Global Environment Facility

GEF/C.28/Inf.12
June 2, 2006

GEF Council
June 6-9, 2006

UNDP-GEF FUEL-CELL BUS PROGRAMME:

UPDATE

(Prepared by UNDP)

United Nations Development Programme

UNDP-GEF Fuel-Cell Bus Programme:

Update

24 May 2006

UNDP-GEF Fuel-Cell Bus Programme: Update

Introduction

1. Since 2002, as requested by the Global Environment Facility (GEF) Council, UNDP has provided yearly progress reports on the implementation of the UNDP-GEF Fuel-Cell Bus (FCB) Programme. As in past years, the purpose of this year's report continues to be updating the status of these FCB projects and also providing additional information on the deployment of FCBs around the world. As recommended in the May 2005 Update, due to the reduced scope of the FCB Programme, annual reporting on the FCB Programme will cease after this Update.

2. This paper includes four main sections. The first section, which includes the same content as updates from the previous year, is intended to remind the reader of the objective and strategy of the FCB Programme. The second section presents recent developments in the FCB market and focuses on non-GEF FCB activities, as they greatly impact and inform the implementation of the UNDP-GEF FCB projects. The third section outlines the implementation status of each FCB project. The paper concludes with an outline of next steps.

1. Overview of the UNDP-GEF Fuel-Cell Bus Programme

3. To help catalyze the commercialization of FCB technology for urban areas of developing countries, the GEF and UNDP launched a program to set the stage for large-scale commercial deployment of FCBs in developing countries. The UNDP-GEF FCB Programme intended to support the commercial demonstrations of FCB and associated refueling systems in the largest bus markets in the developing world: Beijing, Cairo, Mexico City, New Delhi, Sao Paulo, and Shanghai. The Development Objective of the Program was to reduce the long-term greenhouse gas (GHG) emissions from the transport sector in GEF program countries. The achievement of this development objective involved GEF support for preparatory activities and demonstration projects. For the five projects, the total proposed GEF commitment was originally US$ 59.6 million, with approximately US$ 36 million approved by the GEF Council.

4. Through the support of FCBs in GEF program countries, the GEF has taken on a role as an important agent of technology transfer in support of the UNFCCC. By encouraging the early adoption of these buses in a process of "technological leapfrogging", UNDP-GEF intended to assist developing countries in gaining experience with FCBs early in its product cycle. GEF program countries would then develop partnerships with technology developers, thereby increasing technological competence and adapting the technology to local needs. GEF Program countries would also benefit from reduced local air pollution, new export opportunities attributable to local manufacturing, and improved quality of public transit service. Finally, the UNDP-GEF would also be assisting developing countries in preparing for a future transition to newer, cleaner and more efficient fuel-supply systems based on hydrogen.

5. The GEF's justification for participating in FCB projects was the reduced GHG emissions that FCBs offer over conventional diesel buses. Fuel cells fired by hydrogen can offer dramatic reductions in system-wide GHG emissions from the urban transport sector if the system is carefully designed. Although fuel cells are technically proven, they are not yet economically competitive in commercial applications: early investments in the technology were anticipated to reduce its costs to a commercially competitive level within 7 to 15 years. The volume of production required to attain this goal is estimated at between 2000 and 5000 buses, in both developed and GEF program countries. Once fully commercialized, the technology can then play an important role in the stabilization of GHGs by the year 2100, as represented in IPCC scenarios.[1]

6. The UNDP-GEF strategy for FCB commercialization involves a working partnership between GEF, private industry, and local/national governments in GEF Program Countries. The GEF plays three important roles. The first role is funding the incremental costs of FCB projects in recipient countries. The second is facilitating the process of FCB commercialization in developing countries by convening various parties to discuss, collaborate in, and finance the commercialization program. The final role is that of enabling information exchange within and between program countries, industry, and other FCB demonstrations in both donor and recipient countries. By assuming each of these roles, the GEF is placing a reciprocal responsibility on the counterparts in the partnerships. Their contributions to the partnership will include the provision of financing, cooperation, and information to the FCB development process.

7. To meet the development objective of this programmatic initiative, the UNDP-GEF strategy of support involves three distinct phases of support: (I) Preparatory Phase; (II) Demonstration Phase; and (III) Commercialization Phase. GEF is now funding Phase II — the Demonstration Phase — with countries in early implementation of full demonstration activities and proposals for follow-on commercialization work. Whether GEF support will continue to be warranted in Phase III will depend largely on the nature of the GEF's continuing role in climate change; the degree to which the developing country demonstrations have been successful; and the continued investment and interest in the technology within donor countries. Therefore, at present, it is not recommended to commit the GEF to one specific program of support for Phase III projects. Rather, the GEF must make an informed decision most likely between the years 2005 and 2007 (or more likely in the next 3 to 8 years).

[1] *Climate Change 2001: Mitigation* - Contribution of Working Group III to the third assessment report of the Intergovernmental Panel on Climate Change. Edited by B. Metz *et al.* 2001, p 240.

