

Environmental Strategy for Energy: Hydrogen Fuel Cell Bus for Brazil

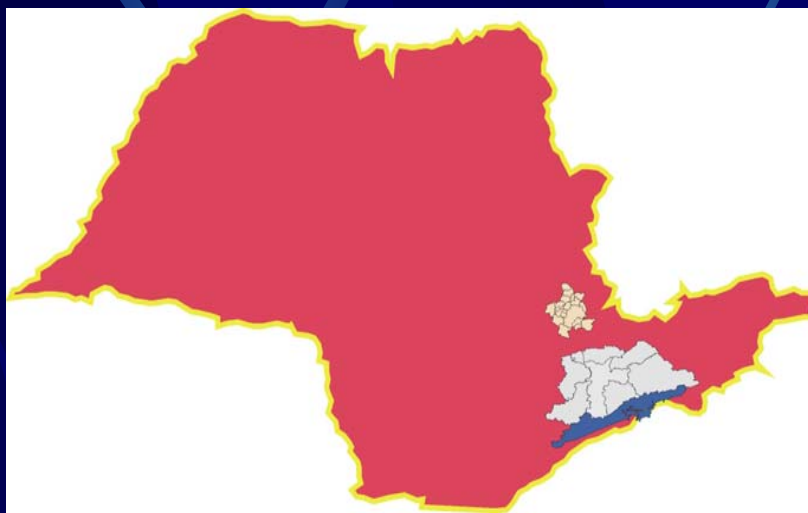
TRANSPORT IN THE METROPOLITAN REGIONS



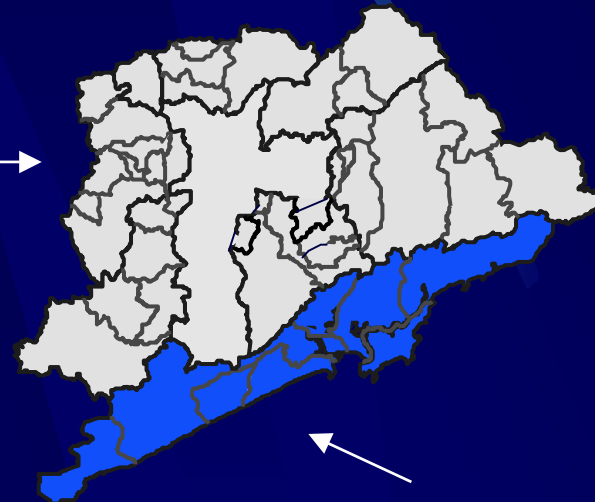
SÃO PAULO METROPOLITAN REGIONS

EMTU

METROPOLITANO



SPMR



CMR



BSMR



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

URBAN BUS FLEET

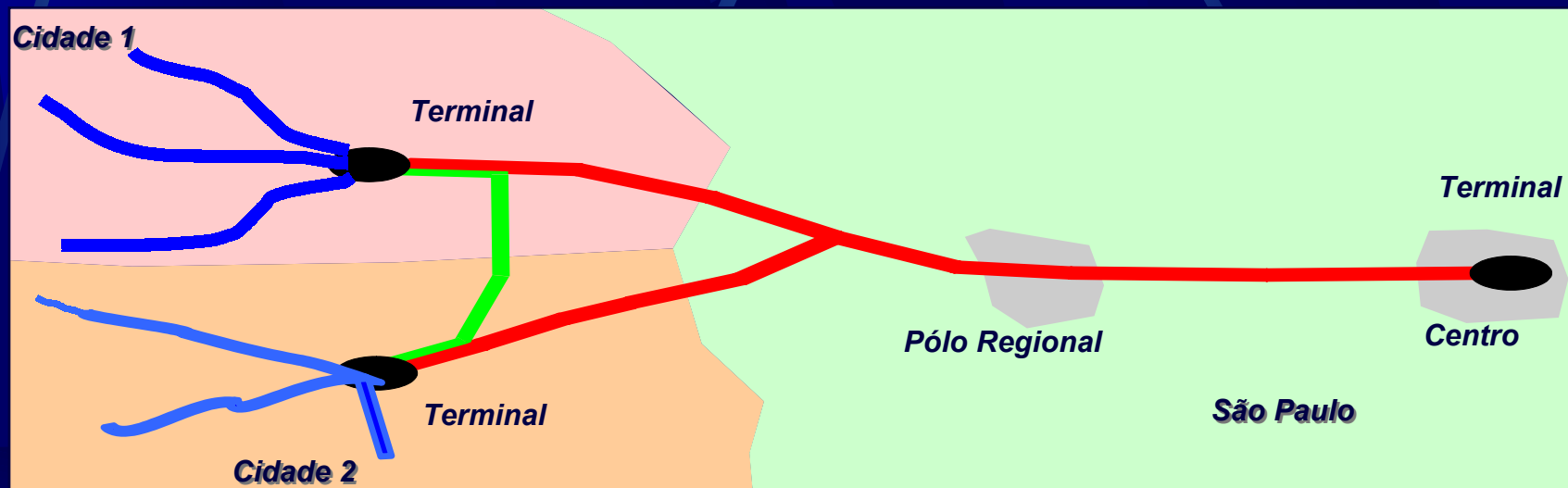
SYSTEM	COMPANY	FLEET
METROPOLITAN CORRIDOR	EMTU	195
CHARTER SYSTEM	EMTU	5.947
REGULAR SYSTEM	EMTU	4.137
AIRPORT SYSTEM	EMTU	21
TOTAL UNDER EMTU RESPONSIBILITY		10.300
MUNICIPAL BUS	SP TRANS	11.300
MUNICIPAL BUS RMSP+RMBS	OTHER	3.400
TOTAL METROPOLITAN AREA RMSP + RMBS		25.000
OTHER METROP. AREAS IN BRAZIL		29.000
TOTAL ESTIMATE BRAZIL		120.000

