GLOBAL ENVIRONMENT FACILITY

PROPOSAL FOR PDF BLOCK B & C GRANTS

(1) cost + subsidy level → transport prices for consumers (2) realistic levels of impact (3) awareness campaign how NGOs can be constructive (4) private firms

Country: Brazil

Focal Area: Climate Change

Project Title: Environmental Strategy for Energy: Hydrogen Fuel Cell Buses for Brazil (ESE/HB)

Amount of Funding Requested: $344,100
Co-funding: $262,600

Requesting Agency: UNDP/National Department of Water & Electrical Energy

Exec. Agency: Coordinating Committee (DNAEE, DNDE, Sao Paulo Agency for Energy applications)

Block B __x__ **Block C** ______

Block A Grant Awarded: No

I. Summary Project Objectives and Description

A key technology that will enable hydrogen to become competitive with fossil fuels in transportation applications is the fuel cell. Vehicles utilizing these electrochemical devices are expected to achieve energy efficiencies up to twice or more those for internal combustion engine vehicles. Moreover, hydrogen fuel cell vehicles are zero emission vehicles, with water vapor as their only by-product. For transportation applications, fuel cells will be commercialized first in buses. The costs of hydrogen fuel cell bus technology are at pre-commercial (uncompetitive) levels today, but further technological/engineering developments and increased volume of production are expected to bring down costs to commercially sustainable levels. The project, whose prefeasibility will be studied under the work proposed here, is aimed at helping to reduce the costs of hydrogen fuel cell bus technology toward levels that are commercially sustainable.

The long-term objective of the project whose prefeasibility will be studied under the work proposed here, is to help accelerate the commercialization of fuel cell buses that can use hydrogen (or hydrogen carriers) produced from renewable resources. It is anticipated that reaching commercially-mature cost levels will allow such buses to play major roles in the urban mass transit systems of Brazil and other countries, thereby helping to reduce the emission of a variety of pollutants, of which carbon dioxide is the most important from a global perspective. While fuel cell bus technology can be considered technically demonstrated, costs are not yet down to commercially-mature levels. Additional development and increased volume of production are needed to reduce costs.

The project consists of two phases. Phase I, the proposal for which is described in this document, will involve completing assessments of the status and prospects for commercialization of hydrogen fuel cell bus technology and potential hydrogen resources and infrastructure in Brazil. Phase I will culminate in the preparation of a proposal to the GEF for hydrogen fuel cell bus demonstration/commercialization activities (Phase II) under GEF Operational Programme 7: *"Reducing the Long-Term Costs of Low Greenhouse Gas-Emitting Energy Technologies"*. The project will be designed to contribute significantly toward achieving the long-term objective described in the previous paragraph.

II. Description of Proposed PDF Activities

1. Assessment of the status and requirements for hydrogen fuel cell bus commercialization

This activity will involve data gathering and analysis in the following areas (among others): relevant previous development work (worldwide) and the current status of hydrogen fuel cell bus technology; key requirements for accelerating commercialization, including, e.g., areas for targeted research, demonstration projects and strategies needed to move bus technologies down a cost-reduction curve to reach commercially-viable levels (this curve will show the conditions in which the technology is cost competitive), and development of manufacturing capabilities in Brazil; the life cycle economics of hydrogen buses, both near-term (early commercial units) and long-term (commercially mature technology) - for this analysis, hydrogen costs in Brazil will be developed (see next activity).

2. Assessment of the hydrogen resource in Brazil

This activity will develop a detailed, quantitative understanding of the potential magnitude and cost (including delivery costs) of alternative sources for producing hydrogen and hydrogen carriers (methanol and ethanol) that could be utilized in fuel cells in Brazil in the near, medium, and long term. This will include consideration of hydrogen available (I) from direct production at industrial sites, e.g., at chloro-alkali facilities and petrochemical refineries, (ii) by electrolysis using hydroelectricity, especially off-peak hydroelectricity, (iii) from thermochemical conversion of biomass, including plantation-grown biomass, biomass residues of industrial processes (e.g. sawmill wastes or sugarcane bagasse), and municipal solid waste, as well as conversion of methane produced from stillage at ethanol distilleries, sewage treatment plants, landfills, etc., (iv) from thermochemical conversion of fossil sources, especially natural gas and coal. Cost estimates for the near-term hydrogen supply options will be based on contacts with present producers and potential ones. Given the large hydroelectric component of Brazil's electricity sector, there will be a special emphasis on understanding the potential relative role for hydrogen produced using off-peak hydroelectricity. The costs of longer-term options will be based on the best information available in the literature from previous studies and through contact with individuals involved in relevant demonstration projects going on worldwide.