2. Major Fuel-cell Bus Demonstration Efforts

8. The FCB market in 2005/2006 continued to be active with demonstrations being conducted worldwide. As of May 2006, over 10 major demonstrations were either underway or in the advanced planning stages. Annex 1 provides information on program locations, number of FCBs and their manufacturers, and the fuel cell manufacturer (from the US Federal Transit Administration Report, Analysis of Electric Drive Technologies for Transit Applications and updated by Fuel Cells 2000). Also provided is a list tabulated by Fuel Cells 2000 detailing FCB activities worldwide, including information on bus manufacturer, operations, bus model, engine type, fuel cell size/type and manufacturer, range and speed (see Annex 2).

9. Currently there are over 60 FCBs operating worldwide, and cumulatively through the end of 2004 approximately 80 FCBs have operated on roadways (Figure 1). As described in the section below, major initiatives include those conducted by DaimlerChrysler-Ballard, the California Fuel-cell Bus Partnership, and Toyota, and several minor demonstrations worldwide.

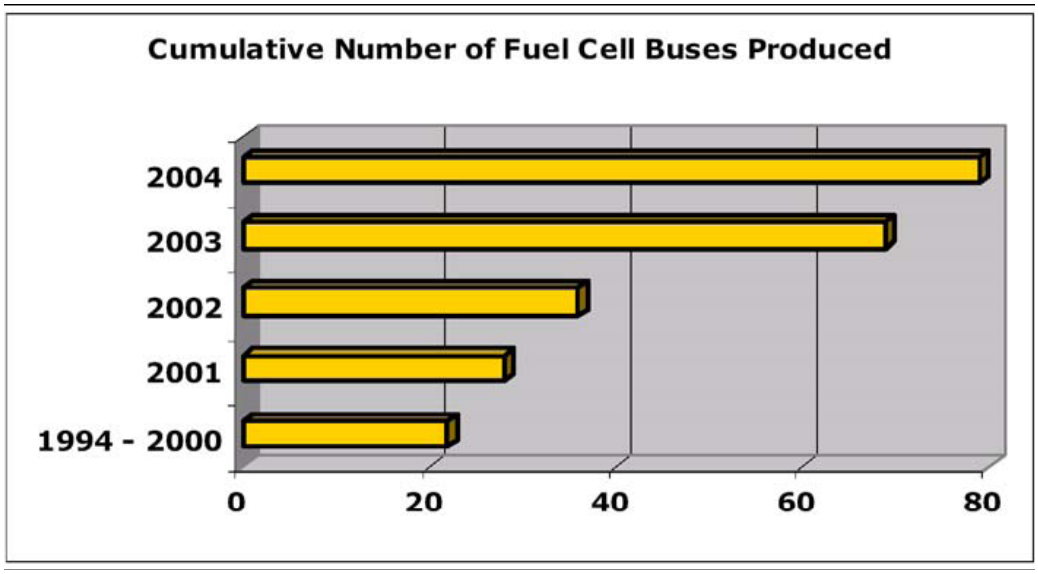

Figure 1. Cumulative Number of Fuel-cell Buses Produced through 2004
(source: K. Adamson, "Fuel Cell Market Survey: Buses," *Fuel Cell Today*, November 2004)
(www.fuelcelltoday.com).

2.1 DAIMLERCHRYSLER/BALLARD FCB DEMONSTRATION PROGRAM

10. The DaimlerChrysler-Ballard FCB demonstration program continues to be the largest in the world. Between the demonstrations of Clean Urban Transport for Europe (CUTE); Ecological City Transport System (ECTOS) in Reykjavik, and Sustainable Transport Energy for Perth (STEP) in Australia, 33 FCBs have been deployed in 11 cities. Buses were run in commercial service on normal public transportation routes.

11. Data on CUTE was collected on a number of performance measures including: reliability, economy, safety, and public acceptance. In addition, a life cycle analysis of costs and emissions from the FCBs was undertaken. Recently the CUTE program announced the results of two years of testing, a summary of which is provided in the Table below.

Table 1. Summary of CUTE Results: 2003 to 2005
(source: cute-hamburg.motum.revorm.com/download/CUTE_Brochure_SummaryAchivements_2006.pdf)

Project investment (Total)	€ 78 million
Project investment (European Commission)	€ 18.5 million
Number of European Cities/Countries	9/7
Number of buses	27
Number of maintenance facilities	2 (new); 7 (adapted from existing facilities)
Number and types of fuelling stations: 1. On site water electrolysis 2. On site steam reforming 3. External supply	 4 2 3
Hydrogen refuelled (total)	>192.000 kgs
Numbers of refuellings	>8.900
Kilometres driven	841.123 kms
Hours of operation	62.545 hours
Average speed	12,8 km/hr
Average fuel consumption	24,6 kg/100 km
Average bus availability	90%
Average refuelling station availability	87%
Passengers carried	>4 million
Number of major safety incidents	None
Number of minor safety incidents	100 (approx.)
Median time to achieve regulatory approval	10 months
Amount of diesel substituted by hydrogen	450.000 litres
Number of technicians/drivers trained	565
Number of presentations/events	946
Number of press articles	479
Number of TV/radio announcements	127
Number of hits on website	6,5 million
Average monthly visitors to website	2.750 (high of 3.500 in November 2005)
Aggregate downloads from website	45 Gigabytes

12. The CUTE report "Summary of Achievements" also presented lessons learned from CUTE, the main points of which are provided below.