Source : EMTU, SPTrans e Operators 1998

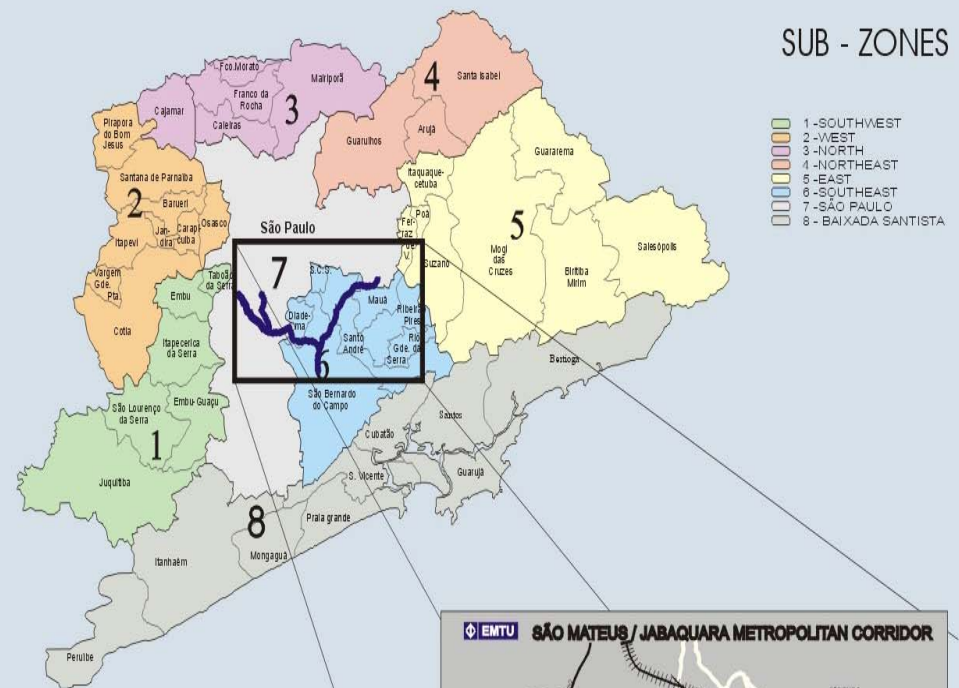
EMTU SUPPORT

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

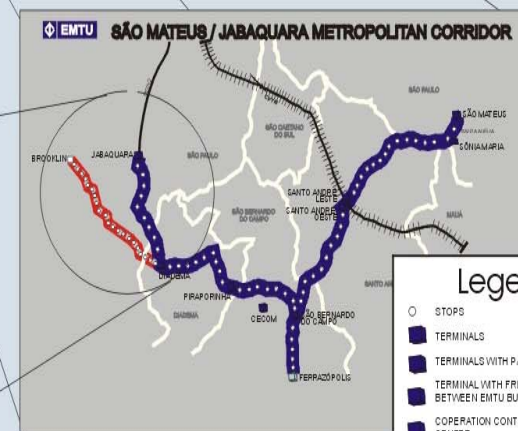
- *Environmental policy:*
New rules with incentives to private operators replace diesel buses for environmentally friendly technologies
- *System Improvements:*
Construction of new terminals and fully or partly-reserved lanes



