Global Environment Facility

GEF

MOHAMED T. EL-ASHRY
CHIEF EXECUTIVE OFFICER
AND CHAIRMAN

March 16, 2000

Dear Council Member:

I am writing to notify you that we have today posted on GEF's website, a medium-sized project proposal entitled *Global: Fuel Bus and Distributed Power Generation Market Prospects and Intervention Strategy Options*. The GEF will contribute $691,000 towards a total cost of $916,000.

This project supports a series of GEF-funded fuel cell projects that are underway or are currently under development. The project's objective is to review the climate change mitigation potential from fuel cell applications in distributed electricity generation and urban buses and develop strategy options for market intervention. This review and the strategies can serve as a reference outlook on fuel cell market prospects to facilitate GEF decision-making on projects in this technology area and provide publicly available information for national policy makers.

The proposal is being posted for your information. We would welcome any comments you may wish to provide by April 5, 2000, in accordance with the procedures approved by the Council.

If you do not have access to the Web, you may request the local field office of UNDP or the World Bank to down load the document for you. Alternatively, you may request a copy of the document from the Secretariat. If you make such request, please confirm for us your current mailing address.

Sincerely,

for Mohamed T. El-Ashry
Chief Executive Officer and Chairman

Cc: Alternates, Implementing Agencies, STAP

United Nations Environment Programme

برنامج الأمم المتحدة للبيئة • 联合国环境规划署

PROGRAMME DES NATIONS UNIES POUR L'ENVIRONNEMENT • PROGRAMA DE LAS NACIONES UNIDAS PARA EL MEDIO AMBIENTE

ПРОГРАММА ОРГАНИЗАЦИИ ОБЪЕДИНЕННЫХ НАЦИЙ ПО ОКРУЖАЮЩЕЙ СРЕДЕ

UNEP

GEF COORDINATION OFFICE

P.O. Box 30552, Nairobi, Kenya • Tel: [254 2] 624165 • Fax: [254 2] 624041 •

E-mail: • Http: www.unep.org/unep/gef/

TELEFAX TRANSMISSION

To :	Ken King Assistant CEO GEF Secretariate 202 522 3240 Attn: Programme Coordination	Date : February 28, 2000
Copy :	Raphael Asenjo Executive Coordinator UNDP/GEF 212 906 6998 Lars Vidaeus Executive Coordinator The World Bank 202 522 3256 Madhav Gadgil Chairperson STAP 91 80 334 1683 Tahar Hadj-Sadok UNFCCC	
From:	Ahmed Djoghlaf Executive Coordinator UNEP/ GEF Nairobi	Mark Zimsky Officer-in charge

Subject: Fuel Cell Bus and Distributed Power Generation Market Prospects and Intervention Strategy Options

Attached please find this MSP proposal for your consideration. If at all possible, comments should be sent within one week in order to allow the project to provide information as early as the GEF Council meeting in May. Otherwise, the 15 working day response period would be until March March 20, 2000.

Please note that the Implementing Agency fee is 146,000 $US.

Thank you for your consideration and comments.

Medium-sized Project Brief

<table>
<tr><td colspan="2">Project Identifiers</td></tr>
<tr><td>1.Project name:
Fuel Cell Bus and Distributed Power Generation Market Prospects and Intervention Strategy Options</td><td>2. GEF Implementing Agency:
UNEP</td></tr>
<tr><td>3.Country/ies in which the project is being implemented:
Global</td><td>4. Country eligibility:
General country interest has been expressed and GEF focal point project endorsements received for fuel cell projects from several countries. This global study will focus on GEF eligible country opportunities.</td></tr>
<tr><td>5. GEF Focal Area:
Climate Change</td><td>6. Operational Programme/short-term measure:
OP 7: Reducing the Long-term Costs of Low Greenhouse Gas-emitting Energy Technologies and
OP 11: Promoting Environmentally Sustainable Transport.</td></tr>
<tr><td colspan="2">7. Project linkage to national priorities, action plans and programmes:
This project supports a series of GEF-funded fuel cell projects underway or in development. Brazil, India, China, Egypt and Mexico have endorsed projects that are in development. This demonstrates a country level interest in fuel cell technologies. Transportation, rural electrification, and industrialization are common national priorities in developing countries. This project will examine global market trends, national priorities, policies, and plans and suggest where fuel cell market interventions could be beneficial in the future. The following key information will assist in decision making by parties at national and international levels.
• What are the market prospects for fuel cells based on potential bus and power generation applications opportunities?
• How fast could the cost of fuel cells technologies fall with increasing production volume?
• What GEF intervention strategies would be justifiable to expedite the utilisation of fuel cells thereby gaining the global benefits accrued by this market acceleration
• Is there an approach that to the intervention that will more likely lead to success? What are the components of the strategy? Partial risk underwriting? Market aggregation? Coordination of support through a consortium of funding agencies?</td></tr>
<tr><td colspan="2">8. GEF national operational focal point and date of country endorsement: not requested.</td></tr>
<tr><td colspan="2">Project Objectives and Activities</td></tr>
<tr><td>9. Project rationale and objectives:
The objective is to review the climate change mitigation potential from fuel cell applications in distributed electricity generation and urban buses and develop strategy options for market intervention. This review and the strategies can serve as a reference outlook on fuel cell market prospects to facilitate GEF decision-making on projects in this technology area and provide publicly available information for national policy makers.</td><td>Indicators:
Fuel cell bus and distributed power generation projects fill an appropriate role in climate change mitigation activities. Specific new proposed GEF operations are developed where cost-effective, complementary and demand-driven.</td></tr>
<tr><td>10. Project outcomes:
Information is developed supporting policy</td><td>Indicators:
Acceptance by the scientific and technical</td></tr>
</table>

decisions by the GEF and national agencies to include fuel cell projects in their mitigation strategies.	community of a role for these fuel cell technologies and development of fuel cell market interventions
11. Planned activities to achieve outcomes: 1. Fuel Cell Bus Technology Review 1.1 Hold a Workshop on Fuel Cell Buses (FCB) in Developing Countries 1.2 Perform an expert review of FCB technology and global market development scenarios 1.3 Define and evaluate options for GEF intervention and national policies that would support FCB market development 2. Forecast Market Prospects for Fuel Cell Distributed Power Generation (FCDPG) 2.1 Determine the Projected Time Frame for Commercial Availability of Fuel Cells for Stationary Applications 2.2 Determine the Expected Cost Reduction Profile Over Time 2.3 Develop an Estimate of the Aggregate Incremental Cost Resources Required to Move Promising Fuel Cell Technologies Down the Cost Curve 2.4 Evaluate the Financing Modalities to Support Projects of an Aggregate Size that would make it Attractive to Industry 3.1 FCDPG Global Market Assessment 3.2 Assessment of the Policy Climate for FCDPG 3.3 Fuel Cell Distributed Power Generation Workshop 4. Consolidate the FCB and FCDPG Analyses	Indicators: A series of published reports will be made available describing the results of the workshops and interim activities. 1.1 Workshop on Fuel Cell Buses in Developing Countries proceedings 1.3 Report on FCB market intervention strategies 2.1 Report on a Time Frame 2.2 Report on Cost Reduction Profile 2.3 Report on the Estimated Incremental Costs and Resources Required 2.4 Report on Options for GEF Intervention 3.3 FCDPG Workshop Proceedings and report on the Market and Policies. 4. Final report: FCB and FCDPG Market Prospects and Intervention Strategy Options
12. Estimated budget (in US$ or local currency): PDF: 0 GEF: 691 k Co-financing: 225 k Total: 916 k	
13. Information on project proposer: UNEP, Imperial College, IFC, UNDP have jointly proposed this project. www.unep.org www.huxley.ic.ac.uk/research/epmg/general/contents.htm www.undp.org www.ifc.org	
14. Information on proposed executing agency: UNDP will execute Task 1 of the project.(170 + 60 k$ cofunding) IFC will execute Task 2 of the project. (319k$ + 105 k$ cofunding)	

