, 1996, *China's Urban Transport Development Strategy: Proceedings of a Symposium in Beijing*, November 8-10, 1995 (World Bank Discussion Paper No. 352), Washington, D.C.
[19] Gong, Z., 2000, "Xinjiang gas heading to Shanghai," *China Daily Business Weekly*, Jan. 30-Feb. 5.
[20] Zhao, S., 2000, "Guangdong plans LNG project," *China Daily Business Weekly*, Jan. 30-Feb. 5.

1.7 China's research and development activities relating to PEMFC vehicles

China is quite advanced in comparison to most, if not all, GEF-eligible countries in science and engineering research relating to fuel-cell vehicles (catalysts, membranes, stack assemblies, integration in vehicles).[21] At the same time, China has done little to advance commercial application of fuel cells. However, the substantial number of knowledgeable scientists and engineers in China provides a strong foundation for a GEF project that will help facilitate a transition toward commercial applications in the country.

Since the early 1990s a variety of scientific and technology institutes throughout China have been involved in research and development relating to proton exchange membrane fuel cells (PEMFC) and their application to vehicles. Researchers at the Changchun Institute of Applied Chemistry, Tsinghua University, Tianjin University, Fudan University, Shanghai University (in cooperation with Beijing Petroleum University), the Beijing University of Science and Technology, Tianjin Institute of Power Sources, the South China University of Technology, and the Dalian Institute of Chemical Physics have all been involved with fundamental research relating to catalysts, electrodes, and/or other components of PEMFCs. The Institute of Engineering Thermal Physics of the Chinese Academy of Science has been involved in studies of gas supply, and thermal and water management for FC stacks.

Building on its fundamental research studies, the Dalian Institute of Chemical Physics has successfully built and tested some 20 PEMFC stacks (some using internally-developed, low-cost membrane material) ranging in size from 1 to 5 kW. In 1998 a 5-kW stack (built by the Beijing Fuyuan New Technology Development Corporation using an imported Nafion membrane) was integrated with an electric drive system in collaboration with the Tsinghua University Automotive Engineering Department and installed in a prototype golf cart to demonstrate the feasibility of developing FC vehicles in China.

The Dalian Institute is now constructing a 30-kW stack that will be integrated into a 7-meter hydrogen-fueled bus for research and demonstration purposes, under a program supported by the Ministry of Science and Technology (MOST). The Institute of Electric Engineering of the Chinese Academy of Science is responsible for development of an electric drive for the vehicle and for overall systems integration. The vehicle will be manufactured in collaboration with engineers at the Technical Center of the Dong Feng Motor Co. (Hubei Province), one of China's largest commercial vehicle manufacturers. MOST is also committed to building a second FCB in 2001 using methanol as a fuel with on-board reforming to hydrogen.

Most of the organizations with past or current interest or activity relating to FC vehicles participated in the 26-27 January 2000 workshop convened by MOST to provide a forum for exchange of information bearing on the design and implementation of the FCB demonstration project proposed here. (See Section 5.1 for additional discussion of the workshop.)

1.8 The long-term potential for FCBs in China

The growth rate of the total vehicle stock in China averaged nearly 12% per year between 1990 and 1998, reaching 13.2 million vehicles by 1999.[9] As noted earlier, the country gives high priority to the development of its public bus fleets, which ensures that the demand for buses in China will continue to grow rapidly. The demand for medium to large-size (7 to 18 m) buses in China is expected to grow at an average rate of 5% per year between 2000 and 2030, which would result in a Chinese bus population of about 0.7 million in 2030.[22] With such an expansion, the number of urban buses in China in 2030 on a per capita basis would be about 1 per 1000,[23] which is somewhat lower than

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[21] See Mao, Z., Yan, J., and Liu, L., 1999, "The history, current situation and prospect for fuel cells in China," *Proceedings of EVS-16, the 16th International Electric Vehicle Symposium*, Beijing, China, 12-16 October.
[22] This is estimated as follows from Tables 5 and 6 in the reference given in footnote 25 and additional figures provided by Ge Zhengze (Senior Engineer, Beijing Public Transit Company, January 2000). Table 5 shows 7163 buses in Beijing in 1996. There will be 7900 buses in Beijing in 2000, a growth of 10.3% over this period. Applying this percentage to the number of buses in China shown in Table 5 (150,625) gives 166,123 buses in China in 2000. Applying a 5% growth rate for 2000-2030 gives 718,000 buses in China in 2030.
[23] This assumes 1998 population of 1.25b, with 1%/yr growth to 2030, for a total 2030 population of 1.7b. The urban population in 2030 is estimated to be 0.7 billion, or about 40% of the total, up from 30% in 1998.

the present-day number of buses per capita in urban areas of Brazil (~1 bus per 800 people). The demand for new buses (counting replacement and new markets) in 2030 under this scenario would be some 108,000 buses per year.[24]

Thus, there is a sizeable potential market for FCBs in China. An expert Chinese team, during the preparation of this proposal, considered whether FCBs mass-produced in China will be cost-competitive with alternatives. The team drew on the scientific and engineering knowledge base in China regarding PEM FCBs and international inputs to estimate the capital costs that are likely to be reached by mass production of 12-meter FCBs in China.[25] The team considered two scenarios involving manufacture of the bus glider and integration of the engine and glider in China. One scenario involved importing the fuel-cell engine from an OECD country. The second assumed indigenous manufacture of the fuel-cell engine. With the imported engine, the estimated cost for a mass-produced FCB was about US$320,000. With a Chinese engine, the cost was about US$237,000. For comparison, the Ballard company of Vancouver, Canada (a leading FCB developer) has indicated that an FCB mass produced entirely in Canada/U.S. could be sold for under $400,000[26], whereas the cost for a FCB in 2001 is US$1,200,000. Ballard has also indicated that the glider would represent about 70% of this cost. Since substantial cost savings in the manufacture of the glider can reasonably be expected in China compared to Canada/US production,[27] the Chinese FCB cost estimates are consistent with the Ballard projections. Based on the Chinese estimates of the cost of FCBs, it appears that mass-produced FCBs will become cost-competitive on a lifecycle basis with diesel buses (Table 3). Aside from the capital cost estimates for the FCB, four key assumptions underlie the numbers in this table. One assumption is that the operating and maintenance (O&M) cost for the FCB will be two-thirds of the O&M cost for the diesel bus. This is based on the assumption that FCBs will suffer less wear and tear than a diesel bus due to relatively low temperatures of operation of the fuel cell (~80^{o}C) together with the absence of vibrations that accompany reciprocating engines. The second assumption, that the FCB will last 20 years compared to a typical diesel bus life of 10 years, follows from this argument as well. The third assumption is that Chinese labor costs continue their increasing trend: a 5% per year real increase in the salaries of operators and mechanics is assumed in the results in the table. The fourth assumption is that the capital cost for a diesel bus does not increase in real terms between now and 2025. (This is a conservative assumption, since it is likely that diesel bus costs will increase as manufacturers strive to meet stricter emissions limits, provide more amenities on-board, etc.).

Table 3 assumes a hydrogen cost of 2.6 RMB/m^3, which is the cost estimated for making hydrogen from coal in a large-scale process that includes capture of the carbon in the coal and sequestering it as CO_2 in depleted natural gas wells. A preliminary analysis of alternative low-carbon emission options[28] indicated that this would be the lowest-cost and most abundant means for providing hydrogen with low CO_2 emissions in the coastal cities of China in the long term (Table 4).[29] Natural gas is another potential feedstock for hydrogen production, and this is envisioned as the hydrogen source for the demonstration project described in Section 2. Coal bed methane is another potentially important source of hydrogen for China.[30]

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[24] Assumes 10% retired annually and expansion of 5% per year.
[25] See State Science & Technology Commission, "Analysis on Funding Requirement of Development and Commercialization of FCPB in China," sub-sector III report of *Capacity Development for Fuel Cell Powered Buses Development and Commercialization in China*, final report to UNDP, Beijing, March 1998.
[26] See Hosier and Larson paper cited in footnote 1.
[27] As a point of reference, the cost of an air-conditioned diesel bus built in China today (using an engine imported from the USA) is about 500,000 RMB, out which 20,000 RMB is the cost of labor. (Information from site visit to Beijing #4 Coach Factory, Jan. 2000.) For comparison, a new transit bus manufactured in the USA/Canada and meeting specifications for use in New York City costs about $250,000 (or about 2.1 million RMB).
[28] See supporting report for details of this analysis.
[29] The analysis of hydrogen production from coal is based on the assumption that conventional technologies would be employed in the production process. Some advanced technologies still at the R&D stage have been identified that, if they are commercialized, would considerably reduce the cost of making hydrogen from coal while separating CO_2 (R.H. Williams, 1999: "Toward Zero Emissions for Coal: Roles for Inorganic Membranes," *Proceedings of the International Symposium: Toward Zero Emissions; the Challenge for Hydrocarbons*, Rome, Italy, March 11-13).
[30] R.H. Williams, 1999, "Hydrogen Production from Coal and Coal Bed Methane, Using Byproduct CO_2 for Enhanced Methane Recovery and Sequestering the CO_2 in the Coal Bed," *Proceedings of the 4thInternational Conference on GHG Control Technologies*, B. Eliasson, P. Riemer, and A. Wokaun, eds., Pergamon, Amsterdam, pp. 799-804.

Table 3: LIFECYCLE COST COMPARISON, US$/bus-km (constant 1999 $)						
	Beijing Diesel Bus		Shanghai Diesel Bus		Fuel Cell Buses, 2025(c)	
	2000(a)	**2025**(b)	**2000**(a)	**2025**(b)	**Domestic engine**	**Foreign engine**
Capital	0.143	0.14	0.125	0.13	0.25	0.34
Fuel	0.082	0.08	0.102	0.10	0.37	0.37
O&M	0.533	1.07	0.441	1.06	0.71	0.71
TOTAL	0.758	1.3	0.668	1.3	1.3	1.4

(a) Diesel 2000: average costs for primary public bus companies in Beijing and Shanghai, with diesel fuel at 2.4 RMB/lit (=$0.29/lit, $7.5/ GJ) for Beijing and 2.5 RMB/lit ($0.31/lit, $7.8/ GJ) for Shanghai.
(b) Diesel 2020: 5% real escalation in salaries, 2000-2025.
(c) FCB 2025: 10% discount rate, 20-year life, $25/ GJ fuel (2.6 RMB/$m^3$), 1.174 m^3H_2/km, O&M cost is 2/3 of average diesel 2020 O&M cost.

The magnitude of potential reductions in carbon dioxide emissions achievable by widespread introduction of FCBs in China can be estimated based on the earlier projections for the bus population in China in 2030. If all 0.72 million buses projected to be on the road in 2030 were to operate on petroleum fuels, carbon dioxide emissions in a single year would amount to about 9.1 million tonnes.[31] Thus, if all petroleum-fueled buses were replaced by hydrogen FCB buses, with hydrogen derived from sources not emitting carbon, the net savings in carbon emissions would be 9.1 million tonnes per year.

Table 4. Preliminary total levelized costs estimated for H_2 production in the long term from fossil fuels in China (including capital, fuel, operation and maintenance). Each case is for a large-scale central station plant, with pipeline transmission of hydrogen to point of use.

	Hydrogen Cost		
Feedstock and CO_2 handling system	**RMB/m^3**	**$/$m^3$**	**$/GJ**
Natural gas (1.4 RMB/m^3); CO_2 capture, no sequestration	3.41	0.41	32.3
Water electrolysis, with electricity at 0.5 RMB/kWh	3.03	0.37	29.1
Coal; CO_2 capture but no sequestration	2.47	0.30	23.6
Coal; CO_2 capture, 120 km CO_2 pipeline, injection into spent gas well	2.58	0.31	24.4

2 OBJECTIVES AND RATIONALE FOR THE PROJECT

2.1 China in the Context of the GEF Strategy on FCBs

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.

The Council decision that "…GEF should develop the five fuel cell bus projects currently in its pipeline…" is consistent with the strategy presented. That strategy proposed GEF support for preparatory, demonstration, and commercialization phases. This project, which has met all of the quality criteria developed as part of the GEF

[31] This assumes petroleum consumption per bus of 13 tonnes per year, the average consumption per bus in Beijing and Shanghai in 1999, and a carbon content of petroleum fuel of 0.98 tC per tonne of fuel.

strategy development process, represents a demonstration phase project. Its results will be carefully monitored prior to submitting any future commercialization phase proposal.

The FCB project in China has several unique features that contribute to the overall GEF FCB portfolio of projects. This project will involve carrying out simultaneous projects in two Chinese cities in order to compare and contrast FCBs operating under the wide range of institutional, social and market conditions found in cities across China; and to maximize future wide-scale implementation of FCBs throughout China. FCB operations will be demonstrated under different physical conditions than the other cities under the program, in particular the higher frequency of short, steep grades on the roadways and high relative humidity in Shanghai. Finally, the project will explore the Chinese market, which is a significant market unto itself, while allowing for expansion into the Asia and the Pacific-rim markets.

The China project, as part of the larger GEF FCB portfolio of projects, will benefit from the coordination that is planned between projects. Three key coordination approaches are planned. First, 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 China project with those from other FCB projects. Second, the FCB Private Sector Advisory Group is intended to provide guidance and support to all of the GEF FCB projects, including China. Third, a GEF FCB website will be developed and maintained, and will host information on progress, lessons learned, and research associated with all FCB projects. This website is intended to facilitate communication between the FCB projects. Further, 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.

2.2 Project Objectives

This project has been designed to be consistent with the GEF Operational Program 11, "Promoting Sustainable Transport." The development objective of the project is to reduce GHG emissions in the long term through widespread commercial introduction of FCBs in urban areas of China. Together with similar projects in other developing countries, a major overall intent is to accelerate buying-down the cost of FCB technology to levels that will enable widespread cost-competitive introduction of FCBs in many of the mega-cities of developing countries.

The involvement of GEF is critical to the successful early commercial introduction of FCBs in China. An earlier effort, which UNDP-China supported (see discussion in Section 5.1), demonstrated that market forces alone are not yet sufficient to drive conversion of bus fleets to FCBs in China. On the other hand, the market analysis that was done as part of the earlier effort confirmed expectations that there will be a substantial commercial market for FCBs in China once the barriers described in Section 1.2 are overcome.

The project proposed here constitutes Phase II of a four-phase program that will culminate in the market-based commercial production and use of FCBs in China. Phase I, which has culminated in the preparation of this proposal, has involved research and data collection and analysis by Chinese experts to provide a basis for the design of the overall program. Phase II of the program, as described in this proposal, will involve demonstrating a small fleet of FCBs (12 in total) in China, along with capacity building activities to strengthen the basis for proceeding. Phase II has been broken down into two implementation segments of 1 (Part I) and 4 years (Part II) duration, to allow for lessons learned from earlier projects to inform later projects.