3. Assessment of future demand for fuel cell buses

This activity will develop a detailed, quantitative understanding of the potential demands for hydrogen fuel cell buses in Brazil, especially São Paulo city and state, in the near-to-long term.

4. Define the Phase II demonstration project and prepare proposal to GEF

Activities 1 through 3 will provide the basis for defining in detail the Phase II demonstration project, including such factors as the number of buses to be operated, candidate bus suppliers (which will help determine what fuel will be used, e.g. hydrogen, methanol, ethanol, or other), the fuel source(s) and mode of supply, the fuel storage system, and the refueling system. Potential technology suppliers will be contacted and an assessment made of their willingness and capability for participating in a demonstration project. Mechanisms will be specified for insuring connection between the Phase II project and related work going on worldwide. GEF incremental costs will be calculated.

III. PDF Outputs

There will be two PDF outputs. One will be a feasibility study encompassing activities 1 through 3 described in the previous section. The second output will be a proposal to the GEF for a follow-on (Phase II) demonstration project.

IV. Eligibility

One of the GEF mandates is to help foster sustainable technologies which are close to commercial viability. The Phase I work will set the stage for a demonstration project intended to help move hydrogen bus technology cost down, towards commercially viable levels. Recent studies suggest that commercially-mature hydrogen-powered fuel cell automobiles will ultimately be competitive with comparable gasoline or diesel oil-powered internal combustion engine automobiles with oil prices not significantly higher than today's levels, even with relatively high-cost hydrogen from renewable sources.[1] While passenger automobile technologies are perhaps 15 to 20 years from reaching this point, fuel cell bus technologies are much closer to commercial reality. Offerings by two or more companies of fuel cell buses on commercial terms are likely before the year 2000. At least one of them, Ballard Power Systems , from Vancouver, Canada, has announced plans to offer hydrogen fuel cell buses[2] on a routine commercial basis starting in 1998. Ballard has sold three full-size demonstration buses to the City of Chicago[3] and three to the City of Vancouver, where they will be operated starting this year -- these cities will be the first cities in the world to use Ballard zero emission bus engines in the public system. The good prospects for

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[1] R. H. Williams *et al.*, Methanol and Hydrogen from Biomass for Transportation, with Comparisons to Methanol and Hydrogen from Natural Gas and Coal, (PU/CEES) Report No. 292, July 1995.

[2] P. F. Howard, "Ballard Zero-Emission Fuel Cell Engine," *Proceedings Commercializing Fuel Cell Vehicles*, Chicago, USA, (17-19 Sept. 1996) pp. 1-10.
B. N. Gorbell *et. al.*, "The Ballard/BC Bus Demonstration Program," *Proceedings Project Hydrogen' 91*, Kansas City, USA (16-18 September 1991) pp. 247-256.

[3] Ballard, "Ballard Secures $8 Million Bus Demonstration Fleet with Chicago Transit Authority," Press Release, Sept. 11, 1995.

commercialization of hydrogen fuel cell buses arise because (I) the power plant is a smaller fraction of the total cost of a bus than of a car, (ii) the weight and volume constraints of a fuel cell power plant are less challenging for a bus than for a car, and (iii) buses have higher operating hours than automobiles, resulting in more rapid amortization of capital costs.

The cost of these initial commercial units sold by Ballard and other companies will be high, but increased volume sales and further technology and engineering developments are expected to bring the manufacturing costs down to levels that will make the hydrogen fuel cell bus competitive with diesel buses.