Imperial College will execute Task 3 of the project and will consolidate all work into a final report under Task 4 of the project. (202k$+ 60 k$cofunding)
15. Date of initial submission of project concept: January/2000
16. Project Identification number: tba
17. Implementing Agency contact person: Ahmed Djoghlaf, Executive Coordinator, UNEP/GEF Nairobi
Project linkage to Implementing Agency programs: UNEP helps meet strategic information needs requiring targeted research or specific technical assessments. The global outlook of this study is well suited to UNEP's comparative advantage in performing global assessments supporting the GEF Secretariat and Implementing Agencies in the development of intervention strategy options and facilitating deployment of climate change mitigation options.

Project Description

Fuel cells are a low-emission technology that electro-chemically convert a variety of fossil and bio-fuels or hydrogen into electricity and are suitable for transportation and modular distributed generation applications. Fuel cells are a key technology for the attainment of broad hydrogen energy systems deployment, which is seen as a long term solution to environmental problems including CC and general air pollution especially from transportation. "Fuelled with pure hydrogen, [*fuel cells*] produce zero emissions of carbon dioxide, oxides of nitrogen or any other pollutant. Even if fuelled with fossil fuels as a source of hydrogen, noxious emissions are orders of magnitude below those for conventional equipment. They offer significant improvements in energy efficiency as they remove the intermediate step of combustion and mechanical devices such as turbines and pistons. Unlike conventional systems, they operate at high efficiency at part load. Also, unlike conventional plants, their high efficiency is not compromised by small sizes. High efficiency saves fuel and reduces CO_2 emissions".[1]

Fuel cells have been in common use for very specialized applications such as space vehicles but it is evidence that this technology is approaching much broader market viability in competition with conventional energy conversion technologies. In distributed power generation applications fuelled by natural gas, net savings to the consumer on energy services of 15% are projected. Dual energy supply grids can be avoided which is most important for dispersed energy loads.

At the12th Meeting of STAP in Washington, DC 16 June 1998, it was recommended that "The GEF should help accelerate the commercialization of H_2 fuel cells and enabling technologies (e.g., H_2 storage technologies) for transportation and CHP markets in developing countries, by supporting demonstration projects and strategies for "buying down" the prices of demonstrated technologies to market-clearing levels. Demonstration projects should focus on applications that are especially relevant to developing countries.

What is needed to break down these barriers to full-scale deployment is an initial market of sufficient scale to justify the investments in further development of fuel cell engines and in the scaling-up of production which will bring them to acceptable levels of cost and

[1] World Fuel Cell Council

reliability. Since most of the infrastructure is in place already in the OECD countries, developing countries and countries with economies in transition are where most of the potential market and global benefit achievement potential exists. Transportation systems in developing countries need significant expansion to accommodate their population and economic development. Light rail and other transport facilities are already in place in developed countries. The relative immaturity of the energy sector in developing countries, also provides important entry points for reliable, distributed generation energy solutions. The size of these markets in stationary fuel cells serve as a significant market pull for the manufacturers' long term, cost-competitive strategies. A combined strategy for the fuel cell bus and distributed power generation markets will take advantage of synergistic technology developments. Stationary applications will reach their size and production cost targets earlier than transport. In most countries, transport represents a more difficult to avoid and larger fossil fuel consumption. The investment by industry in manufacturing facilities that achieve significant economies of scale will not occur as quickly without significant GEF intervention. This would suggest that due to the focus on GEF eligible countries and the global benefits of fuel cell technologies, GEF support to a high percentage of the initial fuel cell production may be justifiable.

Working in concert with the private sector, GEF initiatives could provide the fuel cell industry with an incentive to gear up for sufficient production to decrease prices to where they have broad energy market competitiveness. A production of about 50MW worth of stationary fuel cell units has been proposed by IFC as a significant market launching order to penetrate the premium power and distribution support markets. The potential market targeted by the IFC initiative would represent 300-400 early commercial applications or 3-4 times the existing Phosphoric Acid Fuel Cell installations. This means that, assuming no other major intervention, the initiative could be responsible for more than 75% of the new fuel cell capacity installed globally. FCB industry projections indicate that market competitive production levels for FCBs (piggybacking on the car market) will be reached at a cumulative production level of approximately 2,000 fuel cell buses. Five major cities are developing FCB projects with the UNDP. Ninety percent of new transportation infrastructure development is suggested to exist in GEF eligible countries.

The total market launching production for fuel cells in all applications is on the order of 10 GW. Early markets for FCB and premium FCDPG applications is on the order of 0.5 GW. Emphasis on FCBs market interventions is likely appropriate due to the space and weight constraints in this application and as well as the need for drive train components and associated engineering. The transportation sector also offers large global benefits in GHG emissions reductions. FCBs hold the potential to provide the most environmentally friendly solution for independent (non-rail, portable electric) mass urban transport.

The barrier to Fuel Cell market development is a lack of price competitiveness due to high production costs at low market volume. Similar to photovoltaic solar panels, this technology holds significant potential for CC mitigation as a market competitive technology if incremental initial production costs are funded through multilateral or bilateral intervention. The first market niche is for those who are willing to pay a premium for higher quality independent power such as hospitals or computer installations. Just what share the fuel cell technologies ultimately achieve also depends on the deployment rate and costs of other mitigation technologies. In some cases these developments will be

synergistic for transport especially. In the longer term, hydrogen production from wind, solar or hydro sources of electricity could be used in FCBs replacing diesel-powered buses. Fossil-derived H2 (especially from natural gas) will be much cheaper than the electrolytic sources in the near term. The CO_2 benefits are not as substantial with fossil H2 as with renewable H2, but there are still CO_2 emissions reductions compared to diesel buses due to higher efficiency of fuel cell engine and lower carbon primary energy source (natural gas vs. oil). Fuel cells for distributed electricity power generation can provide a complementary power source or even a storage mechanism for wind, solar or hydro generation. General energy efficiency strategies are compatible with fuel cells technologies. The outcome of future developments cannot be determined but a broad review of mitigation strategies needs to be performed. The target production levels for a viable FCB and FCDPG market launch should be reviewed and GEF's role in their achievement developed.