- The CUTE FCBs operated in cities with a range of topographic, climatic (temperatures of -16C to 39C; 13% to 100% humidity) and traffic conditions. Particularly hilly routes had higher fuel consumption, including when the FCBs were driven downhill (higher consumption of fuel cells during idling). Traffic (number of stops, congestions, weight of passengers) all influenced bus performance, although greater investigation and analysis is required. Overall, the buses were found to be reliable under all conditions, and many

areas for optimization were identified. In particular, the CUTE program identified that "hybridization of the driveline, including regenerative braking, could save up to 20% of energy consumption, depending on driving conditions" (CUTE, 2006, page 19).

- From a life cycle perspective, hydrogen as the form of energy into the system is crucial to the efficiency of the system and to the degree that greenhouse gas emissions can be reduced. Using renewable energy carriers, as opposed to non-renewable sources (natural gas, electricity derived from fossil fuels), will help to reduce greenhouse gas emissions associated with the transport sector. In addition, for the CUTE prototypes "the environmental burdens during manufacturing are approximately twice the burdens caused during the manufacture of a state of the art diesel bus" (CUTE, 2006, page 25). Based on the results, strategies for improvements are being formulated including addressing the need to reducing the environmental footprint.
- Hydrogen supplied by electrolysis met expectations, although hydrogen generated from natural gas experienced some technical difficulties. Overall, refueling stations had an availability of over 80%, and generated 120,000 kg of hydrogen on-site. According to the CUTE report, over 56% of the on-site hydrogen was generated from renewable energy through the use of "green" electricity. Hazards associated with hydrogen can be adequately managed, as CUTE has no safety incidents during the two year demonstration.
- Training and information dissemination activities were a major objective of CUTE. Over 550 drivers and 30 refuelling station staff were trained. Several passenger/customer surveys showed that hydrogen technology was widely supported, and fewer concerns about hydrogen as a fuel were encountered. Outreach and educational activities focusing on FCBs and technology awareness highlighted that close cooperation with schools was beneficial for the development of educational material and their integration within regular curriculum. The CUTE also identified that there is a major need for education and training for regulators, and ongoing public education and information programs.

13. Updated information on the achievements of the CUTE/ECTOS/STEP project are made available to members of the "Fuel Cell Bus Club", and aggregate information is also made available more widely through workshops, in newsletters, and on the internet (see www.fuel-cell-bus-club.com).

2.3 Japan Hydrogen & Fuel Cell Demonstration Project

14. Japan Hydrogen & Fuel Cell Demonstration Project (JHFC) is organized by the Japanese Ministry of Economy, Trade and Industry, and involves a wide range of activities related to the use of fuel cell vehicles. With 8 FCBs, Toyota has the second highest total number of fuel cell engines operating in buses on the road today, and Toyota is also targeting 2010 for reaching commercial viability.

15. In collaboration with Toyota and the bus manufacturer, Hino, and with support from the Japanese government, FCB demonstrations have been completed in Tokyo (1 unit Toyota/Hino FCHV-Bus2; August 2003 to December 2004) and Aichi (8 units Toyota/Hino FCHV-Bus; March to September 2005), where over 1 million people rode the FCBs at the World Exposition. Some results and analysis of the various fuel cell initiatives were recently presented as part of the 4th JHFC Seminar for FY05 (for more information see: www.jhfc.jp/e/data/seminar_report/index.html).

2.2 CALIFORNIA FUEL CELL PARTNERSHIP FCB DEMONSTRATIONS

16. California continues to lead the US-based FCB demonstration efforts. The California Fuel Cell Partnership (CaFCP) is a collaboration of 31 members (including automobile manufacturers, energy providers, government agencies, fuel cell technology companies and transit authorities) that have come together to promote the commercialization of hydrogen fuel cell vehicles.

17. Three California transit agencies operate the CaFCP demonstration sites: SunLine Transit Agency (Coachella Valley), Santa Clara Valley Transportation Authority (Silicon Valley), and AC Transit (Northeast San Francisco Bay):

- At the beginning of 2005, Santa Clara VTA started operating three buses powered by Ballard Power Systems fuel cells (forty-foot FCBs with 205 kW Ballard fuel cell engines integrated with Gillig chassis);

- In September 2005, AC Transit's FCBs completed their testing at ISE Corporation, which included traveling at speeds of up to 70 mph and running on steep grades. These three Van Hool buses are powered by UTC fuel cells and were integrated by ISE (forty-foot buses with PC40 120 kW PEM + 100 kW nickel-sodium chloride battery), and also have regenerative braking. Recently, these FCBs joined the AC Transit fleet and entered regular service; and,

- SunLine Transit Agency also has a new 40 foot FCB that has been in operation since it was unveiled in November 2005. SunLine operates a Van Hool bus using ISE Corporation integration and UTC fuel cell technology, and a bus similar to the AC Transit buses but with a composite body made by North American Bus Industries (NABI).

2.4 Worldwide FCB DEMONSTRATION ACTIVITIES

19. A number of other FCB demonstration activities are either ongoing or planned worldwide. These initiatives are listed in Annexes 1 and 2, with some additional details on key initiatives provided below by country:

- *China (separate from UNDP/GEF)* - The "863 Program" (named for the date it was originally created, March 1986) of the Ministry of Science and Technology is funding US$106 million of hybrid-electric drive and fuel cell vehicle development work during 2001-2005. Private companies are investing an estimated additional $200-300m during this period. The emphasis of the 863 program is on demonstration, commercialization, and support of the Chinese vehicle industry (as distinct from fundamental R&D, which is supported under the separate "973 Program"). Most of the $106 million of 863 funds are being spent on buses (rather than cars), as well as on H_2 production and storage technology. The immediate goal is to develop two full-size 150 kW FCBs by 2005 and three prototype 50 kW FC cars. The 2008 Olympics in Beijing and the 2010 World Expo in Shanghai are viewed as key opportunities to show case Chinese FCB development efforts and major demonstrations of vehicles are likely around these events.