This proposed prefeasibility assessment (Phase I) and follow-on demonstration project (Phase II) are designed to help accelerate this reduction in costs, with the anticipation that when costs for the technology ultimately reach commercially-mature (mass-production) levels, hydrogen fuel cell buses will be a least-cost option for providing bus services. An important result that should come out of the prefeasibility work is a clarification of what can be expected as the long-term commercially-mature costs.

GEF support is justified for the proposed Phase I and Phase II work because hydrogen fuel cell technology is not a least-cost option today, but has the prospect for becoming so through demonstration efforts such as will be proposed for Phase II. And, importantly, hydrogen fuel cell buses would substantially reduce carbon dioxide emissions per unit of bus services provided compared to petroleum internal combustion engine buses. The emissions reductions would be especially substantial if hydrogen were produced from renewable sources.

In Phase II, GEF support will be requested only for incremental costs, I. e., costs in excess of the present costs (diesel engine buses) of providing comparable bus services on a commercial basis. This will be elaborated in the Phase II proposal.

This proposed project is responsive to the Rio Earth Summit objective "to achieve, in accordance with relevant provisions of the Climate Convention, stabilization of greenhouse gas concentration in the atmosphere at a level that would prevent dangerous anthropogenetic interference with the climate system" and to GEF objective of the program : "To reduce the long-term costs of prospective low greenhouse gas emitting energy technologies that are not yet least-cost alternatives by promoting the application of specific technologies to reduce manufacturing costs through learning and economies of scale. Suitable candidate technologies should be proven, but not yet commercially mature. Through a limited number of subsidized demonstration projects, the long-term costs of the technologies should be reduced to the point where the technologies are commercially competitive without any subsidy, i.e. they become the least-cost alternative".

This project is technically viable. It does not require major new breakthroughs, but rather the cooperation of government, utility and transportation companies, university, and industry.

V. National Level Support

The first sketch of this project was drawn when the Commission for the Development of

Hydrogen was established by the Minister of Mines and Energy of Brazil in 1982. Discussions were started with hydroelectric utility companies operating in different regions of Brazil on optimizing electricity uses, aiming at the utilization of surplus hydroelectricity -- diverted energy that could have been turbinated but was not for lack of demand. This energy was envisioned for producing electrolytic hydrogen.

A preliminary National Program for Hydrogen in Brazil was published in 1984.[4] Several papers were presented in international conferences and published in international journals on the subject by Brazilians working for the federal government, hydroelectric utility companies and universities.[5]

A consortium was established in December 1993 involving the Ministry of Mines and Energy (MME), São Paulo Energy Company (CESP), São Paulo Metropolitan Area Transit Authority (EMTU) and University of São Paulo (USP) to develop a project to help accelerate the commercialization of hydrogen bus technology. Subsequently, the São Paulo Agency for Energy Applications replaced CESP in the consortium. MME is represented in the consortium by two of its departments: DNAEE (National Department of Water and Electrical Energy) and DNDE (National Department for Energy Development).

Under the present proposal, the project participants and their responsibilities are as follows:

a) A coordinating committee with representatives from DNAEE, DNDE, and São Paulo Agency for Energy Applications will lead the project. This committee has the following responsibilities: defining directives, approving project execution, approving implementation decisions, approving expenditure of financial resources. The responsible individuals in these institutions are Dr. Demostenes Barbosa da Silva (DNAEE), Dr. Claudio Judice (DNDE) and Dr. Oscar de Lima e Silva (Agency for Energy Applications).[6]

b) Management -- for technical and administrative management, reports, and support to the

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[4] M. C. Mattos, National Hydrogen Energy Program in Brazil. *Int. J. Hydrogen Energy* **10**, pp. 601-606 (1985).

[5] A. D'Ajuz *et al.*, "Electrical Energy Transmission from the Amazon Region: Hydrogen as a Promising Alternative in Brazil," *Int. J. Hydrogen Energy* **14**, pp. 515-523(1989).

E. R. Gonzalez *et al.*, "Hydrogen Evolution Reaction on Ni-S Electrodes in Alkaline Solutions," *Int. J. Hydrogen Energy* **19**, pp. 17-21 (1994).