Project Rationale and Objectives

Strategy options need to be developed for fuel cell applications. Most of the critical information on the price trajectory and supporting future cost-effectiveness is proprietary and the majority of future deployment opportunities are in GEF eligible countries. What share of the future cost benefits and domestic benefits could occur in developing countries and the magnitude of global benefits needs to be further examined. A number of Fuel Cell Projects are in the pipeline and being developed for GEF funding. These include a number of Fuel Cell Buses (FCB) projects through the UNDP and Fuel Cell Distributed Power Generation (FCDPG) projects through the IFC. There is some controversy over the prospects for a market viable technology amongst other mitigation strategies in transportation and distributed power generation. The STAP Technical Review of the Brazil - Hydrogen Fuel Cell Buses for Urban Transport the reviewer states that "much depends on the assumption that the returns to scale and technological "learning" provided by large-scale production eventually will make the lifecycle cost of fuel-cell buses (FCBs) close to that of diesel buses" and "the GEF needs to continually re-evaluate the long-term potential of this transportation pathway". Similar issues apply to the fuel cell market in general.

To address these concerns, a study is proposed to examine the market prospects and recommend GEF intervention strategies. The objective is to review the climate change mitigation potential from fuel cell applications in distributed electricity generation and urban transport and develop strategy options for market interventions supporting early achievement of lower-cost higher-volume production. This review and the strategies can serve as a reference outlook on fuel cell market intervention to facilitate GEF decisions on projects in this technology area and provide publicly available information for national policy makers as well. This will be a cooperative effort bringing together UNEP, UNDP, IFC, GEF and industry experts to develop information supporting policy decisions by GEF and national governments in this technology area.

Current Baseline Activities in Fuel Cell Market Assessment

Fuel cell development is being supported primarily by national agencies and the private sector. Beyond the early adopters in niche markets that justify a premium cost, the larger

long term energy/service supply commodity market for fuel cells dictates that much of the development is in cost engineering the product for maximum competitiveness. This represents a large private sector and national R&D investment. "In the last four years (1994-1998), the EC funding allocated to fuel cells amounted to 54.9 M$, covering R&D activities and demonstration. Together with the national and industrial … programs, the budget allocated to fuel cell development since 1995 amounts *to* approximately 80 M$/year."[2] This figure does not include the Canadian, American or Japanese effort. The international joint venture based on Canadian developed technology Daimler-Chrysler/Ford/Ballard alone has invested was $1 billion through 1999 in fuel cell R&D and commercialization with another $1.5 allocated for through to 2004, their target date for commercialization. The baseline activity in bringing fuel cell technology to market is large. Bringing the benefits of this technology to developing countries is the subject of the fuel cell projects in development for GEF consideration. This market prospects study will provide broad background context for the projects and illustrate strategies that could be chosen. Operational Program #7 guidance calls for "targeted research on cost reduction curves; on integrating information on country resource endowment with cost-effectiveness of potential applications; on the present and prospective readiness; on potential costs and benefits of selected technologies and adaptation to local conditions;" Fuel cell technologies are in need of this kind of analysis. In particular, examining GEF's possible intervention strategies and having an estimate of possible implications for the duration of GEF support is needed.

A complementary project is being executed by the Canadian International Development Agency and the World Bank to develop and disseminate information on the advantages and possible applications of fuel cells. This type of basic technical information illustrative of practical applications and how they could work will by very useful companion information especially to national and project level decision makers.

Expected Project Outcomes

This project is proposed as a means of integrating existing and previously developed public and proprietary information on fuel cell market prospects into a reference global outlook to support GEF and national policy decisions. Through a process involving stakeholder consultation, intervention options can be established that support outcomes in the form of policy decisions supporting fuel cell technology market development. Potentially this assessment could lead to the formation of a coordinated international strategy to expedited fuel cell deployment through a multilateral consortium or linked/staged actions sustaining growth in the market and providing an environment conducive to increasing investment in fuel cell technology production facilities. The study will provide the executing agencies with an articulation of the significant benefits of implementing any program that may be proposed. These significant consequences would include, but not be limited to, acceleration and expansion of the developing country market, the quantification of the importance of the GEF-eligible market for the short and long term commercialization strategy of the private sector, and the volume-price sensitivities of the fuel cell technology if the GEF-eligible countries are fully participatory in the short

[2] Gilles Lequeux, Non Nuclear Programmes, European Commission DG XVII

and mid term commercialization plans by the private sector.

Activities

Outputs

A series of published reports will be made available describing the results of the workshops and interim activities (by task number).

UNDP:
Workshop on fuel cell buses in developing countries proceedings (1.1)
Report on FCB market intervention strategies (1.3)
IFC:
Report on a time frame (2.1)
Report on cost reduction profile (2.2)
Report on the estimated incremental cost (2.3)
Report on options for GEF intervention (2.4)
Imperial College:
FCDPG workshop proceedings and report. (3.3)
Final report on combined FCB and FCDPG market prospects (4.0)

Tasks

Task 1. Fuel Cell Bus Technology Review (UNDP)

Task 1.1 Hold a Workshop on Fuel Cell Buses in Developing Countries

Through presentations and discussion the workshop will develop an understanding of the role and niches for FCBs relative to other GHG mitigation strategies in urban transport, review the status of the development of fuel cell buses (FCB's) and the associated fuel-supply options, review the prospects for FCB technologies achieving commercial viability over the medium to long-term; and identify strategies for accelerating the commercialization of FCBs, with special focus on GEF's role in transferring the technology to developing countries. The workshop will pull together information from about 1 M$ of project development funded activities in 5 developing countries. A report on the workshop will be produced with interim conclusions suitable for immediate use and areas for further analysis during the project.

Task 1.2 Perform an expert review of FCB technology development scenarios

Using expertise from Europe, North America, and Japan, existing literature and market projections should be reviewed and consolidated into a consistent set of projections. The results of project development in 5 developing countries will be combined to form this global outlook.

Task 1.3 Define options for GEF intervention and national policies that would support

FCB market development.

Prepare a report summarizing FCB development scenarios and intervention options.

Task 2. Develop Market Prospects for Fuel Cells in Stationary Applications (IFC)

Task 2.1 Determine the Projected Time Frame for Commercial Availability of Fuel Cells for Stationary Applications

Task 2.1.1 Document and summarize the demonstration and early commercialization experiences of the fuel cell technology. Prepare a summary of the Demonstration & Early Commercialization Experiences.

Task 2.1.2 Review relevant multi- and bi- lateral programs that provide background for assessing options for FCDPG. This would include but not be limited to the Fuel Cells in the 5th Framework Programme of the EU, NEDO as a part of MITI in Japan, the U.S. Department of Defense, and Department of Energy fuel cell demonstration programs, ad PVMTI. Report based on this review including lessons learnt.

Task 2.1.3 Detailed reports on the current and planned commercialization schedule and teaming of international fuel cell companies or joint ventures will be prepared and information provided for use in other tasks.

Task 2.1.4 Develop a summary report and graphics that indicate the forecasted market prospects for stationary fuel cell applications with particular focus on GEF eligible countries. This would include prospects by region, by product size (kW) fuel availability, fuel quality, and other information.

Task 2.1.5 Identify the Existing Policy Support for Distributed Generation, and in Particular Fuel Cells, at Electric Utilities within GEF-Eligible Countries. Identify through interviews with project developers and the literature as to which governments and domestic utilities in the GEF-eligible countries are most supportive of distributed generation and in particular fuel cells. A summary report shall be prepared on the countries and domestic utilities in GEF-eligible countries that have indicated either directly or indirectly an interest in distributed generation and in particular fuel cells. The non-confidential version of this information will be used as relevant input to Task 3.2.