METROPOLITAN CORRIDOR - SPMR



FUTURE DIADEMA / BROOKLIN METROPOLITAN CORRIDOR



Legend

- STOPS
- TERMINALS
- TERMINALS WITH PAID AREA
- TERMINAL WITH FREE TRANSFER BETWEEN EMTU BUS LINES
- COOPERATION CONTROL AND MAINTENANCE CENTER
- EXISTING METROPOLITAN CORRIDOR
- FUTURE METROPOLITAN CORRIDOR
- FUTURE TERMINAL

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



METROPOLITAN CORRIDOR INFRASTRUCTURE

Feasibility for hydrogen production, fuelling of buses and maintenance of the fuel cell buses



MAINTENANCE BUILDING



BUS PARKING AREA

TECHNOLOGIES ALREADY TESTED BY EMTU



NATURAL GAS - 1992
Mercedes-Benz (Brazil)



ETHANOL - 1997
Scania (Sweden)

HYDROGEN FUEL CELL BUS FOR BRAZIL

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:

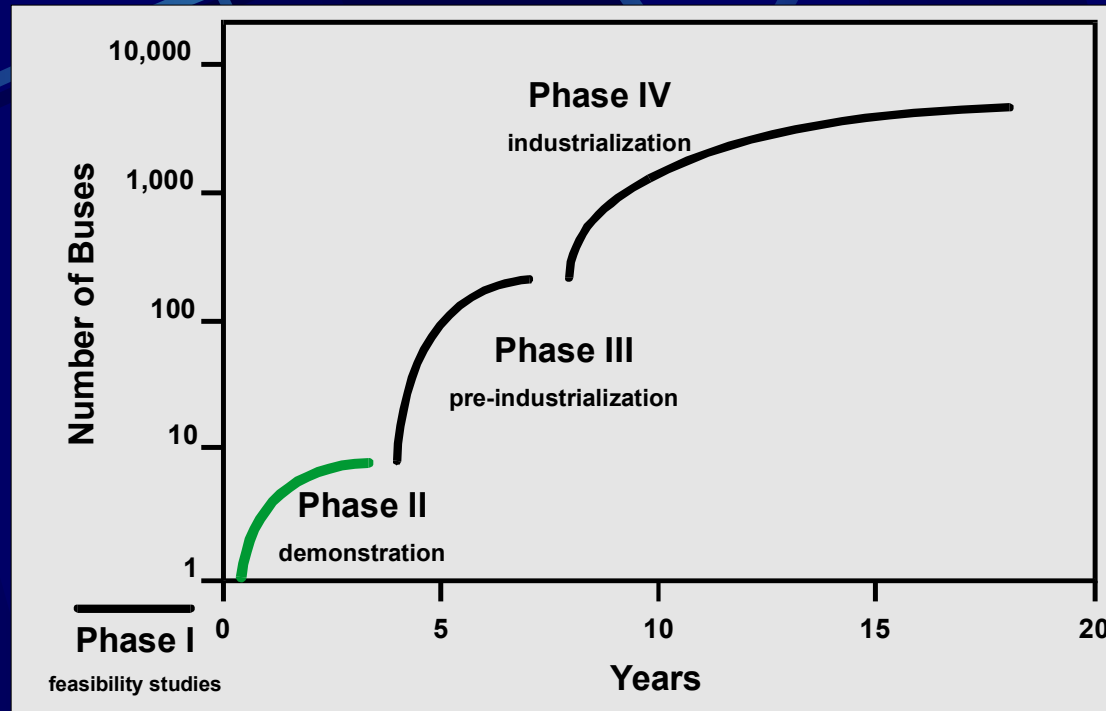
- Aimed to accelerate the commercialization of fuel cell buses which can use hydrogen from renewable resources (hydropower, ethanol, sugarcane tops/leaves)
- Reducing emission of pollutants

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

HYDROGEN FUEL CELL BUS PROGRAM

Expected Development Schedule



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

HYDROGEN FUEL CELL BUS PROGRAM

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



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**SÃO PAULO
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