D. R. de Sena *et al.*, "Characterization of the Limiting Structural Effects on the Electrochemical Behavior of Porous Gas Diffusion Electrodes," *J. Electroanal. Chem.* **357**, pp. 225-236 (1993).

D. B. da Silva *et al.*, "Electrolytic Hydrogen Production in Brazilian Electric Utilities - A Way to Increase Return on Investments," *Int. J. Hydrogen Energy* **13**, pp. 77-79 (1988).

M. J. de Giz *et al.*, "Mechanistic Study of the Hydrogen Evolution Reaction on Ni-Zn and Ni-S cathodes. *J. Appl. Electrochem,*" **23**, pp. 641-645 (1993).

Marieta C. Mattos *et al.*, "Excess Energy Utilization for Producing Electrolytic Hydrogen as a Promising Alternative in Brazil," *Proceedings, 10th World Hydrogen Energy Conf.* Cocoa Beach, USA, (20-24 June 1994) pp. 77-80.

[6] At present, additional information regarding the proposed project can be obtained from Dr. Demostenes Barbosa da Silva, Deputy Director at DNAEE (National Department of Water and Electrical Energy), in Brasilia, fax number (061) 312-5615,telephone number (061) 226-5074.

coordinating committee. The responsible individual is Dr. Marieta Mattos.

c) Operational committee -- for planning the implementation, operational integration, evaluation of results of the project implementation. The responsible agencies in this committee are the following:

> 1) USP, to analyze available technologies, data and results; to give technical orientation on technology adaptation and personnel training. The responsible individual is Prof. Ernesto Rafael Gonzalez.
>
> 2) EMTU, to analyze the implementation and operation of hydrogen fueling stations, and hydrogen fuel cell buses on a demonstration basis and for the longer term, on a wider-spread commercial basis within the greater São Paulo metropolitan area. The responsible individual is Pedro Luiz Machado.

VI. Items to be Financed

Two items will be funded as part of the project (Phase I) proposed here. These are *(I)* a feasibility study to assess the status and requirements for hydrogen fuel cell bus commercialization, the potential hydrogen resource in Brazil, and the potential future demand for hydrogen fuel cell buses in Brazil, and *(ii)* the preparation of a proposal for GEF funding for a fuel cell bus demonstration project (Phase II). The anticipated duration of Phase I is 18 months. A summary of the budget for Phase I is given in the following table. A more detailed budget is provided as an annex.

Phase I preliminary-budget summary (1000 US$)

Outputs ===>	1. Feasibility Assessment		2. Proposal for Phase II		TOTALS	
Inputs	**GEF**	**BRAZIL**	**GEF**	**BRAZIL**	**GEF**	**BRAZIL**
Personnel	173.5	179.7	94.7	82.9	268.2	262.6
Subcontracts	15.0	0.0	0.0	0.0	15.0	0.0
Training	24.7	0.0	18.9	0.0	43.6	0.0
Equipment	2.5	0.0	2.5	0.0	5.0	0.0
Other	6.1	0.0	6.1	0.0	12.2	0.0
TOTAL	221.8	179.7	122.2	82.9	344.0	262.6

VII. Special Features

Many developing nations are reaching a level of development in which problems related to urban pollution and energy demand, consumption or utilization are becoming critical. Energy policies for these countries could take advantage of their lack of heavy infrastructure. This is the ideal time to begin the implementation of the energy systems of the future rather than copying a system which is already well established in industrialized countries and which is now proving inadequate.

It is becoming increasingly recognized that the hydrogen/electricity economy is an environmentally very attractive energy system of the future - big investments have lately been made in Canada, Russia, Germany and Japan in this system. Hydrogen can be produced from a variety of sources either thermochemically (from fossil fuels or biomass) or by electrolysis of water, and it can be transported, stored and converted into other forms of energy, such as electricity, and vehicular propulsion, while generating little if any pollution. Environmental benefits are maximized by production of hydrogen using renewable sources (biomass or wind, solar and hydroelectricity). Isolated demonstration projects during the past 20 years have shown hydrogen's tremendous potential in several applications, and one of them is as fuel in commercial mass transit.