Task 2.2 Determine the Expected Cost Reduction Profile Over Time

Task 2.2.1 Capital Cost and Operation and Maintenance Cost Reduction Trajectories Determine the long term capital and O&M cost reduction potential for stationary fuel cell technologies. Determine the sensitivities to volume, timing and magnitude of innovation as well as the need for concessional financing. A summary report shall establish the rank order and relative importance of the key variables in the reduction of capital and O&M costs of fuel cell systems in order to reach economic

parity with prevailing rates and tariffs for delivered energy. The report shall include the overlapping influence of transportation applications of fuel cells to achieving the volume, performance and cost goals for stationary applications. It is anticipated that technology price reductions will be directly attributable to fuel cell initiatives, and there will be successful examples of market development that will continue to be important in translating future price reductions into greater long-term market penetration. Based upon these findings, the report shall determine the likely market penetration rate of fuel cell technologies for stationary applications and apply the findings to the Gantt chart in Task 2.3.

Task 2.3 Develop Estimates of the Aggregate Incremental Cost of Resources Required to Move Promising Fuel Cell Technologies Down the Cost Curve

Task 2.3.1 Estimate Total Cost/ Resources Required to Accelerate Cost Reduction. High, Low and Medium Scenarios to be developed with relevant input coming from concurrent Task 3.1.

The early adoption in premium markets will be the primary target of these projections. The follow-on, broader market penetration will also be considered. Multiple scenarios are to accommodate variability in the information and provide an indication of the sensitivity of the results to changes.

Task 2.3.2 Provide Intervention Options for multilateral agencies in this Overall Picture and the Cost Effectiveness of Potential Global Benefits over the Long Term

Based upon the findings in all of the previous subtasks, determine an estimate of the likely share of GEF resources that would be required to establish sustainability and the time horizon required to achieve a continuous reduction in the costs of fuel cell technology. A summary report of the total GEF resources that would be required as a function of time in order to establish sustainability of the fuel cell technology.

Task 2.3.3 Perform an Economic Analysis of Avoided and Incremental Costs

An economic analysis will estimate a representative distributed generation end users' avoided economic cost for delivered energy and calculates the economic incremental costs compared with the least cost fossil alternative (as per GEF guidelines). This will help form the basis for the economic justification for use of GEF funds consistent with GEF's Operational Strategy and OP 7.

Task 2.4 Evaluate Preferable Financing Modalities to Support Projects of an Aggregate Size that would make it Attractive to Industry

Task 2.4.1 Examine Types of Financing

Determine the most appropriate types of financing that would mobilize a sufficient amount of private capital to accelerate the market penetration of fuel cell technology for premium applications in developing countries. Also examine the amount of financing to reduce the cost to a level generally competitive with other technologies. A summary report will identify the most appropriate type of

financing that would mobilize the greatest amount of private capital and accelerate the market penetration of fuel cell technology. The report will evaluate the effectiveness of GEF funding in terms of MW's installed, the total avoided emissions and the average $/kW of subsidy provided with GEF funds.

Task 2.4.2 Private Sector Role in Sharing Risk in GEF Program Countries

Obtain from international fuel cell industry their interest and willingness to share risk either through extended warranty, O&M agreements, project co-investment or other instruments. Compile and report the current risk sharing instruments envisioned by the fuel cell industry. Propose where improvements and expansion should be recommended. A summary report on the risk sharing instruments currently envisioned by the fuel cell industry and make recommendations on improvements.

Task 3 Fuel Cell Stationary Applications Assessment (Imperial College)

Task 3.1 Global Market Assessment

Perform a global top-down market assessment with focus on GEF program countries for distributed and stationary power applications of fuel cells. Bottom up information outlining the near term planned or potential projects will be available via IFC's interviews of relevant industry players, but the larger picture will be developed by this task. Global outlook for electricity generation and projected energy source mix information from other studies needs to be examined and reconciled with the bottom up projections. Global fuel availability and purity should also be gathered to complement more country specific information from Task 2. (relevant input coming from Task 2.1.3 and relevant output going to task 2.3)

Task 3.2 Assessment of the Policy Climate

Assess the policy climate in main GEF program country markets (identified in the task above) -- this will set the stage for a short-list of countries for the first projects and study in more detail later. Information from interviewing relevant industry players will be fed to this task where the macro country- based evaluations would be done. Interviews with developing country energy agencies and country studies and interviews with World Bank and Regional Development Bank personnel will assist in developing this information (relevant IFC input coming from Task 2.1.4). A questionnaire to workshop participants would augment this information.

Task 3.3 Workshop on FCs for Stationary Power Generation

In this workshop, the outputs of 2, 3.1 and 3.2 are discussed including the non-confidential components of the IFC study. Obtain broader input and comment on Fuel Cell market prospects for Stationary Applications through a Workshop and interviews. Multilateral agencies will be asked to comment on trends in enabling policy development in various countries and regions. The Workshop will be used to increase confidence that the strategies and targets are appropriate. The policy environment outlook developed here will be merged with the FC project developer's views in the final report. A summary report of the meeting and the

results of Task 3 will be produced.

Task 4 Consolidate the FCB and FCDPG Analyses (Imperial College)

The sub-analyses on these two technologies will be consolidated into one final report with an overall summary, a discussion of synergies between the technologies and an overview of national and multilateral policy environment and intervention strategy options.

Incremental Cost Assessment

The incremental activity as needed by GEF, their national partners and other financial investors and to support their decision making is small relative to the total baseline activity in Fuel Cell development. The ultimate benefits of this technology are expected to be skewed towards GEF countries. If we consider that a total of 400 MW of fuel cell investments may be directly influenced by this assessment and that this assessment improves that investment by only two percent the GHG emissions benefit would be on the order of 5 to 10 \$/t CO_2. This assumes an average saving of about 6.5 $ktCO_2$ per MW (at 1/3 capacity) over a 20-year period. Approximately 100 g/kwh emissions reduction is achieved by substituting fuel cell combined heat and power for diesel.[3] Although many installations will not use combined heat and power, a larger fraction of installations will use renewable energy sources making this a useful mean value estimate.
The potential global benefits in mitigation by FCBs have been estimated by the UNDP as follows:

"The carbon emissions reductions from replacing all diesel buses in developing countries in, say, 2025 with fuel cell buses operating on hydrogen produced from natural gas would be some 440 million tons of CO_2 per year. (This assumes that the number of buses per capita in Brazil today and the fuel economy and annual mileage of Brazilian buses are representative of the average in developing countries in 2025. With this assumption, there would be 6.75 million buses in developing countries in 2025, diesel-bus emissions avoided would be 131 tCO_2 per bus-year, and emissions associated with hydrogen fuel cell buses would be 66 tCO_2 per bus-year)."