Phase III will involve an order-of-magnitude larger demonstration effort. The objectives envisioned at this stage for Phase III include setting up a commercial FCB manufacturing facility to maximize Chinese content in the buses, to achieve major cost reductions by volume production of improved-design FCBs, and to convert and operate an entire garage fleet of FCBs to provide a basis for subsequent replication to other bus garages in China.[32] This will set the stage for Phase IV: mass production in China of cost-competitive FCBs that can be widely introduced on

[32] The size of bus garages in Beijing provide an indication of the likely number of buses that would be involved in such a demonstration. In Beijing, 12 of 19 garages operated by the Beijing Public Transport Company have a capacity for handling about 150 buses each. The other 7 garages have capacities ranging from 800 to 2000, with an average actual operating size of 840 buses.

commercial terms in Chinese cities in the 2010-2015 time frame. MOST, the executing agency for Phase II, has a strong commitment to insuring the success of all four phases of the program.

The specific objectives of this project are to:
1) demonstrate the technical viability of a small fleet of FCBs and the associated fuel supply systems in Beijing and in Shanghai;
2) accumulate data and knowledge that will enable improvements to the design and reductions in the cost of FCBs to be built in the future;
3) train bus company staffs in Beijing and in Shanghai in the operation, maintenance, and management of FCBs and their fueling systems;
4) improve planning and policy-making capacity among public-transport policy makers at the national and municipal levels as well as within the bus companies in Beijing and Shanghai, with the long term goal of maximizing the likelihood of sustainable use of FCBs;
5) enhance scientific, technical, and industrial capacity in China relating to manufacturing and utilization of FCBs and their associated fuel supply systems;
6) increase awareness and acceptance of FCBs among key actors (government policy makers, news media, investors), as well as the general public; and
7) carry out activities needed to lay the basis for pursuing Phase III of the overall program.

2.3 Project design and rationale

The proposed project involves the initial demonstration of FCBs in China and will consist of parallel projects in Beijing and Shanghai. Six hydrogen-fueled buses will be operated in each city over a period of 4 years. In both Beijing and Shanghai, the hydrogen will be made by on-site, small-scale steam reforming of natural gas.[33] In each city, Part I of this project will involve a first batch of three buses introduced and operated, followed by Part II where a second set of 3 buses is introduced. Multiple criteria were considered and balanced in arriving at the overall design of this project.

The decision to carry out simultaneous projects in two cities was made based on the objective of maximizing the chances for future wide-scale implementation of FCBs throughout China. The most important consideration in this regard is the need to demonstrate FCB viability under the wide range of institutional and market conditions found in cities across China. Differential rates of economic and social reform have created a wide range of market and institutional conditions in different cities today. Demonstrating the feasibility of FCBs in two cities that span this range will help catalyze future spread of the technology to cities that have market and institutional conditions similar to one or the other of the demonstration cities. Additional reasons for carrying out parallel demonstrations in two cities include:
- raising greater awareness in China of FCBs, and thereby generating a broader base of support and more momentum for large-scale implementation in the longer-term.
- demonstrating FCB operations under different physical conditions, most significantly the higher frequency of short, steep grades (flyovers) on the roadways and high relative humidity in Shanghai.
- facilitating the participation of more equipment suppliers, which is desirable from the standpoint of developing an FCB industry: involving two cities will enhance the likelihood that a larger number of equipment suppliers can be involved in the project.
- fostering friendly competition between cities to improve the likelihood of success in each.

Beijing and Shanghai were selected as the two demonstration host cities in large part because these cities present a significant contrast in market, institutional, and cultural conditions: each is representative of a large number of other cities in China, with the pace of economic and institutional reform most advanced in Shanghai. Market-oriented reform in Beijing is far behind Shanghai, but is representative of the conditions still found in many Chinese cities. The performance of the local public bus companies reflects the different market and institutional environments. Additional factors leading to the choice of these two cities include the following:

[33] In the long term, the production of H_2 from coal, with sequestering of separated CO_2, is likely to be the most attractive low-GHG option for fuel in many parts of China from a cost standpoint (see Table 4).

- pollution problems are already severe in Beijing and are approaching severe in Shanghai, and the municipal governments in both of these cities are highly committed to reducing air pollution;
- the municipal governments in both of these cities have pledged to strongly support the projects;
- the public bus companies in these cities have demonstrated their commitment to technology innovation, e.g., as evidenced by earlier LPG and CNG bus programs;
- these are the two largest bus markets and the two largest cities in China;
- these cities are well-known in China and throughout the world and hence the national and the global impact of successful projects in these cities will be greater than if the demonstrations were undertaken in lesser-known cities; and,
- the strongest possible teams to carry out the projects can be assembled in these cities.

The decision on the number of buses to demonstrate in each city considered both higher and lower numbers than 6 in each city. The possibility of demonstrating a much larger number of buses at each site, e.g., > 20, was considered unfeasible due to the limited supply capabilities of vendors, the difficulty of effectively operating such a large number of units in China with no prior experience, and the higher project cost (and hence project risks) that would be entailed.

The decision to demonstrate a minimum of 6 buses in each city was based on prior experience with the introduction of CNG buses in Beijing and in Shanghai. The CNG test programs that preceded the wide-scale introduction of CNG buses in Beijing consisted of a 3-bus test over an 18-month period. A minimum of 3 buses was needed to generate statistically significant results. A relatively short test period of 18 months was sufficient because the CNG technology was already well established outside of China, and several cities elsewhere in China (including in Sichuan and Xingjiang provinces) had already introduced CNG buses.

As with the CNG bus tests, a minimum of 3 FCBs will be required in the testing to establish statistically-significant results. However, there is no prior experience in China with FCBs (and very little prior experience outside of China) and operating availabilities for the demonstration vehicles will not reach normal bus operating availabilities, so longer duration testing will be required than with the CNG program in order to identify potential problems. The testing period cannot be extended indefinitely, however, because FCB technology is evolving very rapidly, and thus lessons learned during an extended initial test period may be irrelevant to the technology that would be adopted for Phase III of the Chinese FCB commercialization program.

To avoid an unduly extended testing period, a second batch of 3 buses will be introduced after one year of operating the first batch of 3 buses. This staged introduction approach has several advantages over introducing 6 buses all at once: 1) it allows the project to start with the minimum statistically-acceptable number of units, which will facilitate overcoming startup issues, 2) it provides for a lower cost project, since the second batch of buses can be expected to be lower in cost than the first batch, and 3) it provides for the possibility of technological improvements (by the suppliers) in the second batch of buses compared to the first batch.

The 6-bus design in each city will enable a total of about 800,000 bus-km of FCB operation to be logged in each city. This is the typical lifetime of a bus in Beijing today, and it is adequate to evaluate mean time between failures (MTBF) at the end of the project period. It will also enable each bus to operate a total of 115,000 to 150,000 km, which is 3 or 4 times the target for MTBF and thus should be sufficient to identify likely failure modes.

The estimate of 800,000 bus-km overall is based on the assumption that the FCB will operate at 70 to 85% of the availability of Beijing's diesel buses. FCB suppliers who have been contacted have indicated that initial demonstration FCBs will not be able to achieve operating availabilities greater than 50 to 70% of diesel-bus availability. However, since these availability levels are based on diesel bus travel distances typically found in large cities outside China, they underestimate the availabilities achievable in Beijing, where diesel buses average only 48,000 km per year of operation, compared to much higher distances elsewhere. For example, buses in Sao Paulo and in Cairo operate about 84,000 km/year and 105,000 km/year, respectively.

3 PROJECT ACTIVITIES AND EXPECTED RESULTS

3.1 Expected project outputs

This project consists of two implementation segments (Part I and Part II), to allow for lessons learned from earlier projects to inform later projects. Since the project was conceived as a whole, the expected project outputs stem from activities conducted during both implementation segments. Part I will focus primarily on producing outputs 1, 2 and 4. Part II will complete outputs 1, 2 and 4, and achieve outputs 3, 5, 6 and 7.

Output 1: A commercially-relevant demonstration of the technical feasibility of FCBs and their refueling infrastructure in Beijing and in Shanghai.
Output 2: The accumulation of a substantial body of knowledge about reliability and failure modes, opportunities for improving the design and reducing the cost of FCBs in China, and Chinese public ridership responses to FCBs.
Output 3: A cadre of bus-company staffs trained in the operation, maintenance and management of FCBs.
Output 4: Increased capacity among public-transport policy makers and planners at the national and municipal levels and at bus companies in Beijing and Shanghai for policy and planning to optimize public-transport management, technologies (including FCBs), infrastructure, and operations.
Output 5: Enhanced scientific, technical, and industrial capacity in China relating to commercial utilization of FCBs.
Output 6: Increased awareness and acceptance of FCBs in China among key actors (government policy makers, news media, investors), as well as the general public
Output 7: Activities to lay the basis for pursuing Phase III of the overall program.

3.2 Proposed project activities

The following set of activities will be associated with each of the outputs. Sequence and timing of activities, and the breakdown of activities between implementation segments Part I (year 1) and Part II (years 2 to 5) are described in chart form at the end of this section.

Activity 1

Activities associated with Output 1 will be carried out in parallel by the Beijing and Shanghai teams, with information sharing between the two teams to the fullest extent possible:

Activity 1.1: Undertake communications and site visits to as many potential fuel cell engine suppliers as possible and (if appropriate) selected bus manufacturers. The project team will undertake this activity for two main purposes: 1) to understand the present status of specific companies' technologies, their capabilities for supplying FCBs to the project, and their level of interest in responding to a bid and 2) to maximize the likelihood of receiving multiple bids by encouraging wide participation in the bidding. This activity will be completed under Part I.

Activity 1.2: Specify technical performance targets for the buses and fueling system. The project team will specify the characteristics of the buses and the fuelling system, such that they will meet the needs of the project. The current assumption is that complete fuel cell buses will be procured (as opposed to separately procuring components and assembly). This will be done to reduce the specification and procurement time and effort, and most importantly to minimize technological risks. This activity will be completed under Part I.

Activity 1.3: Issue separate call for tenders for Beijing and for Shanghai projects and select the suppliers. Tenders from different combinations of fuel cell engine and bus chassis/body manufacturers will be sought and encouraged. The expectation is that a single supplier will be required to contract for the whole system (buses plus fueling system) with appropriate sub-contracting arrangements. Different suppliers will be selected for Beijing and for Shanghai, if possible. The vendor(s) will be selected on the basis of lowest cost for the complete Phase II period, subject to meeting the specified technical and performance requirements. Criteria for evaluating proposals will be published as part of the call for tenders. One important evaluation criterion will be the level of participation of Chinese companies or other Chinese organizations. This activity will be completed under Part I.

Activity 1.4: Install, operate and maintain the fueling infrastructure. As part of the main contract, the primary contractor will oversee the installation, operation, and maintenance of the hydrogen generation and refueling system at the host bus garage. Installation of the fueling system will precede the arrival of the initial set of buses. Part I will involve the installation and start-up of the fueling infrastructure, which will be operated and maintained under Part II.

Activity 1.5: Place initial set of 3 buses in operation. Once the supplier is chosen, the next step will be to procure and place 3 buses in service under Part I. These buses will be operated for 4 years, under Part II, operating in revenue service under realistic operating conditions (after an initial non-revenue shake-down/testing period).

Activity 1.6: Part II will involve placing second set of 3 buses in operation starting one year after the first set of buses begins operation. This second set of buses will operate for 3 years.

Activity 2

Activities associated with output 2 will be undertaken in parallel by the Beijing and Shanghai teams, with sharing of information between the two teams.

Activity 2.1: Formulate guidelines for quarterly reports on in-service performance of the buses. It is expected that through a consultative process involving the project team, the suppliers, and other experts, a protocol will be developed for quarterly reporting on the technical operations of the bus fleet (e.g., in-service reliability, failure modes, energy consumption, etc.). These guidelines will be formulated during Part I of the project.

Activity 2.2: Collect, analyze, and evaluate operating data on emissions, efficiencies, reliability, failures, and potential improvements. In collaboration with the suppliers, the project team will engage in systematic logging, analysis and interpretation of operating parameters paying particular attention to reliability, failure modes and potential improvements in design and operation of the buses. Detailed lifecycle emissions and resource-use efficiency analyses will also be carried out on the basis of collected data and compared to similar lifecycle analyses for other bus technologies. Part I will focus on the information system design, and purchasing data collection equipment. Part II will collect data concerning operating labour (over 4 years) and performing life cycle analyses.

Activity 2.3: Collect survey data from general-public bus riders or focus groups to help identify potential improvements to FCB technology for China. Surveys of ridership or conducing focus groups will be carried out under both Part I and II.

Activity 2.4: Prepare semi-annual reports in English summarizing data collection and overall progress in the project. A mailing list of recipients of these reports will be maintained and copies of the reports will be provided to all interested parties. These reports will also serve as the basis for proposals for further product development and improvement. Annual reports will be produced during all years (Part I and II).

Activity 2.5: Exchange experiences with other users of fuel cell buses. This activity gives special emphasis to interactions with other GEF fuel cell bus projects (Sao Paulo, Mexico City, Cairo, New Delhi) and other non-GEF FCB projects (Chicago, Vancouver, California, Europe, and elsewhere). The experiences of these other cities should also be taken into account in formulating future activities relating to commercialization of FCBs for China. Information exchange will occur during each year of project implementation (Part I and II).

Activity 3

Activities associated with output 3 will be undertaken in parallel by the Beijing and Shanghai teams, taking advantage of any opportunities for joint activity to reduce costs and improve effectiveness.

Activity 3.1: Working together with the suppliers, hold on-the-job training seminars for drivers and maintenance staff. This activity must ensure the training of sufficient numbers of operating and maintenance personnel to ensure both the execution of the immediate project and the preparation for a larger follow-on demonstration. This on-the job training will occur throughout Part II of the project.

Activity 3.2: Develop an examination and certification program for FCB operators and mechanics. This certification will occur during Part II, after sufficient training.

Activity 4

Activities associated with output 4 will be undertaken in parallel by the Beijing and Shanghai teams, except for 4.1, which will be undertaken jointly.

Activity 4.1: Undertake study tour to visit selected public transport planners, policy makers, and service providers worldwide, including those operating fuel cell buses, for the purpose of better understanding policy and planning approaches that could be applied to improve public bus systems in China (under Part I of the project).

Activity 4.2: Prepare a policy and planning study (including recommendations) that evaluates options for improving/optimizing bus-company management, technologies, infrastructure, and operations in Beijing and in Shanghai. Carried out during Part I of the project, the purpose of the study is to help provide a basis for strengthening the capacity of the bus companies, which will help insure sustainable, wide-scale introduction of fuel cell buses in the long term.

Activity 5

Activities associated with output 5 will be undertaken jointly by the Beijing and Shanghai teams, in consultation with the Ministry of Science and Technology (MOST). All of activity 5 will be conducted under Part II of the project, and will focus on enhancing the replicability of the project in China.

Activity 5.1: Organize national workshops for exchange of technical information relating to fuel cell vehicles among relevant organizations in China. The purpose of these workshops is both to keep organizations informed of progress in the GEF project and to help foster the advancement of China's scientific, technical, and manufacturing capabilities relating to fuel cell vehicles.

Activity 5.2: Organize an annual competition for funding of Chinese organizations aimed at accelerating the commercialization of FCBs in China. The objective of this activity is to encourage the wider development of varied expertise (science, engineering, manufacturing, management, etc.) in China relating to commercialization of fuel cell vehicles. The activity is designed to enhance ongoing research, development, demonstration, and commercialization activities supported by national funding sources. Activities to be supported could include applied research at universities, technical institutes and private companies, feasibility studies of setting up manufacturing facilities, development of business plans for joint ventures with foreign companies, and other activities. A selection committee and selection process will be established for decision-making regarding funding.