An important impediment to the implementation of hydrogen systems is the tremendous investment that society has already made in sophisticated infrastructure (e.g. by oil companies) in industrialized nations, an investment from which these nations will have to obtain as much return as possible. Developing nations, on the other hand, are only now beginning to pour large investments into building such energy systems. It is therefore desirable that a mix of technologies of the future be taken into account and, where possible, considered in the infrastructure design or, even better, actually implemented during the earliest stages of development.

Brazil is unique as a country for pioneering work in new, clean energy systems. Brazil has already played a major leadership role in energy innovation for the transportation sector: the alcohol program is responsible for 60%, in volume, of the automobile fuel consumption and for 22% of the blend in gasoline for consumption. The major commercial implementation of ethanol technology in the automotive sector was carried out by Brazil years before it spread out to other parts of the world. In 1990, 39% of Brazilian cars ran on pure ethanol, while other countries were just studying or planning alternatives to fossil fuels.

This willingness to implement new solutions concerning energy, coupled with technical qualifications that certainly distinguishes Brazil when compared to other developing countries make Brazil an excellent test country in which to develop a hydrogen energy implementation program.

Moreover, Brazil is in a favorable position to utilize surplus hydroelectric energy for producing electrolytic hydrogen. The Ministry of Mines and Energy is interested in opening markets for the commercialization of this surplus energy. While an importer of 48% of its petroleum in 1994 (much of this importation is to supply diesel oil for utilization in the transportation sector), Brazil has an installed capacity of hydroelectric power which exceeds demand. Surplus energy in the state of São Paulo was 1,225 GWh in 1995. In Brazil, surplus energy is assured now and for future utilizations because of the topology of the electric system: hydropower plants give a strong contribution to this system (more than 90%). Expressive excess electricity is available in the interconnected power system at hydropower plants and, depending only on transmission capacity, available in the largest city of Brazil, São Paulo.

Furthermore, Brazil presents privileged characteristics of land and insolation, with extensive agricultural area, now corresponding to 55×10^6 hectares, about 7% of this area being utilized for cultivating sugar cane. Thus, biomass, that now is responsible for 28% of the national energy matrix, surely will have an important participation in this matrix in the future as well, being able to contribute as a raw material in hydrogen production processes.

The country has made attempts to improve its trade balance,[7] one that could correspond to the dynamism of Brazilian economy, but the amount of imported oil means an impact on the external debt and public deficit.[8] Despite the penetration of ethanol, the transportation sector still accounts for about 50% of the petroleum use in Brazil.[9] It is in Brazil that automotive industries and vehicles fleet are expanding fast - much faster than in other countries.

The greater São Paulo area covers 8,000 km^2 and includes 39 cities and a population of 16.5 million inhabitants. Urban air pollution due to vehicles in São Paulo, as in most metropolitan areas, is a serious problem. The air has become unbreathable. The greater São Paulo area released, in 1995, 4,745 tons of carbon monoxide, 970 tons of hydrocarbons, 1,197 tons of nitrous oxides, 235 tons of sulfur oxides and 86 tons of particulate matter into the air daily, due to vehicular emissions, as presented by CETESB (Companhia de Tecnologia de Saneamento Ambiental) report.[10] In this São Paulo area, where 25% of the country's vehicles circulate (about 25 thousand urban buses, one of the biggest number operating in a metropolitan area in the world), diesel vehicles in this same year released 1,378 tons of carbon monoxide (29% of the carbon monoxide above mentioned value), 225 tons of hydrocarbons (23%), 1,007 tons of nitrous oxides (84%), 211 tons of sulfur oxides (90%) and 63 tons of particulate matter (73%), into the air, daily.

While urban pollution is primarily a domestic concern, it provides a strong motivation for Brazil's interest in using clean hydrogen as fuel, and the use of hydrogen could bring with it major global benefits in the form of reduced carbon dioxide emissions from the transportation sector.

In summary, Brazil provides a supportive setting for commercial demonstration of hydrogen fuel cell vehicle technology:

- In Brazil, there is a willingness to implement new energy solutions, and a high level of technical qualifications that will help guarantee successful carry-through of pioneering projects in hydrogen energy utilization.