The impact of FCDPG will be highly variable depending on the application and due to the wide variety of energy sources. For natural gas, internal combustion engine generators have efficiencies of 25 to 40% and micro turbines 20 to 30%, whereas fuel cells are 40 to 60%. Co-generation of heat and electricity can raise the overall efficiencies of these technologies but in the warmer climates of most developing countries, the uses for heat are less. CO_2 emissions from natural gas source distributed power generation could be cut by one third to one half by substitution of this technology. If biofuels are used displacing diesel, the CO_2 emissions reductions are the same as for other renewable energies but since this technology is more efficient, reliance on the ecosystem to produce the biofuels would be reduced. These global benefit estimates are subjects of this study.

Implementation

[3] Ausilio Bauen, E4Tech

UNEP, UNDP, IFC and Imperial college will cooperatively implement and execute this project. The timing and responsiveness of the project are important to all the Agencies.

A delicate balance has been structured between the interest of the private sector involved in fuel cell technology and deployment with that of the Agencies' interest to obtain an objective and accurate analysis of the challenges and opportunities for fuel cells in distributed power. Therefore, the consultants selected will be individuals that are fuel cell experts and involved in impartial, private sector due diligence analyses and Governmental studies. The consultants interaction with the 20+ fuel cell development teams will be extensive, and it is anticipated that a substantial amount of expensive market and cost data will be provided to the study, without compensation. Additionally the private sector will be providing a significant amount of human resources for the the interviews and review of the various drafts, where appropriate. In summary, the unique information and human resources being offered by the private sector to the WB consultants will elevate the accuracy and sophistication of the analysis without the tainting of the appearance of the study should the private sector provide co-funding.

Budget

Tasks	Consultant effort[1]	Travel[1]	Communication, equipment, meeting costs	GEF Total	Co-funding	Total (GEF + cofunding)
1.1 Hold a Workshop on Fuel Cell Buses in Developing Countries	30	50	6	86	60[2]	146k$
1.2 Perform an expert review of FCB technology development scenarios	53	4	1	58		58k$
1.3 Define options for GEF intervention and national policies that would support FCB market development	22	3	1	26		26k$
UNDP Task 1 subtotal	105	57	8	170	60	230k$
2.1 Projected Time Frame for Commercial Availability of FC in Stationary App's	90	21	3	114	33[3]	147k$
2.2 Determine the Cost Reduction Profile Over Time	93	3	1	97	30[3]	127k$
2.3 Estimate Aggregate Incremental Costs	40	3	3	46	25[3]	71k$
2.4 Evaluation of Financing Modalities	53	6	3	62	17[3]	79k$
IFC Task 2 subtotal:	276	33	10	319	105	424k$
3.1 Global market assessment for distributed power generation	30	4	0	34		34k$
3.2 Assessment of the policy climate regarding power generation	25	0		25		25k$
3.3 Fuel Cell DPG Workshop	30	65	5	100	50[4]	150k$
4. Consolidate the FCB and FCDPG Analyses	30	7	6	43	10[5]	53k$
IC Task 3 and 4 subtotal	115	76	11	202	60	262k$
Total	485k$	170k$	29k$	691K$	225k$	916k$[6]

[1] not including effort and travel costs incurred against co-funding
[2] confirmed private sector cost estimate for participation in the workshop,
[3] estimated private sector participant contribution,
[4] unconfirmed private sector contribution (50k$), European cash funding also possible
[5] dissemination through CIDA/ World Bank fuel cell information project
[6] not including the 1 M$ spent on the UNDP country studies

Implementation Plan

Timing in Months after PDF/B approval (March)

Meetings and Tasks	M	A	M	J	J	A	S	O	N
1.1 Hold a Workshop on Fuel Cell Buses in Developing Countries (report)									
1.2 Perform an expert review of FCB technology development scenarios									
1.3 Define options for GEF intervention and national policies that would support FCB market development (report including 1.2)									
2.1 Projected Time Frame for Commercial Availability of FC in Stationary Applications									
2.2 Determine the Cost Reduction Profile Over Time									
2.3 Estimate Aggregate Incremental Costs									
2.4 Evaluation of Financing Modalities									
3.1Global market assessment for distributed power generation									
3.2 Assessment of the policy climate regarding power generation									
3.3 Fuel Cell DPG Workshop (report including 3.1, 3.2)									
4. Consolidate the FCB and FCDPG Analyses (Final report on all tasks)									

Public Involvement Plan

Key stakeholders in project implementation will be governments, especially urban transportation planners and energy planning departments in GEF eligible countries. Technology manufacturers and project developers are also key to the assessment of this market. Workshops are planned to obtain input from these key stakeholders. Their contribution will be solicited through the workshops with a focus on how they see this technology fitting into their national transportation development plans.

A complementary Canadian International Development Agency/World Bank project will be used as a conduit for dissemination of some of the reports. The policy information from this project will augment the technical awareness raising efforts of the CIDA/WB effort.

Monitoring and Evaluation Plan

The monitoring and evaluation will be performed directly by a steering committee including UNEP, UNDP, IFC, and GEF Secretariat. The acceptance of the findings of the study will be the primary indicator as judged through the acceptance of the report in the scientific and economic communities and future consideration of FC GEF project proposals.

Logical Framework/Project Planning Matrix:

Project Strategy	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Reducing the Long-term Costs of Low Greenhouse Gas-emitting Energy Technologies and Promoting Environmentally Sustainable Transport	Market transformations achieving commercialization	Market surveys	The price of fossil fuel which excludes environmental costs, does not lure investment away from these technologies.
Facilitation of Specific new proposed GEF operations where Cost-effective, complementary and demand-driven.	The level of effort directed to market interventions	The number and size of GEF planned and initiated projects in FCB and FCDPG.	Competing technologies and fuel cell technologies develop as foreseen at the time of the project execution
Activities 1.1 Hold a Workshop on Fuel Cell Buses in Developing Countries	**Output** 1.1 Opinion and review of current state of the art technology and opportunities in major developing country cities in a workshop report.		
1.2 Perform an expert review of FCB technology development scenarios	1.2 An integrated global market prospect including the UNDP country studies and expert reviews for Japan, N. America, and Europe in the a task 1 report on FCB market		
1.3 Define options for GEF intervention and national policies that would support FCB market development	1.3 Results of interviews and literature search on policy environment with intervention strategies to obtain sustainable global benefits in a task 1 report		Cooperation of national and multi lateral agencies
2.1 Projected Time Frame for Commercial Availability of FC in Stationary App's	2.1 Summarised interviews with FC suppliers		
2.2 Determine the Cost Reduction Profile Over Time	2.2 Normalised or averaged information on FC technology developments and cost projections		Proprietary information can be accessed and normalised or averaged so as to be useful
2.3 Estimate Aggregate Incremental Costs	2.3 The aggregate incremental cost of a fuel cell market intervention		
2.4 Evaluation of Financing Modalities	2.4 A report on optional financing mechanisms for market interventions		
3.1 Global market assessment for distributed power generation	3.1 A top-down market assessment including total projected market potential and estimates of possible market share.		
3.2 Assessment of the policy climate regarding power generation	3.2 Interviews and information gathered from multilateral and bilateral agencies		
3.3 Fuel Cell DPG Workshop	3.3 A report on the workshop detailing industry and developing country experts' advice and comments		

4. Consolidate the FCB and FCDPG Analyses	4. An integrated report including possible synergies between FCB and FCDPG market interventions	Market projections and sufficiently accurate to enable development of market intervention strategies

Appendix: **Background**

General Information on Fuel Cell Technology can be found at www.FuelCell.org or at www.FuelCellWorld.com .