Activity 6

Conducted under Part II of the project, activities associated with output 6 will be undertaken jointly or separately by the Beijing and Shanghai teams, as appropriate.

Activity 6.1: Hold a national seminar aimed at public transport sector decision makers, other policy makers, media, investors and other key actors to raise their awareness and support for commercialization of FCBs.

Activity 6.2: Participate in national and international meetings to make the results of the demonstration activities widely known in and out of China.

Activity 6.3: Use information media (newspapers, TV, radio, billboards, internet site, etc.) to publicize results of the demonstration project and plans for future projects. The objective of this activity is to help gain widespread public support for the expansion of FCB programs in China and other countries. Also, to ensure that the GEF's contribution to the project is sufficiently visible, all marketing and communications will recognize GEF support for the project, which will include GEF's logo(s) on the actual FCBs.

Activity 7

Activities associated with output 7 will be led by MOST, and will be carried out during Part II of the project. The objective of this activity is to undertake information exchange efforts with potential Phase III/IV users of FCB technology, to educate potential Phase III/IV investors about investment opportunities, identify policy barriers and discuss removal of these with policy makers, carry out technical, institutional, and financial feasibility studies for potential Phase III sites, design a prototype manufacturing facility, develop hydrogen fuel supply standards and protocols, and design the overall Phase III/IV strategy.

Activity 7.1: Undertake information exchange workshops with targeted sets of key potential Phase III/IV actors, including mayors of cities, financiers, and policy makers. The purpose of these workshops will be to inform the respective audiences about developments toward FCB commercialization and tentative Phase III/IV plans, while also eliciting information to help develop a detailed strategy for Phase III/IV.

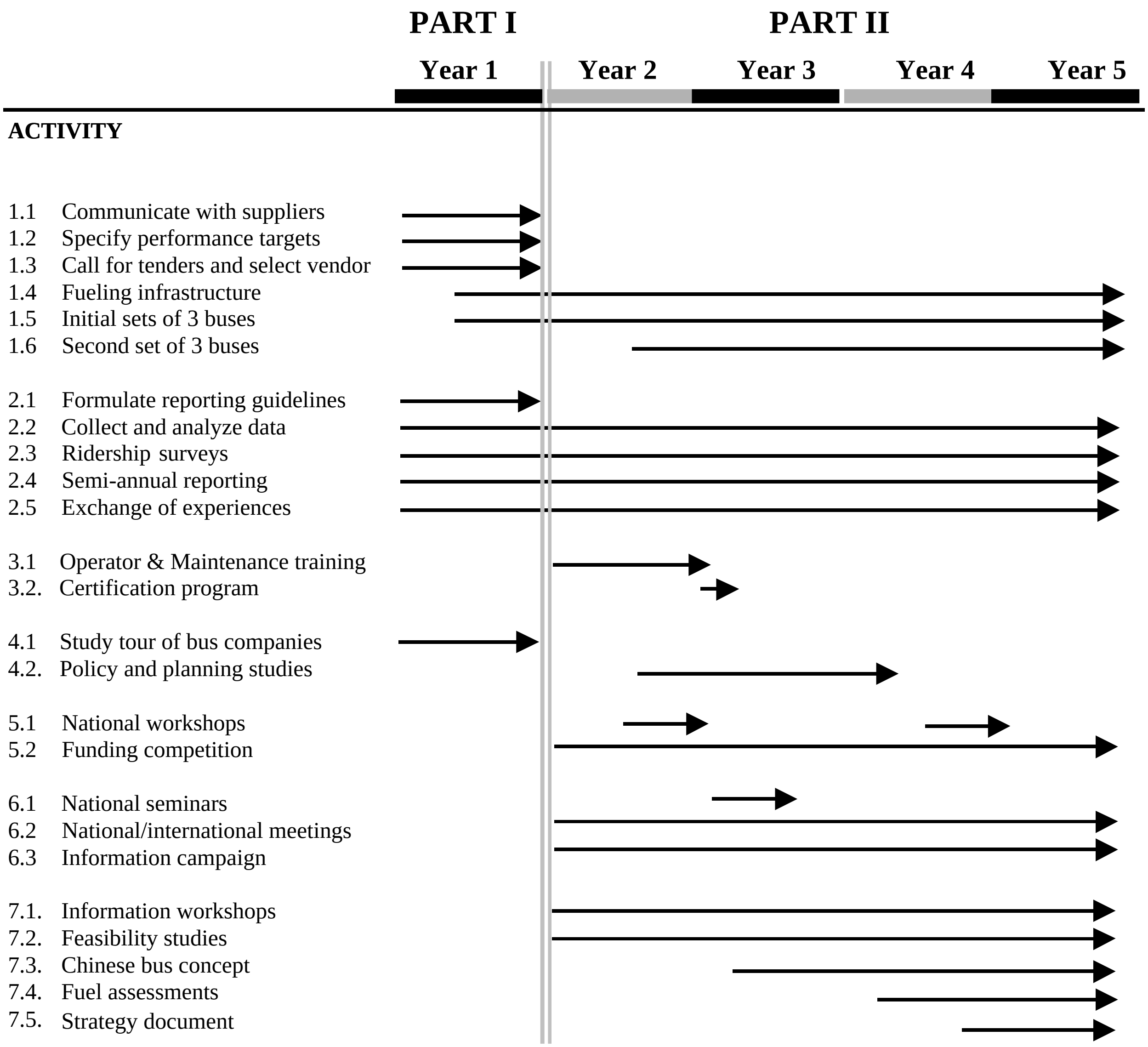
Activity 7.2: Carry out technical, institutional, and financing feasibility studies for candidate Phase III cities.

Activity 7.3: Develop a conceptual design for a hydrogen-powered fuel cell bus that might ultimately be manufactured commercially in China. Based on information generated during the demonstration project, the project team will carry out detailed engineering design and costing of an FCB for large-scale manufacture (in China) for use in Chinese cities. The feasibility of Chinese mass production of the bus in the relatively near-term will also be investigated. The team will formulate Chinese standards for hydrogen fuel cell buses and prepare an initial set of operating and maintenance guidelines.

Activity 7.4: Develop fuel supply assessments and protocols for large-scale utilization of H_2 FCBs. This work will include a detailed evaluation of the technical and economic feasibility of the most promising schemes for H_2 supply to bus depots in the major urban areas of China. The evaluation will include consideration of the possibility of separating carbon dioxide during H_2 production from fossil fuels and sequestering the CO_2 underground. Develop hydrogen fuel standards and refueling protocols for electrolysis and reformer based hydrogen supply systems. This will include H_2 quality standards, safety standards, etc.

Activity 7.5: On the basis of activities 7.1-7.4, prepare a document detailing a strategy for Phase III and for achieving commercial production of FCBs in China and widespread commercial introduction of FCBs and associated fuel supply systems in the major urban areas of China. The strategy will take into consideration the experience with the Phase II demonstration and outside evaluations of this experience, as well as developments elsewhere in the world.

Project timing:



4 RISKS AND SUSTAINABILITY

Two sets of risks with the Phase II project are envisioned.

4.1 Risks associated with technology supply bids

The first set of risks relates to difficulties that may arise with bids from fuel cell engine suppliers. Particular concerns include a lack of bidders to supply the project, unacceptably high bid prices, and difficulties reaching agreement on contract terms with the winning bidders.

There is some risk that the fuel cell engine industry is not sufficiently developed for FCBs to be secured through commercial bidding. Assessing this risk has been one of the preparatory activities for this project. Based on contacts that have been made with potential overseas fuel cell engine suppliers, it is very likely that at least one bid will be received. In fact, one of the leading firms in the industry has visited China several times in anticipation of bidding and has, in fact, submitted a bid in a prior competition (see Section 5.1). Multiple potential suppliers will be contacted again shortly after project inception to inform them of the project's intent to solicit bids and to encourage bidding. Also, given the rapid development in fuel cell vehicle engineering ongoing in China, it is not unrealistic that a bid relying on a Chinese-made fuel cell engine could be received. Given the preparatory work for the project and the strong efforts that are planned to encourage multiple bids, the risk of not receiving any bids is considered small.

There is also some risk that prices on bids will be unacceptably high. This was, in fact, the experience with the prior competition (see Section 5.1). Several factors mitigate against this risk 1) there is an improved likelihood since the last competition that multiple bids will be received, including the possibility of a bid structured with only Chinese involvement; 2) the competition will be for many more buses than in the prior competition (12 versus 2), which provides opportunities for reductions in overhead costs; 3) the winning bidder is likely to be in a favorable bidding position for subsequent large orders that will be sought during Phase III and IV; 4) FCB technology has developed considerably in the last two to three years, which should be reflected in reduced costs; and 4) one of the leaders in the fuel cell engine industry has shared their cost projections for FCBs with the GEF,[34] and these cost projections are the basis for budgeting Phase II. Thus, the circumstances today are such that this risk of unduly high bids being received can be considered relatively minor.

There is a somewhat greater concern that it will not be possible to agree on contract terms with the winning bidder. One issue may be delivery time. If the supplier is unable to deliver on a schedule that satisfies the Phase II design, project completion will obviously be delayed. While this is a risk, it is not a project-ending one. Of greater concern is reaching an agreement, especially with a foreign technology supplier, that satisfactorily protects the technology supplier's intellectual property rights. While this risk cannot be ignored, there are several mitigating factors: 1) China has in place national laws protecting intellectual property rights and, in light of its interest in joining the World Trade Organization, has shown increasing commitment to enforcing these regulations; 2) the fact that one of the leading foreign fuel cell engine companies submitted a bid in the previous competition suggests that at least one foreign supplier is prepared to try to negotiate contract terms; 3) the foreign technology component for which intellectual property rights are perhaps the most sensitive is the fuel cell stack. In the long term (with commercial mass-production of fuel cell buses) the stack is projected to constitute a small fraction (under 10%) of the total value of an FCB, which reduces the incentive to violate intellectual property rights; 4) the Phase II project design envisions a lease arrangement, whereby the FCBs are returned to the supplier at project end; and 5) if foreign suppliers will not participate in the project out of concerns over intellectual property rights or other issues, there remains the possibility of Chinese companies supplying the project.

4.2 Long-term sustainability

Long-term financial and institutional sustainability of FCBs in China requires that cost reductions be achieved and technical and institutional capacity be developed that can support widespread dissemination of FCBs in China. Phase II is designed to initiate this development in China, in part by identifying technology improvements and cost

[34] See Hosier and Larson paper cited in footnote 1.

reductions[35]. As with any technology commercialization effort, there is a risk of slower-than-expected progress in Phase II due to unexpected problems—permitting delays, construction delays, equipment breakdowns, accidents, etc. The net risk associated with such occurrences is the possibility of not obtaining sufficient vehicle-kilometers of experience with the demonstration fleet of 12 buses within a short enough period of time to provide relevant feedback to the design of the next generation of fuel-cell buses and stacks. If bus availability does not increase as rapidly as foreseen or performance falls short, the experience may not provide sufficient insight into the design of the next generation of buses and thus there will not be a firm basis for achieving cost reductions needed to move forward with the envisioned Phase III. The best safeguard against this risk is the strength and quality of the technical and management team to be selected for the project and close and continuous monitoring of all aspects of the project. During the supplier selection process, the project team will scrutinize supplier capabilities and long-term commitments to cost reduction, as the selection of the supplier will be perhaps the most important decision of the project. Together with the project team, UNDP and CICETE will monitor all contractual transactions to further insure that the project runs as effectively as possible. In the worst case, if insufficient progress is made to move forward with Phase III as envisioned, a redesign of Phase III will be required.

5 STAKEHOLDER PARTICIPATION AND IMPLEMENTATION ARRANGEMENTS

5.1 Stakeholder participation in project development

The initiative to commercialize FCB technology for China was first raised in a 1994 meeting of the Energy Working Group of the China Council on International Cooperation on Environment and Development. High level government officials in China expressed their strong support for such an initiative and inserted special provisions into the 9th 5-Year Plan (1996-2000) to support relevant research and development under the direction of the Ministry of Science and Technology (MOST, formerly the Sate Science and Technology Commission). One result has been a burst of technological progress in fuel cell science and engineering in China (as described in Section 1.7 of this brief).

One of the activities supported by MOST under the 9th 5-Year Plan, with co-support from UNDP, was a project titled "Capacity Development for Fuel Cell Powered Buses Development and Commercialization in China," which was initiated in 1996. A project report was completed in March 1998,[36] which included five sub-reports: (1) Summary of Fuel-cell Buses Development in World; (2) Analysis on Potential Social-Economic and Environmental Benefit of development and Commercialization of Fuel Cell Powered Buses in China; (3) Analysis on Funding Requirement of Development and Commercialization of Fuel Cell Powered Buses in China; (4) Development of Fuel Cell Powered Buses and Potential Demand in Market and Analysis on Commercialization in China; and (5) Request for Proposal on Demonstration Study of Fuel Cell Powered Buses in China. This study has provided much of the basis for the preparation of this proposal.

MOST issued the fifth sub-report from the study as an international request for proposals (RFP) for a one-year demonstration of 1 or 2 FCBs in Beijing. MOST received one response by the closing date (June 1998), but the proposal did not respond adequately to the terms specified in the RFP and no demonstration will result from that process. Based on developments since June 1998, the design of a demonstration project envisioned in the RFP is not the most appropriate initial demonstration project for FCBs in China. In particular, MOST feels that a larger demonstration should be undertaken, given the progress that has been made in China's science and technology capabilities relating to fuel cells and the worldwide commercial acceleration of FCB technology. The 10th 5-Year Plan (2001-2005) will include expanded funding support for the FCB technology, including co-financing of Phase II project.

During 26-27 January 2000, MOST convened a stakeholder workshop to provide a forum for exchange of information bearing on the design and implementation of a GEF FCB demonstration project for China. The results of the March 1998 study mentioned above provided a focus for discussion at the workshop, which was attended by

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[35] In 2001, the costs of a FCB are estimated at US$1.2 million per bus.
[36] See Ministry of Science and Technology, *Capacity Development for Fuel Cell Powered Buses Development and Commercialization in China*, final report to UNDP, Beijing, March 1998.

over 65 individuals representing some 36 units from around the country. Decision makers from the national level (e.g., the Department of High Technology Development and Industrialization of the MOST) to the local level (e.g., representatives from the municipalities of Beijing, Shanghai, Chongqing, and Zhejiang, and the Deputy General Engineer of the Beijing Public Transportation Corporation) expressed strong support, including willingness to contribute resources, for a GEF-supported FCB demonstration project in China.

The W. Alton Jones Foundation, which has helped catalyze the interest of the Shanghai municipal government in commercializing fuel-cell vehicles (see Section 1.5), has been following the development of this proposal to GEF. In a meeting in Beijing on 13 December 2000 with the UNDP-China office, CICETE, and the proposed executing agency for the project (MOST), a representative of the Alton Jones Foundation expressed the strong interest and willingness of the Foundation to help facilitate the successful implementation of the project. In this context, the W. Alton Jones Foundation may support joint activities organized with the GEF project.