- *Canada* - With support from Natural Resources Canada, and partnering with New Flyer Bus Company, Hydrogenics has developed a 40-foot hybrid FCB (180 kW PEM plus regenerative braking and ultra-capacitors) for demonstration and testing in Winnipeg

beginning in Fall 2006. This FCB will include Dynetek's hydrogen storage tanks, ISE Research's control technologies for energy management and systems integration, and Maxwell Technologies ultra-capacitors for electrical energy storage. In addition, the Canadian government is targeting a larger in-service fleet demonstration in Whistler, British Columbia. With a planned fleet of 20 FCBs in service by 2009, these 40 foot FCBs will require a hydrogen production supply capacity of 1000 kg/day minimum with fast fueling (8 to 10 minutes per bus).

- *United States, Federal Transit Administration* - The FTA has launched a National Fuel Cell Bus Program (NFCBP), intended to facilitate the development of commercially viable fuel cell bus technology and related infrastructure. Under a competitive selection process, the FTA will enter into grants, contracts and agreements with up to 3 regionally diverse non-profit organizations. Overall, $49 million will be made available from FY 2006 to FY 2009 ($11,250,000 –FY 2006; $11,500,000 –FY 2007; $12,750,000 –FY 2008; $13,500,000 –FY 2009). A 50% cost share will be required (i.e., Federal share not to exceed 50% of the program costs). With the objective of the NFCBP to facilitate the pathway to commercialization, the following targets have been established:

    - durability of 4 to 6 Years/20,000 to 30,000 hours;
    - bus cost of <5x comparable transit bus;
    - reliability of >90% availability;
    - fuel efficiency of 2 times comparable transit bus;
    - emissions to exceed 2010 EPA Standards; and enhanced public acceptance.

- *United States, Air Force* - In February 2004, the United States Air Force took delivery of a 30 foot hybrid FCB with a 20 kW Hydrogenics FC engine at its Hickam, Hawaii base. One year of demonstration and testing was planned, to be followed by routine service use of the bus.

- *United States, Georgetown University* – Georgetown, with the longest continuing fuel cell vehicle development program in the world, has long maintained demonstration efforts with methanol fuel cell buses (using on-board reforming of methanol) in hybrid configuration with batteries. Georgetown has launched a multi-phase Generation III Program. The first phase of this program focuses on the Methanol Fuel Cell System, and is anticipated to run from 2005 to 2007. The goal is to have >50 kW net power output, high power density, low weight and size, rapid response rate, fast start-up, and quiet, low emissions. Next steps are to overcome the weight and reliability issues; demonstrate commercialization configuration; and to provide a cost-effective approach.

3. UNDP-GEF Programme Implementation

3.1 BRAZIL

18. The Consortium agreement for the Brazil FCB project was signed in June 2005. The Consortium, called "Consortium for the Implementation of the UNDP/GEF Project ´Hydrogen Fuel Cell Buses for Urban Transport in Brazil´", is formed by the following companies: Nucellsys GmbH (formerly Ballard Power Systems AG); Ballard Power Systems Inc.; Eletropaulo Metropolitana Eletricidade de São Paulo; EPRI International Inc, Marcopolo S.A., Petrobras Distribuidora S.A., Hydrogenics Corporation (formerly Stuart Energy Systems Corporation), and Tuttotrasporti Comércio de Veículos e Implementos Rodoviários Ltda.

19. As of April 28, 2006, all participating companies have signed the commercial contract with UNDP for the supply of the buses and the hydrogen infrastructure. With the procurement agreement now signed, the Inception Ceremony is scheduled to take place in Sao Paulo in July 2006 thereby marking the official beginning of the project. The First Technical Meeting of the Project is also planned for July 2006, to coincide with the official launch. All enterprises under the Consortium will be represented.

20. A substantial revision to the UNDP-GEF project was undertaken last year, and included an extension of the project according to the new workplan and revised budget. The project is now anticipated to continue implementation until 2010 according to the following schedule:

Milestones	***Schedule***
Completion of the prototype	June 2007
Completion of the verification test protocol	February 2008
Preparation of next phase proposal and decision making process	March 2008
Launch of production buses	November 2008
Project completion	2010

21. During 2005/2006 the Communication Strategy has been negotiated between UNDP and the suppliers. This strategy includes agreements on press releases and the use of logos.

22. The Brazil project continues to be involved in the international FCB network. Representatives from the Brazil project recently participated in the CUTE "The Future of Transportation is Clean" (May 10 to 11, 2006 in Hamburg, Germany), where experiences with FCBs and hydrogen infrastructure operation in the CUTE project were discussed.