Distributed Power Generation (IFC)

Fuel cells are a low-emission technology that electro-chemically convert a variety of fossil and bio-fuels into electricity and are suitable for modular distributed generation applications. Fuel cells for stationary power have an unrealized potential for significant price reductions due to the mass production implications and the synergistic R&D being undertaken for the transportation sector.[4]

Opportunities to advance fuel cells are larger in several GEF-eligible recipient countries than in OECD countries due to their projected high growth in energy demand, and the relative immaturity of the energy sector which provides superior entry points for reliable, distributed generation energy solutions. Proposed IFC initiatives are intended to be a strategic intervention to accelerate the sustainable commercial adoption of fuel cell technology for stationary power requirements in GEF-eligible recipient countries – in line with GEF OP 7 and STAP guidance.

The demand for premium (consistent frequency and voltage) and reliable distributed generation is relatively price inelastic in developing countries (compared with developed countries), and therefore, represents a larger, nearer term market. For developing countries (that are not likely to see fuel cell cars in the foreseeable future), fuel cells for stationary power can be a key technology to pioneer, while also enabling competition with less efficient micro-turbines. The initial markets for fuel cells are likely to be those that (1) place high economic value upon the premium quality and reliability of the power delivered (e.g., micro-electronics manufacturers); and (2) need support for power and distribution system demands within polluted air basins.

Based on industry's estimates, the commercial cost and size targets for using fuel cells in transportation are 5-7 years from being reached. For a viable fuel cell-powered vehicle, the price target for fuel cells in the transportation sector is about $50/kW. The distributed generation market will benefit en route to this goal being achieved because stationary power applications are much less price sensitive and much less demanding in weight and spatial requirements. Stationary power fuel cell technology is already in an advanced prototype and field testing stage and is expected to be commercially available from several vendors in the next two years.

[4] Significant resources are currently being expended on research, development and commercialization of fuel cell technology in OECD countries for use in the transportation sector. There is an impressive list of international companies and joint ventures that are now in the early stages of commercializing fuel cells for stationary power applications, and the leaders of these teams include Ballard, Siemens-Westinghouse, General Electric, Toshiba, United Technologies, Shell International, Allied Signal and a number of small entrepreneurial firms in North America, Europe, and Japan.

Industry currently estimates that commercial stationary power fuel cell products (ranging from residential units of under 3kW to larger models of 250 kW will be available in 2001-2002 and in the cost range of $1,800-3,400/kW.[5] According to industry estimates, with sufficient economies of scales (created by industry's investment in production facilities based on firm demand), total installed costs are likely to be $1,200-1,400/kW within 2-3 years and $600-1,200/kW within 5-6 years after that. The cost reduction trajectory for fuel cell technologies will be substantiated by this independent cost reduction study to be undertaken prior to submitting projects for approval by GEF Council.

While several major corporations are focusing their research on the transportation sector and realize that size and cost targets for stationary power will be achieved earlier, the investment by industry in manufacturing facilities that achieve significant economies of scale is unlikely without significant GEF intervention. Working in concert with the private sector, proposed future initiatives would provide the fuel cell industry with an incentive to gear up for production of about 50MW worth of fuel cell units – a significant market launching order to penetrate the premium power and distribution support markets. The potential market targeted would represent 300-400 early commercial applications or 3-4 times the existing PAFC installations. This means that, assuming no other major intervention, the initiative could be responsible for more than 75% of the new fuel cell capacity installed globally.

Fuel cells will most likely be available in two size ranges – under 10 kW for residential applications and 100-350 kW for commercial and light industrial applications. However, even combining modular fuel cell units, all individual fuel-cell projects are expected to be in the sub-MW range. Given the transaction costs associated with such sub-MW projects, it is likely that these individual distributed generation projects will be aggregated. This could either be done by energy service companies through who the financing (commercial and GEF) can be provided or by other routes that will be more fully explored during pre-appraisal.

While the exact modalities of providing financing remain to be determined, GEF funds could be used to make selected concessional investments in private sector fuel cell projects in three regions. The countries could be selected using, among other factors, the basis of the host country government's interest and stated national development priorities, an enabling environment (power sector reform allowing for distributed generation projects with grid interconnect), availability of appropriate fuel, the spark spread (difference in electricity and gas prices), and the size of the aggregated market (including potential for sustainable replication beyond the proposed initiatives). Policy and market barriers/ incentives will be addressed in this study. Two examples in Thailand and Mexico had two different approaches to incentives but both had a high degree of success. Thailand had a price incentive for serving the distributed generation/remote electric market in order to

[5] Although one product (a phosphoric-acid fuel cell [PAFC] from one vendor) is currently 'commercially available' at a cost of about $4000/kW, this product is marketed primarily to the market for which subsidy is provided by the U.S. Department of Defense. Developments and investments in other competing technologies (proton-exchange membrane [PEM], molten carbonate (MCFC) and solid oxide [SOFC]) have over-taken PAFC and the projected cost reductions are expected to be steeper.

provide service to the difficult-to-serve. Mexico had a de-regulation incentive of exempting self-generators under 30 MWe from federal permitting regulation. ESMAP did a ten country comparative study of incentives and policies for renewable energy for China as the client. The results of that study would be partially applicable to fuel cells in the distributed generation applications. For the US, there is an existing project with the US DOE to examine market barriers/incentives for fuel cells at the state level, and some of the work would be applicable.

GEF financing could target incremental cost and risk reduction using a variety of appropriate grant and non-grant financing modalities including, but not limited to, guarantees for mitigating commercial risk; equity or quasi-equity participation; contingent loans; or extended terms/reduced interest rates on commercial loans (including those from IFC). While GEF funds could underwrite some of the commercial risk, the primary technical and operating risks will be borne by those best able to control and mitigate them – the technology manufacturers/providers. Return to GEF funds is likely under these approaches. In addition, capital cost buy-downs to offset the significantly higher incremental costs of fuel cells (compared to a baseline alternative) are also likely to be a reasonable intervention

Project opportunities will be identifed for strategic impact on reducing long-term cost of 'back stopping' low GHG emitting technologies in a manner consistent with GEF policy and the objectives of OP #7. Criteria will include the assessment of the proposed financial innovation, degree of financial leverage, likelihood of sustainability and replicability on a commercial basis and the expected level of market growth.

This study will develop a strategy for GEF interventions for Fuel Cell technologies consistent with the programmatic objectives of OP 7 and OP 11.The proposed assessment will effectively provide a strategy for the market launch for commercial use of fuel cells in developing countries and should identify potential long-term cost reductions for fuel cells used in stationary power applications (a low GHG-emitting technology that has been recommended by STAP for GEF intervention under OP 7). The potential cost reductions will be estimated and the time frame in which the reduced cost would be achieved. Additional GEF support for fuel cells in stationary power applications may be able to then shift to projects targeting barrier removal in some countries/regions that are not part of the initial projects. However, these later projects will be able to build on the successful examples of market development that will emerge and will continue to be important in translating future price reductions into greater long-term market penetration. Scenarios will be developed with indicators of performance.