5.2 Implementation arrangements

The project will be implemented as follows. Overall guidance at the national level will be provided by a committee consisting of representatives from the Ministry of Science and Technology (which will head the national committee), the State Development Planning Council, the State Economic and Trade Commission, the Ministry of Finance, and the National Environmental Protection Bureau. This national guidance committee will seek advice from outside experts, as needed.

A local project oversight committee will be formed in each of the two host municipalities, Beijing and Shanghai. Each committee will be headed by a Vice Mayor of the municipality and include representatives from the following municipal-level organizations: the Science and Technology Commission, the Economic and Trade Commission, the Development Planning Commission, and the Public Transportation Company. The municipal oversight committees will seek advice from outside experts, as needed. The oversight committee will meet quarterly.

The day-to-day implementation of the project in each city will be under the responsibility of the Beijing Public Transportation General Company and the Shanghai Public Transportation General Company.

The project will be nationally executed. MOST will appoint a senior official to act as national Project Director, will take overall responsibility for ensuring that all national inputs are mobilized in a timely and effective manner, and be responsible to the Government of China and GEF for achieving project objectives. The China International Centre for Economic and Technical Exchanges (CICETE) will be directly responsible for management of the project inputs. UNDP China will be responsible for monitoring and evaluation.

6 PROJECT COSTS, INCREMENTAL COSTS AND FINANCING ARRANGEMENTS

6.1 Project Costs

The total cost of the project is $32.36 million (Table 5). Details are provided in Annex D, where costs are presented separately for Part I and II.

Table 5. Summary project budget and financing plan (US$ thousand) for Part I & II

	GEF	UNDP	MOST	Shanghai	Beijing	Private	TOTALS
Equipment & Personnel	10,700	-	2201	4,383	4,005	2200	23,490
Subcontracts	-	202	1512	-	-	-	1,714
Workshops & Training	-	41	472	-	-	-	513
Travel	-	144	51	-	-	-	195
Other	882	-	5569	-	-	-	6,451
	11,582	387	9,804	4,383	4,005	2,200	32,361

6.2 Baseline and Incremental Costs

The baseline cost, from which the incremental cost is determined, consists of two components. One is the cost of operating a fleet of conventional diesel buses providing the same service (total number of bus-km) as the FCBs will provide during the project. This is approximately 800,000 bus-km in Beijing and 800,000 bus kilometers in Shanghai, or a total of 1.6 million bus-km. Based on the actual cost per bus-km incurred by the Beijing and Shanghai public bus systems (Table 6), the contribution to the baseline cost from diesel bus operation is US$0.632 million (Beijing) plus $0.552 million (Shanghai), for a total of $1.184 million.

Table 6: Current public transit bus costs (RMB) per bus-km

	Beijing	Shanghai
Fuel	0.68	0.85
Salaries	1.86	2.14
Maintenance	0.95	1.09
Depreciation	1.19	1.04
Insurance	0.0	0.07
Administration	1.14	0.36
Other	0.47	0.0
Tax	0.30	0.16
TOTAL	6.59	5.71
TOTAL (US$/km)	0.79	0.69

The typical cost of a new diesel public transit bus in Beijing or Shanghai is 400,000 RMB ($48,200). A depreciation period of 8 years is used for accounting purposes by the Beijing and Shanghai bus companies.

The second component of the baseline cost is the funding support that the central government plans to provide for research, development, and demonstrations relating to FCBs in China regardless of whether a GEF project is undertaken. Some of the activities defined for the project are aimed at enhancing such efforts. It is estimated that central and municipal governments will contribute 60 to 70 million RMB (US$7.2 - 8.4 million, or an average of $7.8 million) toward support for FCB-related activities in China during the 10th 5-Year Plan, which corresponds to the period of this proposed project.[37]

Thus, the total baseline cost for the project is $US8.984 million, and the total incremental cost is $22.8 million. Subsequent demonstration projects will involve lower incremental costs due to cost reductions as FCBs continue down a cost-learning curve toward full commercialization.

Carbon emissions that will be avoided by operating FCBs in lieu of diesel buses in the project are an estimated 178 tC (89 tC avoided in Beijing and the same in Shanghai).[38] It is not meaningful to calculate a cost of saved carbon for this project alone, since the objective of the project is to help achieve cost reductions in the technology that will ultimately enable it to be widely introduced on commercial (unsubsidized) terms. A more meaningful measure of the cost of saved carbon is based on the carbon savings that can be expected in the long term in China (once the

[37] For comparison, the 9th 5-Year period 40 million RMB were committed for building two 30-kW prototype fuel cell buses (one using compressed H_2 for fuel and the other using methanol) and 10 million RMB were committed for R&D relating to hydrogen production and storage.

[38] The carbon savings is estimated as follows. The carbon (C) emissions from diesel buses traveling 1,600,000 km (the total bus-km for the project) with an average fuel consumption of 26 liters per 100km would be 0.26 lit/km * 1,600,000 km * 0.77 kgC/lit * 0.001 t/kg = 320 tC. For FCBs using H_2 produced from natural gas by steam reforming, the C emissions (assuming energy use per km for a FCB will be half that of the equivalent diesel bus) would be 14 kgC/GJ_{CH4} *1.25 GJ_{CH4}/GJ_{H2} * 0.5 $GJ_{H2}/GJ_{diesel\ replaced}$ * 0.26 $lit_{diesel\ repl}/km$ * 0.039 GJ_{diesel}/lit * 1,600,000 km * 0.001 t/kg = 142 tC. The net savings of C emissions for the project is 320 – 142 = 178 tC.

FCBs are being used routinely on a commercial basis) and on the total incremental costs required to reach commercial cost-competitiveness. It is difficult to make such a calculation for China alone since cost-reduction developments achieved through projects throughout the world will help reduce FCB costs in China[39]. However, Hosier and Larson (see footnote 1) have estimated the total incremental cost for the FCB technology to reach commercially-competitive costs, along with the amount of carbon that would be saved globally during *one year* of operation if all diesel buses in developing countries were to be converted eventually to FCBs using hydrogen made from natural gas. With these assumptions they have calculated a cost of saved carbon of about $14/tC. This suggests that the effort to buy down the cost of FCBs to cost-competitive levels will be very cost effective from a carbon mitigation standpoint.

6.3 Financing Plan

Co-financing for the project will be provided from several sources. The central government, through the Ministry of Science and Technology, will provide $9.8m (Part I: $4.922M, Part II: $4.881M) and the municipal governments of Shanghai and Beijing will provide $4.38m (Part I: $2.04M, Part II: $2.34M) and $4.0m (Part I: $1.854M, Part II: $2.152M) respectively. The municipal national and local government co-financing will include both cash and in-kind contributions. Additionally, private sector contributions of $2.2m (Part I: $1.105M, Part II: $1.095M) are expected through an agreement to buy back the FCBs at the conclusion of the project. The general level of private sector contribution to FCB projects was discussed in the note "*GEF Strategy to Develop Fuel-cell Buses (FCB) for the Developing World*", which was presented to and agreed on by the Council. UNDP China will provide $0.4m (Part I: $0.194M, Part II: $0.193M) to support policy-related activities. GEF funds in the amount of $11.6m (Part I: $5.815M, Part II: $5.767M) are being requested, the bulk of which will cover the cost of purchasing the FCB vehicles, since their high incremental cost (relative to conventional diesel buses) represents the greatest barrier to the dissemination of the new technology today.

7 MONITORING AND EVALUATION PLAN

Pre-agreed targets will be set to help monitor and evaluate the project. These targets will be developed as part of the detailed project work plan (with milestones), which will be prepared at the inception of the project. A proposed set of targets follows:

1. Timely execution of specification-setting, solicitation and procurement activities in the first year;
2. Delivery and commissioning of buses, fuelling system, spares inventories, software, etc in the second and third years;
3. Quarterly reports on achievement of hours and kilometers of operation by individual vehicles and the fleet;
4. Quarterly reports on the availability of vehicles and on fuel consumption;
5. Quarterly reports on MTBF (mean time between failures) and FMA (failure mode analysis), for both vehicles and the fueling system;
6. Quarterly reports on proposed engineering modifications and the communication of these to vendors, plus confirmation of actions taken;
7. Quarterly reports on operator and maintenance personnel training and achievement;
8. Annual review of progress towards cost reduction, reliability improvement and increased durability; and
9. Annual records of communication activities: participation in international meetings, information dissemination within China.

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. Further, the contract with the equipment supplier may stipulate that their representatives and/or technicians may be continually present during the demonstration. However, the exact terminology of this arrangement remain to be negotiated when the equipment supplier is chosen.

[39] The current estimated costs of a FCB are US$1.2 million per bus.

ANNEXES (attached)

A. Incremental costs
B. Logical framework matrix
C. STAP roster technical review
C-1. Response to STAP Roster Reviewer's Comments
D. Detailed budget estimate
OFP Endorsement Letter (attached)

ANNEXES (available on request from MOST):

E. Summary report of the January 2000 stakeholder workshop held in Beijing.
F. State Science and Technology Commission (now Ministry of Science & Technology), 1998, *Capacity Development for Fuel Cell Powered Buses Development and Commercialization in China*, final report on UNDP project CPR/96/313, Beijing, March.
G. Mao, Z., Yan, J., and Liu, L., 1999, "The history, current situation and prospect for fuel cells in China," *Proceedings of EVS-16, the 16th International Electric Vehicle Symposium*, Beijing, China, 12-16 October. The World Bank, 1996, *China's Urban Transport Development Strategy: Proceedings of a Symposium in Beijing*, November 8-10, 1995 (World Bank Discussion Paper No. 352), Washington, D.C.
H. UNDP-GEF, 2000, *Commercialization of Fuel Cell Buses: Potential Roles for the GEF*, Proceedings of the April 27-28 workshop held at UN Headquarters, New York, June 6.

Annex A: Incremental Costs

Broad Development Goal

The broad development goal being pursued by the Government of China is the provision of public transport services to its urban inhabitants. It is also interested in doing this in a more environmentally-sustainable way.

Baseline

Under the baseline situation, the municipal transport authorities in Beijing and Shanghai will continue to provide bus transport to its population as needed. In the case of Beijing, the Beijing General Company of Public Transport has estimated that 8853 buses fueled by internal combustion engines operated in Beijing in 1999. Of these buses, approximately 6875 were estimated to be large-scale, heavy duty buses and 4310 were estimated to operate on diesel. Roughly 500 trolley buses were operated in Beijing (see Table 1 in the body of the brief) and the number of buses in Beijing was estimated to have grown at 6.5% per year during the 1990's. In Shanghai, the situation is even more pronounced. In 1999, approximately 17,000 buses were estimated to be under operation, 15,300 of these were considered medium to heavy duty. Of these buses, more than 10,000 are estimated to operate on diesel. Again, only about 500 trolley buses are in operation in Shanghai.

The urban transport sector in these two cities has a major influence on the environmental quality found in the cities. A WHO study undertaken in 1992 found Beijing to be the second most polluted mega-city in world at that time. Shanghai ranked 19th under the same study. Urban transport plays a large role in determining this poor ambient air quality. In Beijing during heating season, traffic-related emissions account for 76% of CO; 94% of HC; and 68% of NOx. During the non-heating seasons, these figures jump to 92%, 98% and 85%, respectively.

Strictly speaking, in the baseline of this project, the test vehicles are estimated to operate for 1.6 m vehicle-kilometers. During this operation, they would be anticipated to emit approximately 320 tonnes of C or 1173 tonnes of CO_2 during the project's lifetime.

Global environmental objectives

The global environmental objective is the reduction of greenhouse gas (GHG) emissions from the urban transport sector in China. Over the immediate term of the project, this will involve the demonstration and testing of fuel cell buses fueled by hydrogen drawn from natural gas. Over the longer term, assuming that this project and its successors perform as designed, this project will lead to an increased production in fuel cell propelled buses, and eventually, the 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". It has also been prepared to be consistent with the "*GEF Strategy to Develop Fuel-cell Buses (FCB) for the Developing World*", approved by the GEF Council in November of 2000.

In order for the long-term programmatic goal of the entire GEF intervention to be achieved, fuel cell buses must be produced for use in other contexts. According to industry projections, after a total of 5000 fuel cell buses have been produced, the costs should fall to where fuel cell buses will be roughly competitive on a lifecycle basis with modern, clean diesel buses.

Global Environmental Benefits

The deployment of fuel-cell buses in China will lead to significant reduction in carbon emissions from the transport sector. Although for this demonstration phase, the project will result in carbon emissions reductions of 178 tonnes C or653 tonnes of CO2. However, the target is not a small-scale demonstration project in Beijing and Shanghai, but rather the replacement of all petroleum fueled buses in China. If all petroleum-fueled buses were replaced by hydrogen FCB buses in the year 2030, with hydrogen derived from sources not emitting carbon (or the carbon being sequestered underground), the net savings in carbon emissions would be 9.1 million tonnes per year.

The immense worldwide potential for reducing global carbon emission can be demonstrated in the following example. If all diesel buses in developing countries in operation in the year 2025 were replaced by fuel-cell buses operation from hydrogen produced from natural gas, the emission of nearly 440 million tons of CO_2 would be reduced per year (120 m tons of C).

Costs

The costs of the baseline course of action are measured by the costs of operating conventional diesel buses for 1.6 million vehicle-kilometers in Beijing and Shanghai. These are estimated at US$1.1m over the five-year project lifespan. In addition, the Government of China has funding for fuel-cells estimated at $7.8m. This funding will occur even in the absence of the project. The costs of the proposed project activities are estimated at US$31.7m, of which US$22.8m are considered incremental. For the first phase of the project, the total costs are equal to $15.93m, of which the GEF is asked to contribute US$5.815m. For the second part of the project, the total costs are equal to $15.798m to which the GEF will be requested to contribute $5.767m. These incremental costs are shared between the GEF, Chinese sources, and the private sector providers of the technology.

System boundary

Although the boundary for this immediate project is the urban transport sector in Beijing and Shanghai, 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 emission of pollutants dangerous to human health and habitat. In particular, the demonstration project will reduce the emission of NO_x, CO, and THC by 13, 9, and 3 tonnes, respectively, as detailed in the incremental cost matrix. In addition, there will be reductions in SO_x and particulate emissions, for which data do not presently exist. If the same factors are used to scale-up these avoided emissions to anticipated 2030 levels, annual reductions of NO_x, CO, and THC might be expected to decrease by as much as 665 thousand tonnes; 460 thousand tonnes; and 153 thousand tonnes, respectively. There are also significant benefits to the global community, the automotive industry, and the technology providers.