3.2 CHINA

23. The project "*Demonstration for Fuel-Cell Bus Commercialization in China*" began active procurement activities in late 2003, under the China International Center for Economic and Technical Exchanges (CICETE). Bids were evaluated in May 2004 and, after extensive negotiations, a contract was signed with DaimlerChrysler for three Citaro buses. In July 2005, the pre-acceptance of the delivery of the FCBs was completed. This phase, conducted in Germany, involved a national delegation consisting of the national PMO, CICETE, Beijing Public Transit Co., Tsinghua University and China Automotive Technology & Research Center officers and other experts. The delegation focused on testing vehicle mobility, breakability and drive stability. Testing was conducted on each bus, and included a vehicle performance on-site test and a 50 km driving complex performance test. During the 50 km test the maximum speed reached was 70km/h and the accumulated distance was 55km. Overall, test results confirmed that the three FCBs met the requirements according to the procurement contract. The pre-acceptance document was signed by the delegation after the test, and the FCBs departed Germany at the end of July for and delivered in China in mid-September.

Figure 1. FCB undergoing pre-acceptance testing in Germany

24. During the opening of the "4th International Clean Vehicle Technology Conference and Exhibition" on November 23, 2005, three hydrogen-powered FCBs were introduced officially in Beijing. These buses, which are similar to those being demonstrated under the Clean Urban Transport for Europe (CUTE) program, then entered the preparatory and testing phase that is currently underway.

Figure 2. Official introduction of the three FCBs in Beijing on November 23, 2005

25. Additional highlights from 2005/2006 include the following:

- The 6th Coordination Meeting of the Beijing Project was held on August 2, 2005. The following were represented: Beijing Municipal Science & Technology Commission, CICETE, Beijing Public Transport Company, Sinohytec Company, DC, BP, UNDP and the Project Management Office;
- The management mode and operational guidelines have been developed for the fourth bus company of Beijing Public Transport Company, which will take responsibility of operation issues;
- A ridership survey, conducted in July 2005, was completed in August 2005;
- A data collection system (hardware and software) has been completed at the end of August 2005. Data that is to be collected includes rider demographics, cost, and operational performance (e.g., hours and distance of operation by each bus and fleet; overall availability of each bus; fuel consumption; and failure frequency and cause, etc.);
- Construction of the FCB maintenance garage (maintenance workshop, storage garage, spare parts room) was completed in mid-October 2005;

Figure 3. Beijing FCB maintenance garage

- The FCB route has been designated, and it starts and ends at the North Gate of the Summer Palace in Beijing. With a total route distance of 18.2 km, the buses will make 11 stops, and will operate 5 days per week.
- The technical requirements for the training plan have been established. Basic training focusing on knowledge of the technology and safety education was conducted in September 2005 for drivers, maintenance workers, operational managers and related government agencies (approximately 40 people). Professional training focusing on operating instructions for six drivers and one maintenance worker was completed in November 2005. Additional on-the-job training will be conducted during the FCB testing phase;
- The hydrogen refilling station has been designed in two phases, providing hydrogen: (i) through onsite tube trailers; and (ii) steam reforming and additional electrolysis. It is anticipated that in Phase II there will be the use of renewable resources from photovoltaic and wind to produce hydrogen. The station is located in Beijing's Hydrogen Park, and provides both a technology showcase and an educational opportunity. Designed at 4,000 standard m3 per day, it has the capacity to address local hydrogen demand in the coming years. The tube trailer and electrolysis section of the hydrogen re-filling station began construction in late 2005 will begin official operation on July 31, 2006; the re-filling services for natural gas reformer will be completed in 2007; and,
- Study tours to Europe and the United States were conducted to gather information from other FCB demonstrations. In addition, twelve newsletters and various reports were prepared.

26. The project "Demonstration of Fuel Cell Bus Commercialization in China, Phase 2" (GEF Grant: $5.77m) was submitted as part of the November 2005 GEF Work Program. The Phase 2 project is intended to support FCB commercial viability and replicability, and will focus on FCB hybrid technology. Hybrid FCBs will introduce lower costs, as engine power requirements for bus operation will be lower, and improved performance through reduced fuel consumption (anticipated to be between 30 to 50% depending on the traffic and topography of the route). To support replication of FCBs within China, the UNDP-GEF demonstration of FCBs in Beijing and Shanghai will be monitored and evaluated extensively. The intention is that these results will be used to promote and replicate FCBs as a commercially-viable transportation alternative for cities sharing similar environmental characteristics and conditions. In complement to the GEF project, Beijing plans to have at least 15 FCBs in demonstration for the 2008 Olympic Games. By 2010, the planned production volume of FCBs is 30 per year. For Shanghai, the Government has committed to demonstrate more than 10 FCBs by 2008 and for the World Expo in 2010 to further expand the demonstration.

3.3 EGYPT, INDIA AND MEXICO

Mexico

27. In December 2004, the Secretary of Environment and Natural Resources (SEMARNAT) of Mexico, through the Operational Focal Point, determined that they would pursue official cancellation of the UNDP-GEF FCB project. The main reasons officially quoted for cancellation of this project, executed by STE (Electric Transport Service of Mexico City), were substantial changes in conditions originally foreseen for the project, in particular technical, financial and institutional aspects of the project. The project was officially cancelled in 2005.

Egypt

28. The UNDP-GEF project entitled "*Fuel Cell Buses Demonstration Project in Cairo*" for Egypt was officially cancelled on July 28, 2005. In the closure of this full project, which did not formally begin implementation, the following reasons were cited: delays in approval of the project; outstanding technological issues; and problems with costing.