- Brazil has a potentially important renewable resource for hydrogen production--surplus

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[7] Table "Trade Balance", Banco Central do Brasil, Research Department, and Secretaria de Comercio Exterior, Industry and Commerce Ministry.

[8] Table "External Debt", Banco Central do Brasil, Research Department.

[9] Mia Layne Birk *et al.*, in *Driving New Directions: Transportation Experiences and Options in Developing Countries*, Introduction, International Institute for Energy Conservation, Washington, DC, June 1991, pp. 5-13.

[10] *Relatório de Qualidade do Ar no Estado de São Paulo* 1995, CETESB, São Paulo (1996).

hydroelectricity that results from natural seasonal variations in rainfall. The hydropower potential in Brazil, 261.4 GW, is estimated to be the third largest in the world. Only 25% of this potential is presently utilized. In 1994, the hydroelectric capacity was 49,056 MW (93.4% of total installed electric generation capacity in Brazil). Further expansion of hydroelectricity supply is envisioned for Brazil. Since the early 1980s, the Ministry of Mines and Energy has maintained an explicit goal of commercializing electrolytic hydrogen from surplus hydropower by seeking to open markets for its utilization in Brazil.

- Brazil also has the potential to produce hydrogen from other renewable sources, in particular plantation-grown biomass. The country is at the forefront globally in the application of sustainable biomass-energy plantation technology.

- A multi-institution consortium was established at a national level in 1993 to advance hydrogen vehicle systems toward commercialization (as described earlier). The present proposal is one result of the work of this consortium.

- The São Paulo metropolitan area provides an excellent opportunity for the introduction of fuel cell bus technology. The São Paulo Metropolitan Area Transit Authority (EMTU) is responsible for the management and fiscalization of mass transit in São Paulo metropolitan area and for the operation of bus routes. It runs some 25,000 buses. With a replacement rate of about 15% per year, about 3,750 buses are retired and replaced with new units annually.

Lessons Learned and Technical Review

Fuel cell bus demonstration projects are presently going on in several cities worldwide. Most of these have only recently been initiated. The interest in such developments is growing. Two significant demonstration projects have been mentioned in Section IV above. Other examples of investments in similar projects are: the German-Swiss project HYPASSE - Hydrogen Powered Automobiles using Seasonal and Weekly Surplus Electricity[11] and the Canadian - European project EURO-QUEBEC - Euro-Quebec Hydrogen Pilot project (this one aims at the utilization of hydrogen electrolytically produced in Quebec for fueling a fleet of 100 buses in Hamburg).[12] Daimler Benz is involved in these two projects. Another recently developed project is the fuel cell bus of Georgetown University that operated in Washington, as a demonstration; this university has a commercialization program for the bus.[13] Peugeot and Citroën have recently presented

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[11] J. Zieger, "Hydrogen Powered Automobiles Using Seasonal and Weekly Surplus of Electricity," *Proceedings, 10th. World Hydrogen Energy Conference*, Cocoa Beach, USA, (20-24 June 1994) pp. 1367-1375.

[12] B. Drolet *et al.*, "The Euro-Quebec Hydro-Hydrogen Pilot Project (EQHHPP): Demonstration Phase," *Int. J. Hydrogen Energy* **21**, pp. 305-316 (1996).
Daimler Benz, "Hydrogen: An Alternative Fuel," private communication.

[13] J. Larkins, "Fuel Cell Powered Transit Bus Commercialization Program," *Proceedings, Commercializing Fuel Cell Vehicles*, Chicago, USA, (17-19 Sept. 1996) pp. 1-13

their developments in fuel cell vehicles,[14] as well as Energy Partners[15] and Southwest Research Institute.[16]

Challenges for commercializing fuel cell vehicles have lately been discussed: the big one is engineering, and to bring the cost down -- research has already been made.

This project is the first one that will show practical applications of hydrogen utilization as fuel in mass transit buses in Brazil -- buses are a realistic short term target for fuel cells powered by hydrogen.