Table A-1 Incremental Cost Matrix

	Baseline	GEF Project	Increment
National impact	• Public transit in Beijing and Shanghai continues to rely heavily on petroleum-fueled buses (especially diesel fuel). • Diesel fuel consumption continues. • Significant local emissions from 1.6m veh-km diesel buses: CO = 5.8 g/km or 9.28 tonnes NO_x = 8.4 g/km or 13.44 t THC = 1.79 g/km or 2.86 t • Some FCB R&D continues.	• Commercial development of FCB's accelerated through GEF support. • Chinese assimilation of FCB technology accelerated. • Zero CO, HC, NO_X, SO_2 and particulate emissions per vehicle-km. • Reduced waste heat emission	• Commercial development of FCB's accelerated through GEF support. • Chinese assimilation of FCB technology accelerated. • Diesel fuel use reduced. • Avoidance of CO, HC, NOx, SO_x, and particulate emissions from diesel bus traffic. Reduction of Local Emissions: CO = 9.28 tonnes NO_x = 13.44 t THC = 2.86 t
Global impact	• Diesel bus emissions: 1173 tonnes of CO_2 or 320 tonnes of C over the 1.6 m vehicle km traveled in the demo project • By 2030, 720,000 Chinese buses are expected to emit over 9m tones of carbon per year (33m tonnes of CO_2).	• Carbon emissions from natural gas reforming estimated at 142 t C or 520 t CO2 • FCB cost reduction and commercialization accelerated. • "Sino-ization" of FCB technology accelerated.	• Carbon emissions reduced by 178 tonnes C or 653 t CO2 during life of demonstration project • If all Chinese buses in 2030 are converted to fuel cells, 9.1m tonnes of carbon per year would be avoided (33m tonnes CO_2) • FCB cost reduction and commercialization accelerated. • "Sino-ization" of FCB technology accelerated.
Cost	• Beijing diesel bus operation = $0.79/bus-km, or $0.632 million. • Shanghai diesel bus operation = $0.69/bus-km, or $0.552 million. • MOST R&D funding for FCBs = $7.8m **Total = $8.9 million**	**Part I:** • MOST = $4.922 million • Beijing municipal government = $1.854 million • Shanghai municipal government = $2.040 million • Private sector = $1.105 million • UNDP-China = $0.194 million • GEF = $5.815 million **Part II:** • MOST = $4.881 million • Beijing municipal government = $2.152 million • Shanghai municipal government = $2.343 million • Private sector = $1.095 million • UNDP-China = $0.193 million • GEF = $5.767 million **Total = $ 32.36 million**	**Part I:** • MOST = $1 million • Beijing municipal government = $1.5 million • Shanghai municipal government = $1.8 million • Private sector = $1.105 million • UNDP-China = $0.2 million • GEF = $5.815 million **Part II:** • MOST = $1 million • Beijing municipal government = $1.814 million • Shanghai municipal government = $2.119 million • Private sector = $1.095 million • UNDP-China = $0.193 million • GEF = $5.767 million **Total = $23.46 million**

Annex B: Logical Framework Matrix

	(1) Programme or project summary	**(2) Indicators**	**(3) Means of verification**	**(4) External factors (assumptions and risks)**
Development objective	To reduce GHG emissions via the introduction of a hydrogen FCBs for urban public transport.	- CO_2 emissions reduced in Beijing and Shanghai during project - larger reductions in China and elsewhere once FCB technology is commercially deployed.	For project: fuel consumption of FCBs and bus-km traveled.	
Immediate objective	To demonstrate the operational viability of FCBs and their refueling infrastructure under Chinese conditions	- 12 buses are operated for 1.6 million vehicle-km so that operational statistics can be gathered	Final project report	
Output 1 <u>Activities</u>	A commercially-relevant demonstration of technical feasibility of FCBs and refueling systems in Beijing and Shanghai: 1.1. Communicate with vendors *(Part I)* 1.2. Specify technical performance targets *(Part I)* 1.3. Issue call for tenders *(Part I)* 1.4. Buy, install, and operate refueling systems *(Part I, II)* 1.5. Buy and operate first sets of buses *(Part I, II)* 1.6. Buy and operate second sets of buses *(Part II)*	- Buses operate according to pre-specified levels (hrs or km per year) - Breakdowns are limited in frequency to acceptable levels, e.g., <50,000km between breakdowns - Refueling station operates satisfactorily to supply sufficient H_2 at reasonable cost	Annual and final project reports Vehicle log books and records	Assumption: The procurement process is adequate so that the buses can therefore be commercially produced. FCBs can be procured from commercial vendors at satisfactory cost Risk of vendor failure
Output 2 <u>Activities</u>	Accumulation of knowledge regarding operation and use of FCBs: 2.1. Formulate reporting guidelines *(Part I)* 2.2. Collect and evaluate data *(Part I, II)* 2.3. Survey ridership or focus groups *(Part I, II)* 2.4. Prepare semi-annual reports *(Part I, II)* 2.5. Exchange information with other FCB projects around the world *(Part I, II)*	- Development of quarterly reporting forms. - Persons consulted in formulating reporting guidelines - Quarterly reports collected - Publication of documents demonstrating accumulated experience and knowledge	Quarterly and annual project reports	

	(1) Programme or project summary	(2) Indicators	(3) Means of verification	(4) External factors (assumptions and risks)
Output 3 <u>Activities</u>	Trained bus-company staffs: 3.1. On-the job training of operators and mechanics. *(Part II)* 3.2. Examination & certification program *(Part II)*	- Number of operators and mechanics trained. - Exam protocol developed.	Quarterly and annual project reports Project files and history	
Output 4 <u>Activities</u>	Increased capabilities among public-transport policy makers and planners for optimizing public-transport management, technologies, infrastructure, and operations: 4.1 Study tour to visit selected public transport planners, policy makers, and service providers worldwide. *(Part I)* 4.2 Prepare policy/planning studies evaluating options for improving public bus transport systems in Beijing and Shanghai. *(Part II)*	- Number of visits successfully completed during study tours - Policy/planning study produced.	Quarterly, annual and final project reports	
Output 5 <u>Activities</u>	Enhanced scientific, technical, and industrial capacity in China relating to utilization of FCBs: 5.1. Hold national workshops *(Part II)* 5.2. Carry out annual competition for funding of projects relevant to commercialization of FCBs. *(Part II)*	- Number of successful workshops held - Number of funding awards made for relevant projects	Project reports Project files Publications produced	
Output 6 <u>Activities</u>	Increased awareness and acceptance of FCBs in China among key actors (government policy makers, news media, investors, etc.), as well as general public: 6.1. Conduct national seminars *(Part II)* 6.2. Attend national and international meetings to present project findings *(Part II)* 6.3. Carry out public relations campaign. *(Part II)*	- Number of local, national and international workshops/ seminars held and attended - Number of professional publications produced - Number of reports in media		

	(1) Programme or project summary	(2) Indicators	(3) Means of verification	(4) External factors (assumptions and risks)
Output 7	Develop detailed strategy for scale-up and commercialization of FCBs in China:			
<u>Activities</u>	7.1. Organize information exchange workshops *(Part II)* 7.2. Carry out feasibility studies for candidate cities to support Phase III project. *(Part II)* 7.3. Develop conceptual design for a Chinese FCB *(Part II)* 7.4. Carry out assessments of options for large-scale FCB fuel supply and standards and codes. *(Part II)* 7.5. Develop document defining detailed strategy for Phase III. *(Part II)*	- Number of workshops held - Number of feasibility studies prepared - Documentation of Chinese FCB design - Reports on large-scale fuel supply options. - Phase III strategy documents written.	Workshops held Reports prepared	
Inputs	- 4-year/6-bus test in Beijing and in Shanghai. - Steam reformed natural gas as source of H_2 in both Beijing and Shanghai. Cost: US$31.758m			

Annex C: STAP Roster Technical Review

Reviewer comments on Project Brief
"Demonstration for Fuel Cell Bus Commercialization in China"
Dr. Sivan Kartha

In the opinion of this reviewer, this project should be approved.

The project is well-conceived, technically sound, and consistent with the relevant GEF Operational Programs (7 and 11). It advances global (GHG) and regional (urban air pollution) environmental goals. There is a strong likelihood that it will contribute to broader replication of an important low-GHG technology, and ultimately to its commercial viability. Meanwhile, it will also enhance local scientific, technical, industrial, and policy-making capacity. The considerable degree of local stakeholder investment and involvement attests to the local benefits.

The six criteria specific to GEF FCB Phase II activities are satisfied.
(1) Climate benefits would result from the intended fueling system – hydrogen production from natural gas.
(2) The project is directly aimed at further replication, (although it is difficult to quantify the future role for multilateral and GEF funding – this depends on how quickly the cost of FCBs is bought down, which in turn depends on the commercialization efforts outside the project).
(3) China is clearly committed reducing transport-related urban air pollution. This project builds on existing efforts and further enhances them through Activity 4.
(4) Significant cost-sharing is demonstrated by the Chinese local and national governments and the private sector.
(5) The indicators are adequate, although it is recommended that two further ones be added, as discussed below.
(6) The five GEF FCB projects are represent sufficient geographic diversity.

This reviewer has some recommendations, which follow from the following observation. The objective of the project is to achieve long-term benefits by launching an FCB market in China and four other developing countries. A key premise is that the project will induce learning (technological, manufacturing, and institutional), helping to buy down the costs of FCBs and make them commercially viable. However, it is also clear that the GEF efforts alone are not of sufficient scale to fully buy down the cost of FCBs. The estimate in *Toward a GEF Strategy to Develop FCBs…* suggests that the number of buses in the five Phase II projects is less than 2% of the number needed to buy down the cost. And assuming the project is successful, and helps to push the FCB on a trajectory toward commercialization in the next decade or so, the cumulative production of FCBs should approach *several hundred* by the time Phase II activities are wrapping up in 2006-7. This small project is valuable in part because of its minor contribution to cumulative production, but more so because of its *potential to catalyze further FCB activity*.

Putting the Phase II activities in this context suggests that the project might increase its impact if it were designed more explicitly to catalyze and support additional FCB activity. The reviewer therefore recommends that this catalytic effect be adopted as an explicit objective of the Phase II project. Some relatively minor adaptations of the project are recommended that would help to enhance this catalytic effect.

I. A stated objective of this project is to build capacity in developing countries. As pointed out in the discussion of FCB costs in section 1.8 of the project brief, the development of a developing country market for FCBs will almost certainly require FCB technology to be indigenized. It might therefore be advisable to build more explicit technology transfer and capacity building for FCB production into this phase of the project. In particular:

> a) The project could make the *technical* involvement of domestic industry an explicit priority. In particular, the call for tenders could require a *substantial* domestic involvement in providing the fueling infrastructure and FCB production. "Substantial" might be explicitly defined to mean involvement in the technical components, not merely site construction and production of standard bus components. To the extent that foreign firms are involved, the criteria for evaluating bids could be defined so as to require joint ventures or licensing agreements with domestic firms. This should not overly compromise the project, as the project

brief (section 1.7) points out that China (perhaps more so than the other FCB host countries) has a considerable indigenous fuel cell capacity, including an incipient FCB program. It also mentions that an all-Chinese bid is conceivable.

b) The project could invest more resources in technology transfer. Activities that include an element of technology transfer include Activity 2.5 (small international meeting and newsletter), Activity 4.1 (international study tours), and Activity 6.2 (almost annual international meetings). They amount to relatively minor activities, and a fairly trivial component of the entire project budget. The bulk of the effort aimed at building technical capacity is exclusively domestic (Activities 5 and 6). This might call for considering more extensive efforts, such as longer-term exchanges or fellowships with foreign government and academic laboratories researching fuel cells and fuel processing, scholarships for attendance at major fuel cell events (e.g., Groves symposium), and internships with private sector firms. The project could also take more direct steps to foster joint ventures and other private sector or public-private collaborations, as has been done with some success in other industries (e.g., the renewable energy industry). If there were a rapid build-up of indigenous capacity, prospects would be greatly improved for the timely emergence of developing country FCB markets.

II. The project could have a strong catalytic affect if it actively attempted to spur further demonstration projects. Indeed, this might well be necessary if this project is to help trigger enough cumulative production to keep the FCB on track to commercialization.

a) This FCB project could be very actively promoted as a demonstration, not just for two Chinese cities but for the world – both developing and developed. Funded outreach to other countries is a minor component of the project (part of Activities 2.5, and 6.2), but could be expanded. Funding for could be set aside for outreach (and perhaps study tours) aimed at prospective project developers from other developing countries.

b) If it is deemed a useful advertising tool, project FCBs could perhaps be “toured”, or otherwise made available for short-term demonstration outside of their home cities. This might interfere with the goal of gathering data under standard operating conditions, but the catalytic effect might justify it.

c) Perhaps most importantly, Annex II activities should be catalyzed. It can be assumed that the bulk of the effort to buy down FCB costs will be born by Annex II private and public sector investment. As the GEF activities will initially be the largest FCB activities in operation, they will be in a position to play a considerable catalytic role. The project should consider how best to achieve this. Part of executing this role successfully will be demonstrating the safety of the on-site hydrogen production system and on-board hydrogen storage and use.

With respect to these points, two further indicators are suggested. The first relates to the fact that the commercialization of FCBs will be on target if the total cumulative production of FCBs considerably outnumbers the ~50 GEF-funded FCBs the close of Phase II. Cumulative production of FCBs can then be taken as an indicator of the success of the project and the appropriateness of initiating Phase III.

The second relates to the fact that the commercialization of FCBs will almost certainly rely on developing country production capability. The production capability in China (or perhaps, in the five GEF FCB host countries combined) can be taken as an indicator of the effectiveness of the project and the appropriateness of initiating Phase III. If all goes well over the next 6-7 years, production capability will be measured in terms of FCBs already built by GEF FCB host country firms, but more likely it will be measured in more qualitative terms: technical skills acquired, manufacturing experience, plant facilities, joint ventures, negotiated licensing agreements, etc.

Annex C-1 Response to STAP Roster Reviewer's Comments

The Reviewer feels that the project is well-designed and should be approved. However, three specific suggestions are made with respect to improving the project's reach and impact. These points are listed below, together with the way in which they will be considered under further project preparation.

1) Increase Chinese involvement in the production of even the initial buses:

This suggestion is designed to encourage greater Chinese participation in the industrial venture and to accelerate the uptake of the technology in China. In general, it is a good idea for these buses to be produced through joint venture companies. There is nothing in the project to prohibit this from taking place. However, it is also not required by the terms of the procurement. The question of requiring a foreign-Chinese joint venture will be considered as the project document undergoes further preparation. While UNDP would encourage such arrangements to accelerate the "Sino-ization" of the technology, further consultations will be undertaken to determine and agree upon the advisability of making this a requirement. In addition, one of UNDP's roles is to monitor the intellectual property rights question – to the maximum extent possible.

2) Focus greater efforts on demonstration activities and communication outreach:

This is a constructive suggestion made in the hopes of accelerating the uptake and production of FCBs in China and elsewhere. As far as adding workshops and information sharing activities, this will be considered further during project document preparation. The project has a number of such activities already. Above and beyond these activities, as one of UNDP's responsibilities in the supervision of this program, UNDP will share experiences and lessons between all five countries participating in the project. In addition, the suggestion has been made that UNDP establish "twinning" arrangements between the 5 cities participating in its program and the various cities in Europe, North America, and Australia that are participating in other FCB demonstration projects. This will all be considered as the projects proceed. However, the suggestion that the UNDP-GEF FCB's engage in a China-wide "road-show" to carry the demonstration to other cities cannot be undertaken until the requisite number of vehicle-km are completed for fear of upsetting the experimental design of the project. After those vehicles have completed the tests, then the buses may be taken to other cities for shorter-term demonstrations. However, during their tests, personnel from the transport agencies in other cities in China will be encouraged to visit the project sites in Beijing and Shanghai.