29. Egypt has formulated a new UNDP-GEF project focusing on sustainable transport, which has been submitted as part of the June 2006 Work Programme (US$6.90M). This project seeks to reduce energy consumption associated with transport while addressing local environmental and urban mobility issues. The project will create an enabling policy and institutional environment, and leverage financial resources for the sustainable transport sector development. In particular, the project will initiate the concept of integrated high quality public transport services for Greater Cairo and its satellite cities through public-private partnerships; promote non-motorized transport in medium sized provincial cities; introduce new traffic demand management measures; improve the energy efficiency of freight transport; and develop institutional capacity to promote sustainable transport during and after the project. The Executing Agency will be the Egyptian Environmental Affairs Agency (EEAA).

India

30. During 2005, activities were undertaken by UNDP and relevant parties to officially cancel the "*Fuel Cell Bus Demonstration Project in New Delhi, India (Part I)*". This project, officially cancelled on July 21, 2005, was cancelled due to changes in interest of key stakeholders,

especially in light of the technological and economic constraints associated with fuel cell technology.

31. India is currently pursuing another sustainable transportation project under OP11 entitled "Cleaner Mobility in Urban India". This project, which entered the GEF pipeline in January 2005, seeks to reduce greenhouse gas (GHG) emissions associated with transportation in urban areas through (i) greater reliance on public transport, (ii) greater reliance on non-motorized vehicles and (iii) incorporation of sustainable transport principles into the urban design of new settlements.

4. Next Steps

32. As outlined in the May 2005 Update, the cancellation of three of the original five FCB projects has had significant implications for the FCB implementation strategy. The project phasing that was intended to maximize the structured learning between projects is no longer relevant. As such, the role of UNDP-GEF in enabling information exchange within and between program countries has also changed. Communication between projects now focuses on interaction between Brazil and China. Progress of the China FCB project is documented on the project website: http://www.chinafcb.org/.

33. The China and Brazil project teams continue to be active in the FCB international community. Representatives from the Brazil project recently participated in the CUTE "The Future of Transportation is Clean" (May 10 to 11, 2006 in Hamburg, Germany), where experiences with FCBs and hydrogen infrastructure operation in the CUTE project were discussed. The Third International FCB Workshop, which took place in Vancouver, Canada, in December 2005 included presentations from FCB initiatives worldwide (see http://www.electricdrive.org). It also involved breakout sessions where critical issues faced by the industry were discussed, and posters from FCB demonstrations. The GEF-UNDP projects were profiled at this poster session. The Fourth International FCB Workshop is scheduled for October 22-24, 2006, in Yokohama, Japan.

34. As also recommended in the May 2005 Update, due to the reduced scope of the FCB Programme, annual reporting on the FCB Programme will cease after this Update. According to its responsibilities as Implementing Agency, UNDP will continue to monitor and report on the FCB projects for Brazil and China through the annual Project Implementation Reviews (PIRs). In addition, the performance of the projects could be included as part of a future GEF climate change portfolio review. Additional information on the FCB projects will continue to be available through the following UNDP-GEF website: http://www.undp.org/gef.

Annex 1. Active FCB Demonstration Programs Worldwide, as of May 2006

(courtesy of the US Federal Transit Administration Report, *Analysis of Electric Drive Technologies for Transit Applications*, and updated by Fuel Cells 2000 in May, 2006)

( ) indicates that bus has not yet been delivered; green denotes that bus is not yet being manufactured.

Program	Location	Number	Bus Manufacturer	Fuel Cell Manufacturer
Clean Urban Transport for Europe (CUTE) in nine European cities		27	DaimlerChrysler EvoBus	Ballard Power Systems
Ecological City Transport System (ECTOS) in Reykjavik, Iceland		3	DaimlerChrysler EvoBus	Ballard Power Systems
Sustainable Transport Energy for Perth (STEP) in Perth, Australia		3	DaimlerChrysler EvoBus	Ballard Power Systems
California Fuel Cell Partnership (CaFCP)				
	Santa Clara	3	Gillig	Ballard Power Systems
	Oakland	3	Van Hool	UTC Fuel Cells
	Palm Springs	1	Van Hool	UTC Fuel Cells
Natural Resources Canada Fuel Cell Program				
	Winnipeg (Fall 2006)	(1)	New Flyer	Hydrogenics
Japan Fuel Cell Bus Program				
	Tokyo	8	Hino	Toyota
United Nations Development Program Global Environment Facility (UNDP–GEF)				
	Beijing	3	DaimlerChrysler EvoBus	Ballard Power Systems
	Shanghai (date TBD)	(6)		
	Sao Paolo (date TBD)	(8)		
	Mexico City (date TBD)	(10)		
	New Delhi (date TBD)	(8)		
	Cairo (date TBD)	(8)		
Federal Transit Administration - Automotive-Based Fuel Cell Hybrid Bus				
	Honolulu, HI	1	El Dorado	Hydrogenics
	Birmingham, AL (date TBD)	(1)	DaimlerChrysler	Ballard Power Systems
	Newark, DE (date TBD)			
	New Haven, CT (date TBD)			
Federal Transit Administration – Georgetown Fuel Cell Bus Program		5		
	Washington, D.C.	1	NovaBus	Ballard Power Systems
	Washington, D.C.	1	NovaBus	UTC Fuel Cell (PAFC)
	Davis, CA	1	BMI	Fuji (PAFC)
	Jacksonville, FL	1	BMI	Fuji (PAFC)
	Gainesville, FL	1	BMI	Fuji (PAFC)
Miscellaneous Demonstrations				
	Augsburg	1	SGL Carbon AG	Proton Motor Fuel Cell
	Flint, Michigan (Sept. '06 or later)	(1)	Program to issue proposals	
	Munich	1	MAN	Ballard Power Systems
	North-Rhine-Westphalia, Germany Ministry for Transport, Energy & State Planning	1	Tecnobus	Hydrogenics
	Turin (CityCell Program)	1	Irisbus	UTC Fuel Cells
	Victoria/Whistler, BC (2010)	(15-20)	To be determined through bidding process	