Fuel Cell Buses (UNDP)

Several FCB projects are in development by the UNDP. The projects are intended to pave the way for fuel cell buses to be commercially produced and provide experience and increased demand for the fuel cell buses. They are intended to contribute to cost-reductions, making the technology more available to other developing countries over the long run. The projects are designed to be consistent with the terms of both GEF Operational Program 11.

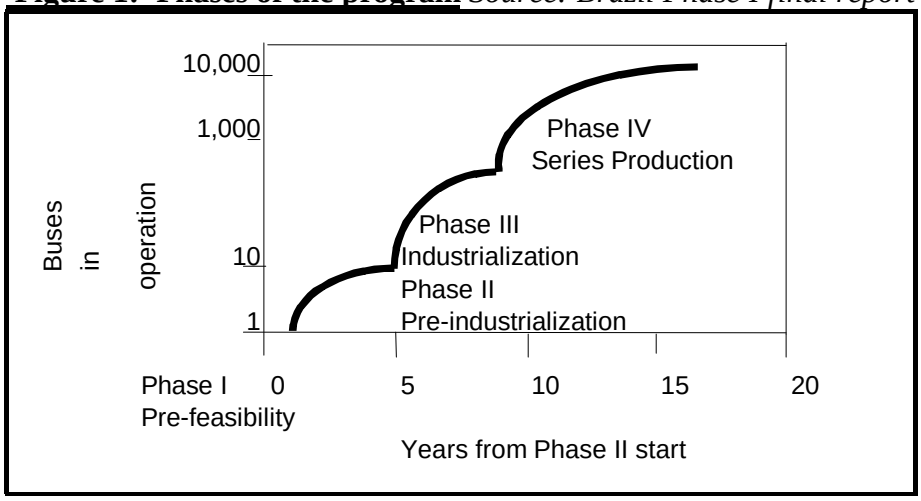
Detailed comparisons of full life cycle costs show that hydrogen fuel cell buses, once they have achieved their series-production cost and durability targets, will be cheaper than trolley-buses and within 30% of the cost of diesel buses (see Brazilin Urban Transport Fuel Cell Buses - Phase I final report). These calculations include the full costs of energy provision. They are also made on a conservative basis for the hydrogen fuel cell buses, which means that their true costs will most likely turn out to be lower. Conversely, the considerable environmental costs of diesel buses have not been factored into their life-cycle costs, which would show an even better economic advantage of fuel cell vehicles. It is worth noting that hydrogen buses will be economically competitive if their useful life is comparable to the trolley-buses - say 20 years to compensate for the higher investment. This is also of interest to enhance bus comfort and other quality items, which are mandatory to attract car users to public transport.

As stated in the UNDP proposal there are major barriers to be overcome before the large-scale deployment of fuel cell buses becomes the cost-competitive option of choice for urban bus fleets in developing countries:

- The gap between the costs of current prototype hydrogen fuel cell buses and those of conventional diesel buses is still considerable - over US$ 2 million versus US$ 250,000 for buses designed to North American specifications. Almost all of this difference is attributable to the higher costs of the drive-line, especially the fuel cell engine, which is still not made in series production;
- A similar gap in the durability of the fuel cell stacks, which are the electricity generating heart of the engine – 4,000 hours at present versus a normal expectation of 30,000 hours before major overhaul for a diesel engine;
- The absence, to date, of a sufficient fleet of buses operated over a long enough period of time for thorough de-bugging of the drive-line technology and for setting standards and guidelines for updating its design to achieve the cost reduction and durability improvement objectives;
- The lack of large-scale experience of operating, fuelling, maintaining and repairing hydrogen fuel cell buses; and
- The lack of public awareness of and support for the new technology.

What is needed to break down these barriers to full-scale deployment is an initial market of sufficient scale to justify the investments in further development of fuel cell engines and in the scaling-up of production which will bring them to acceptable levels of cost and reliability. Industry projections indicate that these levels will be reached at a cumulative production level of approximately 2,000 buses. This target level should be reviewed and GEF’s role in the achievement of a viable FCB market developed. Since most of the infrastructure is in place already in the OECD countries, developing countries and countries with economies in transition are where most of the potential market exists. This would suggest that due to the focus on GEF eligible countries and the global benefits of fuel cell technologies, GEF support to a high percentage of the initial 2000 FCBs produced may be justifiable.

Figure 1: Phases of the program *Source: Brazil Phase I final report*



UNDP FCB Projects:

Hydrogen Fuel Cell Buses for Urban Transport
Brazil
This project is designed to stimulate the development and utilization of fuel cell buses by supporting a significant operational test of fuel cell buses in the greater São Paulo Metropolitan Area. It will assist the Brazilian Government and the Empresa Metropolitana de Transportes Urbanos de São Paulo S/A in obtaining and operating 10 fuel cell buses in order to provide feedback to the technology developers and to gain meaningful experience in the operation and management of buses powered by fuel cell drive trains. Sustainability will be ensured through the building up of national/regional capabilities, which will continue well after the involvement of GEF. It is anticipated that GEF support through either IFC or the World Bank will be required beyond support for the project proposed in this document for achievement of the programmatic goals of the initiative. UNDP FP

Fuel Cell Bus Development in India
India
The project consists of two phases. Phase 1, the proposal for which is described in this document will involve completing assessments of the tatus and prospects for commercialisation of hydrogen fuel cell bus technology, potential hydrogen resource supplies, and refueling and infrastructure networks in India. Phase 1 will culminate in the preparation of a proposal to the GEF for hydrogen fuel cell bus demonstration commercialisation activities. The Phase II project that will be designed to contribute significantly toward achieving the long-term objective of reducing the costs of fuel cell buses to near-competitive levels in India. UNDP PDF/B 03/1998 $0.3

Fuel Cell Bus Demonstration
Mexico
Full-scale project will promote the application of hydrogen fuel cell bus technology, facilitate its commercialization by means of viable demonstrations, and assist in the reduction of manufacturing, production and operational costs to commercially competitive levels. PDF B activities will include detailed assessment and definition of most promising

fuel cell bus technology and most cost-effective fuel supply option. UNDP PDF/B 08/1998 $0.35

Integrated System for Zero or Reduced Emission Fuel Cell Bus Operation in Cairo
Egypt
The project is expected to have a demonstration component where a number of 205 kw PEM fuel cell driven buses would be put in operation in Cairo public transportation routes for demonstration and training (including maintenance training) purposes. Local technicians and drivers will be trained in bus/fuel cell maintenance, operation and refueling issues. A substantial institutional and policy component will be an integral part of the project, thereby facilitating and ensuring the commercialization of the technology in the Egyptian context. UNDP PDF/B 08/1998 $0.32

Demonstration for Fuel Cell Bus Commercialization in China
China
This project intends to run parallel demonstrations of small fleets of FCBs in Beijing and in Shanghai. There will also be a heavy element of training and capacity building within the institutions responsible for urban bus transportation policy, planning, and implementation. The original development of this project was supported by UNDP (through SEED, Project No. CPR/96/313).