3) Increase indicators to include Buses produced within and outside developing countries:

This suggestion will be taken on-board. It is worth noting however, that there are already more than 60 FCBs that are either in operation or are under production to be placed in operation over the next two years in Europe, North America, and Australia.

Annex D: Detailed Budget Estimate
Part I

Part I	COSTS (1000 USD)			FINANCING SOURCES (1000 USD)						
Activity	**Shanghai**	**Beijing**	**Total**	**MOST**	**Shanghai**	**Beijing**	**Private**	**UNDP**	**GEF**	**TOTAL**
1.1 Communications and site visits	**46**	**46**	**93**	**-**	**46**	**46**	**-**	**-**	**-**	**93**
1.2 Develop peformance specifications	**23**	**23**	**46**	**46**	**-**	**-**	**-**	**-**	**-**	**46**
1.3 Issue call for tenders (buses + fuel system)	**25**	**25**	**50**	**-**	**-**	**-**	**-**	**50**	**-**	**50**
1.4 Buy and operate fueling systems	**1,419**	**1,368**	**2,786**	**1,200**	**819**	**768**	**-**	**-**	**-**	**2,786**
Vendor communications/visits	48	48	95	-	48	48	-	-	-	95
Buy H2 production by steam reforming CH4	561	510	1,071	-	561	510	-	-	-	1,071
Buy hydrogen storage	150	150	300	-	150	150	-	-	-	300
Refit vehicles	60	60	120	-	60	60	-	-	-	120
Monitoring system	600	600	1,200	1,200	-	-	-	-	-	1,200
Operate and maintain (4 years)										
Reformer maintenance	-	-	-	-	-	-	-	-	-	-
Operating personnel	-	-	-	-	-	-	-	-	-	-
1.5 Buy and operate first batch of buses	**5,781**	**5,705**	**11,487**	**2,939**	**1,103**	**967**	**1,105**	**-**	**5,373**	**11,487**
Buy buses	3,346	3,346	6,691	989	194	135	-	-	5,373	6,691
Buy spare parts	553	553	1,105	-	-	-	1,105	-	-	1,105
Import duties (25%)	975	975	1,950	1,950	-	-	-	-	-	1,950
Operate and Maintain (4 years)			-							
Electricity	134	120	254	-	134	120	-	-	-	254
Natural Gas	302	247	549	-	302	247	-	-	-	549
Water	1	1	2	-	1	1	-	-	-	2
O&M wages	472	464	936	-	472	464	-	-	-	936
1.6 Buy and operate second batch of buses	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Buy buses	-	-	-	-	-	-	-	-	-	-
Buy spare parts	-	-	-	-	-	-	-	-	-	-
Import duties (25%)	-	-	-	-	-	-	-	-	-	-
Operate and Maintain (3 years)										
Electricity	-	-	-	-	-	-	-	-	-	-
Natural Gas	-	-	-	-	-	-	-	-	-	-
Water	-	-	-	-	-	-	-	-	-	-
O&M wages	-	-	-	-	-	-	-	-	-	-
TOTAL ACTIVITY 1	**7,294**	**7,167**	**14,462**	**4,185**	**1,968**	**1,781**	**1,105**	**50**	**5,373**	**14,462**
2.1 Formulate guidelines for reporting	**-**	**-**	**36**	**-**	**18**	**18**	**-**	**-**	**-**	**36**
2.2 Data collection and evaluation	**27**	**27**	**53**	**-**	**27**	**27**	**-**	**-**	**-**	**53**
Design system of data information	20	20	40	-	20	20	-	-	-	40
Purchase data collection equipment	7	7	13	-	7	7	-	-	-	13
Manage data collection system (4 years)	-	-	-	-	-	-	-	-	-	-
Data collection operating labor (4 years)	-	-	-	-	-	-	-	-	-	-
Lifecycle analyses	-	-	-	-	-	-	-	-	-	-
2.3 Surveys of ridership or focus groups	**11**	**11**	**22**	**-**	**11**	**11**	**-**	**-**	**-**	**22**
2.4 Prepare semi-annual reports (5 years)	**6**	**6**	**12**	**-**	**6**	**6**	**-**	**-**	**-**	**12**
2.5 Exchange information with other projects	**11**	**11**	**22**	**-**	**11**	**11**	**-**	**-**	**-**	**22**
TOTAL ACTIVITY 2	**54**	**54**	**145**	**-**	**72**	**72**	**-**	**-**	**-**	**145**
3.1 On-the-job operator and mechanic training	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
3.2 Develop examination and certification program (in 3.1)										
TOTAL ACTIVITY 3	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
4.1 Study tour	**72**	**72**	**144**	**-**	**-**	**-**	**-**	**144**	**-**	**144**
4.2 Prepare policy and planning study	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
TOTAL ACTIVITY 4	**72**	**72**	**144**	**-**	**-**	**-**	**-**	**144**	**-**	**144**
5.1 Biennial national workshops (total of 2)	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
5.2 Annual funding competition	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
TOTAL ACTIVITY 5	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
6.1 National seminar	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
6.2 Attend national and international meetings	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
6.3 Advertising campaign	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
TOTAL ACTIVITY 6	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
7.1 Information exchange workshops	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
7.2 Phase III city feasibility studies	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
7.3 Conceptual design of Chinese FCB	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
7.4 Fuel supply assessments/protocols for large scale H2 use	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
7.5 Strategy document for Phase III and IV	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
TOTAL ACTIVITY 7	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
TOTAL ACTIVITIES COST			**14,751**	**4,185**	**2,040**	**1,853**	**1,105**	**194**	**5,373**	**14,751**
Contingency (5%)			**738**	**738**	**-**	**-**	**-**	**-**	**-**	**738**
Administrative costs (3%)			**442**	**-**	**-**	**-**	**-**	**-**	**442**	**442**
TOTAL PROJECT			**15,930**	**4,922**	**2,040**	**1,854**	**1,105**	**194**	**5,815**	**15,930**

Annex D: Detailed Budget Estimate (continued)
Part II

Part II	COSTS (1000 USD)			FINANCING SOURCES (1000 USD)						
Activity	**Shanghai**	**Beijing**	**Total**	**MOST**	**Shanghai**	**Beijing**	**Private**	**UNDP**	**GEF**	**TOTAL**
1.1 Communications and site visits	-	-	-	-	-	-	-	-	-	-
1.2 Develop peformance specifications	-	-	-	-	-	-	-	-	-	-
1.3 Issue call for tenders (buses + fuel system)	-	-	-	-	-	-	-	-	-	-
1.4 Buy and operate fueling systems	**1,228**	**1,034**	**2,262**	-	**1,228**	**1,034**	-	-	-	**2,262**
Vendor communications/visits	-	-	-	-	-	-	-	-	-	-
Buy H2 production by steam reforming CH4	-	-	-	-	-	-	-	-	-	-
Buy hydrogen storage	-	-	-	-	-	-	-	-	-	-
Refit vehicles	-	-	-	-	-	-	-	-	-	-
Monitoring system	-	-	-	-	-	-	-	-	-	-
Operate and maintain (4 years)										-
Reformer maintenance	1,074	880	1,954	-	1,074	880	-	-	-	1,954
Operating personnel	154	154	308	-	154	154	-	-	-	308
1.5 Buy and operate first batch of buses	-	-	-	-	-	-	-	-	-	-
Buy buses	-	-	-	-	-	-	-	-	-	-
Buy spare parts	-	-	-	-	-	-	-	-	-	-
Import duties	-	-	-	-	-	-	-	-	-	-
Operate and Maintain (4 years)	-	-	-							-
Electricity	-	-	-	-	-	-	-	-	-	-
Natural Gas	-	-	-	-	-	-	-	-	-	-
Water	-	-	-	-	-	-	-	-	-	-
O&M wages	-	-	-	-	-	-	-	-	-	-
1.6 Buy and operate second batch of buses	**4,805**	**4,754**	**9,559**	**1,662**	**736**	**739**	**1,095**	-	**5,327**	**9,559**
Buy buses	3,002	3,002	6,004	12	55	115	495	-	5,327	6,004
Buy spare parts	300	300	600	-	-	-	600	-	-	600
Import duties	825	825	1,650	1,650	-	-	-	-	-	1,650
Operate and Maintain (3 years)										
Electricity	100	90	190	-	100	90	-	-	-	190
Natural Gas	226	185	411	-	226	185	-	-	-	411
Water	1	1	2	-	1	1	-	-	-	2
O&M wages	351	351	702	-	354	348	-	-	-	702
TOTAL ACTIVITY 1	**6,033**	**5,788**	**11,821**	**1,662**	**1,964**	**1,773**	**1,095**	-	**5,327**	**11,821**
2.1 Formulate guidelines for reporting	-	-	-	-	-	-	-	-	-	-
2.2 Data collection and evaluation	**239**	**239**	**479**	-	**239**	**239**	-	-	-	**479**
Design system of data information	-	-	-	-	-	-	-	-	-	-
Purchase data collection equipment	-	-	-	-	-	-	-	-	-	-
Manage data collection system (4 years)	33	33	66	-	33	33	-	-	-	**66**
Data collection operating labor (4 years)	100	100	200	-	100	100	-	-	-	**200**
Lifecycle analyses	106	106	213	-	106	106	-	-	-	**213**
2.3 Surveys of ridership or focus groups	**44**	**44**	**87**	-	**44**	**44**	-	-	-	**87**
2.4 Prepare semi-annual reports (5 years)	**23**	**23**	**45**	-	**23**	**23**	-	-	-	**45**
2.5 Exchange information with other projects	**73**	**73**	**146**	-	**73**	**73**	-	-	-	**146**
TOTAL ACTIVITY 2	**379**	**379**	**757**	-	**379**	**379**	-	-	-	**757**
3.1 On-the-job operator and mechanic training	**198**	**198**	**397**	**397**	-	-	-	-	-	**397**
3.2 Develop examination and certification program (in 3.1)										
TOTAL ACTIVITY 3	**198**	**198**	**397**	**397**	-	-	-	-	-	**397**
4.1 Study tour	-	-	-	-	-	-	-	-	-	-
4.2 Prepare policy and planning study	**78**	**78**	**155**	-	-	-	-	**152**	-	**152**
TOTAL ACTIVITY 4	**78**	**78**	**155**	-	-	-	-	**152**	-	**152**
5.1 Biennial national workshops (total of 2)	-	-	**41**	-	-	-	-	**41**	-	**41**
5.2 Annual funding competition	**250**	**250**	**500**	**500**	-	-	-	-	-	**500**
TOTAL ACTIVITY 5	**250**	**250**	**541**	**500**	-	-	-	**41**	-	**541**
6.1 National seminar	-	-	**75**	**75**	-	-	-	-	-	**75**
6.2 Attend national and international meetings	**25**	**25**	**51**	**51**	-	-	-	-	-	**51**
6.3 Advertising campaign	-	-	**150**	**150**	-	-	-	-	-	**150**
TOTAL ACTIVITY 6	**25**	**25**	**276**	**275**	-	-	-	-	-	**275**
7.1 Information exchange workshops	-	-	**100**	**100**	-	-	-	-	-	**100**
7.2 Phase III city feasibility studies	-	-	**300**	**300**	-	-	-	-	-	**300**
7.3 Conceptual design of Chinese FCB	-	-	**656**	**656**	-	-	-	-	-	**656**
7.4 Fuel supply assessments/protocols for large scale H2 use	-	-	**160**	**160**	-	-	-	-	-	**160**
7.5 Strategy document for Phase III and IV	-	-	**100**	**100**	-	-	-	-	-	**100**
TOTAL ACTIVITY 7	-	-	**1,316**	**1,316**	-	-	-	-	-	**1,316**
										-
TOTAL ACTIVITIES COST			**14,627**	**4,150**	**2,343**	**2,152**	**1,095**	**193**	**5,327**	**15,260**
Contingency (5%)			**731**	**731**	-	-	-	-	-	**731**
Administrative costs (3%)			**440**	-	-	-	-	-	**440**	**440**
										-
TOTAL PROJECT			**15,798**	**4,881**	**2,343**	**2,152**	**1,095**	**193**	**5,767**	**16,431**

