Environmental Strategy for Energy:
Hydrogen Fuel Cell Bus for Brazil
TRANSPORT IN THE METROPOLITAN REGIONS

STATE GOVERNMENT

SECRETARIAT OF METROPOLITAN TRANSPORTS

CPTM - Trains

METRÔ - Subway

EMTU - Buses/ Medium

EMPLASA - Planning
SÃO PAULO METROPOLITAN REGIONS

SPMR

BSMR

CMR
SÃO PAULO METROPOLITAN REGION - SPMR

GEOGRAPHIC ASPECTS
• Area: 8,051 km²
• 39 Municipalities
• 7 Zones
• 0.1% of Brazilian area
• 4% of State of São Paulo area

ECONOMIC ASPECTS
• G.D.P.: US$ 147 billion
• 18.5% of Brazilian GDP
• 50% of State of São Paulo GDP

DEMOGRAPHIC ASPECTS
• 17.2 millions of inhabitants
• 10.5% of Brazilian population
• 61% of SPMR population live in the São Paulo City

Fonte: Emplasa - Agosto 97/99
<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>COMPANY</th>
<th>FLEET</th>
</tr>
</thead>
<tbody>
<tr>
<td>METROPOLITAN CORRIDOR</td>
<td>EMTU</td>
<td>195</td>
</tr>
<tr>
<td>CHARTER SYSTEM</td>
<td>EMTU</td>
<td>5.947</td>
</tr>
<tr>
<td>REGULAR SYSTEM</td>
<td>EMTU</td>
<td>4.137</td>
</tr>
<tr>
<td>AIRPORT SYSTEM</td>
<td>EMTU</td>
<td>21</td>
</tr>
<tr>
<td><strong>TOTAL UNDER EMTU RESPONSIBILITY</strong></td>
<td></td>
<td><strong>10.300</strong></td>
</tr>
<tr>
<td>MUNICIPAL BUS</td>
<td>SP TRANS</td>
<td>11.300</td>
</tr>
<tr>
<td>MUNICIPAL BUS RMSP+RMBS</td>
<td>OTHER</td>
<td>3.400</td>
</tr>
<tr>
<td><strong>TOTAL METROPOLITAN AREA RMSP + RMBS</strong></td>
<td></td>
<td><strong>25.000</strong></td>
</tr>
<tr>
<td>OTHER METROP. AREAS IN BRAZIL</td>
<td></td>
<td><strong>29.000</strong></td>
</tr>
<tr>
<td><strong>TOTAL ESTIMATE BRAZIL</strong></td>
<td></td>
<td><strong>120.000</strong></td>
</tr>
</tbody>
</table>

Source: EMTU, SPTrans e Operators 1998
EMTU SUPPORT

EMTU projects that will support the market for fuel cell buses and other advanced bus technologies in Brazil, under new concession’s contracts

• Environmental policy:
  New rules with incentives to private operators replace diesel buses for environmentally friendly technologies

• System Improvements:
  Construction of new terminals and fully or partly-reserved lanes
METROPOLITAN CORRIDOR - SPMR

EXTENSION: 33km in operation

UNDER CONSTRUCTION: 11km

ELECTRICAL EXTENSION: 22 km
METROPOLITAN CORRIDOR - SPMR

PASSENGERS: 6.0 MILLION/MONTH

FLEET: 195 BUSES

LINES: 10

TERMINALS: 9
Feasibility for hydrogen production, fuelling of buses and maintenance of the fuel cell buses
TECHNOLOGIES ALREADY TESTED BY EMTU

- NATURAL GAS - 1992
  Mercedes-Benz (Brazil)

- ETHANOL - 1997
  Scania (Sweden)
THE PROJECT:

• Demonstrate functionality and reliability of fuel cell buses and their fuelling infrastructure, under real operating conditions in the São Paulo Metropolitan Region

• Develop fuel cell buses based on Brazilian chassis and body designs
HYDROGEN FUEL CELL BUS FOR BRAZIL

STRATEGIC OBJECTIVES:

• Aimed to accelerate the commercialization of fuel cell buses which can use hydrogen from renewable resources (hydropower, ethanol, sugarcane tops/leaves)

• Reducing emission of pollutants
MILESTONES TOWARD FUEL CELLS COMMERCIALIZATION

• Demonstration program to be developed at highly competitive transport applications (bus corridors), where high investments are viable and incentives may be welcome.

• A successful demonstration program shall result in a complete fuel cell bus specification for local applications.

• Pilot programs may follow demonstration program, considering the implementation of model garages to operate only with fuel cell buses.

• Fuel cell cars, to be produced for polluted cities, shall play important role in fuel cell mass production and consequent cost reduction.
Phase I
- Pre-feasibility study and proposal of entry strategy
- Prepare a proposal to GEF - Global Environment Facility for hydrogen fuel cell bus demonstration
- Phase already concluded
**Phase II** (from 2001 to 2006)
- Demonstration project (08 fuel cell buses)
- To advance bus technologies along a cost-reduction curve to reach commercially viable level
- Development of manufacturing capabilities in Brazil
- Acquire experience in hydrogen handling

**Phase III**
- Scale up a facility for 200 buses operating from a single garage

**Phase IV**
- Commercial and industrial roll out
THE BIDDING PROCESS

Basic Bidding Requirements for Phase II

• Only one supplier or consortium will be responsible for all equipment and buses
• Supplier will be responsible for training, technical support, maintenance and parts replacement during the whole Phase II
• Supplier must share project costs to benefit from project data and results
• The Bidding Process will follow the UNDP proceedings
FUEL SUPPLY SYSTEM OPTIONS

- Compressed hydrogen is best suitable than liquid reforming for urban buses, since their operation is centralized in a few garages

- **Purchasing hydrogen from third parties:**
  ⇒ three times more expensive than water electrolysis, in Brazil
  ⇒ higher potential for contamination (problem risks to fuel cells)
  ⇒ hydrogen available is obtained from non-renewable resources, in Brazil

- **Producing hydrogen from ethanol/biomass reforming:**
  ⇒ technology is still under development
  ⇒ fuel technology development is not the main purpose of EMTU programs

- **Water electrolysis:**
  ⇒ renewable hydroelectric power is available in Brazil (92% of electricity)
  ⇒ well known technology is available
  ⇒ contaminant-free hydrogen
  ⇒ competitive fuel costs
### IMPORTANT FACTS

#### Economic
- Brazil is an emergent economy
- Buses play a major role in urban transportation in Brazil—95%
- Brazil is the world largest bus market
- Brazil is also world largest bus manufacturer - 19,000/year
- Bus fleet in São Paulo Metropolitan Region (SPMR) is the largest concentration in the world

#### Environmental
- São Paulo has one of the world’s worst air pollution problems
- Motor vehicles are responsible for 90% of pollutants released to the atmosphere
- Most buses are powered by diesel engines (96%)
- There are several potential hydrogen sources for fuel cell buses in Brazil
FUEL CELL BUSES

WHAT SIZE IS THE BRAZILIAN MARKET?

• An estimated 10% (2,500 buses) of the metropolitan bus fleet operates in fully or partly reserved lanes

• This part of the market has already used advanced buses (Padron-modern European designs, articulated and trolley buses)

• In this part, higher capital cost is accepted in return for longer operating life

• Estimated market of at least 500 modern vehicles/year during next 10 years

• This is the most promising market for Fuel Cell Buses