WORKSHOP:

FUEL CELL BUSES IN DEVELOPING COUNTRIES:
THE POTENTIAL ROLE FOR GEF

To Be Held at *UN Headquarters, New York City*
April 27-28, 2000

OBJECTIVES:

1. To gain an understanding of the role and niches for FCBs relative to other GHG mitigation strategies in mass urban transport.
2. To review the status of the development of fuel cell buses (FCB's) and the associated fuel-supply options;
3 To review the prospects for FCB technologies achieving commercial viability over the medium to long-term; and
4. To identify strategies for accelerating the commercialization of FCBs, with special focus on GEF's role in transferring the technology to developing countries.

PROPOSED AGENDA

Day 1: Fuel Cell Buses and Their Commercialization

1. Welcome and Introduction: GEF's Interest in Fuel-Cell Buses in Developing Countries (*9-10:10*)
   1.1. Welcome to GEF Sponsored Workshop (15 min)
   1.2. GEF's Operational Strategy and Support for Fuel Cells (20)
   1.3. Overview of GHG mitigation options for urban transport, clean diesel, biofuels, electric trolleys, light rail *Mark DeLucchi (25)*
   1.4. Overview of the Agenda (10 min)

2. Overview of fuel cell programs and activities (*25* minute talks, 10:10-12:40)
   Global overview for FCBs(J. Ogden , Princeton or Reinhold Worster, LudwigBolkow Systemtechnik)
   2.1. California Fuel Cell Initiative (A. Lloyd or T. Cachette, CARB)
   (15 minute coffee break)
   2.2. Chicago bus demonstration (C. Lang, CTA)
   2.3. Vancouver bus demonstration (C. Lythgo, BCT)
   2.4. Discussion (*40* minutes)

Lunch (12:40– 2:00)

3. Industrial progress in fuel cell engine development (2 – 4:30)
   3.1. Ballard – 25
   3.2. Denora – 25
   3.3. IFC – 25
   3.4. Plug power – 25
   3.5. Siemens – 25
   3.6. Toyota – 25

(15 min. Coffee break)

4. Review prospects for FCB technology achieving commercial viability (4:45 – 5:30)
   4.1. DTI, C. Thomas – 20
   4.2. Princeton, E. Larson – 20

5. Fuel supplier industry perspectives (5:30 – 6)
   5.1. Shell Hydrogen – 15
   5.2. Texaco Global Power Systems – 15

Day 2: GEF, Fuel Cell Buses and Developing Countries

1. ***Criteria for best initial niche markets – 25*** (9-9:25)

2. UNDP GEF demonstration projects in planning (9:25-10:40)
   India – 15
   Mexico –15
   Egypt – 15
   China – 15
   Brazil – 15
3. Other potential market opportunities for FCBs –20 (10:40-11:00)

Break (11:00 – 11:20)

4. Discussion: Toward a Strategy for Accelerating FCB Commercialization (11:20 – 12:30)
   R. Hosier and A. Lloyd (?)

5. Summary and Conclusions (12:30 – 1:00)

PROPOSED BUDGET

As envisioned above, the workshop would comprise a period of one and one half days, in New York City. The primary costs of the workshop would be for travel and subsistence for developing country participants; honoraria, travel and subsistence for consultants making presentations; lunch for the entire group; and travel and subsistence for public sector presenters unable to meet the costs of participation from their own budget. In addition, the cost of one consultant and one support staff member for 3 months to make arrangements for the workshop are included. An estimated budget is presented in the table below:

Proposed Budget

Cost Item	**Basis of Calculation**	**Total Amount (US$)**
Consultant Fees + Organization Support Person	60 days * 500/day	30,000
Travel, DSA of Presenters	11 * 2000	22,000
Travel & DSA of Developing Country Participants (Karekezi of STAP, Brazil, China, Egypt, India and Mexico)	6 * ($3500 + 5*$250 DSA)	28,500
Lunch	(65 participants @ $20)	1,300
Proceedings		4,200
Total		86,000

In-Kind Contribution of Industry Participants (estimated)

Cost Item	**Basis of Calculation**	**Total Amount (US$)**
Travel & DSA of Industry Participants	(20 * 2000)	40,000
Industry Participants' time	(10 * 2000)	20,000
Total		60,000

POSSIBLE PARTICIPANTS LIST

General Transport issues and GHG mitigation
Steven Karakesi, STAP
Brian Williams, UNCHS Habitat
WB, RDBs

Status of technologies and demo projects, analysis of long-term economics
- California Air Resources Board[6]
  - Alan Lloyd, Chairman
  - Tom Cackette, Deputy Executive Director
- Direct Technologies, Inc.[7]
  - Sandy Thomas, Vice President Enegy & Environment
- Princeton University[8]
  - Eric Larson
  - Joan Ogden
- Bechtel International Inc.
  - T.P. Chen
- UC Davis, Institute of Transportation Studies
  - Mark Delucchi

[6] F.R. Kalhammer, P.R. Prokopius, V.P. Roan, G.E. Voecks, *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, CA, July 1998.
[7] F.D. Lomax, Jr., B.D. James, G.N. Baum, and C.E. Thomas, *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 1998.
[8] R. Hosier and E.D. Larson, *GEF Participation in Fuel Cell Bus Commercialization*, January 1999 (revised for workshop).

FCB user experience
- British Columbia Transit
  - Chris Lythgo, Vice President for Technology
- Chicago Transit Authority
  - Craig Lang, Vice President for Technology

Fuel cell suppliers
- Ballard (Neil Otto)
- Denora (?)
- IFC (Al Meyers)
- Plug power (Jeff Chen, contact)
- Seimens (Albert Hammerschmidt)
- Toyota (?)

Bus OEMs
- MAN (?)
- Mercedes Benz Brasil (?)
- Neoplan (Stuttgart) (?)
- Skoda, Joseph Stauder (CEO, Skoda Canada)
- Volvo (?)

Fuel suppliers
- Shell Hydrogen, Don Hubberts
- Texaco Global Power Systems, Graham Batchelor
- Air Products and Chemicals, Venke Raman (hydrogen group)
- Praxair (?)

GEF FCB projects
- Brazil, Francesco Christovam (EMTU, responsible for new technology), or Gabriel Branco
- China, Liu Bao Gui (General Manager, Beijing Public Transport Co.) or Ge Zhengze (Chief Engineer, Science and Technology, Beijing Public Transport Co.)
- Egypt (?)
- India (?)
- Mexico, Oscar Diaz (Managing Director, STE)

The ***FCDPG workshop*** will follow a similar format. A similar proportion of private sector participation (contribution in kind) can be anticipated. A further possible contribution from the European Commission or a similar agency may allow expansion of the number of participants (especially developing country power generation experts or authorities having jurisdiction over electricity supply). This further contribution was not included in the proposal but the possibility will be developed during execution.

Cost Item	**Basis of Calculation**	**Total Amount (US$)**
Consultant Fees + Organization Support Person	60 days * 500/day	30,000
Travel, DSA of Presenters	5 * $2500	12,500
Travel & DSA of Developing Country Participants	13*$4000	52,000
Lunch		1,300
Proceedings		4,200
Total		100,000

In-Kind Contribution of Industry Participants (estimated)

Cost Item	Basis of Calculation	Total Amount (US$)
Travel & DSA of Industry Participants	(20 * 2000)	40,000
Industry Participants' time	(10 * 2000)	20,000
Total		60,000