Annex D: Detailed Budget Estimate (continued)
Parts I & II

Parts I and II	COSTS (1000 USD)			FINANCING SOURCES (1000 USD)						
Activity	Part I	Part II	TOTAL	MOST	Shanghai	Beijing	Private	UNDP	GEF	TOTAL
1.1 Communications and site visits	**93**	**-**	**93**	**-**	**46**	**46**	**-**	**-**	**-**	**93**
1.2 Develop peformance specifications	**46**	**-**	**46**	**46**	**-**	**-**	**-**	**-**	**-**	**46**
1.3 Issue call for tenders (buses + fuel system)	**50**	**-**	**50**	**-**	**-**	**-**	**-**	**50**	**-**	**50**
1.4 Buy and operate fueling systems	**2,786**	**2,262**	**5,048**	**1,200**	**2,047**	**1,802**	**-**	**-**	**-**	**5,048**
Vendor communications/visits	95	-	95	-	48	48	-	-	-	95
Buy H2 production by steam reforming CH4	1,071	-	1,071	-	561	510	-	-	-	1,071
Buy hydrogen storage	300	-	300	-	150	150	-	-	-	300
Refit vehicles	120	-	120	-	60	60	-	-	-	120
Monitoring system	1,200	-	1,200	1,200	-	-	-	-	-	1,200
Operate and maintain (4 years)	-	-	-	-	-	-	-	-	-	-
Reformer maintenance	-	1,954	1,954	-	1,074	880	-	-	-	1,954
Operating personnel	-	308	308	-	154	154	-	-	-	308
1.5 Buy and operate first batch of buses	**11,487**	**-**	**11,487**	**2,939**	**1,103**	**967**	**1,105**	**-**	**5,373**	**11,487**
Buy buses	6,691	-	6,691	989	194	135	-	-	5,373	6,691
Buy spare parts	1,105	-	1,105	-	-	-	1,105	-	-	1,105
Import duties (25%)	1,950	-	1,950	1,950	-	-	-	-	-	1,950
Operate and Maintain (4 years)	-	-	-	-	-	-	-	-	-	-
Electricity	254	-	254	-	134	120	-	-	-	254
Natural Gas	549	-	549	-	302	247	-	-	-	549
Water	2	-	2	-	1	1	-	-	-	2
O&M wages	936	-	936	-	472	464	-	-	-	936
1.6 Buy and operate second batch of buses	**-**	**9,559**	**9,559**	**1,662**	**736**	**739**	**1,095**	**-**	**5,327**	**9,559**
Buy buses	-	6,004	6,004	12	55	115	495	-	5,327	6,004
Buy spare parts	-	600	600	-	-	-	600	-	-	600
Import duties (25%)	-	1,650	1,650	1,650	-	-	-	-	-	1,650
Operate and Maintain (3 years)				-	-	-	-	-	-	-
Electricity	-	190	190	-	100	90	-	-	-	190
Natural Gas	-	411	411	-	226	185	-	-	-	411
Water	-	2	2	-	1	1	-	-	-	2
O&M wages	-	702	702	-	354	348	-	-	-	702
TOTAL ACTIVITY 1			**26,283**	**5,847**	**3,932**	**3,554**	**2,200**	**50**	**10,700**	**26,283**
2.1 Formulate guidelines for reporting	**36**	**-**	**36**	**-**	**18**	**18**	**-**	**-**	**-**	**36**
2.2 Data collection and evaluation	**53**	**479**	**532**	**-**	**266**	**266**	**-**	**-**	**-**	**532**
Design system of data information	40	-	40	-	20	20	-	-	-	40
Purchase data collection equipment	13	-	13	-	7	7	-	-	-	13
Manage data collection system (4 years)	-	66	66	-	33	33	-	-	-	66
Data collection operating labor (4 years)	-	200	200	-	100	100	-	-	-	200
Lifecycle analyses	-	213	213	-	106	106	-	-	-	213
2.3 Surveys of ridership or focus groups	**22**	**87**	**109**	**-**	**55**	**55**	**-**	**-**	**-**	**109**
2.4 Prepare semi-annual reports (5 years)	**12**	**45**	**57**	**-**	**28**	**28**	**-**	**-**	**-**	**57**
2.5 Exchange information with other projects	**22**	**146**	**168**	**-**	**84**	**84**	**-**	**-**	**-**	**168**
TOTAL ACTIVITY 2			**902**	**-**	**451**	**451**	**-**	**-**	**-**	**902**
3.1 On-the-job operator and mechanic training	**-**	**397**	**397**	**397**	**-**	**-**	**-**	**-**	**-**	**397**
3.2 Develop examination and certification program (in 3.1)										
TOTAL ACTIVITY 3			**397**	**397**	**-**	**-**	**-**	**-**	**-**	**397**
4.1 Study tour	**144**	**-**	**144**	**-**	**-**	**-**	**-**	**144**	**-**	**144**
4.2 Prepare policy and planning study	**-**	**155**	**155**	**-**	**-**	**-**	**-**	**152**	**-**	**152**
TOTAL ACTIVITY 4			**299**	**-**	**-**	**-**	**-**	**296**	**-**	**296**
5.1 Biennial national workshops (total of 2)	**-**	**41**	**41**	**-**	**-**	**-**	**-**	**41**	**-**	**41**
5.2 Annual funding competition	**-**	**500**	**500**	**500**	**-**	**-**	**-**	**-**	**-**	**500**
TOTAL ACTIVITY 5			**541**	**500**	**-**	**-**	**-**	**41**	**-**	**541**
6.1 National seminar	**-**	**75**	**75**	**75**	**-**	**-**	**-**	**-**	**-**	**75**
6.2 Attend national and international meetings	**-**	**51**	**51**	**51**	**-**	**-**	**-**	**-**	**-**	**51**
6.3 Advertising campaign	**-**	**150**	**150**	**150**	**-**	**-**	**-**	**-**	**-**	**150**
TOTAL ACTIVITY 6			**275**	**275**	**-**	**-**	**-**	**-**	**-**	**275**
7.1 Information exchange workshops	**-**	**100**	**100**	**100**	**-**	**-**	**-**	**-**	**-**	**100**
7.2 Phase III city feasibility studies	**-**	**300**	**300**	**300**	**-**	**-**	**-**	**-**	**-**	**300**
7.3 Conceptual design of Chinese FCB	**-**	**656**	**656**	**656**	**-**	**-**	**-**	**-**	**-**	**656**
7.4 Fuel supply assessments/protocols for large scale H2 use	**-**	**160**	**160**	**160**	**-**	**-**	**-**	**-**	**-**	**160**
7.5 Strategy document for Phase III and IV	**-**	**100**	**100**	**100**	**-**	**-**	**-**	**-**	**-**	**100**
TOTAL ACTIVITY 7			**1,316**	**1,316**	**-**	**-**	**-**	**-**	**-**	**1,316**
TOTAL ACTIVITIES COST	**14,751**	**14,627**	**30,013**	**8,335**	**4,383**	**4,005**	**2,200**	**387**	**10,700**	**30,010**
Contingency (5%)	**738**	**731**	**1,469**	**1,469**	**-**	**-**	**-**	**-**	**-**	**1,469**
Administrative costs (3%)	**442**	**440**	**882**	**-**	**-**	**-**	**-**	**-**	**882**	**882**
TOTAL PROJECT	**15,930**	**15,798**	**31,728**	**9,804**	**4,383**	**4,005**	**2,200**	**387**	**11,582**	**32,361**

Notes for Detailed Budget Estimate

(8.3 Yuan RMB per USD assumed)

ACTIVITY 1

Activity 1.1*:* Undertake communications and site visits to as many potential fuel-cell engine suppliers as possible and (if appropriate) selected bus manufacturers.

1) *For Fuel-cell Engine information:*
   International: Visit Ballard (Canada), Siemens(Germany), IFC & GM (USA), De Nora (Italy);
   4 days/city x 3 experts x 4 cities = 48 Expert.day
   Salary: 5000/22 x 48 =10910
   Traveling fee: 3 experts x 4000 = 12000
   Lodging fee 200 x 48 = 9600
   Travel = $21,600; Salary = $10,910; Total = $32,510.

   In China: Geen Energy(Beijing), Good force (Shanghai), DICP (Dalian)
   4 days/city x 5 experts x 4 cities = 80 Expert.day
   Salary: 90 x 48 =7200
   Traveling fee: 5 experts x 8000/8.3=4819
   Lodging fee: 200 x 80/8.3 = 1928
   Travel = $9,128; Salary = $4,819; Total = $13,947.

2) *For bus information*:
   International: Evobus (Germany), Ford (USA);
   4 days/city x 3 experts x 4 cities = 48 Expert.day
   Salary: 5000/22 x 48 =10910
   Traveling fee: 3 experts x 4000=12000
   Lodging fee 200 x 48 = 9600
   Travel = $21,600; Salary = $10,910; Total = $32,510.

   In China Chuanchu, Hubei, Beijing, Shanghai
   4 days/city x 3 experts x 4 cities = 80 Expert.day
   Salary: 90 x 80 =7200
   Traveling fee: 5 experts x 8000/8.3 = 4819
   Lodging fee 200 x 80/8.3 = 1928
   Travel = $9,128; Salary = $4,819; Total = $13,947.

Total Activity 1.1: Travel = $61,456; Salary = $31,458; Total = $92,914.

Activity 1.2*:* Specify technical performance targets for the buses and fueling system.

1) *For Hydrogen supply information:*
   International: Germany, USA, France, Japan
   4 days/city x 3 experts x 4 cities = 48 Expert.day
   Salary: 5000/22 x 48 =10910
   Traveling fee: 3 experts x 4000=12000
   Lodging fee 200 x 48 = 9600
   Travel = $21,600; Salary = $10,910; Total = $32,510.

   In China:
   4 days/city x 5 experts x 4 cities = 80 Expert.day
   Salary: 90 x 80 =7200
   Traveling fee: 5 experts x 8000/8.3 = 4819
   Lodging fee 200 x 80/8.3 = 1928
   Travel = $6,747; Salary = $7,200: Total = $13,947

Total Activity 1.2: Travel = $28,347; Salary = $18,110; Total = $46,457.

Activity 1.3*: Issue call for tenders*

1) To make a bid: 4 experts x 5 days
   Salary: 90 x 4 x 5 = 1800
   Traveling fee: 4 x 2500/8.3 = 1205
   Lodging fee: 200 x 4 experts x 5 days /8.3 = 482
   Lunch and dinner: 4 expert x 5 days x 150yuan/8.3 = 361
   Rent a meeting room: 200yuan/unit x 2 units/day x 5 days/8.3 = 482
   Travel = $2,048; Other = $2,282
2) Discuss : 15 expert x 5 days
   Salary: 90 x 15 x 5 = 6,750
   Traveling fee: 15 x 2500 /8.3 = 4,518
   Lunch and Dinner: 15 experts x 5 days x 150yuan/8.3 = 1,355
   Lodging fee 200 x 15 experts x 5 days /8.3 = 1807
   Rent a meeting room 500yuan/unit x 2units/day x 5 days/8.3 = 600
   Paper, pen, photocopies, telephone, fax, etc = 1,200
   Travel = $7,680; Other = $8,550
3) Transfer bid to English:
   Subcontract: 8300/8.3 = $1000
4) Review the bid: 5 experts x 2 days
   Salary: 90 x 2 x 5 = 900
   Traveling fee: 2 x 2500 /8.3=600
   Lodging fee 200 x 5 experts x 2 days /8.3= 240
   Lunch and Dinner: 5 experts x 2 days x 150yuan/8.3=180
   Rent a meeting room 200yuan/unit x 2units/day x 5 days/8.3=240
   Travel = $1020; Other = $1,140

All above costs are for Beijing. Same costs for Shanghai.

TOTAL ACTIVITY 1.3: Travel = 2 x 10,748 = $21,496; Other = 2 x 11,972 = $23,944; Subcontract = $2,000. Total = $47,440.

Activity 1.4: Buy and operate fueling system.

Buy and install fueling system (1000 USD) *(all to be subcontracted except for item 1, for which split between travel and "other" expenses assumed to be same as in activity 1.1)*		**Shanghai**	**Beijing**	**Total**
1	Vendor communications/site visits	47.47	47.47	95
2	Methane steam reformer (installed price)	561	510	1070
3	H_2 storage	150	150	300
4	Refit vehicles	60	60	120
5	Monitoring system	600	600	1200
Operate and maintain for 4 years (1000USD) *(all included as "other" expenditure in budget summary)*				
1	Garage Depreciation	0	0	0
2	Reformer Maintenance	1073.6	880	1953.6
3	Operation Persons (8 person-year @40000 RMB/p-yr)	154.22	154.22	308.44
	Total	2646.5	2401.69	5048.19

Total Subcontract = $3,743,600; Total Travel = $63,000; Total Other = $1,237,730

<u>Activity 1.5</u>: Buy and operate first batch of buses

Investment costs (1000 USD) *(All subcontracts, except for item 3)*		**Beijing**	**Shanghai**	**Total**
1	3 FCB for each city @ $1.2million/FCB	3,600	3,600	7,200
2	Spare Parts	300	300	600
3	Import Duties (Mao:25%)	975	975	1950
Operating and maintaining costs, 4 years (1000 USD) *(All "other" category of costs in budget summary.)*				
4	Electricity	120.5	133.9	254.38
5	Natural gas	246.96	301.84	548.8
6	Water	0.72	0.84	1.56
7	O&M wages (see number of staff & salaries below)	464.1	472.3	936.4
Total		5707.26	5783.38	11,491.14

Number of staff and salary

	Beijing		Shanghai	
	No. of persons	Salary (10,000 RMB/person-yr)	No. of persons	Salary (10,000 RMB/person-yr)
Drivers	9	5.0	9	5.0
Repairmen	4	4.0	4	4.0
Technicians	3	6.5	3	7.0
Managers	2	7.9	2	8.0
Total	18	--	18	--
TOTAL WAGES OVER 4 YEARS		[(9*5)+(4*4)+(3*6.5) +(2*7.9)]*10000/8.3* 4 yrs = $464,096		[(9*5)+(4*4)+(3*7)+(2*8)] *10000/8.3* 4 yrs = $472,289

Total Subcontract = $7,800,000; Total Other = $3,475,880

<u>Activity 1.6</u>: Place second set of 3 buses in operation starting one year after the first set of buses begins operation. Operate second set of buses for 3 years. (Total O&M costs are ¾ of O&M costs for first batch of buses, which operates for 4 years.)

Investment costs (1000 USD) *(All subcontracts, except for item 3)*		**Beijing**	**Shanghai**	**Total**
1	3 FCB for each city @ $1.million/FCB	3,000	3,000	6,000
2	Spare Parts	300	300	600
3	Import Duties (Mao:25%)	825	825	1650
Operating and maintaining costs, 3 years (1000 USD) *(All "other" category of costs in budget summary.)*				
4	Electricity #	90.36	100.4	190.76
5	Natural gas #	185.22	225.97	411.2
6	Water #	0.54	0.63	1.17
7	O&M wages (see number of staff & salaries below)	348	354	702
Total		**4748**	**4805**	**9553**

ACTIVITY 2

Activity 2.1: Formulate guidelines for quarterly reporting

1) 2 experts x 0.5 month
   Salary: $90/day x 2 x 15 days = 2700
   5 years and 2 cities: 2700 x 5 x 2 = 27000
2) Translation of quarterly reports:
   200RMB/1000Words x 5000/issue x 4 issue/year x 5 years x 2 cities = 32000RMB = $4800
3) Post fee:40 issue x 200 RMB/issue = 8000RMB =1000 USD
4) Edit and Print: 40 issue x 600 RMB/issue = 24000 RMB = 3000 USD

Total: 35,800 USD ("Other")

Activity 2.2: Data collection and evaluation

1) Design System of Data Information
   System Design and Development
   5 expert x 2 month x 2 city = 20 expert.month
   20 expert.month x 2,000 USD/ expert.month = 40,000 USD
   Total: 40,000 USD (Subcontract)

2) Purchase System Equipment
   Computers: 4 (each city has 2) 15,000 x 4 /8.3 RMB/USD =7,300 USD
   Auxiliary Equipment: 50,000 RMB / 8.3 RMB/USD = 6,000 USD
   Total: 13,300 USD ("Equipment")

3) System Running and Management
   4 person(2 in each city) x 2 day/wk x 4 wk/mon x 12 mon/yr x 4 yrs = 1536 p-days = 69.8 p-mon
   69.8 x 8000 RMB/month / 8.3 RMB/USD = 66,600 USD
   Total: 66,600 USD ("Other")

4) FCB Data Collection
   6 person x 2 day/week x 4 week/month x 12 months/year x 2 city x 4 year = 4608 p-day = 208 person-mo
   Beijing: 208 p-mo x 8000 RMB/p-mo = 830,000 RMB = 200,000 USD (half Beijing, half Shanghai)
   Total: 200,000 USD ("Other")

5) Analysis of Life Cycle: Include FCB, conventional buses, LPG buses and CNG buses
   Experts: 5 expert x 12 month = 60 expert.month
   Fee: 60 x 2,000 USD = 120,000 USD
   Assistants: 8 person x 12 month = 96 person.month
   Fee: 96 x 8000 RMB / 8.3 RMB/USD = 92,530 USD
   Total: 212,530 USD ("Subcontract")

Totals: Other = $266,000; Subcontract = $253,000; Equipment = $13,300; TOTAL = $532,430

Activity 2.3: Collect survey data from general-public bus riders or focus groups, quarterly

2 experts x 15 days/quarter x 4 quarters x 2 city x 5 year = 1200 day = 54.5 expert.month
54.5 expert.month x 2000 USD = 109,000 USD
Total: 109,000 USD (Other)

Activity 2.4: Prepare semi-annual reports.

1) Writing Semi-annual Report
   1 expert x 2 month/year x 5 year x 2 city = 20 expert.month
   20 expert month x 2,000 USD/ expert.month = 40,000 USD
2) Translation of the Report
   20,000 word/issue x 2 city x 2 issue/year x 5 year = 400,000 word
   400,000 word 0.2 RMB/word / 8.3 RMB/USD = 10,000 USD
3) Print and Transmit the Report
   50 issue/city x 2 city x 600 RMB/issue / 8.3 RMB/USD = 7,300 USD

Total: $57,300 (Other)

Activity 2.5: Exchange experiences with other users of FCBs. Holding News Letter and an international seminar.