The prefeasibility phase of the proposed project will seek to understand to the greatest extent possible the details of all projects (already initiated and pending) and to coordinate with such projects to the extent that it is helpful in achieving the cost-reduction goal set forth in Section II above.

The proposal presented here has already undergone substantial refinement since it was first presented in a preliminary form by the Brazilian Government to the UNDP for discussion in early 1994. That document was reviewed separately by two individuals on the roster of STAP reviewers in late 1994. A revised version of the proposal was then put forward to the UNDP for further consideration. A meeting was held at DNAEE on 28 August 1995 with Brazilian and UNDP participants,[17] and the project was subsequently further refined. The resulting document was reviewed by a STAP-approved reviewer in late 1995 and a follow-on meeting was held 1 August 1996 between the reviewer and the project team in Brazil to further revise the proposal. The present document addresses all of the issues raised by all three STAP reviewers.

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[14] R. Monsdale, "P.S.A's PEMFC Vehicle Program," *Proceedings, Commercializing Fuel Cell Vehicles*, Chicago, USA, (17-19 Sept. 1996) pp.1-12.

[15] F. Barbir, "Development of PEM Fuel Cells and Fuel Cell Systems," *Proceedings, Commercializing Fuel Cell Vehicles*, Chicago, USA, (17-19 Sept. 1996) pp.1-8.

[16] E. Bass, "Feasibility of Cylindrical PEM Fuel Cells," *Proceedings, Commercializing Fuel Cell Vehicles*, Chicago, USA, (17-19 Sept. 1996) pp.1-7.

[17] Aide - memoire of the meeting.

ANNEX

Detailed Preliminary Budget for Phase I

	Personnel[b]		Subcontracts		Training[c]		Equipment[d]		Other[e]		TOTALS	
TASK[a]	GEF	Brazil	GEF	Brazil	GEF	Brazil	GEF	Brazil	GEF	Brazil	GEF	Brazil
1.	67.1	65.6	0.0	0.0	13.2	0.0	0.0	0.0	0.0	0.0	80.3	65.6
2.	53.6	65.7	5.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	60.6	65.6
3.	28.8	39.4	5.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	33.8	39.4
4.	80.5	78.8	0.0	0.0	13.2	0.0	0.0	0.0	0.0	0.0	93.7	78.8
5.	40.2	13.1	5.0	0.0	13.2	0.0	5.0	0.0	12.2	0.0	75.7	13.1
Total	268.2	262.6	15.0	0.0	43.6	0.0	5.0	0.0	12.2	0.0	344.1	262.6

(a) Task 1: Assessment of the status and requirements for commercialization of hydrogen fuel cell buses.
Task 2. Assessment of the hydrogen resource in Brazil.
Task 3: Assessment of the future demand for hydrogen mass transit fuel cell buses in Brazil.
Task 4: Defining the Phase II demonstration project and preparing the proposal for Phase II to GEF.
Task 5: Project management

(b) Salaries as specified on the next page.

© Includes national and international travel for information gathering, attendance at conferences and discussions with researchers and equipment vendors.

(d) Computer.

(e) Covers purchases of technical information, operating cost of computer, postage, fax and phone costs, general administrative support and contingencies.

MINISTÉRIO DO PLANEJAMENTO E ORÇAMENTO - MPO
SECRETARIA DE ASSUNTOS INTERNACIONAIS - SEAIN

Ofício nº 223 /SEAIN/MPO

Brasília, 22 de maio de 1995.

Senhor Representante Residente,

Temos a satisfação de informar a Vossa Senhoria que esta SEAIN concorda com o mérito do projeto "Hidrogênio Eletrolítico para Uso Combustível Limpo no Transporte de Massas no Brasil", o qual se enquadra nas prioridades do Governo brasileiro. Solicitamos os bons ofícios de Vossa Senhoria no sentido de iniciar o processo de obtenção de recursos do Global Environment Facility - GEF, sob forma de doação.

Atenciosamente,

ROBERTO JAGUARIBE
Secretário de Assuntos Internacionais

Ao Senhor
CESAR AUGUSTO MIQUEL
Representante Residente do PNUD no Brasil