Annex 2. Summary of Fuel-cell Bus Projects, May 2006

(Source: http://www.fuelcells.org/info/charts/buses.pdf)

FUEL CELLS 2000
www.fuelcells.org

Fuel Cell Buses

Bus Mfr.	Operation	Model	Year Shown	Engine Type	Fuel Cell Size/Type	Fuel Cell Mfr.	Range (mi/km)	Max. Speed	Fuel Type	Picture
Bus Manufacturing U.S.A., Inc.	Generation I of Georgetown University's program	30-foot Transit Bus	1994	Fuel cell/ battery hybrid	50kW Phosphoric Acid FC (PAFC)	Fuji Electric	250mi 402km	55mph 90km/h	Methanol	
Bus Manufacturing U.S.A., Inc.	Generation I of Georgetown University's program	30-foot Transit Bus	1995	Fuel cell/ battery hybrid	50kW PAFC	Fuji Electric	250mi 402km	55mph 90km/h	Methanol	
Bus Manufacturing U.S.A., Inc.	Generation I of Georgetown University's program	30-foot Transit Bus	1995	Fuel cell/ battery hybrid	50kW PAFC	Fuji Electric	250mi 402km	55mph 90km/h	Methanol	
NovaBus Corporation (a subsidiary of Volvo)	Generation II of Georgetown University's program	40-foot heavy duty transit buses	1995	Fuel cell/ battery hybrid	100kW PAFC Ambient-pressure	UTC Fuel Cells	350mi 563km	68mph 109km/h	Methanol	
NovaBus Corporation (a subsidiary of Volvo)	Generation II of Georgetown University's program This bus is used for national demonstration purposes	40-foot heavy duty transit buses	2001	Fuel cell/ battery hybrid	100kW PEMFC	Ballard	350mi 563km	68mph 109km/h	Methanol	
Undetermined	Generation III of Georgetown University's program Team includes EPRI, ZSW, NuCellSys	40-foot low-floor bus platform	Phase 1 - 2005	Fuel cell	At least 240 kW PEMFC	NuCellSys	N/a	N/a	Methanol	
New Flyer Industries Ltd.	Proof of Concept	P1; low fl. transit bus based on New-Flyer model 40	1993 world's first	Fuel cell/ battery hybrid	90kW PEMFC	Ballard	250mi 400km	60mph 95km/h	Compress. Hydrogen	
N/a	Proof of Concept	P2: full-sized, 40-foot	1995	Fuel cell/ battery hybrid	205kW PEMFC	Ballard	250mi 400km	N/a	Compress. Hydrogen	
New Flyer Industries	Demo. service of 3 buses in Chicago (1997) and Vancouver (1998) for 2 years	P3: H40LF models	1998	Fuel cell/ battery hybrid	205kW PEMFC	Ballard	N/a	N/a	Compress. Hydrogen	
New Flyer Industries	Natural Resources Canada (US$1.9 million) and Hydrogenics for demo in Winnipeg, Manitoba, Canada	40 foot	Proj. 2005	Distributed array of 25kW modules w/ ultra-capacitors	150kW PEMFC	Hydrogenics	N/a	N/a	Compress. Hydrogen	
Enova Systems	U.S. Air Force, State of Hawaii's High Technology Development Corporation and Hydrogenics partnership	N/a	2004	Fuel cell/battery hybrid	20kW	Hydrogenics	N/a	N/a	Hydrogen	
EvoBus: a Daimler Chrysler company	Accumulated over 540 hrs driving exper. By 1997: two week road test in Celle, Germany 1999	Nebus: 455 low-fl. urban regular-service bus	1997	Fuel cell/ battery hybrid	205kW PEMFC	Ballard	155mi 250km	50mph 80km/h	Compress. Hydrogen	
EvoBus: a Daimler Chrysler company	Demonstrated at SunLine Transit, AC Transit, and CaFCP	Zebus (P4): 40 ft. (1 year demo with SunLine)	1999	Fuel cell/ battery hybrid	205kW PEMFC	Ballard	N/a	N/a	Compress. Hydrogen	
EvoBus: a Daimler Chrysler company	Sold as part of the CUTE, ECTOS, STEP programs. Cost ~US$3 million unsubsidized each.	Mercedes-Benz Citaro (P5) 33 total for all 3 programs	2003	Fuel cell/ battery hybrid	205kW PEMFC	Ballard	124mi 200km	50mph 80km/h	Compress. Hydrogen @ 5,000 psi	