1) Writing, translating, printing and transmitting the News Letter
   Fee: (consulting activity 2.4) 110,000 USD
2) International Seminar: Representatives from countries of GEF FCB Project such as Brazil, Mexico, Egypt, India, etc. will be invited. Meanwhile, relevant representatives from USA, Canada, German, etc. will participate too. The scale of the meeting is about 40 persons, including 20 foreign representatives, lasting 3 days.

   Renting assembly room: 10,000 RMB x 3 day / 8.3 RMB/USD = 3,600 USD
   Simultaneous interpretation: 20,000 RMB/day x 3 day / 8.3 RMB/USD = 7,300 USD
   Compiling and print seminar files: 50,000 / 8.3 RMB/USD = 6,000 USD
   Traffic and communication: 20,000 RMB / 8.3 RMB/USD = 2,400 USD
   Travel costs, room/board for international participants: 2,500 USD/person x 10 person = 25,000 USD
   Travel costs, room and board of national representatives: 700 USD/person x 20 person = 14,000 USD
   Total: 58,300 USD

Total for Activity 2.5: $168,300 USD (Travel = $39,000; Other = $19,300; Subcontract = $110,000)

Activity 3

Activity 3.1: Working together with the suppliers, hold on-the-job training seminars for drivers and maintenance staff. According to experience of Brazil, they decided to train all drivers and maintenance staff there. The training of 12 repairmen endowed with special skill needs courses which last more than 2 months. But, in China, neither in Beijing nor in Shanghai because of large population, training of all people is not feasible. For example, at Shanghai No. 2 Motor Corporation, which will implement the FCB project, there are now 2000 drivers, 600 repairmen, 200 technicians, 380 managers and 80 oil suppliers. The persons to be trained are as follows:

	Beijing		Shanghai	
	Number of person	Income(10,000RMB/year)	Number of person	Income(10,000RMB/year)
Drivers	24	5.0	24	5.0
Repairmen	8	4.0	8	4.0
Technicians	6	7.0	6	7.0
Managers	4	8.0	4	8.0
Total	42	--	42	--

1) Wages for persons to be trained in each city
   Drivers: 24 * 50,000RMB * 1/6year / 8.3RMB/USD = 24,000 USD
   Repairmen: 8 * 40,000RMB * 1/6year / 8.3RMB/USD = 6,400USD
   Technicians: 6 * 70,000RMB * 1/6year/8.3RMB/USD = 8,400USD
   Managers: 4 * 80,000RMB * 1/6year/8.3RMB/USD = 6,400USD
   Total = 45,200 per city * 2 = $90,400

2) Expenses of teachers
Both national and international experts in the field of FCB will be engaged in teaching. Among them, there will be 8 international experts, including 2 persons dealing with Hydrogen System Techniques, 2 persons dealing with Fuel-cell System Techniques, 2 persons dealing with FCB System Techniques, 2 persons dealing with System Running and Control, and 8 national experts working with them. This training program will be held simultaneously in Beijing and in Shanghai.

International experts: 8 person * 0.5 person.month*1200 USD/day * 22 day = 105,600 USD
International experts travel costs: 8 person * 2000 USD/person =16,000 USD
International experts room & board: 8 person * 250 USD/person * 15 day =30,000 USD
National experts: 8 person * 0.5 person.month*4000 USD/day = 16,000 USD
National experts aircraft tickets and rooms: 8 person * 1000 RMB/day * 15 day + 8 person * 3000 RMB / 8.3 RMB/USD =17,400 USD
Total: 185,000 USD

3) Training fee: including print of teaching materials, field rent, training equipment rent.
Print of teaching materials: 60,000 RMB = 7,200 USD
Field rent: 5000 RMB/day * 50 day * 2 city = 500,000 RMB (60,200 USD)
Training equipment: purchasing 2 epidiascopes, etc. 10,000 USD
Total: 77,400 USD

4) interpreters(written and oral): 4,000 USD
5) compiling teaching materials: 40,000 USD

Total: $396,800 USD (Training)

Activity 3.2: (No extra expenses.)

Activity 4

Activity 4.1: Undertake study tour to visit selected public bus service companies worldwide. Organize 2 teams (one in Beijing and another in Shanghai) to visit public transit agencies in Canada, USA and Germany. Each team has 8 members, including 4 person from motor company, 1 person from Science and Technology Committee of local authority, 1 person from Ministry of Science of Technology and 2 experts.

International air tickets (including local travel): 8 person * 5,000 USD/person * 2 city = 80,000 USD
Quarter abroad: 8 person * 200 USD/day.person * 20 day * 2 city = 64,000 USD
Total: 144,000 USD (Travel)

Activity 4.2: Prepare a policy and planning study. Plan to set up an expert-group to study problems as follow: Survey the existing policies and experience on clear fuel motor, including FCB, both in domestic and overseas. Design of new concepts and new policies. Implement new policies and analyze the effect which may be brought by the implementation of new policies, including society, economy and environment.

Expenses of experts: 5 person * 5 month *50,000 usd/person.month = 125,000 USD
Expenses of information: 10,000 USD
Expenses of information print and publishing: 20,000 USD
Total: 155,000 USD (Other)

Activity 5

Activity 5.1. Organize national workshops for exchange of technical information relating to fuel-cell vehicles among relevant organizations, once every 2 years, total 2 times, each lasts 2 days. The scale of the meeting is 30 participants. Its contents mainly include: summarize the present condition of FCB, including problems existing, runtime, and the analysis of its effect. Meanwhile, experts in GEF headquarters will be invited to participate.

Travel expenses of representatives: 2 times * 30 person *3000 /8.3RMB/USD = 14,500 USD
Lodging of representatives: 2 times * 20 person *1000 RMB/person.day *2 day /8.3RMB/USD =9,600 USD
Rent for meeting room: 2 times * 5000 RMB/day *2 / 8.3RMB/USD = 2,400 USD
Experts of GEF:
international air tickets: 1 person * 4000 USD/person * 2 times = 8,000 USD
Room and board: 1person * 250 USD/person.day * 4 day * 2 times = 2,000 USD
Consultation fee: 1person * 1000 USD/person.day * 2 day * 2 times = 4,000 USD

Total: 40,500 USD (Travel = $34,100; Other = $6,400)

Activity 5.2: Organize an annual competition for funding of Chinese organizations aimed at accelerating the commercialization of FCBs in China.

1) Beijing:
   Cost of applied research: universities, 25,000 USD per year
   technical institutes:25,000USD per year
   Feasibility studies of setting up manufacturing facilities:10,000USD per year
   Development of business plans: 2,500USD per year
   4 yr x 62,500/yr = 250,000 USD
2) Shanghai:
   Cost of applied research: universities, 25,000 USD per year
   technical institutes:25,000USD per year
   Feasibility studies of setting up manufacturing facilities:10,000USD per year
   Development of business plans: 2,500USD per year,

4 yr x 62,500/yr = 250,000 USD

Total: 500,000 USD (Other)

Activity 6

Activity 6.1: Hold national seminar once aimed at public transport sector decision makers, other policy makers, media, investors and other key actors to raise their awareness and support for commercialization of FCBs. The scale of the meeting will be controlled within 100 person, the length of the seminar is 3 days, including to spent a day to visit the demonstration site.

Total cost = 74,600 USD (Other)

Activity 6.2: Participate in national and international meetings to make the results of the demonstration activities widely known in and out of China. Participate in relevant conferences 4 times in 5 years -- 2 in China and 2 out of China. Participants will include 2 representatives coming from Beijing and 2 from Shanghai.

1) Participate international conference:
   Traveling expenses: 4 person* 5000USD/person * 2 times =40,000 USD
   Room and board: 4 person *200 USD/person.day 3 day * 2 times =4,800 USD
2) Participate national conference:
   Traveling expenses: 4 person* 3000RMB/person * 2 times /8.3 RMB/USD =2,900 USD
   Room and board: 4 person *1000 RMB/person.day 3 day * 2 times /8.3RMB/USD =3,000 USD

Total: 50,700 USD (Travel)

Activity 6.3: Use information media (newspapers, TV, radio, billboards, internet site, etc.) to publicize results of the demonstration project and plans for future projects. The objective of this activity is to help gain widespread public support for the expansion of FCB programs in China and other countries.

Total: 30,000 USD/year * 5 year =150,000 USD (Other)

Activity 7

<u>Activity 7.1</u>*:* Conduct information exchange workshops and meetings involving representatives from cities that might participate in Phase III.

Workshops: 20 person* 2 day * 1000RMB/ 8.3 RMB/USD * 5 workshops = 24,096 USD
6 National meetings: 6 x (5000 USD rental of room + 3000 printing costs) = 48,000USD
Other expenses (estimated) = 28,000 USD

Total = 100,000 USD (Other)

<u>Activity 7.2</u>: Prepare Phase III feasibility studies for three candidate cities. 100,000 USD per study
Total = 300,000 USD (Subcontract)

<u>Activity 7.3</u>*:* Develop a conceptual design for a hydrogen-powered FCB that might ultimately be manufactured commercially in China. For this purpose, an expert group is needed, made up of hydrogen-powered fuel-cell system experts, electrical engineering experts, auto-control experts, automobile experts and economic analysis expert. The expert group will design the criteria of FCB, operation standard and maintenance guide.

National experts: 15 person * 16 person.month * 2000 USD/person.month = 480,000 USD
Foreign experts: 2 person * 4 person.month * 20000 USD = 160,000
Foreign expert travel costs: 2 persons * 8,000 = 16,000 USD

Total: 656,000 USD (Subcontract)

<u>Activity 7.4</u>*:* Develop fuel supply assessments for large-scale utilization of H_2 FCBs. For this purpose, a special study group is needed, which is planned to made up by 5 person.

Experts: 15 person * 4 expert.month * 2000 USD/expert.month =120,000 USD
Data collection and survey: 10,000 USD
Design and analysis of technique project: 10,000 USD
Design the criteria of hydrogen quality standard and security standard: 10,000 USD
Economic analysis of system technique and the drafting of budget: 10,000 USD

Total: 160,000 USD (Subcontract)

<u>Activity 7.5</u>*:* Prepare a document detailing a strategy for achieving commercial production of FCBs in China.
Total: 100,000 USD (Other)

INTERNATIONAL DEPARTMENT

MINISTRY OF FINANCE
Sanlihe, Xicheng District
Beijing 100820 People's Republic of China

MOF

中华人民共和国财政部

国 际 司

中国北京三里河南三巷3号100820

December 1, 2000

Ms. Kerstin Leitner
Resident Representative
UNDP

RE: GEF: Demonstration for Fuel Cell Bus Commercialization In China

Ms. Leitner:

As you may aware, the Government of China takes the environment protection as its priority in its new five-year and fifteen-year long-term Development Plan. Urban transit caused lots of air pollution in many large cities. Fuel cell bus is one of the promising options to resolve the problem. It may generate both local and global environment benefits and also lead to a sustainable solution to the urban public transit.

The captioned project will demonstrate the feasibility of commercialization of fuel cell bus in the Country, which fit in with the national development priority Therefore, I would like to endorse this project to apply GEF support.

Best regards.

Sincerely yours,

杨金林

(Jinlin Yang)
Operational Focal Point for China

CHN/99/G33

Kerstin/Yannick/Hon/Mikko

Mikko, pls fax/send this to UNDP/HQs. Tx.
Hon

Tel: (86-10) 6855 1133, 6855 1183 Fax: (86-10) 6855 1183, 6855 1125

Total Implementation Part I	**15.930**
Total Implementation Part II	**16.431**
Total Project Cost	**32.361**

4. OPERATIONAL FOCAL POINT ENDORSEMENT: (letter attached on final page)

Name: Jinlin Yang **Title**: Operational Focal Point for China
Organization: Ministry of Finance **Date**: December 1, 2000

5. IMPLEMENTING AGENCY CONTACT:

Name: Richard Hosier Title: Principal Technical Advisor, UNDP-GEF

Ramon Prudencio C. de Mesa
M:\RAMON\Work Programs\WP03-2001\China Fuel Cell Bus\1PROJECT BRIE1.doc
April 5, 2001 8:08 PM

Cover Note

Project Name: Demonstration for Fuel-cell Bus Commercialization in China
Date: 23 March 2001

	Work Program Inclusion	Reference/Note
1. Country Ownership		
• Country Eligibility		• Cover Sheet (Ratified UNFCCC 5 January 1993).
• Country Drivenness	Clear description of project's fit within: • National reports/communications to Conventions • National or sector development plans	• National priorities in this sector (Section 1.3) • National/sectoral development plans (Sections 1.4 – 1.7)
• Endorsement	• Endorsement by national operational focal point.	• OFP endorsement letter for this project is included in the brief (final page).
2. Program & Policy Conformity		
• Program Designation & Conformity	• Describe how project objectives are consistent with Operational Program objectives or operational criteria.	• Section 2.1 (GEF Strategy on FCBs) and Section 2.1 (OP 11).
• 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 partner.	• Sector issues in Sections 1.3 – 1.6); barriers in Section 1.2. • Annex B (pg. B-1 to B-3). • Objectives in Section 2.1; Outputs Section 3.1; Risks in Section 4.1; Indicators and assumptions Annex B. • Activities in Section 3.2; Outputs in Section 3.1. • Global benefits in Section 1.8 and Annex A • Annex A • Annex B pg. B1 describes global environmental benefits and related activities; Annex A provides costs. • Annex B pg. B1, and Annex A provides national and global impacts • Section 1.8 and Annex A. • Section 6 and Annex A details incremental costs sharing among partners.

	Work Program Inclusion	Reference/Note
	• 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.	• Section 6 and Annex A presents cost estimates, and Annex D provides a detailed budget estimate.
• Sustainability (including financial sustainability)	• Describe proposed approach to address factors influencing sustainability, within and/or outside the project to deal with these factors.	• Sustainability is addressed in Section 4 (4.2)
• 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).	• Replicability is addressed in the project description (Section 3, Activities 5, 6, and 7)
• 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 Section 5. • Ongoing stakeholder involvement is addressed in Section 5.

• 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.
		• Lessons learned are in Section 1.3, 1.5 and 1.7, and Section 2.
		• Monitoring and evaluation is described in Section 7.
		• Indicators and means of verification are addressed in Annex B.
		• M&E implementation in Section 5.2.
		• Reflected in total project cost (Annex D).

3. Financing		
• Financing Plan	• Estimate total project cost. • Estimate contribution by financing partners. • Propose type of financing instrument.	• Total project cost on page i, and in Section 6. Detailed breakdown in Annex D, detailing the 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.	• Annex A.
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 prepared by UNDP Section 2.1
• Consultation, Coordination and Collaboration	• Describe how the proposed project relates to activities of other IAs (and 4 RDBs) in the country/region.	• Section 1.3 informed by WB activities.

	Work Program Inclusion	Reference/Note
between IAs, and IAs and EAs, if appropriate.	• 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 draft 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