Gillig Corporation	VTA, San Metro Transportation District, CaFCP & CARB - 3 FC Buses will be operated at VTA in San Jose, Ca	N/a	2004	Fuel cell/ battery hybrid	205 kW PEMFC	Ballard	N/a	N/a	Hydrogen	
Irisbus: a Renault V.I. and Iveco Co.	Demonstrated in Torino, Italy beginning in 2002	40 foot	2001	Fuel cell/ battery hybrid	60kW PEMFC Ambient-pressure	UTC Fuel Cells	N/a	N/a	Compress. Hydrogen	
MAN "Bavaria 1"	Regular service in Erlangen and Nuremberg, Germany. 50% funded by Bavarian State	40 ft. low-floor city bus NL 263 "Bavaria I"	2000	Fuel cell/ battery hybrid	65kW PEMFC	Ballard	186mi 300km	50mph 80km/ h	1548 L Compress. Hydrogen	
MAN	Will be used for EU's THERMIE program: Berlin, Copenhagen, Lisbon	40 ft. MAN N L223 low floor	Not Compl.	Fuel cell/ Super capacitat or hybrid	5 x 32kW PEMFC	Nuvera	N/a	N/a	700 L Liquid Hydrogen @ -253° C	
MAN	Will deliver one fuel cell bus to be operated as part of the hydrogen project at Munich Airport	40 ft. MAN low floor	Not Compl.	Fuel cell/ battery hybrid	PEMFC	Ballard	N/a	N/a	H2 tanks on the roof at 5,000 psi	N/a
Neoplan	2 years fee-paying service in public traffic in the German spa resort Oberstdorf. Funded by Bavarian State	Midi bus N 8008 FC	1999	Fuel cell/ battery hybrid	40kW PEMFC	Nuvera	373mi 600km	30mph 50km/ h	Compress. Hydrogen	
Neoplan	Available for Sales	N8012 - 33-seat bus	2000	Fuel cell/ 100kW flywheel hybrid	80kW PEMFC	Proton Motor Fuel Cell GmbH	155mi 250km	50mph 80km/ h	Compress. Hydrogen	
NovaBus Corporation (a subsidiary of Volvo)	Demonstrated in NY, NV, and DC. Received FTA funding to continue program.	Standard 40-foot transit bus	1999	Zinc-Air fuel cells with batteries	Zinc-Air	Arotech	N/a	65mph 105km /h	Zinc	
NovaBus Corporation (a subsidiary of Volvo)	Plans for RTC (Nevada Transit Agency) to use 2 – 5 buses	Standard 40-foot transit bus	2001	Zinc-Air fuel cells with ultra-capacitor s	Zinc-Air	Arotech	N/a	N/a	Zinc	
NovaBus Corporation (a subsidiary of Volvo)	BVG - Berlin's public transportation body - to buy 2 prototypes	15.3 meter long Double-Decker	Not Compl	N/a	N/a	Proton Motor Fuel Cell GmbH	N/a	N/a	Hydrogen	
Thor Industries (ThuderPower LLC)	Will be tested by SunLine Transit in 2002 for 6 months (started public service at Sunline Nov. 6, 2002)	30 ft. Low Floor El Dorado National E-Z Rider	2001	Fuel cell/ battery hybrid	75kW PEMFC Ambient-pressure	UTC Fuel Cells	200mi 322km	65mph 90km/ h	Compress. Hydrogen	
Van Hool	3 will be used in regular service at AC Transit, 1 at SunLine Transit	40 foot	2005	Fuel cell/ battery hybrid	120kW PEMFC Ambient-pressure	UTC Fuel Cells	250mi 400km	65mph 105km /h	5,000 psi Compress. Hydrogen	
Van Hool	No Demonstration (Project EUREKA)	18 meter City Bus	1995	Fuel cell/ battery hybrid	75kW PAFC	Elenco	186mi 300km	N/a	700 Liters Liquid Hydrogen	
Van Hool	Will be delivered to DeLijn in Belgium tobe used in Belgium for six months before beinc leased to transit agencies elsewhere in Europe.	40 foot	2005	Fuel cell/ battery hybrid	120 kW PEMFC Ambient-pressure	UTC Fuel Cells	250mi 400km	65mph 105km /h	5,000 psi Compress. Hydrogen	N/a
Mecchi-Ansaldo (EC project EQHHPP)	Company Testing only; part of the EC project EQHHPP	Full size regular floor city bus	1997	Fuel cell/ battery hybrid	45kW PEMFC	Nuvera	250mi 400km	N/a	600 Liters Liquid Hydrogen	
Hino Motors Ltd. (Toyota subsidiary)	Toyota in-house testing	Low-floor city bus: FCHV-BUS1	2001	Fuel cell/ battery hybrid	160kW PEMFC	Toyota	186mi 300km	50mph 80km/ h	Compress. Hydrogen @ 5,000 psi	
Hino Motors Ltd. (Toyota subsidiary)	Tokyo metro. gov. began using this bus during summer 2003 for year. will deploy eight total starting in 2005	FCHV-BUS2	2002, 2nd version shown in 2005	Fuel cell/ battery hybrid	180kW PEMFC [2 x 90kW]	Toyota	186mi 300km	50mph 80km/ h	Compress. Hydrogen @ 5,000 psi